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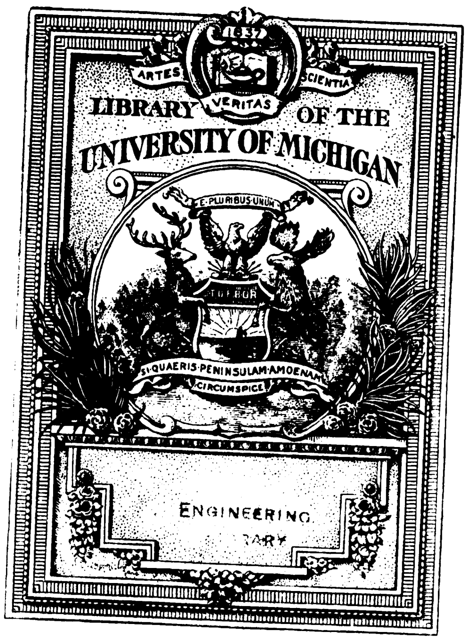
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THE ENGINEER.

JUNE.

The Sub-committee of the Leeds Corporation which recently visited the Continent with the object of studying railless electric trolley cars has reported favourably, and has recommended the adoption of a railless system between the city and Farnley. It is stated that the working expenses of the systems in vogue abroad come out at between 4½d. and 5¼d. per mile, but that the services fall below the standard expected in the neighbourhood of large English towns, and it is probable that the working expenses would be considerably higher in this country, especially when it is borne in mind that in most instances the cars on the Continent are "single-deckers" of limited seating capacity. All things considered, it would seem that, unless the installation of the trackless trolley cars is to be taken as the preliminary step towards an ultimate extension of an existing tramway system, the adoption of a light motor omnibus service offers greater advantages than the restricted form of transit of which many of our municipal authorities seem to be enamoured.

It will be remembered that when some months ago, as the result of a conference in Manchester between representatives of the Engineering Trades Employers' Federation of Manchester on the one hand, and the several trade unions of the workmen on the other, the men agreed to a reduction of one shilling per week on wages and 2½ per cent. on piece-work rates, it was decided that the subject of a further similar reduction should be again brought up for discussion in June, should there be no improvement in trade. Last week a joint conference was again held, and after full discussion it was decided to recommend as a compromise that the present rate of pay should remain undisturbed for a period of five years from July. This decision is now to be placed before the members of the Engineering Trades Employers' Federation of Manchester and the members of the trade unions. Assuming that the workpeople endorse their representatives' recommendation, they will have succeeded in resisting the masters' demand for an immediate reduction, while, on the other hand, the employers will derive some advantage from the fact that, if trade should improve, they will not be confronted with a request for increased pay and the possible dislocation of trade which the refusal to grant such a request might bring about. Altogether between 12,000 and 14,000 skilled workers are said to be affected by the decision.

Some interest is attached to the experiment of the White Star Line last week, when the Cedric, on her homeward passage, made a call at Holyhead to land passengers and mails before proceeding to Liverpool as usual. The chief object of the experiment seems to have been to shorten the journey to London, which it did in this case by about 3¼ hours, owing to the exceptional facilities which the London and North-Western Railway Company placed at the disposal of the London passengers. The distance between Holyhead and Euston is 264 miles, or 71½ miles further than Liverpool, and each of the special trains weighed 400 tons, yet the non-stop journey was covered in 4 hours 56 minutes—a speed of 53½ miles per hour. The gain in time by the landing at Holyhead might occasionally be greater than the above, owing to the difficulties encountered at the bar of the Mersey at certain states of the tide. Liverpool, however, need not be greatly disturbed for the present, at any rate, for the boats must proceed to this port to discharge their cargo and to dock.

The piercing of the great Beacon Hill tunnel, which constitutes the principal engineering feature of the Kowloon-Canton Railway, has just been completed, and it is announced that the line will be open for traffic in May next. The tunnel works were commenced in January, 1907, and the driving continued steadily until the two headings met in May last. The total length of the tunnel is 7212ft., and the whole of it, with the exception of a few hundred feet at the faces, is in hard granite rock. The completed tunnel is 21ft. high by 17ft. wide, but less than one-half of its length has been finished to these dimensions and brick lined; the original heading being 10ft. by 9ft. The maximum rate of progress of the headings from the two faces was 108ft. per week, and the greatest length of tunnel completed in one month 300ft. The cost of the Beacon Hill tunnel represents about one-third of the total expenditure on the British section of the Kowloon-Canton Railway, which has a length of 22 miles. The construction of the line has proved a costly undertaking; the original estimate of £455,000 has been exceeded by considerably over 100 per cent. It is now estimated that the total cost of the line will be upwards of one million sterling. In addition to the Beacon Hill tunnel there are four others on the line, the longest of which—that at Tai-po—is about 900ft. in length. All of them are nearing completion.

The carrying away of a lock gate at the Canadian ship canal around the rapids of the St. Mary's River on June 9th, converted the lock and canal into a great raceway, with Lake Superior as a reservoir. With two vessels in the lock and the upper gates open, an upbound steamer—through misunderstanding in the engine-room, apparently—rammed the lower gates, which were under 20ft. head of water. The gates were torn away, the three vessels were swept into the reach below the lock, and the canal became a roaring torrent. An emergency dam in the upper reach was finally closed a few days later, and repairs put under way. This dam consists of a swing bridge, pivoted on one bank, from one arm of which are suspended hinged panels, whilst the other arm acts as a counterweight. The bridge was swung across the canal and the panels lowered, so that their lower ends rested on the bottom. There are two locks on the American side of the river, so that traffic is not hampered. The Canadian canal is a little over a mile in length, and its lock is 900ft. by 60ft., with 22ft. of water on the sills. It was built in order that Canadian shipping might be independent of the American canal, and was opened in 1895. As to the peculiar type of movable emergency dam, it is of interest to note that a similar structure is provided at the American canal, and that a structure of the same type—but of improved design—has been adopted for use on the Panama Canal. For the same purpose, the Chicago Drainage Canal has a huge steel gate, like a lock gate, pivoted at the middle and lying normally in the axis of the channel. This is open to the objection of subdividing the channel, which would be specially objectionable in a navigable canal, although the Chicago canal is proposed for navigation at some future time.

An event of considerable importance to shipbuilders occurred on the 17th of the month, when the General Committee of Lloyd's Register of Shipping gave their final sanction to revised rules for the construction of steel vessels. The rules which are at present in force have been in existence for many years, so far as their essentials are concerned, and it has been the practice to embody in them the experience which the Society has gained by means of additions and amendments. In view, however, of the changes in design and construction which have taken place since the rules were first framed—changes which have, to a certain extent, rendered unnecessary some of the requirements then made—a thorough investigation of the entire subject was undertaken by the technical staff of the Society. After full discussion of the various questions involved, this scheme was approved as before stated, and the terms will shortly be published. The alterations effected are for the most part of a technical nature, and were discussed fully in our last issue. They are such as will bring within the scope of the rules, not only vessels of a larger size than are now provided for, but all modern types of cargo and passenger ships. The scantlings covered by the new rules will permit of a reduction in the weight of the hull materials as compared with the old, and the magnitude of this reduction may be roughly measured by the difference which at present exists between a spar deck and a three deck vessel of the same dimensions. Concurrently with these revised regulations the Committee have also approved the issue of a complete set of rules for ships intended to carry oil in bulk, setting forth in detail the requirements for this particular form of vessel. According to the constitution of Lloyd's Register, the amended rules will come into force six months after the date of the Committee's approval of them, but they can be made applicable to contracts placed now if desired by the shipowner.

The Labour Exchanges Bill was read for the second time on the 16th of the month without a division. The discussion was instructive in many respects. It showed that a good many of the Government members were far from satisfied with the Bill, either because it did not do enough or because it did too much. For example, Mr. Pickersgill regarded it with grave misgivings, because he believed the result would be that the casual labourer would find it more difficult than ever to get work; Mr. Pointer, a Labour member, welcomed it, but it did not to his mind go far enough—he wanted an eight hours day; Mr. Roberts, another Labour member, recognised that the Bill standing by itself was not going to do anything to solve the great problem of unemployment. He was a socialistic Oliver Twist, and wanted much more. Indeed, he desired to see all factories run by the State. Mr. Hutton, a Liberal member, did not understand how the Bill could be useful unless the exchanges saw to it that boys were put to trades when they left school. And so the debate went on, with some good and some bad arguments. The most interesting point in Mr. Churchill's reply to the various criticisms was that he proposed to extend the scope of the exchanges to the Colonies and advance the workman's fare if he wanted to go abroad. Colonial health trips at the Government expense are clearly likely to put our British labour exchanges far ahead of the German prototype.

A valuable and definite report on the vast project for making the Mississippi River a navigable waterway for ships of moderate draught has been submitted to the United States Congress by a board composed of officers of the United States Engineers. This engineer corps corresponds to the Royal Engineers, and is in charge of harbour works and the improvement of navigable waters. The board was specially instructed to consider the project from the commercial as well as the engineering aspect. In brief, its report is to the effect that the proposed 14ft. channel can be made and maintained, but that its cost would not be warranted—as a national investment—by even a most liberal estimate of the traffic or commerce it could develop. This is especially the case in view of the depth proposed. A 14ft. channel is unnecessarily deep for the craft used in ordinary inland navigation, and would be quite insufficient for ocean steamers or the larger class of steamers on the Great Lakes. For the work on the river between St. Louis and the Gulf of Mexico, about 800 miles long, the estimate is £26,000,000. The project, moreover, includes a waterway—part canal and part river—from the Mississippi to Lake Michigan. This additional distance of over 400 miles is estimated to cost £6,000,000, making a grand total of £32,000,000. The annual expense for maintaining such a waterway would be in the neighbourhood of £1,350,000. This has been one of the many projects urged within the past few years by the advocates of inland navigation, especially by politicians and enthusiastic but ill-informed persons. These have advocated it as being "a great thing for the country," which should be built regardless of such petty considerations as cost and value. Thus there has been much wild talk of the Mississippi River as a main highway for great ocean steamers, with Chicago and St. Louis ranking with Liverpool, Manchester, or Hamburg. On this brilliant but unsubstantial basis the Government have been urged to issue bonds for vast sums, the money to be provided first and the value of the investment to be considered afterwards.

EMPEROR FRANCIS JOSEPH formally opened on the 25th of the month the "Tauernbahn," a very interesting piece of mountain railway running from Schwarzach St. Veit, through the well-known "cure" resort Gastein, to Spittal in the Drau valley, a distance of 81 kiloms. In conjunction with three other new lines, the Karawanken, Wocheiner, and Pyhrn, the Tauernbahn forms a new connection between Central Europe and the Adriatic. But the greatest interest of this part of the route lies in the fact that it will open up to the tourist one of the most picturesque mountainous districts in Austria, that of the high Tauern mountains, hitherto only accessible by road. Although the line is not a very long one it has cost an immense sum to build owing to its engineering difficulties. There is one double track tunnel near Gastein, 8550 m. or rather more than five miles long. In addition there are several shorter tunnels and many viaducts, some of them crossing valleys at a considerable height. The Tauernbahn will contribute largely to the tourist attractions of Austria, affording the visitors to Gastein a new and varied field for excursions. Commercially, too, these new roads will have a very important effect in greatly reducing the cost of goods transportation from Germany and the North Sea to Trieste in the south. The saving of freight rates will amount in some cases to one-half.

THE material collected for the preparation of the Technolexicon has been submitted by the Council of the Verein Deutscher-Ingenieure to Dr. Brodtmann, the Chief Librarian of the Technical High School in Carlsruhe, for critical examination and report, with very unfavourable results. According to the report, the word slips to be considered amount in round numbers to about 3¼ millions, but of these at least 65 per cent. must be regarded as etymologically incomplete. The estimate previously expressed of the amount of work done in the preparation of the material seems also to have been unduly optimistic, as it now appears that 44 per cent. of the slips have not even been alphabetically arranged, and not more than 0.3 per cent. can be considered as fully completed; and even these, when etymologically considered, are somewhat imperfect. In addition to the numerical estimate, a qualitative investigation of several parts of the material in regard to the state of preparation, was equally unfavourable. The aggregated slips could in no way be regarded as a manuscript, but only as a rough collection awaiting preliminary arrangement, the investigation having shown that very little work has been done towards bringing it into shape for use. The course advocated by the report is to start the work afresh upon a more restricted basis, under expert advice and management, using the existing material for reference and control purposes only. Under these conditions, the Council, seeing no possibility of completing the Technolexicon, have recommended the cessation of all further work upon it and the abandonment of the undertaking, which recommendation has been adopted by the general meeting of the Society.

IF the Government by its communistic ideas is gradually killing private charity, it is, on the other hand, fortunately exhibiting a willingness to accept gifts on its own account. We all remember how, only a few months ago, a halfpenny newspaper presented Mr. Haldane with goodness knows how many men for the territorial army, and now we learn that the Secretary of War has gratefully accepted the offer of a dirigible balloon, for which the British public is to subscribe through the *Morning Post*, whilst another paper is spending £5000 on the construction of a garage for a big air ship which the Parliamentary Aërial Defence League has ordered from M. Clément. But that is not the end of the Government's magnanimity in the acceptance of gifts—we say magnanimity, when we recall Asticot's remark that a less great man than Paragot would have refused to share his egg with him—for it has now been announced that the Australian offer of a Dreadnought or its equivalent has been accepted. Australia recognises that in helping to defend the Empire she does England and herself honour, and it would have indicated smallness of mind indeed if the Government had persisted in its hesitation. This generosity seems to have reacted upon the Government, for it now seems that not only are they prepared to accept gifts of ships of the sea and air, but are at length disposed to build them themselves. It has been so persistently reported during the month that the phantom Dreadnoughts will soon be ordered that it is hard to doubt that hopes in that direction will be realised, and it is actually known that a semi-rigid "dirigible" has been laid down at Barrow.

THROUGH its European branch, known as the Vacuum Oil Company, the Standard Oil Trust has for years been trying to gain control of the extensive oilfields in Galicia. Recently it seemed as if its efforts would be crowned with success. In a desperate plight through over-production, and lacking the necessary storage reservoirs to take care of the ever increasing outflow from their wells, the Galician owners entered into an arrangement with the Vacuum people virtually giving the latter complete control of the Austrian petroleum industry. The Americans undertook to build reservoirs for 100,000 cisterns of oil in return for a rental of £77,000, half of the reservoirs to become their absolute property at the end of five years. Another clause in the agreement compelled the oilmen under certain circumstances to deliver a fixed quantity of raw oil to the Vacuum refineries at prices considerably below those charged the Austrian refiners. When these conditions became public, there was a great outcry against the Americans being allowed to gain control of one of the principal industries in the monarchy, and the Government intervened. Now, after further negotiations in the Ministry of Finance, the Galician owners have withdrawn from their agreement with the Americans altogether. The Ministry have undertaken to build the reservoirs and lease them to the oil owners at less than a third of the rent the Americans demanded. Moreover, the Austrian refiners will escape the impossible competition of the American refiners with their unfair advantage from the lower prices paid for the raw product. The Finance Minister rather ingenuously expressed the hope that this breaking off with the Americans would not lead to sharper competition, but that the oil situation would be improved. It is hardly likely, however, that the great Oil Trust will calmly submit to defeat, seeing that it is most anxious to control the Austrian oil export, because of its effect upon the Standard's position in the continental market, especially in Germany. The next move of the Americans is therefore awaited with much interest.

SINCE the completion of the Simplon Tunnel threatened to divert international traffic from the French railways, which had already suffered severely from the competition of the St. Gothard, all sorts of projects have been suggested for putting the French system in direct communication with the Simplon, whereby it will be possible to prevent the traffic from passing through Belgium and Holland, as it is doing at present. The most ambitious proposal was to create a Great Central Railway through France by joining the different sections at St. Nazaire, Nantes, Angers, Tours, Bourges, Chagny, Châlons-sur-Marne, and Lons-le-Saunier, with extension by a tunnel through the Faucille to Geneva. In this way the whole of the American traffic would have a direct route to the Simplon instead of passing up through Antwerp and Rotterdam. The connecting up of the different railway sections would entail comparatively small cost, but the driving of a tunnel through the Faucille offered considerable financial difficulties. As alternatives, the French railway companies proposed to join their systems with the Swiss railways by building a line from Frasne to Vallorbe, so as to avoid the extremely difficult route by Pontarlier, and also a line from Moutiers to Granges. This would have the advantage of economy, but it meant a conflict of interests between the Federal railways and the Loetschberg Railway Company, which could only be avoided by a division of traffic. When the proposals were discussed at a first conference between the Swiss and French delegates these difficulties appeared insuperable, and nothing was done; but at a second conference, held at Berne in June, all these interests were reconciled, and the principle of the building of the Frasne-Vallorbe and Moutiers-Granges sections was approved. As for the Faucille, the Federal authorities would do nothing unless the French could fix a date for the completion of the tunnel and provide a financial guarantee; but as neither of these conditions could be accepted the Faucille proposal remains in abeyance, much to the disappointment of Geneva. Nevertheless, opinion is so strongly in favour of the Great Central Railway and the tunnelling of the Faucille that this scheme is bound to be revived when there appears to be a fair chance of success.

A DISCUSSION which has been in progress more or less languidly, for some four or five years was virtually settled during the month by the publication of the report of a Board of Trade Committee appointed to make inquiries with reference to the form and scope of the accounts and statistical returns rendered by the railway companies under the Railway Regulation Act. No particular exception was taken to these returns save as regards the collection and publication of ton-mile and passenger mile statistics. The conclusions of the Committee have already been given in our columns. They fully bear out the opinions which we have always expressed, namely, that ton-mile figures would be very difficult to get, and that when got they would be of no use. Mr. Acworth, Mr. Paish, and Mr. Peel have signed a minority report, in which they reject the conclusions of their colleagues; but they have failed to adduce any reasons for their opinions, which therefore remain opinions. Another minority report is that of Sir C. Owens, Mr. Walter Bailey, and Mr. Whitelaw. They differ from their colleagues on other grounds. They hold in effect that their condemnation of the scheme is not strong enough. They point out that the witnesses who supported these statistics have been unable, although pressed to do so, to produce one concrete case in which either an increase in receipts or a decrease in expenditure has been brought about by their use, which ought not to have been brought about by other means, and that no witness has been able to put before the Committee any instance of practical use being made of these statistics by the board of directors of any company, foreign or colonial, where they are kept. This ought to settle the matter, but of course it will do nothing of the kind. But we are glad that the whole question has been fully thrashed out, so that there is hope now that nothing more will be heard about ton-miles for some time to come outside a limited circle.

IT would be interesting to learn to what extent the trade done by the implement exhibitors at a Royal Agricultural Show depends upon the attendance of the public, or, to express our meaning better—What ratio does the resulting business bear to the number of people present? The question is suggested by the great falling off in the patronage accorded by the public last month to the Royal Agricultural Society's Show at Gloucester. The wretched weather which was experienced during the whole five days had a very bad effect on the gate-money received, which is a serious matter to the Society. But it is questionable whether the exhibitors of implements derive any material advantage from the huge crowds of sightseers which flock to these exhibitions when they are held in populous centres. There is a strictly limited number of users of farm implements in the neighbourhood of each show, and in all probability the bulk of these find it necessary to attend with a view to inspecting the latest appliances and keeping abreast of the times. Gloucester cannot be considered a centre of a large population, and, therefore, fine weather was essential to obtain an attendance of the public in any way comparable with that at Newcastle, Derby, or Lincoln, for instance. On the whole, we think that the Royal Agricultural Society did as well as could be expected under the conditions that prevailed.

THE remarkable performance of Mr. Hubert Latham at Châlons-sur-Marne during the month has turned attention in France to the monoplone, which seems now in a fair way to recover the public confidence it lost as the results of the demonstrations of Mr. Wilbur Wright with his bi-plane. This is all the more gratifying to our French friends, because they regard the monoplane as a distinctly French invention, in the sense that no other country has attempted to work out the problem of aërial flight with a motor-driven apparatus of this type. It is at least curious that since Mr. Wright returned to the States neither his pupils nor any other exponent of the bi-plane have improved very much on his own flights, and yet during the same time Mr. Hubert Latham, with his Antoinette monoplane, has been flying under conditions that, at first sight, would seem entirely to upset the unfavourable criticisms that have always been advanced against the single plane. He has been out in all weathers, and in quite high winds. He has beaten all records for distance and speed with remarkable facility, remaining in the air for more than seventy minutes, and he has repeatedly allowed his machine to fly without putting his hands on the controlling levers. It is therefore assumed that this special type of monoplane possesses an exceptional stability. Many people, however, believe that Mr. Latham's skill in handling his machine is the skill of an acrobat. It should also be remarked that M. Blériot, who has stuck to the monoplane in spite of numberless difficulties and accidents, is steadily improving his flights, and has remained in the air nearly three quarters of an hour. Having satisfied himself that he can safely pilot his aëroplane in strong winds, Mr. Latham has taken up his headquarters near Calais, with the intention of making a flight across the Channel, and it is understood that two other aëronauts are on the coast projecting the same experiment. The monoplane may certainly be regarded as having retrieved its reputation. It has done all that the bi-plane has done, and even more; but, as this is an isolated case, there is nothing yet to disprove the superiority of the bi-plane over the monoplane machine. At all events, the recent experiments are having the effect of diverting attention to various types of aëroplanes, instead of allowing interest to be centred in the bi-plane, as has been the case until recently.

Negotiations have been carried on for some considerable time between the various municipalities of Berlin with a view to forming a compact—Verkehrs-Zweckverband—whose object it shall be to improve and extend the means of locomotion in the German capital according to one single broad plan, and thus to obviate the inharmonious development of tramways and railways which would result from each suburb carrying out its own special design. Judging by the proceedings at a meeting held this month, however, the likelihood of any complete agreement being arrived at by the various parties concerned seems somewhat questionable. Sweeping railway reforms are proposed in an elaborate illustrated memorial, an abridgment of which was distributed broadcast recently by the proprietor of a number of German newspapers. These proposed reforms are not restricted to the railways in Berlin alone, but apply to railways in general. In this memorial it is asserted that none of the traffic improvements so far suggested in Berlin are thorough enough to prevent for any considerable time a recurrence of the present frequent congestion and delay. A complete reorganisation of railways is suggested. The trains on trunk, branch, and city lines should run much faster and at more frequent and equal intervals. The course mapped out for new railway lines in cities should be made independent of the configuration of the streets by running the lines high up above the housetops. There should be one large central railway station with lines radiating in all directions, which should be intersected by other lines built in the form of concentric circles round the central station. The suggested speed of trains on trunk lines is 200 kms. (125 miles) per hour. It is pointed out that the trials made on the experimental track between Berlin and Zossen conclusively showed that electric trains for this high speed were perfectly practicable, but that it would be extremely difficult to provide an adequate track, and so we come to the kernel of the memorial. This difficulty can, it is said, be overcome by substituting the double line track by a mono-rail, and the author—Herr August Scherl—of the memorial claims to have produced in his workshops a workable mono-rail train which is held erect by gyrostats, and so resembles Brennan's system. Experiments are, it is said, being carried out on a large scale with strong financial support. With these new railways the time of travelling from Berlin to Amsterdam would be reduced from 10 to 4½ hours; from Berlin to Hamburg the time taken would be 1 hour and 40 minutes instead of 3½ hours.

The Seventh International Chemical Congress was held in the Albert Hall at the end of May and beginning of June. It was a distinct success so far as numbers are concerned, no less than 3600 attending it. It was totally out of the question, however, properly to discuss the enormous number of papers which had been presented. There were very nearly a thousand of them, and in spite of the fact that the Congress was divided into seventeen sections and sub-sections, it was manifestly impossible to give a proper period for discussion to each separate contribution. In one section, it is true, the papers were divided in such a manner that several, dealing more or less with the same question, could be taken together. This, of course, was a step in the right direction; but in the case of this Congress, as with only too many other gatherings of the same kind, a great deal too much was undertaken. If only a tenth part of the papers had been properly discussed considerably more good would have ensued. We are far from saying that the Congress was useless; but when we say that one section had to deal on one day with no less than forty-two papers, it will be realised that we have not drawn attention to the matter without real cause. We referred to some of the papers which appeal more especially to our readers in our issue of June 11th, and we need not mention them again.

The time appears to be long since past when they "did these things better in France." We have heard more than enough recently of the squandering of public funds in the French Naval departments, but even these are incapable of showing such a remarkable example of waste and incompetence as that which has been revealed over the reconstruction of the State printing works in Paris. They were to have cost 442,350f., and the work ought to have been completed within five years, but it has already been under construction more than seven years, and Parliament is being asked for further grants which bring up the total expenditure to 10,000,000f. An electrical generating station was to have been built to supply power for the printing machines at a cost of 750,000f., but when it was seen that this sum was being exceeded the generating machines were dispensed with, and transformers were put down to utilise current from the mains. The floor of the printing works was made of armoured concrete, and when it was found that this material was too cold it was replaced with wood. Steps of armoured concrete were pulled down and replaced by stone because they were not sufficiently attractive. A huge bay had been built for the printing machines, and a dozen were installed for trial, when it was realised that it was impossible to clean them because there were no pits. The machines have had to be removed and the floor of the hall reconstructed. It is also found that the architects forgot to provide lodgings for the director and staff, and land will have to be purchased at fancy prices. Government throws the entire blame upon the shoulders of the late director of the Imprimerie Nationale, but the fault lies in the deplorable practice of giving valuable appointments to men on account of their political influence, quite irrespective of their fitness for the work, and thus many of the State services fail because absolutely incompetent men are at the head of them.

On June 10th a new bridge over the Wear at Sunderland was formally opened by the Earl of Durham. This work, which is the joint possession of the Sunderland Corporation and the North-Eastern Railway, is a double-deck bridge having a double line of railway above, and the roadway with a single line of tram rails in its centre below. It joins the districts of Millfield and Pallion on the south side of the river, with Southwick on the north, and has been under construction for four and a-half years, the contractors being Sir William Arrol and Co., Limited. It was dealt with at some length in our issues of June 4th and 11th, but we may here recapitulate one or two facts concerning it. The distance between the principal abutments is 1220ft., and the bridge consists of one main river span 330ft. long and 85ft. above high water, and three land spans—two on the north side and one on the south—each 200ft. long. The approaches are 340ft. long on the south side and 180ft. long on the north. One of the principal items of interest in the construction of the bridge was the method of erecting the main river span. It was impossible to do this by floating out, and the work had to be carried out on the overhang principle. For this purpose temporary vertical posts, erected above the river piers and tied to the piers on the far side of the two spans on either side next the main span, were employed. The main span was then gradually built into position, support being obtained by diagonal ties connecting it temporarily in different places to the vertical posts above mentioned. When the span was completed both posts and ties were removed. The work of erection was eminently successful from every point of view.

There is much in Paris to arouse the admiration of the municipal engineer, and there is much to awaken surprise that such an enlightened city should lag behind in the way of sanitary and other conveniences. A great deal has been done during the past two years to make Paris healthier and cleaner, and still more is likely to be accomplished in the early future, as the result of the public works it is proposed to carry out at a cost of no less than 666,000,000f. Since the days of Baron Haussmann no such programme has been attempted as that which is being submitted to the Municipal Council by the Prefect of the Seine. Of the sum named, more than one-half will be devoted to the widening and extension of the streets and the creation of open spaces, especially in the populous quarters of the city, which are notoriously overcrowded, and 118,000,000f. will be spent upon water and sanitary improvements. There will be an expenditure of 25,000,000f. upon public buildings, 15,000,000f. upon open spaces and promenades, 35,000,000f. upon buildings for the Assistance Publique, or Poor Law Guardians; 30,000,000f. upon the demolition of insanitary houses, and for loans to societies which build houses upon up-to-date plans for the working-classes; 18,000,000f. for improvements to roads, building footways under streets, lighting, &c., 40,000,000f. for the reconstruction of the slaughter-houses, and 4,000,000f. for improvements to schools. It is proposed to raise 700,000,000f. by two loans, one of 300,000,000f. from 1910 to 1919, and another of 400,000,000f. from 1920 to 1929. A sum of 92,000,000f. was voted a year ago for improvements to schools, so that the total amount available would be 792,000,000f.; but from this must be deducted sums already advanced for the construction of hospitals, and also to the new company which has undertaken the construction of the Nord-Sud Underground Railway, thus leaving 666,000,000f. to be spent upon additional new works.

THE ROYAL SOCIETY.

On Thursday, June 24th, the Royal Society held, at Burlington House, its second conversazione of the year. As usual there were many interesting exhibits, but comparatively few were of an engineering character, and some of those had been shown at the conversazione which was held in May, and were referred to in our issue of the 14th of that month. At the same time, however, there were one or two new and noteworthy things having a bearing on engineering which we shall refer to, together with other exhibits of general scientific interest. Professor John Milne, F.R.S., exhibited seismograms of the Messina earthquake of 28th December, 1908. Them records were obtained at Shide, in the Isle of Wight, from two Milne horizontal pendulums. One of them recorded N.-S. motion, and the other E.-W. motion. Details respecting duration, amplitude, &c., were inscribed on the seismogram. Some photographs of the spectrum of scandium were exhibited by Mr. A. Fowler, showing the varying intensities of the scandium lines in the arc-flame, normal arc, and the arc in hydrogen. Corresponding differences are found in the spectra of sun spots and prominences. Scandia for the experiments was kindly provided by Sir William Crookes.

A Thorp-Butler concave replica-grating spectroscope was shown by Mr. C. P. Butler. Some years ago several applications of the Thorp plane replica diffraction gratings were exhibited, and attention was drawn to their use with an opera glass for eclipse work. The only disadvantage of them is the necessity for employing glass lenses for collimator and telescope, which not only increase the expense, but render the application of the instrument somewhat limited, in that the ultra-violet region of the spectrum is more or less absorbed. Recent experiments have shown that concave replica gratings can be made to give very satisfactory results; and by slight modifications of the design of mounting, this form of spectroscope may be employed for any investigation for which the ordinary spectroscope is fitted. A valuable feature appears to be that the radius of curvature may be varied within very wide limits, thus providing instruments of different dispersion and light-grasping power.

The Hon. R. C. Parsons was showing his "Panflex" spring wheel for motor vehicles. The wheel, which has already been dealt with in our columns, is claimed to be exceedingly reliable, and having a solid tire is not subject to bursts or punctures. The wear and tear is small, and should a spring break another can be inserted in a few minutes at a very small cost. There was in his exhibit also a working model apparatus for recording the effects produced upon wheels of various descriptions when passing over obstacles, and a seismograph apparatus for registering the jolts felt by the body of a motor vehicle when run on "Panflex" or pneumatic wheels. As at the previous conversazione, Prof. Silvanus P. Thompson, F.R.S., showed experiments on the contraction, by heat, of india-rubber. India-rubber, under tensile stress, contracts strongly when its temperature is raised. Work is done by its contraction at the expense of the energy of the heat. Hence, it would be possible to construct a thermal engine in which the working substance was india-rubber, instead of steam or hot air, and operated by contraction, instead of expansion, of the working substance. The Linolite Company exhibited metallic filament "Tubolite," for illuminating purposes. The metal filament is held at each end by a zig-zag spring to take up the expansion, and is supported by anchors at two intermediate points. The lamp may be placed in any position, and can be run on an alternating-current or direct-current circuit. The lamp has 30 per cent. more area of glass than an ordinary bulb, thus reducing the blackening. Every point of the filament is in the same position, with regard to the reflector (and there is a larger reflecting surface than can be used with a bulb lamp), which ensures uniformity and efficiency in the distribution of the light.

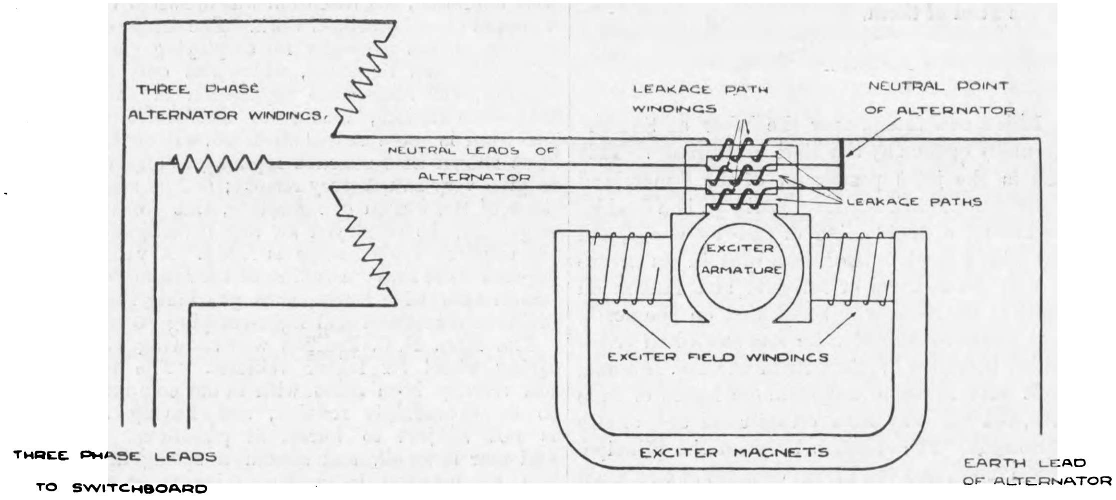
Liquid crystals observed under high temperatures with polarised light by micro-projection apparatus were shown by Messrs. Zeiss. The apparatus was fitted with an arc lamp, self-feeding, to ensure steady light. A collecting lens of extra light-gathering power was fitted to a light-excluding tube provided with a water chamber to cool the heat rays. The microscope was placed on a sole plate with levelling screws, and used in the vertical position. The heating apparatus consisted of a form of Bunsen burner with blow pipe. Gas and air pressure could be regulated by means of two taps with graduated arc. Above the object stage an air blast was fitted hinged with a universal joint, and could be easily adjusted for any position. The analyser and polariser were of a new construction, and the objectives were surrounded by a water-cooling lamp. The specimnes shown were:—Par-az-oxy-anisol with resin, showing rotating drops; cholesteryl-acetat, showing spherical crystals; par-az-oxy-phenetol with resin, showing interference colours; par-az-oxy-benzoe-acid-acethyl-ester with resin, showing uniting of crystals.

Photographs—for identification purposes—of the transverse surface of timbers were exhibited by Mr. R. A. Robertson. Reflected light was used, and the photographs represented the surface appearance. The magnification was purposely chosen to show only the important details for identification—breadth of annual rings, false rings, distribution of vasa, relative porosity and amount of spring and autumn wood, and characters of medullary rays. The object of Professor J. Norman Collie's exhibit was to demonstrate a curious property of neon. Perfectly pure neon, when enclosed in a glass tube with mercury and shaken, glows with a bright orange-red colour. As neon does this at ordinary pressures it appears to be different from other gases. When a silica tube is used and the mercury boiled in it, even at pressures of neon almost as high as atmospheric pressures, the mercury vapour glows bright green.

A permanently luminous watch dial and military night compass was shown by Mr. C. E. S. Phillips. The watch dial is transparent—glass—and the figures are painted upon its upper surface. The dial is backed with a compound containing a minute quantity of Ra Br_2—radium bromide—which renders it luminous, so that the time may be easily read in the dark. The compass is arranged upon the same principle. By means of a luminous disc and strip direction may be determined at night.

Mr. W. M. Mordey's exhibit was designed to show the effect of electrostatic condensers in preventing or extinguishing arcs. A suitable condenser placed in shunt to an arc, or in shunt to a resistance in series with an arc, will instantly extinguish the arc. If connected in shunt to the contacts before they are separated, it will prevent the formation of an arc even in a circuit having considerable electromotive force. For example, on a 200-volt circuit an arc of even 1·100th inch in length cannot be formed between carbon contacts, if a condenser of about 30 microfarads be used in shunt to the arc—the circuit having about 35 ohms resistance. Without the condenser, a persistent arc of about 4 ampères is freely formed. The condenser is effective whether when applied it is in a discharged condition, or charged to the full E.M.F. of the circuit. In the latter case the charge may be in either direction of polarity.

Mr. C. E. Larard showed cylindrical specimens twisted to destruction. These specimens, it will be remembered, were exhibited at the previous conversazione and referred to at the time. Mr. Alfred W. Porter exhibited some interesting electric splashes on photographic plates. To obtain these splashes a photographic plate is backed by a plate-electrode, and a single-spark discharge is allowed to pass over the plate from a second electrode in front; the plate is then developed. The new effects exhibited were brought about (1) by diminishing the pressure of the surrounding atmosphere: (2) by replacing it with other gases; (3) by placing the plate in a magnetic field. The examples shown were for air, nitrogen, carbon dioxide, coal gas, ammonia vapour and pentane at various pressures.


THREE PHASE ALTERNATOR WINDINGS.
LEAKAGE PATH WINDINGS
NEUTRAL POINT OF ALTERNATOR.
NEUTRAL LEADS OF ALTERNATOR
LEAKAGE PATHS
EXCITER ARMATURE
EXCITER FIELD WINDINGS
EXCITER MAGNETS
THREE PHASE LEADS TO SWITCHBOARD
EARTH LEAD OF ALTERNATOR

"The Engineer"

Swain Sc.

Fig. 1—PARSON'S HIGH-SPEED COMPOUND ALTERNATOR

From an electrical engineer's standpoint, the most interesting exhibit was that of the Hon. C. A. Parsons, F.R.S. It consisted of a working model of his compound alternator, which is one of the latest developments in connection with the Parsons high-speed machines.

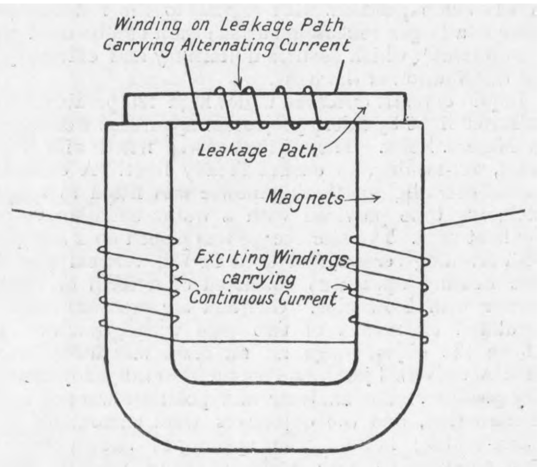

Winding on Leakage Path Carrying Alternating Current
Leakage Path
Magnets
Exciting Windings carrying Continuous Current

Fig. 2—Diagram to Illustrate Principle of Compound Alternator

The action of this compounding device is dependent upon the simple fact that while an alternating current cannot directly produce a unidirectional field, it can have a strong action in diminishing such a field. This will be clear by referring to the illustration—Fig. 2—where a horseshoe magnet is shown, excited with continuous current. The poles of the magnet, it will be noticed, are bridged by a piece of iron, which forms a leakage path. Provided the cross sectional area of the leakage path is less than that of the magnet, the iron of the leakage path will be more or less saturated; thus an increase of exciting current in the coils on the magnet will not send many more magnetic lines through the leakage path. If an alternating current be sent through the winding on the leakage path, when it is passing in one direction, it cannot, owing to the iron being saturated, greatly increase the "leakage flux" in the leakage path, but when passing in the other direction it can and will, provided it be of sufficient strength, greatly reduce the leakage flux. The net result, therefore, is a reduction of the leakage flux. How this principle can be applied to the compounding of an alternator will be readily understood by reference to Fig. 1. It will be seen that the exciter poles are bridged by three leakage paths. These leakage paths, which are of laminated iron, naturally divert a large number of the magnetic lines from the armature, resulting in a lower exciter voltage being obtained than would be the case were the leakage paths not there. Three leakage paths are provided in this particular case, because the alternator is a three-phase machine; but one leakage path would suffice were the alternator wound for single phase. It will be seen that each leakage path is provided with a winding, and that each winding is in series with a separate phase, the leakage path windings being between the windings of the alternator and the neutral point. With an earthed neutral, therefore, the leakage path windings are practically at earth potential. They may, however, be insulated for the full working voltage of the alternator. In a few special cases current transformers are used instead of passing the main current round the leakage paths. Now it is obvious from what has already been said that when the load comes on the alternator the leakage flux in the leakage paths is choked back, thus causing the flux through the armature of the exciter to increase. This, of course, causes the voltage of the exciter to rise, thus automatically increasing the excitation of the alternator. That the action is practically instantaneous is evident, since the increase of current due to the load coming on is used directly to effect regulation. Some voltage regulation curves which have been supplied to us by Messrs. C. A. Parsons and Co. show the voltage regulation of a turbo-alternator, with and without this compounding device. The curves are for a 1000-kilowatt three-phase machine, working at a normal pressure of 3300 volts. When a heavy inductive load of 220 ampères was thrown on the pressure dropped to 2300 volts, so that the load on the plant was only 700 kilowatts. With the device in use, however, the same load thrown on had very little effect upon the voltage. At 25 per cent. overload, and a power factor of ·8, the drop is shown to be only 6 per cent. Alternators can, if desired, be over-compounded with this device; that is to say, the pressure can be made to rise with an increase of load to compensate for the drop in the feeders. That the short-circuit current of alternators with close inherent voltage regulation is great is well known, but with this device it is clearly possible to design alternators with a small short-circuit current without sacrificing the voltage regulation. The old copper machines, such as the Mordey alternator, had close inherent regulation, and they also had a heavy short-circuit current, which was by no means pleasant when an accidental short-circuit occurred. It will be observed that, unlike the other compounding devices which have been invented, this one has no moving parts, such as commutators. With a new exciter the device can be applied to existing plants, and in stations where the regulation is bad, a motor generator exciting set fitted with this device can be provided.

BRAZILIAN TORPEDO-BOAT DESTROYERS.

The sixth of the ten torpedo-boat destroyers which Yarrow and Co., Limited, of Scotstoun, are building for the Brazilian Government was launched on May 18th, and the seventh of the lot is to be consigned to the water this month. The names of the six already launched, several of which have been delivered and put into commission, are as follows:—Para, Piauhy, Amazonas, Matto Grosso, Rio Grande do Norte, and Parahyba. The first three, Para, Piauhy, and Amazones, launched last year, are now in active service in Brazilian waters. The three others, the Matto Grosso, Rio Grande do Norte, and the Parahyba, were in due time successfully launched from Messrs. Yarrow's stocks, and the first-named of the three is on her way to Brazil, whilst the last-named—the Parahyba—has just run very successful official trials on the Clyde this week, the speed attained being 27·29 knots. The four still to be launched are to be named the Alagoas, Santa Catharina, Parana, and Seigipe. All the vessels, needless to say, will be under the command of capable naval officers, and it is a point of interest worth noting that the Alagoas being launched shortly is of the same name as the small river monitor Alagoas, which, under the command of Lieutenant Joaquim Antonio Cordovil Maurity, in the war between Paraguay in February, 1868, forced the passage of Humayta under very trying circumstances, and accomplished one of the most noteworthy feats of comparatively recent naval warfare. It is also pertinent here to note that through the recent retirement of his Excellency Admiral Duarte Huet de Bacellar from the post of Chief of the Brazilian Naval Commission, His Excellency Admiral Maurity has been appointed to that high office.

All these destroyers are of the same dimensions, viz., 240ft. in length and 23ft. 6in. beam, and of about 560 tons displacement. They are propelled by two sets of triple-expansion four-cylinder engines, and two double-ended Yarrow water-tube boilers, each boiler supplying steam for about 4000 indicated horse-power. The vessels are generally similar in appearance to the British "River" class of destroyer, but are a considerable advance on that type as regards speed, the contract being 27 knots as against 25½ knots.

In the matter of propulsive machinery these destroyers possess features which, if not absolutely novel in destroyers, are yet specially noteworthy. A point of outstanding interest is that the Yarrow boilers are fired from both ends, thus making improvements possible in respect of efficiency and favourable working conditions, matters which will afterwards be referred to. For cooling the magazines and the living spaces, the advantage attaching to which, in warm climates especially, cannot be overrated, an efficient refrigerating plant is provided on board. A Marconi wireless telegraphy installation is not the least interesting of the items of up-to date equipment which these Brazilian destroyers possess.

The armament consists of two 4in. Armstrong quick-firing guns, one being placed upon the conning tower at the aft end of the forecastle deck, and forward of the navigating bridge, and the other upon a raised platform aft. On the main deck are placed four—two at each side, well amidships—47 mm. Armstrong guns. There are also two 18in. Armstrong torpedo tubes. For the service of the forward quick-firing gun an Armstrong electric communication hoist is fitted from the forward 4in. shell room to a convenient position at the back of the gun. The shell-room and magazines for the aft 4in. gun are under the officers' quarters. The ammunition for the smaller guns are handed up as usual.

As regards main structural features the hull of the vessels is built of high tensile steel wherever longitudinal strength is important. The hull is sub-divided into eleven main compartments by ten water-tight transverse bulkheads extending from the keel to the upper deck. Below the lower deck there are in addition eight sub-divisional bulkheads, the destined purpose of each compartment being as usual in this class of vessel. There is a water-tight compartment at the fore end, of which absolutely no use is made in the working economy of the vessel. Behind this is the chain locker, and the third and fourth compartments are occupied as firemen's and crew's quarters. Below these are the electrical, naval, and gunners' stores, the main magazine for torpedoes, the magazine and shell room for the 4in. guns, the magazine for the 47 millimetre gun, the provision room, fresh water tank, &c. The boilers occupy the fifth and sixth compartments, a cross coal bunker being situated at the forward end, and wing bunkers at each side of both boiler-rooms. Of the boiler-rooms themselves and their contents, some idea is conveyed by some of the views in our two-page Supplement. Next in order is the compartment containing the engines for propulsive and other purposes, the disposition of the various accessories being so arranged as to bring the items under easy and effective control of the engineers in charge. Leading out of the engine-room is an access door to a compartment containing various auxiliary machines, and underneath this is a compartment devoted to engineers' stores. In this compartment attention can be given to the glands of the shafting.

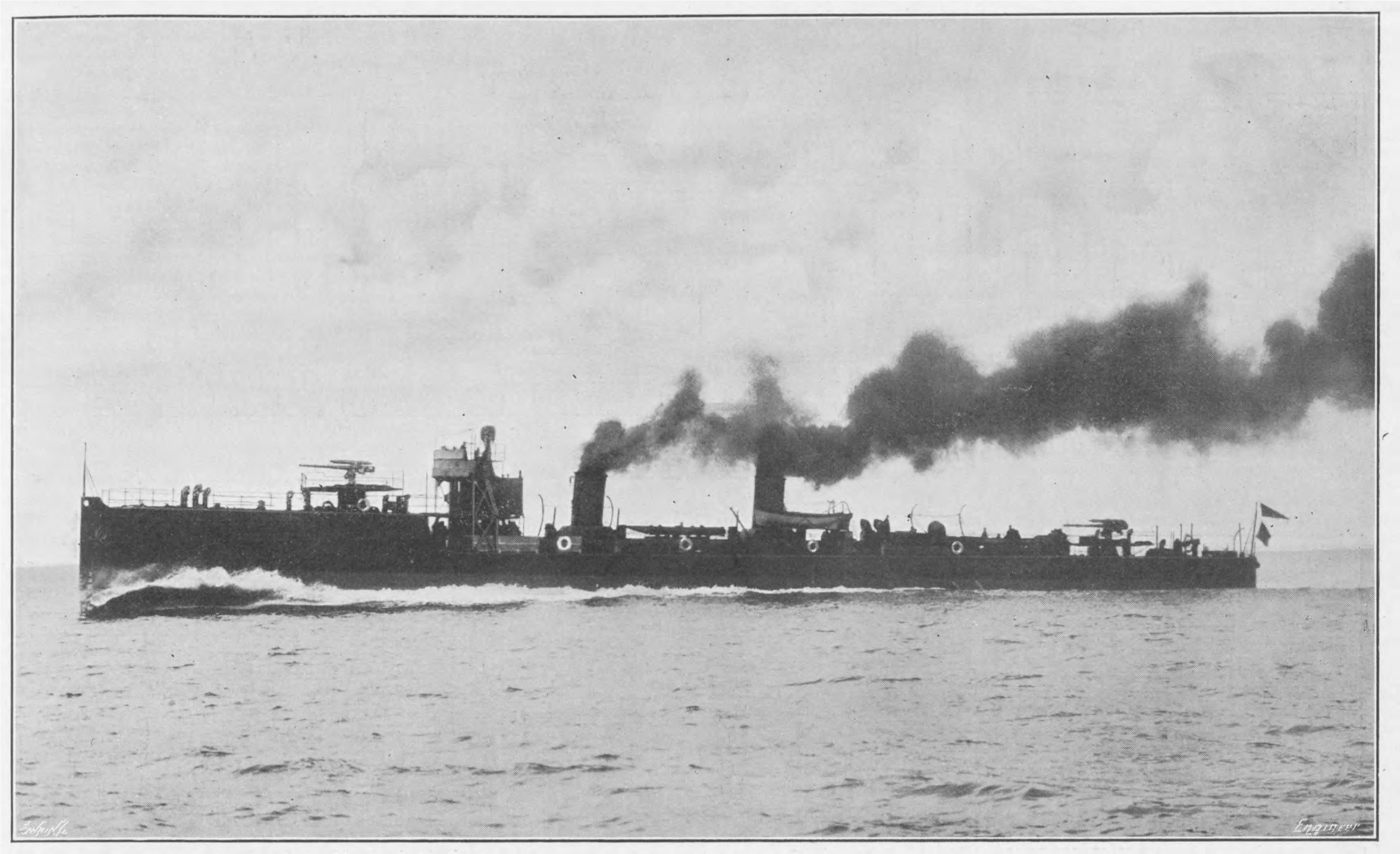
Abaft of this, and with the exception, in the lower parts, of the aft 4in. shell room, magazine, and the magazine for small gun ammunition, captain's store, ward room store, and higher up at the very stern, the bread and other store rooms, all the space is occupied as officers' accommodation. This consists of a ward room, aft—see Supplement—measuring 14ft. long by 21ft. wide, having accommodation for ten officers, and with a pantry adjoining. The furniture in the ward room and all the officers' rooms is of polished mahogany; but here it may be stated that the fittings in all other living spaces and in store rooms are made of metal wherever possible to minimise risk of fire. Expanded metal for vertical erections, such as bins, is much in evidence, and perforated sheet and wove netting for horizontal shelves, berths, &c. The decks are covered with cocoa-nut matting and the floors of the living spaces with "Cortocine," affording both lightness and good foothold. On the starboard side is the captain's cabin—see Supplement—a roomy and well appointed apartment. On the port side of the ward room passage—see page 5—are three roomy double-berth cabins for officers, all being about 8ft. square. Side lights are of course fitted into all these rooms, and a skylight is provided over the centre of the ward room. All the above mentioned living rooms are provided with a supply of cool air from the refrigerating plant in the engine-room.

Forward, on the upper deck, on the starboard side, a separate apartment is divided off from the rest of the living spaces there for six engineer officers, and another separate cabin for four petty officers. On the port side a separate two-berth cabin is arranged as a sick bay. Roominess and general comfort, consistent with the special objects in view in the design and service of these vessels, characterise the living accommodation.

At the forward end of the boiler casing on the upper deck is the cooking galley, and above this is the chart house, immediately behind which and with separate access is the Marconi telegraph station, the sides, floor, and roof of which are completely insulated with 3in. cork. The forecastle deck is extended aft beyond the conning tower and gun platform, so as to afford direct communication with the chart house. Above the latter

BRAZILIAN TORPEDO BOAT DESTROYER MATTO GROSSO

YARROW AND CO., LIMITED, SCOTSTOUN, GLASGOW, BUILDERS



is the navigating bridge with Chadburn's telegraph, Lord Kelvin's compass, Siemens searchlight, &c.

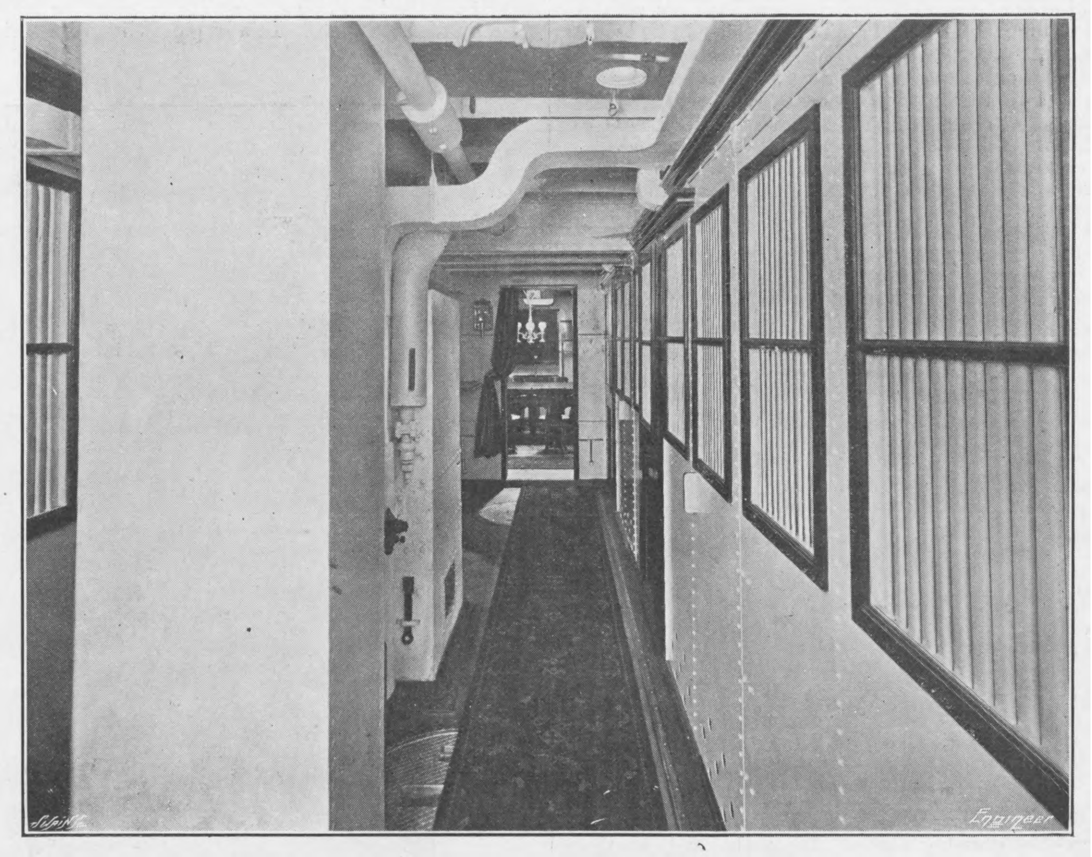
The propulsive power sections of these destroyers, as has already been indicated, are replete with features of interest, and the general arrangement of the engine and boiler rooms can be gathered from the two-page drawing and from the portions of the longitudinal section, cross section, and plan given on page 6. There are, as before mentioned, two Yarrow water-tube boilers fired from both ends and designed for 8000 collective indicated horse-power. Each of them is placed in the mid-length of their respective compartments, thus providing four stokeholds, each of which is fitted with a fan for forced draught driven by an enclosed engine having forced lubrication made by W. H. Allen and Son, Bedford. For dealing with the feed-water there is installed at the aft end of each boiler-room one of Weir's auxiliary feed-pumps.

The twin sets of main engines are of the four-cylinder triple-expansion design, balanced on the Yarrow, Schlick and Tweedy principle, the order of the cylinders, named from the forward end, being:—Low-pressure, high-pressure, intermediate, and low-pressure. The valve gear is of the usual link-motion type, having twin-bar marine-pattern links, all parts liable to wear being so constructed as to facilitate adjustment. All-round reversing gear for both steam and hand control is fitted. Each engine has an air pump, worked by rocking levers and links off the forward low-pressure crossheads. From our two-page line Supplement of the engines of the Matto Grosso in plan and elevation, the general design and the arrangement of adjuncts will be gathered, as well as from the illustration on page 6, which shows one set of the engines—which weigh about 24 tons—slung up under the 50-ton overhead traveller in the builder's covered-in basin, being deposited on board.

The condensers, which are snugly disposed in the wings, are of brass alloy, and have brass tubes. A circulating pump and engine of Yarrow's own make, placed at the forward end, circulates water once through each condenser. Instead of auxiliary air pumps being provided, two small steam ejectors are fitted, with suctions connected to each condenser, so that with a few of the auxiliaries running the condensers can be kept drained when the main engines are not working. Two large combined feed-filters and hot-wells, one for each set of main engines, are placed at the forward end of the engine-room, and into these filtering hot-wells the discharge is taken from the main air pumps, any grease or impurities being intercepted by flannel-covered screens of suitable surface and thickness. A Weir's main feed pump fitted on the outboard side of each of these wells draws from them and delivers straight to the boilers without the usual intervening feed-regulating apparatus. Besides being an extra complication, even the best of automatic feed regulators is apt to become a source of danger under given circumstances. This is so through the risk of the apparatus sticking when the rate of evaporation is suddenly varied from that at which the regulator has been set to deal. If conjoined to this there is inattention to the state of the water gauge on the part of those in the stokeholds, relying, as they perhaps have some right to do, on the proper working of the regulator, very serious trouble will most likely result. The feed in the boilers of these destroyers is controlled by a hand valve fitted on the discharge side of the feed-heaters, and by this means no difficulty whatever is experienced in keeping a proper working level in the boilers.

Other auxiliary plant fitted in the engine-room are—an evaporator and distilling apparatus of Caird and Rayner's make placed at the forward end, and also a fire and bilge pump, and at the aft end the refrigorating plant, consisting of a Hall's No. 5 carbonic-anhydride machine, by which the magazines and crew's spaces are kept cool. For this latter purpose the machine works in connection with two thermo-tanks by the Thermo-Tank Company, one situated in the officers' quarters aft and the other in crew's space forward. The pumping arrangements throughout these destroyers consist of steam ejectors and hand pumps, supplemented by bilge circulation from the main circulation pumps in the engine-room.

In the special auxiliary room, aft of the main engine-room, and having ready access from the latter, are fitted the air-compressor of Brotherhood's make for charging the torpedoes; and the steam steering engine of Napier Brothers' geared vertical wall design. This is connected by mitre wheels and shafting to the steering wheel on the navigation bridge and to one in the conning tower; the wheel aft being actuated by hand. In the auxiliary engine-room also is the combined dynamo and engine of the Siemens-Brotherhood type supplying current for all purposes on board. Under the auxiliary engine-room is the stern gland compartment, which is also fitted as an engineer's storeroom. All the necessary tanks for oil and waste, racks for spanners and other tools, and most of the engineers' spare gear are arranged in the main engine-room.

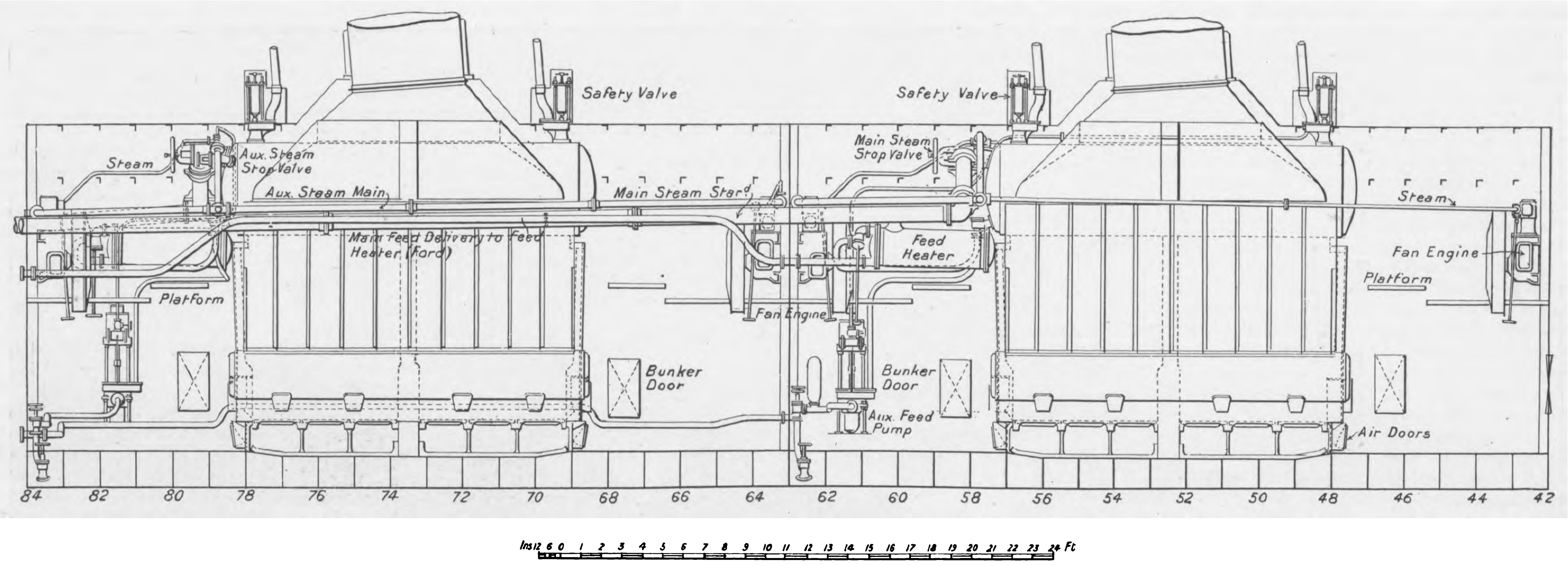


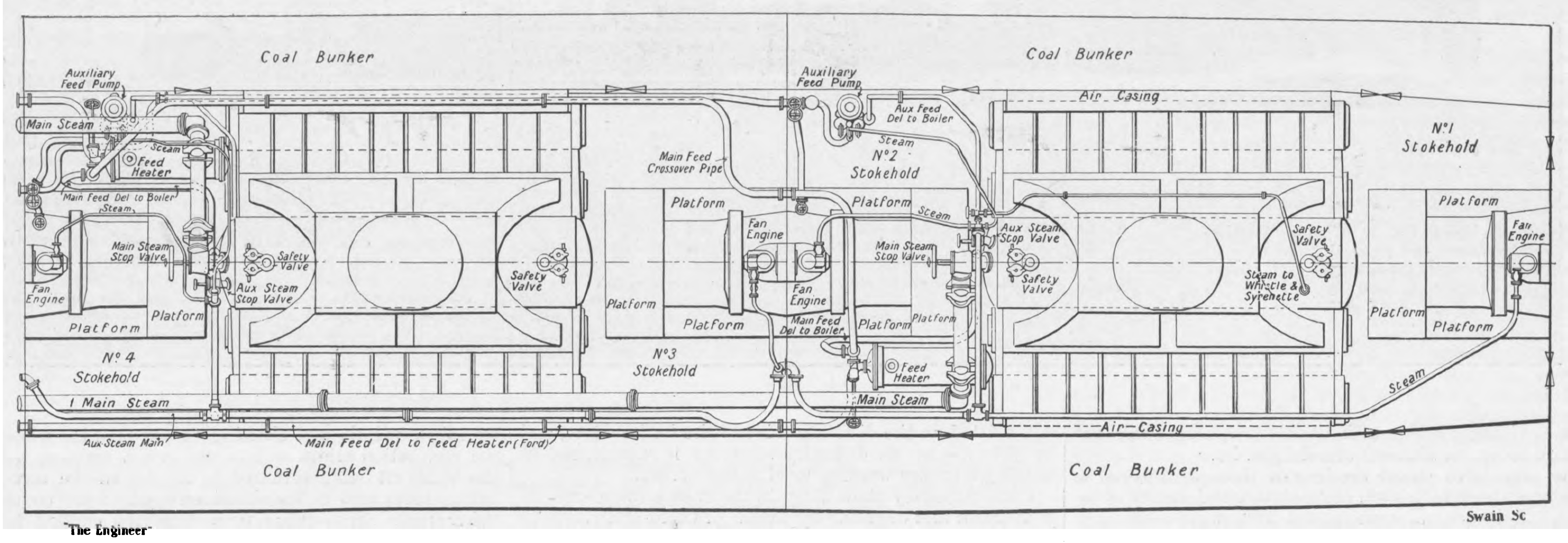
PASSAGE TO WARD-ROOM

From the illustration on page 6, showing the boiler-room compartments in plan and elevation, some idea will be gathered of the disposition of the boilers, feed pumps, feed heaters, fan engines, with their valves and connections. A distinct feature of the Yarrow double-ended boiler is the complete separation of the back and front furnaces from each other by a transverse dividing fire-brick wall, built round and between Field tubes radiating from the steam drum, the tubes in this way while forming a substantial support for the wall, are at the same time protected from the highest temperature of the

BRAZILIAN DESTROYER MATTO GROSSO—BOILER ARRANGEMENT

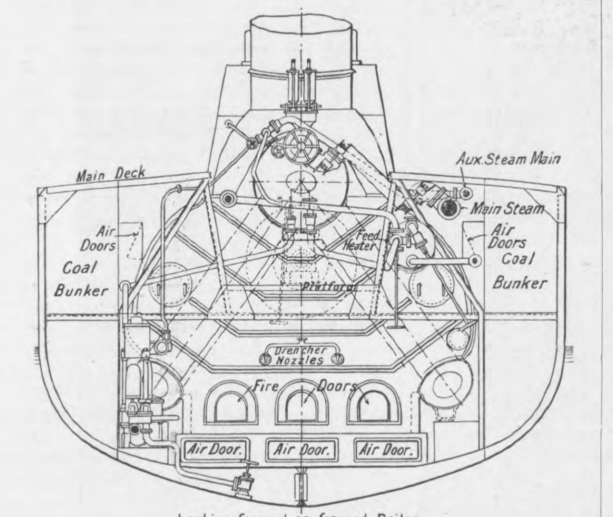
YARROW AND CO., LIMITED, SCOTSTOUN, ENGINEERS


Steam
Aux. Steam Stop Valve
Aux. Steam Main
Safety Valve
Main Steam Stop
Main Feed Delivery to Feed Heater (Ford)
Platform
Bunker Door
Safety Valve
Main Steam Stop Valve
Feed Heater
Fan Engine
Bunker Door
Aux. Feed Pump
Steam
Fan Engine
Platform
Air Doors
84 82 80 78 76 74 72 70 68 66 64 62 60 58 56 54 52 50 48 46 44 42
Ins 12 6 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 Ft


Coal Bunker
Auxiliary Feed Pump
Main Steam
Steam
Feed Heater
Main Feed Del to Boiler
Steam
Main Steam Stop Valve
Fan Engine
Platform
Platform
Safety Valve
Aux Steam Stop Valve
Safety Valve
No 4 Stokehold
Main Steam
Aux Steam Main
Main Feed Del to Feed Heater (Ford)
Coal Bunker
Main Feed Crossover Pipe
Platform
Fan Engine
Fan Engine
Platform
Platform
No 3 Stokehold
Auxiliary Feed Pump
Aux Feed Del to Boiler
Steam
No 2 Stokehold
Platform
Steam
Main Steam Stop Valve
Main Feed Del to Boiler
Platform
Platform
Feed Heater
Main Steam
Aux Steam Stop Valve
Safety Valve
Safety Valve
Steam to Whistle & Syrenette
Coal Bunker
Air Casing
No 1 Stokehold
Platform
Fan Engine
Platform
Platform
Steam
Air Casing
Coal Bunker
The Engineer
Swain Sc

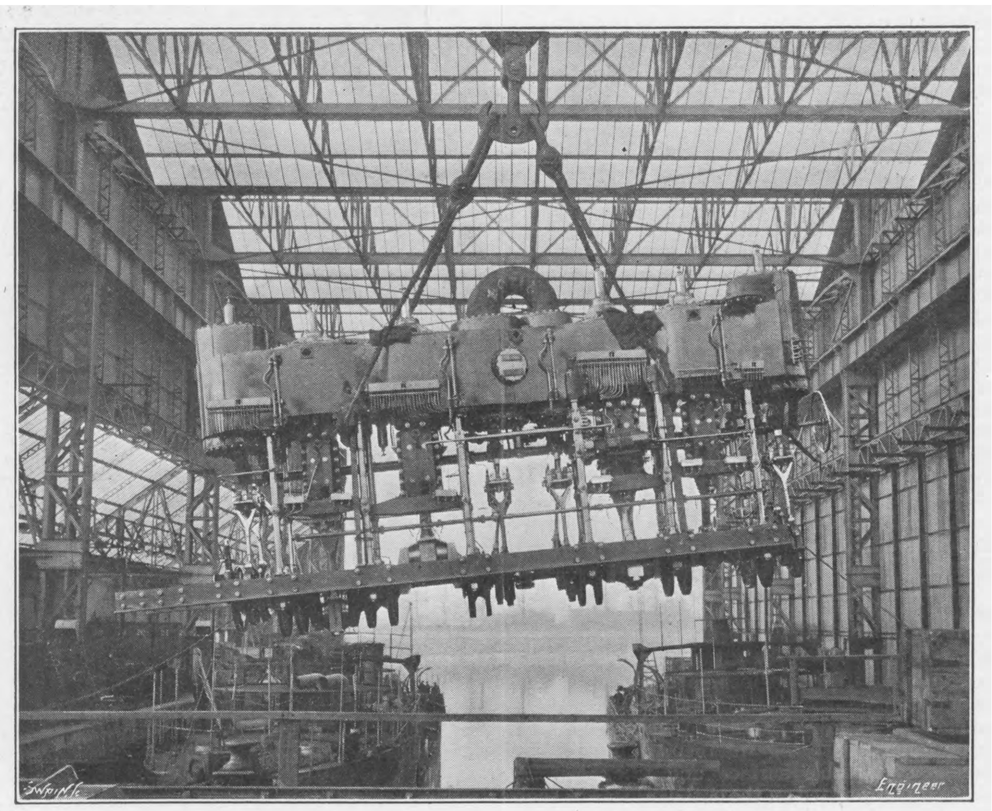
furnaces. The wall is built up to the under side of the steam drum, and out at each side. The lower part of wall is built hollow, and arranged so that the air, which is admitted over the fires, passes on its way to the furnace, through this hollow space, and becomes heated before reaching the air nozzles of the furnace. At the bottom end of each of the Field tubes screw caps are provided for cleaning purposes, and are so placed as to be of easy access. All that is required is removal of the hand-hole doors fitted on the plates forming the bearer for the centre brick walls. Safety air doors and protection boxes are provided, so that in the event of a tube bursting it is not possible for steam and flame to enter the stokehold.

One advantage of the boiler arrangements in these vessels will be readily apparent. This is the reduction of complication in the matter of boiler mountings, pipes, and fittings—see drawing above. The main and auxiliary steam stop valves, feed valves, scum valve, blow-out valve, and water gauges are only necessary at one end of the steam drum. Had boilers of the usual type been fitted, these connecting pipe, joint, and other fittings would have been duplicated, and entailed a greater number of steam and feed joints to maintain in an efficient condition.


Main Deck
Aux. Steam Main
Main Steam
Air Doors
Coal Bunker
Air Doors
Coal Bunker
Feed Heater
Platform
Drencher Nozzles
Fire Doors
Air Door.
Air Door.
Air Door.
Looking forward on forward Boiler.

CROSS SECTION THROUGH STOKEHOLD

Other outstanding advantages of the arrangement may be referred to. There is a saving in overall length of boilers amounting to at least 10 per cent. With boilers fired from both ends weight is saved in that there are only two steam drum ends and four water pocket ends, against four of the former and eight of the latter, where two boilers of the usual type are installed. Each boiler being in one compartment—so to speak, in the middle of one stokehold—there is a cool bulkhead behind the firemen in every case. This, combined with the saving in length, enables the stokeholds to be exceptionally large and cool. With a common stokehold between two boilers, it is impossible for the firemen to find a place away from the heat radiation of the furnaces in front of them and behind them. In a tropical climate especially, and bearing in mind the arduous and difficult work that has to be done in a destroyer stokehold, it is scarcely possible to over-estimate the advantages—as regards the comparative comfort and resulting efficiency of the staff of the stokeholds—made possible by the adoption of these double-ended boilers.


Swain Sc
Engineer

ONE SET OF ENGINES BEING HOISTED INTO PLACE

The simplicity secured by abolishing about half of the usual amount of steam and feed connections, and the reduction of the number of joints and valves claiming the engineers' attention, is supplemented in boilers of this type by the simplicity of the uptakes, it being possible, in fact, to reduce the number of funnels without the necessity of long or one-sided uptakes. Besides, by these means the area exposed to shot is materially reduced.

Owing to the large capacity of the steam drum, the variations in water level and steam pressure are reduced, and from experience gathered on the long voyages made by these vessels, this is an important gain, for it is well known how much better results can be obtained, both as regards economy and speed, if the steam and water are steady. Easy accessibility to all parts, even when steam is up, is not always secured with single-ended boilers, placed back-to-back, or when their backs are in proximity to a bulkhead. Ease in getting to the boiler all round is a great factor in prolonging its life, as any trifling defect such as painting is not neglected. Still further advantages may just be mentioned. The centre of gravity is slightly lowered, and the economy is increased, due partly to reduced surface for radiation. All the advantages enumerated, we think, go to make this boiler a distinct advance over the single-ended boiler. As a proof of the economy, it will be of interest to mention the result of the official eight hours 14-knot consumption trial, carried out with the Para in the estuary of the Clyde. This vessel ran 26.377 knots to the ton of coal, which gives her a radius of action of 3692 knots.

The provisions made to guard against and minimise the extreme heat to which these destroyers will often be subject are as thoroughly thought out in connection with the living accommodation, and with keeping the magazines cool, as has been shown to obtain in the machinery departments, with their ample space and mechanical as well as natural means of ventilation. The cowl ventilators throughout are much larger than is usual in vessels of this type, and this is a feature applying more particularly to the means for ventilating the stokeholds. Here the air supplied to the forced draught fans is taken in through doors in the top of the casings over the boiler-room, instead of through the customary big cowls—difficult to handle and easily damaged—whereby little if any additional duty is imposed on the fan engines.

The thermo-tank system of providing for suitable and agreeable temperature in magazines and living spaces merits, of course, some notice. The Hall's refrigerating machine in the engine-room has already been mentioned. Of the two thermo tanks, one is placed aft in the passage leading to the ward room—see page 5—and the other in the second crew's space forward. The brine pipes connecting the refrigerating machine to the forward thermo tank are very heavily insulated where they pass through the boiler-rooms. The cool air from the thermo tanks is delivered by the electrical fan of each tank into the magazines or into the living quarters through a very complete system of trunkways and controlling valves, the arrangement being such that any of the three following results can be obtained, viz., the air (1) can be drawn from the compartment in which the thermo-tank is situated, passed through the cooler down into the magazine and returned to the compartment; the air (2) can be drawn from the magazine, passed through the cooler, and returned to the magazine; or (3) the air can be drawn from the compartment in which the thermo-tank is placed, passed through the cooler and delivered into the various officers' rooms and crew's spaces. The several principal magazines for torpedo heads and gun shells, both forward and aft, are thickly insulated with cork and felt and thoroughly lined with teak. By this means when the refrigerating machine has sufficiently reduced the temperature in the magazine the same may more easily be maintained.

Incidentally, of course, the lighting of the vessels throughout by electricity ministers to the desired end as regards general interior temperature, and this is especially appreciated in the officers', crew's, and firemen's quarters, spacious and well ventilated as these are. The generating plant—in the auxiliary engine-room—and electric wiring throughout are matters for which the well-known firm of Siemens Brothers has been responsible. All the navigation lanterns, compasses, and telegraphs are electrically lighted. The search-light projector on the navigation bridge is fitted with a Sautter-Harle gold-plated mirror.

One item in the equipment of these Brazilian destroyers is a novelty so far as this class of vessel is concerned. This is a motor pinnace, for which, no doubt, important uses will be found in the course of service. This little craft—there being three other boats to the equipment of each of the destroyers—is 18ft. in length, and is, of course, carried inboard on davits, the weight being well under a ton. While weight is kept down to a minimum, the craft are able little sea boats, with good freeboard, and built on the carvel system with wood of fairly stout scantling. All the motor pinnaces for the destroyers are propelled by 8 horse-power paraffin engines, and have reversible propellers. In connection with these little vessels, it is worthy of note that the firm which has built and is building them—McLaren Bros., Dumbarton—is also to provide a motor tug-boat for use in towing the pinnaces.

Mention has been made of the fact that in the case of the Para's trials on the Clyde the vessel ran 26.377 to the ton of coal, giving her a radius of action of 3692 knots. Other vessels of the series have shown equally good results, and subjoined is the tabulated results as to steam, speed, &c., of the trials over the measured mile at Skelmorlie of the Amazonas made on 29th December last, there being present His Excellency Admiral Duarte Huet de Barcellar, late Chief of the Brazilian Naval Commission, Captain Rosauro de Almeida, Captain Bartholomeo Francisco de Souza e Silva, Commander C. di Vasconcellas, &c.

No.	Hour.	Boilers.	Vac.	Air.	Revs.	Time.	Speed.	Means.	2nd means	Remarks.
1	11.1	215	26·10	1·75	336·5	2 12·5	27·169	27·221		Going north
2	11.10	210	26·10	1·62	335·5	2 12	27·273	27·293	27·257	
3	11.20	215	26·25	1·81	340·5	2 11·8	27·314	27·439	27·366	Advance per rev.: = 8·179ft.
4	11.29	215	26·00	1·68	341·0	2 10·6	27·565	27·544	27·491	
5	11.39	217·5	25·87	1·62	340·5	2 10·8	27·523	27·377	27·460	
6	11.48	210	26·00	1·75	335·75	2 12·2	27·231			Going south
Mean of miles		213·75	26·05	1·70	Mean of means of revolutions 339·801 ; speed 27·411 ; slip 16·01 per cent.					
For two hours		210·5	25·94	1·62	Mean revolutions 335·28 ; mean speed 27·061					

The total revolutions for two hours 80,467 (being 40,234 starboard and 40,233 port), which × advance per revolution and divided by 2 = 54·1233 knots + 27·411 knots for the first hour = a mean of 27·1781 knots mean for the three hours. Everything worked well.

It should be added that the technical authorities appointed by the Brazilian Government to assist in the construction of these vessels are, as regards the hulls and equipment, Capt. A. Rosauro de Almeida, Chief Naval Architect to the Commission, assisted by Lieut. Godofredo A. da Silva; while all technical matters connected with the machinery are under the control of Capt. Bartholomeo Francisco de Souza e Silva, the Chief Engineer to the Commission. The contractors feel, we understand, that a great deal of the success being attained by these vessels is undoubtedly due to the technical assistance they have received throughout the construction of the vessels from the gentlemen named.

THE CRAWFORD DERAILMENT.

(*From a Correspondent.*)

THE Crawford accident and Colonel Yorke's report upon it, referred to in your last impression, are in several ways so remarkable that I hope you will permit me to say a few words about both in your columns.

I have the full text of the report before me. It is more interesting for what it does not say than for what it does. It is an old saying that only the impossible happens. It is borne out by the story of the Crawford derailment, which seems to set at defiance and falsify all the laws of dynamics.

Let me begin at what is said to be, and ostensibly was, the beginning—the breaking of the crank, which was also the leading, axle close to the wheel seat on the left-hand side. This wheel was coupled to that next behind it, and to escape from the engine it must break the coupling rod and the splasher. The last was easy enough, but the first was not. The wheel was advancing at the same speed as the engine, and in the same line. Why should it turn off right or left with any force? Its gyroscopic stability ought to have kept it from turning over, and indeed did, we are told, keep it upright. It ran along the side of the line as a child's hoop runs. The coupling rod was broken close to the pin in the intermediate wheel. What broke it and left the wheel upright? On this point the report is quite silent. It is essential in considering the question that this point should never be lost sight of. If the rod had been broken by cross-bending, the wheel must have tumbled down at once; but it did nothing of the kind. It remained upright and bowled merrily alongside the train for a considerable distance, and finally ran up the side of the shallow cutting, and came to rest leaning against the fence. That is what we are told.

I turn now to the engine. The loss of a wheel made very little difference to it considered as a vehicle. It had nine wheels left to carry it, and so it kept the rails. The end of the axle would probably drop at the most 3in. This would twist the excentric rods and valve gear no doubt, and so explains the wrecking of the reversing gear, but it explains nothing else. The coupling-rod broke, as we have seen, close to the pin of the intermediate driver, so the leading wheel took the greater part of the coupling rod with it. The rods were 7ft. 2in. long between centres, and the wheels 6ft. 6in. in diameter. If the wheel took a length of 6ft. of rod with it, how did it manage to run alongside the track with the end of the rod trailing behind it and digging into the ballast? The statement that it did is apparently incredible. But in any case there was no length of rod left on the engine to fly round like a flail and smash things up. I have said that the dropping down of the left-hand end of the crank axle would be stopped by the keep, but there is another factor to be considered. The distance between the inside of the wheel rim and the side frame would not much exceed 1in., and the dropping of the left-hand end of the axle ought to have brought the right-hand wheel into grinding contact with the right-hand frame. This will account probably for the fact that the frame was bent.

The fracture in the axle was certainly curious. We are told "although a superficial examination of the axle disclosed no hollows or other imperfections in the material, it showed that the fracture had been growing for some time, the surfaces of this flaw, which at the time of the accident extended to about half the area of the shaft, having been rubbed smooth and almost polished. It is impossible to say how long this flaw had existed, though, as there were no signs of rust about it, it probably was not very old. The remaining half of the axle showed signs of sudden fracture, the metal being crystalline in appearance." I have seen a great many fractures in steel, old and new, but nothing in any way like this. It is hard to believe that sufficient motion could have gone on to rub the surfaces together until they were smooth and almost polished.

The bending of the coupling rods and the slipping of the wheels on their axles may be explained by saying that steam was on at the time. The moment a wheel was lost, half the adhesion of the leading driving wheels was lost. The remaining wheel would slip when passing the dead point, and so get out of step with the others.

Take now the evidence of Currie the driver, the accuracy of which was not disputed. "The coupling rod was broken between the left driving wheel and the intermediate wheel on left side. The coupling rod between the intermediate and trailing wheels on left side was bent. The outside frame on the left side was bent and twisted. The coupling rods on right side of engine were also bent, but the wheels were all in place on that side."

Colonel Yorke writes:—"It is evident that during the breaking of the axle and coupling rod some very violent disruptive forces were produced, which caused the engine frame, outside angle, and platform on the left side, to be twisted and bent out of shape, the brake gear and reversing rod and the brakes of the engine to be broken, and the intermediate left-hand wheel and the trailing right-hand wheels to be shifted circumferentially to the extent of 3in. upon their axles, the pins securing the wheels to the axles being sheared through longitudinally." The pins were round keys 1½in. in diameter and 6in. long, driven or screwed into holes drilled half in the wheel, half in the axle, after the wheels had been forced on.

How was it possible for the engine to run three-fourths of a mile with bent coupling rods and shifted wheels? How did they get past the dead centres with rods too short, as these must have been because they were bent? The play in driving-wheel axle-boxes is very small, wedges being used to prevent it. Try to run an engine with the coupling rods half an inch too long or too short, and see what will happen.

I now come to the most important point of all, how was the train derailed? About this not one of the witnesses could give the smallest information. Colonel Yorke says, after stating that a jerk took place which resulted in breaking the coupling between the engine and tender, "the jerk had the effect of derailing the latter and the next three vehicles to the right, while the fourth vehicle got straddle-wise across the rails, the leading end being to the right, and the trailing end to the left, with the result that it tore up the left-hand rail, and the rest of the train, consisting of five coaches, ran off to the left, and came to rest against the side of the shallow cutting, the wheels being more or less buried in the soil. The two portions of the train were separated between the fourth and fifth coaches by a distance of about 20 yards."

The driver says:—"When about three-quarters of a mile past Crawford Station the engine gave a severe lurch, followed by a jerk. That was the first I knew of anything being wrong. Immediately after this the tender seemed to have left the engine, the coupling being broken between the engine and tender. The engine ran on for about three-quarters of a mile, leaving the tender and rest of the train behind."

The tender was very large and heavy. It was carried on two four-wheeled bogies, with wheels 3ft. 6in. diameter, spaced in each bogie 5ft. 6in. apart centre to centre. The bogie pins were 11ft. apart. Now, to throw the tender off the road it is clear that the trailing end of the engine must have swung laterally several inches. I confess I am quite unable to see why such a swing should take place, or, indeed, how it could take place at all while the trailing wheels of the engine kept the road. But this is not all. Ostensibly, the moment the wheel broke away a jerk occurred, and the tender was forced off the rails to the right—that is, into the six foot. But I see from the report that the first mark on the permanent way was no less than 43 yards behind the tail of the train, so that the tender must have run 43 yards and a whole train's length, say, 150 yards more, before it came to rest. We are not told what was the nature of the first mark. But from this spot to the front of the train "the whole of the down line was destroyed, the right-hand rail being damaged and displaced, and the left-hand rail torn up and twisted for a considerable distance; one of the rails was forced through the fence at the side of the line, and another was found to be resting on the top of the axles of one of the coaches."

It is clear that the engine did not do the mischief. If it had torn up the road it must have been derailed. Are we to assume that the tender having been derailed tore up the road and the rest of the train completed the work of destruction? The damage done to the permanent way was much greater than is usual in such cases, and there is no available evidence that the tender and the two next coaches ran along the sleepers for any distance. The report is, indeed, lamentably meagre.

Let me return now for a moment to Colonel Yorke's words:—"The first sign of any damage to the permanent way was found at a spot forty-three yards in rear of the second portion of the train, and from here to the front of the tender, a distance of 250 yards, the permanent way was destroyed, the right-hand rail being bent and thrown out of line, while the left-hand rail, as far as the front of the fourth coach, was completely torn up. North of the tender, and south of the spot referred to, the permanent way was absolutely undamaged. It may be taken for granted that the place where the damage to the permanent way commenced marks the spot where the axle snapped and the driving-wheel became detached from the engine, and, as already stated, the distance from here to the front of the tender was only 250 yards, or about 60 yards more than the length of the train." This "first sign," then, was the place where the engine lurched, and the wheel came off. We are told that the wheel ran about 110 yards. It would be interesting to know whether the distance was measured from the first mark. On this point there is no evidence.

If we do not accept Col. Yorke's explanation, does any other suggest itself? Two have already been hinted at in your leading article last Friday. Did the coupling-rod break first? If it did it would probably fly round at first, smashing up the splasher, bending the running board, and so on. We may take it that a flaw existed in the axle. If the end of the coupling-rod struck a sleeper or a chair endways the weakened axle would give way, and at the same time a rail might be forced out of place, and the derailment of the tender would follow. This is a perfectly feasible explanation. The derailment of the tender would break the coupling between it and the engine, and cause the jerk and lurch.

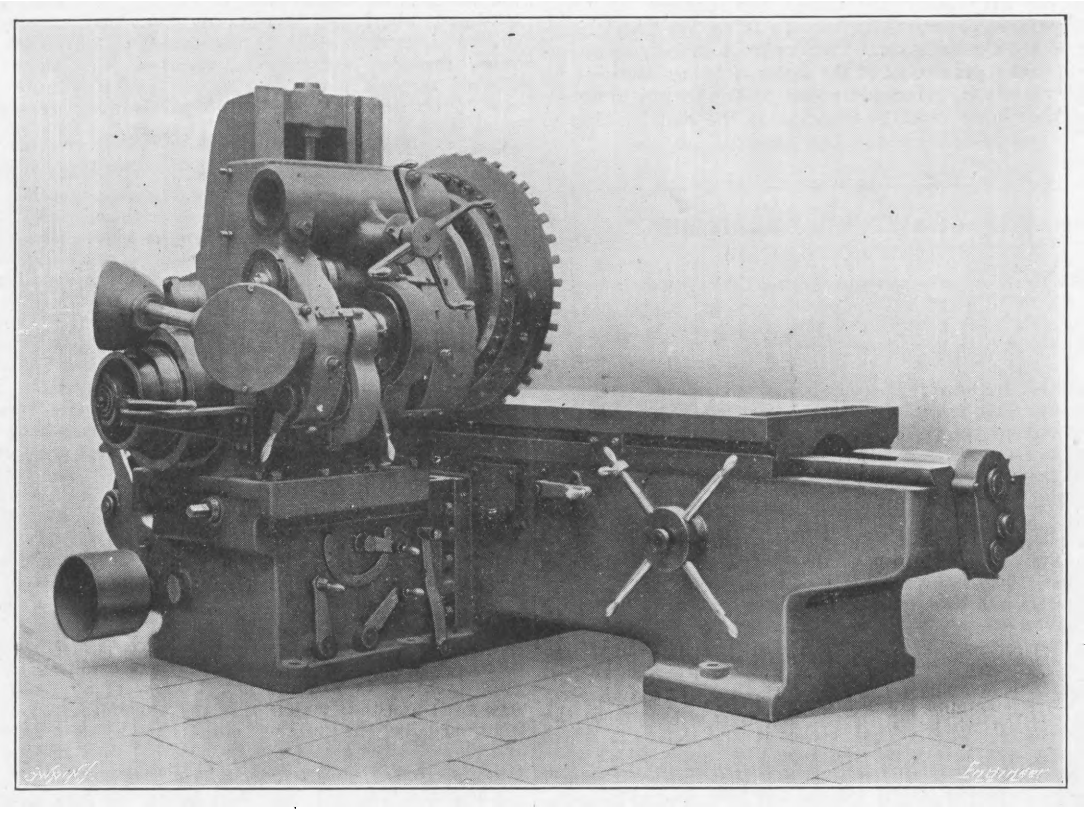
The second is that a rail was broken by the engine, and that the first result was a jerk which broke the flawed axle. The tender was then pulled off the road by the derailed coaches, and parted from the engine. Instead of the engine shaking off the tender, the tender would shake off the engine, which is a different thing.

I think many of your readers will agree with me that more detailed information would be not only interesting but very valuable. The escape has been quite narrow, and there is nothing like the spread of information to prevent accidents.

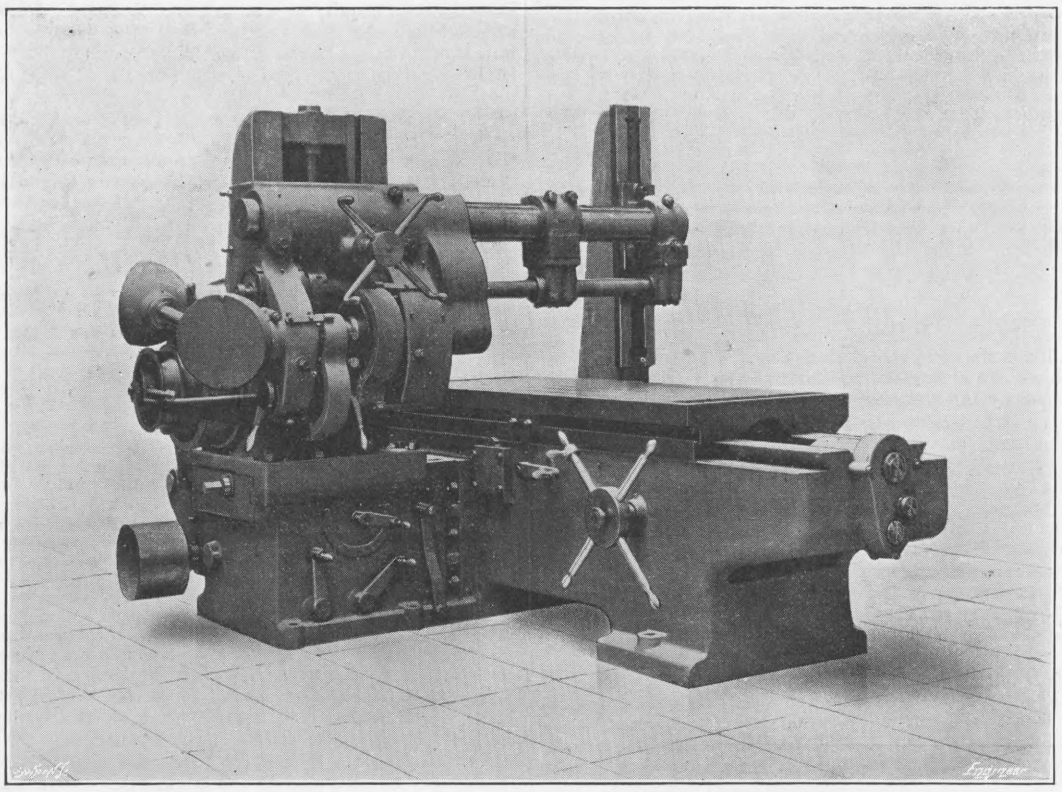
Institution of Mining Electrical Engineers.—The formation of a branch of the new Institution is projected in Scotland, and a meeting for this purpose will take place on Saturday, July 3rd, at 7 p.m., at the offices of the Institution of Engineers and Shipbuilders in Scotland, Elmbank-street, Glasgow, when local officers will be proposed and elected for the Scottish districts.

MILLING MACHINE

TANGYES, LIMITED, BIRMINGHAM, ENGINEERS



MACHINE ARRANGED FOR FACE MILLING



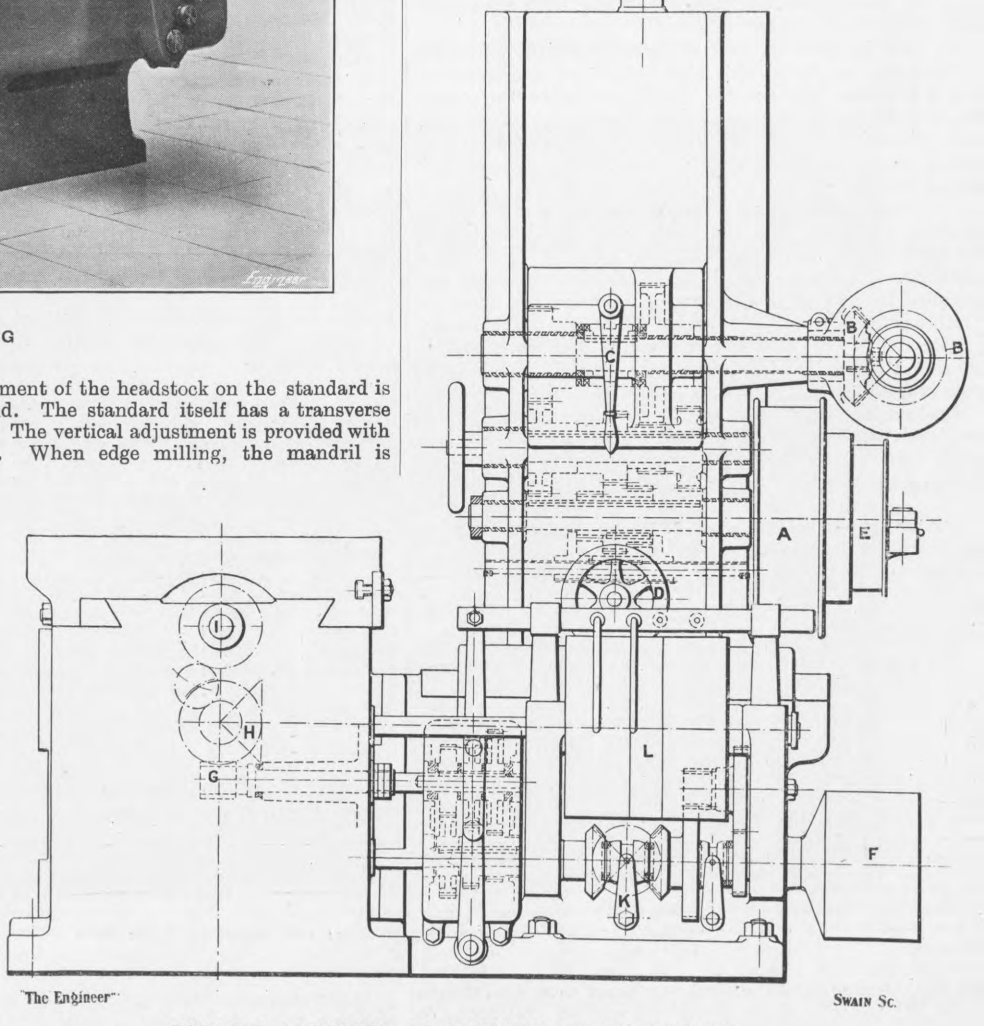
MACHINE ARRANGED FOR EDGE MILLING

A HEAVY-MILLING MACHINE.

A MILLING machine designed especially for extra heavy work has been recently constructed by Tangyes Limited, Birmingham, and forms the subject of the illustrations on this page. The machine can be used for either face or edge milling, and the two photographs reproduced show it as arranged for these two classes of work.

The machine is driven by a constant belt, and the changes of speed are obtained wholly by gearing. The belt pulley is marked A in the end elevation given herewith, and it is provided with a friction clutch, which allows of instantaneous stopping and starting. An extension of the first motion shaft carries the pulley E, which drives the feed pulley F by a belt. In the event, therefore, of the main belt breaking or slipping, the feed also ceases, and damage is avoided. From the main pulley A power is conveyed through the gearing shown to the mitre wheel B, which drives a wheel keyed on a shaft having slight endwise motion. This shaft conveys power to the headstock, and the arrangement, it will be seen, permits of the headstock sliding vertically on the column. The changes of spindle speed, twelve in number for edge and eight for face milling, are effected by the lever C, hand wheel D, and back gear on the headstock itself. The feed is conveyed from the pulley F, through the reversing gear K, and gear-box shown to the worm G, driving the wheel H and, ultimately, the feed-screw I. All the handles for controlling the feed are brought to the front, as seen in the engravings; they give six changes. The table has, furthermore, a hand feed and a quick-power movement in either direction; the latter is taken from cross and open belts on the set of pulleys marked L, and it is controlled by the long upright lever at the front of the machine.

The spindle is of forged steel, and runs in conical bearings. A disc is wrought on the front end to carry the facing block, and hardened steel collars, with adjusting nuts, take the end thrust. The adjustment of the headstock on the standard is effected only by hand. The standard itself has a transverse adjustment of 5in. The vertical adjustment is provided with micrometer setting. When edge milling, the mandril is supported by a bracket and standard in the manner shown. The second bracket shown is put on when required as an additional support. A special arrangement is fitted whereby these brackets may be quickly removed or replaced. A cutter 35in. diameter is provided for face cutting. The table is 72in. long by 29½in. wide, and the maximum distance from its face to the centre of the spindle is 27in. The spindle is 7in. diameter at the front end. The whole machine has been constructed to withstand very heavy cutting.



BACK-END ELEVATION OF TANGYE'S MILLING MACHINE

BIRTHDAY HONOURS.

NOT very many names connected with engineering or kindred sciences and professions appear in the Birthday Honours, but there are some to which, following our usual custom, we may refer. First of all, knighthood has been conferred upon Mr. Joseph Larmor, Mr. Thomas Matthews, Mr. Walter Menzies, and Dr. Thomas Edward Thorpe. Mr. Larmor is possibly best known in his capacity of secretary to the Royal Society; Mr. Thomas Matthews has for many years been chief engineer to the Trinity House; Mr. Menzies succeeded his father as principal of James Menzies and Co., tube makers, of Glasgow, but retired nearly ten years ago; and Dr. Thorpe is the eminent chemist and director of the Government Laboratories, London. Next in order of precedence comes Mr. Henry Parsall Burt, A.M. Inst. C.E., manager of the North-Western Railway of India, who has been made C.I.E. Then there are three C.M.G.'s—Mr. Matthew Joseph Butler, chief engineer of Government Railways and Canals in Canada; Mr. Alexander Bain Moncrieff, chief engineer of Harbours and Jetties in South Australia; and Major George Edward Smith, R.E., Director of Surveys, East Africa Protectorate. Mr. J. C. Aylan, late manager of the East Laboratory, Royal Arsenal; Mr. S. H. Knyvett, Deputy Chief Superintendent of Factories, Home-office; and Mr. J. K. Logan, Superintendent of Electric Lines, Post-office and Telegraph Department, Dominion of New Zealand, have all three been made Companions of the Imperial Service Order. We ought to mention, perhaps, that Viscount Kitchener can now add to the large number of letters after his name those of G.C.S.I.

LABOUR EXCHANGES BILL.

FINANCIAL STATEMENT.

THE national system of Labour Exchanges which it is proposed to establish under the present Bill contemplates the division of the United Kingdom into ten great districts, each Division being a unit complete in itself, under the supervision of a Divisional Central Office or "Clearing House," and containing a network of minor exchanges, varying in importance with the localities which they serve. The Divisional Centres will be co-ordinated with each other and with the central office or "National Clearing House" of the whole system, which will be situated in London.

For the complete and efficient organisation of this system, at least 240 Exchanges will probably be required, and the best and more economical method for the provision of accommodation for these Exchanges has been carefully considered by a small committee of the Board of Trade.

The Exchanges have, for purposes of convenience, been very roughly classified as follows:—

A. For towns with over 100,000 inhabitants.
B. For towns with from 50,000 to 100,000 inhabitants.
C. For towns with from 25,000 to 50,000 inhabitants and suburban districts.
D. Docks and Casual Labour Centres (waiting-rooms).

It has been estimated that the numbers of each of the types of offices will be approximately:—

A. From 30 to 35.
B. From 40 to 45.
C. From 130 to 160.
D. (Waiting-rooms), from 20 to 30.

This is exclusive of the Divisional Clearing Houses, which will be located in the same building as the principal Exchange in each Division, and the Central Office or National Clearing House in London.

It will not, of course, be possible to bring the whole system into being during the present financial year; the utmost that can be done will be to set up about half the total number proposed, but these will include nearly all the more important Exchanges, the remainder being established in 1910-11.

The method which it is proposed to adopt as a rule at the outset is to hire existing premises throughout the United Kingdom, and to carry out the necessary alterations and adaptations to fit them for the purposes of Labour Exchanges.

The accommodation required for these Exchanges is, however, necessarily of a somewhat special character, including adequate waiting-rooms, commanded by and easily accessible from the offices set aside for the staff. This is not always readily obtainable, and, especially in the case of the more important, *i.e.*, the Class A Exchanges, it is not likely that entirely suitable premises will be obtained without a great amount of costly adaptation. For this reason especially, and generally for the more efficient working of the system, it is proposed eventually to erect buildings, at least for the Class A Exchanges, such construction being spread over a period of some ten years. While this course will necessitate additional capital expenditure, the estimates which have been framed go to show that it will result in considerable ultimate economy owing to saving of rent.

Estimates have been framed showing the probable cost of renting and adapting premises for the different types of Exchanges. This expenditure falls naturally into two divisions, viz. (1) initial expenditure, for alterations, fittings, and furniture; and (2) annual expenditure, for rent and taxes, heating, lighting, and maintenance. The total amount for each of these categories is estimated to be approximately £100,000 and £60,000 respectively, for the full number of Exchanges contemplated.

The eventual cost of purchasing sites and erecting buildings for Class A Exchanges would, it is estimated, amount to some £180,000, and, as has already been pointed out, this process would be spread over a period of years, probably about ten. The ten Exchanges housing the Divisional Clearing Houses should, however, be constructed in two years, *i.e.*, in the years 1910-11 and 1911-12, as it is most important that the Divisional Centres should be suitably housed and adequately equipped at the earliest moment possible. The saving effected in annual cost of rent, &c., at the end of the period of construction has been estimated to amount to about £10,000 per annum.

The initial expenditure on buildings, including sites, would amount to about £65,000 in the present financial year, £65,000 in the following year, £36,000 in 1911-12, and rather under £20,000 in each of the following six or seven years; the annual expenditure on rental, upkeep and maintenance would rise from about £10,000 in the present year to about £50,000 in 1910-11. In 1911-12 the figure would amount to about £55,000, and would decline gradually to about £45,000, as the building of premises for the Exchanges is completed.

Each Exchange will have a staff varying from the single clerk-caretaker of a simple waiting-room to the staff of about a dozen for a Divisional Clearing House. The total number of officers of all grades required will probably be over 800, and the average annual cost of salaries and wages when the scheme is in complete working order is estimated approximately at £95,000. The expenditure on salaries in the present financial year will be about £15,000, in the second £65,000, rising ultimately to the figure stated above.

The two items already dealt with cover the major portion of the amounts required.

In addition to this, postage, printing, and stationery is estimated to account for another £25,000 a year; and telephones, which form a most important feature of the system, together with travelling and incidental expenses, will require about £12,500 more.

The total sum in respect of expenses other than on account of salaries and buildings is thus about £37,500. In the present year about £12,000 will be required under this heading.

The total expenditure, so far as can be estimated at present, will be approximately as follows:—

	£
1909-10	100,000
1910-11	210,000
1911-12	210,000
1912-13	200,000
1913-14	200,000
1914-15	200,000
1915-16	200,000
1916-17	200,000
1917-18	200,000
1918-19	200,000
1919-20 and subsequent years	180,000

LETTERS TO THE EDITOR.

(We do not hold ourselves responsible for the opinions of our correspondents.)

TIME AND OVERTIME.

SIR,—In your late strictures against the proposal to abolish overtime by compulsion, unless in actual breakdown cases, you almost naturally omit one point.

Workmen as a rule have children or dependents to support for the larger part of their lives. The needs and wants in a family are numerous. Most workmen, therefore, however they dislike extra hours, are thankful to get a little extra money by working late. Thinking over this on previous occasions when the abolishing of overtime has been mooted, the present writer has thought—how is it that everyone likes extras? Whether it be a wage of 25s. or a salary of £25 per week, an extra is appreciated. On the part of a workman it is obtained by usually honest extra work. On the part of others it may be obtained by outside work of one kind and another. And on the part of some superintendents and managers they are got through actual bribery or dishonesty.

But as far as workmen are concerned it is difficult for them to hold for their liberty when some union official or individual says, "If no overtime is worked so many more men will be employed." It looks selfish to claim a free hand, and men are inclined to conceal their real thoughts on the subject, unless to those who understand. No doubt too much overtime, say, every night till nine and all night through on Fridays for weeks together, wears a man out, notwithstanding the uplifting pleasure of being able to get a new suit for one of the boys or a new dress for the wife. A man has his duties to others, but in cases of apparent perplexity his duty is to his own family. You have pointed out the impracticability of abolishing overtime. The masters will do their duty to their men as well as to themselves by resisting the attempt to abolish necessary overtime.

Another point arises here. Fifty years ago or so in many cases masters knew their men and appreciated those who were reliable and capable. This brought out ability, as it always does. Men remained with such masters all their days. Sons succeeded fathers in a successful business, but, in so many cases, in a different spirit. Money, that root of all evil, which makes one man feel competent to lecture or advise the Government, makes the majority believe they are superior to those of their fellows, who, like a famous apostle, have to work with their hands. Or worse, a limited company is formed, the directors of which know little or nothing of work, so far as handiwork is concerned. A manager is chosen. THE ENGINEER has often pointed out the small chance ability has against influence in engineering. Is real ability merciless? The manager may be a cunning man who works on the abilities of others. Or he may be pressed by the directors. The result is, men are taken on when work comes and are paid off when work is finished. This evil has assumed alarming proportions. Nothing is more degrading or demoralising to men, except vicious living, than to be taken on for a few days or weeks, then paid off to wander about like tramps, till another amount of work is forward. The answer to this is always ready, that men cannot get work if there is none. This is so far true, and so far deplorable, but it does not cover all the ground. I will give a typical case, the facts of which have been vouched for to me. A well-known shipping line has a repair shop. Till within a year or so the men between repair times prepared spare parts for the various boats. A new manager was installed and abolished the work between times. Men accustomed to steady employment are now taken on on a Monday, Tuesday, or Wednesday, to be paid off on the Friday night. And one of the partners is a socialist! Possibly this is a case of one manager trying to work cheaper than a former one. But have we no responsibility here or hereafter how we act to our fellow men? Establishments cannot be carried on at an ultimate loss. But there is a wide margin between that and the losing of 1 or 2 per cent. in order to treat men considerately—as one would like to be treated himself.

From what one observes, it would appear that the companies who treat their men fairly are those who reap the reward ultimately in better service.

June 28th. BEECHWOOD.

TIDAL POWER *v.* GAS POWER.

SIR,—I have read the articles appearing in THE ENGINEER of February 26th and March 5th respectively, by W. C. Horsnaill, A.M.I. Mech. E., A.M.I.E.E., treating on the above-mentioned subject. Being deeply interested in the problem of the utilisation of the energy contained in the ever moving tides of the sea for electro-generating purposes, I read said articles very minutely, and I would desire to differ, with your permission, and with all due respect for Mr. Horsnaill's professional opinion regarding the future prospects of the utilisation of tidal power, as expressed by him as follows:—"In whatever way the question is approached, there appears to be no field for tidal power so long as coal remains at its present value, and we are more likely to see the closing down of the few tidal mills still in operation than an extension of this form of power to other industries." This opinion, I think, his own showing does not warrant, as is very clearly demonstrated in his comparative table, which brings out, so to speak, on top, commercially, a very old and now considered obsolete method of utilising the tides for the production of motive power, even when comparing with one of the latest, and admittedly the most up-to-date means of producing, at any rate, a limited output of motive power, namely, the gas engine, with a small intermittent tidal power installation at Walton-on-the-Naze, of the limited extent of 1,110,000 square feet, or close on $25\frac{1}{2}$ acres, approximately 12ft. tidal range, and necessitating the employment of a storage battery costing £800, as compared with one allotted to the gas engine costing only £400. Yet, as is shown by the aforementioned comparative table, the now admittedly old and antiquated method of operations in order to produce 85 E.H.P. or say, $3\frac{1}{3}$E.H.P. per acre, is made to show, on said comparative table, a clear saving of £39 10s. per annum, in comparison with the annual expenses in connection with the working and upkeep of the gas engine in the production of a similar volume of motive power, or within a fraction of 10 per cent. per annum; or, in other words, about 10s. per horse-power per annum. Take, for example, a tidal power installation of, say, 20,000 horse-power and upwards, and which would necessitate the empoyment of a great number of gas engines and storage batteries to produce, resulting in an annual saving for upkeep, &c, in favour of tidal power of £10,000 and upwards per annum, in proportion to the magnitude of the installation. Query: What would the saving amount to in the case of the employment of a comparatively simple and much more efficient system of operating the tides, enabling the production of continuous and practically uniform electro-generating power without the aid of a storage battery, which same is costly to erect and maintain? Such a system is not at present unknown in England and elsewhere, it being the principle—viz., a plurality of reservoirs—as propounded by the writer, but only partially adopted in at least three proposed tidal-power installations in various parts of England, estimated to produce from 8000 E.H.P. up to 240,000 E.H.P., and one in a sister island said to be capable of producing upwards of 500,000 horse-power continuously, together with at least two adjacent to the Bay of Fundy, one convenient to Perth, Western Australia, and one in Western Port Bay, Victoria, said to be equal to an output of 250,000 horse-power.

According to the published result of calculations made, based on certain ascertained data by a well-known civil engineer in London, respecting the three first-mentioned installations, showing an annual income of 12 per cent. of the initial capital cost from the disposal of the output of the electric energy to consumers at only £4 5s. per E.H.P. per annum, on the basis of an estimated output of only 1 E.H.P. per acre of the total area of the tidal waters impounded, having a 12ft. tidal range, which is said to be a sufficiently large percentage to provide for interest, depreciation, maintenance, and working expenses of hydro-electro installations, as compared with the tidal power installation at Walton-on-Naze showing an output of $3\frac{1}{3}$ E.H.P. per acre from a 12ft. rise of tide, working for nine or ten hours out of every twelve hours, and costing to produce 85 E.H.P., as per comparative table above referred to, £413 per annum or £4 17s. 2d. per E.H.P. per annum, whilst the "up-to-date" gas engine costs, for a similar amount of work, £452 10s., or £5 6s. 6d. per E.H.P. per annum.

By the adoption of the full provisions as embodied in the principles underlying the Continuous Tidal Power Scheme, and taking, for example, an area of tidal waters having only a 6ft. tidal range, and the necessary embankments equipped with the most suitable type of turbines, it will produce over 3 theoretical horse-power, continuously, per acre of the area of tidal waters impounded; and allowing, say 50 per cent. for efficiency, gives at the rate of $1\frac{1}{2}$ E.H.P. per acre. But, on the other hand, should the rise of tide be 12ft., same as that under consideration, the output of motive power will be just four times as great from a similar size area, seeing that the head, or fall, and volume flowing would be each double that of the former, namely, 12 theoretical horse-power, and, say, 6 E.H.P. per acre respectively, and that without the aid of a storage battery, as the direct motive power is absolutely continuous.

Dunedin, N.Z., May 15th. J. JAMISON.

MARINE PROPULSION.

SIR,—Since "T. S. C." dismisses every one of my endeavours at logical examination into cause and effect—action and reaction—in quite a number of mechanical transmissions of energy as irrelevant dissertations, and yet keeps asking me for proof that the work of action equals the work of reaction, I am really at a loss to think what proof he wants. I should therefore be very pleased if you, Sir, could assist in obtaining a verdict from a competent authority as to whose interpretation or transcription of the third law of motion is correct, and answer the following few questions:—"T. S. C." says: "The work of action is of a different amount to the work of reaction, and, in fact, is inversely proportional to the respective masses in any one particular system" (see THE ENGINEER, May 7th, page 483). I say: "That, as action and reaction are equal and opposite, this is synonymous to saying that the work done by action equals the work done by reaction in any one particular system." (1) Which of the two is correct? (2) Can any work be done without action taking place, or (3) can any action take place without work being done? (4) Is there any difference between (if so, what) work doing—action proceeding—or work done—action complete? If I can obtain authoritative replies to the foregoing questions, which I hope you, Sir, will kindly assist me to, then, if still necessary, I will deal further with "T. S. C.'s" arguments. In the meantime I beg to inform "T. S. C." that the copy of Aveling's "Natural Philosophy" which I possess was published by W. Stewart and Co., now of 210, Strand, London, W.C. If, however, "T. S. C." still fails to obtain a copy, I shall be quite pleased to lend him mine for about two or three weeks against payment of postage both ways.

June 26th. W. PREIDEL.

[We have already advised our correspondents to consult the late Sir William Anderson's "Conversion of Heat into Work," where the point at issue, as referred to a gun and its recoil, is dealt with in exceptionally clear language. We quote a few sentences. On page 152, &c.—"The work being external, there must be the same amount of *work* in the recoil; because, according to the third law of motion, to every action there must be an equal and opposite reaction, and therefore the quantity of motion must be the same." Our correspondents will notice that we have put the word *work* in italics. On page 153—"But not only must the accelerated motion of recoil take place in the same time as that occupied by the discharge, but because, according to Newton, velocity is proportional to the impressed force; the rate of acceleration of the shot and gases as they move along the bore at each instant must have its counterpart in the motion of recoil, hence the curve of velocities of recoil, could we construct one, would correspond to that for the velocities in the bore but on a reduced scale. Because of the quantities of motion in the discharge and recoil being equal, and of the weight of the gun and its carriage being much greater than that of the shot and gases, the motion of the former will be so much slower than that of the latter . . . ." Finally, page 162—"The time of discharge will also be the time of the acceleration of recoil." These few sentences can leave the matter in no doubt $\frac{m \cdot v^2}{2g}$ is certainly equal to $\frac{M \cdot V^2}{2g}$. If our correspondents will imagine the case of a simple steam engine they will see that the piston and its attachments are doing the work, and the cylinder and its attachments taking the recoil. They will admit, we have no doubt, that if the piston were held, and the cylinder suitably coupled to the crank the same amount of work would be done. To avoid confusion they may imagine that the cylinder and piston are the same weight.—ED. THE E.]

LATENT AND SENSIBLE HEAT.

SIR,—If Mr. Dines will kindly read my letter again he will see that I am not raising the question of wire-drawing steam by a cock, but what is the total heat in saturated steam. He will also see that it is not I, but Regnault, who points out that if steam is wire-drawn by a cock it *may* (not *must*) lose heat. Regnault's object was to emphasise the absolute necessity of the steam being saturated steam, when the heat is measured, if the total heat in saturated steam is to be arrived at beyond doubt.

Mr. Dines, by leaving out the word "may," raises a most important question, but it is obvious that totally different conclusions can be arrived at, according to whether Regnault or Southern is accepted.

As regards turbines exhausting superheated steam. Twenty-six degrees of superheat has been noticed in a turbine's exhaust and superheat has not been noticed simply once or twice, but in a very large number of cases. In the cases of superheating, within my own knowledge, the accuracy of the pressure was checked in a special way, and I satisfied myself that the pressure shown by the mercury column, corrected to the barometer, was the pressure which ought to be present, according to the heat present, if Southern's law is accepted.

The chief object of this letter is to ask if there is any independent experimental evidence which confirms Regnault. I can find none. Certainly there are experiments which have been made, but the steam has always been throttled or wire-drawn before the heat has been measured, a thing Regnault says must not be done. I believe the reason why this throttling has been done is because, if Regnault's figures are examined, it apparently makes no difference whether the steam is throttled or not throttled. These throttling experiments, therefore, do not depend upon themselves for their truth, but on the assumption that Regnault measured the heat in saturated steam, whilst I have proved Regnault himself throttled the steam.

I do hope if there is any evidence which confirms Regnault it will be brought forward. Of course, mathematical evidence based upon Regnault proves nothing. I should also like to know if anybody has ever repeated Regnault's experiments; so far as I can ascertain, no one has ever done so.

As regards the missing quantity, I do not see how any definite conclusions can be arrived at till the question is settled. Are we to believe Carnot's fundamental basis and Southern's law, or Regnault, Rankine and Clausius? It is obvious if Carnot and Southern are accepted, the liquefaction theory is a myth, the volumes of saturated steam are not what we believe, the condensation and re-evaporation which can take place in a cylinder are different to what we believe, the curve which steam will give if it only loses the heat converted into work is different to what we believe.

What the true missing quantity at any point of the stroke is has never been proved. This is in answer to "G. B. D."

Blackheath, June 28th. F. B. ASPINALL.

THE GEOLOGISTS' ASSOCIATION.—The next meeting of the Geologists' Association will be held at the apartments of the Geological Society, Burlington House, Piccadilly, on Friday, July 9th, 1909, at 8 p.m., when a paper, descriptive of the area to be visited during the long excursion, will be read—"The Geology of the Arenig District, North Wales," by Wm. George Fearnsides, M.A., F.G.S. The lecture will be illustrated with lantern views. The Council of the Association will meet at 7 o'clock the same evening. The long excursion to the Arenigs will take place from July 28th to August 7th, 1909. The train by which members will travel leaves Paddington on Wednesday, July 28th, at 11.25 a.m., arriving at Bala 4.47. Programmes of the excursion may be obtained from the Excursion Secretary, Mr. Alfred C. Young, F.G.S., 17, Vicar's-hill, Lewisham, S.E.

GRADUATE ENGINEERS' MEETINGS IN SHEFFIELD.—The Graduates' Association of the Institution of Mechanical Engineers held their summer meetings in Sheffield last week. Members were present from London, Manchester, Birmingham, Coventry, Liverpool, Bolton, Harwich, Alfreton, Gainsborough and Rotherham. The visiting members arrived in Sheffield on the 23rd ult., and next day visited the cutlery works of Joseph Rodgers and Sons, and the East Hecla Works of Hadfield's Steel Foundry Company, Limited. On the 25th ult. they inspected the Applied Science Department of the University of Sheffield, and later in the day went over the Sheffield Testing Works, and the Norfolk Works of Messrs. Thomas Firth and Sons, Limited. The general meeting of the Graduates' Association was held at the Applied Science Department the same evening, when Professor Ripper presided in the absence of Sir Robert Hadfield, who has not yet returned from the United States. Three papers were read. Professor Arnold dealt with "The Correlation of Micro-structure with the Elasticity of Materials of Construction;" Mr. John Heath, Sheffield, took for his subject "Drawing-office Systems;" and Mr. Frederick Hollingsworth, of Cape Town, read a paper entitled "Some Notes on the Causes and Treatment of Leaking in Locomotive Fire-boxes." An interesting discussion followed the papers, the readers of which were accorded a hearty vote of thanks. On the 26th ult. a visit was paid to Bentley Colliery at Doncaster.

RAILWAY MATTERS.

It is stated that the two existing signal cabins at London-road Station, Manchester, are to be replaced by one large electrical cabin. The alteration will be made in connection with an important extension scheme being carried out by the London and North-Western Railway Company.

The block signalling installation now under way on the St. Louis and San Francisco Railway, states the *Engineering Record*, is one of the largest continuous automatic signalling systems ever put down at one time. It covers a total of 719 miles, most of which is single track, with a maximum block length of 2½ miles on single track and 1 mile on double track. The signals are of the three-position upper-quadrant normal-clear type.

The Calcutta *Railways* states that "the extended use of the mono-rail system of transport for passengers and goods depends very much upon a satisfactory pattern of carriage, and Mr. Brennan is working hard to reach success in this direction. Experiments are now being made in short lengths on roads near Kamarhati and Dharampur—Kalka-Simla road—with a view to testing the value of mono-rail for military purposes on hill roads. A report will be furnished when the trials have come to an end."

A consular report, dealing with the trade and commerce of Mozambique (Portugal), states that a light railway running from Matamba, in the Bay of Inhambane, to Inharrime, 50 miles to the south-west of that point, has been under contemplation for some few years past. This scheme, for which it is understood orders have now been placed for the rails and sleepers, is intended to develop the rich northern districts of Gaza, which are regarded as among the most valuable in the province. No work has yet been commenced, however, possibly because of a heavy rainy season.

The New York Railway Club has appointed a special committee to study the subject of steam railway electrification, which will render a report of its work for consideration at the annual electrical meeting of the club next March. The committee is to collate and tabulate such general data as may be of interest to railway men, and make such suggestions as may appear pertinent to them with reference to the direction in which it would be desirable to have further investigation and information. The Maintenance of Way Association and the American Railway Association are considering the subject of electrification along substantially the same lines.

The improvements at the London-road—Manchester—Station of the London and North-Western Railway, states the *Railway News*, are making excellent progress, and, with the completion of the new local station, the terminal facilities will be materially increased. The advantages of the Levenshulme to Wilmslow line are already being felt, and some of the fast trains between Manchester and Euston use the new link, picking up Stockport and Lancashire and Yorkshire passengers at Wilmslow, and running from thence non-stop to Euston. The London and North-Western is also carrying out the widening scheme on the Trent Valley line, which foreshadows new traffic developments.

We hear that the scheme for a moving stairway between the Central London station at the British Museum and the Piccadilly Tube Company's Holborn station is now taking definite shape. The stations which it is proposed to connect are separated by a distance of about 400ft., and a rather steep grade or stairways would have to be features of any passage between them. Passengers desiring to go from one station to the other would simply have to get on the moving platform and be carried from one to the other without any exertion on their part. Handrails will move with the platforms, and will travel at exactly the same rate of speed as the platforms. It remains to be seen how passengers will take to this innovation, but the advantages of a direct means of communication between the two stations are undoubted.

According to the *Railway News*, the Bavarian Government's decision regarding the application of the Badische Anilin and Soda Fabrik for the concession of the water power of the Lower Alz has again been postponed, and the matter will, it is said, remain under consideration until autumn. The State railway authorities have secured control of the Walchensee power, which they intend to use for railway electrification, but will not require that of the lower reaches of the Alz. The Government, however, appear still to be undecided whether to erect their own power station and themselves supply the electricity direct to consumers, or to grant the desired concession to the Badische Company, or to divide it up among other concerns. Part of the power has already been granted to the Cyanide Company, but about 45,000 horsepower still remains to be disposed of.

An American consular report states that with the completion of the second section of the municipally-owned electric railway at Osaka, nine miles have been opened to traffic. This includes a line three miles in length to the harbour. Work is now being commenced on the third section - 32 miles—and a fourth section—13 miles—is also contemplated. Osaka will eventually be linked with all the neighbouring towns by an electric railway system. Connection with Kobe—the Haushui Electric Railway—and the Hawadera—a seaside resort 15 miles distant on the Nankai Railway—has already been established. It is now proposed to electrify the rest of the Nankai Railway to Wakayama, 40 miles distant. Electric railways to Kyoto and Arima, mineral springs and summer resorts in the hills on the north-west, are also under construction.

The Sub-committee of the Leeds Corporation which recently visited the Continent to study the question of railless electric trolley cars has issued its report, which speaks favourably of the system, and recommends its installation between Leeds and Farnley. The report gives particulars of the working expenses of some of the continental installations. With the Mercédès-Stoll system the overhead construction cost £1690 per mile, the chassis —without bodies - for the cars £550 each, and the working expenses, including such items as taxes and repairs, amounted to only 4.52d. per mile. At Milan, on the Filovia system, the cost of operation was 5.65d. per mile. It may be gathered that the continental services are somewhat below the standard expected in the neighbourhood of large English towns, where these costs would most likely be exceeded. The omnibuses employed on the Continent are mostly single-deckers, with comparatively small seating capacity.

In the *American Engineer and Railroad Journal* Mr. S. S. Riegel records some interesting tests upon model half-boilers of locomotives. The models were approximately to scale, one half-boiler being of the standard type, and the other provided with the Riegel water tubes arranged at an angle over the fire, between the mud ring and crown sheet of the fire-box. The tests were conducted at atmospheric pressure with scaly water. The general results showed a greater evaporation of about 50 or more per cent. in favour of the cross-tube design, although, as the models were short in the barrel, this percentage would be somewhat less in practice. The cross tubes were found to promote a very active circulation about the fire-box, and kept it free from scale, which was, however, deposited on the outside of the plain fire-box. In comparing the performances of the two types of fire-box it should be pointed out that the cross-tube boiler had also 10 per cent. more tubes in the barrel than the standard, and since both boilers were heated by the same fire and fed into the same chimney it is clear that the bulk of the hot gases would be drawn through the new type of boiler. Indeed, it is thought probable that the greater part of the extra evaporation obtained was due to this cause.

NOTES AND MEMORANDA.

Discoveries of copper, gold, and silver are reported to have been made on the Fiji Islands, and Western Australian mining men are at Suva, Viti Levu, awaiting the publication by the local Government of regulations under which mining may be carried on, after which the new discoveries will be thoroughly exploited. No mining on a commercial scale has ever been done on these islands.

The making of tin-plates originated in Bohemia, according to a recent paper by Mr. William E. Gray, hammered iron plates having been coated with tin in that country some time before the year 1600. Tin-plate making was introduced in England in 1665, the art being brought there from Saxony. In France the first tin-plate factory was established in 1714. The first commercial manufacture of tin-plates in the United States was at Pittsburg, in 1872; but the industry did not develop largely until after 1890.

The total output of electricity from the three generating stations of the Manchester Corporation electricity works during the past twelve months amounted to 88,766,232 units, as compared with 82,752,989 units of the previous year, an increase of 7.27 per cent. The quantity measured and accounted for during the same time was 73,715,884 units, showing a difference of 15,050,348 units, or 16.96 per cent. The corresponding percentage in the previous year was 18.65. The total mileage of main conductors laid at the 31st March, 1909, equals 352 miles 256 yards, being 13 miles 932 yards more than at 31st March, 1908.

Calcium chloride is a grayish-white substance, which has the power of strongly attracting moisture from the atmosphere and of holding same. When used to dampen dust on coal mine roads, it contains nothing that can be injurious to the miner, roadways, haulage ropes, &c. It does not give off any smell or gas. Comparing its hygroscopic property with that of salt, salt of itself has not the power of attracting moisture, but owes what little power it does possess to a small amount of impurity which it contains in the form of magnesium chloride, and cannot be for one moment compared with calcium chloride as a moisture-attracting substance.

A Gas Heating Research Committee, appointed by the Institution of Gas Engineers in connection with the University of Leeds, reports that:—(*a*) The total radiation from an open gas fire is about 32 per cent., and this is unaffected by the amount of ventilation through the room; (*b*) no carbon monoxide escapes under ordinary conditions into the room, and very little is ever found in the flue; (*c*) about 30 per cent. of the heat generated in the stove passes directly into the flue—this figure varies with the volume of air passing through the stove flue; (*d*) there is no necessity for products of combustion to enter the room and cause discomfort; (*e*) reflectors may be usefully employed to produce a sensible increase of radiation into the region where it is most wanted.

As far as the British Consul is able to procure particulars, the output of tin ore in the Western Siamese States of the Malay Peninsula last year was 3713½ tons, valued at £334,077 10s. and of smelted block tin, 2392 tons, valued at £317,221 10s., the total value of tin and tin ore together thus amounting to £651,299. This was probably all won in Monthon Puket. As a tin country the possibilities of Kedah are yet to be tried. There is probably some tin to be found everywhere on the rising ground of the interior, and for years it has been worked in South Kedah round the foothills of the high mountain at the end of the main range which forms the backbone of the lower portion of the peninsula. But the difficulties and cost of transport have hitherto prevented even the enterprising Chinaman from carrying on operations to any large extent. The normal export from Kedah at the present time may be put down, roughly, at from 400 to 500 tons a year.

A number of coal briquette press installations have been made in the United States during the last few years, but only a small quantity of briquettes have been manufactured, and with some exceptions the plants were short lived. The enormous increase in the coal production in the country, together with the low cost, and the accessibility of thick veins, has scarcely warranted coal operators devoting much time and money to the subject, and where plants have been erected, it is believed that the conditions were not sufficiently investigated. A number of machines were manufactured or imported and sold to coal companies on the representation of results based on the experience of similar plants in foreign countries. It usually turned out, however, that in some important features the results differed largely from the representations made, and in consequence of many failures, briqueting has been considered an impracticable proposition.

According to the *Electrical Review and Western Electrician*, a solar electric generator, the invention of Mr. George H. Cove, of Somerville, Mass., consists of a steel framework, which is placed where it will receive the direct rays of the sun. Short plugs of a secret metallic composition are set into this framework, which is divided into sixteen 12in. squares, each containing 61 metallic plugs. These plugs are set with one end under glass while the sun shines on them. The other ends are exposed to the open air and sheltered from the sun's rays. The difference in temperature of the two ends of the metallic plugs generates a thermo-electric current, which is used for charging a storage battery. If the sun goes under a cloud and the voltage drops below that of the storage batteries, an automatic circuit-breaker breaks the circuit between the generator and the storage batteries. When the sun sets in the evening, the circuit is automatically broken.

Insects play a most important part in timber destruction. The injury done is generally underestimated, as their depredations go on gradually, but forcibly, attracting little observation. When they bore into the timber they open up air chambers and channels which make it easy for rain water to seep in and thus keep the wood in a moist condition. Fungus spores floating through the air are enabled to germinate with greater rapidity and with increased effectiveness, and the decomposition of the pole consequently is materially hastened. Several years ago the Forest Service co-operated with one of the large telephone companies in Georgia and Florida to experiment with various preservatives in protecting the butts of telephone poles from decay. These preservatives were simply painted upon the wood and, of course, did not sink in to any great depth. A recent examination made of this pole line showed that wherever the preservative had entered the wood no destruction due to insect attack had taken place, but where the wood was unprotected such injury was frequently quite serious.

A paper on "Inductance and Resistance in Telephonic Circuits" was read by Dr. J. W. Nicholson, at a recent meeting of the Physical Society. A general formula for the effective inductance of a circuit consisting of two long parallel wires has been given by the author, and is suitable for cases in which the current distribution in either wire is greatly affected by the frequency of alternation. In the present paper certain important cases are examined in detail, and formulæ are obtained capable of immediate use. A calculation of the effective resistance is also made in each case. Attention has been mainly directed to that of the simple telephone circuit, in which the leads are not twisted round each other in order to annul the inductive effects of the earth and of neighbouring circuits. Throughout the investigation only iron and copper wires as the two extreme cases are considered. The large permeability of iron completely changes the character of the effect of frequency on its self-induction, as compared with other metals. To all metals greatly used in practice except iron, the formulæ developed for copper wires may be applied with a a nearly identical order of accuracy.

MISCELLANEA.

The arrangements for the erection of an Admiralty wireless station on the high ground of Sastland Hill overlooking Rosyth naval base, states *Electrical Engineering*, have been completed. It is expected that the station will be complete and ready for use in twelve months' time.

The Institute of France has awarded the Osiris prize, of the value of £4000, to M. Louis Blériot and M. Gabriel Voisin, for their experiments and achievements in aërial navigation. The prize is awarded every three years for the most remarkable contribution to the cause of human progress during that period.

We have received a copy of the programme and rules of the International Agricultural Exhibition which will be held by the Argentine Rural Society at Buenos Aires, from the 3rd of June to the 31st July, 1910, under the auspices of the Argentine Government, in celebration of the first centenary of Argentine independence.

Considerable attention is now being paid in Portugal to water power. Some water power is already being utilised for industrial and lighting purposes, and its development in the near future is likely to be considerable. The Swiss and German manufacturers of both turbines and electrical machinery have, it is stated, so far received all the orders that have been placed.

The Uruguayan Government have presented a Bill to authorise the sum of £300,000 for the construction of a State telephone system. There are already two companies working telephone systems in Uruguay, and the present intention of the Government is to compete with these, and not to acquire them. It is proposed to issue a loan for the amount mentioned, bearing interest at 5 per cent.

In a report from India it is stated that not far from the city of Chittagong natural gas issues from a crevice in the ground in considerable quantity. It has been burning so long that the oldest inhabitant can give no idea of when or how it was set on fire. The general belief among the natives is that the gas has been on fire for centuries. It is now suggested, and some steps have been taken to carry out the suggestion, that the fire be extinguished and the gas be brought under control, and utilised for lighting, fuel, and power purposes.

The province of Mozambique, states a Consular report, furnishes the gold mining industry of the Transvaal colony with the greater number of its native labourers—it is understood that the proportion supplied amounts to about two-thirds. In the year ended September 30th, 1908, 47,258 natives entered the Transvaal from Portuguese East Africa, and 35,037 on the expiry of their contracts returned to their homes. In addition to the foregoing, some 1500 were recruited in the northern portion of the province for labour on the cacao plantations of São Thomé and Principe.

At last Monday's meeting of the Council of the University of Paris two important and generous benefactions for furthering the study of aviation were announced. In the first place, M. Henry de la Meurthe offered the sum of half a million francs (£20,000), together with an annual subsidy of 150,000 francs (£600) for the foundation of an Aëro-Technical Institute, for the pursuance of technical researches and studies with a view to attaining perfection in aërial navigation. The second gift, one of 700,000 francs (£2800), was offered by M. Basil Zaharoff, a gentleman of Greek nationality, to found a chair of aviation in connection with the faculty of sciences. Both gifts were accepted and the donors heartily thanked.

A consular report dealing with the consular district of Nice states that it ought to be possible for British dealers to obtain a larger share than they do at present in the increasing trade in automobiles. Seven years ago there were only eight firms dealing in automobiles in Nice; now there are forty-five. Not one of the forty-five is British or under British management; but it is an encouraging fact that, whereas British motorists used to show preference for French cars, France having got the start for a time of all other countries in the automobile building industry, that is not the case now. The United Kingdom is making up its leeway, and Englishmen in France are using British automobiles.

In the course of a report to headquarters, Mr. Stuart K. Lupton, the United States Consul in the Catania district, states that whilst nothing has been done to re-establish the city of Messina, there can be no doubt that it will regain its old place, if for no other reason than because of its geographical position. It has the second best harbour of Italy, is situated on one of the great highways of commerce, and is the natural centre for the products of Eastern Sicily and Calabria. It has often been devastated by war and pestilence, and has more than once been shaken by violent earthquakes, but its natural advantages are too many to be disregarded, and it is probable there will be a city of Messina as long as there is any Sicily. The town will be rebuilt, but its reconstruction will be slow unless substantial aid is received from the Government. After the great disaster of 1783 it was made a free port, and rapidly recovered from its losses on that account.

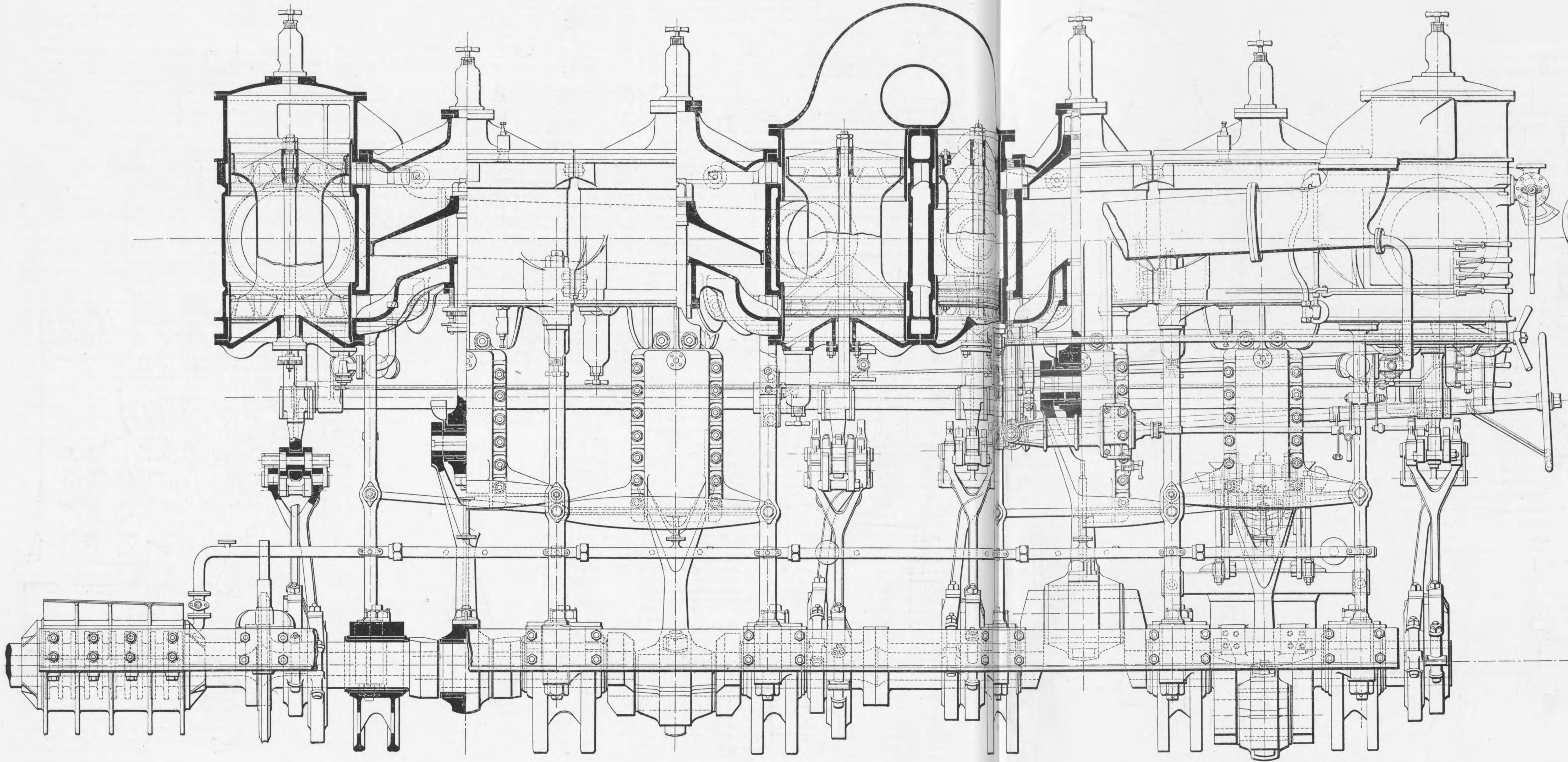
A consular report, dealing with the trade and navigation of the consular district of Kobe, states that in the supply of electrical machinery, equipment, &c., there has been active competition between British, American, and German manufacturers. Until recently an American firm had practically a monopoly in this district, but latterly British and German firms have secured contracts. With the opening up of electric railways and the extension of various electric light companies it is probable that large quantities of electrical machinery, &c., will be required during the next few years. Generally speaking, the report states, the engines and boilers in Osaka factories are of British make. At present there is considerable demand for boilers made by a British firm which seems likely to secure a monopoly in the future. It is impossible for British manufacturers to secure contracts for machinery, &c., unless they have an experienced representative on the spot, as a knowledge of local and personal considerations and the methods of tendering, &c., is absolutely essential. The import of bicycles increased from 1901 in 1907 to 5193 in 1908. There are a few bicycle factories in Osaka which make an inferior class of machine, importing some of the parts for the purpose.

The report for 1908 of Mr. Arthur H. Stokes, H.M. Inspector of Mines for the Midland District No. 8 (Derby, Leicester, Nottingham, Warwick, and Northampton), states that although there was a considerable decrease in the output of coal compared with the phenomenal year of 1907, the output of last year has been only once exceeded in quantity. The production of coal was 35,229,641 tons, compared with 37,182,553 tons in 1907. In his last report he stated that one mine had raised 3836 tons of coal in 10 hours, but that record has been beaten, for a new mine in Nottinghamshire turned out 4263 tons in 8½ hours in December last. Referring to the Eight Hours Act, the Inspector says:—"I do not feel myself in a position at the present time to anticipate the result of a limitation of the hours of labour as will be required to comply with the Act. Actual experience will, no doubt, lead to the introduction of methods of work and regulations for getting to and from the working face which will help to meet the demands of the altered conditions as to hours of labour, and I am of opinion that whatever may be the result as to the economical production of coal, there will be no scarcity of coal output to meet the country's demand. We have vast resources of coal yet untouched. We have engineers of exceptional skill and ability who can wrest from nature the mineral wealth in quantity to meet any demand yet made, and we have miners who are worthy of the national traditions for manual labour in the mine."

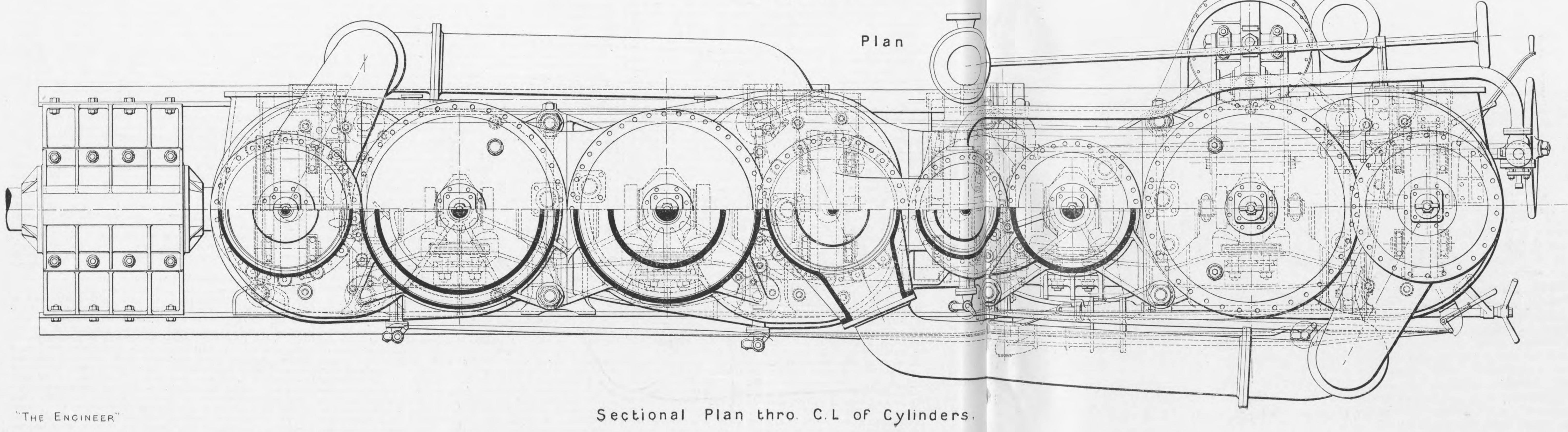
ENGINES OF THE BRAZILIAN TORPEDO BOAT DESTROYER MATTO GROSSO

YARROW AND CO, LIMITED, SCOTSTOUN, ENGINEERS

(For description see page 4)

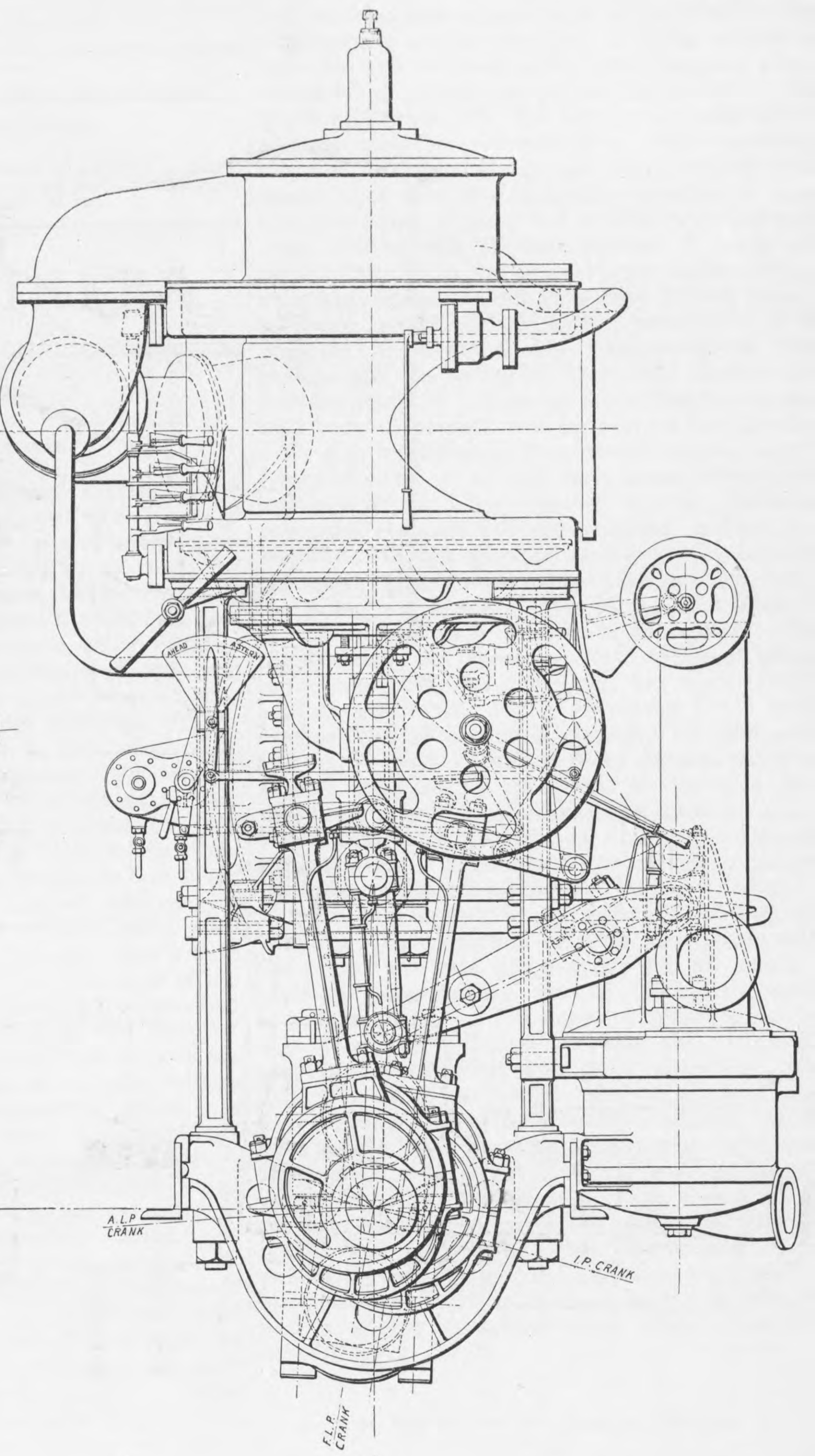


Looking to Port.



Plan

Sectional Plan thro. C.L of Cylinders.



Looking Aft on Port Engine.

"The Engineer"

Swain Sc.

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PUBLISHER'S NOTICES.

*** *With this week's number is issued, as Supplements, a Two-page Engraving and a Two-page Drawing of the Brazilian Torpedo-boat Destroyer Matto Grosso. Every copy as issued by the Publisher includes copies of these Supplements, and subscribers are requested to notify the fact should they not receive them.*

H.M.S. VANGUARD.

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TO CORRESPONDENTS.

☞ *In order to avoid trouble and confusion we find it necessary to inform correspondents that letters of inquiry addressed to the public, and intended for insertion in this column, must in all cases be accompanied by a large envelope legibly directed by the writer to himself, and stamped, in order that answers received by us may be forwarded to their destination. No notice can be taken of communications which do not comply with these instructions.*

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MEETINGS NEXT WEEK.

The Railway Club.—Thursday, July 8th. Visit the Works of Messrs. Bass and Co., Burton-on-Trent, and the Ashby and Burton Electric Light Railway. Train leaves Leicester (Midland) at 12.22 p.m.

THE ENGINEER.

JULY 2, 1909.

Labour Exchanges.

On the 16th of June, the second reading of the Labour Exchanges Bill took place in the House of Commons without a division. In ordinary cases second readings are not of much consequence, for the fate of a Bill is rarely or never decided by them, and there is no reason for supposing that in the present instance the ordinary sequence, which puts the real burden upon the third presentation of a measure, will be changed, but there is nevertheless no little danger that, in the excitement produced by the Budget, a Bill such as this—a Bill which calls for the expenditure of a comparatively insignificant sum of money—may be permitted to find its way to the Statute Book without the full discussion which is its due. When millions are at stake a few hundreds of thousands are likely enough to pass unnoticed. Indeed, the sum involved is so small, and the prognosticated good so great, that if the former did not carry with it a dangerous principle, and if the realisation of the latter were assured, no one susceptible to unselfish emotions would refuse his support to the measure. It is because, to our minds, the Bill fails in both the ways indicated that we urge on all who will be effected by it—and the engineering trades are amongst those specified—to insist upon its full and careful consideration before it is passed into law.

No labour measure was ever introduced which did not appeal to the compassion and sympathy of a large proportion of the population. Misery and suffering are hateful to the great bulk of mankind, and the "bottom dog" will always find a score of hands held out to help him. But where the kinder emotions come in judgment is only too likely to fly out, and, as the records of promiscuous charity have proved over and over again, the ills of unwise benefaction are often worse than the complaint cured. Unemployment is a terrible evil, but in our desire to prevent it we must not permit our sympathies to run away with our wits. Mr. Churchill's Bill has no doubt been drafted with a real desire to reduce unemployment; it therefore attracts our sympathies, but we must not allow ourselves to be moved so far as to forget to ask if it is really likely to attain the object at which it is aimed. Now the avowed object of labour exchanges is to increase employment, and if they cannot achieve that end the reason for their existence comes to an end before they are born. Let us ask, then, if there are any grounds for believing that they can indeed find work. The debate on the second reading comes to our assistance. We shall take the views of three members who may be regarded as experts on this subject. Mr. Pickersgill said, "To the extent to which the labour exchanges were successful, there would be a surplus of—casual—labour." Mr. Pointer, the latest Labour member to join the House, said, "If it were to stand alone, he did not think it would give much worth having." Mr. Roberts, another representative of labour, recognised "that this Bill by itself was not going to do anything to solve the great problem of unemployment." The opinion of these three experts is then against the Bill, and yet every one of them tendered it his support. They supported it for a reason which must be carefully pondered. They saw in it only the stepping-stone to something more. "Unless," said Mr. Roberts, "the Government were prepared to follow this Bill with other legislation to supersede the private ownership of the larger means of wealth production by collective ownership, he feared little would be done towards an abiding solution of this problem." Mr. Pointer regarded the Bill as "a step leading up to other reforms now in the background." It is obvious from these extracts that to some of the Labour members, and probably to all, the Bill is regarded only as the first step in a socialistic progress. If that is so, it would be better to stamp it out of existence at once, without further discussion, for its good is problematical, whilst its evil is certain. That such a strong measures would be justified is proved by the experience of another country. It is the fashion to close the eyes to every nation but Germany when industrial questions are under discussion, or the plight of France with her labour exchanges could scarcely have escaped attention. We cannot go into their history at the present time, but it is well known that they are socialistic strongholds, and that they make nothing but a shallow pretence of equal dealing with all their clients. Is there no cause to fear, with the avowed hopes of the Labour members sounding in our ears, that British labour exchanges would be bent to the same end? It is proposed to create a new bureaucracy of 800 persons; in the course of years the number will increase manifold. Who can doubt that by degrees that body of officials will become to the Labour party a political item of considerable consequence? Every member of it will have some power and influence in the labour market, and may use that power for purposes not contemplated, perhaps, by Mr. Churchill, but seized on readily by the Labour members. That is a real danger against which, with the example of France before us, we must beware. And there is another inherent in the system. To the workman the labour exchange will be an office to find him work, and if it cannot find work he will hold it responsible. In his estimation it will have been established to find employment for him, and find employment it must. So by degrees, out of a scheme intended to assist the workman in his search for private employers, would grow an institution from which the workman would expect to get either work or its equivalent; every labour exchange would be a banner inscribed the "Right to Work."

These may appear to be extravagant views to take of a simple seeming measure; the future will show. At any rate, there are in the air enough hints of approaching troubles for wise men to use precaution. "Put not a sword in the hands of your enemy." Those who seek the industrial peace of England must think twice before they put under the feet of the revolutionary party something they regard as a stepping stone to Socialism. If it were certain that immediate good would come out of the measure we might shut our eyes to distant danger, but when there is, as we have shown on a previous occasion, no certainty that a particle of benefit will accrue, and when there is a large probability that evil and trouble will result, elementary prudence bids us hesitate before we plunge into a course of action from which retreat is impossible.

The Report on the French Marine.

The report that has just been issued by the Parliamentary Commission of Inquiry under the Presidency of M. Delcassé confirms on every point the lamentable shortcomings in the French Marine which have been revealed by the inquiry that has been proceeding for the past four months. Rarely has an official document been so incisive in its condemnation of a public service as the report prepared on behalf of the Commission by M. Michel. The reasons that have brought about the existing state of things, and temporarily deprived France of her position as a naval Power, are clearly set forth, and it becomes evident that while a want of proper organisation is mainly responsible for the decline of the Marine, much is also due to the Socialist "reforms" of a former Minister whose attempts at levelling down everything had merely the effect of destroying discipline, order, and influence. Taking first the cost of construction, M. Michel points out that the plans of battleships were never completed by the time orders were given out. The plans of the Justice were altered fourteen times after this vessel was put on the stocks, and the same might be said of the other battleships and cruisers, while the contracts for the material required for the ships authorised by the programme of 1906 were given out before any decision had been come to as to the design of the turrets and the types of boilers. For battleships of the Danton class the original estimate of 220,000,000f. was exceeded by 100,000,000f., mainly on account of the continued changes to plans.

Much has already been said concerning the alleged action of firms in combining to uphold prices for material supplied to the Marine. Although there may certainly be some ground for this, engineering firms having always pleaded justification because the State is a hard taskmaster, and delays payment as much as possible, the Commission has come to the conclusion that prices all round have considerably increased, notably as regards armour plates, turrets, and engines, while the cost of turbines appears particularly high. In this latter case, the high prices asked are undoubtedly due to the fact that the firms who lay down plant for the manufacture of turbines especially for the Marine have to allow a considerable amount for depreciation, because, for the moment at any rate, the business being done in turbines is very small. Another reason for the high cost of construction is to be found in the low efficiency of the arsenals, which may be attributed to the obsolete machinery employed and also to the suppression of piece-work. This was one of the "reforms" carried out by M. Pelletan, who introduced the Socialist principle of levelling down everything and reducing the hours of work, while at the same time foremen and engineers were practically deprived of all authority over the men. As a means of remedying this state of things, the Commission invites the Chamber of Deputies to refuse permission to construct any vessel in the future until the plans are practically complete and arrangements are advanced for giving out orders. So far as concerns the high cost of material, the Commission is of the opinion that the steady increase in prices is due to the fact that the Marine Department does not look sufficiently after its interests, while, by its unnecessary exactions, it compels manufacturers to provide for contingencies that do not exist with ordinary contracts. Consequently the Commission is of the opinion that the Marine Department should suppress clauses in contracts that are not really necessary, and every other method should be adopted to secure a reduction in prices. The conclusion of the Commission as regards the arsenals is that they are not at present in a state to carry out rapidly the work of construction and repairs, that the plant is insufficient and out of date, that piece-work should be generally adopted, that in cases where the character of the work does not allow of the introduction of piece-work the men should be paid wages equivalent to those paid to men employed in other departments upon piecework, that the foremen should be invested with greater authority, and that work should only be given outside when it is found impossible to undertake it in the arsenals.

The question of boilers has, perhaps, attracted more attention than any other when discussing the cost of building battleships. While Parliament has always advocated increasing the number of boiler firms from whom tenders are received, the Naval Department has preferred to limit the types of boilers to two, with the object of unifying the steam generating equipment and facilitating the training of stokers; but it is argued that any advantage obtained by uniformity of boilers is lost by the high prices that have to be paid to firms who look upon the business as a monopoly. The Commission inclines to this latter point of view. It regrets that during the past ten years the Ministers of Marine have failed to utilise competition as a means of reducing prices and securing an improvement in boilers which are generally recognised as the best; that the Minister, after obtaining from the Technical Committee a list of boiler firms from whom tenders could be invited for the nine battleships and armoured cruisers under construction, ordered them from two firms on the list without inviting tenders from the others, notwithstanding that the boilers so ordered were not the types unanimously approved of by naval officers and marine engineers. Consequently the Commission recommends that in future tenders for boilers shall always be invited from firms approved of by the Technical Committee. The manufacture and storage of explosives are to be subjected to a much more rigorous supervision, and this supervision is to be assisted by naval officers who are to prepare themselves for the task by undergoing a period of instruction in the powder factories. The armament of battleships comes in for severe strictures from the Commission. It states that the four divisions of battleships and the division of armoured cruisers in the Mediterranean have not their full supplies of steel shells; that the division of armoured cruisers forming part of the Northern Squadron have only a third of their supplies; that neither for the Mediterranean nor the Northern Squadrons are there any reserves of steel shells, despite the fact that the types of shells were fixed upon as early as 1905 and 1906; that the type of shell for battleships of the Danton class was only settled upon at the end of February last, so that it is a practical impossibility to have them manufactured by the time the Danton is ready for service at the end of next year. The Budget estimates have, in fact, made no provision for the manufacture of these shells. The Commission blames this "want of foresight," and urges that it should be remedied without delay. The same absence of foresight is observable in the harbour works. The law of 1901 authorising the building of dry docks and basins has been utterly ignored. These should have been completed in 1909, but nothing has been done. No one has even thought of the necessity of building dry docks to take battleships of the Danton class. Nor is there sufficient provision for the storage of coal. When it is observed how much has not been done it may reasonably be asked what has become of the enormous sums of money voted for the carrying out of these works. The former Ministers are blamed for this state of things, as well as most of the other shortcomings, and they are likely to have anything but a pleasant time when they are called upon to defend themselves in the Chamber of Deputies. The general organisation of the marine, or rather the want of it, is summed up in the statement that "between the different services of the central administration there is no unity of views, no systematic effort, no method, and no defined responsibility. There is too often negligence, disorder, and confusion."

This report effectually clears the way for the reforms in the organisation of the marine which the country is determined to carry out. And it will prove a formidable undertaking. There is enough in the Commission's recommendations to occupy attention for a considerable time, but it covers much of the ground previously gone over by M. Picard, whose proposals are for the most part merely emphasised, and the report will certainly have the effect of inducing the Chamber of Deputies immediately to vote the sums required by the Minister for doing what he claims to be an absolute minimum to put the navy on something like a satisfactory basis. The Commission has, moreover, shown the necessity of undertaking work which M. Picard was obliged to leave in the background for fear of frightening the country over the expenditure that would have to be incurred. The Commission, on the other hand, does not hesitate to make the most of the situation, and it is highly probable that the Chamber of Deputies will be induced to vote more than is asked for in order to clear up arrears of work in the way of harbour improvements, stocks of explosives and shells, and the equipment of existing ships as soon as possible. Until this is accomplished, and it is likely to occupy some years, it is difficult to see what can be done with the new shipbuilding programme beyond preparing plans and advancing preliminaries, so as to push forward the construction as soon as funds are available. Unfortunately, the Government is committed to such a huge expenditure in other directions that fresh sources of revenue will have to be found before the new shipbuilding programme can be started upon, and this will probably be one of the questions discussed in the forthcoming debate upon the development of the navy.

Jet Condensers.

THE jet condenser has done good service for a century. In these latter days it has gone out of fashion, and is largely superseded by the surface condenser. We use the words "out of fashion" advisedly; for there are of a certainty fashions in engineering just as there are fashions in dress, feminine and masculine. The surface condenser must be used at sea; but the conditions prevailing on land do not dictate its adoption. Far from it. We very often find it used when a jet condenser would be far better. The reason is no doubt to some extent that the merits of the jet condenser are not understood. There is a belief, quite unfounded, that maximum economy can only be secured with surface-condensing engines. This faith has no better foundation than the circumstance that some exceptionally excellent engines have been fitted with surface condensers. If we make inquiries, we shall find that the modern engineer looks on the jet condenser as an old-world device. He classes it with hemp-packed pistons, and long D slide valves, and beams, and parallel motions. This is the result of want of observation. He will find if he looks that many land engines of the very highest class, both at home and abroad, are fitted with jet condensers. The relative advantages of the two methods of destroying steam are worth consideration, particularly by those who design power-house plant.

Steam is so readily condensed by direct contact with cold water, that, given water enough, it is impossible to avoid having a good vacuum unless there are air leaks in the condenser or pipes. We have heard it argued that the jet condenser requires more water than the surface condenser. This is an error. The jet condenser, properly designed, will require not more than one-third to one-half the water needed by its rival. Good practice allows 25 lb. of condensing water for every 1 lb. of feed-water. No surface condenser will give a satisfactory vacuum with less than forty to fifty times the feed-water, unless, indeed, we take into account some of the recently designed surface condensers. The fact that there is air in the condensing water has no effect when the water is used as a jet. Those who have followed Mr. Morison's arguments will see what this implies. It is possible that the jet condenser will not suit the turbine because of the air. All that can be said is that a vacuum within 2in. of the atmospheric barometer can very easily be had; and it is not impossible that with an auxiliary air-pump something still better may be secured. It is not necessary, however, to labour the point. The turbine has not yet beaten the piston engine out of the field; far from it. One of the reasons why the turbine supersedes the reciprocating engine is that its first cost is much smaller. Now the first cost of a jet is very much less than that of a surface condenser, while its upkeep is nothing. The maintenance of a surface condenser, on the other hand, is costly. In many cases water is very scarce, and cooling towers or other devices have to be used to economise it. This also is expensive plant. The cost will, of course, be a minimum with the jet condenser, because of the small quantity of cooling water to be dealt with. Again, the surface condenser demands a circulating pump of some kind. The air pump is also the circulating pump with the jet. Furthermore, in many instances a barometric head is obtained by the simple device of using a long upright pipe. These and other differences between the two systems represent an important saving in first cost and maintenance in favour of the jet.

An important point remains for consideration. We lose a boiler feed of condensed steam. Instead we have to trust in ordinary well or river or canal water. But distilled water is not always an unmixed blessing; and so much has been done, and is being done, in the present day in the way of softening and purifying feed-water that there is probably very little in the argument as regards land engines. It may be said that we lose the heat imparted to the water, and get, in effect, cold feed if we do not draw from the hot well. But this is a matter of no importance, since all steam plants pretending to be economical are provided with economisers of some kind—such, for example, as Green's. Indeed, it is by no means easy to see what can be said in favour of surface condensation, where the conditions are equally favourable to both types; unless we grant the assumption to be well founded that only a surface condenser can give the vacuum essential to the efficiency of the Parsons turbine; and this does not, of course, apply to reciprocating engines. Again, we have heard it said that much power is required to work the large air pump. But is it greater than that needed to drive a smaller air pump and a centrifugal circulating pump, to say nothing of the extra power required to lift the extra water to the top of the cooling towers?

Notwithstanding the fact that so many thousands of jet condensers have been made and put to work, it is by no means certain that the most has been made of the system. The reason is simply that no interest has been shown in securing a very high vacuum, and that, as a rule, there is plenty of water to be had. The jet is so far efficient that little thought has been given to improvements which can, perhaps, save nothing but water. It is, however, certain that jets are often fitted very carelessly. We have ourselves seen a condenser opened up in which the jet, instead of directing the cooling water among the steam, sent a large part of it against the side of the condenser. It ran down the plate and did no good. This was altered, and a couple of inches were added to the vacuum, with less water Much might be gained, no doubt, if the cooling water was converted into fine spray by some such device as that employed in the Abol garden syringe. The water going to the jet is compelled to take a spiral course, comes out revolving rapidly, and is at once broken up into mist by centrifugal effort. A portion, if not the whole, of the condensing water might be introduced in this way with advantage.

We have said nothing of the various forms of exhaust steam, and so-called barometric, condensers, which are finding their way into well-deserved favour, nor is it necessary that we should do more than mention them. Our object has been to call the attention of our younger readers to facts fully appreciated by men of the last generation—facts which have in no way lost their value. In designing power stations especially, the claims of both systems should be carefully balanced before either one or the other is adopted.

THE ROYAL AGRICULTURAL SOCIETY'S SHOW.

No. II.*

THE display of wind motors was of more than average dimensions, the exhibitors being H. P. Saunderson and Co, Limited, Bedford; William Hopkins, Cheltenham; Wakes and Lamb, Newark-on-Trent; John Wallis Titt, Warminster; E. and H. Roberts, Limited, Stony Stratford; Duke and Ockenden, Limited, London; Thomas and Son, Worcester; F. C. Thorne and Co., Lincoln; John S. Millar and Son, Annan; Rickman and Co., London; Cornelius Cadle, Dublin; and J. G. Childs and Co., Limited, Willesden Green. The energy derived from the wind in most cases was utilised for pumping water for irrigation and drainage purposes. The exhibit of Messrs. Childs, however, demonstrated how the winds can be harnessed and the power thus generated utilised for domestic purposes, such as cooking. The sign "Cooking by wind," although not literally accurate, was a great attraction to the housewives who visited the Gloucester show. The apparatus employed by the above firm consists of a 24ft diameter wind engine, mounted on a steel tower 60ft. high, with a vertical shaft driving a Morris Hawkins variable speed electric generator, also suspended vertically. The generator charges a 28 cell Pritchett and Gold battery, which has a discharge capacity of 450 amperè hours. It is divided into two parts, and by means of a special device a pressure of 50 volts can be used for culinary purposes, while to enable metallic filament lamps to be used for lighting, a pressure of 25 volts can be had. The plant, in addition to lighting a model cottage, was shown in use supplying heat for an oven, grill, fan, and other appliances. The generator has a special switch, by means of which it can be run as a variable speed motor for driving when there is no wind available by taking current from the battery. Where the wind averages about 8 miles per hour, it is estimated that this plant will produce about 3000 units per annum.

On the other hand, as an example of a simple means of obtaining power from a stream of water, the exhibit of J. J. Armfield and Co., Ringwood, Hants, furnished an object lesson. This firm showed different sizes of the "British Empire" horizontal turbine, which is made with a self-contained volute case and gate-box complete. To this compact appliance the water has merely to be conducted by a pipe, or the gate-box may be fitted to the dam which retains the water, no flume being required. The buckets are designed so as to deliver the water after it has done its work at the slowest moving portion of the turbine, and thus at the least possible velocity. The bearings are of lignum vitæ. A feature of the buckets—which are excellent examples of cast iron moulding—is that the hoods are deep and open, particularly towards the centre, to allow the water after it has exerted its pressure on the curved surfaces of the wheel an unimpeded discharge, the inlet gate regulating the quantity which passes. The area of this gate, therefore, represents the capacity of the machine, and the water issues at a low velocity into the tail race. The apparatus is very simple, should cost little to fix, and is easy to start and stop, the gate sliding to and fro on guide rollers, while the turbine readily adapts itself to varying flows. Waterwheels were also shown by E. and H. Roberts, Limited, Stony Stratford; John S. Millar and Son, Annan; and Mr. Cornelius Cadle, Dublin.

Milking machines have been available for some years, but have not been adopted to a great extent in this country, for several reasons. Those hitherto seen require a considerable capital outlay for the necessary pumping apparatus by which the vacuum is created, and they do not, therefore, come within the reach of most dairy farmers. They have, moreover, to be erected in a particular building to which the cows must be brought, and cases of injury to animals have been known owing to the application of the vacuum. An altogether new invention in this branch of dairying was exhibited at the late show, and like very many other dairying appliances has been devised by a Swede named Mr. Hj. Loquist. He has avoided all mechanism which depends for its operation on pneumatic principles, the construction of the machine being entirely mechanical and can be worked either by hand or power. Moreover, it can be used if necessary in the open field. We give an illustration in Fig. 8 of the portable machine, which will be seen to consist essentially of three parts, namely, the driving gear composed of a central spur wheel into which a number of pinions—usually five to milk this number of animals at once—are adapted to mesh. These pinions are connected to the milking machine—which is held suspended beneath the cow by straps—by means of flexible shafts, and any one or all of the pinions can be thrown in or out of gear when desired by moving small knobs. The machine proper weighs about 6 lb., is 19½in. long by 10½in. wide by 4½in. deep. It comprises four pairs of rubber covered pads, one of each pair of which remains stationary, but can be adjusted as desired, while the other pad of each pair is caused to reciprocate on slides by means of cam mechanism worked by the flexible shaft and suitable gearing. The sliding motion of the pads—shown in Fig. 9—is such that the action of the thumb and finger of the milker is closely copied. The teats are first gripped at the roots, the pressure being then gradually transferred from the top to the bottom of the pad, pressing the milk out of the four teats in a natural manner. From a sanitary point of view, too, the appliance has a distinct advantage over others, for the milk neither comes into contact with the rubber pads, nor is it required to pass through tubing, which is liable to affect the flavour. It flows straight into a pail, from which it is easily removed. The machine was shown by the Milkmaid Patent Milking Machine Company, 20, High Holborn, London.

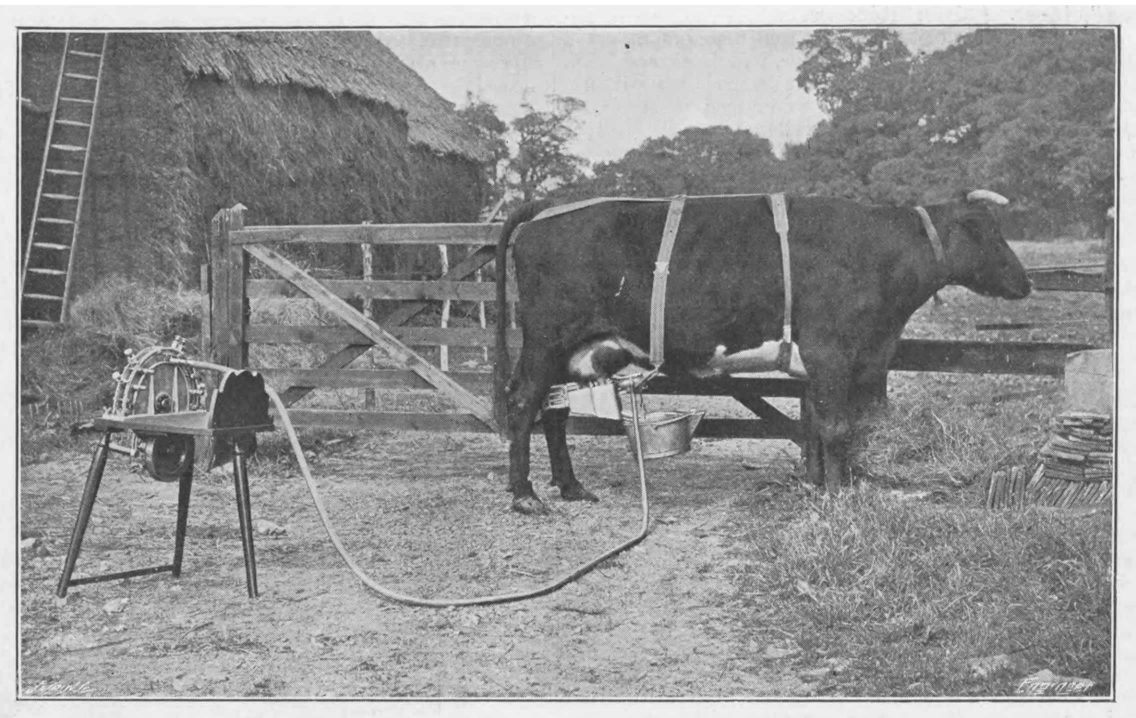
Fig. 8—MECHANICAL MILKER

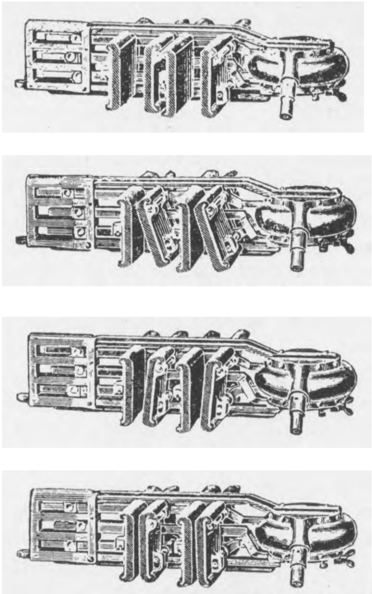
Fig. 9—DETAIL OF MILKING MACHINE

Amongst other purely agricultural exhibits the improved perpetual hay or straw baling press made by J. and F. Howard, of Bedford, requires mention. The machine is self-feeding, and has an automatic hinged dropper, so that the attendant is relieved from the labour of feeding, and the risk of breakage in putting the followers or dividing bars into the baling chamber is reduced. The feeder arm is flexibly connected to the rear of the ram, so that it cannot come into collision with the ram in the baling chamber. As the ram is being withdrawn the feeder arm descends and carries the material into the baling chamber, and while the ram advances the feeder arm rises clear of the press. The machine is substantially built, and requires about 5 horse-power to drive it. Messrs. Howards are also introducing a new and inexpensive form of light straw presser for the farmer's own use as distinct from the travelling equipment, a swath turner of modified design, and a new side delivery rake. E. R. and F. Turner, of Ipswich, exhibited flour milling and grinding machinery, and steam engines. The latter included a portable engine, winding and hoisting engine, and vertical and horizontal engines of standard patterns. The milling appliances included the Turner diagonal four-roller mill, with rolls 10in. diameter by 40in. long. It is a double mill, a pair of rolls on each side, one being smooth, the other fluted. The quality of the work turned out by these mills depends largely on the method of feeding in the material. The makers' feed system consists of two rolls, one travelling at a considerably higher speed than

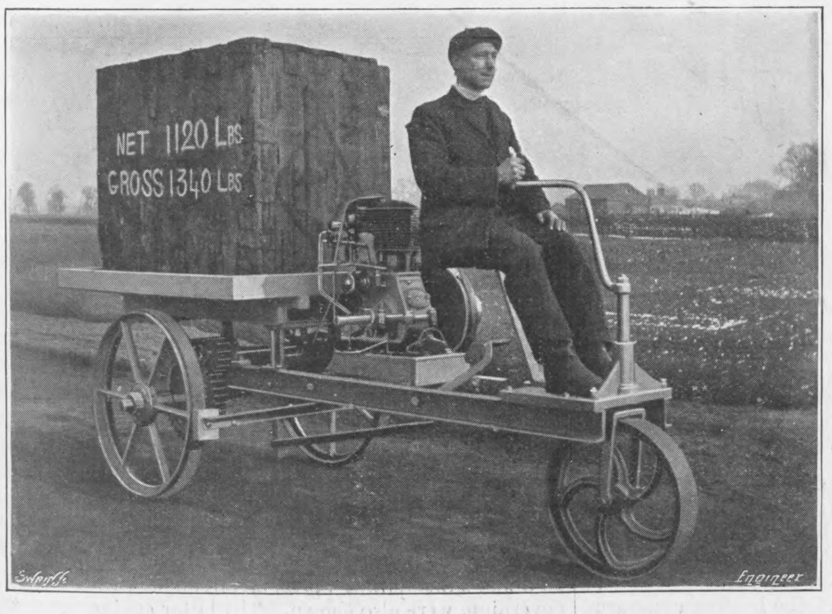

Fig. 10—THE SAUNDERSON TRACTOR

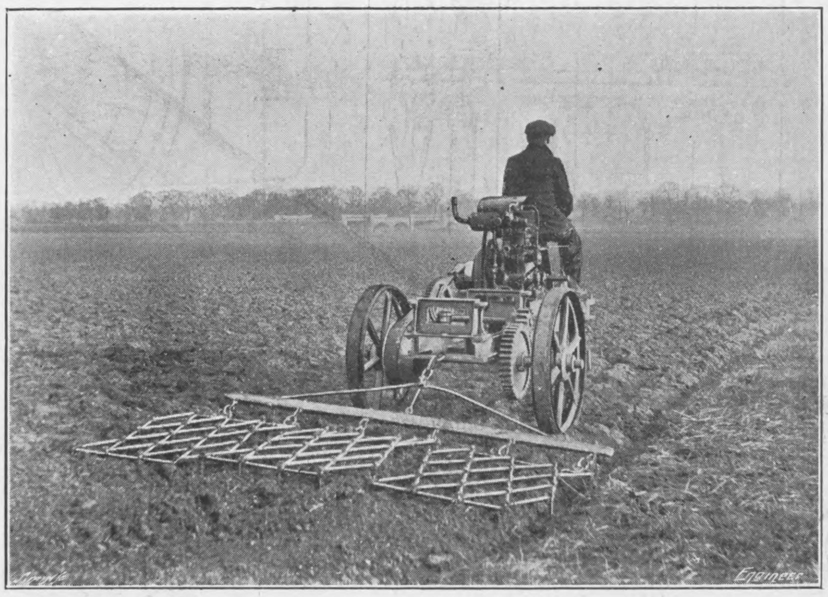
Fig. 11—THE SAUNDERSON TRACTOR DRAWING A HARROW

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* No. I. appeared June 25th.

the other, which has the effect of distributing the material and delivering it in a thin even stream into the nip of the rolls. The smooth rolls are also provided with a special scraper which obviates the use of detachers. A complete automatic roller plant in one frame, to deliver a sack of flour per hour, is also shown. This plant is supplied to farmers in the Colonies for producing a good "straight run" of flour. Although it does not include the latest refinements in this class of machinery, this machine makes a good separation of wheat into flour, middlings, and bran, and is inexpensive. A feature of the design is accessibility, so that if anything should become deranged it can easily be rectified. Another novelty exhibited is a little plant consisting of two separate machines for making flour for domestic purposes, and is driven entirely by hand. The grinding is done on a small mill, and the meal is then dressed through a wire cover on a hand-power dresser which makes four separations—flour, middlings, pollard, and bran. The two mills weigh under 5 cwt.

Amongst the firms that are tackling the problem of the agricultural motor tractor H. P. Saunderson and Co., Limited, Bedford, are making a special effort to provide handy little vehicles for hauling purposes, the engine of which can be easily adapted for driving light machinery, such as grinders, chaff cutters, hay elevators, circular saws, by belting. Such a machine is shown in the illustrations—Figs. 10 and 11—and is made with two sizes of air-cooled engines designed to run on paraffin. The parts of the machine have been reduced down to the minimum without sacrificing strength, and the cost of the tractor is little, if any, more than that of a useful horse. It has a channel frame, transverse gear-box, and live axle driven by very substantial gearing. Three speeds are provided, and the machine is built with or without differential and reverse gear. The clutch and brakes are operated by pedals. There are two pulleys on the engine crank shaft for driving machinery, and the steering is done by a tiller direct. When desired the platform can be easily removed, and a grinding mill, pump, or other device attached so as to be operated by the engine. Our illustrations show the tractor arranged for carrying a load and harrowing respectively, but a plough can also be attached. We are informed by the makers that air-cooled engines properly designed, answer for this class of work quite well.

The Cyclone Agricultural Tractor Company, Limited, 30, Moorgate-street, London, also exhibited an agricultural tractor built on more ambitious lines. The frame of the tractor is of 4in. by 2in. channel steel, and the engine has two cylinders fitted with Bosch magneto and metal-to-metal clutch. The engine is the product of the Aster Engineering Company, and is equally adaptable for petrol or paraffin fuel. A special feature of the machine is the construction of the cutter bar as an integral part of the tractor, the knife being reciprocated off the main shaft by means of an excentric. When the cutter bar is detached the machine becomes an ordinary tractor, or can be used for driving a thrashing machine or other agricultural implement off a pulley fixed in front of the engine. The gearing is such that when the engine is making 900 revolutions per minute the road speed is about $5\frac{1}{2}$ miles per hour. Two speeds and a reverse are provided. The road wheels are 2ft. 8in. diameter by 9in. wide.

The tipping wagon—Fig. 12—with 20 horse-power two-cylinder petrol engine, exhibited by Clayton and Company (Huddersfield) Limited, is a serviceable vehicle for hauling 2-ton loads. By placing the engine under the driving platform the length of the wheel base is kept within reasonable dimensions, while the accessibility of the engine has not been lost sight of. Power is transmitted from the engine to the gear-box by means of a Hele-Shaw plate clutch, and from the gear-box to the road wheels by strong chains. The back axle is a solid round steel bar, $3\frac{1}{4}$in. diameter, and is so attached that it can be easily removed. The frame of the vehicle is of channel section, $4\frac{1}{8}$in. by 2in., and the tipping frame and tipping gear all self-contained. The front axle is of the Kirkstall built-up type. A gate change is provided for the gear-box, and the latter has short shafts. The engine has low-tension magneto ignition, and the governor is arranged to act on the throttle so that the speed of the engine is limited to 900 revolutions per minute, or a maximum road speed of 16 miles per hour. In view of the difficulties which are sometimes experienced with the sticking of clutches built up of a number of plates, it is interesting to note that this company runs the clutch in a metal cutting compound with satisfactory results.

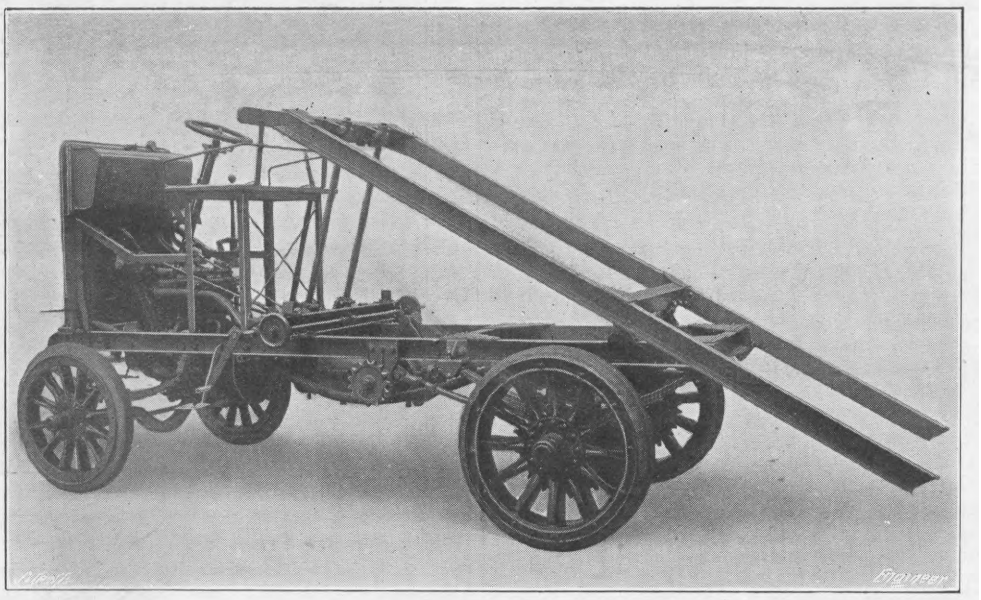


Fig. 12—THE CLAYTON TIPPING WAGON

Aveling and Porter, Limited, Rochester, showed amongst other exhibits a 10-tons compound steam road roller—Fig. 13—with Belpaire fire-box, giving an exceptionally large steam capacity and flat foot to the cylinder, ensuring an easy joint being made. The cylinders have outside valve chests and an auxiliary valve to the low-pressure cylinder. The driving and front roller wheels have special cast steel renewable rims. The boiler and fire-box are of the best mild steel plates, hydraulic flanged and riveted. The working pressure is 160 lb.; but the boiler is tested to 300 lb. per square inch. The gearing is of the best cast steel throughout, and the double-throw crank shaft is cut from a solid ingot. The driving rollers are fitted with patented scrapers, and angle steel scrapers are provided for the steering rollers. Extra steel side and end plates are provided on the tender, as well as a Morrison road scarifier, with a set of six steel tynes.

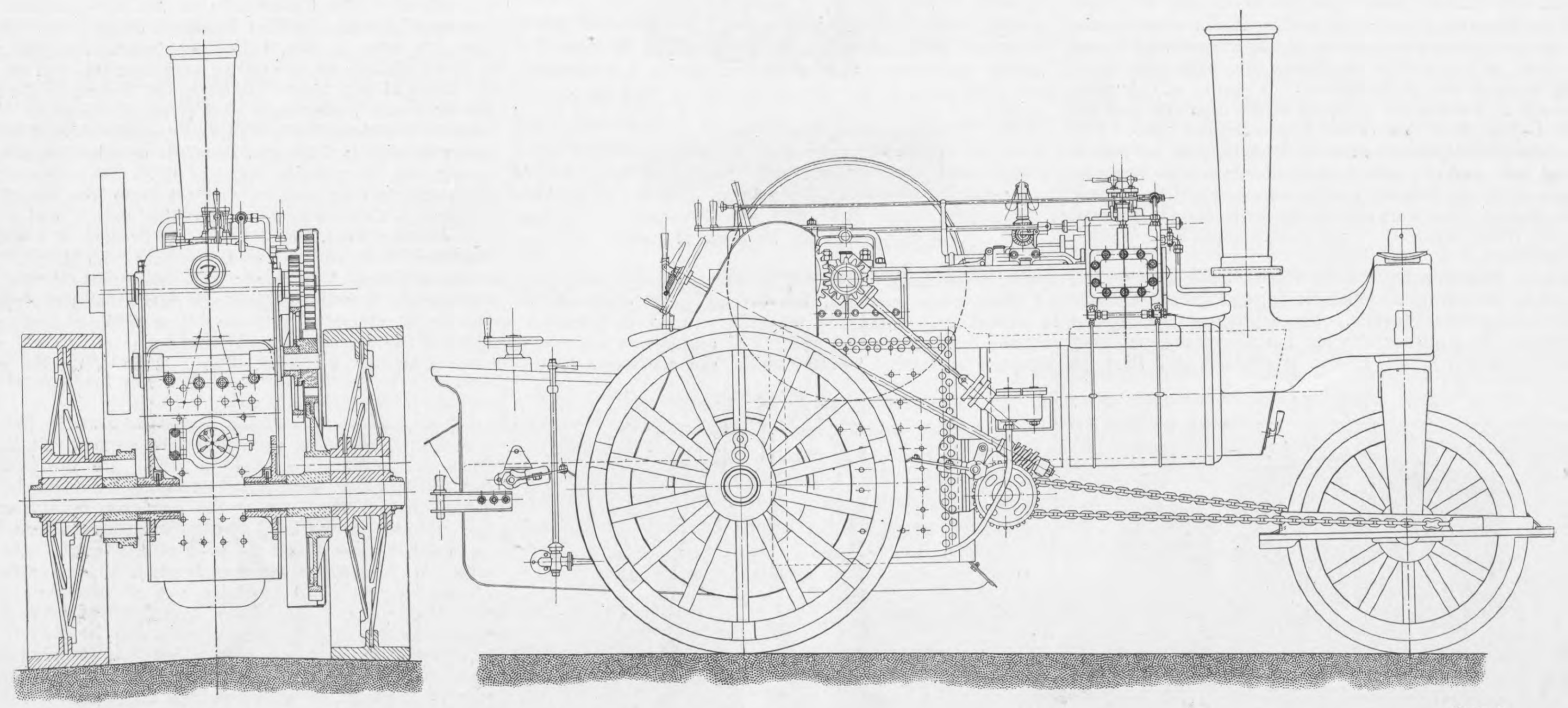


Fig. 13—AVELING AND PORTER 10-TONS COMPOUND STEAM ROAD ROLLERS

Several makers of oil engines showed by their exhibits that they were alive to the necessity for designing their agricultural engines to be able to work on the commonest kinds of fuel. Amongst these, the firm of James B. Petter and Sons, Limited, Yeovil, showed for the first time a 22 brake horse-power engine—Fig. 14—which can utilise all kinds of petroleum, both refined and crude, without any alteration except the adjustment of the oil inlet, an operation that can be effected while the engine is running. Fig. 15 shows the arrangement of the heating apparatus and oil supply system by means of which the consistency of the fuel can be regulated as desired. Experiments made by the makers with this apparatus have shown that while it took 5 min. 35 sec. for a half-pint of thick oil to flow through a $\frac{3}{16}$in. hole when at 56 deg. Fah., it took only 43 sec. under otherwise similar conditions when the temperature was raised to 110 deg. Fah. The pump on the lay shaft is constructed to raise a larger quantity of oil than is required by the engine, and the overflow of heated oil is returned by the piping shown to the oil supply tank through the suction oil heater, so that while the bulk of the oil in the tank may be so thick that it cannot be pumped, that small quantity which is immediately around the suction pipe of the pump is warmed and flows readily to the pump. Further, it is claimed that the heating of the oil before it passes to the vaporiser assists vaporisation and ensures the more complete combustion of the fuel. Another feature of the device is the dial-feed arrangement on the oil inlet, which enables the oil feed to be immediately adjusted to the correct position for dealing with fuels of different thicknesses. The general arrangement of the pump, heater, piping, and valves, is clearly shown in the drawing, and requires no further description. The makers inform us that this engine has been well tested during the past winter, both in this country and in colder climates, and has given satisfaction.

Richard Hornsby and Sons, Limited, Grantham, were also amongst the exhibitors of oil engines adapted to the use of crude fuels. Their exhibit was designed particularly to show that their standard engine is adaptable to shale and other heavy oils, but we need not remind our readers that the suitability of the Hornsby-Ackroyd system for such fuels was demonstrated many years ago. They also showed the Hornsby-Stockport gas engine and suction gas plant, and a neat 5 horse-power portable oil engine. In addition to the engines there was on this stand a large display of the firm's well known implements, including self-binders, straw trussers, mowers, corn drills with a forced feed arrangement, and ploughs of various kinds. The National Gas Engine Company, Ashton-under-Lyne, exhibited a range of sizes of gas engines from a 50 horse-power engine, for suction gas, to a $4\frac{1}{2}$ brake horse-power engine. The newest design of 15 brake horse-power oil engine and a 10 brake horse-power portable oil engine, with exhaust governing, were also shown. The latter engine was fitted with Little's water cooler. It has an oil tank underneath the engine, and balanced cranks. Crossley Brothers, Limited, Manchester, had their usual extensive display of engines to run on gas, both towns and producer, small petrol engines and dynamos, and a vertical engine and dynamo of the "C. V. I." type, combined with a dynamo, and giving 6 brake horse-power at 700 revolutions. This engine is arranged to work with either gas, refined oils, petrol or alcohol, and has already been illustrated in THE ENGINEER. The Dudbridge Ironworks, Limited, Stroud, Gloucestershire, had in operation a 12 brake horse-power oil engine, and one of Scott's patented air compressors, which are made by Petrie and Co., Limited, Rochdale. These compressors differ from others on the market in one or two essential features. In the smaller sizes the valves consist of a considerable number of ordinary steel balls, such as are used for ball bearings, and each ball has a seat of its own in a steel plate, the lift being regulated by a guard plate, the holes in which are pitched in between those on the lower plate. By this system of construction a large valve area is obtained with a very short lift of about $\frac{1}{16}$in., while springs and other complications are absent. In the smaller compressors built on this system the mechanical opening of the suction valves has been obviated by the action of the balls in the top of the piston. For the larger sizes of machines three single-acting cylinders are mounted in a frame. Two cylinders act as low pressure and one as high pressure. The air is admitted into the cylinders through valves in each piston. These valves are made of thin steel plates, and are operated by a rod which passes through the centre of the piston-rod, as shown in the accompanying sectional view, Fig. 16. The lower end of this rod is fitted with a guide and roller and spring for closing. The roller is moved by an adjustable hardened steel cam placed in the jaw of the connecting-rod. As this connecting-rod swings across the top centre at a time when its horizontal movement is greatest and its vertical motion negligible, the cam causes the suction valves to open so rapidly that they are wide open by the time the piston has completed only about one-quarter of its stroke, and are shut again when the piston reaches to within $\frac{1}{16}$in. of the bottom. Both the delivery and suction valves are made with a number of balls as above described. The steel delivery valve plates form the top covers of the cylinders, and are held down by strong steel springs, which are not in action when the compressor is working, but are merely provided to act as buffers in case the piston touches the cover.

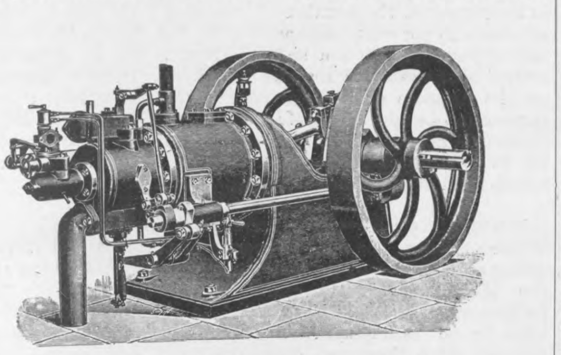
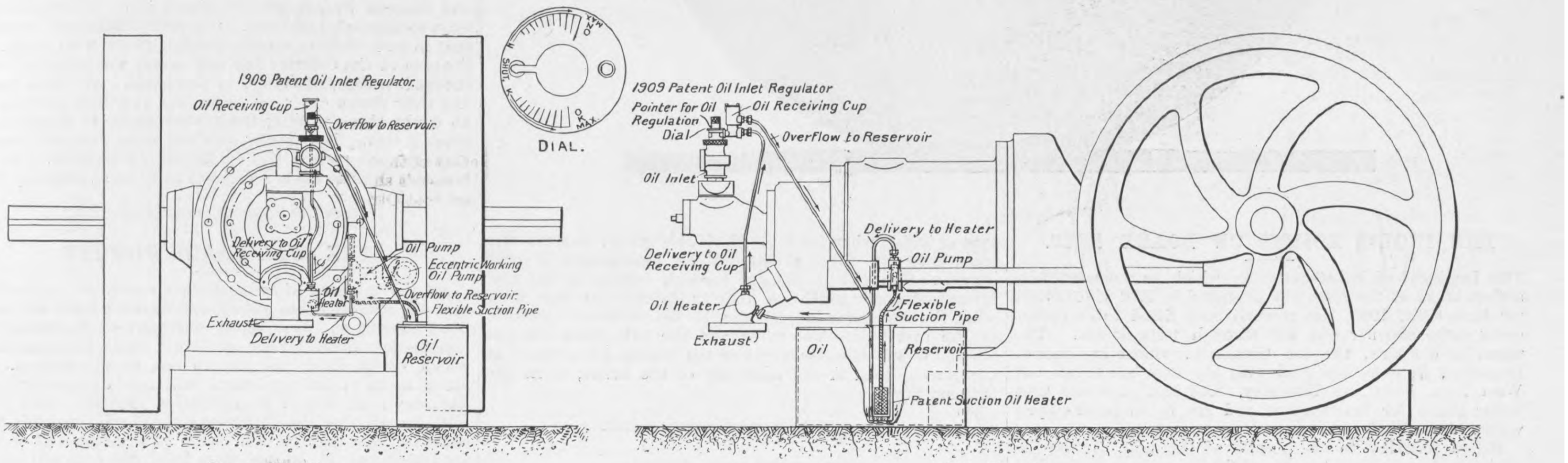


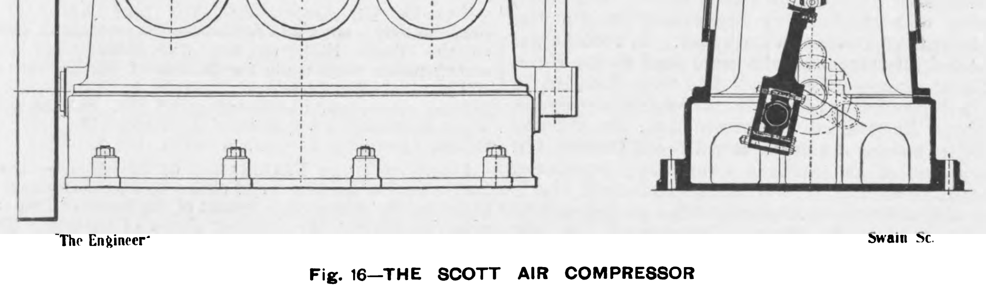
Fig. 14—THE PETTER OIL ENGINE



Front Elevation. Side Elevation.

"THE ENGINEER" Swain Sc.

Fig. 15—THE PETTER OIL ENGINE—OIL SUPPLY ARRANGEMENTS



The Engineer Swain Sc.

Fig. 16—THE SCOTT AIR COMPRESSOR

The Campbell Gas Engine Company, Limited, Halifax, showed two sizes of gas engines, 35 and 16 horse-power, with suction plants, and horizontal stationary oil engines from 20 horse-power to 2½ horse-power. Tangyes, Limited, Birmingham, had a miscellaneous stand including suction gas engines, oil engines, pumps and steam engines. The 35 horse-power suction gas engine shown in operation was of the T type, and drove a dynamo, which in turn supplied current to operate two sets of pumps. This engine had variable low-tension ignition, and variable lift of the induction valve, the quantity of the charge being regulated by a sensitive governor. The crank shaft bearings had ring lubrication, and the lubrication of the cylinder walls was performed by a pump. Marshall, Sons and Company, Limited; Ruston, Proctor and Co., Limited; Corbett Williams and Son, Limited; John Wallis Titt; Blackstone and Co., Limited; Hardy and Padmore, Limited; Walsh and Clark, Limited; Naylor and Co., Limited; the Eagle Engineering Company; Teasdale Brothers, Limited; Fairbanks, Morse and Co.; the Britannia Engineering Company, Limited; the Fairbanks Company also exhibited oil and gas engines.

W. Tasker and Sons, Limited, Andover, who were among the first to take up the building of steam tractors, exhibited at Gloucester a steam wagon with a locomotive type of boiler, built to carry 200 lb. pressure, and with a heating surface of 70 square feet. It has a compound engine mounted on top of the boiler, with cylinders 4¼in. and 6½in. diameter by 7in. stroke. The cylinders are steam jacketed and drained, and a valve is provided to admit h.p. steam into both when necessary. Special attention had been given in this vehicle to the spring suspension, and lubrication of the main bearings. The wagon was to carry a net load of 5 tons and haul a trailer carrying about 4 tons. A special feature had been made of the steering gear, two wheels being provided, so that either man on the wagon could steer while the other was otherwise engaged.

Martin's Cultivator Company, Limited, Stamford, showed two new farm implements, namely, a new potato digger and a mower. The latter was constructed on a novel principle with a spring balanced floating knife bar, epicyclic enclosed self-lubricating gearing and no connecting-rod. The machine was so arranged that it would cut at any angle. The potato digger was designed so as to avoid damaging the crop and to leave the potatoes in a close row to facilitate picking.

In the trials for fruit-tree spraying machines operated by hand power the first prize of £10 was awarded to Weeks and Son, Limited, Maidstone, and the second prize to Drake and Fletcher, Limited, also of Maidstone. In the class for machines operated by "steam, petrol, or mechanical power," these two firms were again awarded first and second prizes respectively. In addition to the above prizes, the Royal Agricultural Society have awarded three silver medals—one to William Ball and Son, Limited, for a farmer's cart with combined tipping and brake arrangements; one to the firm of Lott and Walne, Limited, for a zig-zag harrow with solid frame and reversible tines; and the third to Messrs. R. J. Fulwood and Bland for a cream separator made by the Aktiebolaget Pump Separator Company, Stockholm, with a capacity of 27 gallons per hour.

The attendance of the public was unfortunately adversely affected by the unseasonable weather which prevailed during the whole week. The week's total was 88,396, against 213,850 at Newcastle last year, 133,006 at Lincoln in 1907, and 119,143 at Derby. Poor as the attendance was, however, this year, it was very largely in excess of that at each of the three shows held at Park Royal.

OBITUARY.

THOMAS NIELD ROBINSON.

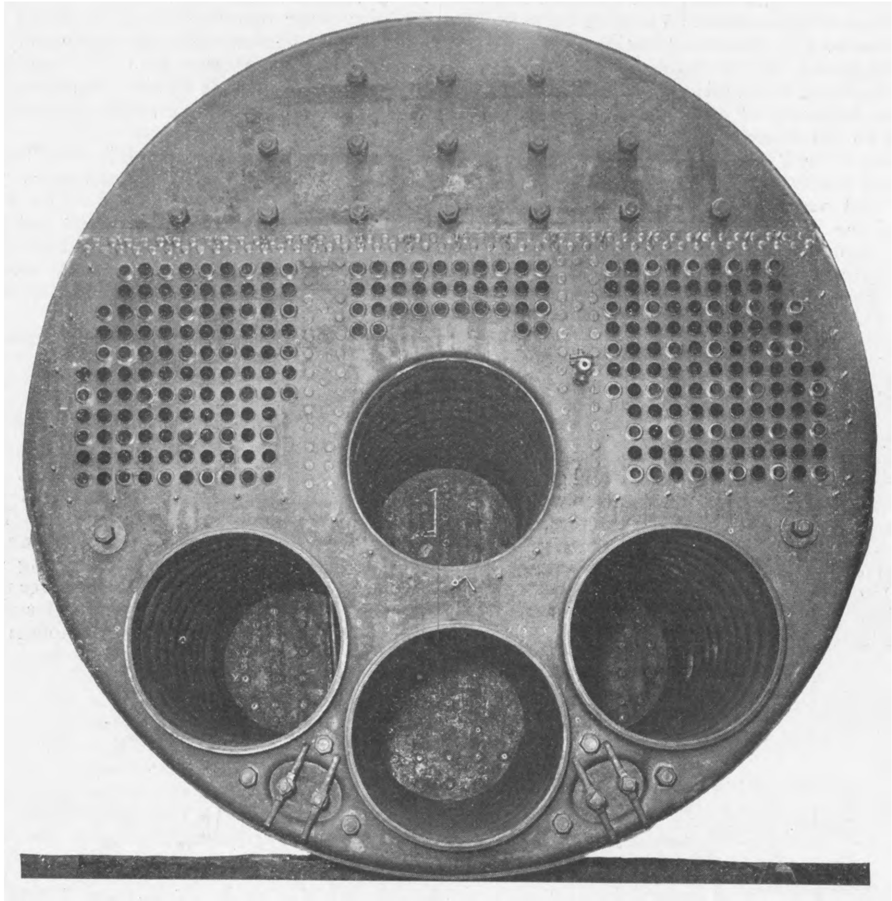
WE regret to have to announce the death at his home near Harrogate, on June 17th, of Mr. Thomas Nield Robinson, J.P., chairman of directors of the firm of Thomas Robinson and Son, Limited, Rochdale. Mr. Robinson was in his fifty-sixth year, and had been in failing health for a year or two, having suffered from a nervous breakdown from which he never really recovered. He was the third son of the late Alderman Robinson, of Rochdale, and grandson of Mr. Thomas Robinson, the originator of the well-known firm, and was educated at the Rochdale Grammar School, Clifton College and Owens College, Manchester. After leaving school, Mr. Robinson passed as an ordinary apprentice through the fitting shops, foundry, and drawing-office, and about thirty-five years ago entered the firm, which at that time devoted itself exclusively to the manufacture and erection of wood-working machinery. After seven years' workshop experience, during which time he earned the respect of those around him, Mr. Robinson took charge of the erection of wood-working machinery abroad, and the experience thus obtained was enhanced by visits to timber-producing regions in Canada and the United States. The knowledge he then gained of foreign languages assisted Mr. Robinson materially in the conduct of the large business which the firm does abroad. About 1880, the making of flour milling machinery was added to the firm's business; and, later still, that of making mechanical conveyors and elevators.

On the death of Mr. John Robinson in 1877, the firm was converted into a limited liability company, with Mr. James Salkeld Robinson at its head. On the death of this gentleman in 1892, a new company was formed, most of the shares being held by the Robinson family, and of this company Mr. T. N. Robinson was the chairman from its commencement until the time of his death. He was a member of the Institution of Mechanical Engineers and of the Iron and Steel Institute, and contributed a paper on "Wood-working Machinery" to the "Proceedings" of the former society in 1875. Unlike his father, he did not take any active part in public affairs, but was far from indifferent to the interests of his native town. He took special interest in technical education, the importance of which he recognised. As a result largely of his interest in this direction, the firm has rendered assistance to higher education in Rochdale by granting scholarships and by special facilities and encouragement extended to the apprentices at the Railway Works.

THE LOADS ON TACKLE.—A diagram illustrating the load on the various parts of pulley blocks, with different purchases, has been sent to us by Messrs. Davey and Co., of West India Dock-road. This diagram, which, we are informed, is based on experimental results, shows that to lift a ton with a single pulley requires a pull of 22¼ cwt., and puts a load of 42¾ cwt. on the supporting hook when lifting and 37½ cwt. when lowering. With single purchase the pull is 12 cwt., the load on the hook raising 33 cwt., lowering 29½ cwt.; load on the beckett, 9½ cwt. raising and 10¾ cwt. lowering. With three sheaves each in the fixed and flying blocks, the load on the hook is 28 cwt. raising and 24¼ cwt. lowering, and on the beckett 2 cwt. raising and 4½ cwt. lowering. The sheets are printed in two sizes, and will be found well worth gumming into some standard book on applied mechanics,

INGLIS MARINE BOILER

BARCLAY, CURLE AND CO., LIMITED, GLASGOW, ENGINEERS



THE INGLIS BOILER ON BOARD SHIP.

THE Inglis cylindrical steam boiler, which, as represented by a first boiler of the type, was described in THE ENGINEER for June 30th, 1905, has recently been fitted to an ocean-going cargo steamer and put through tests at sea. The vessel in question, the s.s. Glencairn, owned by Messrs. Denholm, Bo'ness, equipped with the new boiler, left the West Pier, Leith, on Thursday, 10th inst., and was kept under steam for between five and six hours in the open waters of the Firth of Forth.

Before referring to the results of the trip, it may be advisable to recapitulate very briefly the general features of the boiler, which is the invention of Mr. Inglis, of the Airdrie Boiler Works. While the Glencairn's boiler, which was made by Messrs. Barclay, Curle and Co., Glasgow, is worked under natural draught, it should here be pointed out that the potentialities of the boiler are not fully made apparent under a natural draught system. The great object, in fact, in the design has been to produce a boiler that can be forced in a closed stokehold to a much greater extent than the present type of cylindrical boiler, and that can be so used without damage to itself and with economy under the same conditions.

The Inglis generator, generally speaking, is a Scotch or tank marine boiler, but with a very material difference. The fuel is burnt in three flues, and the gases meet in a common combustion chamber at the back. Instead of at once entering tubes and passing to an uptake over the fire-doors, they find themselves in a fourth flue of approximately the same diameter as the other three, where there is time and opportunity for all the gases to be thoroughly lighted. Thence they pass into still another chamber, where they spread out, complete their combustion, and pass through a large number of tubes into the uptake at the back. It will be seen at once that the superiority over an ordinary tank marine boiler lies in the great combustion chamber provided by the upper flue.

The Glencairn's old boiler, which the Inglis patent boiler displaces, was 14ft. 6in. diameter by 10ft. 3in. in length. The new boiler, while of the same diameter, is only 9ft. 6in. long, so that to this extent, had the circumstances been ordinary, the new would be somewhat penalised as to heating surface and other points. The net results, however, and the incidental advantages of the stokehold and other working arrangements which the new type of boiler secures, show that the latter comes well out of the comparison. Taking figures certified as representative of the old boiler's best performances, the coal burned per indicated horse-power was 1.85 lb., the working pressure at the boiler being 158 lb., and the revolutions of engines 75. The performances of the Inglis boiler on the occasion of the trial, with a steam pressure of 154 and engine revolutions of 85, were measured by a consumption over the period at the rate of only 1.42 lb. per indicated horse-power. The important feature of absence of smoke was also successfully demonstrated. For a short time, on firing up, there was a faint trail of smoke, quickly dissipating itself into the surrounding atmosphere; but afterwards, and, generally speaking, throughout the run, scarcely any smoke, except of a light diaphanous character, was visible. The freedom from smoke with the steam pressure at about 160 lb., and a steam supply greater than the engines could take up, was in remarkable contrast to the heavy trails of black smoke in the wake of other vessels in the Firth.

At luncheon, served in the course of the run, which was presided over by Mr. Nimmo, chairman of the Inglis Boiler Syndicate, Mr. Inglis, in thanking the company for responding to the toast of his health, drew attention to the behaviour of the new type of boiler as compared with the ordinary cylindrical type in respect of forcing, which in the latter case invariably causes serious leakage at tube ends, depositing scoria on the tube plates, and in a short time beginning to close up the tubes themselves. In the ordinary type, when forcing with about 1½in. air pressure, the temperature of the gases entering the tubes is as high as 2500 degrees, falling when firing takes place to about 1000 degrees. In the new type of boiler, when forcing with double the air pressure, the gases enter the tubes at the uniform temperature of 1680 degrees. The risk of damage through forcing in the new boiler is therefore much less than in the ordinary type, even when the new boiler is working with double the air pressure in the stokehold. The tubes and the tube plate are not affected in any deleterious way by the forcing, being placed at the front instead of the back end of the boiler, as in the ordinary type.

SHIPBUILDING NOTES.

ONE of the notable events of last month, to which a good deal of prominence was given in the Press, was the important changes made in the Construction Rules of Lloyd's Register, a notice of which appeared in the last issue of THE ENGINEER. At the time of writing, the Rules have not been officially published, but it would appear that the alterations made are radical in their nature, and are such as to remove some of the disabilities imposed by the old Rules. We hope to return to this subject when fuller information is available.

THE promulgation of these Rules coincides with the retirement of the Chief Ship Surveyor to Lloyd's Register, Mr. H. J. Cornish, and they round off his long and honourable connection with the Registry with a completeness which is not the lot of everyone in his position. On Friday, the 25th inst., Mr. Cornish was entertained at a complimentary dinner in the Trocadero Restaurant by his colleagues and friends, and associated with him in this function were Mr. J. E. Stoddart, assistant to the Chief Engineer Surveyor, Mr. C. H. Jordan, a principal surveyor on the Chief Ship Surveyors' staff, who also retire at this time, and Dr. J. Bruhn, whose appointment to the Norske Veritas was announced in this column a fortnight ago. These gentlemen were presented with tangible tokens of the esteem in which they are held by their colleagues, whose good wishes were extended to them for their future welfare.

MR. CORNISH'S successor is Mr. S. J. P. Thearle, who has been his principal assistant since the death of the late Mr. G. Stanbury. Mr. Thearle has also had a long and distinguished career, the success of which is due almost entirely to himself. His connection with shipbuilding commenced in the year 1860, when he entered Devonport Dockyard. In 1865 he was one of four Admiralty students who were sent to the Royal School of Naval Architecture, which had been founded by Parliament in the preceding year. After undergoing three years of training there, he obtained, by examination, the diploma of Fellow. After passing out of the Royal Naval College, Mr. Thearle was appointed an Assistant Admiralty Inspector of ships being built by contract on the Thames and Clyde, and in 1872 he was admitted to the Admiralty-office as a draughtsman in the Controller of the Navy's Department. In 1876 he left the service to join the surveying staff of Lloyd's Register, and from that date he has been employed in the responsible duties of that office at the ports of London, Bristol, Greenock, and Glasgow. He was appointed Principal Surveyor at Newcastle in 1898, and two years later he was appointed one of Mr. Cornish's assistants, to whose office he has now succeeded.

MESSRS. SCOTT'S, of Greenock, are not allowing the grass to grow under their feet in their preparations for building H.M.S. Colossus, the battleship of the Dreadnought class which they have contracted to build. The keel blocks are already in position—550ft. of them—and the actual commencement of construction represented by the laying of the keel plates will probably take place in a few days.

THAT the present depression in shipbuilding is not confined to this country is shown by reports from France and Germany which are published from time to time, and a recent consular report from Nagasaki shows that Japan also is suffering somewhat from the same cause. At that port, which may be taken as fairly representative of Japan's general shipbuilding industry, both new work and ship repairs have decreased in volume during the past year, and, in consequence, the number of workpeople has also decreased by about 25 per cent., compared with the figures for the preceding year. There are signs, however, that in America a revival of the industry may be looked for. Some of the yards on the Atlantic coast have recently booked orders, and to these must be added the Maryland Steel Company's yard at Sparrow's Point, near Baltimore, which has secured orders for four large cargo vessels, three of which are 410ft. in length, and are intended for the Pacific trade.

WHEN the controversy between Dr. Caird and Sir William White regarding the relative merits of turbines and reciprocating engines was at its height, it was remarked here that the Mauretania would easily eclipse her previous performances under the better conditions of weather, &c., which were to be anticipated. This prediction has been amply fulfilled since then, and especially so in her latest record-making voyage, which ended on Monday, June 21st, at Queenstown. The passage was made in 4 days 17 hours 21 minutes, being the fastest for the home voyage. The average speed record was also exceeded, and was 25.88 knots as against 25.70 knots, her previous best. These figures speak for themselves.

THE last of the three Clyde-built Orient steamers—the Osterley—achieved a very gratifying performance on her speed trials at the end of last month. The maximum speed attained was 19¼ knots, which is a considerable increase on the maximum trial speeds of the other two vessels. The London and Glasgow Shipbuilding Company is to be congratulated upon so successful an issue. Our readers may have remarked that in each of these vessels turning trials were made. In the case of the Osterley the best result was attained when she made a complete circle in 550 yards. All three vessels had their sterns cut away after the Admiralty pattern, and no doubt these turning trials were made to ascertain the effect of this. The results bear out those obtained from his Majesty's ships where this construction is adopted. The Belfast boat Otranto made a mean of 18.95 on Wednesday last.

THE COAL TRADE DISPUTE.

AT the moment of writing there seems every probability that the coal crisis has passed, and that the trade will settle down once more. Just before midnight on Wednesday, the Conciliation Board sitting at Cardiff came to an agreement which seems likely to put an end to the trouble. The actual terms of the agreement will not be formulated until Saturday next, but it is understood that the basis of the settlement is that the employers agree to call the men's representatives into consultation before new methods of working are introduced, if, on the other hand, the men will agree to adopt double shifts wherever practicable. These matters, however, will probably be referred to an independent person appointed by the Conciliation Board, or, if such an appointment cannot be made, to an arbitrator nominated by the Home Secretary. The sixty hours' question is still unsettled, the men's representatives holding to their contention that it was never intended that the clause should be applied as the owners desire. It, with several minor points, will be discussed on Saturday.

LAUNCHES AND TRIAL TRIPS.

VICTOR HUGO, steel screw cargo steamer; built by Sir Raylton Dixon and Co., Limited; to the order of Messrs. Delmas Frères, of La Rochelle; dimensions, 301ft. by 43ft. by 21ft. 4in.; to carry 1300 tons; engines, triple-expansion, 22in., 35in., 59in. by 39in. stroke, pressure 180 lb.; constructed by Richardsons, Westgarth and Co.; launch, June 17th.

CATERINO, steel screw steamer; built by W. Gray and Co., Limited; to the order of Furness, Withy and Co., Limited, of West Hartlepool; dimensions, 358ft. by 50ft. 8in. by 25ft. 6in.; engines, triple-expansion, 25in., 40in., 65in. by 42in. stroke; constructed by the builders; trial trip, June 22nd.

NYLAND, turret steamer; built by William Doxford and Son, Limited; to the order of Messrs. Axel Broström and Son, Gothenburg; dimensions, 331ft. by 48½ft. by 24¼ft.; to carry 5400 tons; engines, triple-expansion, 24½in. by 40in. by 66in. by 42in. stroke; constructed by the builders; launch, June 22nd, 1909.

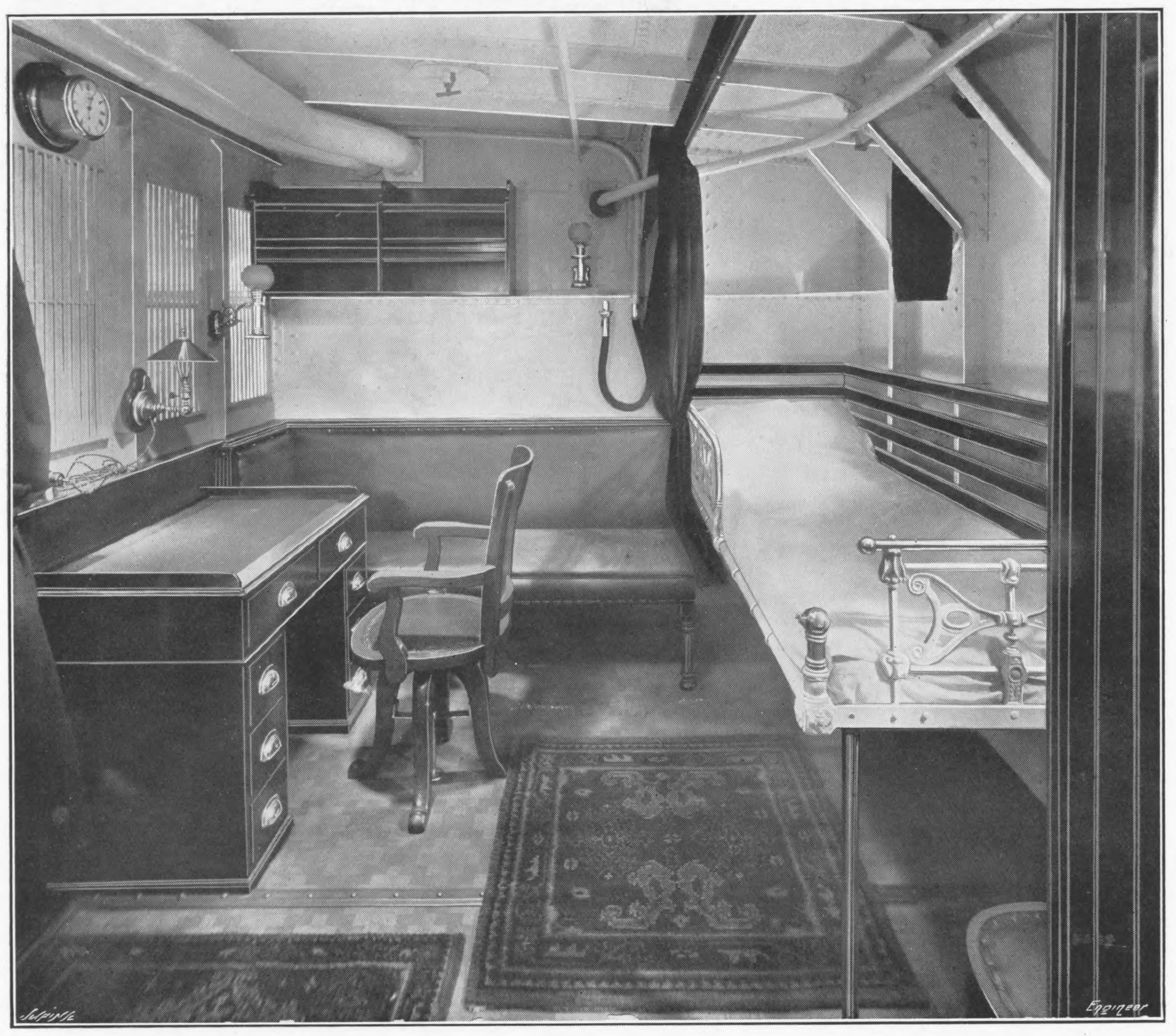
THE NATIONAL ELECTRICAL MANUFACTURERS' ASSOCIATION.—We are asked to state that a Committee meeting of this Association will be held at Balfour House, Finsbury-pavement, E.C., on Tuesday, the 13th inst., at 2.30. p.m.

THE BRITISH ASSOCIATION.—The Lord Mayor of Sheffield presided over a large and representative meeting of citizens, held at the Town Hall, on the 28th ult., when preliminary arrangements were made for the visit of the British Association which is to hold its annual meetings in Sheffield next year. A general committee, numbering about 350, was appointed, from which an executive committee was elected. The last visit of the British Association to Sheffield was in 1879.

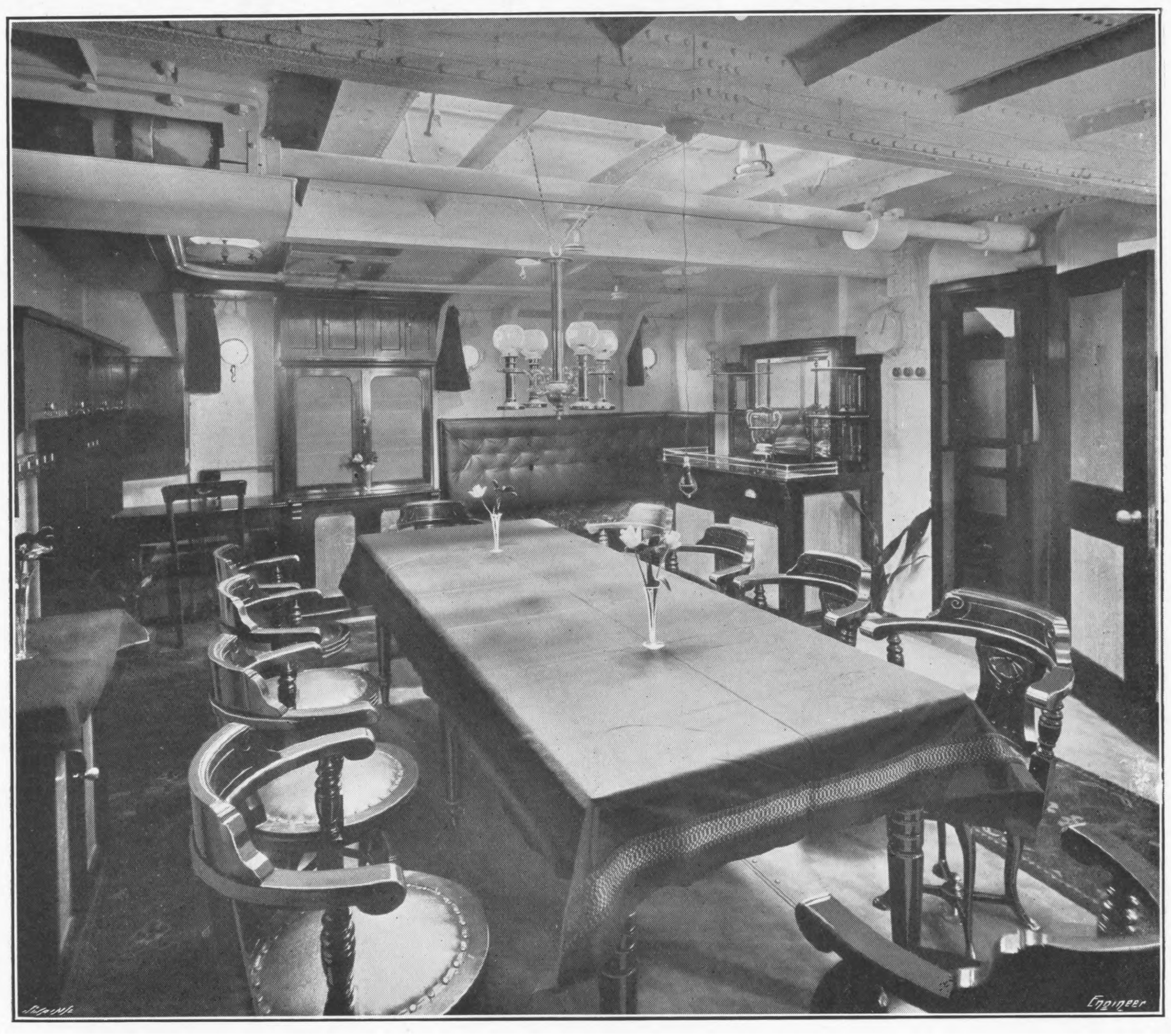
BOARD OF TRADE EXAMINATION OF ENGINEERS.—The following instructions to examiners and notice to candidates have just been issued by the Marine Department of the Board of Trade:—On and after January 1st, 1910, the last clause of paragraph 23 (*a*) of the Regulations relating to the Examination of Engineers in the Mercantile Marine will be cancelled, and the following clauses will be substituted therefor:—"If the candidate has served as an apprentice engineer or as journeyman, under the conditions above prescribed, for less than four years, he will be required to make up the deficiency or to complete this period of four years by service as engineer at sea on regular watch on the main engines or boilers (1) of a foreign-going steamer of not less than 66 nominal horse-power, or (2) of a home trade steamer of not less than 66 nominal horse-power, such service to be counted as equivalent in the case of (1) to two-thirds, and in the case of (2) to four-ninths, of service as apprentice engineer or as journeyman. If the candidate has not served at all as apprentice engineer or as journeyman, he will be required to have served at sea, in lieu thereof, as engineer on regular watch on the main engines or boilers, six years in a foreign-going steamer of not less than 66 nominal horse-power, or nine years in a home trade steamer of not less than 66 nominal horse-power."

THE BRAZILIAN TORPEDO BOAT DESTROYER "MATTO GROSSO"

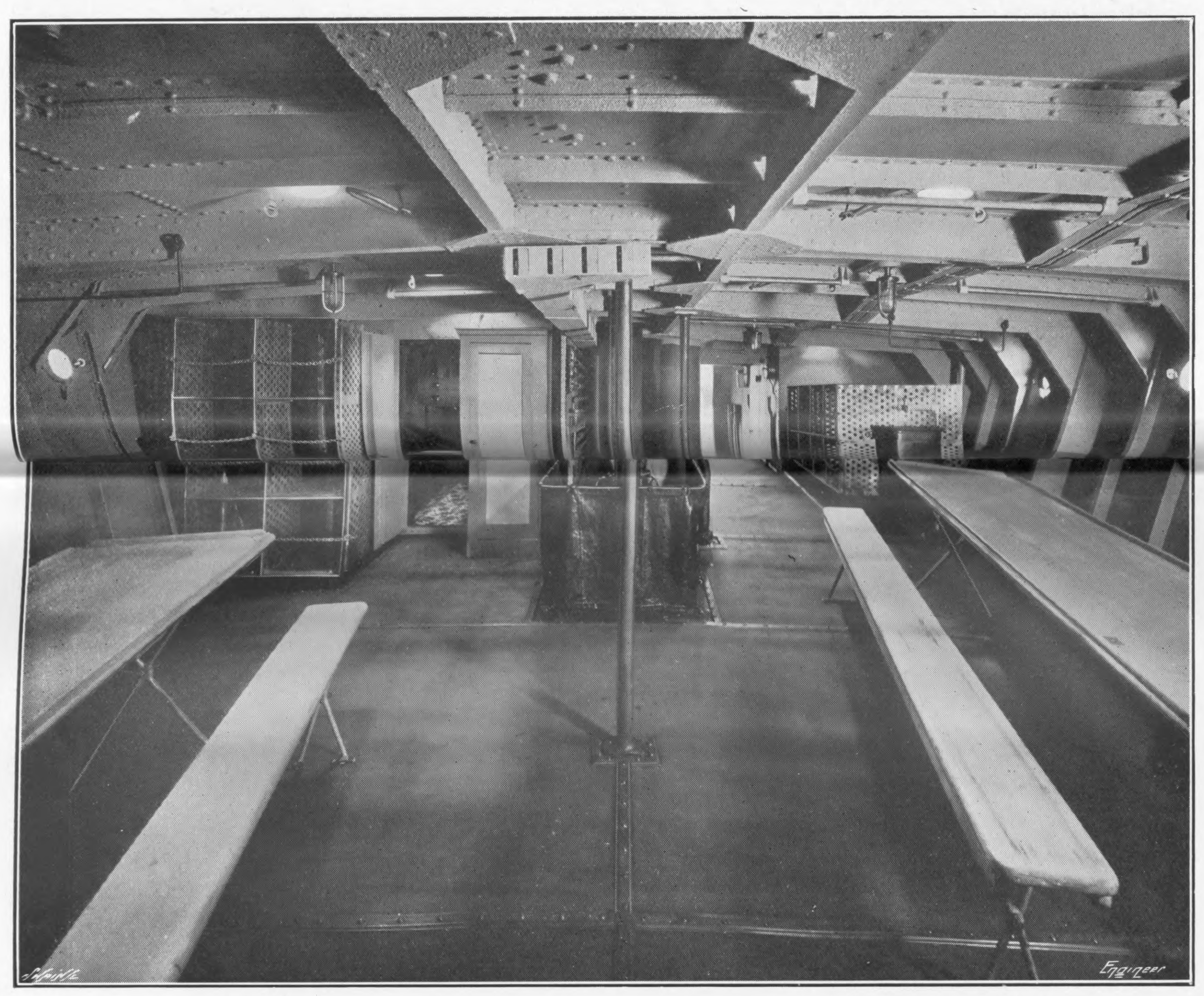
YARROW AND CO., LIMITED, SCOTSTOUN, BUILDERS



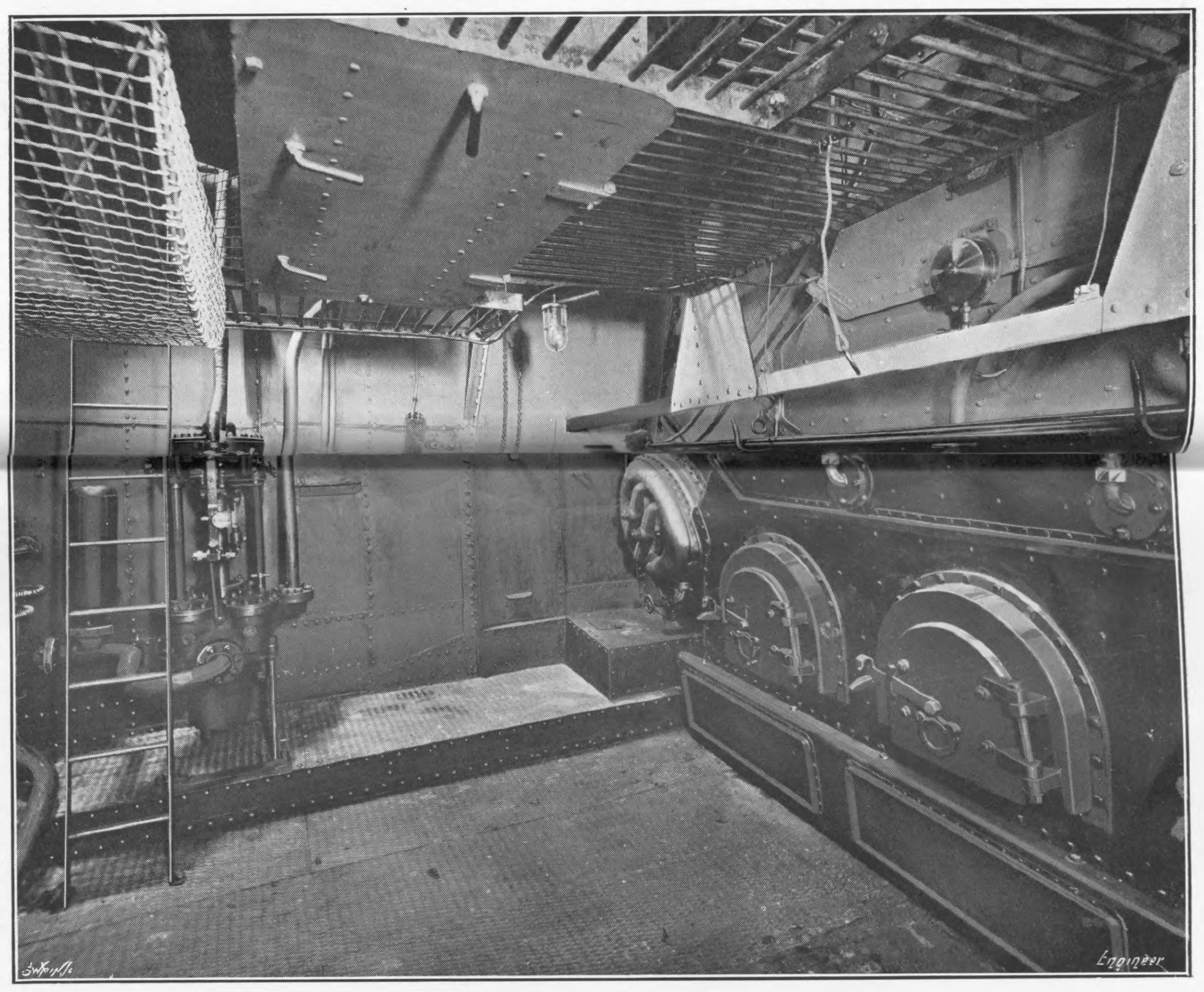
THE CAPTAIN'S CABIN



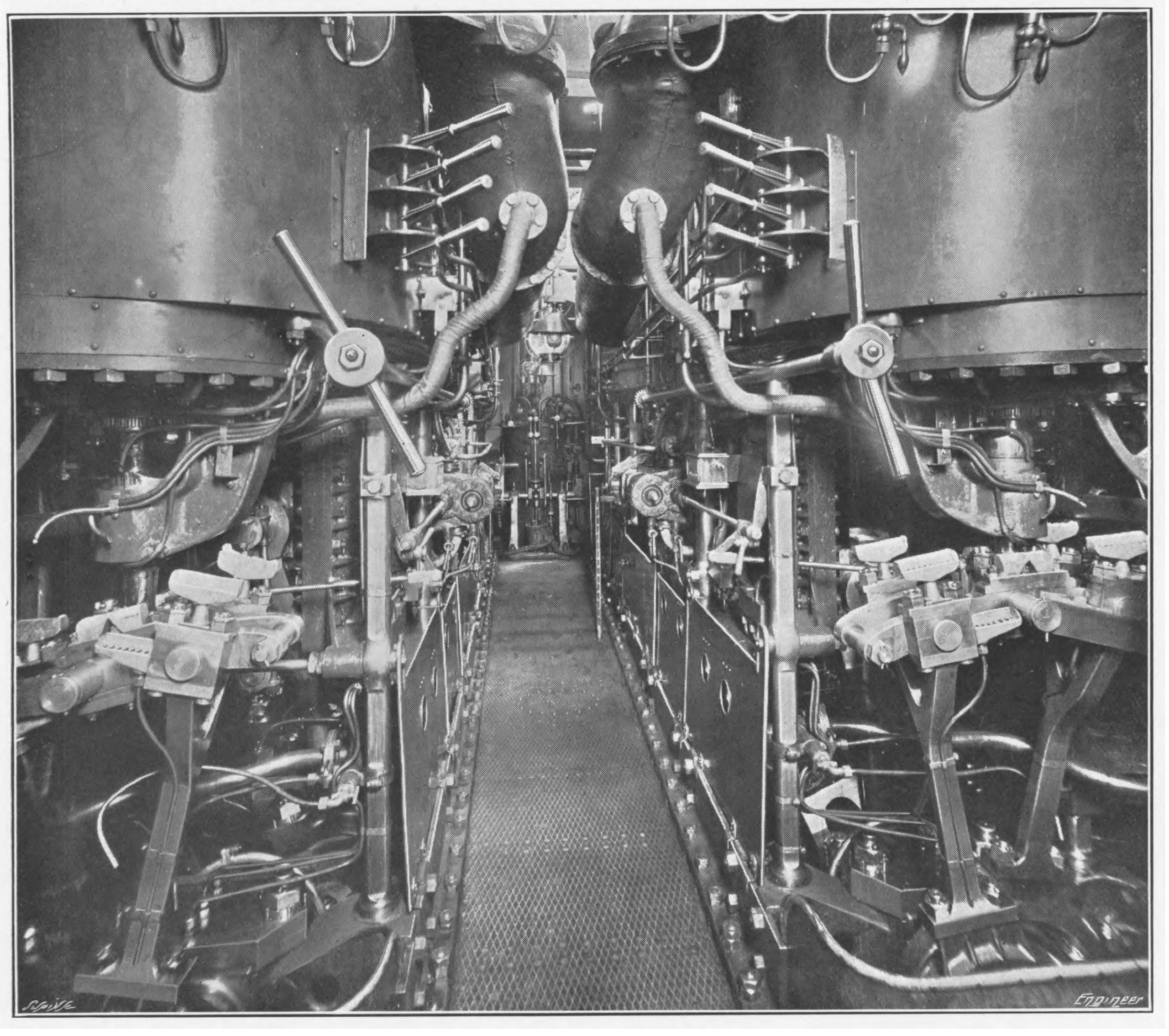
THE WARD ROOM



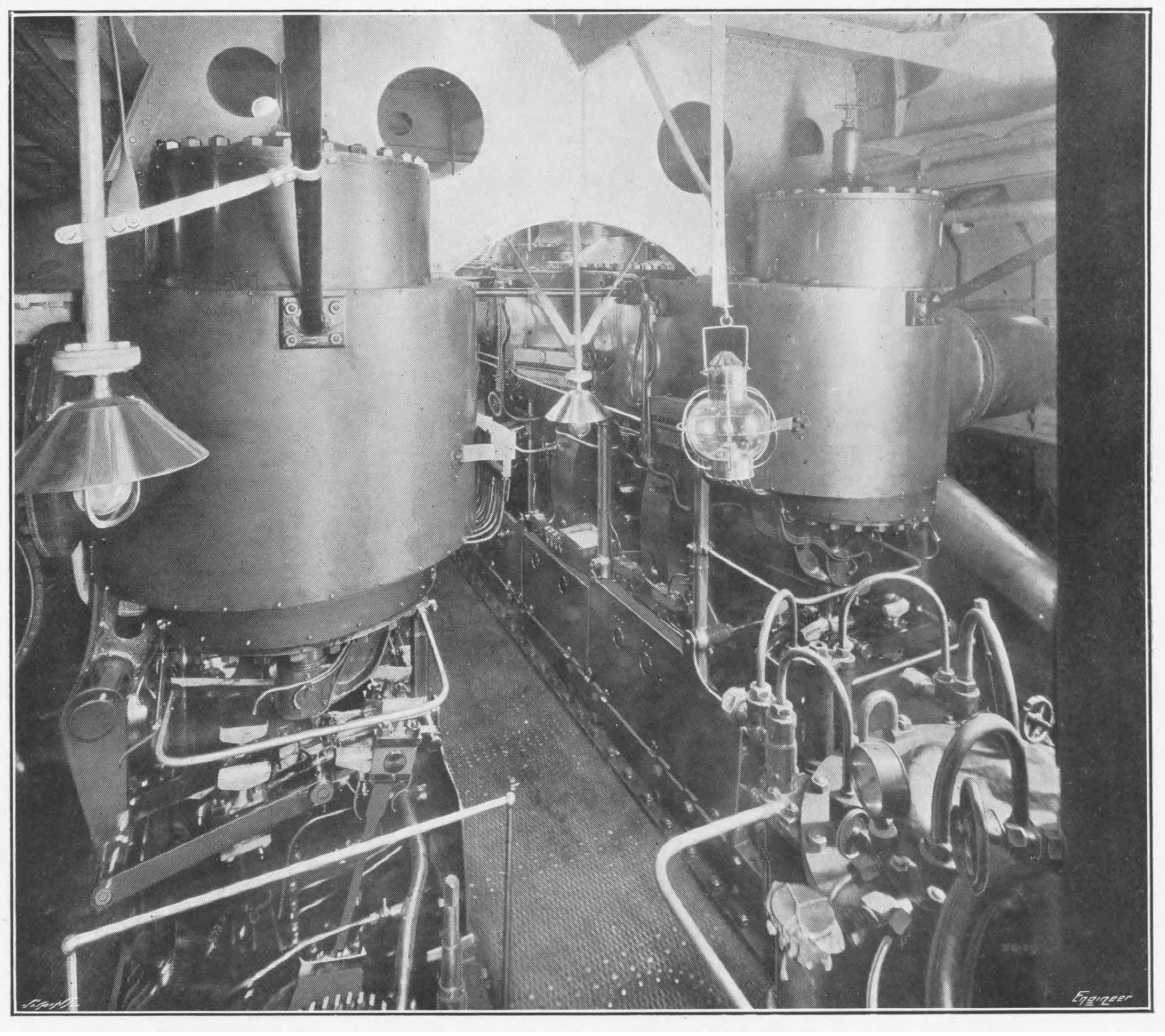
ONE OF THE CREW'S SPACES



ONE OF THE STOKEHOLDS



ENGINE ROOM—LOOKING AFT



ENGINE ROOM—LOOKING FORWARD

THE OPERATION AND MANAGEMENT OF THE PARSONS MARINE STEAM TURBINE AS PRACTISED ON THE U.S. S. CHESTER.

By Lieutenant A. F. H. YATES, U.S.N., Member.*

(*Concluded from page* 670, *vol.* cvii.)

The two most essential points in connection with the economical operation of the turbine are undoubtedly dry steam and a high vacuum. The Chester's boilers furnish a high quality of dry steam, and no ill effects from this source are experienced by me, as a rule. It has already been mentioned, however, that, with a drop in the boiler steam pressure, the quality is affected, and a difference in speed is noticed as a result. The effect of the wet steam is to cause increased blade friction. Strainers are installed above the throttle valves, but their function is principally to prevent foreign matter, such as might injure the blades, from entering the turbines.

As regards a high vacuum, the reason for its importance lies in the fact that the steam undergoes a greater range of expansion in the turbines than in the reciprocating engine. The theoretical loss due to a drop in the vacuum is usually expressed in terms of percentage of increase in the steam consumption. Such figures perhaps express the importance of a high vacuum most tritely, but it may be expressed also in terms of decrease in speed for the same steam-belt pressure. If running under a constant steam-belt pressure, all other conditions, such as wind and sea, being constant, as well as the vacuum, the speed will be constant. If, however, the vacuum drops, a perceptible drop in the speed will follow. I might say, roughly, that for 1in. drop of vacuum on the Chester her speed will drop off half a knot. Vacuum being such an important matter, it is well to have an accurate gauge on it. The regular standard type of vacuum gauge is supplied the Chester, and also mercury columns. Perfect reliance cannot be placed in them, however, and it is thought that the use of a thermo meter at the exhaust end of the low-pressure turbine would be a valuable accessory. Several degrees change in temperature would represent about ¼in. of mercury, so that coarse and fine readings could be obtained at this point, which is really where the high vacuum is desired.

The provisions made for the utilisation of auxiliary exhaust steam in the turbines has already been referred to above. There are many different conditions under which the auxiliary exhaust steam might be used, sometimes in one place and sometimes in another, depending upon the relative pressure conditions. The advantage to be derived should, however, be determined before it is used. Under some circumstances, as will be shown later, the auxiliary exhaust is drawn off to feed the gland system. Then, again, it may be used in the feed heaters. If it is used for these purposes there are not many occasions where it will be found sufficiently plentiful for additional use in any of the turbines Therein lies a question as to whether greater benefit is derived from its use in the feed heater or in the turbine. I am hardly prepared to speak authoritatively in reply thereto. Benefit is derived in each case. Conditions have been noticed on the Chester where its application to the turbines resulted in a half knot increase in speed; whereas, on the other hand, its use in the feed heaters would have provided feed-water of a temperature of 230 deg. Fah. or 240 deg. Fah. Occasionally a surplus, when using it in the feed heaters, is drawn off in the turbines. Special tests along these lines would be of great interest, but I am inclined to the belief that slightly more advantage would be found in the use of the steam in the turbines. On some recent runs the auxiliary exhaust steam was used in the feed heaters only to the extent of keeping the feed-water at a temperature of 180 deg. Fah., and the surplus was used in the low-pressure turbines. There is no advantage claimed for this division in its use. The fire-rooms had been used to having its full benefit in the feed water on most all previous occasions, and on these runs it was thought best to let them down easy merely to avoid misunderstandings in that part of the department. Management of the situation thus proved very satisfactory. When running it into the turbines the dynamo engines may with economy be run open to the back-pressure line, but as a rule a separate condenser is used for that plant.

The gland system on the turbines is one which requires more or less constant attention. As installed on the Chester it consists of a main pipe, which passes the entire length of the two engine-rooms, forward and after. Branch pipes connect it with each gland of all the turbines, twelve in all. The only valves in the system are on the main pipe. There are two cut-out valves, one to isolate the portions of the main pipe which lie in the respective engine-rooms, to permit of independent management, and one to isolate the extreme end of the main pipe which lies abreast the cruising turbines. Neither valve is ever closed, as the gland system is worked as one unit, and independent management in the two engine-rooms not attempted; the one for isolating the cruising turbine gland system would only be used in the event of those turbines being disconnected from the main shafts. There is, therefore, free communication in the system between all glands. The only other valves are one in each engine-room for the admission of auxiliary exhaust steam to the main pipe, and a valve in a branch pipe to the condenser with which to relieve any excessive pressure on the system. In order to thoroughly understand the management of the system one must first have a clear understanding of the functions of the glands, especially as these functions are dependent upon existing conditions. The steam gland is, of course, the counterpart of the stuffing-box on the reciprocating engine, and is intended to prevent leaks. Where a turbine is under a steam pressure above that of the atmosphere the function of the gland is to prevent the leakage of the steam into the atmosphere, most naturally. On the other hand, part of the turbines are always running under pressure below that of the atmosphere. The initial-stage turbine must always come under the first class, whereas, as the steam takes its course through the successive turbines, some of the latter come under the second class. How many there are of the one and how many of the other depends upon conditions, but the fact remains that, while some of the glands tend to blow steam, others tend to suck air. The amount of steam leakage from glands under internal pressure depends upon the efficiency of the same and cannot be entirely avoided. The effect of the leakage of air through the others into the turbine will be noticed by a drop in the vacuum. As was stated above, the glands are all in free internal communication through the gland-system piping, so the leak-off steam from glands under internal pressure finds its way to the other glands and has the effect of sealing them against air leakage. Some of the steam leakage enters the atmosphere, but that cannot be avoided with the type of gland fitted. The amount of leak-off steam which enters the system is not always sufficient to seal the other glands, and in such cases auxiliary exhaust steam must be used in addition. On the other hand, the leak-off steam is, under some conditions, excessive, and it is then that the gland relief valve is opened to draw off the surplus to the condenser. About one pound steam pressure per gauge is ordinarily used on the gland system with good results.

In view of the high speed at which the shafts revolve, a constant and vigilant watch must at all times be kept on the bearings and on the oil system. Once a bearing becomes warm, as a result of abnormal conditions, it expands, becomes hot, and burns almost instantaneously. Experience has taught the necessity for the quickest possible action in such cases by promptly slowing down or stopping, increasing the oil supply and pressure and the water supply to the oil-cooling surface. Care of the bearings and of the oil service equals in importance the skilful warming up of the turbines for service. Several hot thrust bearings have been experienced on the Chester, and in all cases they have been due to faulty lubrication in one form or another. In two recent cases they were the result of too close adjustment of float, which, of course, left too limited an oil clearance. In one of these cases it had not been expected, and, indeed, was only discovered upon the occasion of an overhauling shortly afterwards. Then the scorched appearance of the bearing gave testimony. This was an extremely mild case, however, or its occurrence could not possibly have been overlooked. In the other case I detected the bearing myself, first smelling burning oil. I was standing within 2ft. of the thrust bearing, and reached out with my hand to open a small flap door in its casing. Before my hand had touched it, the smoke poured out in a cloud. The turbine was slowed down, and a temporary adjustment of float effected, as insufficient float was at once known to be the cause of the accident in this particular case. In other cases it was found to be due to rust and corrosion in the thrust, this in turn being a result of water in the oil. At the same time, considerable dirt was found in the oil system, and the oil had become in a condition of questionable efficiency. The main bearing journals are so constructed that, in the event of the babbitt melting. certain raised portions of the brass will take the weight of the shaft during the time necessary to slow down and stop. This is in order to save the stripping of the blades, which otherwise would be a natural consequence. The use of the hose on the bearing casing when a hot bearing develops is a useless alternative, though after the turbine is stopped it can do no harm to reduce the temperature. Sight glasses are fitted in all of the branch discharge pipes from bearings, and a glance at these shows whether or not the flow of oil is normal. Thermometers are also fitted at these points, and the temperature of the oil discharged from each bearing is readily observed. Care should be taken to see that the stems of all thermometers extend to a point where the oil washes over them, so their readings will really represent the temperature of the oil proper. The oilers in making their rounds should not be guided entirely by these devices, but should feel each bearing with the hand. In the tropics the oil gets thin, and all bearing temperatures rise. They have ranged between 110 deg. Fah. and 115 deg. Fah., whereas under ordinary conditions they run from 100 deg. Fah. to 105 deg. Fah. The oil first used on the Chester was of the brand used by the builders of the ship, but shortly afterwards the Government made an annual contract for turbine oil of a different brand, and since that time the latter brand has been in use. Oil of the first brand was used for nearly five months, and during that time considerable difficulty was experienced. While it was not all attributed to the grade of oil, still the brand now used is considered, on the whole, more satisfactory. No calculations have been made on the amount of oil required for operation, as sufficient time has not lapsed since the remedying of certain difficulties at first experienced, but the tremendous oil saving with the use of turbines is most apparent. On one occasion, early in commission, oil of different grade, intended for use on auxiliaries, was accidentally placed in the system and ruined the oil then in it. This necessitated a cleaning out of the system and the replenishing of the supply. Later, water appeared in the system in a greater quantity than could be accounted for, but this finally ceased, after more frequent attention to gravity-return oil tanks. Then, again, much oil was lost from the after spring bearings on both inboard shafts, particularly in the tropics, where the oil was thin, and also at times when the ship was much down by the stern. The latter condition affected the gravity return of the oil to the tanks. Independent return pipes are now installed from these bearings, and but little loss has taken place to date. The first oil seemed to change colour after a short time in use, and had to be renewed at frequent intervals. It finally became soapy and white, and the whole system was boiled out with steam and water before the new brand of oil was tried. A precaution that should be observed is the daily inspection of the gravity return oil tanks when in port for the presence of grit, dirt, or an excessive amount of water. The water can be drawn off, but if it is excessive steps should at once be taken to ascertain where it comes from. It should not come from the coolers, on account of the oil pressure being greater than the water pressure, but this is one place that should at least be inspected. Another place is in the water jackets on the spring bearings. The water should, of course, be tasted first to determine whether salt or fresh. It is surprising how much water may be expected from sweating. Reference is invited to Figs. 7 and 8.

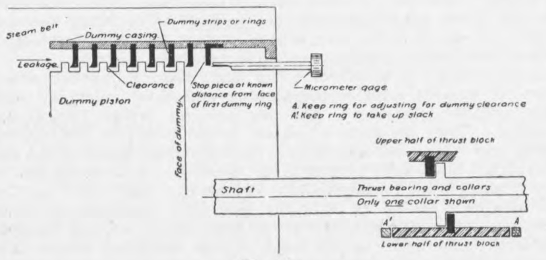

Steam belt
Dummy casing
Dummy strips or rings
Leakage
Clearance
Dummy piston
Stop piece at known distance from face of first dummy ring
Micrometer gage
A. Keep ring for adjusting for dummy clearance
A'. Keep ring to take up slack
Face of dummy
Upper half of thrust block
Shaft
Thrust bearing and collars
Only one collar shown
A'
A
Lower half of thrust block

Fig. 4

The measure of horse-power is determined by the use of a torsion meter, one of the Denny and Johnson type having been used on the Chester. There is little need for such an instrument in service, and the one now installed is only for use during the special trials being conducted for information as to the relative merits of the types of machinery on the three scout cruisers. The torsion of the shaft over a certain length is shown by this instrument, and, the shaft having been calibrated previous to installation, the brake horse-power is determined by a formula covering the principle involved.

The marked effects of cavitation supposed to exist when high power is reached exist more in fancy than in fact. The second standardisation trial of the Chester conclusively proved that she had made all speeds that had ever been claimed for her. The efficiency of the propellers falls off at the higher speeds, but not to an alarming extent, and no evidence of their breaking down or of erratic behaviour has ever been detected. New propellers of even greater disc area are to be fitted later, and slightly greater speed is expected.

My remarks on operation must be brought to a close after mention of the following points to be observed when securing the turbines after coming to anchor. Steam should be tightly shut off the glands and off the vacuum augmenters. Special precautions should be taken to see that water service is kept on the vacuum augmenter condensers, however, and the main air and circulating pumps should be run for about three hours after steam is shut off the turbines. The latter is necessary, as hot vapour remains in the turbines and develops for a considerable time after the steam and water has been drained out, and the condensers might be damaged if secured too early, even after securing condensation continues for a considerable length of time, for the turbines remain more or less warm from twelve to twenty-four hours, depending on the surrounding temperature.

The adjustment of dummy clearances.—The clearance between the dummy piston and the dummy rings is a direct gauge on the leakage of steam from the steam belt. Fig. 4 roughly illustrates how the dummy rings are fitted to the dummy casing and how the serrated faces on the dummy piston revolve in close proximity to the sharp edges of these rings. The importance of preserving a fine adjustment of this clearance as regards the prevention of leakage is apparent. Likewise, the adjustment must not be too fine or the dummy rings would be stripped and the turbine put out of commission. Further reference is invited to Fig. 5, which shows the relative location of these parts to the other parts of the turbine. The adjustment of these clearances, when necessary, is accomplished through the adjustment of the lower and upper halves of the thrust blocks, primarily of the former. Fig. 4 illustrates this to some extent, while Fig. 6 shows a top-view plan of the lower half of a thrust block. The position of the lower half of the thrust block is fixed by the brass half rings, which are fitted around it in recesses. These rings are called keep rings, and the forward one of the two is the one of vital importance, as the after ring is merely put in to make up for the slack and need not be a fit closer than to a few thousandths of an inch. The thickness of the forward ring marks the limit of the forward movement of the lower half of the thrust block, which, in turn, limits the forward movement of the shaft itself, and in consequence of the latter the limit is established of minimum clearance between dummy and dummy rings. The upper half of the thrust block is contained in a casing which is bolted to the casing in which the lower half is contained. The bolt holes are oval in shape to permit of fore-and-aft adjustment of this upper casing before firmly bolting the two together. The adjustment of the upper thrust block is for the purpose of allowing for float. By this is meant the amount of clearance in the thrust bearing for lubrication. In the Parsons turbine the lower half of the thrust block takes only the propeller thrust. The upper half is intended to take the steam thrust only. The turbines are designed to be steam balanced the end thrust on the rotor and the unbalanced thrust on the blades both resulting from the steam pressure, which acts in the opposite direction to the propeller thrust, being so calculated for in designing as to balance the latter at practically all speeds. Perfect equilibrium is not possible, however, and under some pressure conditions the steam pressure preponderates, while under others the propeller thrust preponderates. When the latter is the case the shaft comes all the way in and the lower half of the thrust block takes the strain. On the other hand, if the steam pressure is greatest the tendency of the shaft is to run out and the steam thrust is taken up on the upper half of the thrust block. The amount of fore-and-aft play in the bearing to accommodate these conditions, and likewise to permit of oil clearance, is the float. It must be at least .002in., as that is the thickness of a film of oil, and it must not be too great, or it will permit of too large a dummy clearance; whereas the keep-ring adjustment of the lower thrust block limits the least clearance, the position in which the upper half of the thrust block is bolted limits the greatest clearance. It may be said for the turbines of the Chester that a float of about .010in. should be allowed. The figure .002in., supposed to represent the thickness of a film of oil, is known by experience to be entirely too fine a figure for practical consideration. It was never used in service, but while making an adjustment on one occasion only .002in. float resulted, causing the heating of a bearing. As regards the primary adjustment, that of the lower half of the thrust block for "least clearance," it must not be made to approach too nearly zero, as wear in the lower thrust bearing to a slight extent must be expected, and would reduce the clearance to a dangerous figure. The wear should really be inappreciable, as the balance feature of the thrust minimises the strain on the thrust bearings. The faces of thrust collars on the Chester were at one time affected by corrosion, and a few thousandths of an inch reduction in clearance resulted from cleaning and stowing them. Twenty-five thousand miles of steaming has not affected them except to a few thousandths of an inch.

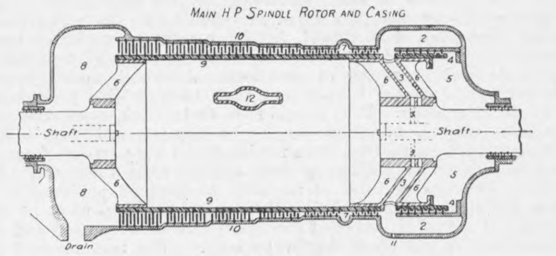


Fig. 5

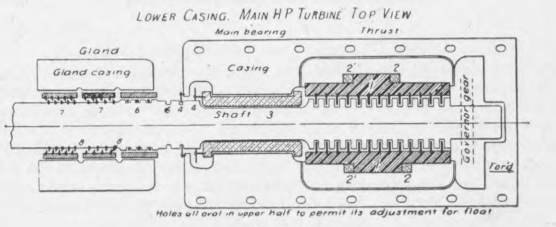

Lower Casing. Main H P Turbine Top View
Main bearing
Thrust
Gland
Gland casing
Casing
2'
2
7
6
4
Shaft
3
8
Governor gear
For'd
Holes all oval in upper half to permit its adjustment for float

Fig. 6

The dummy clearance is determined by micrometer gauges fitted to the casing of each turbine. The device consists of a spindle stem, which passes through a stuffing-box in the casing and into the turbine—see Fig. 4. The end of the stem is recessed on one side to permit of its passing clear of a stop piece. The position of the stem in the figure is with the end of the stem against the stop piece. A reading of the gauge is taken and the stem then turned half around to clear this stop piece. The end is next placed against the face of the dummy piston and another reading of the gauge taken. This is not considered the proper sequence in which to take the readings, however. I personally believe that the rule should be followed of taking the first reading on the dummy piston face, so that at the conclusion of the second reading the end of the micrometer stem will be in its "secure" position. When the reverse order is followed the one who took the readings might neglect to pull the micrometer back into its "secure" position, and its spindle end would grind on the dummy face and burr, perhaps get hot also and bend. Besides, it might cause alarm by making a noise which could not immediately be accounted for. The difference between the two readings is the distance between the face of the dummy and the face of the stop piece. A known constant, representing the distance between the face of the stop piece and the edge of the first dummy ring, is subtracted from the difference between the two readings, and the result is the clearance between edge of first ring and face of dummy piston. This represents as well the clearances of all the dummy rings, as they are all spaced perfectly and at equal intervals. The two cruising turbines are on No. 2 and No. 3 shafts respectively, their part of these shafts having an expansion-coupling connection with the remaining part. Owing to the nature of this coupling, no propeller thrust is experienced in the cruising turbine thrust bearings, and a very slight clearance is necessary. The same type of bearing is fitted, however, and adjustments made in the same manner. An important point is the examination of the ends of micrometer spindles from time to time. Burrs may develop and cause inaccurate readings. Inaccurate readings are also possible if the face of the dummy pistons rust and blister. While this is not likely to happen, it might, after a long stay in port with the turbines idle. Rust on the internal parts of the turbines is insignificant in extent as a rule, even after comparatively long rests, and should cause no anxiety.

Different clearances in the same turbine are found for the different conditions that exist. As previously explained, the float is one reason, accounting as it does for a greatest and least clearance. The clearances also vary with the temperature. It would not be easy to secure greatest and least clearances when the turbines are cold, but if it were it would be found that they would not agree with those obtained when the turbines were warmed for getting under way. Neither would it be found that these limits of clearance, could they be obtained under the latter conditions, would quite agree with those obtained with the turbines thoroughly warmed as when under way. The differences between greatest and least in each case would possibly be alike, but the greatest clearance would differ slightly from one another as would the least clearances. In the construction of the turbine provision is made to minimise any such differences, though it is an open question whether the means adopted are beneficial. The arms of the wheel to which the rotor is secured at its forward end are cast hollow and open into a recess in the centre of the shaft, this to permit these spaces as well as the hollow shaft to be always filled with steam and automatically regulate the conditions of expansion, so that uniform dummy clearances will exist for varying conditions of temperature. Finger pieces are fitted with ends running in a recess in the shaft—as shown in Fig. 6. These are such crude affairs that their use for very fine adjustments would be impossible. They are merely alternatives to be used when conditions demand. Considerable practice is necessary with the micrometer gauge before becoming proficient. The reading depends on the touch, and even a difference in reading of .001in. by two different persons must be expected. In taking readings under way for certain conditions of pressure and speed one should wait until such conditions have become settled. It may take several hours before the turbines find their true position, though such a long delay in securing readings is only necessary for accurate records and knowledge. Adjustment for clearances is exceedingly delicate work, and none but the most careful men must be allowed any part in it. It should only be undertaken when necessary, and should not be necessary except at long intervals. It should also be avoided until a thorough confidence is had in one's knowledge of conditions. A careful record should be kept of the sizes of keep rings installed and in what position in each bearing block. They should have their thicknesses stamped on their peripheries. Guide stems with lock nuts are fitted to the casings which contain upper-thrust blocks for the purpose of gauging the change in position of such casings when regulating the float. The nuts on these stems must be handled judiciously or they will cause much mischief. Once adjusted, they must be let alone. A historical record of changes made in keep rings and of alterations in the float should be kept. The best method of adjusting the float is to pull the spindle in until top and bottom bearing surfaces in the bearing are in firm contact, thus leaving no float. The guide stems above referred to should then be adjusted so that their ends are open by the amount desired for float, the adjusting nut being properly set to correspond. Then, by a stroke of a sledge hammer, the casing containing the upper-thrust block can be knocked into position and all holding-down nuts set up on and guide-stem locking nuts secured.

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* From the *Journal* of the American Society of Naval Engineers.

A complete record of micrometer readings should be kept, for otherwise a true knowledge of the turbine clearances cannot be had. The record to be of real value should show the pressure conditions under which the readings were taken. It is well to take an occasional set of readings when the turbines are cold, and a set should always be taken when the turbines are warm, just before they are tried. They should always be in sets, including the clearances in all of the turbines. When under way they should be taken daily, and with each change of speed, if the new speed is to be maintained for sufficient time to warrant it. A note-book is recommended for keeping these records, with pages arranged in table form. The following suggestion is offered :—

LINE SHAFT BEARING

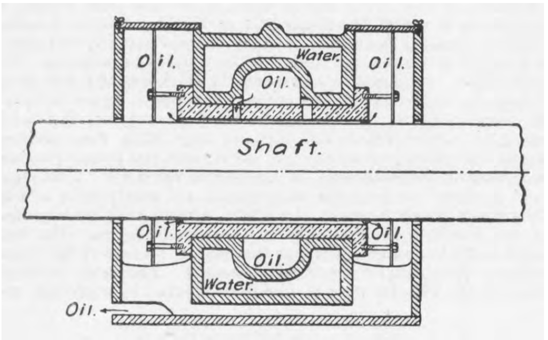


Fig. 7

Date.	Approx. speed.	—	H. P. C.	I. P. C.	S. H. P.	S. L. P.	P. H. P.	P. L. P.
May 1st, 1909.	12 knots	Gauge pressure ..	Lb. 85	Lb. 22	Lb. 10	In. vac. 23.5	Lb. 7	In. vac. 22
		Clearance	In. .009	In. .015	In. .014	In. .021	In. .018	In. .028

While it has nothing to do with dummy clearances and their tabulation, it might also be suggested that in the same note-book there be kept a record of bridge-gauge measurements on journal bearings in the following form :—

		April 1st, '08.	Oct. 1st, '08.	April 1st, '09.
H.P.C.	forward bearing	.018	......	......
	after bearing	.027	......	......
I.P.C.	forward bearing	.032	......	......
	after bearing	.012	......	......
S.H.P.	forward bearing	.038	......	......
	after bearing	.010	......	......
S.L.P.	forward bearing	.022	......	......
	after bearing	.021	......	......
P.H.P.	forward bearing	.023	......	......
	after bearing	.008	......	......
P.L.P.	forward bearing	.019	......	......
	after bearing	.002	......	......

Upkeep.—Successful operation of the turbine should be possible for an indefinite period and necessitate but the slightest amount of work of upkeep. In one year of service, during which the turbines have driven the ship 25,000 miles, no repairs have been effected on the Chester's turbines that required more than one day's work, and even these repairs have been very few. The large jobs which might become necessary, such as re-blading, refitting dummy rings and re-alignment of shafts, need seldom be expected if the operation of the turbine is conducted with care. The re-alignment of a short length of shafting on the Chester is soon to be undertaken, as this particular length, in finding its true alignment, wore down its bearings about .005in., and this had a detrimental effect on the gland-packing strips, causing undue leakage. With a new installation some such incident as this must be expected, and it is safe to say that when this repair is effected it will last for an almost indefinite period. The examination of the turbine internally should not be necessary except at very long intervals. It is understood that the British requirements on merchant marine installations call for the opening of one pair of the Mauretania's turbines annually. I had the pleasure of attending the acceptance trials of the turbine steamer Camden, built by the Bath Ironworks, Bath, Maine, for the Eastern Steamship Company, and became familiar with her turbines in that way. Her trials were held in May, 1907, and she was placed in service a few days after the trials and remained on her route through the summer and fall. She was laid up for the winter at the Bath Ironworks, and in the spring her turbine casings were lifted. There was a small amount of core sand and light dust found, but it had done no harm and might almost as well have been left undisturbed. The blading was intact and the rust appearance was too slight to be worthy of mention. The writer can hardly agree with a statement read by him in a text-book which, in barely touching upon turbine matters, gave the impression that it was necessary to lift the top casings once in three months in order to clear the blades of red lead, &c., despite the steam strainers. The steam strainers of the main turbines of the Chester were examined before her recent twenty-four-hour full-power endurance trial and were in perfect condition. Not having been examined before during her one year in commission, an especially careful examination was made. No doubt the top casings should be lifted after the turbines have been first tried, and this is usually done in our Navy on the occasion of the post-trial examination by the Board of Inspection. Owing to the liberal amount of head room usually found in turbine engine-rooms, the facilities for lifting these top casings makes it no very difficult operation. Indeed, the breaking and re-making of joints and tearing away and replacing of lagging is the greater part of the work. Turbine builders, while engaged at installing, with their facilities at hand and their men in training, think nothing of lifting and replacing a top casing on the same day. The large surface joints between the two casings of the Chester's turbines are all made up with a preparation called manganesite. It comes in the form of bricks, and is broken up and mixed with raw oil. It then resembles graphite in a sticky form. It proves very efficient for joints of this nature. Only in one small place has it blown out, and, while this will eventually necessitate the re-making of the joint, the leak has been stopped thus far by the application of rust cement. The leak referred to is in a very awkward place, near a gland-casing joint. The result is that the gland-casing joint has been affected and it has had to be re-made on several occasions. After re-making this gland joint the turbine was put under heavy pressure, its exhaust valve being securely closed. It can thus be seen that a perfect test was practicable without the turbine turning over to the slightest degree.

It is perhaps wise to examine the main bearing journals about every six months after commissioning and check them up with their original positions. For this purpose bridge gauges are supplied. They are spans which are bolted firmly to the bearing casing and have a centre point. Between this centre point and the journal the height is measured. Records of these should be kept whenever such examinations are made. The first examination may be expected to show the bearing to be down not more than one or two-thousandths of an inch below original heights. The next examination should really not be necessary sooner than a year. With one or two exceptions, the bearings of the Chester are in almost their original positions.

For some unknown reason I conceived a notion before beginning active operations with the turbine that my troubles would be mostly with the glands. Such, however, has not been the case. Still these devices must meet with their share of criticism. They are, no doubt, the only practical solution to the problem involved, on account of the high surface speed at which the shafts revolve, but they do leak an abnormal amount of steam, and improvement in them must be looked for. They are packed by strips bedded on the one side into the shaft and on the opposite side into the gland sleeves. The thin edges of these strips just clear the opposite member. Snap rings are fitted at the outer end of each gland box, in addition, to prevent the leakage into the atmosphere of such steam as may wire-draw past the packing strips. My notion was that these snap rings would break and need frequent renewal, but no such need has ever developed and is no longer expected. On rare occasions a click, click, click, has been heard in the gland box, caused by these snap rings not having found their running position promptly, but it would die away in a couple of minutes and never recur. These rings run loose in slots, tightly fitting, and are so cut that they can be spread and passed over the thrust and gland collars to be put in place. In connection with the re-alignment of the short length of shaft previously referred to, the fitting of new packing strips in the glands will be necessary. The effect of wear-down of the bearings in question was to cause the gland-packing strips in the glands to wear down their edges. This naturally reduces the efficiency of the gland and causes undue leakage through the same. The re-packing of this gland will be a very neat job, as a wearing fit must be made. On the Curtis turbine these glands are made tight by rings of carbon, the rings being made up of several sectors, each of the sectors being held fairly tight against the shaft by flat springs. Between the successive rings fitted a steam seal is applied. This type of gland is quite successful, but is not considered suited to use with Parsons' turbines on account of the friction due to high surface speeds.

The leakage of steam through the glands and into the engine-room not only means the loss of steam but the filling of the engine-rooms with dampness as well. This dampness is most disagreeable to the *personnel* and has a bad effect on lagging, pipe covering, decks overhead, &c. For this reason good ventilation is of the utmost importance. The turbines make a hotter engine-room than a reciprocating engine-room, but when the air is laden with moisture in addition the effect is doubly severe.

Throttle valves must be a tight fit at all times. The turbine being so well balanced, turns its shaft on the slightest provocation, and a leaky throttle valve becomes a serious nuisance. Valves of the double-poppet type are hard to keep in perfect adjustment, though this is considered as partly due to faulty construction. If they were made up of different materials, having different coefficients of expansion, it is believed that this difficulty would be obviated. The turning over of the shafts when at anchor, or when the ship is stopped, cannot be tolerated, yet this is very apt to happen. To illustrate how readily they revolve, on an occasion for trying the turbines preparatory to getting under way the starboard high-pressure turbine was turned over slow ahead and the throttle valve then closed hand-tight. The shaft continued to revolve and the valve was closed tightly with a wrench. Still the shaft kept in motion and at the same speed. This continued for five or ten minutes, until finally the vacuum, which was 29in., was broken down to more nearly 20in. The shaft then stopped. The vacuum was raised to its original height, but the shaft did not again move. The shaft before this had been revolving about 100 revolutions per minute, which, while it does not represent much power, is sufficient to give the ship motion. In this connection it might be mentioned that idle shafts will drag at a number of revolutions per minute equal to about 50 per cent. of the revolutions per minute of the shafts under steam.

The propellers should be very carefully guarded so as not to be struck and deformed. Slight deformation in turbine propellers have a marked effect. Whenever they are examined special pains should be taken to repair any defects of this nature.

Personnel.—No good opportunity has been had to make fair comparison of the relative demands of the two types of machinery, turbine and reciprocating, in this respect, but there is believed to be no very great difference. There should be a saving in the number of oilers required at high powers on turbine vessels, but at lower powers the same numbers would serve both types. As regards machinists, there should be more demand for them around reciprocating engines, as more overhauling is undoubtedly necessary. As regards the type of machinists, the most skilled hands should, of course, be selected for service with the turbine, for such work as is necessary is of a delicate nature.

ARRANGEMENT OF SHAFTING AND BEARINGS

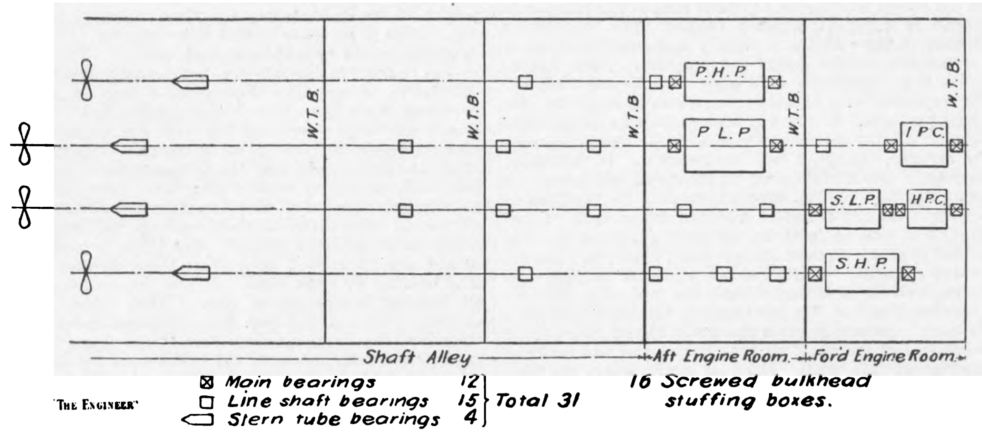


Fig. 8

CATALOGUES.

THE SANITAS ELECTRICAL COMPANY, Limited, 61, New Cavendish-street, W.—This is a supplementary catalogue of some forty pages devoted to electrical lamps for surgical purposes.

HOLT AND WILLETTS, Lion Works, Cradley Heath.—In commemoration of the completion of this firm's forty-first year of trading an excellently illustrated calendar has been published.

THE DAIMLER MOTOR COMPANY, Limited, Daimler Works, Coventry.—This company has just issued a well got up booklet which deals with Daimler successes during the seasons 1907 to 1908. It is full of interesting information and excellent illustrations.

T. W. BROADBENT, Limited, Victoria Electrical Works, East Parade, Huddersfield.—A leaflet from this company has reference to its D type continuous-current dynamos, F type shunt regulators, and S type switches. Illustrations, prices, and other particulars are given.

W. H. PALFREYMAN AND CO., 17, Goree-Piazzas, Liverpool.—"Hints about Casehardening" is the title of a little booklet received from this company. It contains particulars concerning and instructions for using the company's hydro-carbonated bone black for hardening, annealing, and colouring iron and steel.

SIEMENS BROTHERS AND CO., Limited, Caxton House, Westminster, S.W.—Pamphlet No. 522 has been sent to us by this company. It deals with the Siemens electric revolution indicator. This apparatus is used for indicating the speed in revolutions per minute of an engine or other shaft at positions situated at a distance from the shaft.

H. W. WARD AND CO., Limited, Lionel-street, Birmingham.—A new pocket catalogue dealing with machine tools has just been issued by this company. It deals with boring machines, lathes of various types, drilling machines, grinding machines, milling machines, shaping machines, &c. The catalogue is well illustrated, and each illustration is accompanied by a specification.

THE BRITISH MANNESMANN TUBE COMPANY, Limited, Salisbury House, London-wall, E.C.—A booklet to hand from this company contains a large number of testimonials relating to the advantages and economies connected with the use of weldless steel spigot and faucet tubes. We have also received a pamphlet which describes the special features of these tubes and gives full particulars relating to them.

ELLIOTT BROTHERS, 36, Leicester-square, London, W.C.—From this company we have received a tasteful little booklet dealing with micrometers. A point about these micrometers worthy of mention is that a special arrangement of the figures round the measuring head has been adopted, so that each division is numbered, thus enabling the micrometer to be very easily read. Prices are included in the booklet.

MARSHALL, SONS AND CO., Limited, Britannia Ironworks, Gainsborough.—We have received a well illustrated little publication from this company which has reference to the "Marshall" oil motor. Views of the company's shops are given, while other illustrations show the Marshall oil motor in various kinds of agricultural service. At the end of the pamphlet a 60 brake horse-power oil tractor is dealt with.

TANGYES LIMITED, Cornwall Works, Birmingham.—List No. 128 has reached us. It has reference to the company's new pump, the "Tan-Gyro." This pump is an entirely new pattern, and we are informed that it is designed to give a high efficiency over a wide fluctuation of duty. It is particularly suitable for irrigation, feeding canals, sewage works, emptying docks, &c. Price list No. 321 gives prices for all the different types and sizes of these pumps.

THE BUSINESS STATISTICS PUBLISHING COMPANY, Limited, 12, James-street, Cardiff.—From this company we have received a new railway map of the South Wales steam-coal district. Each railway line is shown in a different colour, and the positions of all collieries and fuel works are indicated. We are informed that the map has been brought right up to date, and includes the various proposals of the 1909 sessions which are now engaging the attention of the House of Lords Committee.

MORRIS AND LISTER, Carlton Works, Lockhurst-lane, Coventry.—List No. 14 has reached us. It deals with the "Bruston" automatic transformer switch, which has been introduced to add to the economy obtained with metallic filament lamp installations. The no-load losses of the auto-transformers, it is pointed out, although small, add up to an appreciable amount during the hours when the lamps are not in use. This switch automatically cuts out the transformer at times of no load, and connects it in circuit again when a lamp is switched on. Thus the cost of the no-load losses is saved.

THE IRON, COAL, AND GENERAL TRADES OF BIRMINGHAM, WOLVERHAMPTON, AND OTHER DISTRICTS.

(*From our own Correspondent.*)

The New Half-year.

THE new half-year opens rather quietly with the works moderately engaged, and with traders generally waiting for the July quarterly meeting (which is to be held on the 8th inst.) in the hope of being able at that gathering to book further orders. Doubtless a certain amount of new business will be forthcoming on that occasion as usual, but it is hardly likely to be of much extent. The continued good accounts from the United States are still having a favourable influence.

Structural Steel.

Makers of constructional steel are fairly busy in satisfaction of engineering requirements, and are able to keep up quotations at recent figures. Girder plates are quoted £5 15s. to £5 17s. 6d.; boiler plates, £7; mild steel bars, £6 7s. 6d. to £6 17s. 6d.; angles, £5 10s. to £5 15s. There is a fair amount of work on hand for boiler plates, which are quoted £7.

Semi-finished Steel.

The Midland output of semi-finished steel has lately been considerably enlarged, although it is said that concessions have had to be made to secure business. Meanwhile Bessemer sheet bars are quoted nominally £4 12s. 6d., with Siemens £4 15s.

Manufactured Iron.

The marked bar makers are expecting the renewal of contracts at the forthcoming quarterly meeting. They have lately been fairly well engaged and are quoting £8, with £8 12s. 6d. for Earl Dudley's brand. There is a moderate demand for hoop iron at £6 17s. 6d., while gas strip is quiet at £6 5s. to £6 7s. 6d. Galvanised sheets are quoted at £12 10s., with a good foreign demand.

Pig Iron.

There is, as usual, not much business passing at the close of the half-year, but more is expected shortly, and meanwhile quotations are maintained at the following levels:—Staffordshire common, 46s.; part-mine, 48s. to 49s. 6d.; best all-mine, 80s. to 81s.; cold blast, 110s.; Northamptonshire, 46s. to 47s.; Derbyshire, 47s. 6d. to 48s. 6d.; and North Staffordshire, 49s. to 50s.

The Late Mr. Alderman Williams, of Wednesbury.

Great regret is expressed in the Midlands at the death, on June 28th, at his residence, Brunswick House, Wednesbury, at the advanced age of 92, of Alderman Richard Williams. He had retired about eighteen years before his death, but prior to then he was for the long period of forty-seven years a well-known engineer, having been throughout that time - from 1844 to 1891—associated in various capacities, including general manager and director, with the business latterly known as the Patent Shaft and Axletree Company. For thirty years he was connected with the old Local Board, and was then elected the town's first mayor. He held many public offices. He was a Justice of the Peace, both for the county of Stafford and for the borough of Wednesbury. He was also a member of the South Staffordshire Mines Drainage Commissioners and of other bodies. He was one of the oldest members of the Institute of Mechanical Engineers and of the Iron and Steel Institute. He was born in 1817, his father being a civil engineer in Liverpool.

NOTES FROM LANCASHIRE.

(*From our own Correspondent.*)

MANCHESTER, Wednesday.

The Tone in Pig Iron.

THE opening of July has brought no note of improvement in pig iron. On the Manchester Iron Exchange on Tuesday, although the attendance was good, though perhaps not up to the average, there was an absence of important buyers. It was stated that many founders were buying "scrap," which serves their purpose quite as well as hematite, at prices below No. 3 foundry. There was no reason to doubt this, as inquiries showed that many travellers had returned with very bare order books, as compared with previous weeks. Still, there should be a consumptive inquiry in view of low stocks, but buyers hold off in the expectation of still lower prices ruling. So far as English brands were concerned we heard of little or no change, although Middlesbrough was flat, and Scotch, with the exception of Gartsherrie, was in buyers' favour. Forge iron was a shade weaker. Hematite ruled firm, but there was not much being done on the spot.

Finished Iron and Steel.

The feeling was decidedly quiet, but makers made no concessions for new business.

Copper.

The recent reductions have been followed by some recovery in tubes, say ¼d. per lb., but there was scarcely enough business passing to test prices. Sheets were unchanged. Tough ingot lower.

Lead and Tin.

Sheet lead was advanced 15s. per ton. Tin: English ingots were a shade lower.

Quotations.

Lincolnshire No. 3 foundry, 52s. to 52s. 6d.; Staffordshire, 51s. to 51s. 6d.; Derbyshire, 52s. 6d. to 53s.; Middlesbrough, open brands, 57s. 7d. Scotch: Gartsherrie, 58s.; Glengarnock, 57s. 6d.; Eglinton, 57s.; Dalmellington, 57s., delivered Manchester; West Coast hematite, 58s.; East Coast ditto, 55s. 6d., both f.o.t. Delivered Heysham: Gartsherrie, 56s.; Glengarnock, 55s. 6d.; Eglinton, 55s.; Dalmellington, 55s. Delivered Preston: Gartsherrie, 57s.; Glengarnock, 56s. 6d.; Eglinton, 56s.; Dalmellington, 56s. Finished iron: Bars, £6 10s.; hoops, £7 12s. 6d.; sheets, £7 15s. to £8. Steel: Bars, £6 5s. Lancashire hoops, £7 5s.; Staffordshire ditto, £6 17s. 6d. to £7; sheets, £7 17s. 6d. to £8; boiler plates, £7 2s. 6d.; plates for tank, girder, and bridge work, £6 to £6 5s.; English billets, £4 10s. to £4 15s.; foreign ditto, £4 2s. 6d. to £4 5s.; cold drawn steel, £9 5s. to £9 10s. Copper: Sheets, £73; tough ingot, £61 10s.; best selected, £62 10s. per ton; copper tubes, 8¼d.; brass tubes, 6d.; condenser, 7d.; rolled brass, 6¼d.; brass wire, 6½d.; brass turning rods, 6⅞d.; yellow metal, 6⅛d. to 6¼d. per lb. Sheet lead, £17 15s. per ton. English tin ingots, £130 10s. per ton.

The Lancashire Coal Trade.

The attendance on the Coal Exchange on Tuesday was about an average one, but the greatest uncertainty prevailed as to the future, and sellers were not anxious, while buyers were. The Eight Hours Act is not regarded with much suspicion in Lancashire, and already several collieries have fallen in with the new *régime*. How it will act remains to be seen, especially with the overplus on the sixty hours per week. So far, there has been no difficulty here. There was a better inquiry for best house coal, but common sorts were neglected. In any case prices were well maintained, and for forward delivery higher figures were reported.

BARROW-IN-FURNESS, Thursday.

Hematites.

There is no improvement in the demand for hematite iron, but the market is steady, and the run of orders is sufficient to consume the production of the twenty-six furnaces in blast. The home demand is not large, because steel makers are not requiring so much iron as when they are well off for orders, but there is a better trade on continental account, and the business being done with the Colonies shows expansion, but on American account there is no trade at all, although occasional inquiries are coming to hand. Makers generally speaking are fairly supplied with orders, but they have been expecting for some time past that the market would improve, and they have been getting additional furnaces ready for blast so soon as there is a chance of selling more iron. The sales of special hematites are well maintained, and inquiries are coming to hand from a variety of sources for high-graded specifications of metal which are being sold at from 60s. to 61s. 6d. per ton net f.o.b., according to quality, while ordinary mixed Bessemer numbers are at 58s., and warrant sellers at 57s. 1½d. net cash. Makers of ferro-manganese are selling a fairly good tonnage of this metal to both home and foreign buyers, and it is probable this trade will grow. Spiegeleisen is in moderate request, and some stocks are held. Scrap iron is in small demand, and there is much of it made in this district. Purchasers are mainly to be found in South Wales. Only a small trade is being done in charcoal iron, but then the production of this valuable metal is not large. Prices range at about £7 10s. per ton. In iron ore the trade shows very little life, and raisers are not doing much business except with local smelters. There are fairly large deliveries by shipping from the mines at Hodbarrow for use by smelters in the South Wales and Scotch districts. Prices are steady at 17s. 6d. to 11s. per ton for best and ordinary classes net at mines. Some large cargoes of foreign ores are expected in the next few weeks.

Steel.

There is a moderate demand for steel rails, and makers are on the look out for one or two large orders on Colonial account which are likely to be placed in this country. In merchant steel the demand is quiet. Shipbuilders are not in a position to order much material. The plate mills at Barrow have been at a standstill for about fourteen months, and it would be impossible to work them at a profit at present prices, and particularly so as there would be no chance of running them regularly with so small a demand as exists at present.

Shipbuilding and Engineering.

Work in the shipbuilding trades at Barrow is quiet, and inquiries for ordinary mercantile tonnage are very few. There are, however, prospects of orders for warships, especially on foreign account, but these sort of orders are very slow to move. The chances are, however, that some important orders of this sort will be placed later on in the year. Engineers are gradually getting busier in gun mountings.

Shipping and Coal.

The exports of iron and steel from West Coast ports last week amounted to 11,494 tons—iron 4610 tons and steel 6884 tons—as against 6840 tons for the corresponding period of last year, an increase of 4654 tons. For the year to date the shipments aggregate at 300,614 tons, against 250,583 for the corresponding period of last year, an increase of 50,031 tons. Coal and coke represent moderate trades.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

The Eight Hours Act.

THIS Act came into force on the 1st inst. Up to the present all the relations between the masters and men in the Yorkshire coalfield have been of the most amicable character. Both sides have recognised difficulties in bringing the Act into operation. At the same time, they have shown the most friendly spirit with a view to smooth down the rough places, and work commences with every desire on the part of employers and employed to give the Act a fair trial. Some points which were under discussion have been waived as not being immediately determinable, and settlement of these will come after a little working experience of the new statute. It seems to be impressed upon masters and men alike that two shifts of working will have to be established. Of course, at the present time there are not sufficient men to work the two shifts as largely as the single shift, even if the trade demand allowed, and, therefore, some adjustment will be required of the men on the alternate shifts. The adjustments which may be necessary will no doubt temporarily raise the cost of getting the coal, and this in turn will probably have its influence on prices.

The Coal Trade.

The most active feature is the shipping trade. For the week ending June 22nd—the latest date available—the exports of coal from Hull amounted to 109,883 tons, compared with 78,229 tons for the corresponding week of last year. Quotations in the open market are maintained at 9s. per ton, which is 6d. per ton above the contract rate. Steam nuts are also in considerable request. In house coal the demand is fairly good, considering the advanced season of the year. Best Barnsley, at the pit, commands from 11s. 6d. to 13s. per ton; secondary descriptions from 10s. 6d. to 11s. 6d. per ton. Gas fuels are being satisfactorily called for, and a disposition is evident to lay down heavy stocks. The contracts being arranged continue on the basis of 6d. per ton under last year's prices.

Small Coal and Coke.

The demand for Lancashire, so far as we can learn, is not affected at present by the proposed limitation of the mills, and continues normal, qualities for the cotton and woollen districts still fetching from 4s. 6d. to 5s. 6d. per ton. A fair business is reported in coke, best washed remaining at 10s. 6d. to 11s. per ton; unwashed, 10s. to 10s. 6d. per ton.

The Iron Trade.

Owing to the prevalence of stock-taking at this time of the year, the pig iron market is in a quiescent condition, makers not pressing sales, and buyers not requiring deliveries. The hopeful feeling still keeps prices fairly firm. Hematites, West Coast, 68s. to 69s. per ton; East Coast, 64s. to 65s. per ton, both less 2½ per cent., delivered in Sheffield and Rotherham. Lincolnshire, No. 3 foundry, 50s. per ton; No. 4 foundry, 49s. per ton; No. 4 forge, 49s. per ton; No. 5 forge, mottled and white, 49s. per ton; basic, 50s 6d. per ton. Derbyshire, No. 3 foundry, 50s. per ton; No. 4 forge, 49s. per ton. Lincolnshire and Derbyshire iron net, delivered in Sheffield and Rotherham. Bar iron, £6 10s. per ton; hoops, £7 10s. per ton; sheets, £8 10s. per ton.

The Heavy and Light Industries.

We cannot hear of any distinct improvement as regards Sheffield trade generally. The general engineering departments are quiet. Steel manufacturers are but inadequately employed. The United States demand has been rather a gratifying feature of the export business, but that is stated to be scarcely so pronounced as it was. The forgings for the machinery of the two new Dreadnoughts being built in private yards have been, as we anticipated, for the most part placed in Sheffield. In the marine and railway material manufactures the situation remains pretty much as previously reported. The prospects of revival are not more apparent than they have been of late, though here, as in the iron trade, a hopeful feeling of betterment in the early autumn is entertained. In the lighter trades of the city the British implement makers afford acceptable orders in machine knives and steel parts, which in quantity are quite up to the average of previous years. Complaints of Dutch trade are freely heard in the cutlery and plating industries, the weather having been an adverse factor in the retail trade during the late spring and early summer. Some improvement is reported from distant markets, more especially New Zealand, Australia, and Canada. That, however, is only slight, but it is expected to get more satisfactory as the season advances.

Sir Charles McLaren on Trade.

Sir Charles McLaren, Bart., presiding, on the 29th ult., at the annual meeting of the shareholders of John Brown and Co., Limited, Sheffield, stated that things were bad twelve months ago, and he was sorry to say they were bad still. He had seen no evidence of improvement during the last twelve months, and really there was very little evidence of distinct improvement in the immediate future. Coal prices were to-day at the lowest point. There had been no real improvement in the iron trade, and though now and then hopes had been entertained, they did not seem to have fructified. He was sorry also to say there was no real demand for merchant ships. If they took almost any one of the particular trades in which they were engaged, they would find there had been a reduced output. Take armour-plate; the net amount turned out had been smaller than for some years, but he considered that in this department the outlook was a distinctly hopeful one. There was a time a few years ago when he began to think that armour-plates for ships might cease to be built, but with the advent of the Dreadnought and the tremendous shipbuilding programme of Germany it had become perfectly clear—and it was admitted by everybody of all shades of opinion—that we must make a very large increase in our armoured ships in this country in order to maintain our national position. That being so, they might fairly consider the outlook for John Brown and Co. in this direction was a very hopeful one.

NORTH OF ENGLAND.

(*From our own Correspondent.*)

Cleveland Pig Iron.

TRADE fails to improve in Cleveland pig iron, and the tone has been very flat all the week. Business is disorganised by the state of affairs in the coal trade, and everything is in such a condition of uncertainty that consumers cannot make up their minds what to do in the matter of buying; all who can put off purchasing iron are doing so, and the somewhat more favourable tone that appeared in the market towards the close of last week has gone off. There is not much disposition to speculate, nor was there at any time in the month of June, and the fluctuations, though noticeable every day—there was not a day when prices could be called steady—yet were within narrow compass, for with the exception of one day, when 49s. cash buyers for Cleveland warrants was reached, the changes were all in the "forty-eights," ranging between 48s. 10d. and 48s. 2d., the figure at the close being 48s. 2½d. cash buyers. The continuous increase in the stock of Cleveland pig iron in Connal's public store has tended to weaken the position of sellers, as it is clearly shown that they are producing more pig iron than the market needs, and furthermore, what is usually a quiet time of the year has been entered upon. The immediate outlook is not encouraging, though there is this to be reported, that for Cleveland warrants to be delivered in three months a higher price by 7d. or 8d. per ton is paid than the rates that rule for prompt. No. 3 Cleveland G.M.B. pig iron has been mostly quoted this week at 48s. 3d. per ton for prompt f.o.b. delivery, No. 1 at 50s. 9d., No. 4 foundry at 47s. 3d., No. 4 forge at 47s., and mottled and white at 46s. 6d. per ton. But for autumn deliveries of these qualities fully 6d. per ton more is asked.

Iron Ore.

Despite the depression the Cleveland ironstone mines are run to the full extent of their capacity, and it has not been necessary to close any of the more recently opened workings, for the output of the district is hardly equal to the requirements. The only difference which the depression has made is that ironmasters have not now to go to Northamptonshire and other Midland counties to get supplies of stone to produce ordinary Cleveland iron. The cost of Northamptonshire ironstone delivered on Teesside is considerably greater than that of Cleveland stone—between 9s. and 10s. per ton, as against 6s. to 6s. 6d. for Cleveland stone on the average. Mineowners in this district are continuing to open out further deposits, but have to be content with ores less rich in metallic iron than those which have hitherto been generally worked. With respect to the adoption of the Eight Hours Act the Cleveland mineowners and the miners' representatives consider that that measure should be amended on at least one point, viz., that the interval between a workman leaving work on a Friday night and resuming on Saturday should be eight hours instead of sixteen as defined by the Act. They also want an interval of twenty hours instead of twenty-four between the times of work being commenced during the week. The representatives of the masters' and men's association on Tuesday this week had an interview with Mr. Donald Bain, of Durham, the Government Inspector of Mines, on the subject. It is probable that a short Act of Parliament will be promoted to enable the desires alike of employers and workmen to be carried out in Cleveland.

Hematite Pig Iron.

Makers of hematite pig iron in this district look in vain for an improvement in their trade, and there are no indications at all of any approaching change for the better. This branch of the iron trade is probably suffering more from depression than any other, and much difficulty is experienced in realising any profits, for materials are relatively dearer than the pig iron produced. The makers, it is reported, hold considerable stocks, and before long it will become necessary for some of them to blow out furnaces. They cannot keep them going in the production of ordinary Cleveland pig iron, because there is already too much of that turned out, and besides, there would be the difficulty of securing supplies of the Cleveland ironstone. It cannot be said that the prospects for East Coast hematite iron makers are encouraging, for those branches of the steel industry which are the chief consumers of hematite iron are badly situated, and have poor prospects. A revival of the hematite iron trade of this district is not likely until there is a very substantial improvement in the shipbuilding industry, and of that there is yet scarcely any sign. The price of mixed numbers E.C. hematite pig iron for early delivery is 55s. per ton, and for delivery over the current half-year 55s. 6d.; these must be accounted poor prices with the present rates for materials. Rubio ore is maintained at 16s. per ton c.i.f. Middlesbrough, but some of the merchants hold out for 16s. 3d. Coke is somewhat weaker in price, and there are somewhat heavy stocks at the ovens which sellers are anxious to get off their hands; they ask 15s. 3d. per ton for furnace coke, delivered equal to Middlesbrough, but plenty of sales at 15s. have been reported.

Stocks and Shipments of Pig Iron.

It is a feature that is the reverse of satisfactory to have to record the continuous increase in the stock of Cleveland pig iron in Connal's store. A year ago less than 48,000 tons were held; now nearly a quarter of a million—on Wednesday the quantity was 238,533 tons, an increase for the month of 17,455 tons—the stock consisting of 233,558 tons of No. 3, 4450 tons of No. 4 foundry, and 525 tons of other pig iron not deliverable as standard.

The stock in makers' yards is likewise increasing, though it is impossible to say to what extent, as there are no official figures collected. It is also stated that the stock of Cleveland pig iron in Scotland is increasing, and that a part of which is going from this district to Grangemouth is not finding its way promptly into consumption. The exports of pig iron from the Cleveland district during June have been disappointing. There have been deliveries to the United States, but it has not been of ordinary pig iron; it has been mainly spiegeleisen, silico-spiegel, and ferro-silicon. The exports of pig iron for June amounted to 105,203 tons, as compared with 114,200 tons in May, 1909; 121,554 tons in June, 1908; and 172,808 tons in June, 1907.

Manufactured Iron and Steel.

Few manufacturers have a good word to say with respect to business in finished iron and steel, and most of them could produce a good deal more than they are at present called upon to supply. The only mills that are even fairly well occupied are those turning out rails, sheets—black and galvanised—and hoops. Those most affected by the depression are the plate and angle mills; it is many years since they were so badly situated, and they are not likely to have a more active trade until there is a substantial revival in the shipbuilding industry. There is no sign of that as yet, and it is not likely that any further reductions in quotations would tempt consumers to order supplies. Steel ship plates are at £5 15s.; steel boiler plates, £6 15s.; steel girder plates, £6; iron ship plates, £6; steel ship angles, £5 7s. 6d.; iron ship angles, £6 15s.; packing iron and steel, £5 5s.; steel bars, £6 5s.; iron bars, £6 15s.; iron ship rivets, £7 7s. 6d.; steel hoops, £6 10s.; steel strip, £6 7s. 6d.; steel sheets (singles), £7 7s. 6d., all less 2½ per cent. f.o.t. Galvanised and corrugated iron or steel sheets, 24 w.g., in bundles, are being sold at £12 10s f.o.b., less 4 per cent. for export, and 2½ per cent. for home consumption. Steel ship plates when required on export account can be bought at £5 12s. 6d., less 2½ per cent., or at half a crown less than is quoted for home consumption. Heavy steel rails are firm at £5 5s. per ton net f.o.b., and deliveries on shipping account are good.

Shipbuilding.

There is still a lack of improvement in the shipbuilding industry, and there is not the least doubt that the majority of the builders could turn out double the tonnage of shipping that is now being reported. There is nothing to induce shipowners to add to their fleets. The rates of freight are almost the worst on record, and the cost of running steamers is more than usually heavy, partly because of the high cost of bunker coals. This is a period of the year when there should be fuller employment for shipping than at almost any other period of the year, but, nevertheless, over fifty vessels are still laid up in the Tyne, these representing something like 86,000 tons as a total.

Coal and Coke.

The coal trade in this district will probably become very active by reason of the labour troubles in competing districts over the Eight Hours Act, and on the strength of that, prices have moved up considerably this week. Best steam coal, which could last week be got at 11s. 6d. per ton f.o.b., is now quoted 12s. to 12s. 3d., and some sellers are shy about accepting these enhanced rates, as they expect to be able to get much better figures very soon; in fact, 13s. per ton is confidently looked for. It is now difficult to meet the demands of consumers, and exports are increasing rapidly. All the wharves and docks are crowded with shipping, waiting for coal cargoes, and a good many steamers which usually get their bunker coals in South Wales are being sent round to the Tyne; this has led to the prices rising, until 10s. to 10s. 6d. f.o.b. Tyne Dock has to be paid. Coke, however, is weak, and can be bought at 15s. per ton delivered at Middlesbrough furnaces, though 15s. 3d. is the regular quotation. Foundry coke is at 16s. 6d. per ton f.o.b.

NOTES FROM SCOTLAND.

(*From our own Correspondent.*)

The General Trade Outlook.

THERE has been a quiet feeling in nearly every department of the iron and steel trades. We are now within a couple of weeks of the annual trade holidays in Glasgow and district, and in ordinary times it has been usual to work a good deal of overtime in shipbuilding, engineering, and other branches, in order to finish up work of an urgent description. On the present occasion, however, it has been remarked that there is a remarkable absence of activity, and only in very exceptional cases is there any necessity for extra labour preparatory to the stoppage. There is every likelihood, on the other hand, that the holidays will be prolonged in not a few instances. The dispute in the coal trade with reference to wages and the apprehension of a general strike of miners have exercised an unsettling influence on business generally.

The Clyde Shipbuilding Trade.

The half-year's output of new shipping on the Clyde amounts to 157,090 tons, compared with 140,149 tons in the corresponding six months of 1908. This improvement of over 17,000 tons is no doubt an encouraging item, inasmuch as it appears to mark an improvement on recent severe depression. But when the output is compared with the 302,847 tons in the first half of 1907, and the record total of 336,258 tons in the first six months of 1906, it will be seen that there is yet much leeway to be recovered before the industry can be regarded as in a prosperous condition. The fresh orders placed during June amount to about 20,000 tons, and fully replaces the total of 17,000 tons launched in the course of the month.

The Iron Market.

The Glasgow pig iron warrant market has been somewhat irregular during the week, and the amount of business has been limited. Since last report Cleveland warrants have sold from 48s. 2d. to 48s. 5½d. and back to 48s. 3d. cash, at 48s. 5d. to 48s. 8½d. and 48s. 7d. one month, and 48s. 10½d. to 49s. 1½d. and back to 48s. 5½d. three months. Transactions are also recorded at 48s. 5d. for delivery in fourteen days. There has been an absence of speculative business, and now that we are on the eve of the holiday season, there is not much likelihood of its renewal for some weeks to come.

Scotch Makers' Iron.

The demand for the special brands of Scotch makers' iron has been quiet, but the makers seem to be well occupied with deliveries under existing orders. Fair quantities of iron are going to Canada and Australia, and there has also been a renewal of shipments to the United States, for which latter country, however, it is not expected that very large quantities will be required. There is a good steady business in special brands with English consumers, but the current Scotch inquiry is somewhat feeble. Prices of Scotch makers' iron are steady. Monkland, No. 1, is quoted f.o.s. at Glasgow 56s.; No. 3, 54s.; Carnbroe, No. 1, 57s. 6d.; No. 3, 54s. 6d.; Clyde, No. 1, 60s.; No. 3, 54s.; Gartsherrie, No. 1, 60s. 6d.; No. 3, 54s. 6d.; Summerlee and Langloan, Nos. 1, 61s.; Nos. 3, 56s.; Coltness, No. 1, 88s.; No. 3, 56s.; Glengarnock, at Ardrossan, No. 1, 63s. 6d.; No. 3, 57s.; Eglinton, at Ardrossan or Troon, No. 1, 55s. 6d.; No. 3, 53s. 6d.; Dalmellington, at Ayr, No. 1, 58s. 6d.; No. 3, 53s. 6d.; Shotts, at Leith or Glasgow, No. 1, 60s. 6d.; No. 3, 55s. 6d.; Carron, at Grangemouth, No. 1, 63s.; No. 3, 56s. per ton. There are eighty-two furnaces in blast in Scotland, compared with seventy-five at this time last year, and of the total thirty-nine are making ordinary, thirty-eight hematite, and five basic iron.

Shipments of Pig Iron.

The shipments of pig iron from Scottish ports during the past week were 6152 tons, against 4763 in the corresponding week of 1908. There was despatched to the United States 625 tons, Australia 430, Canada 425, India 140, Holland 120, South America 20, France 10, China and Japan 100, other countries 423, the coastwise shipments being 3794 tons, compared with 2288 in the corresponding week of last year. The arrivals at Grangemouth of pig iron from Cleveland and district were 8074 tons, being 217 tons less than in the corresponding week of last year.

The Hematite Trade.

A dozen cargoes of hematite ore reached the Clyde in the last six days, all being from abroad, except one which came from the north-west of England. The output of hematite pig iron is maintained, but the sales are disappointing and considerable additions are being made to stocks. The prices of Scotch hematite pig iron are nominally unaltered at 57s. 6d. for delivery at the steel works, but buyers are in some cases mentioning 56s., and it is doubtful if they are prepared to purchase even at that figure.

Finished Iron and Steel.

There has been a little more inquiry for steel goods during the last few days, and the work coming to hand partakes more of the heavy character than has been the case for some time, although miscellaneous structural material is also in fair demand for export. The recent reduction in prices has made it less easy for Welsh makers to compete for Clyde business, and there seems to be a prospect that Scotch steelmakers will have a larger share of the available specifications for shipbuilding steel. Foreign competition for structural steel continues very keen, and merchants representing continental manufacturers are quoting low prices. The makers of malleable iron report a rather better inquiry, but some of the works are still very poorly supplied with orders. In both iron and steel the business is for the most part of a prompt description, there being little or no disposition to enter into contracts for future delivery.

The Coal Trade.

Shipments of coal have been on a larger scale than usual, in consequence of fears that there might be a general strike of colliers. On some days there was considerable excitement in the coal markets and high prices have been paid for special supplies, but, as a rule, the coal available is fully equal to all requirements. For small hard coal and dross the demand has been active at higher rates, but prices generally do not yet show much advance on those of last week. The near approach of the trade holidays largely accounts for this state of matters, consumers being in a position to stop their works in the course of a few days, if necessary.

WALES AND ADJOINING COUNTIES.

(*From our own Correspondent.*)

Last Week's Coal Trade.

THE week has had all the worst features of those preceding long strikes, and it has been difficult even for the oldest members on 'Change to glean the probable turn of things from the events as they pass. The most reliable figures have been as given below:—Small parcels excluded; for the latter fancy prices were asked.

Latest Cardiff Prices.

Steam coal: Best large, 18s. to 19s.; best seconds, 17s. to 17s. 6d.; ordinary seconds, 16s. to 16s. 6d.; best drys, 17s. to 18s.; ordinary drys, 14s. 6d. to 15s. 6d.; best washed nuts, 14s. to 15s.; seconds, 13s. to 13s. 6d.; best washed peas, 12s. 6d. to 13s.; seconds, 11s. to 12s.; very best smalls, 11s. to 11s. 3d.; best ordinaries, 9s. 6d. to 10s. 6d.; inferior sorts, 9s. to 9s. 3d.; very best Monmouthshire black vein, 15s. 9d. to 16s. 3d.; ordinary Western Valleys, 15s. 3d. to 15s. 6d.; best Eastern Valleys, 13s. 9d. to 14s. 6d.; seconds, 13s. to 13s. 3d. Bituminous coal: Very best households, 16s. 6d. to 17s. 6d.; best ordinaries, 14s. 6d. to 15s. 6d.; No. 3 Rhondda, large, 17s. 6d. to 17s. 9d.; brush, 13s. 9d. to 14s.; smalls, 10s. 9d. to 11s.; No. 2 Rhondda, large, 12s. 9d. to 13s.; through and through, 10s. to 10s. 6d.; smalls, 8s. 9d. to 9s. 3d. Patent fuel, 16s. to 16s. 6d. Coke: Special foundry, 24s. to 26s.; foundry, 18s. 6d. to 20s. 6d.; furnace, 16s. to 17s. Pitwood, 19s. to 19s. 3d.

Newport Coals.

Rapid shipment has been going on. Local agents are busy buying spot cargoes of coals, in order to complete arrangements for chartering changes to the Tyne, &c. Stagnation is everywhere to be met with. "It is," remarked a coalowner, a day or so ago, "a pity that so great an entanglement has been brought about in so purposeless a manner. Some great principle at stake, some national object to gain, ought alone to bring about a serious wreck of commerce." Nominal figures must be taken this week:—Best Newport—black vein—large steam, 15s. 6d. to 15s. 9d.; Newport Western Valleys, large steam, 15s. to 15s. 3d.; Newport Eastern Valleys, large steam, 13s. 6d. to 14s.; other sorts, 12s. 9d. to 13s.; smalls, best, 9s. 3d. to 9s. 9d.; seconds, 8s. 9d. to 9s.; inferiors, 8s. to 8s. 3d. through coals, 11s. 6d. to 12s. 3d.; other sorts, 11s. to 11s. 6d.; nut coals, best washed, 13s. to 13s. 6d.; other sorts, 12s. 6d. to 13s.; smithy coals, 11s. 3d. to 11s. 6d. House coals: Best, 15s to 15s. 3d.; seconds, 14s. to 14s. 3d. Patent fuel, 14s. 6d. to 15s.; all f.o.b., less 2½ per cent., cash in 30 days. Pitwood 18s. 6d. to 19s. (ex ship). Coke: Foundry, 17s. to 18s.; furnace, 16s. to 16s. 6d.

Swansea Prices, Including Anthracite.

Anthracite: Stanllyd hand-picked malting, large, 23s. to 24s. 6d. net; second quality malting, 21s. to 22s. net; Swansea Valley, big vein, large, 20s. to 21s., less 2½ per cent.; red vein, 12s. 6d. to 13s. 6d., less 2½ per cent.; machine-made cobbles, 22s. 3d. to 23s. net; machine-made French nuts, 24s. to 25s. net; machine-made German nuts, 24s. to 25s. net; machine-made beans, 18s. to 20s. net; screened beans, 9s. to 10s. net; machine-made peas, 12s. to 13s. net; rubbly culm, 6s. 6d. to 7s., less 2½ per cent.; duff, 3s. to 3s. 6d., less 2½ per cent. Steam: Best large, 17s. 9d. to 18s. 3d., less 2½ per cent.; second quality, 15s. to 16s., less 2½ per cent.; ordinary large, 13s. to 14s., less 2½ per cent.; through bunkers, 12s. to 12s. 6d., less 2½ per cent.; small, according to quality, 9s. to 10s. 6d., less 2½ per cent. Bituminous: No. 3 Rhondda, large, 17s. 9d. to 18s. 6d., less 2½ per cent.; small, 9s. 9d. to 10s. 6d., less 2½ per cent. Patent fuel, 15s. to 15s. 6d., less 2½ per cent. All f.o.b. Swansea for cash 30 days.

Tin-plate.

There was a very large shipment of tin-plates last week—no less than 186,015 boxes—and receipts from works showed up well, totalling 100,229 boxes. Stocks now consist of 255 boxes. Loadings now going on include large ones for the Far East, Persia, and Italian ports, and North America. There is a strong belief in the tin-plate district of Llanelly that no stoppage will take place in the trade. Good news is coming in, and substantial orders are said to be placed. A fine new engine is being placed at the Old Castle Works, and a number of additional mills are being laid down at the St. David's Works. It is also stated that a new works is shortly to be built on the outskirts of the town. A new seam has been struck within the last few days by the Crown Colliery Company, which gives significance to the rumours of better times. Tin-plates at present are a quiet market, and prices are nominal and unchanged pending some definite settlement with coal trade. It is difficult to get quotations. They may be taken as follows:—Ordinary Bessemer and Siemens, 12s. 1½d.; ternes, 21s. 6d. Other quotations: C.A. roofing sheets, £8 7s. 6d. per ton; big sheets for galvanising, £8 7s. 6d. to £8 12s. 6d. per ton; finished black plates, £9 5s. to £9 10s.; galvanised sheets, 24 g., £12 10s.; block tin, £132 5s. cash, and £133 17s. 6d. three months; copper, £59 2s. 6d. cash, and £60 three months. Lead: English, £13 17s. 6d.; Spanish, £12 17s. 6d.; silver, 24d. per ounce. Pig iron: Hematite, mixed numbers, 57s. 1½d. cash and month; Middlesbrough, 48s. 3d. cash, and 48s. 6d. month; Scotch, 54s. 3d. cash and month; Welsh hematite, 62s. to 62s. 6d. delivered; East Coast hematite, 60s. to 61s. c.i.f. Steel bars: Siemens, £4 10s. per ton; Bessemer, £4 10s. Rubio, 15s. 6d. to 16s., Cardiff.

Iron and Coal Trade.

Good substantial totals have been brought about at Dowlais lately. Fish-plates, Big Mills, Goat Mills, heavy steel rails department, and steel sleepers departments, have all been busy, and the result has been to give renewed confidence, the only regret being the re-echo of the one frequently-repeated comment that, with the exception of Dowlais, there is little or no animation in the trade.

Barry Railway Bill.

Newport Company's opposition withdrawn. The Alexandra—Newport and South Wales—Docks and Railway Company has notified the Commons Private Bill-office of the withdrawal of their opposition to the Barry Railway Bill when before a Select Committee. The Bill has passed the Lords.

AMERICAN NOTES.

(*From our own Correspondent.*)

NEW YORK, June 23rd.

LARGE orders for car equipment are now being placed by several companies, the total aggregate of which is said to be 15,000 cars. These are to be delivered in instalments each month during the rest of the year. Nearly all of the larger systems are buying steel cars, and displacing wooden cars as fast as the new cars are received. Car building is being stimulated, and all the larger plants are now running full time. This has naturally stimulated the demand for steel plate and common bar iron, and the plate and bar mills, therefore, are filling up rapidly. There are still a great many idle cars, but, notwithstanding that fact, the companies are building or ordering steel cars which will eventually supplant the great majority of rolling stock. Most of the new cars built are of 50 tons capacity. A great deal of material is ordered for bridge building, the orders for the past week amounting to 20,000 tons, one-third of which was taken by the American Bridge Company. A large amount of material will be wanted for bridge work in Atlantic Coast cities, particularly Philadelphia. The Chicago, Milwaukee and St. Paul Railroad Company is in the market this week for 12,000 tons of bridge-building material. Other kinds of iron and steel are in improving demand, and the general tone of the market is decidedly stronger than it was two weeks ago.

It is reported to-day that the Baltimore and Ohio Railroad is in the market for 10,000 freight cars, but this improbable circumstance requires confirmation. The Harriman system wants 3335 steel underframed box cars, 500 all-steel gondolas, and 500 flat cars Whichever way the market may go, prices are likely to advance, as a great deal of contracting will be done during the early summer on account of the strong upward tendency in prices. Bar iron has just been advanced at Pittsburg to 1.45. Sheet is selling better, and merchant steel is in good shape. Tin-plates are selling freely, and the mills are running pretty full time. From all sections of the steel-producing territory reports are of a favourable character. Tariff adjustments are slow and disappointing. The reductions will be much less than was anticipated by the country at large, because of the determined attitude of the stronger manufacturing interests. The copper market is quiet under a fair domestic demand. Exports have been quite heavy so far this month, and it is probable that the total of the month will exceed that of any month for several months past. Quotations to-day are 13½ for lake, 13 for electrolitic, and 12¾ for castings. The tin market is quiet, and for the first fifteen days of the month arrivals amounted to 2625 tons, with amount reported afloat of 2381 tons. Other metals are dull and without notable change.

WORKS ANNUAL OUTING.—The workpeople, numbering over 100, of W. P. Butterfield, galvanising and tank works, Shipley, left Bradford on Saturday, the 26th ult., by the 6.35 for Liverpool for their annual outing, and from thence proceeded to Lever Brothers' works at Port Sunlight, and enjoyed very much looking over their works. After dining at the Bridge Inn, Port Sunlight, they proceeded to New Brighton, and closed the day in a most enjoyable manner, leaving Liverpool at eleven o'clock *en route* for Shipley.

DIRECTORY.— The Directory of Contractors and Public Works Annual, 1909," by M. Sharpe. London: The *Contractors' Chronicle*, Limited, 48, Gray's Inn-road, W.C. Price 15s.—The 1909 edition of this Directory has been revised and brought up to date. A list of officials of the Metropolitan Water Board has been added, and all the features of the previous edition have been retained. Great pains, we are informed, have been taken to ensure accuracy in every detail. As is well known, the Directory gives the names of responsible firms who are open to accept contracts falling within the category of public works. There is also a list of responsible officers of local works and a list of the public works that are in progress or for which provisional orders have been secured. The section of the book which deals with some of the principal legal cases decided should prove useful to both the public official and the contractor.

ROYAL SOCIETY OF ARTS.—The annual general meeting of the Royal Society of Arts, the 155th since the foundation of the Society in 1754, was held on Wednesday, the 30th of June, Sir William H. White, K.C.B., chairman of the council, in the chair. H.R.H. the Prince of Wales was re-elected for the ninth time in succession president of the Society, and the council, with certain additions and alterations, was re-elected. The principal business of the meeting was the reading of the annual report. It recorded the proceedings of the Society during the past year. The Albert Medal had been awarded to Sir Andrew Noble, Bart., K.C.B., for his researches in explosives, and a number of silver medals were awarded to the readers of various papers. During the past year prizes had been awarded under the Owen Jones, Mulready, and Stock Trusts for various art objects; and the Swiney prize for the best published work on jurisprudence had been given to Dr. Charles Mercier for his book on "Criminal Responsibility." The foundation of a new Trust in memory of the late Mr. Francis Cobb, who was for many years treasurer of the Society, was recorded. Reference was made to the failure of the renewed attempt made by the managers of the London Institution to amalgamate with the Society. The number of the Society's members is now 3490, and the finances were reported as being in a satisfactory condition, the accounts for the year showing a moderate surplus.

NOTES FROM GERMANY, FRANCE, BELGIUM, &c.

(*From our own Correspondent.*)

Rhenish-Westphalian Iron Market.

BUSINESS in the different departments continues limited. Bar makers report that they are receiving more work from inland and also from foreign customers, but they are by no means busy, and quotations remain low and unremunerative. South German works have appeared with uncommonly low offers on the market lately, and so have some of the Rhenish-Westphalian works, because they cannot afford to let an order go now. Recently M. 94 p.t. are reported to have been offered for Rhenish-Westphalian basic bars, while the Lorraine-Luxemburg works went down as far as M. 92 p.t. and M. 90 p.t. free Luxemburg works. Exports leave much to be desired, and quotations are very unfavourable, M. 88 to M. 90 p.t. being the average quotation f.o.b. Antwerp for steel bars. Iron bars are quoted M. 122.50 to M. 125 p.t., but there is much underquoting going on.

Iron and Steel in Silesia.

The mills and foundries of the district are working fairly regularly, specifications have come in rather more freely of late, without influencing prices in the least. Producers, in the first instance, try to get rid of their rather large stocks, regardless of the prices they fetch, but they are decidedly disinclined to book forward orders at the present low rates, although buyers are pressing for it. The building department shows a little more life than previously. The firm of A. Borsig, Berlin, on the 23rd ult. delivered its seven thousandth locomotive.

The German Steel Convention.

At the general meeting of the Convention on the 24th ult., it was stated that the majority of consumers had already covered their requirements for the third quarter. There is a little more life stirring in the export trade; the tendency in the rail department, for instance, is improving, and some fair orders were secured. Sectional iron has been in better request than was the case a few weeks ago.

Output of Pig Iron since January, 1907.

	1907. Tons.	1908. Tons.	1909. Tons.
January	1,062,152	1,061,329	1,021,721
February	978,191	994,186	949,667
March	1,090,257	1,046,998	1,073,116
April	1,077,703	997,866	1,047,197
May	1,094,314	1,010,917	1,090,467
June	1,044,336	956,425	—
July	1,123,996	1,010,770	—
August	1,117,545	935,445	—
September	1,091,020	928,729	—
October	1,138,676	941,582	—
November	1,112,225	930,738	—
December	1,106,375	1,016,520	—
	13,045,760	11,813,511	—

Slight Revival in Coal.

From Rheinland-Westphalia, as well as from Silesia, an improvement in demand for coal is reported, and shipments have increased. Silesian coalowners are selling freely to Austria-Hungary; on the South German coal market also a more healthy tone generally was noticeable.

Iron and Steel in Austria-Hungary.

Nothing has happened since former reports, and the condition generally prevailing is not favourable. Quietness that is bordering on stagnation in many branches can be noticed, and the outlook altogether is dull. Demand and inquiry in the coal trade has also been moderate, but the cokeries are doing a good business.

Want of Life in Belgium.

While pig iron and semi-finished steel maintain their former position pretty firmly, finished articles are becoming more depressed from week to week. The steel works, being but insufficiently supplied with work, have turned more and more to the manufacture of light steel articles, and now competition in these has become very keen, preventing anything like paying prices. The number of orders that can be obtained in iron bars is ridiculously small. Heavy plates are in better demand than was the case earlier in the quarter, but sheets remain neglected. Railmakers are pretty well, but not actively, employed, and the business in girders is but normal. The output in pig iron has been increasing steadily, and rates show much firmness, 62f. p.t. being quoted for forge pig, 67.50f. p.t. for basic, and 69f. p.t. for foundry pig, free Charleroi. Of 44 existing blast furnaces 36 are in blow, producing 4678 t. per day, against 3660 t. for the same period the year before. Except in briquettes, which continue flat, there is a good trade done in fuel of all descriptions, and stores are reported to be decreasing at most pits. If prices are not likely to advance for the present they are at least exceedingly firm. Coke sells freely; the 25 per cent reduction in output has prevented stocks from increasing, and the present make is readily disposed of. The briquette trade is becoming more unfavourable every week, and stocks increase, though rates have been reduced.

France.

Business transactions on the iron and steel market are stated to have been satisfactory during the week. In coal also a better trade was done, Rhenish-Westphalian competition having been less keen than before.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

MR. C. E. HALL, mining engineer, informs us that he has removed from 58, Foster Buildings, High-street, Sheffield, to Town Hall Chambers, 87, Fargate, Sheffield.

MESSRS. BAKER AND SHELFORD, M.M. Inst. C.E., advise us that the Government authorities have acquired their present offices under the Public Offices Sites (extension) Act, 1908, and their address will in future be 1, Victoria-street, Westminster, S.W.

WE are asked to state that the M.A.N. (Maschinenfabrik Augsburg-Nurnberg A.G.), in the English gas engine trade hitherto known in England as "the Nuremberg Company," has, as a result of a friendly arrangement, terminated its agency agreement with Mr. James Halcrow, 18, Coleman-street, London, E.C., and has opened an office in London. All communications should in future be addressed: M.A.N., 219, Caxton House, Westminster, S.W.; Telegraphic address, Klettillo, London; Telephone, 3775 Victoria.

CONTRACTS.—Crossley Brothers, Limited, have received an order from Messrs. W. Bailey and Sons, contractors, Bushey Heath, Watford, for two "N" type engines and pumps for the Bushey Urban District Council Sewage Pumping Station. The pumps are 4½in. by 6in. stroke, and are to deliver against a head of 180ft., and will be arranged so that either pump can be driven by either engine.—Lobnitz and Co., Limited, have lately completed the shipment of a gold dredger for Peru, built under the direction of Messrs. Inder and Henderson for the Inambari Gold Dredging Concessions, Limited. This dredger is fitted with a patented propulsion screen, which is an entirely new departure. The same firm has also completed the shipment, in pieces, to Singapore, of three towing hopper barges for depositing mud in shallow water. These were built to the order of Sir John Jackson, Limited.—The Dutch Government have recently entered into a contract with Yarrow and Co., Limited, of Glasgow, for the construction of two destroyers of the most modern type.

BRITISH PATENT SPECIFICATIONS.

When an invention is communicated from abroad the name and address of the Communicator is printed in italics.

When the abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent-office Sale Branch, 25, Southampton-buildings, Chancery-lane, London, W.C., at 8d. each.

The first date given is the date of application; the second date at the end of the abridgment is the date of the advertisement of the acceptance the complete specification.

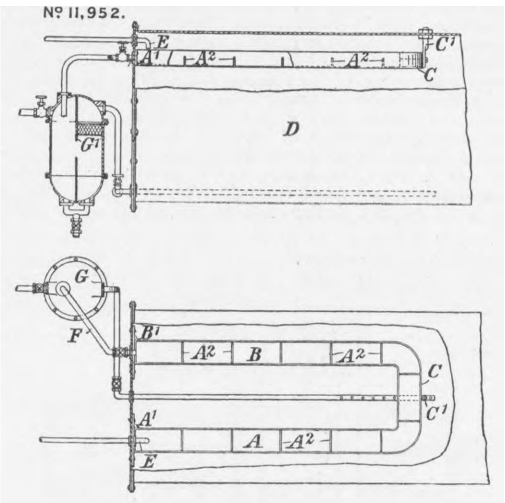
Any person may on any of the grounds mentioned in the Acts, within two months of the date given at the end of the abridgment, give notice at the Patent-office of opposition to the grant of a Patent.

STEAM GENERATORS.

11,952. June 2nd, 1908.—IMPROVEMENTS IN OR RELATING TO STEAM GENERATORS, Ernest Joseph Hasler Christie, of 173, Castle Boulevard, and Thomas Essex Neal, of Berkeley-avenue, Brewer, both in the City of Nottingham.

According to this invention, an open-feed water trough consisting of two longitudinal members of any desired length, and a transverse connecting part C at their rear ends, is situated in the steam space of the generator D. The two ends A^1 B^1 of this trough may be secured to the boiler front, as shown, whilst the part C is attached by a stay C^1 to the crown of the generator D. This feed water trough is divided into compartments by means of preferably removable partitions A^2, and the feed water, which is delivered by a pipe E into the end A^1 of the trough, is thus caused to travel gradually along the same to the outlet end B^1. If preferred, the trough may have a gradual fall. As the feed water travels slowly along the trough it becomes thoroughly heated, and a considerable portion of it is evaporated; the remainder is heated sufficiently to throw out mineral matter in solution, which is together with any matter contained in suspension, mainly deposited in the trough, and is thus prevented from getting into the main body of water, and becoming deposited on the heating surface of the generator. When the feed water reaches the outlet end B^1 of the trough, it is conveyed by a pipe F to the exterior of the generator, and is there delivered into a closed vessel G, which constitutes a settling chamber, and may also be utilised as a filtering chamber. The upper end of this vessel G is divided by a partition G^1. By passing the heated feed water through a settling chamber and filter, as described, further matter in suspension may be removed, and owing to the chamber being situated on the exterior of the generator, the scum and deposited matter may be readily removed from the same at frequent intervals, without interfering with the proper working of the steam generator itself.—*June 9th*, 1909.

Nº 11,952.

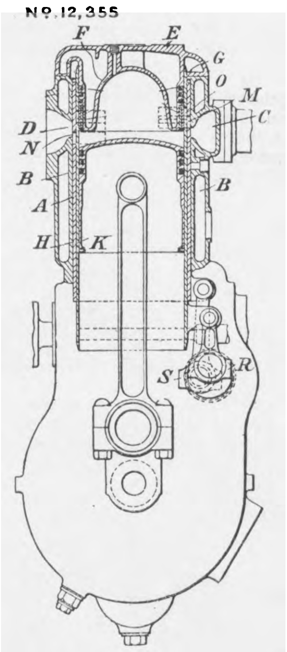


INTERNAL-COMBUSTION ENGINES.

12,355. July 6th, 1908.—IMPROVEMENTS IN INTERNAL-COMBUSTION ENGINES, *Charles Y. Knight, of* 154, *Lake-street, Chicago, United States of America.*

This invention relates to internal-combustion engines, and particularly to petrol engines and the like, which are required to run at high speed. The object of the invention is so to construct the engine that the inlet and exhaust valves open very rapidly, giving a large port area, and also close very rapidly, so that the charge can be very quickly taken in, and the exhaust products very quickly expelled from the engine, whereby very high speeds can be efficiently obtained. In the modification shown, suitable for a petrol engine working on the ordinary four-stroke cycle, the straight part A of the cylinder is constructed with a water jacket B along its whole length, and the inlet and exhaust ports C D respectively are formed through the water jacket at the combustion chamber end of the straight part A of the cylinder. The end of the cylinder is closed by a water-cooled head E, having a water-cooled part F projecting internally, forming a groove G with the straight part of the cylinder. In this groove the ends of sleeves H K slide. These sleeves, the outer one of which need not completely surround the inner, are provided with ports M N and O P adapted to register with the ports C and D respectively in the cylinder at parts of their movement for the purpose of obtaining the inlet and exhaust to the cylinder. The sleeves H K are actuated by means of a pair of excentrics R S, one of which operates the outer sleeve H, while the other operates the inner sleeve K. The excentric R in this form is placed 90 deg. ahead of the other excentric S. Rings are provided in the internal-projection F from the head of the cylinder, and bear against the inner sleeve K, forming a gas-tight sliding contact. The excentrics actuating the sleeves rotate once every two revolutions of the main shaft.—*June 9th*, 1909.

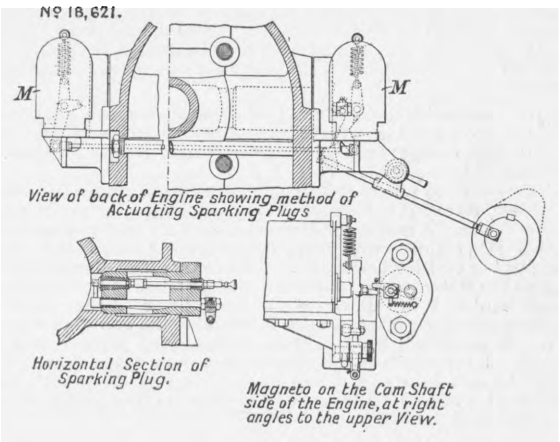
Nº 12,355



18,621. September 4th, 1908.—IMPROVEMENTS RELATING TO IGNITION DEVICES FOR INTERNAL-COMBUSTION ENGINES, Henry Nield Bickerton, Philip Warwick Robson, Engineers, and the National Gas Engine Company, Limited, all of Wellington Works, Ashton-under-Lyne, Lancaster.

This invention consists in providing double ignition by means of two separate magnetos and sparking plugs actuated by only one gear. The invention further consists in the mechanism by which advancing or retarding the spark is effected at both sparking plugs by a single actuating mechanism. The invention also consists in so arranging the mechanism that the ignition plugs can be withdrawn without disturbing any links or mechanism. According to one modification, the sparking plugs are placed at opposite sides of the combustion chamber in such a position that when the engine is stopped and one of the plugs withdrawn the other can be readily examined to see that it is in proper working order. Separate magnetos M are provided for the two sparking plugs, one being placed on each side of the engine.—*June 9th*, 1909.

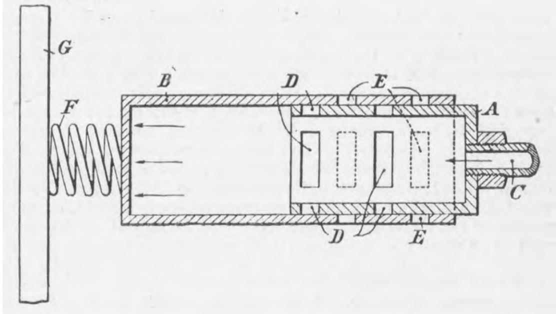
Nº 18,621.


M
M
View of back of Engine showing method of Actuating Sparking Plugs
Horizontal Section of Sparking Plug.
Magneto on the Cam Shaft side of the Engine, at right angles to the upper View.

27,340. December 16th, 1908.—SILENCER FOR EXPLOSION ENGINES, *Pierre Ajasson de Grandsagne, of* 9, *Rue Montessuy, Paris, France.*

The present invention relates to improvements in a silencer for explosion engines of that type in which the exhaust of the exploded gases is facilitated, but the return of said gases into the apparatus and the inflow of the outer air is prevented. The valve which characterises the invention is constituted by a cylindrical slide composed of two cylinders A and B adapted to slide the one upon the other. Cylinder A is fixed and, for example, rigidly connected with the frame of a motor car; it is open at one end and closed at the other end, where it communicates with the exhaust of the engine by means of a pipe C. This cylinder A is perforated by a great number of openings D. Cylinder B is also open at one end and adapted to slide upon or in cylinder A which guides said cylinder B. Cylinder B is perforated by openings E which correspond exactly with the openings D with which they can communicate. Between the end plate of cylinder B and a suitable fixed bracket G a spiral spring F is located which exerts a continuous pressure upon the movable cylinder B in the direction opposite to the direction of the exhaust gases. Cylinders A and B form together a relief chamber of variable volume. Normally, spring F maintains the movable cylinder B in the position shown—that is to say, in such a position that the openings E and D are not superposed. As soon, however, as the engine is started, each exhaust stroke of the engine will push back the movable cylinder B in compressing spring F, whereby the openings E are made to coincide more or less with the openings D so that the gases can escape. During the three other strokes of the engine the parts of the silencer will return to their original positions. This muffling apparatus allows the pressure of the gases to be divided into two parts, the pressure being assimilated to the pressure existing in the relief chamber A B before the openings D E communicate.—*June 9th*, 1909.

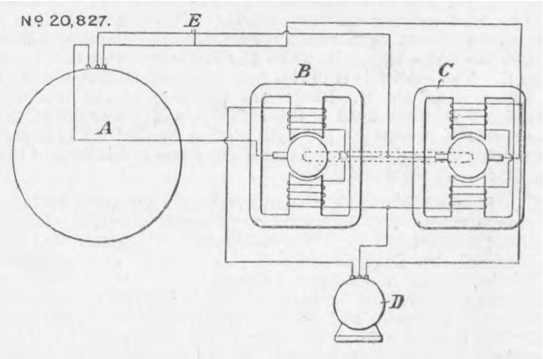
Nº 27,340.



DYNAMOS AND MOTORS.

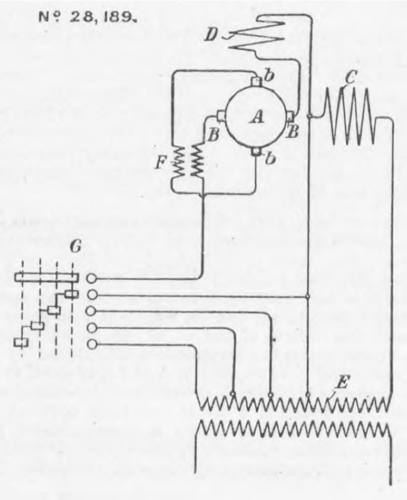
20,827. October 2nd, 1908.—IMPROVEMENTS RELATING TO THE STARTING OF POLYPHASE MOTORS, *Aktiengesellschaft Brown Boveri et Cie., of Baden, Switzerland.*

The object of this invention is to obtain an improved system for starting polyphase motors. The invention consists in a method of starting polyphase motors wherein a number of separate starting dynamos corresponding to the number of phases of the motor is used to supply starting current to the motor. The invention also consists in an improved method of and apparatus for starting polyphase motors which consists in the use of a number of starting dynamos corresponding to the number of phases of the motor excited to have increasing frequency and potential. Electric installations in which special machines are reserved for motor starting are usually designed for large outputs, so that it is frequently advisable to divide the starting machines into a number of units. In such cases two polyphase dynamos might be employed, and arranged to work in parallel. According to one form of this invention, however, it is preferred in such a case to employ two single-phase dynamos, and to excite them in such a manner as to shift their potential curves 90 deg. apart from each other. A mode of connection according to one form of the invention is illustrated in which the two-phase wound main motor is represented by A; the single-phase commutator generators to which exciting energy with correspondingly increasing frequency and intensity is supplied by the exciter D are represented by B and C respectively. Exciting current which is supplied to the starting machine B is shifted through an angle of 90 deg. relative to the current supplied to the starter C, so that two-phase current flows in the leads E. An arrangement of this kind, it is claimed, is cheaper and better than a multi-polyphase unit system.—*June 9th*, 1909.


Nº 20,827.

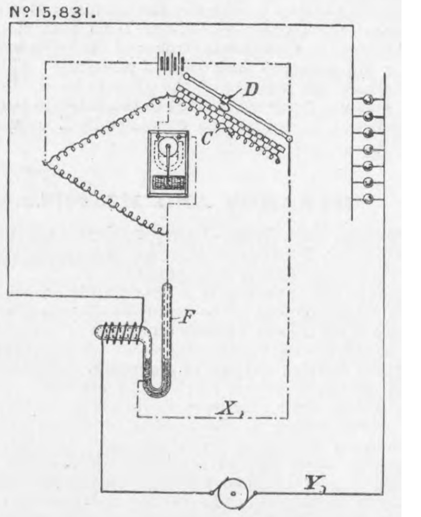
28,189. December 24th, 1908.—IMPROVEMENTS IN AND RELATING TO SINGLE-PHASE ALTERNATING-CURRENT ELECTRIC MOTORS OF THE COMMUTATOR TYPE, *Ernst Fredrik Werner Alexanderson, Schenectady, New York, U.S.A.*

This invention relates to single-phase motors of the commutator type, and its object is to improve the commutation efficiency and power factor. A represents diagrammatically a motor armature, which is provided with main commutator brushes B B and auxiliary or exciting brushes *b b*. C represents the inducing winding on the stator, which produces a magnetisation in line with the main brushes B B. D represents the exciting winding on the stator producing a magnetisation in line with the exciting brushes *b b*. E represents a transformer for supplying current to the motor. F represents a transformer having its primary in series with the main brushes B B, and its secondary in series with the exciting brushes *b b*. The exciting brushes are thus connected in series with the main brushes through the transformer F. G represents a controlling switch for the motor. It will be seen that the inducing winding C, the exciting winding D, and the main brushes B B are connected in series with each other. The inducing winding C is connected across a portion of the supply transformer E. With the switch G in its first position a short circuit is formed, including the main brushes B B, the exciting winding D, and the primary of transformer F. The motor consequently starts like a repulsion motor, the current induced in the armature between the main brushes B B being supplied directly to the exciting winding D and through the transformer to the exciting brushes *b b*. When the motor has started, and the switch G is moved to its second position, a small shunt voltage, derived from the transformer E, is included in the circuit of the main brushes and the exciting winding for the purpose of improving the commutation. For operation at higher speeds, the switch G is moved to its third and fourth positions, increasing the amount of the shunt voltage impressed on the armature and exciting winding, and thereby adapting the motor for good commutation at those higher speeds.—*June 9th*, 1909.


Nº 28,189.

MEASURING AND TESTING INSTRUMENTS.

15,831. July 25th, 1908.—A NEW OR IMPROVED METHOD OF AND APPLIANCES OR DEVICES FOR INDICATING TEMPERATURES, Arthur Barry, of 22, Cavendish-road, Stretford, electrical engineer, and Fred Ferrand, of 13, Torrington-street, Heywood, both near Manchester.

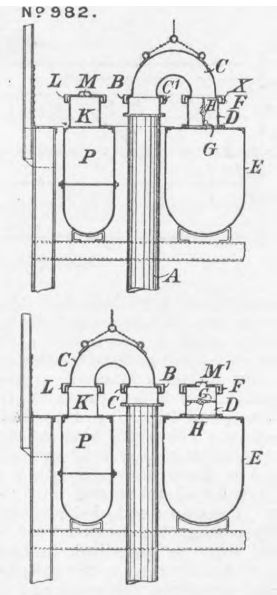

Nº 15,831.

This invention relates to a new and improved method of and appliances for indicating temperature—and recording it if desired—at any required distance from the point where such temperature exists. In the engraving the apparatus is used in such a manner that the temperature set up at the thermometer is the measure of the amount of current flowing through a circuit. Y is the circuit the current of which is to be measured, and part of it or a derivation from it is wound in a coil around an air or other bulb of the thermometer F, or the thermometer is otherwise exposed or presented to the circuit in such a manner as to be affected by the heat set up as a consequence of the passage of current through such circuit. The arm *c* of the bridge has its resistance so that the bridge is in equilibrium when the normal amount of current is passing and there is in consequence a normal resistance in the circuit X. Should an excess current be flowing through the circuit Y the mercury in the thermometer is affected by the heat set up by such excess current, the resistance of the circuit X is altered, the equilibrium of the bridge is disturbed, and the indicator is affected by the consequent flow of current through it and measures to an extent corresponding to the amount of current flowing through it, and which is in itself a measure of the temperature, and consequently, in the example referred to, of the electric current which has varied the temperature. By means of the slide D the instrument can be brought to zero and set to be its equilibrium with any other temperature than that which has previously been its zero or normal. The specification also deals with several other modifications, and there are four other illustrations.—*June 9th*, 1909.

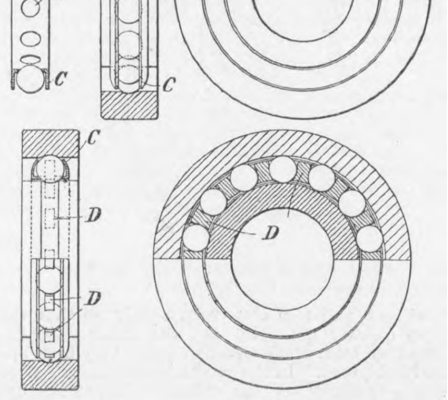
MISCELLANEOUS.

982. January 14th, 1909.—IMPROVEMENTS IN GAS OR COKE OVEN PLANT, *Heinrich Koppers, of* 30 *Isenbergstrasse, Essen-Ruhr, in Germany.*

This invention relates to the connection of the gas ascension pipe with the hydraulic main in gasworks and coke oven works, and to means for closing the entrance to the hydraulic main when the ascension pipe is disconnected therefrom. The object of the invention is to provide improved closing devices not liable to be obstructed in, or rendered difficult of operation by, the accumulation or condensation of tar thereon, but capable of being worked without expenditure of great force. A further object is to so contrive the closing devices that their presence will not prevent or obstruct the operation of cleaning the hydraulic main. The ascension pipe A from the retort or coke oven is enlarged at its upper end to form the annular cup B, which is filled with water and receives the foot C^1 of the bridge pipe C. The other foot X of the latter enters a similar cup F formed at the upper end of the tubular neck D of the hydraulic main E. Within the tubular neck D is arranged a damper G movable on an axis lying transversely of the neck, the axle H of the damper being cranked outside the tube. When the damper is open, access to the interior of the hydraulic main can easily be had by means of suitable tools for cleaning purposes, after removal of the bridge pipe. In order that the same bridge pipe may be used for connecting the ascension pipe A to the Pipe P for receiving the gas that rises during charging or discharging, the tubular neck K leading to the pipe P is constructed with an annular cup L, and is positioned so that the bridge pipe can connect with it when the bridge pipe is swung round or lifted over. When the bridge pipe is not connected to it, the orifice of the neck K can be closed by means of the lid M, the flange of which enters the cup L. The orifice of the neck D is also closed, after removal of the bridge pipe, by means of a lid M^1 sealed by the water in the cup F, in order to make gas-tight the closure already effected by means of the damper G. The escape of gas and entrance of air are thus reduced to a minimum.—*June 9th*, 1909.


Nº 982.

12,141. June 4th, 1908.—IMPROVEMENTS IN CAGES FOR BALL BEARINGS, The Hoffman Manufacturing Company, Limited, of King's Head-court, Beech-street, London, E.C., and Chelmsford, in the County of Essex, and Otto Alwin Schmidt, of 54, Rainsford-road, Chelmsford.


Nº 12,141.

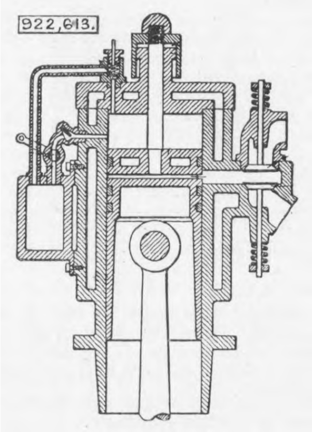
This invention relates to cages for ball bearings, the object being to provide a simple and inexpensive form in which the balls can be easily assembled and held while the cage is being handled, the construction being particularly applicable to bearings of the two point type. According to this invention the cage, which is in part of the above type, has its side flanges carried up to such a point that they can be bent over the balls above their working axes without necessarily touching same, so that the balls are loosely held in the seats which the holes in the ring form for them, but yet are kept separate and also prevented from falling outwardly. In the three left-hand engravings the ring portion A has the holes B, the side flanges C being plain, and when first formed as by stamping, casting, turning, spinning, or in other ways being preferably at right angles to the ring A. To complete the cage, the balls are first inserted, and then the side flanges are bent over in any suitable way as shown, so that their upper edges close or partly close over the balls at a point above the working axes of the balls and entirely free of the same. In this form the balls in their rolling movement around the tracks of the bearing will support and propel the cage with them by the contact they have with it at their seats in the ring portion A, but it is preferred that this support and movement should take place at a point nearer the centre line between the two tracks, and to this end the cage may be provided as shown in the bottom right-hand engravings, with abutment or distance pieces D formed preferably in one with the ring A and located between and normally in contact with each ball, or so nearly in contact that the ball may touch the one ahead of it in its forward movement.—*June 9th*, 1909.

SELECTED AMERICAN PATENTS.

From the United States Patent-office Official Gazette.

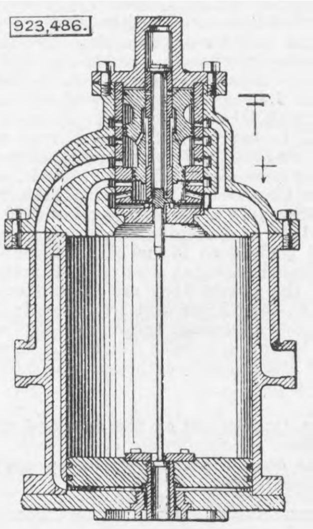
922,613. INTERNAL-COMBUSTION ENGINE, *C. D. McClintock, Oakland, Cal., assignor of one-half to S. R. Bogue, San Francisco, Cal.—Filed June* 23*rd*, 1908.

This invention consists in the combination with the working piston of a second piston, forming the opposing wall of the combustion chamber. A pneumatic cushion is established behind this second piston, and means are provided for increasing or diminishing the resistance of the cushion, so that the amount of compression in the working cylinder may be varied. There is only one claim.


922,613.

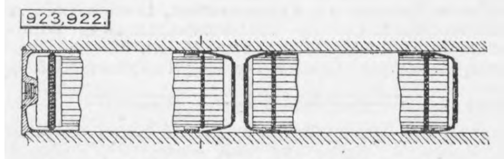
923,486. VALVE MECHANISM FOR STEAM ENGINES, *E. L. Bowen, McComb City, Miss.—Filed September* 30*th*, 1908.

A sliding piston is provided with various suitable ports for distributing the steam. It is worked by a central rod, which is moved at each end of the stroke by the main piston in a way that will be readily understood from the drawings. There are six exceedingly long claims.


923,486.

923,922. CARTOUCHE CHARGE FOR GUNS, *A. Wratzke, Essen-Rüttenscheid, Germany, assignor to Fried. Krupp Aktiengesellschaft, Essen-on-the-Ruhr, Germany.—Filed January* 28*th*, 1907.

A cartouche charge for guns comprising a plurality of subcharges, each subcharge being contained in a separate metallic enclosing envelope, and the enclosing envelope of the rearmost subcharge being constructed in the form of an obturating shell. There are four claims.


923,922.

IT was recently reported that telephonic communication had been established between Stockholm and Paris, and Sundsvall and Paris, *viâ* Copenhagen, a distance of 2270 miles, with the aid of a new microphone, invented by two Swedish engineers. Efforts are now being made to obtain through communication between London and Copenhagen, *viâ* Paris.

PISTONS AND PISTON VALVES.

No. III.*

A SPECIAL type of piston valve which has been recently taken up by several of the leading high-speed engine builders in this country is shown in Fig. 32. The main object of the valve is to allow of the cut-off being varied without altering the travel, and, as will be seen, the valve can then be positively driven and the cut off modified by slightly rotating it on its spindle. Steam is admitted from the centre portion past the inclined edges of the valve at A. Ports of triangular shape to correspond are cut in the liner as shown at B. The exhaust takes place past the outer edges and through the valve in the usual way. Referring to Fig. 32A, which shows a detail of the port and valve at lead position, it will be seen that the lead is C. If the valve is now rotated to the position shown in dotted lines the lead will be altered to D, and the cut-off a corresponding amount. In altering the lap in this way there is only the friction of the valve in the liner to overcome, consequently it affords a handy means for varying the cut-off by the governor if it is suitably connected up. In altering the cut-off in this manner, the variation in the cut-off, of course, is limited, owing to the great reduction in port opening at light loads and the excessive leads at heavy loads; but as it has been proved to be more economical to govern by throttling at light loads, this valve gives all the range that is necessary, and is usually coupled up to the governor in combination with a throttle valve. Under ordinary conditions a range of from 70 to 40 per cent. cut-off can be obtained, and below that the engine is governed by throttling.

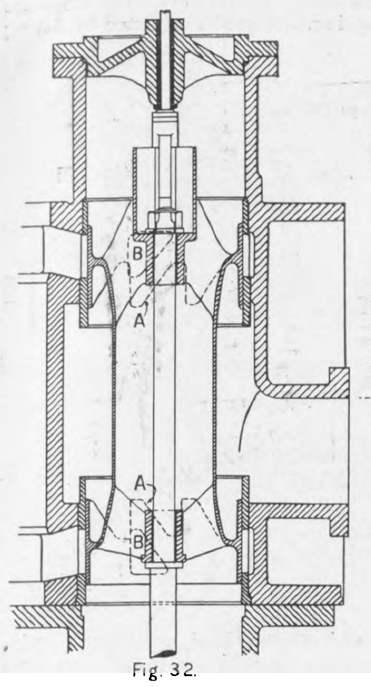


Fig. 32.

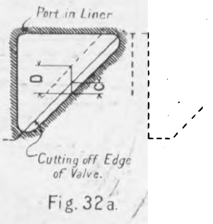

Port in Liner
D
Cutting off Edge of Valve.

Fig. 32a.

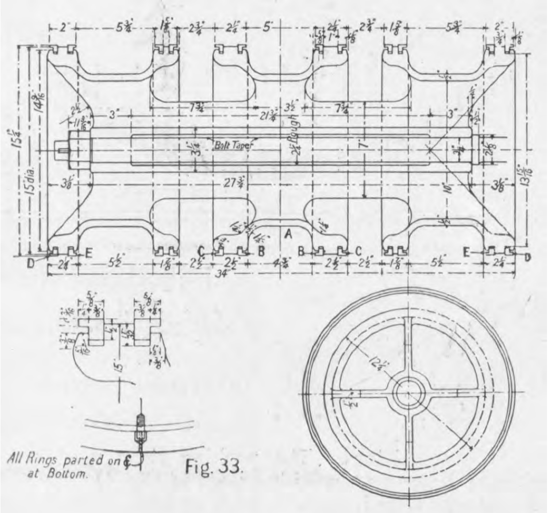

Bolt Taper
A
B
C
D
E
All Rings parted on at Bottom.

Fig. 33.

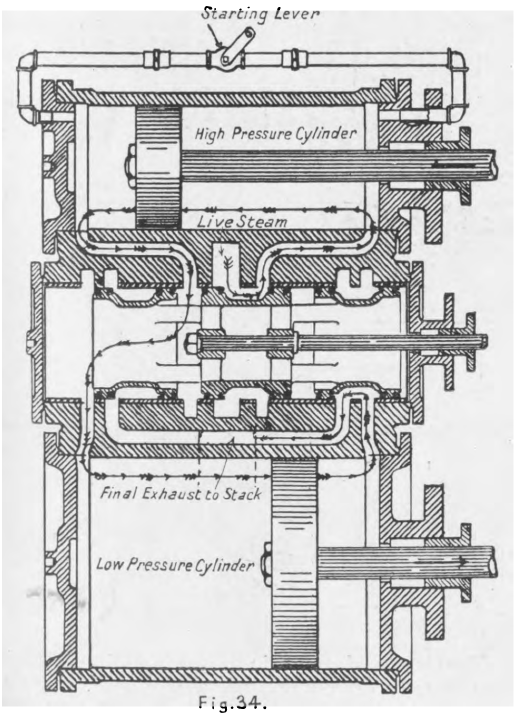

Starting Lever
High Pressure Cylinder
Live Steam
Final Exhaust to Stack
Low Pressure Cylinder

Fig. 34.

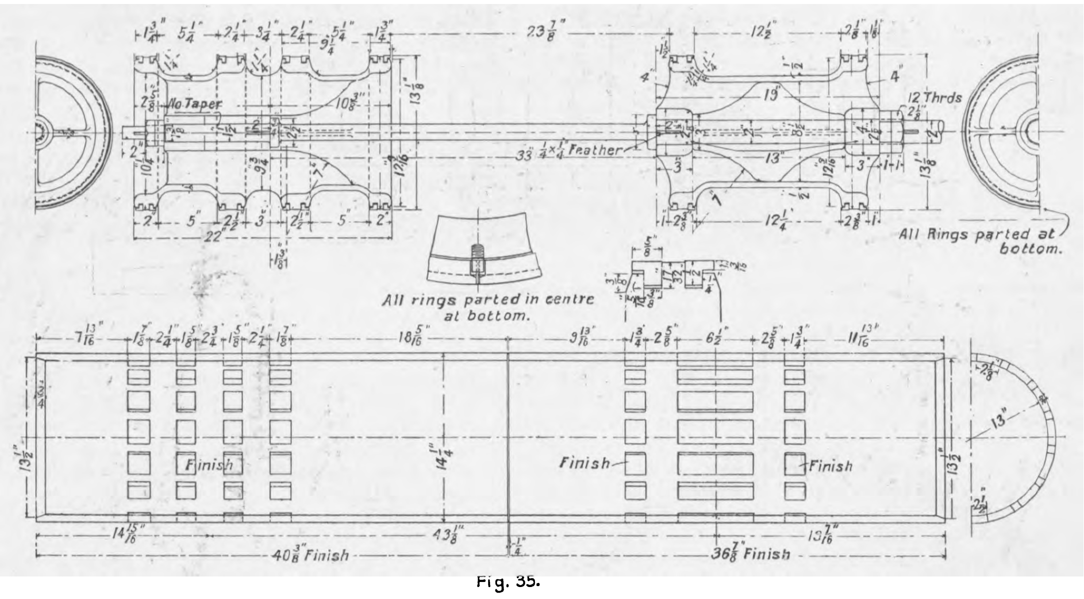

No Taper
Feather
12 Thrds
All Rings parted at bottom.
All rings parted in centre at bottom.
Finish
Finish
Finish
40 3/8" Finish
36 7/8" Finish

Fig. 35.

Two types of piston valves as used by the Baldwin Locomotive Works, of America, are illustrated in Figs. 33 to 36. Fig. 33 is the form of valve used on the Baldwin balanced compound locomotive. The valve is 15in. in diameter, with a cast iron body made in one piece, and carrying three sets of packing rings. Live steam enters through the annular space A, and its admission to the high-pressure cylinder is controlled by rings B. The exhaust from the high-pressure cylinder is controlled by rings C, and the admission to the low-pressure cylinder by rings D. The final exhaust to the stack is controlled by rings E. The rings are L-shaped, and sprung into position. The valve works in a liner extending the full length of the cylinders, and cast in one piece. This form of valve has been applied to upwards of 350 locomotives built at the Baldwin Works since 1902. The arrangement of cylinders and the course of the steam is shown in Fig. 34. The live steam port is centrally placed between the induction ports of the high-pressure cylinder. Steam enters the high-pressure cylinder through the steam port and the central external cavity in the valve. The exhaust from the high-pressure cylinders takes place through the opposite steam port to the interior of the valve, which acts as a receiver. The outer edges of the valve control the admission of steam to the low-pressure cylinder. The steam passes from the front to the high-pressure cylinder through the valve to the front of the low-pressure cylinder, or from the back of the high-pressure to the back of the low-pressure cylinder. The exhaust from the low-pressure cylinder takes place through external cavities under the front and back portion of the valve, which communicate with the final exhaust port. The starting valve connects the two live steam ports to the high-pressure cylinder to allow the steam to pass over the piston.

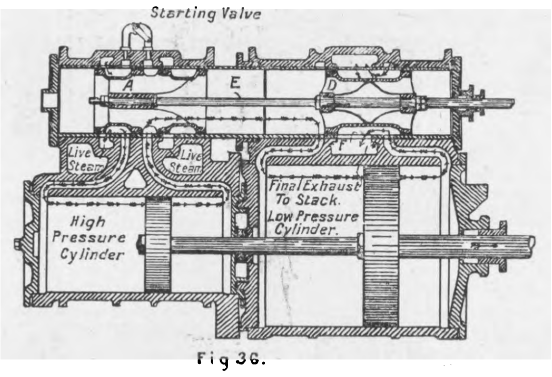

Starting Valve
A
E
D
F
Live Steam
Live Steam
Final Exhaust To Stack.
Low Pressure Cylinder.
High Pressure Cylinder

Fig 36.

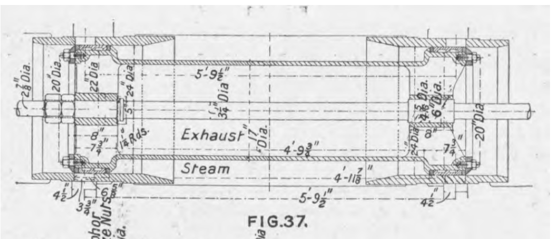

Exhaust
Steam
Phosphor Bronze

FIG. 37.

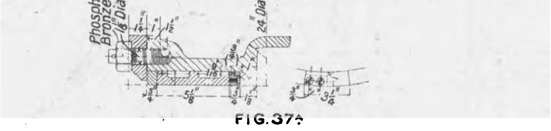


FIG. 37a

Fig. 35 shows a detailed drawing of the valve and liner used on the tandem compound locomotives built by the Baldwin Locomotive Works Company. The valve consists of two separate sections, 13in. in diameter, mounted on one spindle. The liner is also in two pieces, the high-pressure portion entering the low-pressure cylinder through a gland and stuffing-box, thus forming an expansion joint—Fig. 36. The valve, which is double and hollow, admits steam to the high-pressure cylinder, and at the same time distributes the high-pressure exhaust from the front end of the high pressure cylinder to the back end of the low-pressure cylinder or *vice versâ*, as the case may be, without the necessity of crossed ports. As shown in Fig. 36, A is the high-pressure valve by which steam is conducted from the live-steam openings through external cavities B and B to the high-pressure cylinder. The exhaust from the high-pressure cylinder passes through the opening C to the steam chest, which acts as a receiver. D is the low-pressure valve connected to the high-pressure through the external cavity F. The starting valve connects the live steam ports of the high-pressure cylinder.

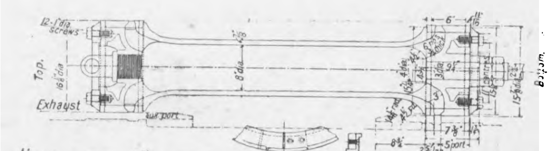

12-1" dia. Screws
Top.
Exhaust
Bottom.

Fig 38.

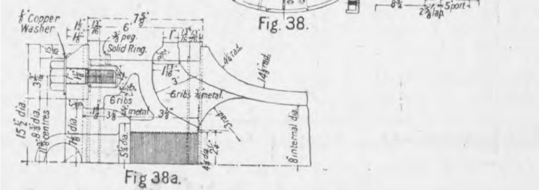

Copper Washer
Solid Ring
6 ribs
8 internal dia.

Fig 38a.

As examples of piston valves for very large rolling mill engines, &c., four valves, of engines made by Davy Brothers, Limited, of Sheffield, are illustrated in detail in Fig. 37 to Fig. 40. Fig. 37 shows a piston valve as fitted to a 45in. by 52in. horizontal rolling mill engine. This valve steams from the centre portion, and exhausts from the one end through the inner portion of the valve. It is driven from one end only, being free to slide on the valve spindle at the other, thus relieving it of all stresses due to contraction and expansion. The packing

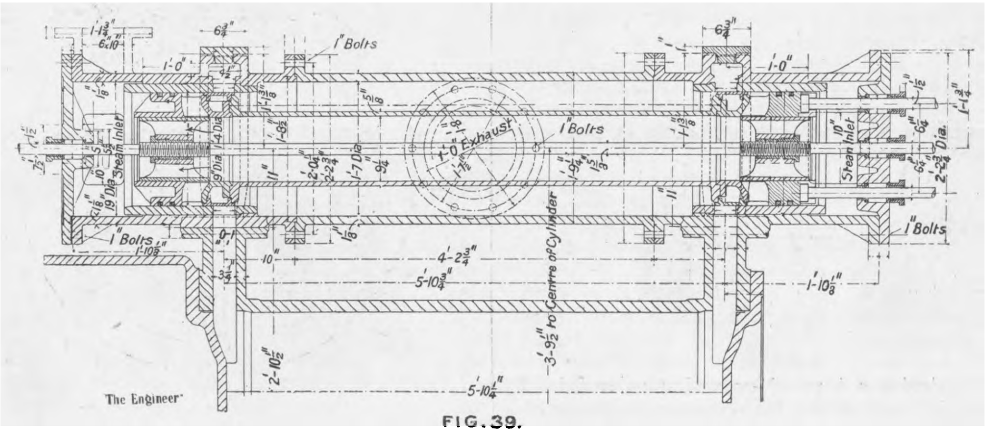

Bolts
Steam Inlet
Exhaust
Bolts
Steam Inlet
Bolts
Bolts
Centre of Cylinder
The Engineer

FIG. 39.

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* No. II. appeared June 25th.

rings are of a special type, which have been used by Davy Brothers, Limited, for many years with successful results. An enlarged detail is shown in Fig. 37*a*. It consists of two outer rings A, which are split, and one central ring B, which is solid. The junk ring tightens on to these rings. The valve is put into the liner with the junk rings loose. This allows the spring rings to take their position; it is then tightened up. When it is necessary to adjust the rings the junk ring nuts are simply slacked back, when the spring rings will take up the adjustment. The spring rings are fitted with lapping plates at the joints, as shown in detail. Fig. 38 shows a 16in. diameter piston valve as fitted to a 40in. diameter by 48in. stroke three-cylinder vertical rolling mill engine. This valve is also driven from one end only, and it is double-ported so as to shorten the travel on account of the high speed of the engines. The packing rings are of a similar design to those just described, but the spring rings are of the restrained type, being turned with a lip on the inner sides, which engages with a recess turned in the solid ring when the spring rings have worn slightly—see Fig. 38*a*. They are also fitted with a lap or tongue piece at the joint.

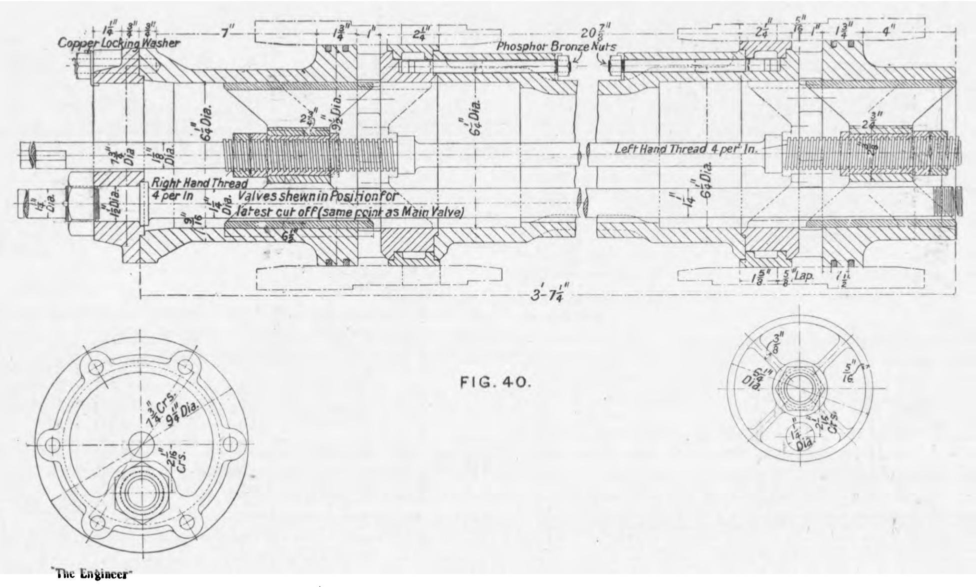

Copper Locking Washer
Phosphor Bronze Nuts
Left Hand Thread 4 per In.
Right Hand Thread 4 per In
Valves shewn in Position for latest cut off (same point as Main Valve)
Lap
3'-7¼"

FIG. 40.

"The Engineer"

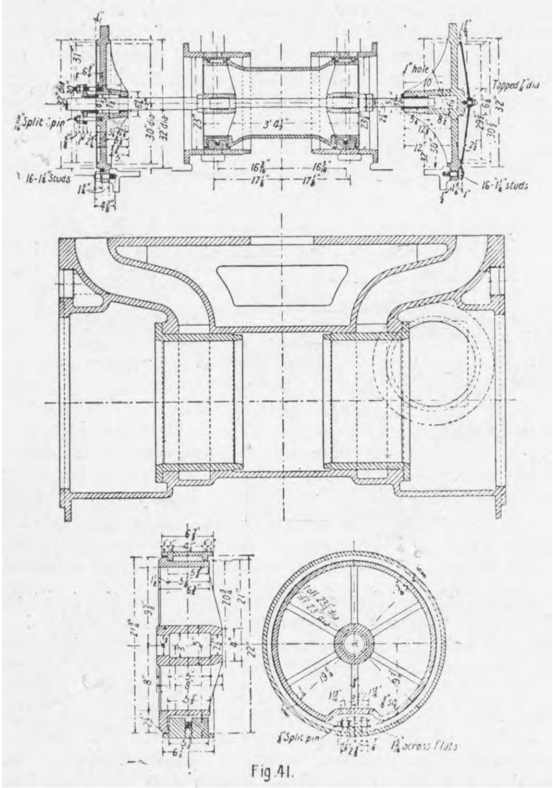

Split pin
16-1⅛ Studs
Tapped ⅞ dia
Split pin

Fig 41.

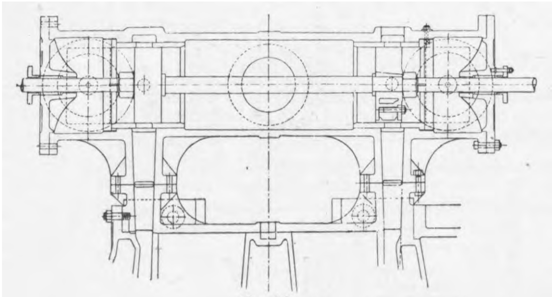


Fig 42.

Fig. 39 illustrates a type of expansion valve fitted by Davy Bros., Limited, to the high-pressure cylinder of a horizontal blast engine, with cylinders 45in. and 96in. diameter by 60in. stroke. The main valve is fitted with an internal one on the Meyer principle. As will be seen, steam enters through the inner portion of the valve and exhausts round the outside of the central portion. Owing to the great length of the casting, and for convenience of manufacture, the steam chest is cast in the form of a tube or pipe, and bolted to the cylinder at the ports. The main valve is formed in three pieces screwed together by studs, and is fitted with two floating rings in the way of the cylinder ports, and four Ramsbottom rings—two at each end—to prevent leakage of steam at the ends. The main valve is actuated through two spindles, and the cut-off valves by a central spindle in the usual way. Fig. 40 shows the design of valves used for a 16in. diameter by 24in. stroke three-cylinder high-pressure vertical engine, also by Davy Brothers. This valve is fitted with internal expansion valves on the Meyer principle, similar to that just described, but owing to the small diameter available, special arrangements have been made both for the connection of the valve to the spindle and the securing together of the three pieces which form the valve. It will be seen that all nuts are securely locked by means of copper washers bent up against the flat of the nut after being screwed home.

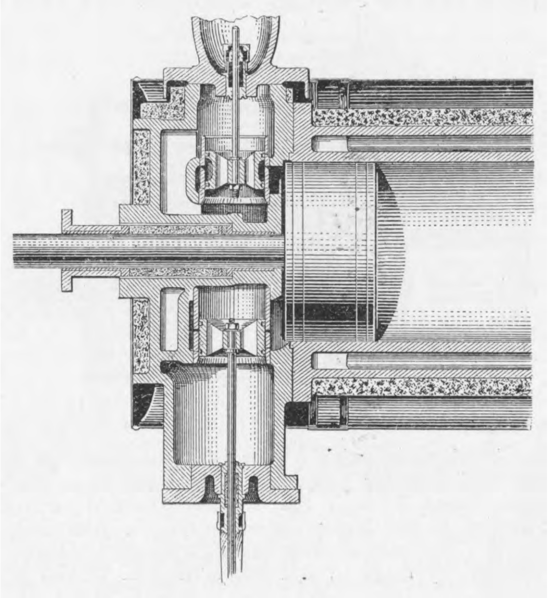


Fig. 43

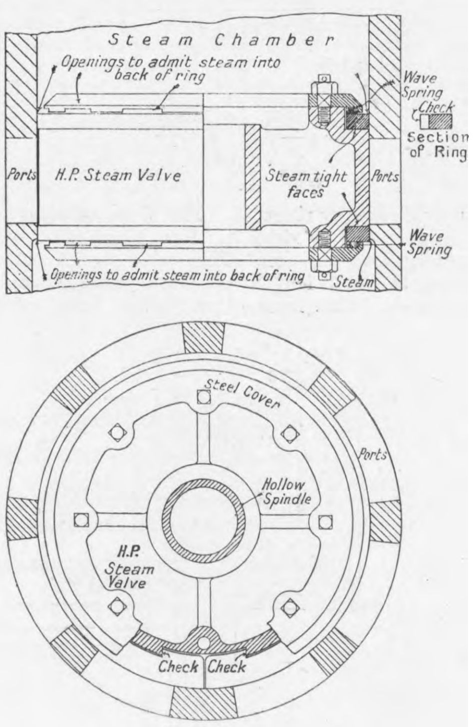

Steam Chamber
Openings to admit steam into back of ring
Wave Spring
Check
Section of Ring
Ports
H.P. Steam Valve
Steam tight faces
Ports
Wave Spring
Openings to admit steam into back of ring
Steam
Steel Cover
Ports
Hollow Spindle
H.P. Steam Valve
Check
Check

Fig. 44.

In Fig. 41 is shown a detailed drawing of a 23in. diameter piston valve as fitted by Stewart and Co. (1902), Limited, of Glasgow, to rolling mill and sugar mill engines, with cylinders 44in. diameter by 60in. stroke. No special claim is made for this design of valve beyond the fact that it represents good engineering practice and design. This it certainly does. The valve body is constructed in three pieces, and may be said to consist of two junk rings and a distance piece, the whole being held together by the valve spindle nuts. The packing rings are of a type largely used in marine work. They extend the full width of the face, and split at one point, being held together by a bolt fitting into a slot. The rings are given a slight initial spring, and can be adjusted by fitting in liners at the joint, and afterwards tightening up again. To all intents and purposes the rings are the same as solid floating rings, and work with as little friction, but they have the advantage of being adjustable. In Fig. 42 is shown the arrangement of piston valve and cylinder as used by the same firm for rolling mill engines, with cylinders 54in. diameter by 60in. stroke. In this case, owing to the great length between the ports, the valve is made in the form of two pistons. The packing rings used are of the same design as those illustrated in Fig. 41.

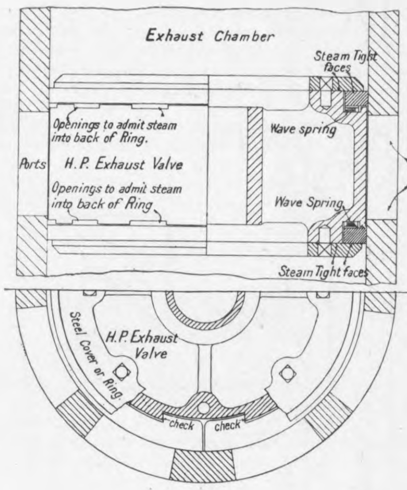

Exhaust Chamber
Steam Tight faces
Check
Section of Ring.
Openings to admit steam into back of Ring.
Wave spring
Ports
H. P. Exhaust Valve
Exhaust Steam from Cylinder.
Openings to admit steam into back of Ring
Wave Spring
Steam Tight faces
Steel Cover or Ring
H.P. Exhaust Valve
check
check

Fig. 45.

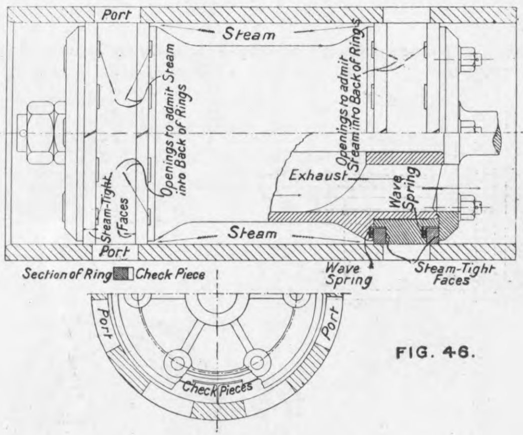

Port
Steam
Openings to admit Steam into Back of Rings
Openings to admit Steam into Back of Rings
Exhaust
Wave Spring
Steam-Tight Faces
Steam
Port
Section of Ring
Check Piece
Wave Spring
Steam-Tight Faces
Port
Port
Check Pieces

FIG. 46.

As already stated, quite a large number of slow-speed engines are now being fitted with trip piston valves, as originally made by Messrs. Van den Kerchove, of Ghent. The arrangement of valves is shown in Fig. 43. The clearance space can be made as small as in a Corliss engine, and the valves are practically frictionless, whereas the Corliss valves require a powerful gear to drive them. The steam valves are in the top end of the cylinder, and are usually driven through a trip gear, while the exhaust valves are in the bottom half, and are usually driven through a positive gear with wrist-plate motion giving a quick opening and closing of the valves.

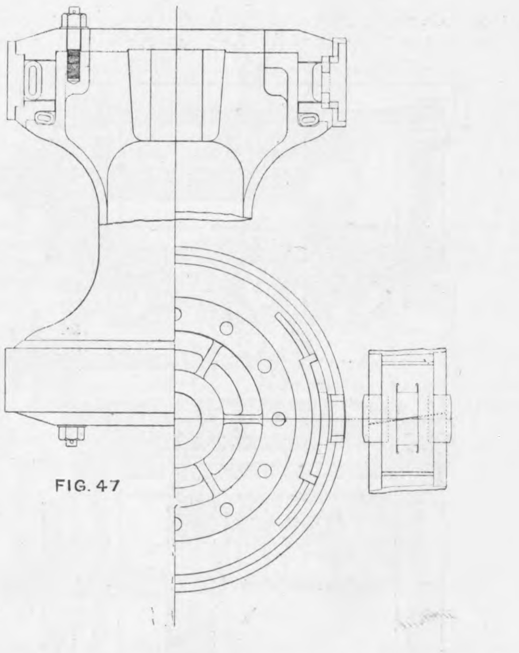
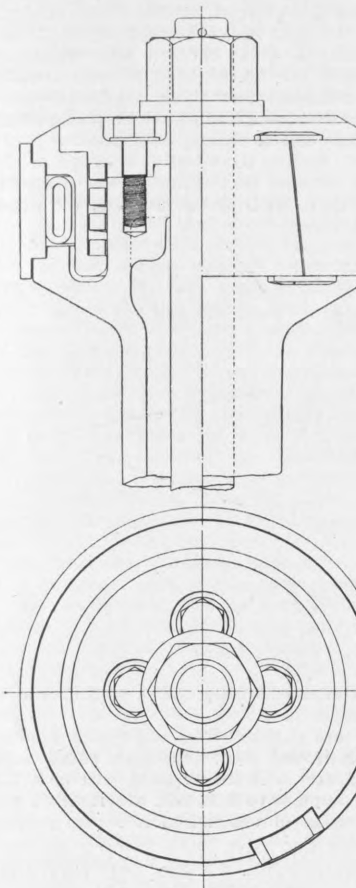


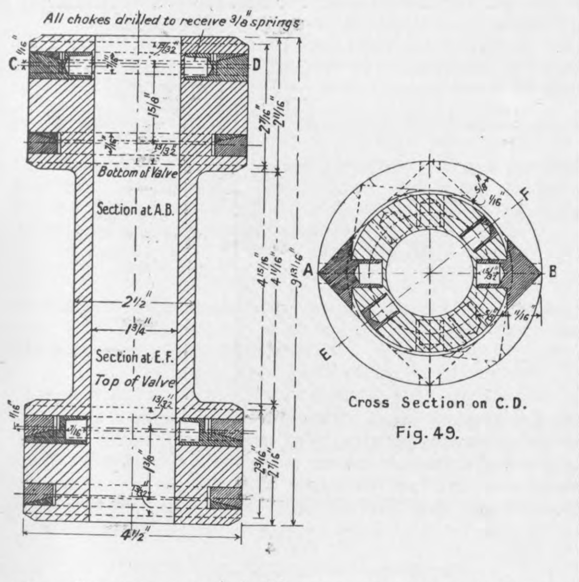
FIG. 47

Messrs. Dobson and Co., of Belfast, have made a speciality of their rings for this type of engine, details are shown in Figs. 44 and 45. The check pieces, which are of very neat design, are the same as adopted for their pistons. It will be noted that the wave springs which hold the rings on to the face of the valve lips or junk rings are always placed so as to act in conjunction with the steam pressure. These rings are working satisfactorily at all pressures and temperatures up to 750 deg. Fah. When this type of ring is adopted for ordinary piston slide valves, the arrangement is as shown in Fig. 46. As the ring is restrained it is not possible for it to spring into the ports, or wear the liner excessively, due to steam expansion, and as the steam is freely admitted through the slots shown to the back of the rings, they do not collapse when passing over the ports.



Follower Piston Valve.

Fig. 48



Cross Section on C.D.

Fig. 49.

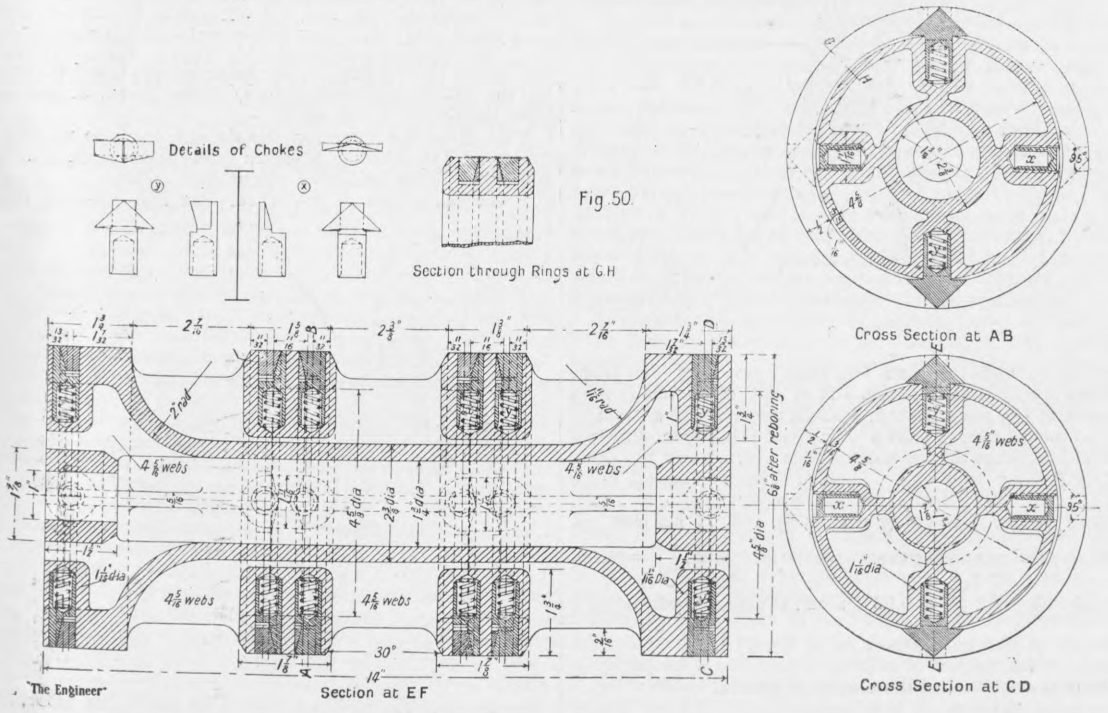


Fig. 50.

Cross Section at AB

Cross Section at CD

Another design of valve is that made by W. Buckley and Co., Ltd., of Sheffield, under Pagan's patents, and is illustrated in Fig. 47. It is specially suitable for high speeds, high pressures, and superheated steam. The valve shown in Fig. 47 is one used for the high-pressure cylinder of a marine engine working with steam at 180 lb. per square inch, and is 26in. diameter, and in Fig. 48 is shown the arrangement for smaller sizes. The packing ring in this valve, which is the full width of the bearing surfaces, is expanded by the firm's usual type of coiled spring, which is adjustable for the outward pressure it gives, and it only exerts pressure outwards; the endwise pressure required to keep the ring steam-tight against the valve flanges is obtained by means of a compression spring in the case of small valves—see Fig. 48—and a conical coiled spring in the case of large valves, as shown in Fig. 47. This spring presses upon the follower, which bears on the upper part of the packing ring. The spring for the follower ring is held in place by a junk ring of the usual type. The packing rings are fitted with a restraining tongue-piece, and if a coil spring or compression spring should break through any unforeseen cause, no damage would be done.

In Figs. 49 and 50 are shown two working drawings showing the application of the "Allen's" piston rings to piston valves. The general principle of the packing rings is the same as already described for pistons Figs. 19 and 19*a*, but in this case the wedge segments are made at such an angle that external pressure—such as a piston valve has to withstand when passing over the ports—will not close in the packing; the rings therefore will expand, but cannot contract.

PROGRESS OF WARSHIPS AND MACHINERY UNDER CONSTRUCTION IN ENGLAND.

As only brief details of the absolutely new constructions in some of the Royal dockyards are at present known, priority in our half-yearly record of warship construction in England is given to vessels which have already made good progress or passed into service. Our record is as follows:—The machinery acceptance, and final trials of the battleship Bellerophon, built at Pembroke, and her passing out of dockyard hands took place in the course of the week ending January 16th last. Good progress has been made with the battleship St. Vincent, also being built at Portsmouth, and she is now nearing completion.

Marked progress has been made since her launch with the battleship Collingwood, built at Devonport, her side armour having been fixed in position in three working days; the whole of her boilers—some eighteen in number—each weighing about 30 tons, were shipped on board in four days, and the tripod masts (two) in two days; the actual lifting and placing of each of the latter in position occupying but one hour. The whole of this smart work was effected with the assistance of the 75-ton electric crane fitted on the dock side, coupled with well organised labour.

The steam trials of the battleship Temeraire, built at Devonport, took place between the 20th and 23rd of February, and were highly satisfactory. When making 22 knots an hour, little noise of the machinery or vibration of the ship was perceptible. The vessel as a whole is considered the most perfect specimen of her class built up to now. She has bunker capacity for 2400 tons of coal, and at full speed will not burn more than 500 tons a day.

The progress in the construction of the armoured cruiser Bellona, at Pembroke Dockyard, has been highly satisfactory, the boring out of the propeller shaft brackets and tubes having been effected between the 22nd of January and the 1st of February, so that the vessel was enabled to be put into the water on the 20th of March last, the construction of the launching cradle to effect this having been pushed on as fast as possible. Since her launch she has made excellent progress, all the pieces of the propeller shafting having been adjusted in their final position, and the turbine engines coupled up.

The basin trials, on the 8th of March, of the armoured cruiser Boadicea, built at Pembroke, gave satisfactory results, the turbines on the admission of steam to them starting without a hitch. On the ten hours' steaming trial, with the assistance of oil fuel, she attained a speed of practically 28 knots an hour, and when running free at full power it is believed that 29 knots will be attained. The acceptance trial of the ship was concluded on the 3rd of June, and the propelling machinery taken over from the engineer contractors, the vessel leaving Pembroke on June 10th.

The unarmoured cruiser Blanche, the keel plate of which was laid down in Pembroke Dockyard on April 12th, had in a fortnight from that date made fair progress, as in the interval about 100 tons of material had been worked into her hull. She is a vessel of the Boadicea type and form, 385ft. long, 41ft. 6in. beam, 3360 tons displacement, with a mean water draught of 13ft. 6in. Her propelling engines are to be turbines of 18,000 horse-power, and are expected to give her a speed of 25 knots an hour.

Taking now in order (as to their keel laying dates) the newest warships, the first to be noted is the battleship Neptune, being built at Portsmouth, the keel of which was laid on January 19th. She will be 540ft. long, 86ft. beam, have a displacement of 20,050 tons, and a draught of 30ft. Her engines will be of turbine type of 25,000 horse-power, and are expected to realise a speed of 21 knots an hour. A good start was made with the construction of her hull, as by April 1st 1000 tons of material had been worked into it, the framework being then well forward, and the bulkheads secured in position. The Neptune will be the largest and most powerful warship in the Navy, and she will very probably have reached the launching stage by the end of August.

Another notable ship is the armoured cruiser Indefatigable under construction at Devonport, a vessel reputed to be the biggest of her class in the world. The "slip" on which she is being built, not having been previously of sufficient length, was increased, and the keel-plate laid on the 23rd of last February. The new ship is to have a length of 555ft., a beam of 80ft., a displacement of 19,000 tons, and a draught of 26½ft. Her engines will be turbines of 45,000 indicated horse-power, estimated—at her load draught—to give her a speed of 25 knots an hour.

Turning now to the progress made in the construction of warships and machinery in the private shipbuilding yards and engine works in England in the past half-year, we find that during that time Sir W. G. Armstrong, Whitworth and Co., Limited, have completed the armoured cruiser Invincible, and handed her over to the Admiralty. The battleship Superb has completed her official trials in a very satisfactory manner, and has been finished and handed over to the same authority. A commencement has been made with the second-class protected cruiser Newcastle, the framing of the vessel being now well in hand. The Argentine gunboats Parana and Rosario, having both completed their trials in a satisfactory manner, are now being finished, and will shortly be handed over. The Minas Geraes, Brazilian battleship, is now well advanced, and will shortly be ready for her official trials. The Brazilian scouts Bahia and Rio Grande Do Sul, which were launched early in the year, are now having their machinery placed on board.

Hawthorn, Leslie and Co.'s report of progress in warship work within the past half-year is as follows:—The trials of the Afridi, 33-knot torpedo-boat destroyer, are now completed, the hand steering gear of the vessel being the last tested. The first-class torpedo boats Nos. 21 and 22 built at Hebburn, were handed over to the Admiralty in March last. The machinery of the battleship Temeraire, built at Devonport Dockyard, was tried at moorings early in February; and the whole of the steam trials at sea, which were run through consecutively without a hitch, took place during the last week of February and the first week of March. The opening up of the machinery after the trials, and the completion trial of 24 hours being satisfactorily carried through, the vessel was handed over to the Admiralty on May 7th. Of the first-class torpedo boats Nos. 33 and 34, built at Hebburn, the trials of the first have been satisfactorily completed, and the vessel was handed over to the Admiralty on June 10th. Those of No. 34 are now being run, and it is expected the vessel will be handed over this month. The boilers, funnels, and uptakes of the battleship Collingwood, built at Devonport Dockyard, are now all on board, and the turbines for the two wing shafts are completed and being put on board. The low-pressure and cruising turbines are being steam tested at the works, and will be despatched to the ship during August. Owing to the delay occasioned by the recent strike of engineers and shipwrights on the Tyne, work on the 33-knot destroyer Zulu at Hebburn has not progressed. The boiler funnels and uptakes, however, are now on board the ship, and as soon as the stern tubes are bored out, the propellers and shafting now finished in the shops will be fitted in place. The turbines and condensers are also well in hand. The whole of the material for the 27-knot destroyer Scourge has been ordered, and a considerable portion of it has been delivered. An order for the machinery of the unarmoured cruiser Blanche (under construction at Pembroke Dockyard) was placed with Hawthorns a couple of months ago, and the work is well in hand in their drawing-office, and all the material has been ordered. The patterns for the turbines are made, and are now in the foundry. An exceptionally short time is available for the construction of this machinery, as the vessel has to be completed and handed over during October of next year.

Palmer's Shipbuilding and Iron Company at Jarrow has during the past half-year delivered to the Admiralty the two torpedo boat destroyers Albacore and Bonetta, and within the past fortnight the first-class torpedo boat No. 24, which has successfully undergone her speed trials. The official trials of torpedo boat No. 33 are now being held, and those of the sister boat No. 36 will take place shortly. The Viking 33-knot destroyer is still on the stocks. The material for the battleship Hercules, an order to build which was received by the firm during the past half-year, is being rapidly collected, but no details as to the vessel's design or dimensions are yet to hand. At the only war shipbuilding works now existent on the river Thames—the Thames Ironworks Company—there is only now in hand for the British Admiralty the construction of the 27-knot torpedo boat destroyer the Nautilus.

At the shipyard of the Southampton works of Jno. I. Thornycroft and Co., Limited, at Woolston, of the progress of warship building in the past half-year, the record is as follows:—Having passed all trials satisfactorily, torpedo boats Nos. 31 and 32 were delivered to the Admiralty on the 10th of February and 12th of March respectively; the speed on trial over eight hours' continuous running was 26.437 knots for No. 31 boat, and 26.22 for No. 32 boat. The Amazon torpedo boat destroyer passed all her trials successfully, and attained a speed of 33.734 knots on the mile at Skelmorlie, and maintained a mean speed of 33.217 knots during the six hours' trial. She was handed over to the British Admiralty on the 7th of April. The 33-knot British torpedo boat destroyer Nubian is undergoing trials at the present time, and it is expected that she will be delivered to the Admiralty in about eight weeks time. The torpedo boat destroyer Savage is making satisfactory progress, is now in full frame and partially plated, while the turbines and boilers are well in hand. The vessel is a coal-burning destroyer, while the others use oil fuel; all, however, have turbine machinery and water-tube boilers.

At Yarrow and Co.'s works at Scotstoun, Glasgow, of the ten Brazilian destroyers under construction the third, fourth, and fifth have passed their official trials, and the sixth started her trials last week. The first three of these destroyers have reached Rio, and the fourth Las Palmas on the 24th of June. The last four of the ten vessels are in an advanced stage of construction, the seventh being about ready for launching. A shallow-draught gunboat 120ft. long by 20ft. beam, for the Portuguese Government service in Macao, has been shipped to Hong Kong for re-erection there, and two shallow-draught side-wheel steamers for the same Government are on the point of shipment to Portuguese Guinea. Two sets of internal-combustion machinery similar to that fitted in two Austrian gunboats by the firm have also been constructed at the works, together with the Yarrrow water-tube boilers for the British destroyer Rattlesnake.

At the works of Vickers, Sons and Maxim at Barrow the battleship Vanguard was launched on the 22nd of February last. This vessel, which is similar to the Collingwood, is 500ft. long between perpendiculars, has a beam of 84ft., a displacement a little over 19,250 tons, with turbine engines of 24,500 indicated horse-power, estimated to give a speed of 21 knots. She will be the cheapest armoured ship of her size and power ever built. Her launching weight was 10,250 tons, a thousand more than any battleship previously put into the water from any shipyard. The Sao Paulo battleship, built for the Brazilian Government at the Barrow shipyard, was launched on the 19th of April, her launching weight being 10,400 tons. She is 530ft. long, 82ft. beam, 19,100 tons displacement, with a water draught of 25ft. She will have reciprocating engines of 24,000 horse-power, driving twin screws, a speed of 21 knots being guaranteed, and Babcock and Wilcox boilers, bunker room for 2000 tons of coal being provided, together with arrangement for carrying oil fuel.

Cammell, Laird and Co., Limited, of Birkenhead, are to build three of the destroyers lately put out to contract, they are to be named Racoon, Renard, and Wolverine. The Swift, ocean-going destroyer, built by the firm, after new wing propellers had been fitted, ran trials on February 16th, and attained a speed of 36 knots, while under full pressure 38 knots were realised, further alterations having been made in her propellers, in order to find out the best type for the vessel.

THE PRESSURE ON LOCOMOTIVE BRAKE BLOCKS.

A KNOWLEDGE of the pressure exerted by the brake blocks on the wheels of a locomotive and tender is often of importance; it has to be considered by the designer, and it is fundamental when the results of brake trials, either absolute or comparative, have to be considered.

In such few books as deal with the locomotive, the subject is generally dismissed as "simply a matter of leverage," with, perhaps, a numerical example. Granted that it is "simply a matter of leverage," in practice the difficult problem is very often, "What is the leverage?" and it is this aspect of the question—which is usually ignored—that is the subject of the following article:—

The leverage between the brake cylinder, or the screw of the hand brake, and the bottom of the brake hanger, does not offer any difficulty when equalising or distributing levers are used, and when such levers are not provided for in the design it is usual to assume that the braking force is equally distributed amongst the hangers when they are all, as is generally the case, similar and similarly situated with regard to the wheels. The problem now becomes, "Given the amount and the direction of the force acting at the end of the brake hanger, what is the effective pressure on the brake block?"

The answer to this question depends on the method of securing the brake block to the hanger, and there are two systems in everyday use, with one of which the solution is perfectly definite, while with the other, although the pressure is not statically determinate, a satisfactory practical solution can be obtained by making one assumption, the accuracy of which will be admitted to be sufficient for the purpose for which it is used.

The first case is where the brake block is secured to the hanger by means of a single pin, as shown in Fig. 1, and in this case, if a is the length of the perpendicular from the fulcrum of the hanger on to the line of action of the pull P at the bottom of the hanger, and b is the distance of the pin carrying the brake block from the fulcrum, the effective pressure on the block is evidently $P\frac{b}{a}$, and calls for no further remark.

The objection to this arrangement is that the brake block will not retain its position relatively to the hanger, except when it is pressing on the wheel; so, in order to prevent the block from turning round on its pin until the top comes in contact with the wheel, it is customary to introduce a small tension spring at the top, or a small compression spring at the bottom, which serves to hold the block in its right position away from the wheel.

From this it was a natural transition to the brake block with a small "stop" cast on, to bear against the hanger and so hold it in position, as shown in Fig. 2. This stop is both cheaper and less troublesome than the spring, but has the disadvantage of rendering the pressure on the brake block indefinite, for the block being supported at two points, and the distribution of pressure between the block and the wheel unknown, the science of statics offers no means of apportioning the load between the two supports.

There are three methods of estimating the leverage, which are used by different engineers—viz., the effective arm is taken to be b, $b + c$, and $b + \frac{c}{2}$, where b is the distance from the fulcrum to the centre of the pin carrying the block, and c is the distance between the centres of the pin and the stop. Of these the two first are obviously the extreme limits, and give brake block pressures in excess and defect respectively; while the third, which is probably the most often used, is the mean between the other two. Yet another way is to assume the effective arm as being to the centre of the length of the block. Evidently there is no sound basis for any of these methods, while they lead to very different results, so that if it is stated that a wheel is braked to, say, 80 per cent. of the load on it, it is necessary to know on what basis the calculation was made before the result is of any value for comparative purposes. For instance, if $b = 12$in. and $a = 3$in., which are quite practical figures, and if the 80 per cent. was based on an effective arm equal to b, then a calculation based on $b + c$ would give 64 per cent., while one based on $b + \frac{c}{2}$ would give 71 per cent., and the differences are so great that it is evidently impossible to make any comparison between braking forces unless they are all known to be calculated on the same basis, and even then, since the positions of the stop, and of the block itself with reference to the pin and stop, are to a great extent arbitrary, it by no means follows that a comparison between different brake blocks, when all the calculations are made on the same basis, will be a true one. Thus, if there be a second block with $c = 2$in. fitted to the previous hanger with $b = 12$in., the three methods would give 80, 68½, and 74 per cent. respectively, and comparing these with the foregoing, $\frac{80}{80} = 1.00$, $\frac{64}{68\frac{1}{2}} = 0.935$, and $\frac{71}{74} = 0.96$ for the three methods, so that the result of the comparison is to a very great extent dependent on the method of making it, and it is doubtful as to which, or if even one, of the results is correct.

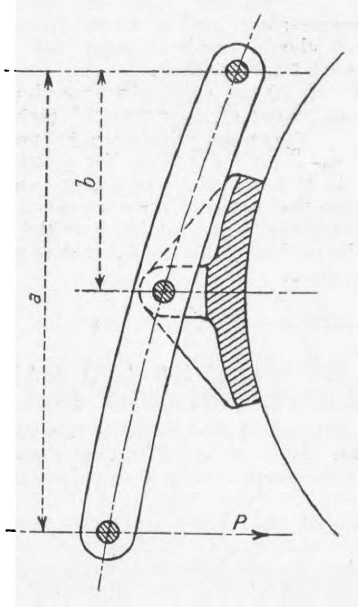


Fig. 1

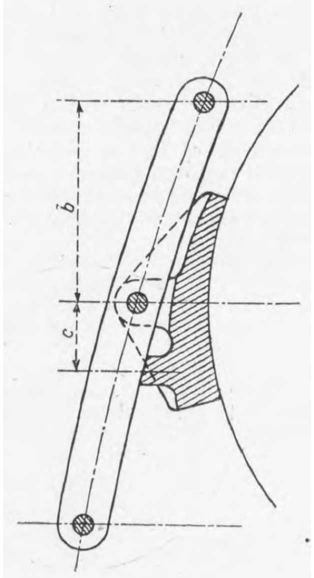


Fig. 2

This being the case, it is necessary to try and find something which is definite, and it will be at once noticed that the wear of the brake block is perfectly so. The block, bearing on the hanger at two points, must, as it wears, revolve with the hanger round the fulcrum, and the shape of the worn block is known with the same certainty as that of the unworn one, and is independent of the positions of the pin and the stop.

Now let the following apparently reasonable assumption be made:—"The normal pressure on the block at any place is proportional to the wear that takes place there," and a basis is obtained which is quite definite, and which will give strictly comparable results, while such results will be considerably more accurate than those obtained by the use of any of the above-mentioned arbitrary methods, even though the hypothesis may not be strictly axiomatic.

The problem of finding the effective leverage, or the centre of pressure, now becomes that of finding the centre of wear.

Referring to Fig. 3, let O be the centre of the wheel, C the fulcrum of the brake hanger, and A and B the top and bottom of the brake block.

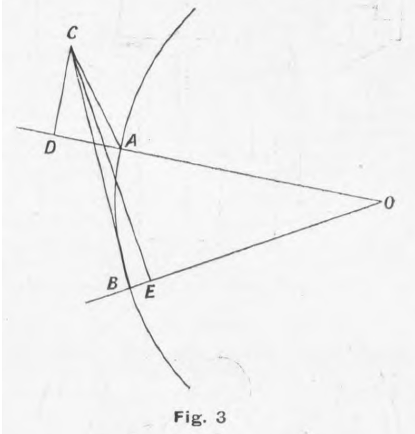


Fig. 3

If the block wears slightly, the hanger, and the remainder of the block with it, will turn through a small angle, say θ (in circular measure). The wear at A will be $\theta . CA$ in a direction at right angles to C A, and the resolved portion of this in the direction of the radius A O (the normal wear) will be

$$\theta . CA . \cos\left(CAO - \frac{\pi}{2}\right) = \theta . CA . \sin CAO.$$

Similarly the normal wear at B will be

$$\theta . CB . \sin CBO.$$

Now $CD = CA . \sin CAO$ and $CE = CB . \sin CBO$, where C D and C E are the perpendiculars from C on A O and B O so that

$$\frac{\text{Normal wear at A}}{\text{Normal wear at B}} = \frac{\theta . CA . \sin CAO}{\theta . CB . \sin CBO} = \frac{CD}{CE}.$$

The wear at intermediate points is practically proportional to the width of the trapezium of Fig. 4, of which the height l is equal to the length of the block (A B of Fig. 3), and the top and bottom, b and a, are proportional to the wear at the ends, or to C D and C E. The distance of the centre of gravity of this from the bottom is

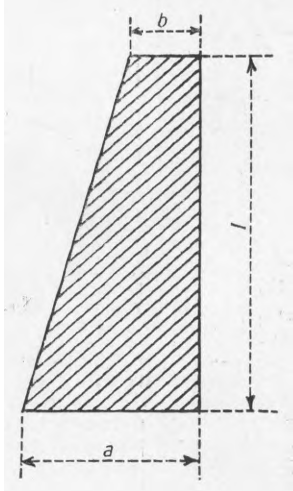


Fig. 4

$$\frac{l}{2} - \frac{l}{6}\left(\frac{a - b}{a + b}\right)$$

and this is the distance of the centre of wear, and therefore, on the assumption made above, of the centre of pressure, from the bottom of the block.

This gives the following simple and accurate method of obtaining the effective pressure on a brake block which is supported by the hanger at two or more points.

From the centre of the wheel—see Fig. 5—draw radial lines through the top and bottom of the brake block, and draw perpendiculars to these lines from the fulcrum of the hanger. Let the lengths of these perpendiculars be b and a, and the length of the block be l; then x, the distance

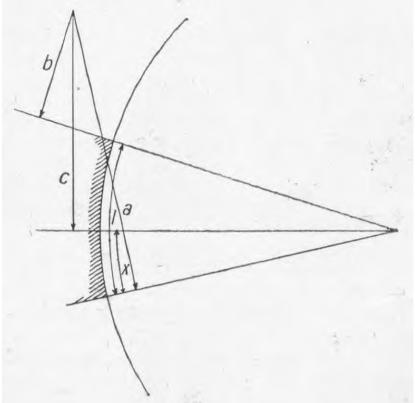


Fig. 5

of the centre of pressure above the bottom of the block, is equal to

$$\frac{l}{2} - \frac{l}{6}\left(\frac{a - b}{a + b}\right).$$

Measure this length along the block from the bottom, draw a radial line through the point so found, and drop a perpendicular, c, from the fulcrum; then the length of this perpendicular is the effective lever arm for the block, and the effective pressure on the block is, of course, obtained by dividing the turning moment of the force acting along the brake pull rods, about the fulcrum of the hanger, by this arm.

If the radial line through the centre of pressure should happen to lie above that through the centre of the carrying pin, it is an indication that the block is very badly proportioned, and an alteration should be made; such a case, however, will very seldom occur in practice.

An examination by this method of a number of the standard brake blocks and hangers used by one of the leading railway companies in this country, covering over two thousand engines and tenders, shows that, for most ordinary proportions, x lies between $0.37\,l$ and $0.40\,l$, with an average of $0.38\,l$, so that there is, in general, no necessity to go through the whole of the calculation, but simply, having drawn the block in position against the wheel, to measure off $0.38\,l$ upwards from the bottom of the block, which will give the centre of pressure. Drawing a radial line through this, and dropping a perpendicular from the brake hanger fulcrum, will give the effective arm. In special cases, where the proportions are much different from the average, it will be better to make the complete calculation, which is quite simple in any case: also, as the proportions of the standard blocks used by different makers vary somewhat, it will be advisable to try a few before accepting the value of x as $0.38\,l$; but it is not likely that any great deviation will be found.

This method will be found to give much more satisfactory and uniform results than those in common use, and it may obviously be applied when the brake block is fixed to the hanger, as is sometimes the case.

There is one other point which may be mentioned in this article, and that is the pressure in the brake cylinder or from the brake screw. The power brake may be either steam or air, and if the latter, pressure (Westinghouse) or vacuum.

With the steam brake it is not likely that the pressure in the brake cylinder ever rises so high as that in the boiler, though the drop depends on many things: as an approximation, it is probable that about 90 per cent. of the boiler pressure is a fair average for comparative purposes where the brake cylinders are exposed or the steam pipes are long, and about 95 per cent. where the cylinders are sheltered or lagged, and the steam pipe short. For the Westinghouse pressure brake the normal braking pressure in the cylinder is 50 lb. per square inch with a train pipe pressure of 70 lb. per square inch. For the vacuum brake about 85 per cent. of the initial vacuum may be allowed as a fair average for brakes and cylinders in good condition.

For the hand brake there are several methods of estimating the pressure in use, but it appears most satisfactory to allow for the friction of the screw and the maximum wrench a man can give on the handle. For a square-threaded screw the efficiency is $\frac{\tan \alpha}{\tan (\alpha + \epsilon)}$ where α is the mean angle of the thread [and ϵ is the angle of friction, so that $\tan \epsilon$ is the coefficient of friction. $\tan \epsilon$ may be taken as about 0.1 for a brake screw, and if d is the outside diameter of the screw, and n is the number of threads per inch, then

$$\tan \alpha = \frac{2}{\pi (2\,n\,d - 1)} = \frac{0.64}{2\,n\,d - 1}.$$

As both α and ϵ are small, and the calculation is not an exact one, it is sufficient to take $\tan \alpha = \alpha$, $\tan \epsilon = \epsilon$, and $\tan (\alpha + \epsilon) = \alpha + \epsilon$, from which

$$\text{efficiency} = \frac{6.4}{2\,n\,d + 5.4}$$

this (which must be multiplied by 100 to bring it to a percentage) gives an efficiency of about 45 per cent. for an ordinary brake screw. The maximum pressure which a man can exert on the handle is about 100 lb., and this figure, combined with the above efficiency, will give very fair comparative results.

ORIENT LINE T.S.S. OTRANTO.

THE new twin-screw steamer Otranto, built by Workman, Clark and Co., Limited, Belfast, left the Alexandra Wharf early on Tuesday morning of last week, and, after adjustment of compasses in the Lough, proceeded to the Clyde for her speed trials. The Otranto is the first of two vessels being built by Workman, Clark and Co., Limited, for the Orient Steam Navigation Company, which company, as our readers are aware, is, in accordance with the terms of its new mail contract with the Australian Government, adding five new steamers to its fleet, three of which have already been delivered. The Otranto is 554ft. in length, with a gross tonnage of about 12,500, while her loaded displacement will be over 17,000 tons. She has been built under special survey for the highest class in Lloyds' registry, complying also with the requirements of the British Board of Trade and the conditions laid down in the Commonwealth Navigation Act. The passenger accommodation has received most careful consideration. Accommodation is provided for 300 first-class, 140 second-class, and 400 third-class passengers, as well as 450 emigrants.

The first-class rooms occupy the midship portion of three decks, and a special feature has been made in the single-berth rooms and rooms for two persons; a number of cabins *de luxe* and cabins arranged *en suite* are also provided, these latter comprising a separate sitting-room, bedroom, and lavatory, the decorations and furnishing being designed in various harmonious styles. The shelter-deck state-rooms are arranged on the tandem system, by which the inner rooms have a wing extending to the side of the vessel, with a ventilating opening port, thus affording the same advantages of lighting and ventilation which are enjoyed in the outer rooms. The lower berths in a large number of the rooms are designed to draw out, and so to form a double berth. The first-class dining saloon is on the upper deck. It is arranged for the accommodation of 156 persons, and is lighted by ventilating ports arranged in pairs, and by a large central lighting well surrounded by balustrades. The walls are panelled in light French grey oak, with gold ornaments, and relieved with tapestry panels and large mirrors, while the ceiling in fibrous plaster is most delicately moulded, and decorated in white and gold.

A miniature saloon has been devoted to the use of the children, where they will be able to enjoy themselves in their games and pastimes in the charge of their attendants. It is placed near the dining saloon. The remainder of the public rooms are situated on the promenade deck, and include the lounge, music-room, and smoking-room. An electric hoist for conveying passengers down to the dining saloon corridor is placed in the former room.

The second-class accommodation is placed on the upper and shelter decks, and the cabins are mostly arranged on the tandem system, a large number of these being two berth rooms, while the style and finish throughout is very similar to those of the first class. The dining saloon is commodious and well lighted, and extends the full width of the vessel, having seating accommodation for over 150 persons. It is lighted by large round ports in the ship's sides and by a large central well. The stairway from the deck leads to the main entrance hall and vestibule on the shelter deck.

Third-class accommodation for 400 persons is provided in well-lighted state-rooms on the upper and main decks. These rooms are arranged for two and four persons, and are fitted with fixed berths and wash-basins. The dining saloon on the lower deck affords accommodation for over 200 persons, and is provided with revolving chairs placed round small tables, while the room is lighted by round ports in the ship's sides. The deck space for promenading and amusements is provided for all classes, the first-class main promenade on the boat deck being about 40ft. above the load water-line. The wireless telegraph room is situated on the boat deck, and is furnished with all the necessary instruments for receiving and despatching messages by telegraph.

The first and second-class galleys are in one compartment on the upper deck, having the first-class pantry opening off the fore end, and the second-class pantry at the after end, from each of which there is direct access to the respective dining saloons. The main galley is a suite of rooms, each set apart for some special purpose, and comprises a confectionery room, bakery, vegetable room, butcher's shop, and sculleries, each of these rooms being provided with the necessary fittings and utensils required, electric power being utilised as far as possible. In connection with this department large refrigerated chambers have been fitted up on the lower deck for the storage and preservation of perishable stores required for use during the voyage. There is a fully-equipped laundry with electrically-driven appliances.

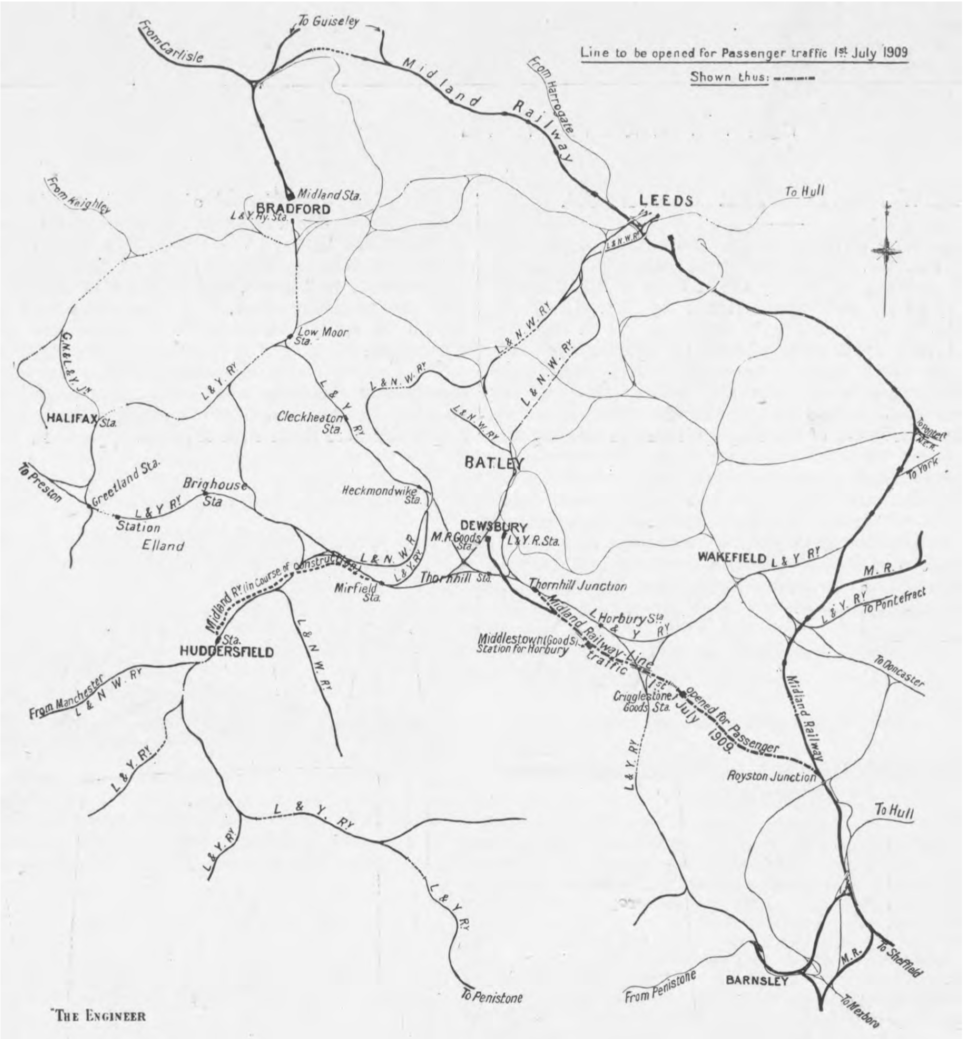
As regards the sanitary arrangements, many of the fittings have been specially designed for this vessel with a view to secure simplicity of details so as to facilitate cleaning or repairs while the vessel is at sea. Complete arrangements have been made to secure an ample service of hot and cold salt and fresh water in all the lavatories, which are ventilated by electrically driven outcast fans. A steam heating system has been fitted throughout the passengers', officers', and crew's accommodation, so as to ensure the comfort of all when in the cold climates. For the ventilation large electrically-driven fans and punkahs are fitted in the first-class saloon and *cabines de luxe*, while in the second-class saloon and all other public rooms and state-rooms there are large electric fans which can be regulated to various speeds. Electric lighting is fitted to every part of the vessel, the current for this and motor driving purposes being generated by four dynamos. The cargo space is divided into five holds, the three foremost of these being completely insulated and otherwise prepared for the reception of meat and fruit cargoes in bulk.

The propelling machinery consists of two independent sets of quadruple-expansion engines balanced on the Schlick system. The twin-screw propellers have each three blades of manganese bronze fixed to cast steel bosses, while the shafting is of hydraulically pressed Siemens-Martin steel. The boiler-room outfit consists of four double-ended and two single-ended steel multitubular cylindrical boilers arranged in two separate rooms with double funnels of oval section to each group of boilers. All the boilers are arranged to work on Howden's latest and most improved system of forced draught, the pressure being sustained by five large motor-driven fans. A series of trials were conducted on the Firth of Clyde, all of which were eminently satisfactory, the speed attained being, as we have already announced, 18.95 knots.

We may add that Workman, Clarke and Co., Limited, successfully launched the Orvieto from their North Yard on Wednesday last. The Orvieto is sister vessel to the Otranto, and is intended for the same service.

THE THORNHILL AND ROYSTON LINE, MIDLAND RAILWAY.

THE new railway brought into use for passenger traffic on the 1st inst. forms a portion of the Midland Company's West Riding lines, which have been open for goods traffic between Royston and Dewsbury for the past three years. The length of the line from the junction at Royston with the Midland main line to the junction at Thornhill with the Lancashire and Yorkshire Railway is a little over eight miles. The first seven miles of this line form a portion of the proposed Midland new main line to Bradford, and has been constructed with no gradients worse than 1 in 200, and no curves sharper than one mile radius, though the last mile of the line to be opened, forming a branch to the Lancashire and Yorkshire Railway, has steeper gradients and somewhat sharper curves. The principal works on the new line have been the two viaducts, one at Crigglestone, a quarter of a mile in length, consisting of twenty-one arches of spans varying from 50ft. to 61ft. 6in., and maximum height of 80ft. from ground rail level, and the other at Horbury, 300 yards long, consisting of seventeen arches of 45ft. span, and height of 50ft. above ground. Both of these viaducts are built of brickwork faced with best brindled bricks, and have been constructed in a thoroughly satisfactory manner. There is also a tunnel 250 yards in length at Crigglestone. The earthworks have been heavy throughout; several of the cuttings are over 45ft. in depth, two of the embankments being 50ft. high. A plan of the network of railways in the district, showing the new railway by dotted lines, is given herewith. We are indebted for it and for the above particulars to Mr. W. B. Worthington, M. Inst. C.E., Engineer-in-Chief of the Midland Railway.



THE THORNHILL AND ROYSTON RAILWAY AND LINES IN THE DISTRICT

INSTITUTION OF MINING ELECTRICAL ENGINEERS.—A meeting of this Institution will be held at the Grand Hotel, Manchester, on Saturday, 10th inst, at 7 p.m. The meeting held at the offices of the Institution of Engineers and Shipbuilders in Scotland, Elmbank-street, Glasgow, was adjourned.

ROYAL INSTITUTION.—A general monthly meeting of the members of the Royal Institution was held on Monday afternoon (the 5th instant), the Duke of Northumberland, K.G., President, in the chair. The Duchess of Northumberland, Lady Victoria A. Percy, Mr. H. E. Edmunds, Colonel Sir Charles Euan-Smith, K.C.B., and Mr. Alfred Rowe were elected members.

THE INSTITUTION OF CIVIL ENGINEERS: NEWCASTLE-UPON-TYNE ASSOCIATION OF STUDENTS.—A visit will be made on Wednesday, the 14th inst., to Addison Potter and Son's Tyne Cement Works at Willington Quay, and the works of the North-Eastern Marine Engineering Company, Limited, at Wallsend. Members will travel to Point Pleasant Station by the riverside train leaving the Central Station, Newcastle-on-Tyne, at 1.25 p.m.

THE MITCHELL CANTILEVER GRAIN ELEVATOR

THE NEW CONVEYOR CO., LIMITED, SMETHWICK, ENGINEERS

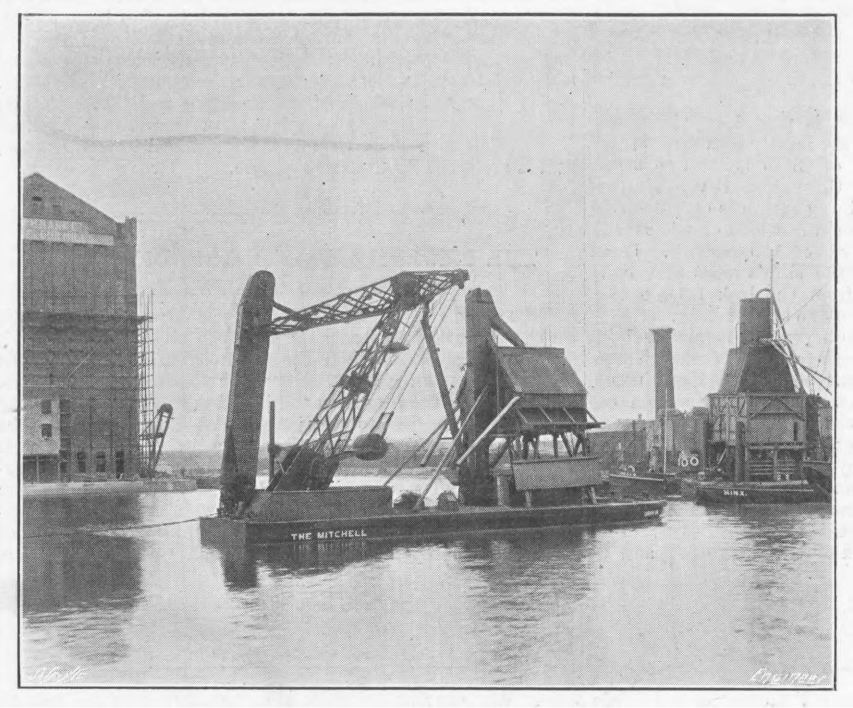


Fig. 1—IN POSITION FOR TOWING

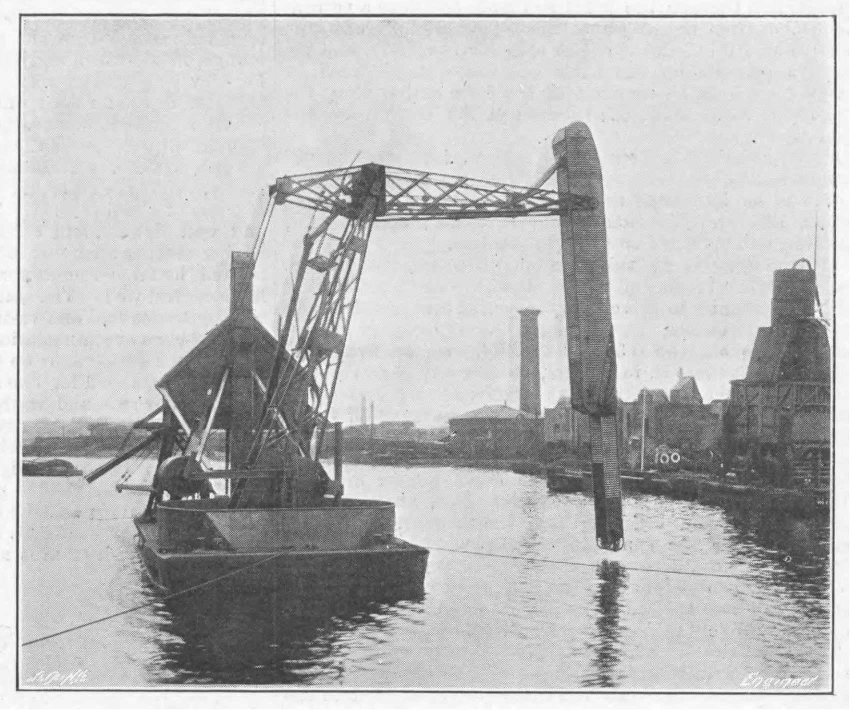


Fig. 2—IN POSITION FOR WORKING SIDE ON

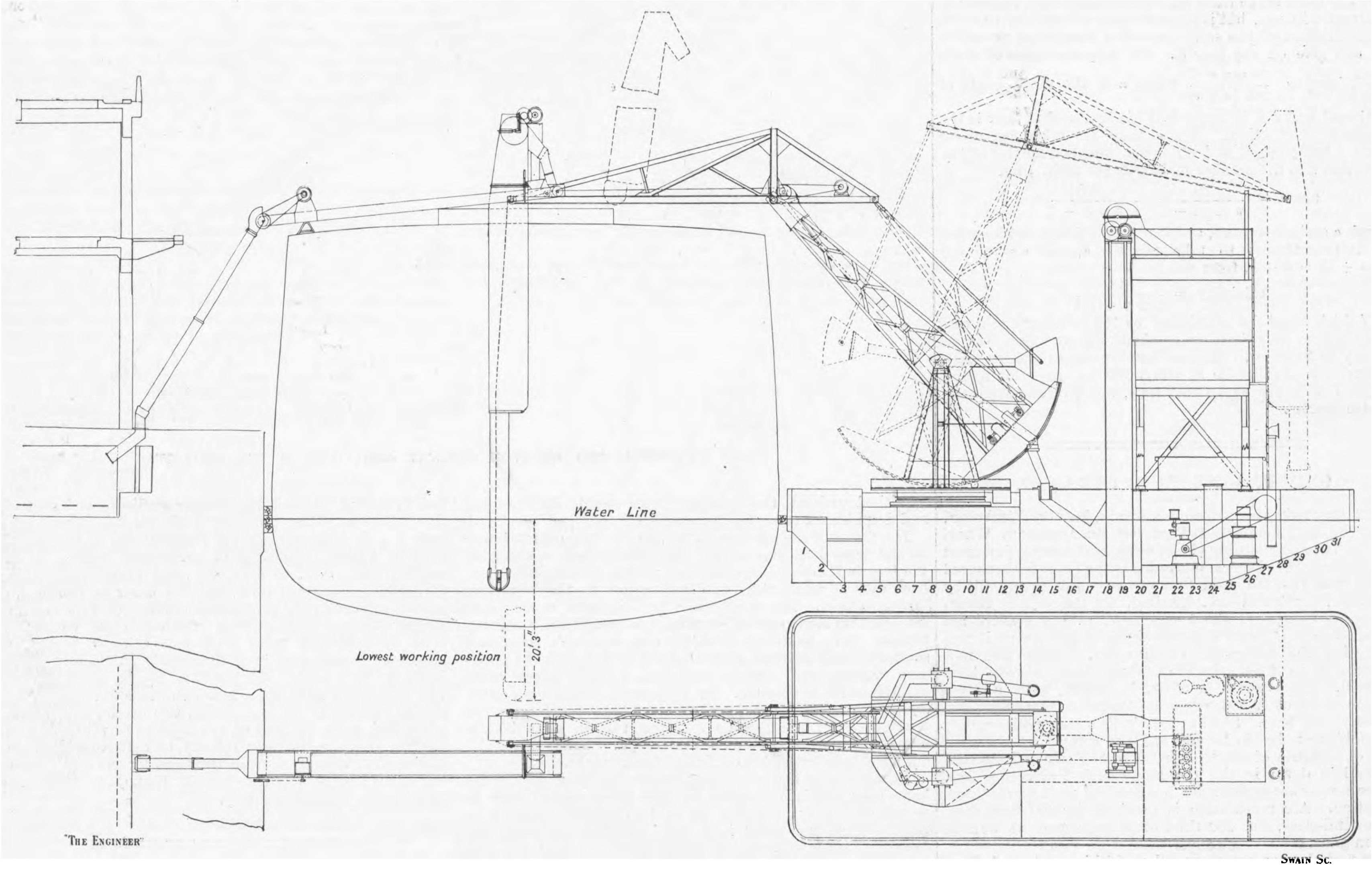
A NEW CANTILEVER ELEVATOR.

Some important advantages are claimed for a new type of floating elevator, which we were recently invited to inspect. It is being worked by the London Grain Elevator Company, Limited, and was designed by Mr. Alfred H. Mitchell, who is the company's engineer. It is used for discharging grain from ships' holds to lighters, and it is constructed to work side or end-on to the ship, and has the advantage when working end-on that it can deliver to two barges at the same time. Mr. Mitchell points out that the conditions of working grain from ocean-going steamers vary considerably as regards the size of the steamer, and the position and manner in which the grain is stored. When the work of discharging is commenced, the grain is probably at a height of some 15ft. to 20ft. above the water-line, whereas a short time afterwards the bottom point of the elevator may require to be taken as low as 20ft. below the water-line—in other words, to the bottom of the ship. When the ship is discharged it is necessary to lift the bottom end of the elevator over the highest point of the ship's coamings, which may be as much as 40ft. above the water line. Thus the bottom or digging end of the elevator must have a vertical range of some 60ft. The clear length of the leg below the supporting arm must be sufficient to reach the bottom of the deepest hold of any ship, which may be 40ft. for a moderate-sized steamer, and considerably more for some of the ocean liners. The width of a ship is also another important factor. The majority of ships being divided by longitudinal bulkheads, and in the after holds by a tunnel over the propeller shaft, it is important that the elevator should be easily able to work on either side of the ship's centre line.

The London Grain Elevator Company has several types of machines in operation, and during our recent visit we were afforded the opportunity of inspecting each, in order that we might compare them with this new type. In one instance, as is common practice, a portable machine is lifted into the ship by means of the ship's booms, and rested upon beams placed across the hatch coamings. In some cases, we are informed, the time taken in fixing the machine is greater than that taken to remove the grain. There was also a pneumatic machine, which had apparently been in use for many years, and although it still performs its work satisfactorily, we are told that it takes no less than 500 horse-power to operate it. Its initial and maintenance costs are also said to be high.

In order to show the advantages claimed for this new type of machine the illustrations Figs. 4, 5, and 6 are given. In the ordinary type of self-contained grain elevator, which is shown in Fig. 4, it will be noticed that there is an arm of considerable length which is fitted to the top of a tower and counterbalanced by a weight at the back end. The first step in the development of this new cantilever elevator was the bringing down of the back balance weight, as in Fig. 5, and connecting it by links and levers as shown. If the lever be equal in length to the back end of the jib, and the suspending link be equal in length to that portion of the post above the link, there is a parallel motion whereby the weight partakes of the same movement as the back end of the jib and balances it as before. This arrangement reduces the top weight by probably some 400 foot-tons in an ordinary sized machine, which in turn reduces the size of the barge or pontoon carrying it. The final modification is illustrated in Fig. 6, where it will be seen that the post, which is shown rigid in Figs. 4 and 5, is now supported by a trunnion at the top of a frame, which is placed on the turntable on the deck. With this arrangement it is possible to shorten the length of the cantilever arm by the amount by which the vertical post can swing forward. Thus the weight of the jib is not only lightened, but the amount of weight required to balance it is also considerably reduced.

If we assume the elevator leg to be perfectly balanced by the jib balance weight the centre of gravity of the whole combination will pass through some definite point on the



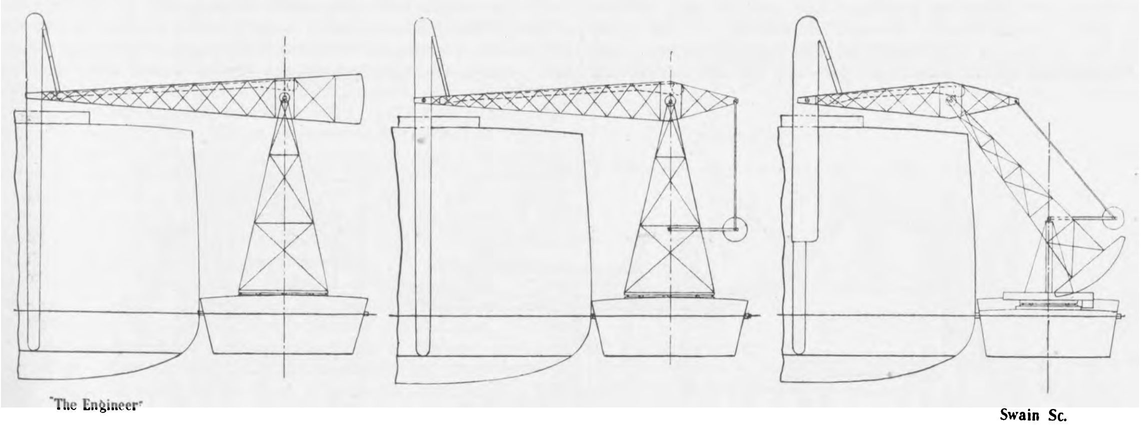
Swain Sc.

Fig. 3—MITCHELL GRAIN ELEVATOR—PLAN AND ELEVATION

upper side of the post. When this point is found it becomes possible by ballasting the lower end of the tilting post to bring the centre of gravity of the whole combination to the middle of the trunnion pin, at which point it will remain whatever be the position of the elevator. It will be seen that not only have the weights been brought down to a very low point, but the compound balance described enables the elevator to be worked side on or to work in broad or narrow ships without any tendency to give the barge a list or alter trim, so that a smaller barge can be used to carry it. The full weight of the elevator leg is not absolutely balanced, a certain excess being allowed on the elevator end for sinking the leg into the grain.

The elevator, which has been constructed for the London Grain Elevator Company by the New Conveyor Company, Limited, of Smethwick, Birmingham, is shown in Figs. 1, 2, and 3. The leg is telescoped and has a length when extended of 41ft. clear under the suspending pin. The buckets are carried upon an endless chain, and are so arranged that as the telescopic leg is lifted the exact amount of chain that is let out on the front of the leg is taken up in the back, so that the chain remains of the same length and of even tension throughout. The buckets, which are 10½in. apart, have a capacity of 100 tons of wheat per hour at full speed, and deliver at the rate of 320 buckets per minute. The elevator is carried at the end of a cantilever jib 25ft. long centre to centre, and 9ft. 6in. at the back end. The weight of the leg is partly balanced by the balance weight at the back, connected by means of parallel bars and lever, as shown. The grain is discharged from the elevator head by means of adjustable shoots on to an endless conveyor band carried on the inside of the jib. This band is of canvas with rubber on one side and is provided with diagonal ribs on the side which carries the grain, to facilitate the grain running up hill when the jib is lowered into its lowest position. These ribs are placed diagonally to allow them to run freely over the supporting rolls which carry the slack side of the belt. At the top of the post this belt discharges into a second receiver, which by means of the long telescopic shoot shown, discharges into the boot of a second elevator which is placed on the deck, and which in turn raises it and discharges it into the weighing-house or hopper, from which it is delivered to craft. The elevator jib is carried at the top of the inclined post, which in turn is supported at the trunnion pin at the top of the frame, which rotates upon the turntable, the supporting ring and rack of the latter being secured to the bottom of the craft. The length of the tilting post above the trunnion is 30ft., and the height of the trunnion pin above the bottom of the barge is 17ft. 3in. The weighing-house is provided with six Avery's patented automatic grain scales of 250 lb. capacity each, which can discharge into sacks or loose into craft, as required. We are informed that the time required for putting the machine into a ship is about four minutes, the corresponding time to ship and unship the portable machine previously referred to being anything from two to four hours. As will be gathered from the illustrations, this combination of the two levers and the telescopic leg gives a great range of motion. Figs. 1 and 2 show the leg housed for towing, and the elevator swung out to its maximum range respectively. The precise angle of the jib is controlled by means of an electric winch and wire hauling gear acting on the back ends of the jib, whilst the tilting of the post is performed by means of a screw and nut carried in a bracket near the trunnion pin on the post.

All the controlling motions are performed by series wound motors of 4 brake horse-power each. The driving of the elevator is done by a 20 brake horse-power motor attached to the turntable. Continuous current at 110 volts is generated on board by means of a Crossley suction gas engine, which drives a dynamo through the medium of a belt. The dynamo and all the motors are by Messrs. Holmes and Co., of Newcastle-on-Tyne. The deck elevator is driven from a countershaft in the engine-room and a chain belt. The drawing, Fig. 3, is for some much larger machines than the one just dealt with, which are at present being constructed by Spencer and Co., Limited, of Melksham, Wilts. These machines are provided with additional means of delivering grain ashore as well as to craft by means of a portable conveyor belt and telescopic shoot. It will be noticed that the elevator is driven in this case by a motor attached direct to the head of the elevator; thus doing away with all gearing. The grain is also delivered by means of shoots fixed inside the post and discharged by swivelling shoots into the second elevator, which is also driven by a direct coupled motor. The generating plant in this case consists of a high-speed direct coupled gas engine and suction gas plant, generating continuous current at 110 volts. The whole apparatus is controlled by one man, who is situated in a driver's cabin on the turntable.


"The Engineer"

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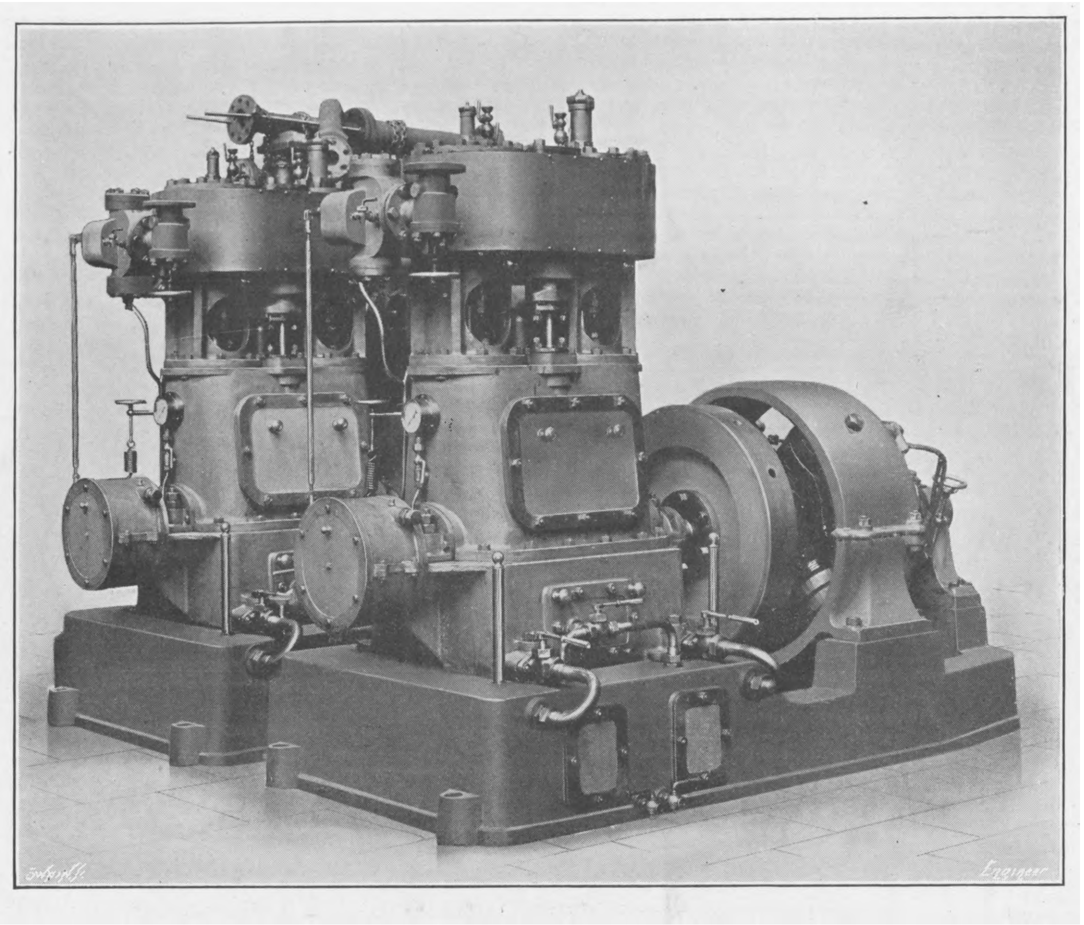
Figs. 4, 5, and 6—GRAIN ELEVATORS

In the House of Commons recently Mr. Tyson Wilson asked the First Lord of the Admiralty if he would give the date when the contract for constructing the naval base at Rosyth was signed; and whether the amended fair wages clause applied to that contract. In reply Mr. M'Kenna said that the contract for Rosyth was signed on the 1st March, 1909. The old fair wages clause was included in the particulars sent to the contractors on the 23rd October last, and it was embodied in the contract as signed.

S.S. TORTUGUERO ELECTRIC LIGHTING SET

W. H. ALLEN, SON, AND CO. LIMITED, BEDFORD, ENGINEERS



COMBINED STEAM ENGINE AND DYNAMO.

ON page 30 of this issue will be found a description of the fruit-carrying steamer Tortuguero. This vessel is very completely equipped, and is, of course, lit throughout by electricity. The current for this purpose is provided by two sets of combined steam engines and dynamos, supplied by W. H. Allen, Son and Co. An illustration of one of these sets is given above.

Each set has an output of 600 ampères at 100 volts when running at 500 revolutions per minute. The combined plant is of the enclosed type built specially by this firm for this service. The engines are of the vertical enclosed double-acting two-crank compound type, and are provided with a system of forced lubrication, the oil being circulated to all bearing surfaces by means of a valveless pump driven from the engine excentric. Each has one high-pressure cylinder 10in. in diameter and one low-pressure cylinder 14in. in diameter, the stroke being 6½in. The cylinders with the two valve chests are cast together, a valve chest being on either side of the horizontal centre line, and between the two cylinders, thus bringing the overall length of the engine within moderate limits and reducing the distance between the centres of the cylinders. The high-pressure and low-pressure valves are driven from one excentric forged solid with the shaft and situated between the cranks. The cross-head guides, which are cast in one with the trunk casing, are of the marine type, permitting easy access to the crossheads for inspection, and adjustment through the door on the front of the engine. Each engine is provided with a special arrangement of tanks and change valves for storing the lubricating oil, in accordance with the requirements of Mr. A. W. Prim, the superintending engineer to the owners. This consists of a large reservoir forming the base of the engine, fitted with case iron partition, and the oil drains from the crank chamber into either compartment of the reservoir. The oil pump suction branch can be connected to either compartment by means of a two-way cock, so that the oil which is not being used for circulation can be completely isolated from the lubrication system, and withdrawn for the purposes of cleaning, cooling, or replenishing, without stopping the engine, as the plant is designed with large bearing surfaces, &c., to enable it to run almost continuously. The governors are of the centrifugal pattern, fitted to the end of the crank shaft, and connected to the throttle valve by a vertical rod and lever, and a spring with hand regulation is provided whereby the speed is capable of being varied 5 per cent. above and below the normal while the engine is running. The permanent difference of speed between full and no load is 4 per cent. Forced lubrication is fitted to the governors, the oil being supplied from a hole drilled through the end of the crank shaft which distributes the lubricant to the governor spindle, and from this two pipes are led to the moving pins and levers which carry the governor weights. The dynamos are of Messrs. Allen's latest four-pole compound wound type, designed so as to give as nearly as possible a constant voltage at all loads. Each dynamo has four sets of carbon brushes, six brushes to each set. These are of a special grade of carbon, and each is connected to the brush box by a flexible copper "pig-tail," and has a separate adjustable pressure spring. Any brush may be removed while the engine is running. The outer bearings are automatically oiled by ring lubricators, and oil throwers are shrunk on the armature spindles to prevent waste oil creeping over the commutator surfaces. The armature and field coils are designed to reduce the temperature rise to a minimum.

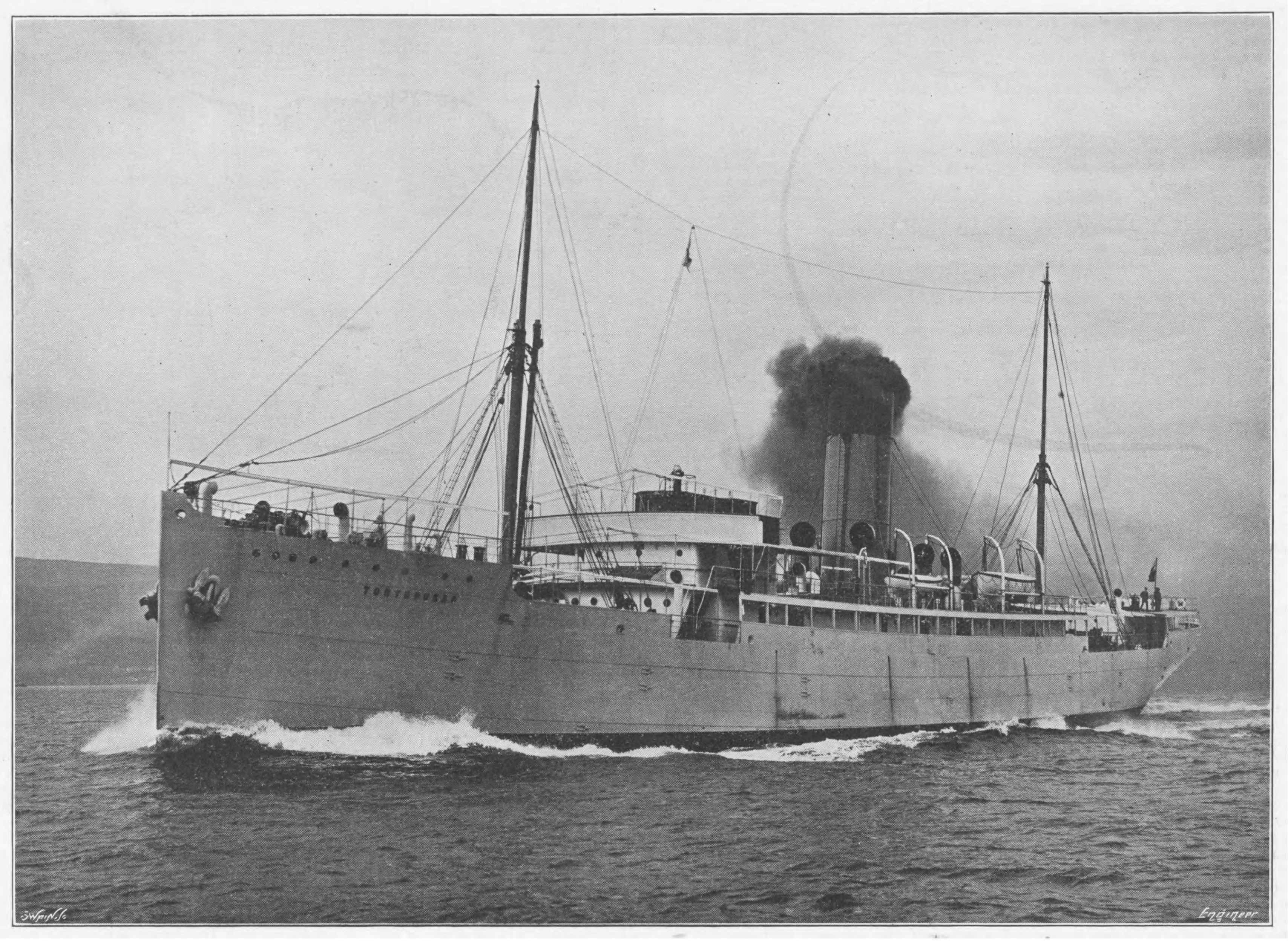
THE INSTITUTION OF MECHANICAL ENGINEERS

IN accordance with previous announcements, the summer meeting of the Institution of Mechanical Engineers will be held in Liverpool, and will begin on Tuesday, 27th July. A reception committee has been formed, consisting of the Lord Mayor and members of the Institution, and other influential gentlemen residing in Liverpool and neighbourhood. The following papers have been offered for reading and discussion, and will be read as time permits, but not necessarily in the order here given:—"Locomotives Designed and Built at Horwich, with some Results," by Mr. George Hughes; "The Advance of Marine Engineering in the Early Twentieth Century," by Mr. Arthur J. Maginnis; "Reinforced Concrete," by Mr. Arthur C. Auden; "Indicating of Gas-engines," by Professor F. W. Burstall; "The Electrical Operation of Textile Factories," by Mr. Herbert W. Wilson. The outline programme of the meeting is as follows:—On Monday, 26th inst., the secretaries' office will be open from 3 p.m. to 6 p.m. at the Municipal Central Technical School, Byrom-street, Liverpool, for the registration of addresses, issue of badges. On the Tuesday, 10 a.m., the Lord Mayor of Liverpool and the members of the Liverpool Reception Committee will welcome the President, the council and members of the Institution, in the lecture hall of the Central Technical School, and then will follow the reading and discussion of papers. In the afternoon a visit will be paid to the Liverpool Corporation Electricity Works, and at 7.30 the Institution Dinner will be held in the Exchange Station Hotel. On the Wednesday, the reading and discussion of papers will be continued in the morning at 10 a.m. In the afternoon visits will be paid to works and other places of interest in Liverpool. At 9 p.m., a reception in the Town Hall will be held by kind invitation of the Lord Mayor and Lady Mayoress. On the Thursday, alternative visits will be paid to the Walker engineering and other laboratories of the University, to the docks, to the Liverpool and Southport Electrified Railway, to the Lancashire and Yorkshire Railway Company's Locomotive Works at Horwich, or to Northwich, by invitation of the Salt Union, visiting old style salt works and vacuum plant, and passing through Vale Royal Park, the Anderton boat lift, and the rock salt mine at Marston. On the Friday, alternative whole-day visits will be paid either to Chester or Southport.

Water Arbitration Prize.—We have received the following copy of conditions for the second water arbitration prize to be made in 1910:—(1) The award will be made for the best original paper dealing with any branch of the mechanics of the supply or distribution of water, accepted by the Council for publication with or without discussion in the Institution "Proceedings" of 1910, provided that the paper be of sufficient merit in the judgment of the Council. (2) Papers should be sent in as soon as possible, but not later than 1st September, 1910. (3) Papers should be illustrated by scale drawings, but may be accompanied by photographs, lantern slides and specimens. (4) Any paper not accepted for printing in the "Proceedings" will be returned to the author. (5) The prize will have a value of about £30, and will be accompanied by a certificate bearing the seal of the Institution.

FRUIT AND PASSENGER STEAMER TORTUGUERO

ALEXANDER STEPHEN AND SONS, LIMITED, LINTHOUSE, BUILDERS



FRUIT AND PASSENGER STEAMER TORTUGUERO.

WHEN the well-known firm of shipowners, Elders and Fyffe's, Limited, commenced importing bananas on a comparatively small scale, some seven years ago, from Costa Rica and Jamaica, it could scarcely have been anticipated that the trade would have grown to such large dimensions in so short a period. The banana has become so popular an article of diet that the company, which started with four converted steamers, now finds full employment in the Manchester service alone for ten boats, of about 41,000 total gross tonnage, which are specially adapted for the carriage of this kind of fruit. Some idea of the extent of this trade may be gathered from the figures for last year, when it appears that the bunches delivered in the port of Manchester numbered over two and a-half millions, or only a few less than the total for the whole of this country. The delicate cargo has not only to be delivered regularly, it has also to be in a condition to suit the state of the market and the stock in hand. The latter requirement necessitates highly efficient systems of ventilation and refrigeration.

We are enabled herewith to place before our readers illustrations and particulars of the latest vessel to be added to the fleet, in which every essential feature for maintaining regularity of service and perfect temperature conditions has been embodied. The Tortuguero, built by Alexander Stephen and Sons, Limited, Linthouse, was launched on March 24th last, and sailed on April 22nd. She is a two-masted steel screw steamer of 5000 tons gross, and her principal dimensions are:—Length, 374ft.; breadth, 47ft. 6in.; and depth to upper deck, 32ft. 6in. In addition to fruit the vessel will carry mails and a limited number of passengers. She is divided into two large insulated fruit spaces, one forward and one aft, each carrying fruit in three tiers on orlop, lower, and main decks, the remainder of the space below the upper deck being occupied by the machinery and bunkers, while the refrigerating plant, passengers, and crew are placed above the upper deck in deck-houses and forecastle. The capacity of the insulated spaces is 220,000 cubic feet, and the bins for the fruit take up 175,000 cubic feet of this total. The bunkers will contain 1900 tons of coal, being sufficient for the round voyage out and home. The vessel goes out with bunkers full at an economical speed, and returns at full speed with her delicate cargo of fruit.

To gain as much insulated space as possible, the cargo being of a light nature, all the available space round the engine and boiler-rooms has been utilised for bunkers, while the forward hold from the boiler-room to the collision bulkhead under the fruit space is utilised solely for coal, experience having shown that it is not desirable to carry the insulation down to the tank top if the lower compartments can be made use of otherwise, as in this case, for fuel. The coal is loaded from tips in the Manchester Ship Canal through four large hatches, two through the boat deck to the side bunkers round the machinery space, and two main hatches forward being trunked through the fruit spaces. These trunks are fitted with large steel plate doors, which are closed when coaling to form coal shoots, but are left open to the fruit holds and the bunker covered over to gain additional fruit space on the homeward voyage. The disposition of the fruit spaces and bunkers is clearly shown in the elevation and plans of the vessel on page 34. A number of trimming hatches with plug covers is fitted in the orlop deck over the coal to act as escape doors into the fruit spaces. The fuel under the forward lower deck is burned on the outward voyage, leaving the ship in proper trim for loading fruit on her arrival at the loading port, as during the voyage out under easy steam more men are available to wheel the coal to the boilers from the comparatively distant fore-hold. The coal round the boilers is thus used on the return voyage, and on this account special means are provided for the ventilation of the coal spaces by cowl and other ventilators. Screens are also fitted to prevent the heat from the boilers reaching the coal bunkers. The accommodation throughout the ship is arranged on a generous scale, the seamen and petty officers being housed forward in the forecastle in large rooms, with wash-houses, store-rooms, &c. The mail room is also situated here, while a small entrance to the forward fruit space is provided for emergency access during the voyage. The firemen are placed aft in the fore-end of the after deck-house, with lavatories, shower bath, &c. In the aft peak an entrance to the refrigerated provision room is placed. This room is insulated in the usual manner, and is cooled by means of a separate machine placed in the refrigerating engine-room, having connecting brine pipes cased in the 'tween decks. The officers and engineers are arranged in a large midship deck-house, with the boat-deck overhead, and each has a separate room, and there are lavatories and a mess-room, the latter being served by a small pantry in direct communication with the galley. The galley is placed forward of the fiddley, with scullery and store-rooms alongside. These are divided from the galley by expanded metal partitions to ensure a free circulation of air. The ventilation generally, in view of the trade the vessel is engaged in, is designed for extremes of temperature, and is well over the Board of Trade requirements.

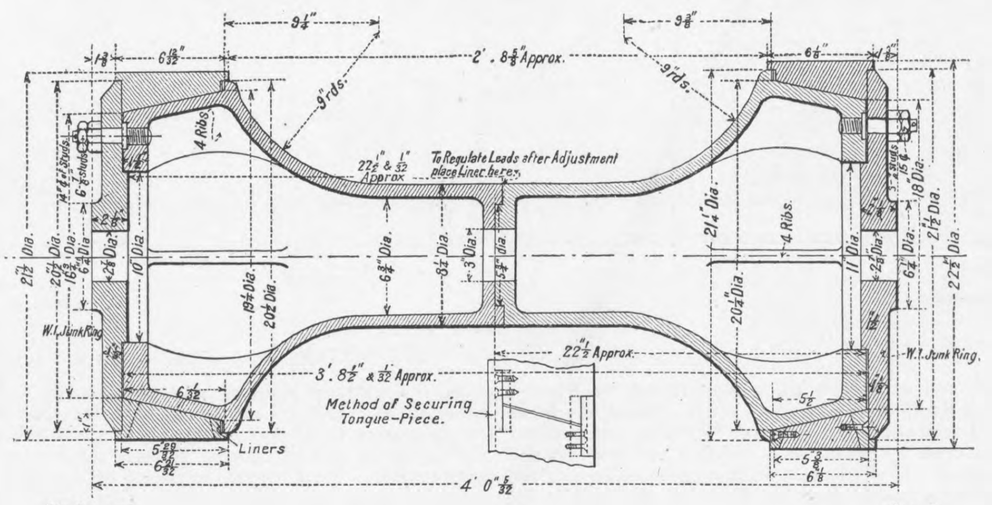


Fig. 1—PISTON VALVE OF MAIN ENGINES

The passenger accommodation is arranged at the fore end of the midship house and in a deck-house above. It consists of six state-rooms, lavatories and bathrooms, a dining saloon and pantry, a smoking-room on the boat deck above, and a staircase. The apartments are roomy, well equipped, and the weather deck for the passengers' use is covered with a light sun deck. It is, however, the fruit spaces and the methods adopted for preserving their contents that call for chief attention. As mentioned above, the ship is divided mainly into two insulated chambers of equal capacity, one forward and the other aft, and each chamber is divided by the decks into three separate compartments, which are again subdivided into bins about 20ft. square. The chambers are insulated all round on the upper deck, the orlop deck, the ship's sides, and the end bulkheads, but the lower deck is insulated on the under side and also a short distance inwards from the sides a ribbon is fitted to absorb the heat conducted by the steel decks from the outside shell. This method is illustrated in the transverse sectional view, Fig. 3, and has given the best results for the particular requirements of the fruit-carrying trade. For this trade a very low temperature is not necessary, but rather a uniform temperature, neither high enough to ripen the cargo nor too low to freeze it. This effect is enhanced by the two uninsulated divisional decks, which are also necessary in order to distribute the weight of the fruit to advantage. Except where bunkers and the refrigerating material are concerned, the insulating material employed throughout is granulated cork, which is found to be the lightest, cleanest to work, and damp resisting. It also combines with its insulating properties a certain degree of elasticity which resists the tendency to "settle," due to the constant vibration and movement of the ship's structure. During construction the cork is rammed hard in as the divisions are built up; but even with this material and with every care taken in the building, it has been found by experience advisable to make the top portion of the vertical bulkheads portable to facilitate examination after a few years. The average thickness of cork is from 7in. to 8in., and it is held in place against the sides of the ship and the bulkheads, and below the decks, by sheets of 16 w.g. galvanised iron, which are attached by means of brass screws to a wooden framework previously fitted to the frames and beams. The employment of this material, which may at first sight seem a retrograde step, has been proved by the owners' experiments in small sections in their older steamers to be the best possible for the purpose, having regard to repair and upkeep considerations.

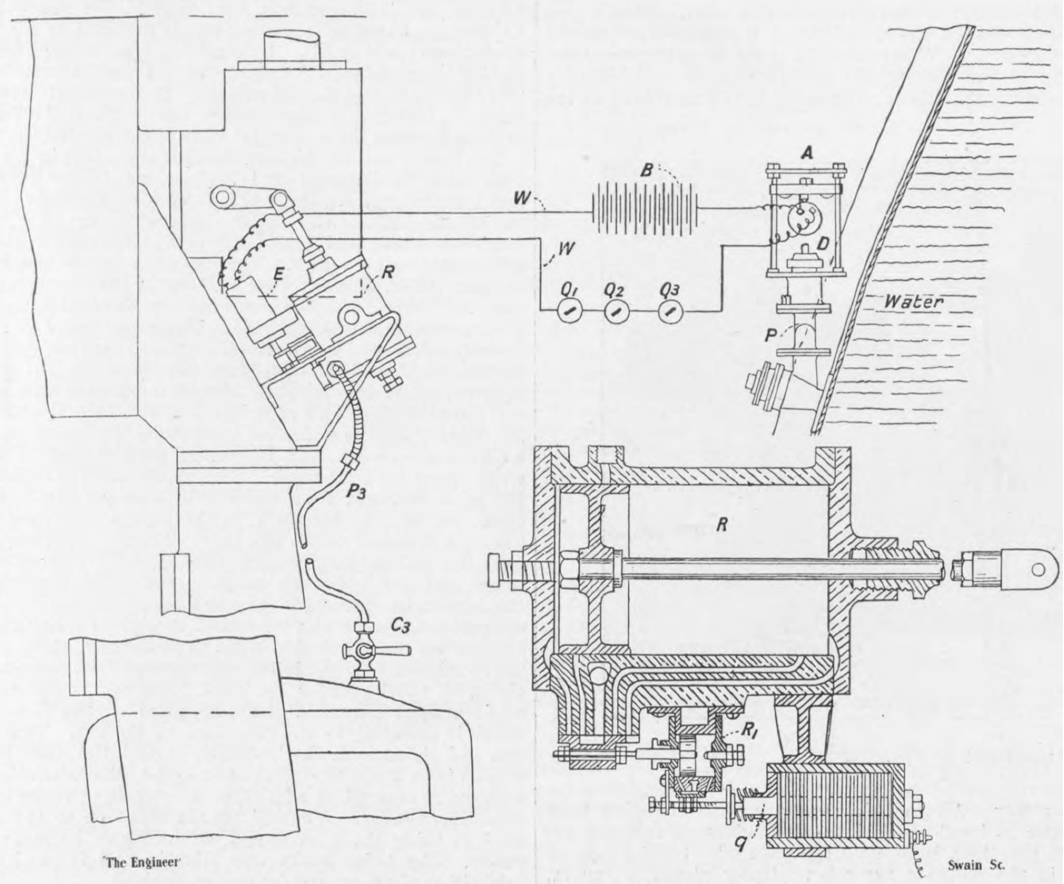


Fig. 2—KERR'S ANTICIPATING MARINE GOVERNOR

It is important that the green fruit should not rest against a metal surface during transit. The method of air cooling, described later, effectively prevents this, while the bare steel decks are covered with wooden gratings, and all ironwork, such as pillars, is protected by the wooden battens of which the bins are constructed or by hemp rope coverings. As above stated, the bins are about 20ft. square, and are formed of 5in. pine battens fitted horizontally, berth and space, into heavy wooden posts. These prevent the movement of the fruit without impeding the circulation of the air. Generally the fore and aft divisions are fixed, while those athwartship are made portable for convenience in loading, and a narrow passage is provided on each deck at about the centre of the space for inspecting the fruit during transit. This passage also divides each deck into approximately two equal divisions, each loaded and unloaded through a main hatch in the centre. The loading operations are facilitated at Port Limon by steam conveyors from the wharf to the hatches. These are worked by steam from the ship's boilers through the winch steam pipes. At Manchester the fruit is first lifted from the holds to the deck by elevators operated by the vessel's winches, and from the deck is removed by hand to warehouses and railway fruit vans.

As the speed of loading and discharging is of prime importance during the fruit season, each hatch is provided with a cage about 6ft. square, which is filled with fruit and lowered into the last space left on the hatch of the top 'tween decks. This cage is lifted bodily out on arrival home, thus utilising the last fraction of space, and giving room for men to work immediately on arrival. The handling of the fruit is further facilitated by numerous doors through the sides of the ship, with side hatches down to the lowest 'tween decks placed opposite the doors, but arranged so as not to be directly in a vertical line. This enables the bunches of bananas to be handed up from the lowest deck to the door. The fruit is kept in condition during the voyage by the constant circulation of cold air, which is forced into the hold at one side and drawn out at the other side. The three main spaces are quite independent. Upon each side of a 'tween deck a narrow air passage is formed by a tongued and grooved pine division the full height of the deck, and just wide enough to allow a man to pass along for inspection. This division is pierced by numerous small air slides, which may be opened or shut as required by the condition of the fruit opposite each slide. These air passages communicate with Sirocco fans, three 40in. and one 45in., running at 500 revolutions, and driven by electric motors supplied by W. H. Allen and Co., situated in an insulated chamber in the deckhouse amidships. The Sirocco fans can be run either coupled or separately by either motor. These fans draw air up from one side of the space, and deliver it across an arrangement of cold brine grids down to the other side continuously during the whole voyage, the same air being used over and over again for three days, when it is discharged through exhaust ventilators and a new supply drawn from the atmosphere. This is necessitated by the fouling of the air by the gases generated by the fruit, which would render the daily inspection of the cargo impossible. The air should, however, be changed as seldom as possible in order to give economical working of the cooling system.

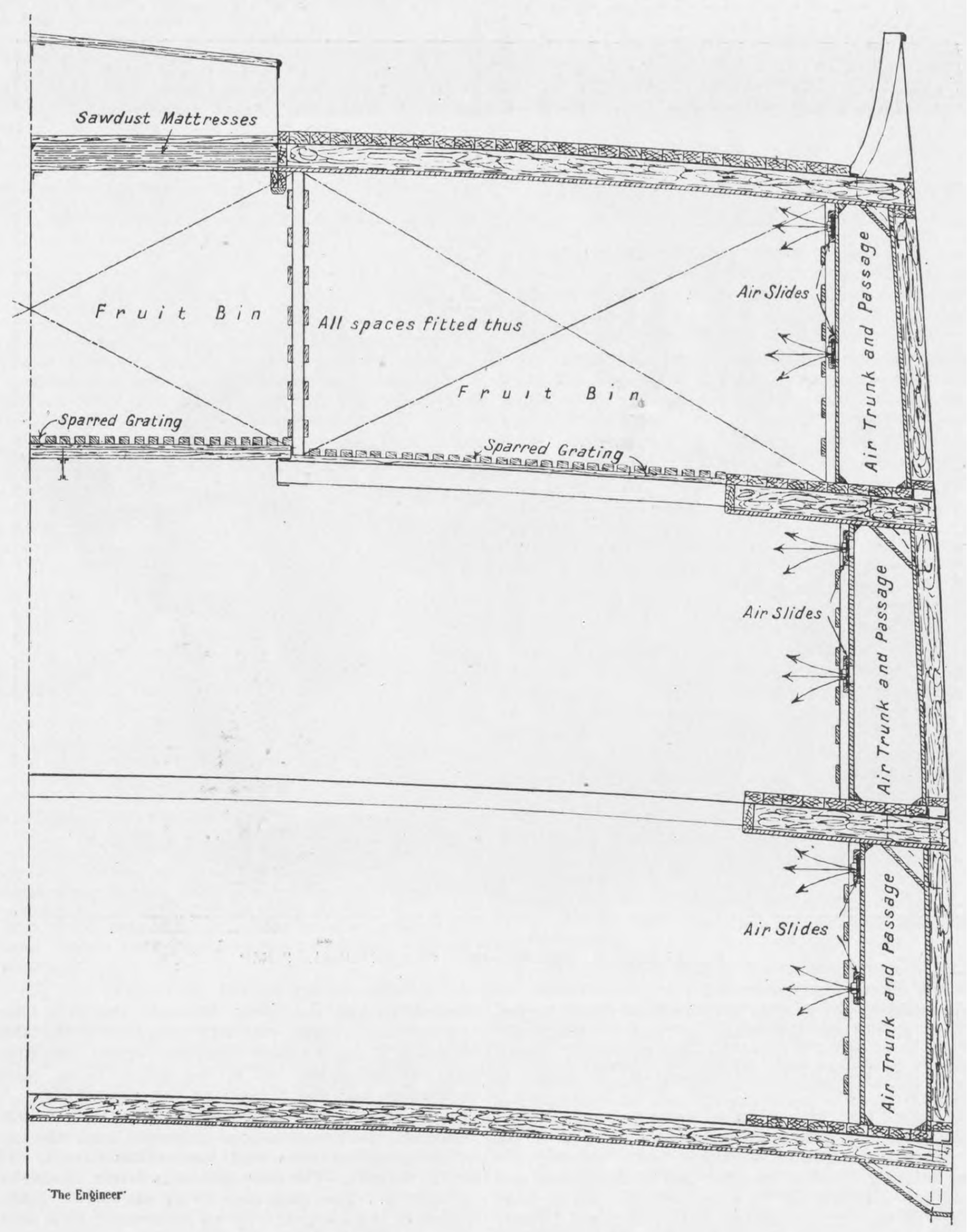


Fig. 3—SECTION THROUGH THE FRUIT SPACES

The brine in the grids is cooled on Hall's CO_2 system, the refrigerating machinery being situated in a large space at the aft end of the midship deck-house which is entered direct from the engine space. The machine shown in Fig. 5 is of the horizontal duplex pattern, driven by a compound surface-condensing steam engine working with steam at 120 lb. pressure. The copper CO_2 condenser coils are contained in the base, while the evaporator coils are placed in a separate D-shaped casing, the two halves of the machine being each a complete unit capable of working independently. The steam connections enable either cylinder to be worked as a simple engine with the halves of the crank shaft disconnected. The brine pumps, made by Mumfords of Colchester, are of the vertical duplex pattern, two in number, either of which is capable of performing the full duty on emergency. The machines and fans are run during the last day or so of the outward voyage to cool down the spaces in readiness to receive the fruit. During the first few days of the homeward voyage the cooling plant is operated continuously in order to extract the heat from the fruit and so retard ripening. The condition of the fruit is afterwards kept under close supervision, the temperature being read at regular intervals day and night. After a few days at sea the temperature will have been got well under control, and care has only to be taken that the fruit is not chilled. The refrigerating machine can then be slowed down, and perhaps one of the compressors may be disconnected, allowing just sufficient cooling to be effected to maintain an even temperature of 55 deg. Fah. All the fruit spaces are illuminated by electric incandescent lamps, but these are only used while the fruit is being handled, as the heat from them would injuriously effect the refrigeration. For inspection portable electric hand lamps are used. The fruit is stored without covering of any kind, the lowest bunches being arranged with stems vertical and the final layer placed horizontally, an arrangement which gives the best results both in utilising space and freedom from damage.

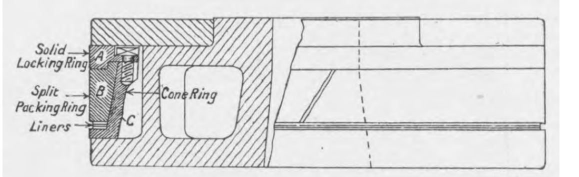


Fig. 4—PISTON OF AUXILIARY ENGINES

The main propelling engines were built by Messrs. Alex. Stephen and Son, and are capable of developing 3800 horse-power. On her trial, when loaded to below her normal trim, the engines propelled the Tortuguero at a speed of $14\frac{3}{4}$ knots. The engines are of the three-cylinder triple-expansion type, having cylinders 27in., 45in., and 75in. diameter, by 54in. stroke, and use steam at 190 lb. pressure per square inch. All excentric straps are of wrought iron, extra wide to ensure cool running, and are lined with Stone's white metal. The condenser has 5035 square feet of cooling surface, and is served by a 13in. circulating pump of the centrifugal type directly connected to two-crank compound engine. This pump and engine were supplied by W. H. Allen, Son, and Co., of Bedford, and are illustrated in Fig. 6 herewith. The casing is of cast iron, and is fitted with a gun-metal revolving disc 32in. diameter, the spindle being of bronze. The pump is provided with outside bearings and caps, the glands being water-sealed. The engine has cylinders 6in. and 10in.

diameter, by 6in. stroke. The cylinders and valve chests are cast together and securely bolted to two cast iron columns, which carry the guides for the crossheads. The lubrication is effected on the syphon gravity feed system from a central oil reservoir in front of the engine. The main feed pumps are of Weir's well-known make, two in number, with steam cylinders, 9in. and 12in. diameter, by 21in. stroke, having complete gun-metal water end buckets and manganese bronze rods. They are regulated from a float tank by automatic control gear. Working in conjunction with these is a Weir direct contact feed-water heater utilising the auxiliary exhausts, and suitable for dealing with the whole of the feed. An auxiliary donkey pump is also fitted, with steam cylinders 5½in. and 8in. diameter by 12in. stroke. This has a cast iron water end fitted with a gun-metal liner and bronze rod. The auxiliary condenser is of the Weir-Uniflux type, capable of dealing with 11,500 lb. of steam per hour at atmospheric pressure, with cooling water at 80 deg. Fah. The proportions of the condenser are based on Messrs. Weir's series of experiments on transmission rates, and the contour is arranged to secure the passage of the steam over the tube surface at uniform velocity. The evaporator is of the Weir vertical type, capable of producing 35 tons of fresh water per day, and is fitted with the firm's latest improved coupling device, enabling each coil to be taken out separately for cleaning, and alternatively enabling the door to be opened and steam turned on and a hose played on the tubes to crack off the scale. Hocking's feed-water filter is fitted between the main engine feed pump and the Weir heater to prevent the admission of oil to the boilers.

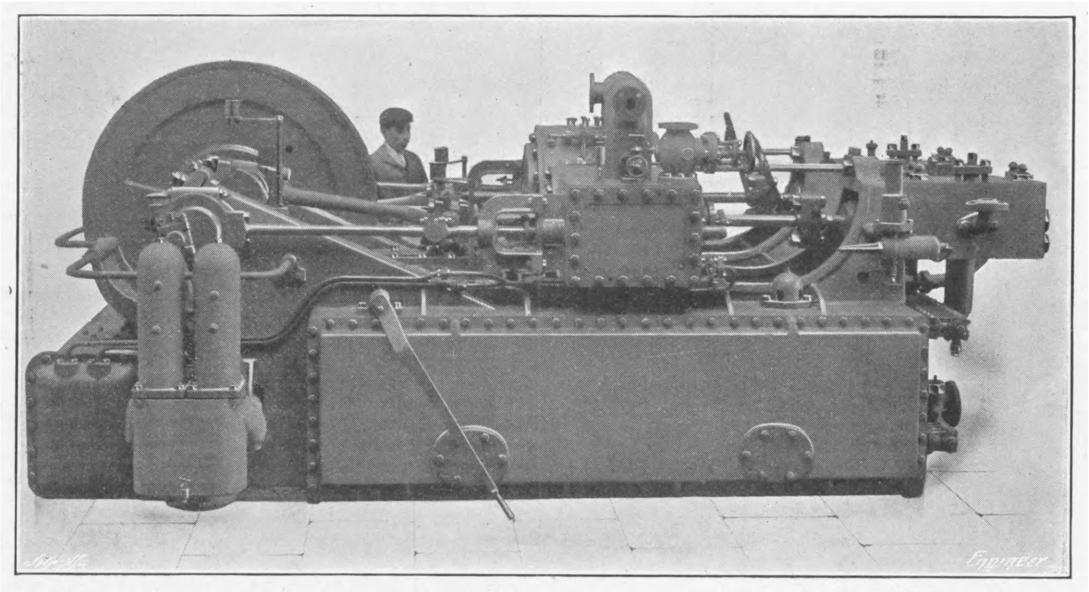


Fig. 5—REFRIGERATING MACHINE

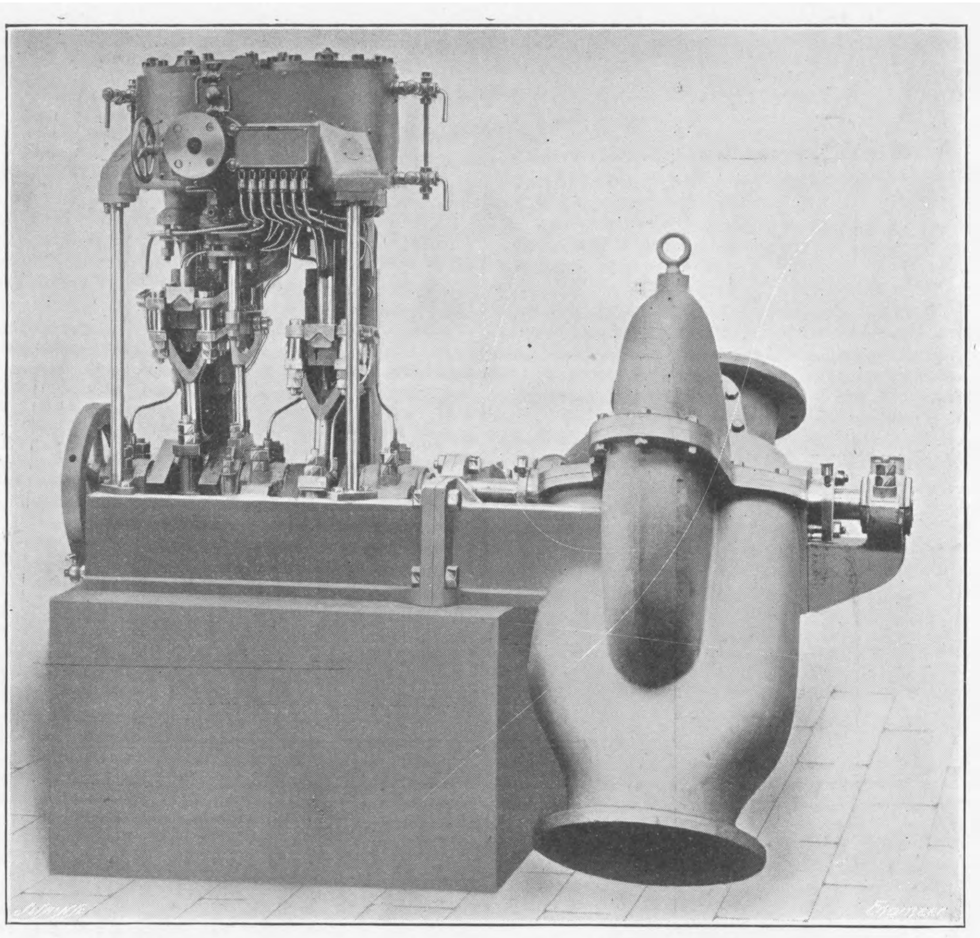


Fig. 6—STEAM ENGINE AND CENTRIFUGAL PUMP

The engines are fitted with Kerr's "anticipating" marine governor, of which we give an illustration in Fig. 2. This apparatus consists essentially of three parts, namely, an anticipating cylinder fitted in the after end of the tunnel and put in connection with the sea by a sea cock; a double relay cylinder fitted on the engine and having its piston-rod directly connected to the throttle valve lever; a battery of Leclanché cells, with the necessary wiring between the anticipating and relay cylinders. In addition to the anticipating governor, a small inertia governor, or emergency switch, driven from some reciprocating part of the engine is put in circuit, so that in the event of a shaft breakdown or the loss of the propeller this immediately completes the circuit and the relay cylinder piston closes the throttle, which remains closed until the engineer throws the switch out of gear. The operation of the apparatus will be better understood by reference to the diagram, Fig. 2. On the right-hand side is shown a seacock attached to the ship's skin, to which is bolted the anticipating cylinder A. The relay cylinder R is mounted on trunnions on some suitable form of bracket at the engine column, with its piston-rod connected directly to the throttle valve lever. P^3 is a pipe connection between the cylinder and the three-way cock on the condenser C^3. When this cock is closed to the condenser and open to the atmosphere the relay piston can be easily moved and the throttle valve operated by the hand lever in the ordinary way. All that is necessary when changing from automatic to hand throttling for manœuvring into and out of port, therefore, is to close the cock C^3. In the position shown in the diagram the relay cylinder piston is full in. The bottom is open to the condenser, the top to the atmosphere, and the throttle valve is full open. B is the battery and W the wiring between the anticipating and relay cylinders. Q^1, Q^2, Q^3 are hand switches which can be used for working the relay cylinder if required, so as to obviate the labour of working the throttle hand lever or to stop the engines quickly in case of accident. The operation of the whole system is as follows:—When the stern of the ship begins to rise the head of water above the piston of the anticipating cylinder A diminishes and the piston descends, throwing the anticipating switch D into gear and completing the circuit. The solenoid E immediately acts and brings the relay cylinder into operation, the top of the piston being opened to the condenser and the bottom to the atmosphere. The piston is thus driven out and closes the throttle. When the stern descends the pressure head increases, and the anticipating cylinder piston rises and breaks the circuit. The reverse action follows. The relay piston is driven in and the throttle is opened. The construction of the relay cylinder and the action of the solenoid will be understood by a perusal of the sectional drawing.

The electric light plant consists of two engines and dynamos constructed by W. H. Allen, Son and Co., Limited, Bedford. This plant is described on page 29.

The pistons of the auxiliary engines and the piston valves of the main engines are of Dearns' adjustable type, made by the Manchester Dry Docks Company, Trafford Park, Manchester. Sections of one of the valves and pistons are shown in Figs. 1 and 4. The makers claim that this piston possesses the advantages of the solid plug piston without introducing the disadvantage due to want of adjustment. It will be observed that although the rings A B C, in Fig. 4, are securely locked together, they are free to float and adapt themselves to the surfaces of the cylinder walls between the junk ring and the flange of the piston block. Adjustment of the split packing ring is provided by the liners shown between B and C. By removing these as required, and placing them between B and A, the ring can be expanded by being forced up the conical surface. In the case of the piston valve the lead may be regulated by the insertion of a liner or packing between the horizontal joint of the two halves.

The boilers are of the single-ended type, four in number, each 15ft. 3in. diameter by 11ft. 6in. long. They have each four furnaces, and are designed for a working pressure of 190 lb. per square inch. The boiler feed valves are of Hough's combined check and inside stop type, controlled on the system introduced by him. The valves so control the flow of the feed water, that the wear and tear of the valves, and the noise and danger of breakdowns between the feed pumps and boilers are completely removed. The chests are of an exceptionally substantial character. They have Deighton's patented furnaces, and are fitted with Howden's forced draught system, with non-clinkering slab bars. The fan is driven by a two-crank compound engine, with cylinders 6in. and 10in. diameter by 6in. stroke, and draws hot air from under the boilers, keeping a clean engine-room, and increasing the temperature of the air delivered for combustion. The combination of engine and fan is so arranged that either cylinder alone will suffice to drive the fan, if necessary. The boilers are fitted with Carson's patented smoke-box door. For removing the ashes from the boilers, MacTaggart, Scott, and Co.'s direct-acting steam and hydraulic ash hoist is used. This consists of a steam cylinder, with slide valve and casing, having steam and exhaust branches. The top end of the cylinder has a gland, stuffing-box, and neck ring bored to fit the ram which carries the crosshead. On the latter are mounted four rope pulleys, giving an 8 to 1 gear for the hoist. The ram is bored inside to fit a fixed hydraulic piston mounted on the piston-rod, which is attached to the air vessel on the top. This bored ram and piston form the hydraulic control, the water having to pass from one side of the piston to the other when the ram is raised or lowered by admitting or exhausting steam to and from the cylinder. A cut-off gear is attached to the crosshead to bring the hoist to rest at the top or bottom of the stroke. The hoist works very silently, and is particularly suitable on that account for passenger ships.

The steering gear is of the Wilson-Pirrie type made by Messrs. John Hastie and Co., Greenock, and is provided with all the latest improvements. The tiller is, as usual, keyed on the rudder stock, and the quadrant is free to move, and these are connected by strong spiral springs arranged so that they are always in compression. Extreme care is used in the manufacture of these buffers, the rods being fitted with brass bushes, leather pads being introduced between the metallic faces. The steering engine is of the vertical type, adjustable in every way, and is fitted with a double sole plate so that the pinion wheel may be put deeper into gear with the toothed quadrant. The vertical shaft of the worm wheel is also fixed on sliding bearings, so that this wheel may be put further into gear with the worm in case wear takes place. The worm wheel has a bronze rim of a special mixture to reduce wear. The teeth are lubricated by means of an oil pump, and the engine is controlled both by a telemotor on the bridge and mechanically by a steering standard on the poop.

The construction of the ship has been carried out under the supervision of Captain F. Bartlett, the marine superintendent to Elders and Fyffe's, Limited; while the installation of the engines and machinery has been under the direct guidance and supervision of Mr. A. W. Prim, the superintending engineer to the line.

NAVAL ENGINEER APPOINTMENTS.

THE following appointments have been made by the Admiralty:—

Engineer-Commanders.—H. Hawkins, to the Terrible, additional, for the Renown; H. Bone, to the Natal; W. R. Parsons, to the Victory, additional, for the Neptune, and to assist on the Staff of Admiral Superintendent of District.

Engineer-Lieutenants.—H. F. Pocock, to the Pembroke, supernumerary, and lent the Eclipse, temporarily, for the manœuvres; E. J. Allen, to the Tamar, additional, for charge of stores and duty with t.-b.'s, and to assist the Engineer Commander. R. Tindal-Carill-Worsley, to the Saracen; E. J. Allen, to the King Alfred, for study of Japanese, are cancelled.

Sub-Lieutenants.—D. R. Macdonald, to the Irresistible; H. P. Mead, to the Blake, additional, for the Kale; R. D. Binney, to the Blake, additional, for the Itchen; E. R. M. Geake, to the Albemarle; W. W. Skynner, to the Albemarle; H. G. M. Hill, to the Lancaster; C. S. Sandford, to the Bacchante; F. P. O. Bridgeman, to the Bedford; J. N. Pelly, to the Kent; the Hon. Humphrey A. Pakington, to the Swiftsure.

JUNIOR INSTITUTION OF ENGINEERS.—A large number of members, accompanied by ladies, availed themselves of the invitation kindly extended to the Institution by the directors of the Menpes Printing Company to visit their well-known colour-printing works at Watford on a recent Saturday afternoon, the machinery, &c., being kept running for their benefit. The works are situated between Watford Junction and Croxley Green, quite close to the Grand Junction Canal, and on the borders of Cassiobury Park. The building is of a modern structure, and composed of the ground floor only, with north lights, to obtain the full advantage of daylight, which is one of the chief factors in good colour printing. The departments of the building comprise a spacious machine-room, containing twenty of the latest Miehle presses and twenty-five Colt platens. The composing and folding departments—giving ample room to meet sudden pressures of work—are situated on the south and north side of the machine-room respectively. The photo-engraving department and studio, where the three and four-colour blocks are made, is situated in an annexe to the main building, and comprise a most modern plant, including a powerful search-light and a recently invented etching machine. The work turned out from this department is some of the finest produced in England. As the party were conducted over each department of the works, many fine examples of the company's productions were examined with great interest, and the circumstance was recalled that Messrs. A. and G. Black's reproductions of the old masters were engraved and printed by this firm.

RAILWAY MATTERS.

According to the *Engineering Record*, electric freight locomotives have been ordered by the New York, New Haven and Hatford Railroad for trial on its main line.

A project has been submitted to the Chilian Government by Don Roberto von Braun to convert the No. 1 section of the State Railways to electric traction, and a Special Commission has been appointed to consider and report upon the scheme.

The *Sole* (Milan) of 20th June notifies that plans have been prepared in connection with the construction of the Montallegno-Siculiana branch line of railway, which will form part of the Sicilian complementary railways system. The new branch will be eight miles long, and the cost of construction is estimated at 2,010,000 lire (£80,400).

The *Gaceta de Madrid* of 21st June notifies that Mr. Juan H. Cresswell, on behalf of the Compañia Anónima de Ferrocarriles Secundarios, has applied to the Dirección General de Obras Públicas, Madrid, for a concession for the construction and working of a railway from Moguer to Rabida, and that a period of 60 days from the date of the *Gaceta* is allowed for the presentation of competing offers at the above-mentioned Dirección.

Rail failures in New York State, exclusive of New York City, totalled 1829 in the four months from December, 1908, to March, 1909, inclusive, as against 3917 for the same months in the previous year. The data, furnished by fifty-four steam roads to the Public Service Commission of the Second District, show failures on thirty-two roads during the latter period, four causing accidents to freight, but none to passenger trains. Of the total failures seventy-five were in open-hearth rails.

Automatic block signals now stretch from the Atlantic to the Pacific Ocean, except for short distances aggregating a total of 127 miles, according to the *Railroad Age Gazette*. Of the distance unprotected by this system, 94·3 miles on the Southern Pacific, in the Sierra Nevada Mountains, use the electric train staff, and the next longest gap in the automatic system is 20 miles, due to a proposed change in line. The remaining distance is made up of four parts, on bridges and where changes are in progress. The line thus blocked runs from Jersey City on the east to Oakland, Cal., on the west, a total of 3245 miles, including the Lehigh Valley Railway, from Jersey City to Buffalo, the Lake Shore and Michigan Southern Railway to Chicago, the Chicago and North-Western Railway to Council Bluffs, the Union Pacific Railroad to Ogden, and the Southern Pacific to Oakland.

The Midland Company announces that the opening of the new line between Royston and Thornhill this month will bring about the introduction of a service of corridor expresses to and from Sheffield, and will place Huddersfield, Halifax, and the surrounding towns in direct communication with the system, besides providing an alternative route from Bradford. Three expresses in each direction have been arranged between Bradford and Sheffield in direct connection with trains from the South and West of England. Through corridor carriages are to run from Bradford to London and Bournemouth *viâ* Bath, Huddersfield to London, Bradford to Sheffield, Halifax to Bristol, and Halifax to London. In the opposite direction through connections are to be given from St. Pancras and from Bristol and Bournemouth *viâ* Bath.

The preliminary arrangements in connection with the Tientsin-P'uk'ou Railway, states a consular report, have been progressing steadily during 1908. Not only have the surveys been completed in this province, but nearly all the land required has been purchased between Chinan and the Shan-tung-Chihli border, while the embankment has already been thrown up between Chinan and Lok'ou, on the Yellow River. Work on the most important piece of engineering on the line—the Yellow River bridge—which is in the hands of the Nürnberger Bridge Building Company, is also being taken in hand. The total length of the bridge, with approaches, will be about 2 kiloms.; in the river bed itself there will be four iron supports, making five spans across the river, in addition to which there are to be seventeen culverts of an average width of 70 m. to 80 m. South of Chinan work has not yet begun, but the engineers have been carefully surveying the line of route, and work is to be taken in hand in the spring.

The new station which has been constructed by the Great Western Railway Company at Moor-street as part of its great scheme of improvements in Birmingham was opened as a terminus for passenger and parcel traffic on the 1st inst. Twenty-one motor trains and twelve ordinary trains will run into and depart from the station daily except on Sundays, the service being designed for the convenience of passengers for places south of Birmingham. The motor service on the new North Warwickshire line will terminate at Moor-street on ordinary days, but on Sundays these trains will run into Snow Hill as at present. It is not intended that the opening of the new station shall reduce the services to and from Snow Hill. The station has not yet been completed, the waiting-rooms and booking-office at present constructed being of a temporary character. They will be replaced by masonry buildings. The terminus will be lighted throughout by electricity, and will be similar to the stations at Acock's Green and Tyseley. Ultimately there will be four platforms, each about 600ft. long.

What is said to be a record achievement in the movement of a heavy freight train has been accomplished on the Pennsylvania Railway between Altoono and Encola, near Harrisburg, Pa. To determine what could be done in actual road service, as the result of some of the company's recent expenditure for improvements, 85 steel gondola cars, loaded with a total of 4451 tons of coal, were on June 14th attached to a freight engine of the most improved type. The total weight of the train was 6151 tons, and its length from the pilot of the locomotive to the rear platform of the cabin car was 3000ft.—nearly three-fifths of a mile. The run of approximately 124 miles was made in 7 hours 15 minutes, the average speed of the train being about 17 miles per hour. The company had made a number of road tests previously, but this performance surpassed all others. These runs were made possible by the fact that the company has now reduced all gradients and compensated all curves on the middle division of its main line between New York and Pittsburg, so that the ruling gradient there is less than 12ft. to the mile. Formerly it was necessary to have a "pusher," or extra locomotive, to assist long freight trains over the heavy gradients. Now it is possible for single locomotives un aided to accomplish these record results.

It is only within very recent years that the London County Council would entertain the idea of adopting the trolley wire. Only a few examples of the latter system have been put into use, and the latest of these is the Putney to Hammersmith line. It is 2¼ miles long, and is practically level all the way. Regarding the disposition of the track, the only special feature is that on Putney Bridge, where the carriage-way is somewhat narrow, and each track has been placed close to the respective footpaths. The near rail is 2ft. 6in. from the kerb, and the space between tracks, centre to centre, is 15ft. The line is fed from a sub-station in Great Church-lane, two low-tension, single-core, lead-covered, paper-insulated cables being employed. The sub-station itself is no less than ten miles distant from the Council's generating station at Greenwich, and the system presents at present the longest transmission in connection with the London tramways. The pressure of the three-phase alternating current generated at Greenwich is 6500 volts, and in the transmission to Hammersmith there is a drop of about 400 volts, or 6 per cent. The sub-station contains three motor generators. Two are of 500 kilowatts each, and one of 150 kilowatts, the latter being used chiefly as a starter for the larger machines.

NOTES AND MEMORANDA.

Metallic chromium, states *The Brass World*, is now a commercial article, and can readily be obtained of high purity and at a reasonable price. As far as known, it has not yet become a constituent of the non-ferrous alloys, although it has long been used in making very hard and tough steels.

The making of tin-plates originated in Bohemia, according to a recent paper by William E. Gray, hammered iron plates having been coated with tin in that country some time before the year 1600. Tin-plate making was introduced in England in 1665, the art being brought there from Saxony. In France the first tin-plate factory was established in 1714. The first commercial manufacture of tin-plates in the United States was at Pittsburg, in 1872.

Fresh discoveries of asbestos have been made upon the property of the South Urals Asbestos Company in the Orsk district. The average content in asbestos of one deposit is 15 per cent. At times it reaches as high as 80 per cent., in point of quality resembling chrysolite, and being very soft and woolly. The fibre is strong, while the colour in lumps is olive green, but the single staple appears to be pure white. A second deposit presents similar conditions and wealth of content.

Transfusion of particles of different kinds of metals through the agency of electrical current has been held by some to take place just the same as in the case of electrolytes upon which action electro-plating depends. To prove or disprove this contention an experiment was carried out on a product composed of aluminium and copper, firmly welded, through which an electrical current was passed continually for one year. After the two parts were separated it was found that neither metal contained any particles or traces of each other.

Seismometers, or seismographs, as they are more generally termed, are instruments for detecting or measuring the earthquake shock or wave. Some of the modern ones are extremely delicate and sensitive, so sensitive, in fact, according to Milne, that if the solid column of masonry communicating with the rocky floor be pressed with the hand, the seismograph which rests on the masonry will be affected, and the horizontal boom or pendulum will be set in rapid vibration. If two Milne seismographs provided with horizontal pendulums be put on high buildings opposite each other on one of London's traffic streets when crowded with heavy drays, they will show that the tops of the buildings bend over slightly towards each other.

Silesia this year celebrates its zinc centenary. The first zinc furnace (very primitive) in that country was constructed in 1798, but it was only with improved reduction furnaces in 1809 that zinc could be obtained direct from the calamine. The production that year made 122 tons; it was 1000 tons in 1816, and 12,167 tons in 1825; thereafter 40,354 tons were recorded for 1860, 65,663 tons for 1880, and 102,213 tons for 1900. Last year (1908) the production was 141,461 tons, of the value of 55,000,000 marks. If we add the Rhineland and Westphalia production, the German total last year reached 216,000 tons, which gives her the premier position again, which the United States took up in 1907. Silesia exports 32 per cent. of her zinc to Austria-Hungary, Great Britain, Russia, Italy, France, Denmark, Sweden, the British Indies, China, Japan, Canada, and the United States.

The Marine Department of the Board of Trade has just issued an important circular relative to the tests of steel material in the case where copies of the results of tests witnessed by the surveyor are required. The circular states that the tensile and bending samples should, in all cases, be selected by the surveyor, and, before the test samples are cut from the article to be tested, whether plate, bar, forging or casting, the surveyor should see that such article and the test samples are stamped with the makers' identification number and with the surveyor's initial stamp. Any heat treatment adopted should be applied simultaneously to both the article and the test pieces. When plates are of such size that tests are required from each end, the samples should be taken strictly from the parts named. The tensile and cold bending samples should be tested in the condition—normal, annealed, or otherwise heat-treated—in which the plates, bars, forgings, or castings are delivered from the makers' works, and the makers should be required to certify to this.

During the five months ending May 31st Great Britain exported iron and steel and manufactures thereof to the value of nearly fifteen and a-quarter millions; other metals, over three and a-quarter millions; cutlery, hardware, &c, over two millions; machinery, over eleven and a-half millions; and ships over two and three-quarter millions. Our exports of iron and steel and manufactures thereof for May amounted to £3,140,187; of other metals to £659,533; of cutlery, hardware, &c., to £429,071; of machinery to £2,415,312; and of ships to £418,846. The total British exports for May amounted to £29,525,746. The total value of exports from the United Kingdom during the five months ended May 31st was £147,216,375. The exports of all classes of textile machinery from Germany have, almost without exception, decreased very considerably since 1907. The exceptions were only fine-spinning, lace-making, and washing machinery. England's share of Egypt's imports during April amounted to 35 per cent., against 33.3 per cent. for March, and 31 per cent. in February.

In a paper read before the American Institute of Electrical Engineers by Mr. Stott on the cost of power, a number of curves are given for the cost of power at the bus-bars per kilowatt-hour for reciprocating steam plant, steam-turbine plant, reciprocating engine combined with low-pressure turbine plant, gas engine, gas engine and steam turbine, and hydraulic plant. The ordinates of the curves are in "mills" per kilowatt-hour [presumably a mill is a thousandth of a dollar], and the ordinates the percentage load given to 150 per cent., or 50 per cent. overload. One curve is given for fixed charges, and two for coal and water, and also for total operating charges. In addition there are other curves given connecting cost per kilowatt-hour with the time by the clock both for winter and summer lighting loads, and railway loads. It must, however, be remembered that many of the items of cost are very indeterminate, such as foundations, cost of labour, &c., so that the curves in this paper are given with the idea that they may form a guide to show at least the fundamental relations between the various items going to make up the cost of power, and at the same time show what is actually being done at the present time in large plants having a maximum load of over 30,000 kilowatts.

The folly of subjecting hollow metal articles to the action of heat without first carefully ascertaining that they contain no water, states the *Vulcan*, is again illustrated in the case of an explosion which recently occurred at a railway works at Ludgershall. In this case the piston had been removed from a locomotive in order to put in a new piston-rod. To do this it was necessary to take off the piston head. This could not be done cold, so it was placed near a fire on the forge in order to warm it. After being in this position about eight minutes the piston head exploded, with the result that three men were injured by the flying fragments, one so severely that he subsequently died. The piston head, which was constructed of cast iron, was 13in. diameter by 4in. thick, and there was a cavity in the head on either side of the rod. At the inquest which was subsequently held, a foreman fitter employed at the works stated that "it was the usual thing when taking off the head of a piston to warm it at the fire." Such a proceeding is a dangerous one, as is evident from the results in the present case. All hollow metal articles that have to be heated should have one or more holes drilled in them so as to allow of any water being drained away. The adoption of this simple precaution would have prevented many similar accidents.

MISCELLANEA.

There are ninety-one motor cars licensed in Corunna, Spain, of which seventy-five are French, and almost all the rest Italian and German. Cars for this district must be good hill-climbers.

Re-foresting experiments will be made by the United States Forest Service on several thousand acres of land in Washington, formerly covered with Douglas fir, but burned over in 1890, 1896 and 1906.

It is reported from France that it is proposed to manufacture fuel from peat under a new patented process in the peaty district on the borders of the Charente Inférieure and Deux Sèvres Departments. The fuel produced experimentally is said to be of good quality.

China is showing much interest in mining affairs, according to the *Far Eastern Review*. The Government at Peking has directed the Governor of Chinese Turkestan to investigate and report on the copper deposits of Kucha and Paichang, with a view to developing them along modern lines.

Something like a record has been made in the life of accumulators in the case of an accumulator fitted to a car supplied seven years ago. A report is to hand, states the *Autocar*, to the effect that the car is still in daily use, although it has covered over 86,000 to 90,000 miles, and nothing whatever has been done to the accumulator beyond charging it.

At a meeting of the City Lighting Committee of Newcastle Corporation last Tuesday the report of the deputation appointed to visit towns where an automatic system for lighting and extinguishing public gas lamps was in operation was further considered. It was agreed to recommend that a trial of 250 controllers be made as an experiment.

According to the *Review of the River Plate* (Buenos Aires) of 28th May, plans have been prepared, and approved by the Uruguayan Government, for the establishment of a State telephone service for the Department of Montevideo, and the Government have placed a Bill before Congress authorising the expenditure on the work of 1,500,000 dols. (about £320,000).

The Admiralty have decided that in future engineer-lieutenants are not to be allowed to present themselves for examination for advancement to the senior list until they have completed four years' service as engineer-lieutenant and have had three years' watch-keeping service as engineer-lieutenant and engineer sub-lieutenant on board seagoing ships in commission.

A new paper mill has been started at Chinan in the buildings formerly occupied by the Mint. The machinery, which was supplied by a German firm, at a contract price of 110,000 taels, is said to have a possible output of 4000 catties (5333 lb.) per working day of twelve hours. The materials used in the manufacture of the paper include rags, wheat, and paddy straw, cotton waste, hemp, and jute. The mill is to be in working order very shortly.

The Chungking Electric Light Company, a Chinese company, started operations on a small scale in June, 1908. It is running 220 lamps of 16 candle-power each, and the dynamo is driven by a 5in. belt from a small vertical engine of about 22 horse-power. The company is now considering tenders from various firms for the erection of a big plant to light the whole city, and a piece of ground has been bought outside the Tai Ping Men on which to erect the plant.

The German official statistics of strikes and lock-outs for April show that the number of labour disputes terminated in Germany in 1908 was 1524 (1347 strikes and 177 lock-outs). Compared with 1907 there was a decrease of 988, or 39.3 per cent., the strikes in that year numbering 2266, and the lock-outs 246. The decline in the number of workpeople affected by disputes was even more marked, the figures having fallen from 286,016 in 1907 to 119,781 in 1908, or by 58.1 per cent.

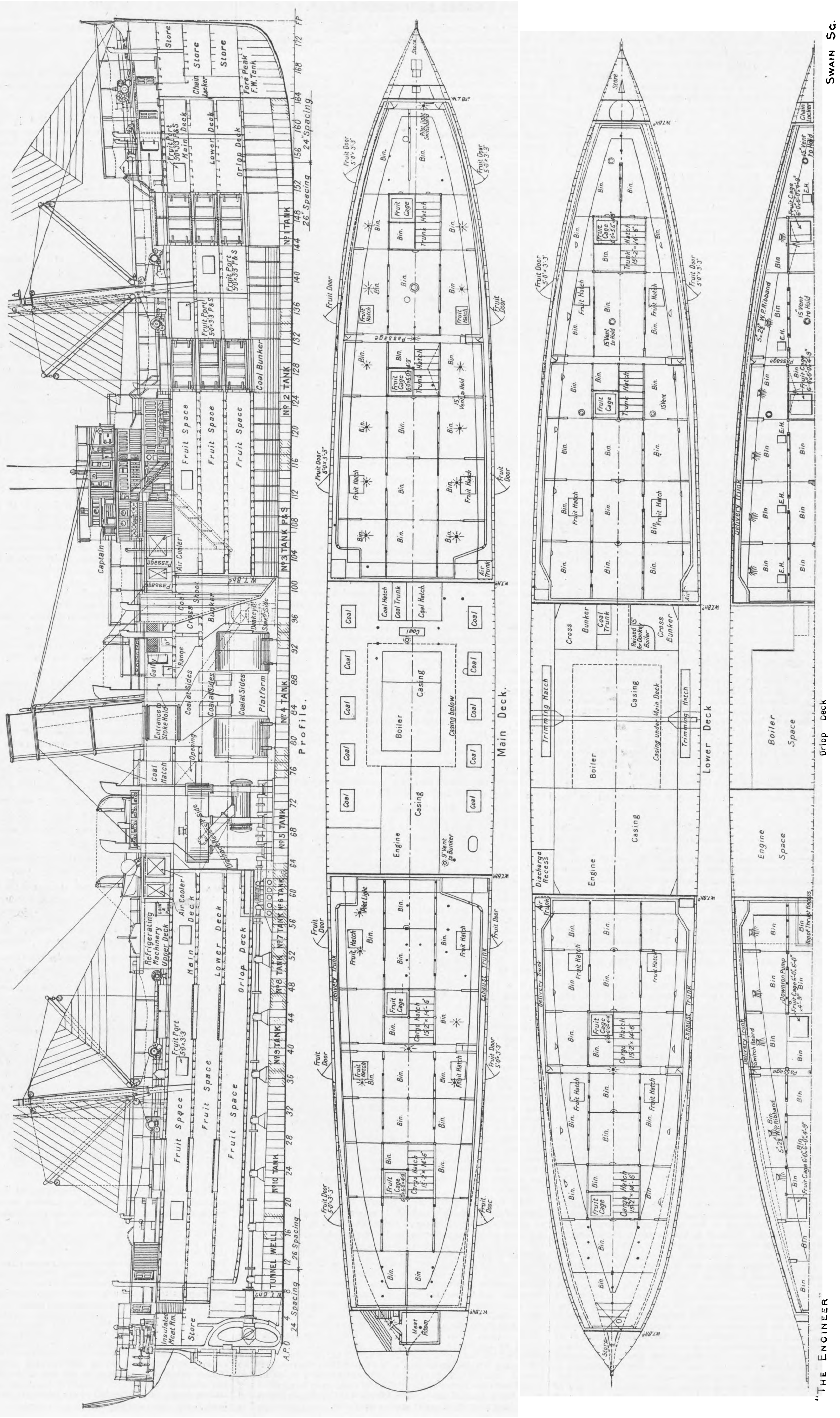
Mr. S. E. Fedden, electric engineer for the Sheffield Corporation, states that the electric lighting revenue of the city has fallen £4000 through the introduction of the new metallic filament lamps. New customers, he says, are wanted to make up for the loss on each change. In a few years it is expected that this loss will be recovered several times over through the greater use of electricity. The heads of the department, therefore, continue to press the advantages of the new lamp.

According to a consular report dealing with the trade of Tientsin, China, the value of machinery imported shows a fairly constant increase. This trade has hitherto been chiefly in the hands of German local firms, but the attention of many of the leading British firms in China is being increasingly drawn to the vast possibilities offered by modern developments to the expansion of this trade, and British manufacturers are also beginning to send their own agents to make inquiries on the spot, and thus bring themselves into closer touch with purchasers.

The tests that are in progress at Brant Rock, Mass., in connection with the project for erecting a 1000ft. tower somewhere in the vicinity of Washington or Annapolis for a wireless telegraph station will not be concluded for several months yet, and the whole project depends on the result of these tests. It is not entirely settled that any advantage would follow from the use of a tower of such great height, and unless the instruments adopted in the undertaking demand it, the cost of erecting a 1000ft. tower would be largely a waste.

It is reported that the Imperial Government have agreed to a scheme which cannot fail to be of the greatest importance in connection with British West Africa. The Colonial Office have sanctioned the formation of a special sanitary branch of the British West Africa Medical Service, the basis of the scheme being that special sanitary officers will be appointed in each West African colony, whose duties will be exclusively confined to questions of sanitation, which are of vital consequence to the well-being and development of that part of the Empire. In the opinion of those best qualified to judge, the new scheme will revolutionise the whole health conditions of British West Africa, and should accomplish there what Americans have achieved first in Cuba and since in Panama.

The United States Navy Department has ordered the establishment of yearly steaming contests between battleships, armoured cruisers, destroyers, and torpedo-boats. Owing to the varied duty, steaming under widely different conditions, with different grades of coal, and the lack of sufficient data to place other vessels of the service on an equal basis for competition, only these classes of vessels will enter into the first competition. Standards for the different classes of vessels have been established from experience gained in the past; and, while certain ships may be favoured in some instances, every effort will be exerted by the department to adopt such measures in improving the machinery where demonstrated to be necessary in order to even conditions. The winning vessels will receive suitable trophies, which will be carried for the following year in some conspicuous place, and the name of the vessel with the year she won it will be inscribed on each trophy. The commanding officers and engineer officers of the winning vessels will receive commendatory letters from the department, copies of which will be filed with their records. Money prizes will be given to the men of the engineers' force of the winning vessels, but no man not actively engaged on his station during one of the full power trials will be entitled to prize money.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Lower Deck
Orlop Deck
Fruit Space
Coal Bunker
Boiler
Casing
Engine
Boiler Space
Engine Space
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Air Cooler
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Cargo Hatch
Fruit Hatch
Fruit Door
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(For description see page 30)

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☞ *We cannot undertake to return drawings or manuscripts; we must, therefore, request correspondents to keep copies.*

REPLIES.

E. and A. L. and Co.—The filter you inquire about is made in the United States. The representative in this country is Mr. John Brett, 8, Lendal, York.

MEETINGS NEXT WEEK.

The Junior Institution of Engineers.—Saturday, July 17th, at 10 a.m. Visit the Ordnance Engineering Works of Vickers, Sons, and Maxim, Limited, at Erith.

THE ENGINEER.

JULY 9, 1909.

The Newport Disaster.

The terrible disaster which occurred on Friday last on the South Dock extension works at Newport is one of the most serious in the annals of public works construction in this country in recent times. On the evening of the 2nd July, immediately before the day gang was to cease work and make way for the night shift, the timbering of a deep trench, which had been excavated for the foundations of the external north-west wing wall of the new lock, suddenly collapsed, the majority of the men engaged in the excavation at the time being buried under the *débris* of the timbering and hundreds of tons of soil.

The new lock, which has been under construction for nearly two years, will, when completed, be the largest in the Bristol Channel, and one of the largest in the world. Its length is 1000ft. and the breadth 100ft. The entrance sill is 7ft. below low water of spring tides, 16ft. below low water of neap tides, and there will be 45ft. of water over the sill at high water of ordinary spring tides. The Channel entrance to the lock is to be flanked by two wing walls, which are intended to act as retaining walls at the ends of the pitched embankments which surround the reclaimed area upon which the dock extension is being constructed. The wing walls are stepped down from the lock head towards the Channel, following the slope of the face of the embankment, to which they act as terminals. Thus at the inner or lock end the wings will be over 70ft. in depth from coping to foundation, while at their toe or channel ends the depth is decreased to about 25ft. In extension of the concrete wing walls two timber jetties will extend seawards, forming a bell-mouthed approach from the deep water channel at the mouth of the river Usk. For the purpose of constructing the lock entrance and the wing walls, a temporary tipped embankment, crescent-shaped in plan, with its convex face seaward, has been constructed on the foreshore outside the site of the works. The entire site is covered with a thick deposit of treacherous mud, under which is a bed of sandy gravel and silt, which itself covers the hard marl rock forming the foundation to which all the walls in the new work have been carried. To ensure the safety of the temporary dam or embankment, the contractors—Messrs. Easton Gibb and Son—dredged away the overlying mud and silt on the site of the dam, and deposited the tipped material upon the gravel substratum. The dam, although not absolutely water-tight, has served its purpose, and does not appear to have had any immediate connection with the failure of the wing wall trench. The excavation of the foundations has been a matter of considerable difficulty throughout the course of the work. Difficulties in this connection were anticipated from the beginning, both by the engineers—Sir John Wolfe Barry and Partners—and the contractors, and we believe, monolithic construction was at one time suggested as an alternative to concrete in trench work for certain portions of the walls. The trench in which the disaster occurred had been excavated for the foundations of the whole of the north-west wing wall and a portion of the lock wall. The maximum depth of the trench was about 60ft., and its width on the site of the wing wall over 20ft. The portion intended for the lock wall was wider. The timbering was exceptionally heavy, 13in. and 14in. square pitch pine baulks being used for the piling which formed the side walls of the trench. These were strutted from top to bottom by 11in. and 12in. square timbers. The excavation had been carried down to the marl rock, and the bottom had been cleared ready for concreting. In fact, the resident engineer and the contractor's engineer had only inspected the work preparatory to the commencement of the concreting operations when the failure took place. Between sixty and seventy men were engaged at the bottom when, without any warning, the timbering appears to have lifted bodily, and the sides of the trench caved in, carrying away the crane and wagon roads over and alongside the work, and precipitating them into the excavation. About twenty of the men managed to get clear, and others were extricated from among the *débris*, some of them badly injured. It is believed that at least thirty men lost their lives. Rescue operations were immediately commenced, and carried on with the utmost vigour throughout the night of Friday, and all day on Saturday. Unfortunately, however, the pumping plant, which had been in use up to the time of the disaster for the purpose of keeping the excavation free from water, was completely wrecked, and it was found impossible to rig up a temporary connection with the sump. The flooding of the trench was therefore only a matter of hours, and any men who may have been imprisoned alive at the bottom, beyond the reach of the rescue parties, must have been drowned before Saturday had passed. Several of the men engaged in the trench appear to have had marvellous escapes, and the sad story is brightened by the splendid heroism of more than one of the rescuers.

The immediate cause of the disaster is a matter of doubt. In the absence of complete technical evidence, such as will certainly be presented at the Home-office inquiry which will be held, it is almost useless to surmise. The material in which the excavation had been made is undoubtedly treacherous, and the timbering must have been exposed to a considerable head of water. It is noteworthy that the accident occurred about the time of high water, and on the approach of spring tides, when the tidal range at Newport often exceeds 38ft. The failure does not appear, so far as the evidence goes at present, to have been due immediately to the collapse of the cross timbering and strutting, and the sudden lifting of the side timbering would seem to point to a very considerable upward thrust from the surrounding strata. It is very easy to be wise after the event, and the thought which is likely to occur to many engineers in view of the accident is regret that monolithic construction was not adopted in place of open trench work. Anyone who has visited the site of the dock works since the outer embankment was constructed must have been impressed with the difficulties which have faced the engineers and contractors. Portions of the embankments have slipped again and again; thousands of tons of embankment material have disappeared beneath the vast expanse of slimy mud visible at low tide, and rail tracks originally straight and fairly level have rapidly become serpentine in form.

Accidents such as that at Newport are happily not common occurrences in this country; but within the last four years there have been two other serious disasters of a somewhat similar character, although differing in material respects. One of these—the failure of the cofferdam at the Vittoria Dock, Birkenhead, on March 6th of this year—resulted in the loss of fourteen lives. The other disaster we refer to is the collapse, in October, 1905, of the wall separating the new graving dock works at Belfast from the old Alexandra Dock, which has delayed the completion of the new dock by over two years, but was, fortunately, unattended by loss of life. How far the Newport disaster will delay the completion of the new entrance lock is uncertain, but it is hardly likely that more than a few months will be lost.

Population and Unemployment.

In his second article on unemployment in the *Contemporary Review* Mr. H. Stanley Jevons gives us a new cure for unemployment:—(1) Unemployment is due to the increase of unskilled labour; (2) the increase of unskilled labour is due to the fact that workpeople have large families; (3) workpeople have large families because their standard of life is low; (4) their standard of life is low because their wages are small; (5) hence to decrease unemployment in unskilled trades you must raise the standard of life. That is to be effected according to Mr. Jevons by improving education so as to give workpeople more refinement; give them, as old-fashioned people would have said, "ideas above their station," and the result will be that in order to be able to meet the expenses of a reformed life they will have smaller families. This we believe to be an accurate statement in brief of Mr. Jevons' ingenious argument. But there is obviously an alternative. If instead of the remedy given by him, viz., refined education, we put increased pay, which is clearly a correct deduction from step 4, we arrive at the result that in order to limit families—and hence unemployment—we must increase the pay of the worker! That deduction was avoided by the author because it would have clashed with the next section of his essay, which is directed to show that trades unions by increasing the rate of wages have decreased employment. If we read this second part in conjunction with the first, it becomes evident that Mr. Stanley Jevons' belief is that since, if the general welfare of the country is to be preserved wages cannot be increased, the alternative is to encourage the wage earner, or at least the unskilled labourer, to enlarge his tastes, as he will then spend more on refinements and luxuries and will be unable to afford large families.

We are here presented with an industrial problem which is as fascinating as it is difficult. It has been held for many years that the cost of labour is settled by supply and demand—just as the cost of any other commodity is settled. Buckle expressed this view as clearly and concisely as anyone, and a quotation from his pages will not be amiss "It is evident," he writes, "that wages being the price paid for labour, the rate of wages must, like the price of all other commodities, vary according to the changes in the market. If the supply of labourers outstrips the demand, wages will fall; if the demand exceeds the supply, they will rise. Supposing, therefore, that in any country there is a given amount of wealth to be divided between employers and workmen, every increase in the number of the workmen will tend to lessen the average reward each can receive. And if we set aside those disturbing causes by which all general views are affected, it will be found that, in the long run, the question of wages is a question of population; for although the total sum of the wages actually paid depends upon the largeness of the fund from which they are drawn, still the amount of wages received by each man must diminish as the claimants increase, unless, owing to other circumstances, the fund should so advance as to keep pace with the greater demands made upon it." Buckle wrote many years ago, and many things that affect the conditions of labour have occurred since his time; but, nevertheless, the general terms of the paragraph just quoted cannot be challenged. In every branch of business, trade, or profession the competition for the lower positions is so great that remuneration tends to get continually less. In organised trades this tendency is checked by concerted action, but in unorganised trades, in professions, and in sweated trades it is more active to-day than it was fifty years ago. The kernel of Buckle's argument is that "the question of wages is a question of population," and with this view Mr. Stanley Jevons appears to agree; but it must be observed that his plan defeats the object in view, for if by increasing the refinement of workpeople we give them tastes for luxuries, with the result that the size of families decreases, then the number of labourers must become less and less, and, according to Buckle's hypothesis, wages must rise, which, according to Mr. Jevons, would result in increased unemployment. We are, then, on the horns of a dilemma. If families decrease, wages will rise—Buckle. If wages rise, unemployment will increase—Jevons. What course are we to take? Shall we give our workpeople tastes for good music, good pictures, and refined surroundings and decrease their families, ultimately increase wages, and so ruin the country; or shall we discourage all attempts at refinement, advocate large families, and so lower wages and increase employment? These are alternatives for philosophers to discuss, and we shall not attempt to select the better plan. The argument, however, may be carried a step further with interest and amusement, if with comparatively little profit. Turning again to Buckle, we find two valuable observations. Discussing the miserable conditions of the Irish he wrote, "The most active cause, however, was that their wages were so low as to debar them, not only from the comforts, but from the decencies of civilised life; and this evil condition was the natural result of the cheap and abundant food, which encouraged the people to so rapid an increase that the labour market was continually gorged." And again, "We shall see that other things remaining equal, the food of the people determines the increase of their numbers and the increase of their numbers determines the ratio of wages." Need we commend these passages to disputants on tariff reform? Do they not make it clear that cheap food is after all a curse in disguise, ultimately leading to a congested labour market and low wages, whereas dear food means smaller families and higher pay?"

Conjectures and discussions of the sort in which Mr. Stanley Jevons is indulging are interesting and entertaining enough, but the cure they offer for unemployment is too distant and problematical—as we have shown—to be of any material service to the present generation. There is only one cure for unemployment, as we have said over and over again, and that is more work. We may wear out endless nibs and talk ourselves hoarse over the theories of labour, and we shall get no nearer settling the difficulty. What is needed is practical politics by practical men. So far unemployment is not a chronic complaint, and there are reasons for believing that it never will be. It is a remittent fever which comes to certain trades at certain seasons, and to all trades in some years. Seasonal variations, as for example in the building trades, might be met partly by better organisation and improved methods. Cyclical variations affecting the whole trade of a country, the waves of depression which sweep over the whole industrial world every ten to twelve years, can be dealt with only by high politics. The individual can do but little to prevent them; to stop the swing of the great trade pendulum is beyond the power of any one man. A Government alone could hope to effect it.

Underground Electric Railways.

It is a remarkable fact that although London was the first capital in the world to proceed with the construction of underground electric railways, the latter have so far yielded for the English metropolis results which are less satisfactory from a commercial point of view than the lines of a similar character which are in existence in Paris and Berlin. It is a well understood proposition that the initiators of new enterprises generally have to pay for their experience, and although there may be exceptions to this theory, London does not form one in the present instance. The City and South London Railway in particular has suffered from the disadvantage attaching to pioneers, and if the other electric railways which have profited from its experience naturally did so primarily in their own individual interests, they have rather benefited the public than themselves down to the present time. Excluding the converted Metropolitan and District Railways there are now six underground tube lines, the Waterloo and City Railway having been merged some time ago into the London and South-Western Railway after having been guaranteed by the latter from the date of its opening. It seems extraordinary that six separate and independent lines, representing a total of only thirty-eight miles of route, should have been authorised without the forethought or foresight that an interchange of traffic between them would be desirable, in the general interest of the owners and the travelling public, by the construction of physical junctions where the proximity of the railways would permit of this being accomplished. The City and South London Railway, which was originally projected as a cable railway, has, of course, to be excepted on account of the smaller size of most of the early tunnelling, although, as all the London lines have been built to the standard gauge, and are worked on the direct current system, the trains of the pioneer line could travel over the systems of the other railways, notwithstanding the impossibility of accepting "foreign" traffic in return. But each electric railway stands forth as a self-contained unit, and the mistake is to be perpetuated in the case of the two or three underground electric lines which have already been authorised by Parliament, and which will probably be proceeded with as soon as a favourable opportunity occurs for raising the capital needed for their construction.

The lack of uniformity or of system in London forms a striking contrast to the precision with which a comprehensive scheme for the construction of a network of shallow underground lines was projected in Paris under parliamentary authority, and which is being jointly carried out by the Municipal Council and the Paris Metropolitan Railway Company, the latter holding a working concession which will expire in 1950. As will be recollected, the Municipal Council undertakes the construction of the tunnels, whilst the company lays the permanent way and provides the rolling stock and equipment, passenger stations and generating and distributing plants, and pays to the city as rent for the concession or for the use of the tunnels a fixed proportion of the gross receipts derived from the passenger traffic every year. At the end of 1908 the company had in operation a length of 32 miles of track as compared with the 38 miles owned by the six electric railways in London, and extensions of the Paris network are still being continued under the co-operation of the Municipal Council and the company. The sum of £521,000 has been paid over to the city as the latter's share in the gross receipts for 1908, when the shareholders in the company had received a dividend at the rate of 8 per cent., or a fraction in excess of that which was distributed for the preceding year. But even in Paris, where the Metropolitan promises eventually to cover fairly well the whole of the city, the mistake is being made of allowing a second company to enter the field for the construction of an underground railway between the north and the south, without the establishment of a physical junction with the Metropolitan Railway so as to maintain uniformity. In the case of the Berlin Elevated and Underground Railway, which is the representative electric railway in the German capital, there is a material difference between it and the lines both in London and Paris, as it is partly of the shallow type and partly high level. The railway, which is being gradually extended according as the difficulties incidental to obtaining the consents of the city, police, and State authorities are overcome, has a total length of 11 miles at present, and from the earning of small profits after the opening of the line in 1902 it has been possible to advance to the position of paying dividends at the rate of 5 per cent. in each of the past two years.

The individual prosperity of either the Paris, Metropolitan, or the Berlin Elevated and Underground Railway has hitherto surpassed that of any single electric railway in London, although the conditions are not strictly comparable. The railways in each capital are confronted with surface competition from electric tramways and motor omnibuses, but the rivalry in Paris and Berlin is that of one private enterprise against another, and it is therefore possible for each to yield a return on the invested capital. On the other hand, the County Council tramways in London are employed for the purpose of diverting all classes of traffic from other methods of transportation, quite irrespective of present financial considerations, whilst the principal omnibus companies have been compelled to amalgamate in order to prevent self-destruction, and this may indirectly be of advantage to certain of the underground railways. At any rate, it is reasonable to conclude that the unfavourable effects produced on some of the underground lines by the operation of tramway and motor omnibus competition have either reached, or are approaching, the high-water mark, and that in the course of the next few years the working results of the former, having regard to the gradual expansion in the passenger traffic throughout London, will tend to improve and reward the patience of those who have witnessed the almost frenzied rivalry between different systems in the past five years due to the over-abundance of means of transport. A further point to be considered in this connection is that the powers held by the London companies are in perpetuity, whereas the Paris concession will expire in 1950, and that in Berlin in 1980, if expropriation is not exercised before that period arrives; but the prospect of increased competition both in Paris and Berlin, particularly in the latter city from projected municipal and other underground railways, represents a factor in the future development of transport facilities in those cities. On the other hand, the hope exists that private enterprise has witnessed its worst days in London, and that present indications foreshadow the possibility of more favourable periods in store for the underground railways, which, with two exceptions, and including the Metropolitan and District Railways, show materially improved results for the present half-year as compared with the corresponding weeks of 1908.

The Naval Works Vote.

The discussion in Committee of the House of Commons on the Naval Works Vote gave plenty of opportunity to opponents of the Government and critics of Admiralty policy for fault finding, on questions ranging from the granite used at Rosyth, to the relative merits and demerits of graving and floating docks. The debate followed closely on Lord Charles Beresford's pronouncement before the London Chamber of Commerce on June 30th, and the chief interest naturally centred on the question of dock accommodation on the East Coast, as to which Mr. McKenna has been bombarded with questions for some months past. Lord Charles had included in his demands the provision of four floating docks of Dreadnought capacity, all of which he desired to see placed at ports or other suitable positions on the East Coast. A few days earlier the First Lord of the Admiralty admitted in reply to a question that two floating docks for Dreadnoughts and Invincibles were about to be constructed, one of which would be stationed in the Medway, and the second possibly at some other point on the East Coast. In reply to another question as to the number and location of all docks capable of taking vessels of the Dreadnought or Invincible type in the United Kingdom, Mr. McKenna gave the total as 13, two of which would take an Invincible only. On being pressed as to the location of these facilities, he stated that some of the docks were on the East Coast, but, in his opinion, it was undesirable to say where. It is really difficult to understand the object of such futile reticence and useless evasion of the facts. In the meantime it is evident that the attention of the Admiralty is being directed to the selection of suitable sites for graving and floating docks, for deputations of naval officials have already visited the Medway, Humber and Tyne, in order to examine and report on suggested localities, and it is understood that Cromarty Firth and Kirkwall have also been considered. A statement has been made to the effect that three of the principal shipbuilding and dock-owning firms on the Tyne have been asked by the Admiralty to tender for the construction of docking facilities on the river for the purpose of a naval repairing base. It is suggested that the three firms may form a syndicate for the building of a large floating or graving dock at Jarrow Slake.

To return to the discussion in the House of Commons:—Mr. Lambert, the Civil Lord of the Admiralty, defended the decision of the Government not to have recourse to loan Bills, and expressed the hope that measures of the kind would never again be introduced except to meet very grave national emergencies. He said we would have to rebuild many of our docks; for he had not the smallest doubt that for the large loan expenditure that has been incurred, we have only got one really good Government docking establishment—that at Devonport. The Admiralty hoped that the contractor for the Rosyth works would earn a year's bonus at the rate of £800 per week by the completion of the work in six years, from March 1st, 1909. In regard to the new Portsmouth dock, which was due for completion within four years, a bonus of £400 per week had been offered. Mr. Lambert announced that the Admiralty had, after searching inquiry, satisfied themselves that floating docks were suitable for use in home waters; they had numerous advantages over graving docks, not the least of which were rapidity of construction and economy of plant. Floating docks of the largest size could be constructed within eighteen months. As to Haulbowline, the enlargement of the graving dock at that yard would be completed by April, 1910. On the question of the Immingham negotiations, Mr. Lambert made the somewhat disappointing announcement that they had come to nought. For the cost of constructing a graving dock at that port up to Admiralty requirements they could build two, if not three, floating docks of equal capacity. On the Tyne, the Admiralty, said Mr. Lambert, were quite willing to co-operate with private firms, but the initiative must be taken locally. Evidently the negotiations which, as is well known, have been in progress for some time past with reference to the Tyne have not as yet resulted in any decision one way or the other. It will be a matter of regret, and, in our opinion, the wasting of a valuable opportunity, if some means are not devised whereby a dock of adequate capacity—of either floating or graving type—can be constructed on the Tyne without further delay. The latest failure of the Admiralty to seize upon Immingham as a site for a naval dock in the absence of the offer of very favourable terms by the dock authorities is not a matter for serious condemnation when the convenience and physical advantages of the site are compared with those obtaining on the Tyne. The latter is admirably fitted in most and all important respects for the establishment of a repairing dock at moderate cost, and without undue loss of time. The Immingham works are now so far advanced that the opportunity for the provision of a large naval graving dock on easy terms, which offered when the works were commenced three years ago, no longer exists. The pity of it is that the opportunity was not seized upon when it did occur. The Admiralty have hitherto held aloof from the system of subsidising private docks from reasons which it is difficult to regard as conclusive. The present necessity is an admirable opportunity for making an experiment in this direction at a cost which cannot but be moderate when compared with the expenditure entailed by the construction of an exclusively naval dry dock at any East Coast port. We do not mean to say that a co-operative arrangement in respect of any one new dry dock—let us say on the Tyne—will meet the whole necessities of the situation, but it will be a substantial addition to the facilities which the Admiralty have at last promised to provide by the construction of the two new floating docks.

The Engineering of Ordnance.

ON the last day of June Lieut. Trevor Dawson delivered before the Junior Institution of Engineers the first Gustave Canet lecture. We need not remind our readers that the lecture is delivered every fourth year by the recipient of the Canet Gold Medal, which is awarded through the Council by Madame Canet in memory of the late M. Canet, who was President for the year 1908. The first lecture, it was felt, should deal with the subject which Monsieur Canet had made his own, and the selection of Lieut. Dawson as the first lecturer was very fitting. The lecture itself has been reprinted in book form, and makes quite a substantial volume. It traces rapidly the development of ordnance during the past fifty years; touches upon the influence that the science and practice of metallurgy has have upon gun construction; discusses the nature of propellants and their influence upon ballistics, and then arrives at the real subject of the lecture, which is the development of the mechanical devices used for the loading, training, elevating, and fixing of guns. This part of the lecture is almost wholly descriptive, and a good deal of it is familiar, but towards the end the lecturer touches upon the very modern subject of aërial attack, and after describing the special ordnance used against air ships, concludes with the observation, "But as ships offer the best means of warding off attack by ships, so the airship of the enemy must be met by better airships, and more of them. It is a case of Greek meeting Greek. Airships will increase in size and offensive power, and the problems of design and construction of guns for these war vessels must exercise the ingenuity of the mechanic and metallurgist." From which it may be gathered that Lieutenant Dawson sees in the advent of the airship new times of prosperity for ordnance makers, and it will not be forgotten that his firm has shown its desire to be in the van of progress by laying down an airship at Barrow. We shall conclude this brief notice of an interesting address by quoting the few last lines of the lecturer's peroration. "War has thus become an exact science, with the issue dependent only on the sufficiency of the implements and *personnel*, on the skill of the strategist, and on the efficiency and courage of the officers and men. We have every reason to believe that the rank and file of the Navy are as capable, as earnest, as heroic, as their predecessors of other generations, and we trust, not without confidence, to our statesmen to fulfil the will of the people to make our defensive forces supreme, to safeguard that mastery of the sea which is vital in the fullest degree to our Empire, to our kindred nations beyond the seas, as well as to the mother island home."

THE PIT LADS' REVOLT.

A PLEASANT feature of the introduction of the Eight Hours Act into the mining districts of Yorkshire and adjoining coalfields has been the good sense shown both by employers and employed, to give the new statute a thoroughly fair trial. With that view various conferences have been held, and the representatives of masters and men have loyally collaborated to smooth the way of such difficulties as might occur at the start, and arrange to deal with others as they developed themselves. The result has been a hopeful beginning in the new order of things. The only note of discord has been raised by the boys at certain collieries. The ordinary newspaper reader who gives any attention to the great coal industry, in the interesting transition process it is now undergoing in practical working, cannot fail to have observed that what is described as "the revolt of the pit lads," which has in several instances thrown many miners idle, has been chiefly over the question of "snap time." How many know what the phrase "snap time" means? The explanation is easy. Snap time is the same as snack time—the portion of time allowed to the lads for taking food during working hours. In any job which is continuous on the surface, or in the pit—a job which cannot be set down—arrangements are made for allowing a number of the boys a short time—from twenty minutes to half-an-hour—in rotation with other boys, so that all of them have this time in turn, or as the work will allow. That has been the rule under former conditions. It will be continued under the Eight Hours Act. Boys will still be allowed time to have their "snap," but no doubt arrangements will have to be modified according to the requirements of the colliery. This modification appears not to be relished by the boys, who, amongst other matters, make a grievance of not having been consulted as they hold they ought to have been. The boys, for the most part, are not in the Miners' Union, but they have an understanding amongst themselves which appears to be practically and effectively operative for the purpose they have in view. The difficulties which have arisen are being met with judgment and patience by the colliery managers and representatives of the men, as well as by the men themselves. Settlements have already been effected in several instances, and no doubt amicable arrangements will be gradually arrived at ere long all round.

LITERATURE.

SHORT NOTICES.

The Rise and Progress of the British Explosives Industry. Published under the auspices of the Seventh International Congress of Applied Chemistry, by its Explosives Section. Edited by E. A. Brayley Hodgetts. London: Whittaker and Co., 2, White Hart-street, E.C. Price 15s. net.—Those who are interested in explosives will undoubtedly appreciate this book, for it contains what is one of the most complete histories of the manufacture of explosives which has been published in this country. The historical part, which is composed of about 300 pages, is exceptionally good. It deals with the history of gunpowder, researches on gunpowder, nitro-cellulose, nitro-glycerine, and nitro-glycerine explosives, researches on nitro-glycerine, permitted explosives, percussion caps, Bickford's safety fuse, military fireworks, pleasure fireworks, &c. A list of gunpowder makers up to 1800 is also given in this section. The descriptive part, which is made up of about 111 pages, has reference to existing Government explosive establishments, also private establishments. A list of manufacturers of picric acid is also included in this section. The book contains many illustrations, and those of works are of historical interest. The portraits which are given are confined to those who were connected prominently with the epoch-making events in the past of the explosive industry. The preparation of the vast amount of information given in the book has unquestionably involved an immense amount of labour.

Hydraulic Tables and Diagrams for Practical Engineers. By Capt. A. ff. Garrett, R.E. London: Longmans, Green and Co., 39, Paternoster-row, E.C. Price 15s. net.—The object of the tables and diagrams given in this book is to reduce the labour of hydraulic calculations to the lowest possible limit consistent with the accuracy which is required for practical work. The author has not attempted to set forth fundamental principles, for the book is intended for practical engineers, and he has, therefore, only given such explanations as are necessary to make clear the application of the tables and diagrams which the book contains. The first part of the book is devoted to hydraulic units. Then there is a chapter entitled hydraulic calculations, and following this one on the pressure of water. Other sections of the book deal with orifices, weirs, and notches, flow of water in pipes, the flow of liquids in sewers, and the flow of water in open channels. The remainder of the book is devoted to weir discharge diagrams, pipe discharge diagrams, sewer discharge diagrams, and canal discharge diagrams. The book deals with most calculations with which a hydraulic engineer is concerned, and the tables which are given for calculating the velocities and discharges in pipes and sewers partially full should prove particularly useful to those associated with drainage works. The author claims that by plotting the diagrams logarithmically he has been able to make them more compact and to give them a greater range than any diagrams hitherto published, while at the same time providing ample accuracy for all practical purposes.

The Motor Car: A Practical Manual. By R. W. A. Brewer. London: Crosby Lockwood and Son, Stationers' Hall-court, E.C. Price 5s. net.—This book is the outcome of a series of lectures delivered by the author at the Crystal Palace School of Practical Engineering, the Royal United Service Institution, and the Royal Automobile Club. The author commences by explaining the evolution which had to take place in internal combustion work before the motor car could become a commercial possibility. The fundamental principles governing the action of the engine are discussed under the heading of gas engines. Some space is devoted to the discussion of liquid fuel and its utilisation. There are twenty-two chapters in all, the titles of some of the most important being:—Mechanical details of construction, details of moving parts, stratification, thermal efficiency, cause and extent of heat losses, testing of gas engines and calculations of results, gas producers, oil engines, the petrol engine as employed in the motor car, power and weight of petrol engines, clutches, and change-speed gears, frames, ignition mechanism, carburation, liquid fuel, the care of the car, &c. The information which the book contains is of a practical character, and it can be followed by anyone with a slight engineering knowledge.

BOOKS RECEIVED.

Tabellen für die Berechnung von Eisenbetonkonstruktionen. By G. Funke. Berlin: Julius Springer. Price M. 0.60.

The Journal of the Institute of Metals. Vol. I. Edited by G. Shaw Scott, M.Sc. London: The Institute of Metals, Caxton House, Westminster.

Fighting Ships, 1909 (12th year of issue). Fred T. Jane. London: Sampson Low, Marston and Co., Limited, Overy House, 100, Southwark-street, S.E. Price 21s. net.

The Royal Automobile Club Year-book, 1909. London: The Royal Automobile Club, 18, Down-street, Piccadilly, W. Price 5s. net. Free to members and associates of the R.A.C.

THE BRAY AND WICKLOW RAILWAY

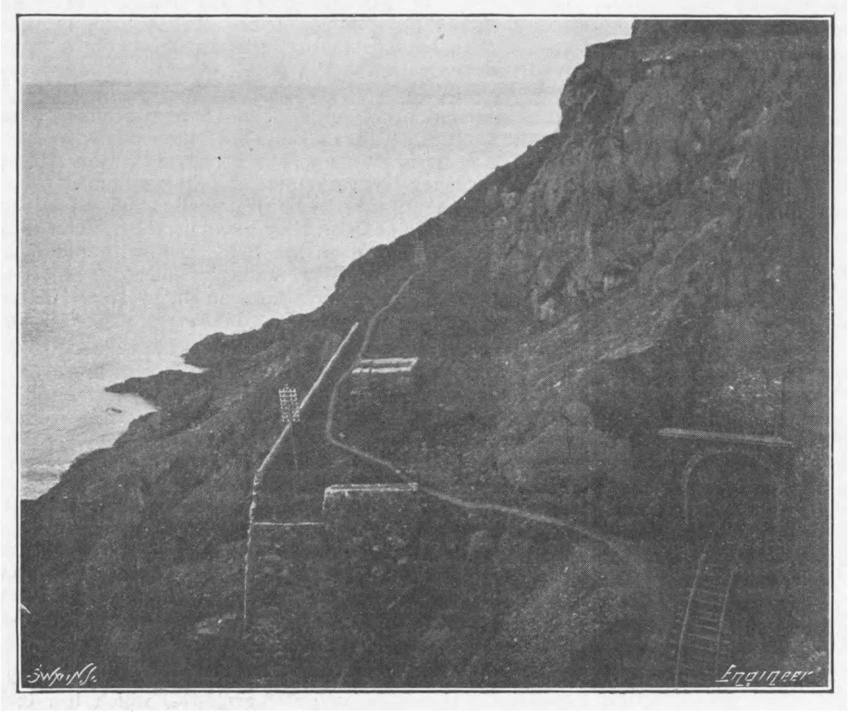


Fig. 1—BRAMSTONE TUNNEL—NORTH FACE

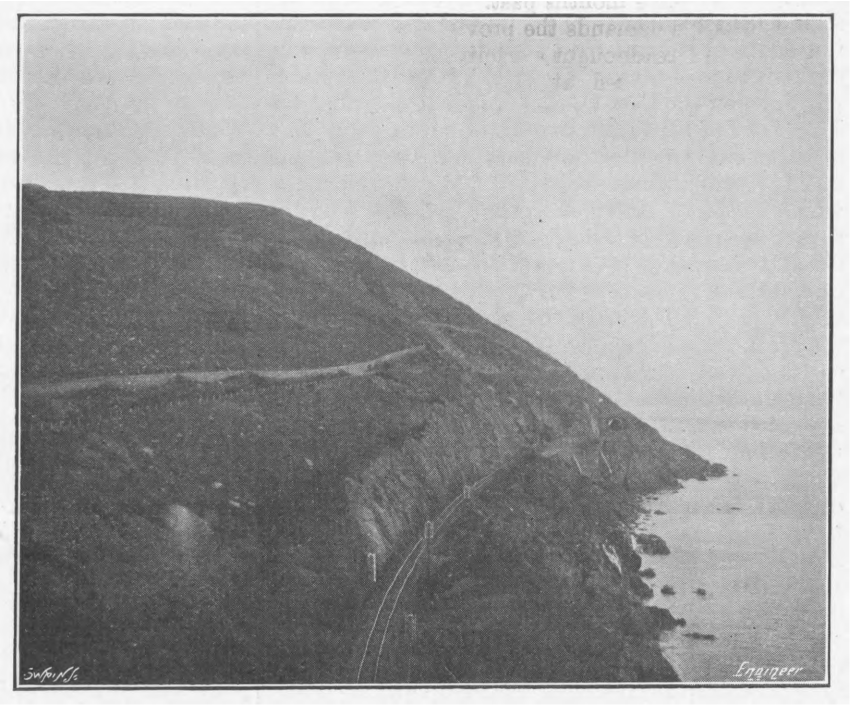


Fig. 2—BRANDY HOLE AND RAM SCALP TUNNELS

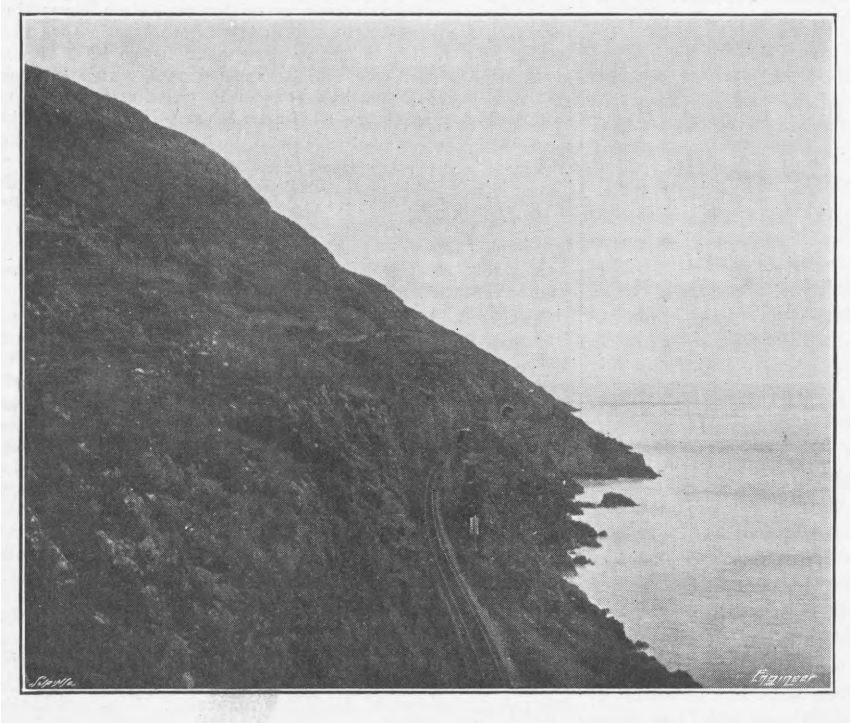


Fig. 3—TUNNELS LOOKING NORTH FROM CABLE ROCK

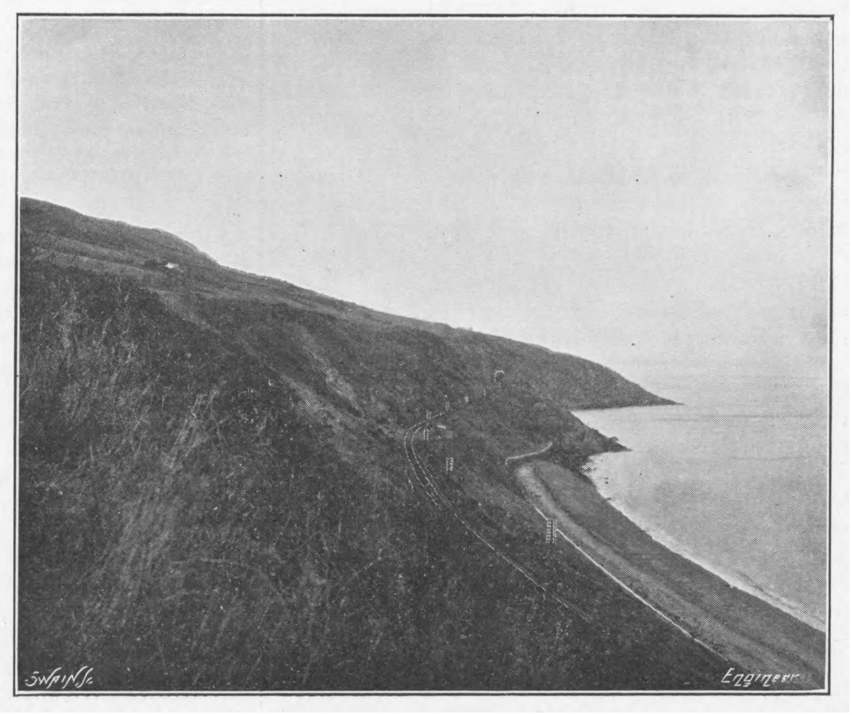


Fig. 4—VIEW OF THE LINE SOUTH OF BRAY HEAD.

THE BRAY AND WICKLOW RAILWAY.

In the course of his evidence before the Viceregal Commission on Irish Railways the general manager of the Dublin and South-Eastern Railway referred to the great expense to which his company had been put for many years in attempting to frustrate the encroachments of the sea on their line, principally between Bray Head and Newcastle, County Wicklow, and at other points where it skirts the seashore very closely. The witness stated that some £40,000 had been spent in this manner during the past ten years alone, and went on to suggest that the Government ought to subsidise his company's defensive works, since they benefited all the adjoining property owners, and inasmuch as if there were no railway along the coast landlords would be obliged in their own interests to safeguard their property against coast erosion.

This novel plea for State aid may be made the occasion for some description of the remarkable character of the railway between Bray and Wicklow.

The Dublin and South-Eastern system originated as follows:—Its nucleus was the Dublin and Kingstown line, which was the first railway in Ireland, being opened in 1834. In 1846 a short extension of the latter, viz., from Sandycove to Dalkey, 1¾ miles long, and following the route of the old tram-road, which had been built for the conveyance of the stone used in the construction of Kingstown Harbour from the Dalkey quarries, was made and equipped for Messrs. Clegg and Samuda's system of atmospheric propulsion. And as this was the first, so it was the last railway to be worked on that principle of traction. It both anticipated and survived the more famous experiments on the Croydon and South Devon lines.

In 1846 two undertakings, for the construction respectively of an inland railway from Dublin to Bray and a line from Bray to Wicklow, amalgamated, and were incorporated as the Waterford, Wexford, Wicklow and Dublin Railway Company. This association obtained a 999 years' lease of the Dublin and Kingstown railway and also acquired the Dalkey atmospheric line, in order to convert the latter to locomotive traction, and extend it to Bray. The entire coast route between Dublin (Westland-row) and Bray was opened at the same time as the line from Bray to Wicklow on the 25th October, 1855.

Brunel engineered the Bray and Wicklow section, which is sixteen miles in length, carrying it round the formidable promontories that comprise Bray Head, and from thence giving it an uninterrupted and almost level run along the seashore to Wicklow.

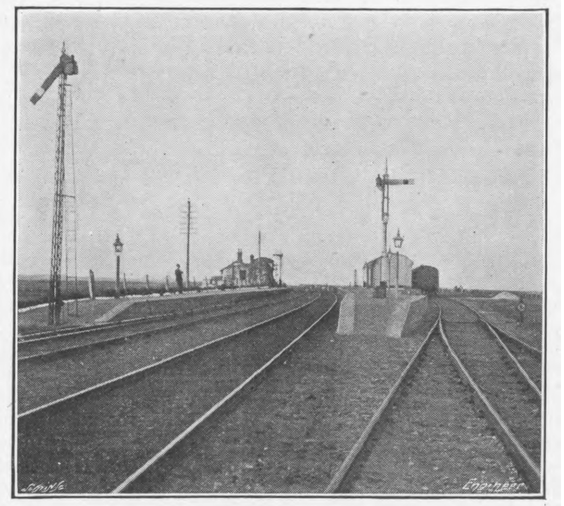


Fig. 5—NEWCASTLE STATION

The purchase of the land cost the company very little, but owing to the great and unexpected difficulties—by no means confined to the passage of the Head, hitherto regarded as an inaccessible, bluff, rocky promontory, in which each step was fraught with greater peril than the last—experienced in carrying out the undertaking, the cost of the whole averaged £25,000 per mile.

Round Bray Head—which accounts for three miles of the route—the coast is deeply serrated, and the projecting formation being both rough and irregular in its outline, the railway is sometimes carried through deep cuttings, and sometimes along a ledge of the rock, where it reaches an elevation of about 70ft. above the sea, while the three leading projections are pierced by short tunnels. Proceeding from Bray, the first engineering feature is the Bramstone tunnel, Fig. 1, a mile away, and adjacent to which is a deep chasm, and a point known as the Ram Scalp. Originally the line crossed that ravine on a wooden viaduct, 300ft. in length, and 75ft. high; it then entered a shorter tunnel, lying further to seaward, after which it was carried across a smaller ravine on another wooden viaduct.

The construction of the first viaduct was attended with great difficulties. It was once nearly completed, when in one night the whole fabric was swept away, and carried out by the waves. Subsequently, on the morning of August 9th, 1867, it was the scene of a sensational accident. An "up" passenger train had reached half-way across it, when the engine left the line, and sprang into the ravine at the land side, dragging with it a third-class carriage, while the next carriage turned over on its side, and hung suspended, half on the bridge. Most providentially the engine fell over on the land side, where the depth of the shelving side of the rock was not more than 40ft. Had it gone over on the sea side, it would in all probability have pulled the whole train with it, and the fall would have been 100ft. Owing to this accident, in which two persons were killed and fifteen injured, and which was found to be due to the spreading of the rails, caused by the assaults of the waves against the piers of the viaduct, it was deemed advisable to divert the line at this point, bringing it further inland, so as to escape crossing the ravines. This necessitated piercing the promontory with the longer tunnel now used. The old track, including the disused tunnel, and the masonry buttresses, Fig. 2, of the vanished viaducts, still forms a conspicuous object from the train.

The second tunnel through Brandy Hole headland, Fig. 2, so called from its having in former days been the resort of smugglers, is 250 yards in length, and on a reverse curve· After running through numerous short passes cleft in the solid rock, two of which are artificially roofed, in order to protect the line from falling stones, a third tunnel is arrived at, one-eighth of a mile in length, and cut through a portion of the mountain known as the Cable Rock. The effect of the several tunnels through the mass of stone is singular in the extreme, Fig. 3. At each end of the passage the sea is visible, and at one spot the four tunnels are distinctly seen in front, whilst a solid wall lies between the train and the sea, and overhead, on the other hand, in one unbroken steep towers the bulk of Bray Head attaining to an altitude of 800ft. above sea level.

Ever since the accident of 1867 flagmen have been stationed at frequent intervals to notify any mishap, such as the fall of masses of rock and sudden landslips. A wall has been built 100ft. above the line as an additional protection from the former risk, while the terraced sections resist the erosion of the waves below by the aid of lofty retaining walls and groynes.

On leaving Bray Head, the line enters a clayey soil, extending to Greystones, Fig. 4, on which one might imagine the difficulties of the engineer had been brought to a conclusion. But at no point were the skill and patience of all connected with the undertaking more severely tested. Owing to numberless springs, the extremely soft and slippery nature of the ground, and the proximity of the sea, landslips of several hundred feet at a time were constantly taking place, and the impediments were at length only overcome by the formation of water tables to carry off the moisture. Some ten years ago, however, owing to the inroads of the sea, it was found necessary to divert more than a mile of the line further inland, and in places this deviation is beginning to be threatened.

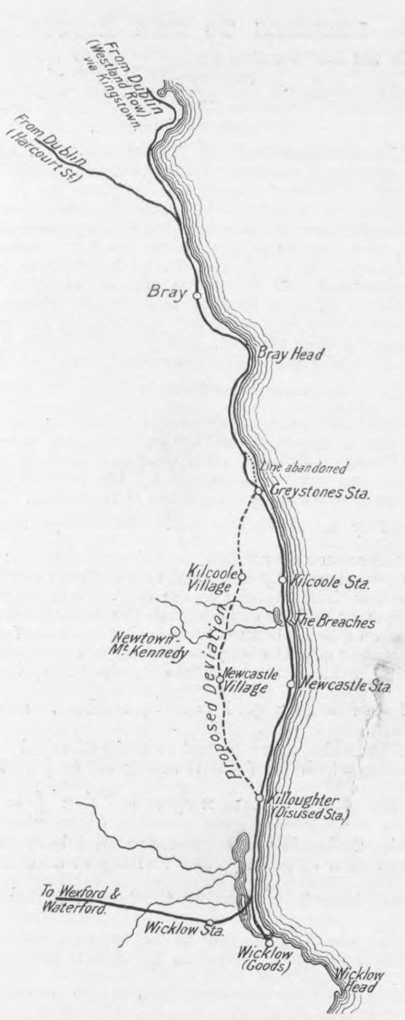


Fig. 6—BRAY AND WICKLOW RAILWAY

On the $5\frac{1}{2}$ miles between Greystones and Newcastle the line skirts the seashore more closely than ever. About midway occurs a remarkable feature. The accumulated water of the level ground forces its way through the sand and gravel, which in the summer is washed up into a barrier by the advancing tides, to be again driven out in the winter by the rush of water from the neighbouring hills. From this circumstance the place has obtained the name of "The Breaches." To ease the pressure on the shifting mass a large canal-shaped drain has been made by the company along this portion of the country, running parallel with the line. However, nearly the whole of this section is the scene of the most important coast defence works, which are essential if the line is not to be devoured by the sea. During severe easterly gales it has been washed away in places several times, when also considerable damage has been done to the station buildings of Kilcoole and Newcastle, Fig. 5. From Newcastle to Wicklow, beyond which the line turns inland, and runs through the picturesque Wicklow valleys, the track does not hug the seashore quite so closely, and the configuration of the coast affords better protection.

Except at stations the line is single from Bray to Newcastle, south of which it is double to Wicklow. In addition to the large sums expended upon coast defence works, the permanent way has been considerably improved of late. Several miles have been relaid with heavier chaired rails and sleepers, and crushed granite ballast is being generally used.

Of course, the choice of route between Bray and Wicklow was all a colossal, glaring mistake. It is evident that vanity prompted Brunel to carry the line round Bray Head, for a much easier alternative in the shape of the pass behind, known as the Glen of the Downs, was available. Certainly, however, he succeeded in executing a daring engineering feat; indeed, it is difficult to find anywhere more romantically placed or boldly executed work. But the choice of route for the remaining distance to Wicklow was, to say the least of it, unwise, for apart from the question of coast erosion, it lies far removed from nearly all the villages, and the numerous centres of attraction to tourists, for which this part of the County Wicklow is justly celebrated.

The company has obtained powers to construct a new line further inland, but apparently no funds are available to carry it into effect. The projected deviation would turn inland south of Bray Head, and after pursuing a course from one to three miles distant from the sea, it would rejoin the old line at Killoughter, $2\frac{1}{2}$ miles north of Wicklow. Until the railway was extended south of Wicklow, Killoughter was the site of a station, since closed and dismantled. Fig. 6 shows the railway from Bray to Wicklow, together with the proposed deviation.

THE DEMARCATION OF SHIPYARD OPERATIONS.

The scheme which a committee representing the Federation of Shipbuilding Employers and the Federation of Engineering Employers has drawn out for the prevention of disputes between trades unions and workmen regarding work which may be claimed by more than one class of men in shipyards and engines shops, is at present being considered by the twenty-four different unions interested in the two industries. Hitherto demarcation disputes have been the most difficult form of trouble in shipbuilding, because they are always between different classes of men, and the employers have in most cases to stand by and await developments, while work is being delayed and the shipyard or engine works more or less disorganised. The difficulty is usually brought before the employers by one or other of the trades concerned, with the request that the work in dispute should be given to them; but this leaves on the employers the onus of deciding the matter, and also lays them open to the charge—if they decide in favour of the lowest paid trade—of acting as interested parties. Under the proposed agreement the practice at present prevailing—that of first of all endeavouring to settle a dispute at the works where it arises—will be adhered to as much as possible. In the event, however, of the trades involved and their own employers failing to arrive at a settlement, the matter in dispute will be remitted to a standing committee consisting of three employers and three delegates from each of the societies concerned, the firm to give a provisional decision which shall rule pending the consideration of the matter by the committee. The terms of the agreement are intended to work out so that when several societies claim the same work each will present its case to the committee, and that which has the weakest case will be ruled out first, that which has the second weakest next, and so on, until there is only one society left. This society, of course, will then be declared entitled to the work. The new agreement, as has been stated, aims at confirming the present practice of settling a dispute at the works where it has arisen, and it is to be hoped that it will at all events prevent disputes of this kind reaching the stage when they disorganise labour. If it does so it will remove one of the worst irritants in the relations between masters and men in the shipbuilding and marine engineering districts.

Considering the vast changes which the evolution of the ship has caused in shipyard practice and methods—from the days when wood was all in all, till now, when wood scarcely enters at all into the main structure, and less and less into the coverings and fitments—considering also the effect of power appliances in displacing and reallocating handwork, and especially the general tendency of metal to oust wood, and "all the workers thereof," it is little to be wondered at that demarcation troubles have constantly been the worry of shipbuilders. Of the transition in boiler-making also, from the tank boiler, with its plain but ponderous structural items, to the tubular boiler of modern times, with its small, intricate, and multitudinous pieces, demanding comparatively delicate handling, adjustment and assembling, the same remark may be made, as well as of the transition from the reciprocating to the turbine type of engine.

Doubtless the differentiation between one branch of work and another is sometimes not very pronounced, and there is a natural interlocking of operations which has rendered the "demarcation question" a difficult one to resolve and satisfactorily adjust. For example, some years ago there was a long dispute at the Clydebank shipbuilding works between the "platers" and the "sheet iron" workers as to which branch of operatives was entitled to certain work which both classes had had in turn to deal with—and probably both were equally capable of performing—although originally it formed the unquestioned province of the joiners, not of the "black squad" at all. Wood on warships now-a-days is an infinitesimal quantity, even although the much talked of experiments with non-flammable timber have not brought about the revolution anticipated. Wood cements of various kinds now enter largely into both war and merchant ships for deck coverings and other purposes. Joiners and carpenters will by-and-by apparently have no legitimate reason whatever for going aboard a warship.

While the wood-worker is thus almost wholly shut off from participating in warship construction, affairs are not so bad in connection with merchant shipbuilding, although even here there is a great curtailment of his functions. This was so true even some years ago that in one of the shipyards in Aberdeen 60 shipwrights came out on strike owing to a dispute which had arisen in connection with the carrying of wood from the stack yard to the joiners' workshop. The shipwrights held that they should do this work, while the employers maintained it should be performed by the labourers. Thus the occupation of "the skilled artificer in wood" is now such that even the carrying of rough timber from one place to another is fought for and made the occasion of a wholesale strike! The joiner, however, still has a fine field in the elaborate saloon work and state-room accommodation on board high-class mail and passenger liners. It is in cargo-carrying ships especially that the diminished province of the wood-worker—carpenter and joiner as well—is most strikingly realised. Wood deckhouses on cargo vessels—and very largely on passenger ships as well—have been practically abolished. Wood decks are the exception on many types of cargo carriers, as are wood rails and mouldings and wood skylights. Masts and spars, unless of the smallest diameter, are, of course, now all of steel or iron.

The changed order of things no doubt bears hardest on the shipwright or carpenter. He who used to be chief in the art of shipbuilding has his time-honoured functions reduced to a minimum. He is, in fact, not infrequently referred to—poor man—as "nothing but a glorified labourer." What is left to him, however, is still highly important, although not affording the same constancy of employment for large numbers as when wood shipbuilding still obtained. It has less to do with the details of shipbuilding than with the heavier operations at the beginning and end of the work of construction. The carpenters' duties mainly are the preparation and placing of the keel blocks; laying "well and truly" the keel bars or plate thereon; erecting on end, and putting into accurate place the framework of the vessel. Then, as the launching stage approaches, the really important work of laying the launching ways and fitting the cradle is still the duty of the carpenter. This, of course, has been a part of shipyard work growing in arduousness and responsibility as the size and weight of ships have developed, and what this means in such leviathans as are now common, only those who have at least walked round one of them prior to the launch can adequately appreciate.

THE SUMMER TRAIN SERVICES.

The depression of British railway affairs generally, combined with the movement towards the reduction of working expenses by means of co-operation, is reflected in a marked degree in the summer train services. This season there are but very few novelties in the way of additional trains or accelerations, while none possesses remarkable interest. The most prominent feature of a lean year in passenger train enterprise is the Midland Railway Company's invasion of the West Riding *viâ* Royston and Thornhill, which, although a new route for passenger traffic, has been used by goods since its completion three or four years ago. This new service affords a more convenient means of communication between the Midland and the Lancashire and Yorkshire railway systems. It gives three through trains from St. Pancras, which are joined at Sheffield by through carriages from Bournemouth, Bath, Birmingham, &c., and at Thornhill these trains are split up, one portion proceeding along the Lancashire and Yorkshire line to Huddersfield and Halifax, and the other to Bradford (Exchange). The service is balanced in the reverse direction. The best times are as follows:—St. Pancras and Huddersfield, 4 h. 22 min. (fastest connection previously *viâ* Wakefield, 5 h. 35 min.); St. Pancras and Halifax, 4 h. 27 min. (fastest connection previously 5 h. 25 min.); St. Pancras and Bradford (Exchange), 4 h. 28 min. (fastest connection *viâ* Leeds, Bradford (Market-street), in 1907, was 4 h. 30 min., but in 1908, and till June 30th, 1909, 4 h. 38 min.). This new Midland and Lancashire and Yorkshire service is competitive, first, where London is concerned with both the Great Central and Great Northern routes, and, second, in respect of North and West cross-country services, with those carried on by (*a*) the Great Western and London and North-Western, *viâ* the Severn Tunnel; (*b*), the Great Central and Great Western, *viâ* Banbury; (*c*), the Great Central, Great Western, and London and South-Western, *viâ* Reading and Basingstoke. The Great Central Railway has met the above move by attaching through coaches for Huddersfield and Bradford, reached *viâ* Penistone, to the 1.50 p.m. and 3.15 p.m. trains from Marylebone, and to corresponding "up" expresses; thus giving an additional and accelerated service to Huddersfield in 4 h. 2 min., and to Bradford (Exchange) in 4 h. 57 min., though the journey is performed slightly quicker by the 6.20 p.m. from Marylebone, which previously served both places. The Great Northern Railway, owning the shortest route, is under no necessity to improve its existing train service, but it prominently advertises the fact that the latter is still the quickest. From the foregoing particulars, it will be gathered that, despite the recent working agreements, competition between the northern lines is by no means dead. Indeed, they rather inspire the belief that the old competition on the part of individual railway companies will merely be superseded by that between various grouped companies.

Hitherto there has been only one through service between Birmingham and the West, *viâ* the Great Western Company's new route, made up of the new lines extending from Tyseley (Birmingham), to Stratford-on-Avon, and Honeybourne to Cheltenham (Malvern-road), and by the exercise of dormant running powers over the Midland Railway between Standish Junction (six miles south of Gloucester) and Yate. This route was described and illustrated in The Engineer of October 11th, 1907, and opened with the above-mentioned service, a through train between Wolverhampton and Penzance in each direction, on July 1st, 1908. At first, however, owing to a dispute with the Midland Railway as to the interpretation of the old running rights, the Great Western Company's one and only through train ran between Yate and Bristol over the former company's metals, instead of being transferred to its own, viz., the so-called Badminton route to Bristol, by means of the loops at Westerleigh

Junction, Yate. Two additional services have now been placed on this cross-country route, and the litigation having ended in favour of the Great Western Railway, all three travel between Yate and Bristol, *viâ* the Badminton line.

The new services consist of a through train in each direction between Birkenhead and Weston-super-Mare, which is called the "Shakespeare Express," and a through train in each direction between Wolverhampton and Weston. These trains call at Stratford-on-Avon, Cheltenham (Malvern-road), and Stapleton-road (Bristol), and time has also been allowed for a stop at Chequer's-road (Gloucester), when that new station, situated on the loop line, which avoids the town, is ready for use. Good connections are given at all stopping places, and, again, to and from the Great Western main line west of Bristol. These trains convey first and third-class passengers only, and are composed of the latest vestibuled, corridor carriages, together with a restaurant car.

The journey time between Birmingham and Bristol occupies 2 h. 20 min., which does not rival that of the Midland trains, whose route is ten miles shorter. Consequently, the Midland Company, which had accelerated its service at the menace of Great Western competition, has reverted to its old timings, and discontinued non-stop trains between those towns. The Midland route, however, extends as far north as Derby, and it may be noted that as between Birmingham and Derby the few minutes saving, which we stated would result from the new Water-Orton and Kingsbury line—*vide* THE ENGINEER, May 7th, 1909—has come to pass in the summer timetable.

While on the subject of through cross-country journeys it should be mentioned that the revival of last season's remarkable service between South Wales and the seaside resorts of East Anglia is accompanied by an acceleration of 50 minutes to Lowestoft, and 1 h. 20 min. to Yarmouth. This has been accomplished by joining the east-bound train at March to a Great Central express from Manchester for the same destinations, and running it direct by the Trowse curve at Norwich, instead of in and out of Thorpe terminus. The London and North-Western Railway has often run between London and Holyhead, 263½ miles, and on rarer occasions between London and Carlisle, 299¼ miles, without a stop; but previously its longest regular non-stop run was over the 192 miles separating Euston and Liverpool (Edge Hill), a performance surpassed all the year round by the London-Plymouth run on the Great Western, and during the summer by those from London to Shipley and Leeds to London on the Midland. This season, however, the North-Western Company ranks second by means of the new non-stop run awarded to the 11.15 a.m. North Wales tourist express from Euston, viz., to Rhyl, 209¼ miles, in 3 h. 57 min. speed 52.97 miles per hour. Last season this train stopped at Crewe to change engines. Moreover, from August 7th to September 18th inclusive, there will be a balancing "up" train, running non-stop from Rhyl (dep. 3.38 p.m.) to Willesden Junction, 203¾ miles, in 3 h. 54 min. speed 52.2 miles per hour.

The outstanding feature of the summer arrangements of 1908 was a new Glasgow express by the Midland route, starting from London at 11.30 a.m.; running to Carlisle, 308 miles, in 5 h. 59 min., with but one stop at Shipley for service purposes; and reaching Glasgow, 423½ miles, in the record time for this route of 8½ hours. The train is running again this season, but on a slower schedule. The journey time to Carlisle takes eight minutes longer, which increase is allotted to the London-Shipley break of 206½ miles. The latter now occupies 4 h. 5 min., instead of 3 h. 57 min. Then, the journey time to Glasgow is 8¾ hours, the Glasgow and South-Western Company having discontinued the non-stop run from Carlisle to St. Enoch's, 115½ miles. This train also now starts from St. Pancras at 11.50 a.m. instead of 11.30 a.m. The fastest Midland train between London and Carlisle now is the 1.10 p.m. "up," accomplishing the journey in 6 h. 5 min., and running without intermediate stop from Leeds—196¼ miles, in 3 h. 40 min., speed 53.7 miles per hour. Last year this latter run was performed two minutes quicker, and the year before that seven minutes quicker. The Great Central Company's famous non-stop run from London to Sheffield, *viâ* Aylesbury, 164¾ miles, is now performed in 2 h. 57 min., speed 55.8, or three minutes quicker than it has been since July 1st, 1907, but still seven minutes slower than the record timing.

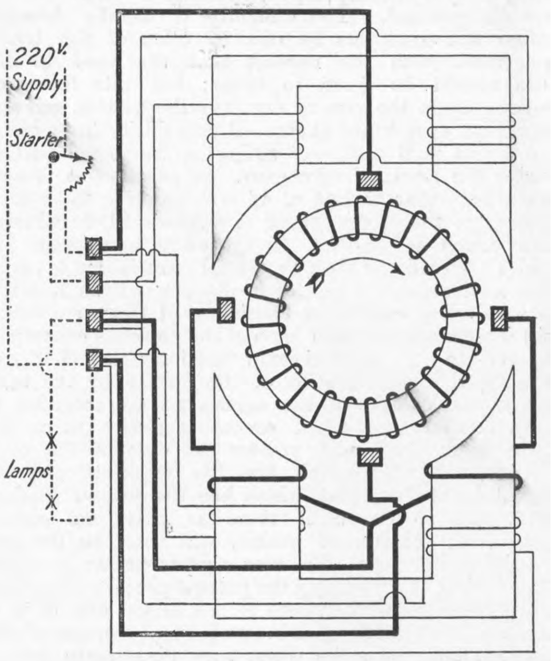
Formerly there was no Sunday day service by either of the three Anglo-Scottish routes. That inconvenience has been partially remedied by an entirely new service between Edinburgh and York, and beyond both. One can leave Edinburgh at 12.10 p.m. and reach London (King's Cross) at 9.40 p.m. In the reverse direction, however, the new train leaving York at 2.15 p.m. for Newcastle, Berwick, Dunbar, Edinburgh, and Glasgow, is confined to a connection from Normanton and the Lancashire and Yorkshire line. The service between King's Cross, Scarborough, and Whitby, has been strengthened and accelerated, the journey time to Scarborough (230¼ miles) being 4¾ hours, whereas previously the quickest connection occupied 4 h. 58 min., while the journey to Whitby (244¾ miles) is performed in 5 h. 35 min., which is thirty minutes less than any formerly given.

In certain quarters diatribes are being uttered against the so-called unchecked competition alleged to prevail between the Great Western and London and South-Western Companies where the south-west counties are concerned. It is true that the principle of co-operation has not made any headway in this direction, but the public receive an unsurpassed train service. This summer the best expresses to and from Waterloo have undergone a few minutes' acceleration, so that they attain a running average of 55 miles per hour between London and Exeter, which, considering the hard grades encountered west of Salisbury, is very creditable.

A NEW CONVERTER.

FOR reducing the voltage of a continuous-current circuit so that arc lamps, search-lights, cinematograph lantern lamps, metallic filament lamps, &c., may be used economically, Crompton and Co., Limited, of Chelmsford, have introduced a new type of converter, which we have recently had an opportunity of inspecting. It has one armature, one armature winding, one commutator, and one set of brush gear, and, unlike most continuous-current machines, the armature is ring wound. The diagram which shows the connections for a machine suitable for arc lamp work will assist in making the general principle clear. The machine has four poles, the two upper poles being magnetically separated from the two at the bottom of the machine. Current is supplied to the two main brushes at the top and bottom of the commutator, whilst two other brushes which are short-circuited through windings on the two lower poles bear on the commutator at approximately equidistant points from the other brushes. The bottom, or negative brush, lead, and a tapping taken off from the joining point of the two windings, which short-circuit the brushes, constitute the secondary mains; whilst the leads connected to the main top and bottom brushes form the primary mains.

Assuming for the present that the field magnets are excited in the ordinary way with a shunt winding, if current be supplied to the top and bottom brushes, the machine will run as a motor, and there will be a rise in potential round the commutator on both sides. The higher the short-circuited brushes are shifted up towards the positive brush the greater will be the potential difference across the secondary circuit. Since both the short-circuited brushes are at practically the same potential there will be little or no current in the short-circuited path. The part of the armature between the short-circuited brushes and the top main brush may, together with the top field magnets, be regarded as the motor part of the machine, whilst that part of the armature below the short-circuited brushes, together with the bottom poles, may be considered as the generator section. The voltage generated in the motor and generator part of the armature will naturally be proportional to the magnetic fluxes due to their respective field systems, and to the number of conductors on the two armature sections. To vary the secondary voltage therefore without shifting the short-circuited brushes, the relative values of the two magnetic fluxes must be varied, and to enable this to be done the two field systems are magnetically separated. To vary the secondary voltage the armature must also obviously be ring wound. If current be taken from the secondary at low voltage, that is, when the lower poles are only slightly magnetised, there will be a much larger current flowing in the generator part of the armature than in the motor section, which gives rise to armature reaction; the effect is to raise the potential of one of the short-circuited brushes to a higher value than that of the other, and a strong current flows through the short-circuited path. When the current in the motor section is greatest the circulating current flows in the reverse direction.



CONTINUOUS CURRENT PRESSURE CONVERTER

The effects of this circulating current are well known; it is liable to cause sparking, dangerous racing, and to prevent the desired secondary voltage and current being obtained. If the diagram be examined, however, it will be found that the winding on the top or motor poles is shunted across the positive brush and the short-circuited brushes, the shunt winding on the left-hand bottom pole is connected across the primary, whilst the shunt winding on the right-hand bottom pole is across the secondary. Also, as already stated, there is a series winding on each bottom pole, which are in series with the short-circuited brushes. The series coils on the bottom poles are connected so as to oppose the flux due to the bottom shunt coils. How a machine arranged in this manner can be made to give a practically constant current with variable voltage can easily be seen. If the secondary current momentarily increases, the current in the series coils increases, and since they oppose the flux due to the bottom shunt coils the secondary volts drop. The left-hand bottom shunt coil prevents the generator field disappearing altogether. The reduced secondary volts naturally gives rise to an increased voltage across the positive brush and short-circuited brushes, which strengthens the top poles and replaces the reduced flux on the bottom poles, and so keeps the speed practically constant.

If the machine is used for lighting arc lamps, when the carbons are together the current in the generator part of the armature will be much greater than that in the motor part, and consequently there will be a large current flowing in the short-circuited path, as previously described. With this arrangement of the windings the circulating current is controlled and the undesirable effects referred to are eliminated, for the current in the short-circuited path strengthens the flux in the left-hand bottom pole and weakens the right-hand one. The constant current in the bottom left-hand shunt winding also helps this end considerably. Thus the machine automatically supplies a constant current with variable voltage, and if the secondary is short-circuited the current remains normal.

With such a machine it is obvious that an arc lamp or lamps can be run on ordinary circuits without a steadying resistance, and since the efficiency of the machine is higher than the ordinary continuous-current transformer, and the initial cost less, the saving, particularly with arcs taking heavy currents—50 or 60 ampères for example—is very considerable. It is estimated that a machine of this type, when used in place of a steadying resistance for a large cinematograph lantern with current at 3d. per unit, would save as much as £5 per week, the supply voltage being 440. With a 110-volt supply it would save £1 10s. Machines of this type when provided with suitable windings are supplied for constant secondary voltage with variable current, suitable for metallic filament lamps, also for balancing a three-wire system, for the control of electric vehicles of all kinds, for colliery winding, rolling mills, electric welding, printing machinery, &c.

It is claimed that a constant-voltage machine, having an output of 2 kilowatts, will enable consumers, by replacing carbon incandescent lamps with metal filament lamps, to save 70 per cent. of their power bill, and at the same time to run one or two-flame or other arc lamps economically off the same circuit. Constant-voltage machines have the same windings as shown in the diagram, but all the shunt coils are in series, and they are connected across the primary.

LETTERS TO THE EDITOR.

(*We do not hold ourselves responsible for the opinions of our correspondents.*)

MARINE PROPULSION.

SIR,—Your correspondent, W. Preidel, appears to have got into the usual muddle of confusing momentum and energy, and, I am afraid, starts with very slender qualifications for discussing the above subject. As a result of his failure to grasp first principles he is putting forward all sorts of extraordinary views on dynamical questions, and leading others on to the ice. The subject has cropped up before in your columns, and has been ably dealt with by correspondents and in special articles, whilst in any good, modern text-book it is soundly and clearly treated, though I believe some earlier writers fell into confusion in the matter.

Adopting the usual symbols, and pound-foot-second units, the quantity $m\,v$ is said to measure the momentum of a body, and the expression $\frac{m\ v}{g}$ represents the force in lb., which, acting for one second, would give to the mass m the velocity v, or conversely, the force that must act against the body to bring it to rest in one second. Energy is defined in any good text-book as capacity for doing work, and work is measured by the product of the force into the space or distance over which it is applied. The energy is measured by the expression $\frac{m\ v^2}{2\,g}$. Momentum takes no cognisance of the space over which the force was applied; energy, by its definition, necessarily does, and this is the crux of the matter. Let us see how these expressions are derived and related.

The only way that we can estimate the momentum and energy stored up in a moving body is to find what amount of force would be competent to give the body its motion in a given time. Now, the velocity imparted to any mass m by the force f in one second is $\frac{f}{m}\,g$, from which we get $f = \frac{m\,v}{g}$, as above. But this force being uniform, the space passed over by the body in the one second during which the force is acting will be $\frac{1}{2}\,v$. Hence work done in the second = force × space $= \frac{m\,v}{g} \times \frac{v}{2} = \frac{m\,v^2}{2\,g}$, or our old friend. On looking at it another way, a body falling freely under the action of gravity, and arriving at a velocity v, must have fallen through $\frac{v^2}{2\,g}$ feet, by the laws of falling bodies. In this case the force is measured by the weight of the body, which we will take as being the same as the mass; hence, again, work stored up $= \frac{m\,v^2}{2\,g}$, for obviously this is the number of foot-pounds that must have been expended in raising the body to the height $\frac{v^2}{2\,g}$, and it is clearly immaterial whether we consider the body as moving downwards under gravity, or to have been put into motion by any other force, or to be moving in any direction whatever. In ordinary language, if we suppose the mass constant, by doubling the velocity we have not only to double the force, which, acting for one second, would be required to impart that velocity, but also to double the space that the force will have acted over in the second; hence the work done will vary as the square of the final velocity in all cases.

The distinction between momentum and energy is of profound significance in mechanics. As shown in more advanced works, the total energy of a pair or system of bodies isolated from external forces, *i.e.*, subjected only to their mutual actions and reactions, may be entirely altered, but the total momentum, properly considered with respect to sign, is fixed and unchangeable. Some of the most fascinating problems of astronomical physics involve this great law; indeed, the evolution of the sidereal and solar systems from diffused cosmical matter, and their present configuration, can now be shown to be a necessary consequence of its operation.

There is thus no necessary equality between the work of action and the work of reaction. Any two bodies under the action of one and the same force will in any given time acquire velocities inversely proportional to their respective masses. Their momenta will be equal, which is really only another way of saying the same thing. But the energy, or work stored up in each, will be proportional to the mass multiplied by the square of the velocity in each case, which means that it will vary inversely as the mass of each of the bodies. The larger, therefore, we can make the mass concerned with the reaction, or that part of the phenomenon we do not desire to bring about, the less energy do we waste. If the gun be rigidly fixed to the earth, the velocity of recoil is infinitesimal, and the energy lost evanescent, so far as reaction is concerned. In all cases of action and reaction, one and the same force is involved, and one and the same interval of time, and if we wish that force to do a great deal of work we must give it a small mass to move, so that it may exert itself through a large space in that time, and *vice versâ*. The work is the force multiplied into the space, not the mass multiplied into the space.

All this is really elementary matter to-day, and some apology is due to you for occupying your space with it, but there is perhaps some justification, for your own editorial note to W. Preidel's last week's letter is somewhat disconcerting. The first part of the first of Sir William Anderson's statements you quote is clearly wrong, while your illustration of the cylinder and piston is hardly to the point. While the piston is doing work, the cylinder is doing none, and in the case supposed by you of fixing the piston and connecting up the cylinder to the mechanism, the cylinder would be doing all the work and the piston none. This is not at all the same as the work of action being equal to the work of reaction. What we are concerned with just now is the work done on the respective masses during the same interval of time.

With regard to the subject of propeller action, with which I believe this discussion commenced, the complete theory of the screw propeller is not yet developed, but the basis of its action is undoubtedly the acceleration of the water dealt with, and so far as slip represents the velocity of the backward-driven water to that extent is it loss. If for the present purpose we regard the propeller as a pump, or contrivance for throwing water astern, then the thrust will be equal to that force which is competent to accelerate a given quantity of water per second up to a given velocity. It will, in fact, be $\frac{m v}{g}$. But a given thrust can be obtained by accelerating a small quantity of water up to a high velocity, or a large mass to a low velocity. In the former case, however, much more energy will be delivered to the water than in the latter, for the energy will be $\frac{m v^2}{2g}$. Hence, the most efficient propeller, other things being equal, will be one which delivers the largest quantity of water astern at the lowest velocity, but there are conditions limiting the size of propeller, so that all propellers are in practice compromises. If it were not for the frictional resistance offered to the blades, then the largest propeller possible would be the best, for, as in the case of the gun and projectile, the nearer we can get to the extreme condition of communicating the momentum of reaction direct to the earth the less energy do we waste. In practice, we have to communicate the momentum to a small mass, first at a relatively high velocity, hence loss of energy, which energy is dissipated in friction in the process of final passing on the momentum to the earth.

I trust I have correctly diagnosed the misapprehensions responsible for the remarkable views your correspondent is propounding, and that it is not some more subtle point that he is labouring. It is possible that he has been led astray by Aveling's book; this writer may be one of those who held erroneous views on the subject. The principles I have endeavoured to bring to your correspondent's notice, and the definitions adopted, are as laid down by Newton, Rankine, and other undoubted authorities, and, as mentioned, are followed in all standard works. I have not got Dr. Aveling's "Natural Philosophy," and personally have no curiosity to see it.

Sunderland, July 5th. HENRY BARNES.

[Sir William Anderson's book may be found in any good public library, and we commend it to our correspondent's attention.—ED. THE E.]

THE LIFE OF A LOCOMOTIVE.

SIR,—I much appreciate the consideration shown me in the favourable notice of my paper on this subject in a leading article in your issue of the 18th ult. There are, however, a few points in it which put a wrong construction on the meaning intended to be conveyed by me in the term thirty years' serviceable life of a locomotive, to which I crave leave to draw attention as having an important bearing upon the main subject of my paper. You state that I have adopted the happy mean of thirty years as the average life of a locomotive. I should explain that this is not the case, but an assumed extreme limit of the serviceable life of the most durable portions of the machine the least subject to the destructive effects of the wear and tear of the traffic, such, for instance, as the side frames, and it was adopted by me with the approval of the late Mr. Ramsbottom and his then principal assistant and subsequent successor, the late Mr. Webb, which enabled me, in an estimate I made in 1869 with the very valuable and most detailed particulars they furnished—of the prime cost, crop value, and duration and mileage it was capable of running of each of the more than 2000 parts of a new standard type of a London and North-Western locomotive—to calculate what the total amount of the expenditure would be in completing its entire renewal in the next thirty years alluded to, and the amount of that estimated expenditure per engine is, together with full particulars, given in my paper on the "Maintenance and Renewals of Rolling Stock," read and discussed at the Institution of Civil Engineers (Vol. xxx., 1870), and as is stated in the paper now under review, the total actual expenditure and the expenditure per engine in the maintenance and renewal of the entire stock of the London and North-Western Company's Railways, number of engines in each of the succeeding years (1869-1889) subsequently furnished by Mr. Webb, amounted almost exactly to the same cost per engine as was estimated in the case of the single standard type of engine, notwithstanding the fact that the size and tractive power during that long period had largely increased. I mention these facts in order to show that the thirty years' period is not assumed to be the average life of a locomotive, but a definite period during which a stock of well-constructed efficiently, but not excessively, worked locomotives may, as a whole, safely be considered as the limit of time during which they can be maintained in a serviceable condition by means of the average annual amount per engine expended in the renewals of the worn-out portions of the entire stock, which by this means have become restored again, not to their original new condition, but to their normal and standard serviceable condition, essential to ensure a continuance of the efficient working of the ceaseless and ever-increasing traffic.

There are, however, other great advantages in the adoption of the thirty-year limiting period of the serviceable life of a locomotive in affording, as it does, most reliable means of instituting comparisons as to the variations in the amount of the renewal expenditure per engine, not only on a particular railway during the given period, but as between the cost per engine on the other railways in different years.

But far and beyond all this in importance, the adoption of the thirty years' limit of serviceable life of a stock of locomotives on a given railway affords the means of readily ascertaining the annual number of worn-out engines, inasmuch as the annual cost of renewals per engine in each of the successive years of the thirty years' limiting serviceable life period being admittedly the equivalent of the annual death-rate of the worn-out engines, it follows that thirty times the annual expenditure in each particular year constitutes the total amount of expenditure per engine during a past period of thirty years; or, in fact, as I have termed it, "the money life" of some of the engines in that year, so that by dividing the total locomotive renewal expenditure in that year by the "money life" we get the equivalent number of worn-out engines in that year, as will be seen from a reference to column 6 in Table III in the appendix to the paper of mine, and as exemplified in the typical case of the locomotive stock of the London and North-Western Railway. The fact that the total number of worn-out engines during the thirty years almost exactly corresponds with the total average number of the entire stock during that period confirms the correctness of the calculations, which are based on actuarial principles.

You draw attention to the fact that the prime cost of the much larger and more powerful types of engines of the present time is far greater than £2500. I should, however, point out that I am dealing in my paper with the average prime cost of more than 18,000 engines of different types, sizes and tractive power during the thirty-year period in question.

As regards the point to which Mr. Darbishire draws attention in his letter in your issue of the following week, that it is unfortunate that in one of my leading data I have been misled by adopting the Board of Trade Returns as the source of information, and in accepting as correct the number of locomotives owned by each company, inasmuch as some of the companies have not and others have made returns of the duplicate engines they have. I would merely observe that the Board of Trade require returns to be made of all the locomotive stocks owned by the railway companies, and how comes it that there are duplicates at all, and why have some of the companies failed to furnish their number, which I know is relatively very small; and since most of the principal companies have very large stocks—most of them having over a thousand, and five having numbers varying from two to three thousand—the omission of these few duplicates would not, however, appreciably affect the average cost per engine. I am dealing with large quantities and big questions, and this regrettable omission in no way affects the principle I am dealing with. The omission, however, of the annual amounts per engine expended in renewals by the Lancashire and Yorkshire and Taff Vale Railways in the Board of Trade returns, to which I draw attention in my paper, does seriously affect any useful comparisons being made between the cost of renewals on these lines and the other principal railways. The Council of the Institution have, however, most considerately made good this omission in their memorandum attached to my paper, and I have availed myself of it and rectified the figures in Table No. II. It will be noted that it only adds just £4 10s. to the average cost per engine per annum of the entire stock of the fifteen railways during the whole of the ten-year period.

It would be impossible within the limits of a letter to deal with Mr. Darbishire's remarks on the subject of locomotive depreciation, one of the principal subjects dealt with in his able and very interesting paper on "The Repairs and Renewal and Depreciation of Working Plant and Machine," recently read and discussed at the Institution of Mechanical Engineers. I can only state here that I adhere to the views on the subject as given in this paper of mine, and as expressed by me during the discussion on his paper.

The Whitehall Club, A. PRICE WILLIAMS.
Horse Guards'-avenue, July 7th.

ENGINEERS AND THE TERRITORIALS.

SIR,—I look upon the prominent position which you give in your issue of the 21st May to an article on the subject of "Engineers and the Territorials" and the sound arguments included therein as additional signs of how the attention of the nation is turning towards the important practical question of home defence, and that the country at large is waking up to an appreciation of the personal responsibility which attaches to each of its citizens in this respect.

To the important body of engineers this responsibility is a very real and practical one. From the earliest ages engineering has played an indispensable part in every war, and as the science of war and the science of engineering have developed, the relative importance of the latter as an assistant to the former has increased by leaps and bounds. The responsibilities and the duties of the engineer in modern war are enormous, and whereas in former days it has been no exception to find the available number of military engineers inadequate to the calls made upon their services, in all important wars of the future this cannot fail to be very largely the case.

With the object of providing a source from which to supply this deficiency, the Special Reserve of Royal Engineers has been authorised, and should in course of time provide an abundant supply of engineers trained to military conditions, who could relieve the regulars of many of what might be called the line of communication and municipal engineering duties of a campaign.

But far more important than this is the necessity that the various engineer units of the Territorial Force should be officered by professional engineers, because on these officers will fall the bulk of the military engineering duties and responsibilities of the Home Defence Army. As these duties and responsibilities come to be appreciated, it is probable that these appointments will be eagerly sought after; but it must naturally be expected of those who accept such appointments that they will devote considerably more of their leisure to their military duties than the Special Reserve officers mentioned above, for not only will they have to train their men, and take part in the combined training with other arms, but they themselves will also require a high training and study of military engineering in all its many and intricate branches.

That efficiency is attainable without a considerable amount of self-sacrifice cannot be expected, but that it is possible even to the busiest of civil engineers, no one with any knowledge of the two professions would attempt to dispute.

The recent campaigns in South Africa and Manchuria have given us some idea of the important share which the engineer must take in future wars, and everything points to the probability that not only will the engineering training of the Army at large require steadily increasing attention, but also that the proportion of engineer units in the Army will have to be steadily augmented. So far as the Territorial force is concerned a very large supply of highly skilled material for the rank and file is available, and if the engineering profession supports the movement, as you, Sir, recommend, there should be no difficulty in securing an abundance of capable officers.

But this is perhaps looking further ahead than we are at present justified in doing, and it should be enough for the present if the whole body of civil engineers would take the existing units under its protection, to assist them in their efforts to become efficient and to encourage the best men both as officers and rank and file to take service in their ranks. There are many ways in which this good work can be done—the publication of occasional articles on military engineering subjects, and of the gazettes as far as they concern the Territorial engineer units, in the professional journals, might go far to stimulate interest in the work and progress of these units, and by no means the least important is that hinted at in the last few lines of your article, that the heads of the profession especially should take a share in this work and devote a small portion of their valuable time to a personal interest in certain companies or corps, as many of them already do, and whether officially as honorary colonels or unofficially, should assist them as they undoubtedly could in many useful ways, which would be highly appreciated by the units themselves and by all who take a patriotic interest in home defence.

Weymouth, June 29th. F. E. G. SKEY,
Lieut.-Col. R.E.

WORKSHOP ACCURACY.

SIR,—I have just read in *La Nature* a very interesting article entitled "A Marvel of Precision" (issue of June 12th, 1909, pages 28 and 29).

As you know, I was, as long ago as 1881, engaged, after the example of your celebrated engineer Sir Joseph Whitworth, in introducing into my works a simple and reliable method of producing objects of given dimensions with considerable accuracy, and of reproducing such objects with the same degree of precision.

I should very much like to know if, after more than twenty-five years the method I then evolved has been improved upon, and if so, what extent of improvement has been realised. In the course of numerous visits which I have paid during this interval of time to the best equipped works, I have rarely met with a manufactory in which it would have been possible to produce an article—given the necessary drawings and dimensions—with an accuracy sufficient even for ordinary commercial requirements. How would such a works replace an article which was at work some distance away from the factory, and which was either worn out or broken, unless an exact record of all the dimensions had been preserved?

It is true that with articles of small size it is not impossible to preserve the dimensions or to have a small machine of the type introduced by Sir Joseph Whitworth so many years ago. But how about larger pieces of mechanism such as are constantly met with in steam engines, turbines, and similar big machines? This is what gave me the idea a long while ago of working out and designing the simple and easily worked measuring machine which you described in THE ENGINEER at the time of its introduction, and which was so excellently constructed by your celebrated and clever builders of apparatus of precision, Messrs. Cook and Sons, of York, that a copy of it was asked for by the Conservatoire des Arts et Métiers, of Paris, in which establishment it now rests and holds its own amidst the most accurate and best made instruments which the Conservatoire possesses.

This apparatus makes no pretension to possessing absolute or nearly absolute accuracy, such as are possessed by the gauges of M. Johansson, inspector of fire-arm manufactories in Sweden, which appear to represent truly marvellous accuracy in construction, as is proved by the fact that the adherence between two surfaces is so great that it requires a force greater than 11 kilos. per square centimetre, say 156.5 lb. per square inch, to tear them apart. This fact, by the way, upsets the theory that the adherence of two perfectly smooth surfaces is due solely to atmospheric pressure. It would be interesting to know, first, what process was employed to obtain such perfection of work; and, secondly, what is the cost of obtaining such accuracy. I propose to ask the latter question of the constructor, since he refrains from answering the first, which, however, is the more interesting.

I am tempted to think that my measuring machine, which is less exact but also less costly than that of Sir Joseph Whitworth, and which only gives approximate accuracy up to about the two-hundredth of a millimetre—surely sufficient accuracy for an ordinary workshop—has the advantage over most others in that it does not require the addition of supplementary measurements, and in that a machine to give all measurements between 0 and 1½ metres - in metric or British units—only costs £120.

P. VAN DEN KERCHOVE.
Ghent, Belgium, July 2nd.

TIDAL POWER *v.* GAS POWER.

SIR,—Referring to Mr. J. Jamison's letter in your issue of July 2nd, I quite admit that it is possible to construct a system of pounds which will give continuous running, but the cost for dams, conduits, sluices, &c., must be very heavy. The capital outlay upon turbines and speeding up gear would roughly equal the cost of gas plant having the same power, as turbines working at such low heads are very expensive, and the speed would be so slow as to prohibit direct coupling of the generators. Then again, at these low heads I do not think turbines could be constructed in larger units than gas engines, hence an equal number would be necessary.

Storage batteries would, of course, be quite out of court in any large gas engine scheme, and with continuous running tidal power they would be equally superfluous.

Assuming the capital cost to be about the same for either turbines or gas plant, it is simply a question of whether the fuel saved by using tidal power would equal the capital and maintenance charges for the dams, sluices, &c., involved by the construction of the reservoirs.

In some parts of the world natural conditions may be sufficiently favourable to a large tidal power scheme as to ensure success, but it is doubtful whether any similar openings exist in this country, as where the natural features are favourable navigation has to be considered. This factor entails an Act of Parliament, with probable opposition, together with costly locks and other works for the convenience of vessels using the estuary needed for a reservoir. Furthermore, a demand for power is unlikely to exist alongside of a suitable site, hence transmission lines would have to be laid down, the capital charges being thereby substantially increased.

As regards existing tide mills or proposed small power installations continuous running could not be obtained without a large outlay upon dredging, as the tide does not usually enter the pounds until it has risen several feet outside, and even then only a narrow channel in the middle is affected. Also continuous running by tidal power without a battery would not be so advantageous for electric supply as intermittent running with electrical storage, the peak load in the former case being limited to the average power throughout the twenty-four hours.

Personally, I should be very glad to see the development of tidal power on a large scale in this country, provided it can be made commercially successful, and if Mr. Jamison can put before us a practicable scheme for utilising tidal power at, say, Langston Harbour, with properly worked out figures in support of his contentions, I shall be among the first to welcome his proposal.

W. O. HORSNAILL.
Ipswich, July 7th.

THE ROYAL AGRICULTURAL SHOW.—Referring to the description of Mr. Charles H. Scott's air compressor exhibited at the recent Royal Show at Gloucester, which description appeared in our issue of last week, we inadvertently said "the cam causes the suction valves to open so rapidly that they are wide open by the time the piston has completed only about one quarter of its stroke." We should have said "one quarter inch of its stroke."

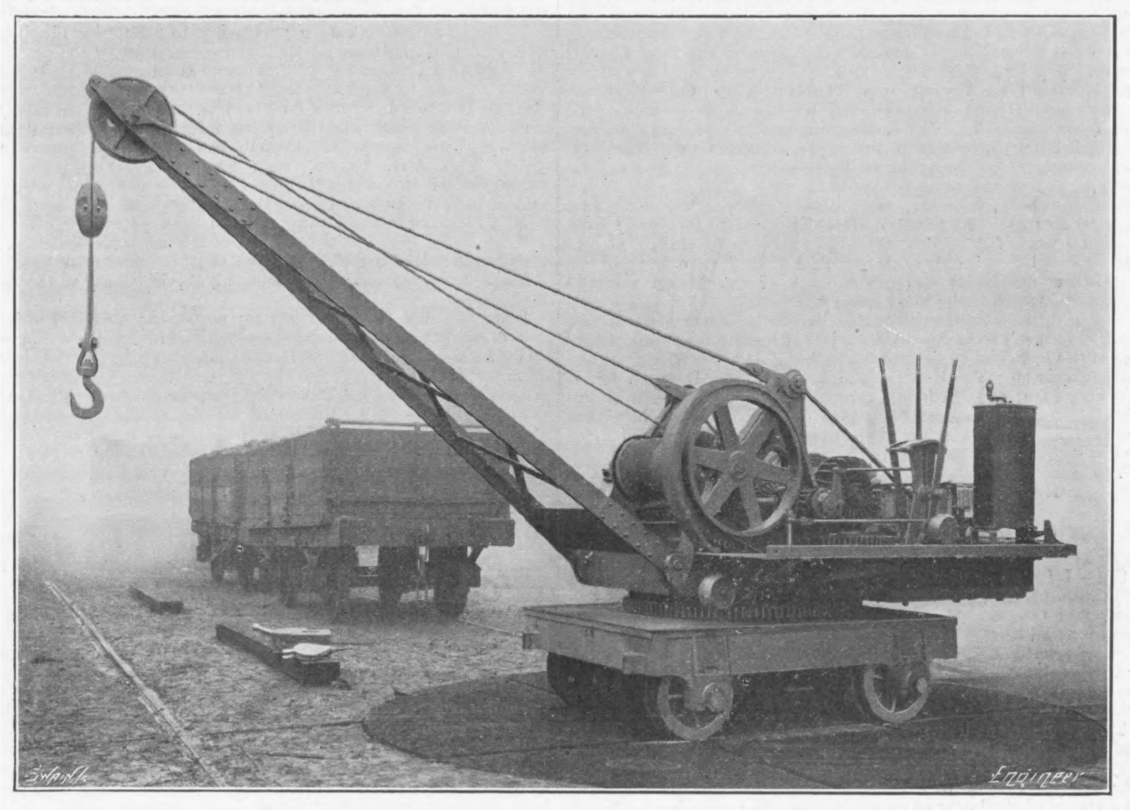
THE BRITISH EMBASSY at Madrid, in reviewing the trade of Spain in 1908, remarks upon the Royal Order published in the *Madrid Gazette* in March, laying down the conditions on which the duty paid on tin-plates imported in sheets will be refunded on their re-exportation in the form of boxes containing foodstuffs. In the preamble to the Order it is stated that the measure has been taken with a view to encouraging the export trade in tinned goods by freeing it from a duty against which the manufacturers of certain competing foreign countries do not have to contend. The system of paying the full duty on importation, subject to a refund on re-exportation, has been adopted in preference to the deposit of a guarantee, owing to the greater facility with which it can be controlled by the Customs authorities.

THE ALBERT MEDAL.—The Council of the Royal Society of Arts attended at Marlborough House on Wednesday morning last, when His Royal Highness the Prince of Wales, President of the Society, presented its Albert Medal to Sir Andrew Noble, Bart. "in recognition of his long continued and valuable researches into the nature and action of explosives, which have resulted in the great development and improvement of modern ordnance." The members of the Council present were:—Sir William White (Chairman), Sir Steuart Colvin Bayley, Sir George Birdwood, Lord Blyth, Thomas Jewell Bennett, Sir William Bousfield, Henry Taylor Bovey, William Henry Davison, Hon. Sir Charles W. Fremantle, Sir John Cameron Lamb, Sir William Lee-Warner, Sir Westby Perceval, Sir William Henry Preece, Sir Boverton Redwood, Carmichael Thomas, Professor John Millar Thomson, Sir William Hood Treacher, Sir John Wolfe-Barry, and Sir Henry Trueman Wood (Secretary).

TECHNICAL COLLEGE FOR YOUNG MEN.—A large number of City men, in connection with the Central Y.M.C.A. have planned the erection of new headquarters for the Y.M.C.A., which shall include a technical college and a hostel. This is to be erected on an island site in the Tottenham Court-road at a cost of £140,000. Two of the departments are (1) a business man's college, and (2) a hostel for young men. In the former, which is to be on the second floor, an educational department is to be instituted for supplying the needs of young professional and commercial men. Provision is being made for a laboratory class-rooms, reference library, and lecture rooms. The department is to be placed under the control of a fully qualified director of education who will plan the syllabus in order to secure the maximum of assistance to the students for the London University or Civil Service examinations, and also for other specialised courses of study. The accommodation for the hostel will be provided in the upper floors, where 200 bedrooms are to be reserved.

THREE-TON ELECTRIC CONTRACTOR'S CRANE

J. H. WILSON AND CO., LIMITED, BIRKENHEAD, ENGINEERS



AN ELECTRIC LOCOMOTIVE CRANE.

TO meet the demand for electrically-operated locomotive cranes suitable for contractor's use, the firm of J. H. Wilson and Co., Limited, of Birkenhead, has standardised a set of cranes similar to that illustrated above. The sizes in which this type of crane are made are of 2, 3, 5, 7, and 10 tons capacity respectively. The crane illustrated has a capacity of 3 tons. As in the case of the others, of different lifting capacities, it has a radius of 16ft., and it is constructed for 4ft. 8$\frac{1}{2}$in. gauge rails. The current in each case can be collected either from a protected live rail, at or near the ground level, or from an overhead conductor. Motors for any kind of supply can naturally be fitted. The motor which operates the crane shown in the illustration is of the continuous-current type, and it is capable of developing 38 brake horse-power. The crane with this motor will lift, travel and slew with three tons at 16ft. radius; the lifting speed being 120ft. per minute with full load. This high speed, combined with a rapid slewing motion, it is pointed out, makes the crane particularly suitable for trench work, where a lift of from 60ft. to 80ft. is frequently required. Any of these cranes can be supplied with or without derricking motions. Both electric and hand power brakes are fitted in each case. We are informed that so far as possible the mechanical details are duplicates of the corresponding parts of the firm's ordinary steam cranes of the same type.

100,000-CYCLE ALTERNATOR.

ALTERNATORS working at enormous periodicities find a sphere of usefulness in connection with wireless telegraphy and telephony, but so far few such machines have been built. To the Americans, however, belongs the distinction of having constructed an alternator rated at two kilowatts and 100,000 cycles per second. Mr. Duddell, we believe, designed a machine which worked up to 120,000 cycles per second, but it only had an output of a fraction of a watt. The American machine referred to above is described and illustrated in a paper by Mr. E. F. W. Alexanderson, which was presented at the twenty-sixth Annual Convention of the American Institute of Electrical Engineers. The alternator is of the inductor type with a revolving steel disc, with the armature at the side. The armature has 600 slots, with one conductor per slot of .013 copper wire, triple silk covered and varnished. The wire is wound in a continuous wave up and down in the successive slots. The rotating disc has 300 projections, which as the machine is of the inductor type, corresponds to 600 poles of a machine of the ordinary alternate pole type.

The armature is mounted on a frame which is threaded into the stationary field frame, and the air gap can be set by screwing the armature tight against the rotary disc and then moving it back a distance corresponding to the desired clearance. For this purpose the stationary frame is provided with a scale, so that rotating the armature on its thread one division corresponds to one-thousandth of an inch change of the air gap. At a speed of 20,000 revolutions per minute, it would not be practical to use a rigid shaft, and it was therefore necessary to adopt the principle employed in the De Laval steam turbine, *i.e.*, that of a flexible shaft, thus avoiding any stress on the bearings due to centrifugal force. Naturally the shaft is very thin. It has a diameter of 1.25in. in the middle and .625in. at the ends, the length between the centres of the bearings being 28in.

The first machine built was belt driven, and after a considerable amount of experimenting with different kinds of belts it was found possible to run it at 15,000 revolutions per minute, corresponding to 75,000 cycles per second. It turned out, however, that this method of driving could not be accepted for practical use and gears have been substituted. The revolving disc is made of chrome-nickel steel with an elastic limit of about 200,000 lb. per square inch. At a frequency of 100,000 cycles per second, the speed is 20,000 revolutions per minute. The diameter of the disc being 1ft., the peripheral speed is 1000ft. per second, or 700 miles per hour. The centrifugal force of the material in the edge of the disc is 68,000 times its own weight, but because of the shape of the disc, which is designed for maximum strength, the stresses are only 30,000 lb. per square inch, having a factor of safety of 6.7 to 1.

If it is borne in mind that the disc has 300 teeth on each side spaced at a distance of .125in. and that these teeth pass the face of the stationary armature at a rate of 1000ft. per second with a clearance of .015in., it will readily be understood that the air friction in the gap must be considerable. It was found that the machine heated up excessively in consequence of air friction, but this was overcome by filling the slots with non-magnetic metal, so that the disc offered a perfectly smooth surface. Then another difficulty was encountered owing to the centrifugal force acting on the fillers. The generator has two sets of bearings, one on each side of, and close to, the revolving disc, and one at each end of the shaft.

During normal operation, the shaft does not touch the middle bearings, as they are bored to give $\frac{1}{64}$in. clearance. Generators of this kind are used in conjunction with a capacity which is situated either in the aërial, as in the case of wireless telegraphy, or in a condenser of suitable capacity used in order to obtain the proper tuning. A condenser connected in series with the generator having an impedance equal to the inductive impedance of the generator gives the generator a maximum output for any load. In the case of the particular machine under consideration, the reactance of the armature winding is 5.4 ohms at 100,000 cycles, which means that the condenser should have a capacity of .3 microfarad. The maximum continuous load of the machine with the condenser is 70 volts and 30 ampères, or 2.1 kilowatts.

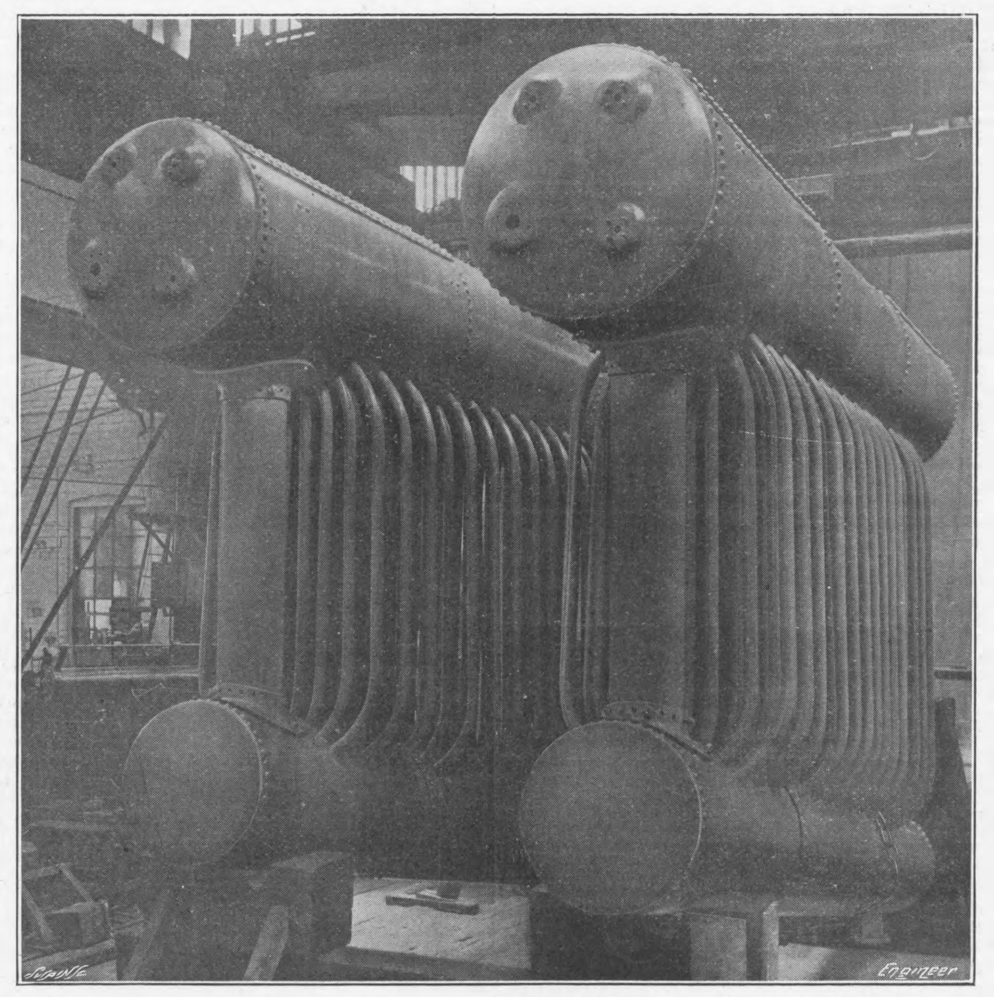
WATER-TUBE BOILERS.

THE illustration given herewith is reproduced from a photograph of a pair of Suckling water-tube boilers without casing, as erected in the works at Sheffield of the makers, Hawksley, Wild and Co., Limited. These particular boilers have been built for external firing, and are being exported to the Andes, where they are to work at an elevation of 16,000ft. above the sea level, the fuel to be used being peat and llama dung. They are designed for a working pressure of 200 lb., and have been tested hydraulically up to 300 lb. per square inch. They have each 178 2$\frac{1}{2}$in. solid drawn curved steel tubes, presenting a total heating surface of 1050 square feet, and giving freedom of expansion. The top horizontal steam and water drum is of ample size to give a good steam space and water storage, being 3ft. 6in. diameter by 22ft. long. It is composed of three rings of steel plates $\frac{9}{16}$in. thick, single riveted circumferentially and double riveted longitudinally.

The water drum is 2ft. 6in. diameter and 21ft. long; it is built up of three rings of $\frac{1}{2}$in. steel plates, and has a fall from the furnace to the rear end equal to 2in. per foot. The two drums are connected at each end by vertical welded steel tubes 12in. diameter. The ends of the two drums are of pressed steel, the steam and water gauges on the top front end plate being secured to flats formed in the process of pressing. The 2$\frac{1}{2}$in. tubes are divided into three groups transversely, a space sufficient to admit a man being provided between them immediately above the circumferential seams of the lower drum. In order to break up the flow of the gases throughout the tubes a perforated longitudinal baffle plate is provided.

The external furnace will have 33 square feet of grate area, and although the two boilers will be surrounded by a common metal casing with firebrick lining, they will be separated by a partition, so that they can be worked as individual units when necessary. The feed-pipe enters the top drum at the front end, and is carried along below the water-line to the back neck piece. The boilers have wrought steel fittings throughout, and are fitted with anti-priming pipes. It will be noted that the top drum is somewhat longer than the lower drum, the extra length being provided to give a quiescent condition to the water and steam at the front end where the gauges are fixed.

Two boilers of this type are being put in hand for a Sheffield firm to work with waste heat from furnaces, and a third is being built for one of the gold mines in the Rand. It will be seen that the Suckling boiler is specially adapted for transport, being divisible into comparatively small sections.



SUCKLING WATER-TUBE BOILER

LACK OF WOOD IN AMERICA.—Efforts are being made in the United States to prevent the starving of the national industries for lack of wood. America is now using as much wood in a single year as grows in three years, with only twenty years' supply of virgin growth in sight. Mr. Consul W. Powell enumerates the steps being taken by the Government to remedy the evil. Ten years ago there was not a single forestry school in the country; now there are several which rank with those in Germany and other parts of Europe, with twenty or more in elementary forestry, whose usefulness is steadily increasing. Forest lands under the management of State Governments have grown from one or two tracts to many, amounting at the present time to 7,503,000 scattered throughout thirty-nine States; and the national forests under the Federal Government have increased from 39,000,000 acres, which formerly were practically unused and unprotected, to 165,000,000 acres, now used, guarded, and improved both in productiveness and accessibility.

A LABORATORY MACHINE FOR APPLYING BENDING AND TWISTING MOMENTS SIMULTANEOUSLY.[*]

By Professor E. G. COKER, M.A., D.Sc., of the City and Guilds of London Technical College, Finsbury.

APPARATUS for applying simple tension or compression stresses, and also for applying bending or twisting moments to materials, are in common use in laboratories, but such machines are, as a rule, not very well adapted for experiments on combined stresses, although the frequency of such cases in practice make it very desirable that experiments on the effects of combinations of stresses should be carried out by engineering students. This is particularly the case with shafts which are generally subjected to stresses due to combined bending and twisting moments. The present paper describes a machine built by students of the City and Guilds Technical College, Finsbury, in which uniform bending and twisting moments can be applied simultaneously over the whole length of the specimen, and in any desired proportion to each other.

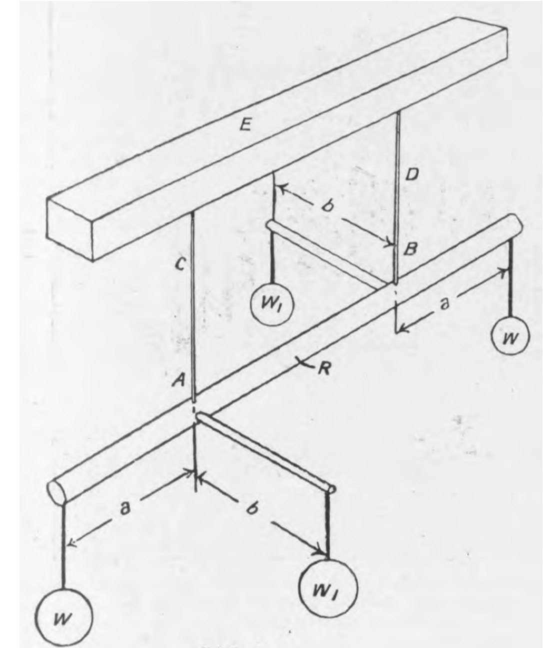


FIG. 1.

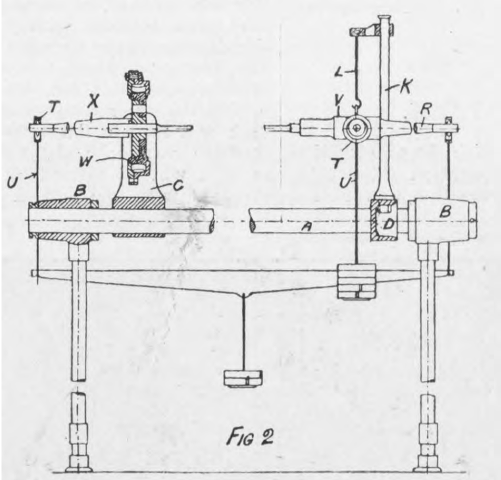


FIG 2

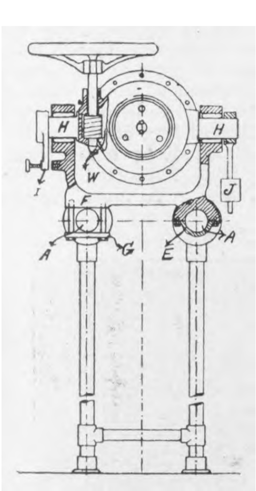


FIG 3

"The Engineer"

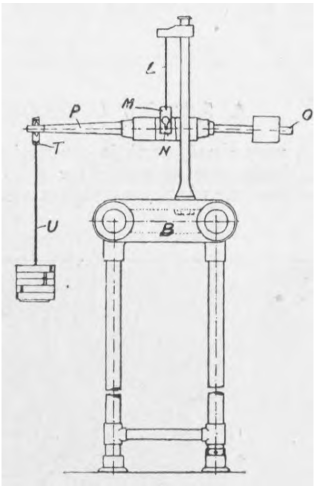


FIG 4

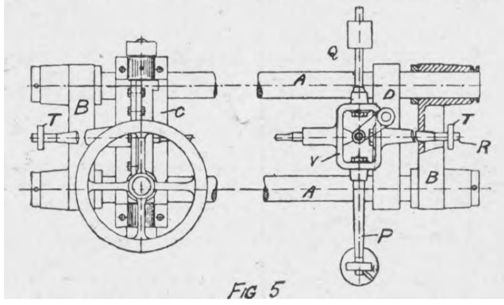


FIG 5

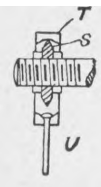
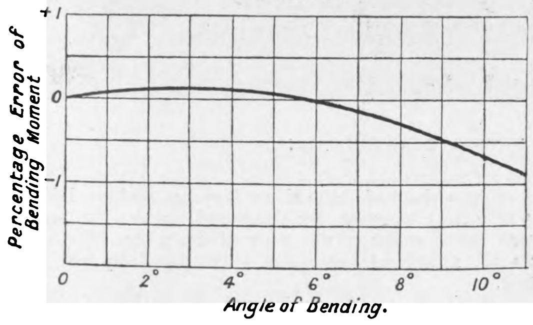


FIG 6

The machine is similar to one designed by the author for the testing laboratory at McGill University, Montreal, but with some modifications suggested by experience with the earlier machine. The principle on which the design is based is illustrated by Fig. 1, in which a rod R is suspended at intermediate points A, B, by wires C, D, depending from a fixed support E. The equal overhanging ends of the rod are loaded by weights W, so that the applied couple between the points of support is uniform and of amount Wa, where a is the length of the lever arm. The rod is also twisted by weights W_1 attached to equal arms of length b, so that there is a uniform twisting moment of amount W_1 between the points of suspension. The two systems of loading are independent and their ratio can be adjusted to any value desired.

FIG. 7.



In carrying out this arrangement in practice it is convenient to arrange that one of the levers for applying the twisting moment shall always remain in a horizontal position, and that the other shall be capable of turning through an arc to bring the first lever back to zero after each application of the load. The most convenient way of carrying this out is to replace the adjustable lever by a worm and worm wheel gear secured in a casing and turned by a hand wheel. To allow freedom for bending the worm wheel casing must be pivoted to rotate around a line intersecting the axis of the specimen and perpendicular thereto, and this method of pivoting must also be adopted at the horizontal lever. This arrangement only differs from that of the perfectly freely suspended arrangement shown by Fig. 1 in fixing one point of the rod, and this has the indirect advantage of stilling vibration, which is troublesome in the freely suspended bar.

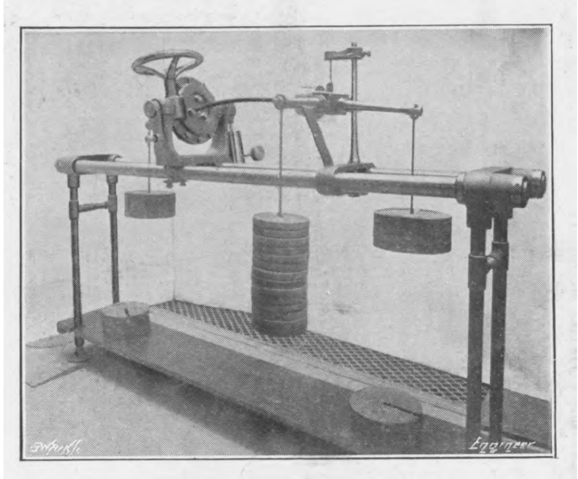


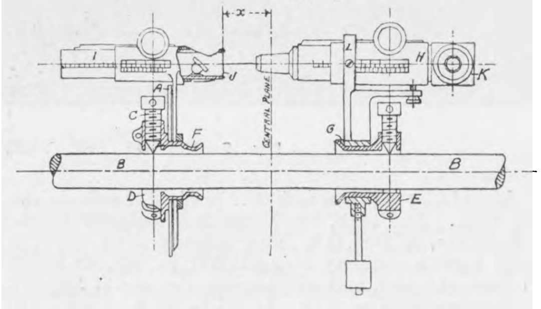
Fig. 8

The arrangement described above is carried into effect in the manner indicated by Figs. 2, 3, 4, and 5, showing the apparatus in side elevation, end elevations, and plan respectively.

The various parts are supported in a built up frame consisting of two planished steel shafts, A secured in cast iron cross frames, B mounted on four standards, one of which latter is adjustable in height to secure steadiness on an uneven floor. Upon the steel shafts are two castings C, D, each of which has a cylindrical bearing encircling one of the shafts and resting with a flat face F in line contact with the other shaft, and secured in position by a cross bar G threaded on studs. This connection is perfectly rigid, since it removes all degrees of freedom and it is readily released by simply turning back one of the cross bar nuts, leaving the casting free to slide into a new position. It also has the advantage that no accurate fitting is required for the supporting frame. The casting C carrying the worm wheel gear W has trunnion bearings H at right angles to and intersecting the axis of the specimen. The bearings are fitted with friction rollers, and when the machine is used simply for torsion the worm wheel is kept in a vertical position by an arm I keyed to the bearing H and locked in position by a thumb screw. A weight J attached by an arm to the second bearing balances the pivoted casing in all positions.

The weigh levers are supported from a vertical standard K of the frame D by a wire L, terminating in a thin plate M with a keyhole slot encircling the spindle N. Formerly a roller bearing was used for this spindle, but this is an unnecessary refinement, as the friction is extremely small, and can be easily taken into account.

FIG. 9

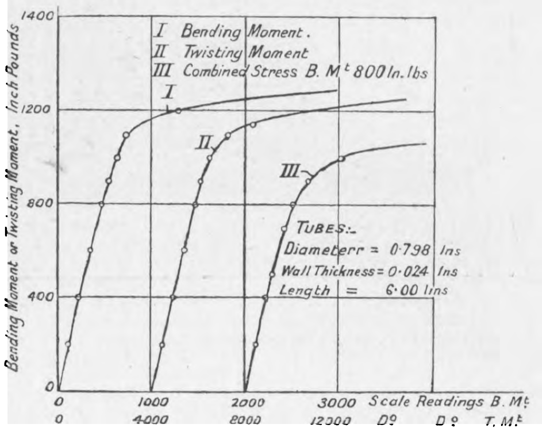


The casting supported in this way has three levers, P, Q, and R, the first two of which are for the application of twisting moments S, and the third R, in the line of the specimen, is for applying a bending moment.

All the loading levers are provided with knife edges S—Fig. 6—of circular form, made by turning an ordinary Whitworth nut down to form a disc with a V-shaped edge. These discs carry rings T with wide angled V-shaped recesses on the inner sides, and light rods V screwed into these rings carry the weights. This arrangement of knife edge is very easy to adjust accurately, and when bending and twisting stresses are applied simultaneously the rolling-line contact adjusts itself to the bending and twisting of the specimen. The bending of the specimen causes a change in the effective arm of the bending levers, which is generally negligible, but a correction may be necessary with a very long specimen. For if a is the length of the lever arm and b is the radius of the circular knife edge, an angular deviation of amount θ will cause a change of $a - (a \cos \theta + b \sin \theta)$ in the lever arm, and this is zero when $\theta = 0$, and also when $a = a \cos \theta + b \sin \theta$.

In the machine described a is 10in. and b is 0.5in., and the angles $\theta = 0$ and $\theta = 5.75$ deg. both correspond to an effective length of 10in. The maximum correction between these values is easily shown to be at an angle θ given by the equation $b \cos \theta = a \sin \theta$, in the present case 2 9 deg. approximately, for which value the correction is 0.12 per cent. For values of θ greater than 6 deg. the correction increases more rapidly, and its amount may be obtained from the diagram, Fig. 7, which shows the percentage error for all angles up to 10 deg. In the majority of tests the angular change at the ends rarely exceeds 5 deg., and the correction is therefore so very small as to be practically negligible.

FIG. 10.



The worm wheel W and the casting V for the weigh levers are bored out to receive the ends of the specimen, and are provided with fixed keys, which slide in corresponding keyways cut in the specimen. When tubes are subjected to stress they are provided with solid ends secured by transverse pins, thereby avoiding brazed joints, since these latter are troublesome, owing to the state of the metal being altered by the brazing. The end of the specimen projecting through the worm wheel is fitted with a lever X for applying bending moment, and both levers for bending may be loaded independently or by a cross bar suspended from stirrups, as shown in Fig. 2.

A photograph of the machine is reproduced in Fig. 8, with a specimen inserted which has failed under the combined effect of bending moment and twisting moments.

Measurement of the strains.—The worm wheel is graduated in degrees, and a vernier circle enables 0·1 of a degree to be read with ease, while in order to start with a zero reading this vernier is carried on a ring sliding in a groove in the casing, so that it can be adjusted to any angular position. This arrangement measures the twist on the whole specimen, and includes any motion due to backlash in the keys and keyways during a test; it is therefore only suitable for measurements with long wires having substantial ends, and for plastic strains in which the end effects are negligible in comparison.

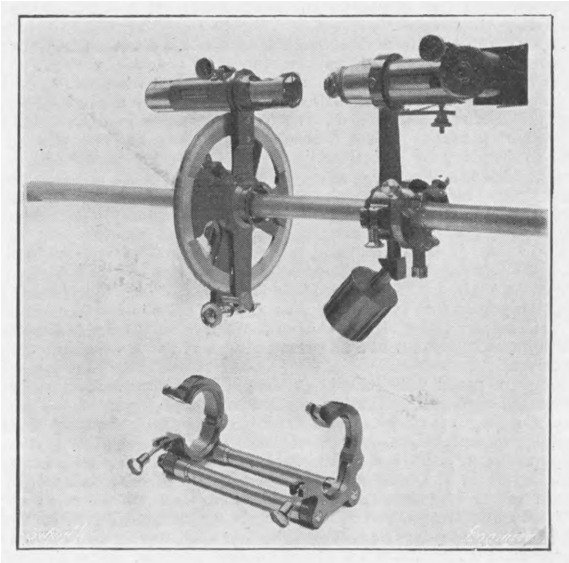


Fig. 11

For observations within the elastic limit the author prefers to use an instrument[*] which is secured to the specimen and is self-contained.

This instrument was originally designed to measure the angle of twist within the elastic limit, and with some recent alterations it can be adjusted in a few seconds for measuring the angular change due to bending. The calibration of the readings is effected on the specimen, and serves for both bending and twisting. Fig. 9 shows the apparatus in part longitudinal section, and Fig. 11 is from a photograph.

It consists of a graduated circle A mounted on the specimen B by three screws C in the chuck plate D. A sleeve E provided with three screws grips the specimen at a fixed distance away from the first set.

The spacing of these two main pieces on the specimen is effected by a clamp, not shown in the figure, which grips the double cones F, G, and maintains them at the correct distance apart, until the set screws are adjusted.

The clamp, Fig. 11, is afterwards removed, leaving the plane of the graduated circle perpendicular to the axis of the specimen and the sleeve correctly set and ready to receive the reading microscope H.

The vernier plate carries a sliding tube I, on which a wire J is mounted, and the movement of this latter due to bending or twist is measured by a scale in the eyepiece K, the divisions of which are calibrated by reference to the graduated circle. It is found convenient to have the microscope tube pivoted about an axis perpendicular to its central line at L, so that any slight difference due to imperfect centering can be adjusted by the screw M to make the calibration value agree for a series of specimens.

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[*] From the "Proceedings" of the Physical Society of London, vol. xxi.; also *Phil. Mag.*, April, 1909. Read February 26th, 1909.

[*] "On Instruments for Measuring Small Torsional Strains," *Phil. Mag.*, ecember, 1899.

The observation wire may be set at any convenient position for calibration, but for observations of the angle of twist when the specimen is also subjected to a uniform bending moment the wire should be in the central plane perpendicular to the specimen. For if the bending is in the plane containing the axis of the specimen and the observation wire, it has the effect of causing new parts of the wire to come into view on the scale, but no error is caused thereby. If the specimen is bent in a plane at right angles to the former, then the change in the reading is $(\theta - \phi)\,l$, where θ and ϕ are the alterations of angle at the ends and $2\,l$ is the length of the specimen under observation. Since the bending is uniform $\theta = \phi$ and no correction is necessary. Bending in any other plane can be resolved into components in the vertical and horizontal planes, and therefore falls under the preceding cases. In order to effect the adjustment required, both the wire and the microscope slide in adjustable tubes provided with graduated scales, and the movement to bring the wire into focus is divided between them. To check the setting of the wire in the central position it is convenient to apply a uniform bending moment, and then to observe if any change takes place in the reading. The position for no change in the reading can be found in a few seconds.

In experiments where the bending moment is constant and the twisting moment is varied, no adjustment is practically required during the elastic life of the specimen ; and even when the bending moment is variable the adjustment is practically negligible, as the length of the specimen under test is only a few inches.

The instrument is used for observation of the angular change due to bending by adjusting the wire in the horizontal plane passing through the axis of the specimen, and at a fixed distance away from the central plane, as shown in Fig. 7. Thus, if the wire is at a distance x from the central plane, and the specimen is subjected to a uniform bending moment, the reading will be $(l + x)\,\theta - (l - x)\,\theta = 2\,x\,\theta$, and this is a measure of the angular change θ between the ends, since any correction involves higher powers of θ which are negligible for elastic strains. The instrument may therefore be used for measuring strains due to bending or twisting, and the single calibration required for both sets of readings is effected when the instrument is in position on the specimen.

With the usual notation the value of Young's modulus can be calculated from the equation $E\,I_1\,d\,y^2/d\,x^2 = M$, from which we obtain $EI_1\,\theta_1 = M\,l$ for determining E. Similarly the rigidity modulus for specimens of circular sections may be calculated from the equation $C = T\,l/I_2\,\theta_2$. The ratio of C to E can also be readily obtained from the value $a\,\theta_1/\theta_2$, where a is an instrument constant: values of Poisson's ratio may be determined in this way without calculating C and E separately. As an example, we may take the case of a test on a steel tube 6in. long, having an external diameter of 0.748in. and a wall thickness of 0.024in.

The calibration value of the eyepiece scale where referred to the graduated circle was found to be 10.35 divisions for one minute of arc. The following readings were obtained :—

Twisting moment. Inch-pounds.	Reading	△.
0	0	
100	237	-237
200	474	-237
300	712	-238
400	920	-238
500	1188	-238

and the value of C – 12,400,000 in inches and pounds was determined from these observations.

The observation wire was then rotated into a horizontal position and set at a distance of 1in. from the central plane. Bending moments were applied and readings were observed as follows :—

Bending moment. Inch-pounds.	Reading	△.
0	0	
100	59	-59
200	118	-59
300	178	-60
400	239	-61
500	297	-58

from which the value of E was calculated. The angular change θ_2 of one end of the specimen was determined from the readings R by the formula $R = 2\,x\,\theta_2$, where $x = 1$in., and account was taken of the fact that the effective radius of arc was changed from r_1 to r_2 in the new adjustment of the instrument so that the angle θ_2 must be multiplied by r_1/r_2. In this instance r_1/r_2 was 1.61 and $E/C = r_2/r_1 \cdot \theta_1/\theta_2 = 2.485$ or $E = 30{,}800{,}000$ and Poisson's ratio $= .243$.

A tension test on a similar piece of tube gave $E = 30{,}700{,}000$.

In addition to its applications for bending and twisting the apparatus may be used for testing a variety of cases of combined stress if a pump is added to give a fluid pressure in the interior of tubes.

The accompanying diagram—Fig. 10—shows the results of tests to failure of bicycle tubing when subjected to (I.) bending, (II.) twisting, and (III.) twisting combined with a uniform bending moment.

MODEL OF HUGE WATER TANK FOR CALCUTTA

DESIGNED BY MR. W. B. MACCABE, M. INST. C.E., ENGINEER TO THE CORPORATION OF CALCUTTA

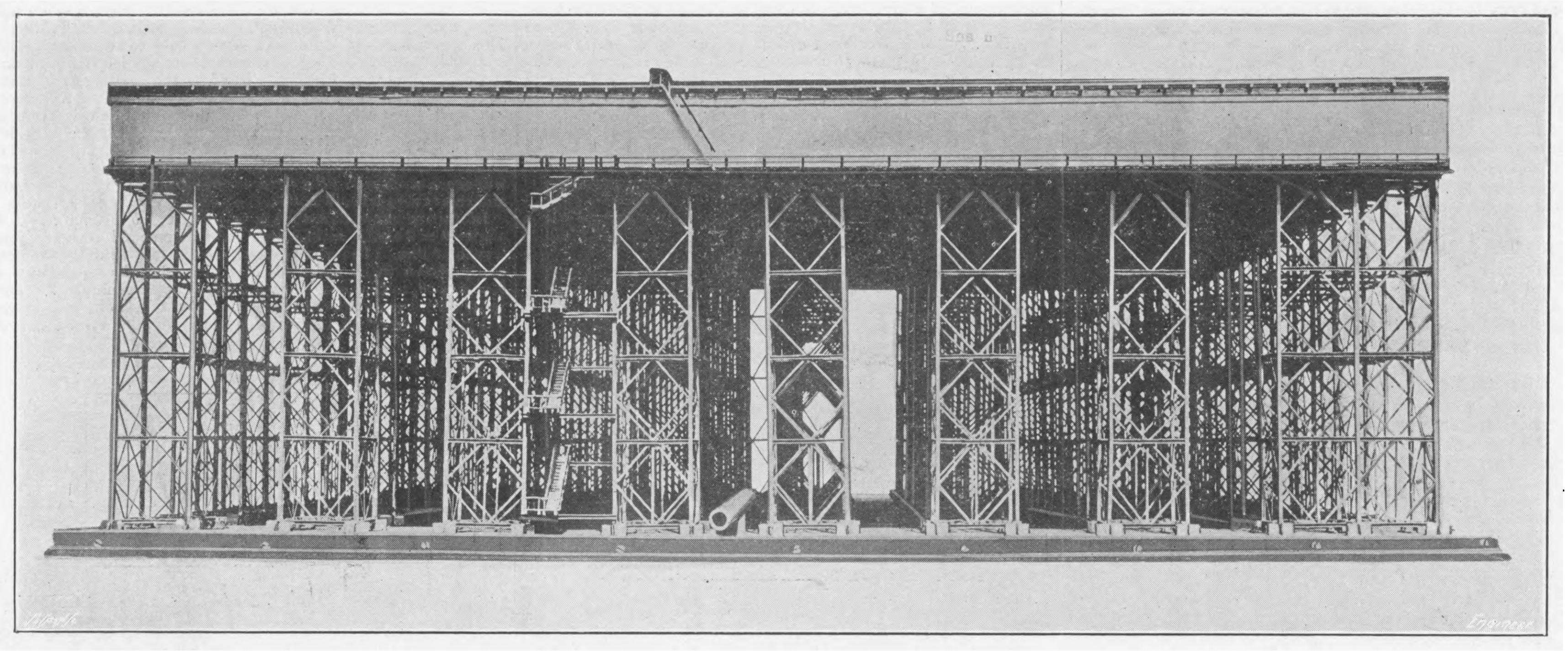


Fig. 1

A 9,000,000 GALLONS TANK.

THE preliminary work in connection with the construction of the huge water reservoir for the Corporation of Calcutta, the contract for which, our readers will remember, was allotted to the firm of Clayton, Son and Co., Limited, Leeds, is now well in hand. The tank, which has been designed by Mr. W. B. MacCabe, M. Inst. C.E., chief engineer to the Corporation, will have a capacity of 9,000,000 gallons, or nearly 40,200 tons of water, and will involve the use of approximately 7000 tons of steel work. It will be 321ft. square, 16ft. deep, and will be divided by cross frames into four equal compartments, which can be used independently of each other, so that one or more compartments can at any time be thrown out of work for repairs or cleaning without interruption of the supply to the town. To give the necessary head the tank will be supported on steel columns, the height from the top of the reservoir to the ground level being fixed at 110ft., giving a water pressure of about 47 lb. per square inch. Our illustration above is from a photograph of a model of the tank, and shows the means by which it will be supported, while the figure below shows one of the steel trestles with staircase during erection at the builders' works in Leeds. There will be eighty-one of these huge columns, each composed of four rolled steel beams, braced together at intervals by smaller beams, and each trestle will carry cross beams at the top to support a 20ft. section of the tank floor. Provision for expansion and contraction of the tank will be made by making the bottom flexible, so that the only effect of changes of temperature will be that the slight sagging of the bottom which will take place between each pair of the supporting joists will slightly increase or decrease as the temperature rises or falls. The 60in. pipe, which will act both as the inlet and outlet branch, will be fitted with an expansion joint, while to protect the water from contamination and to keep it cool the tank will have a flat terrace roof consisting of 2$\frac{5}{8}$in. of fine concrete carried on slates laid between steel rafters. These in turn will be carried on steel joists supported on steel columns from the bottom of the tank. To make the roof water-tight a sheet of Callender's bitumen will be laid over the whole area between the slates and the concrete, and to prevent birds entering the tank through the ventilating spaces all means of ingress will be closed by brass wire netting.

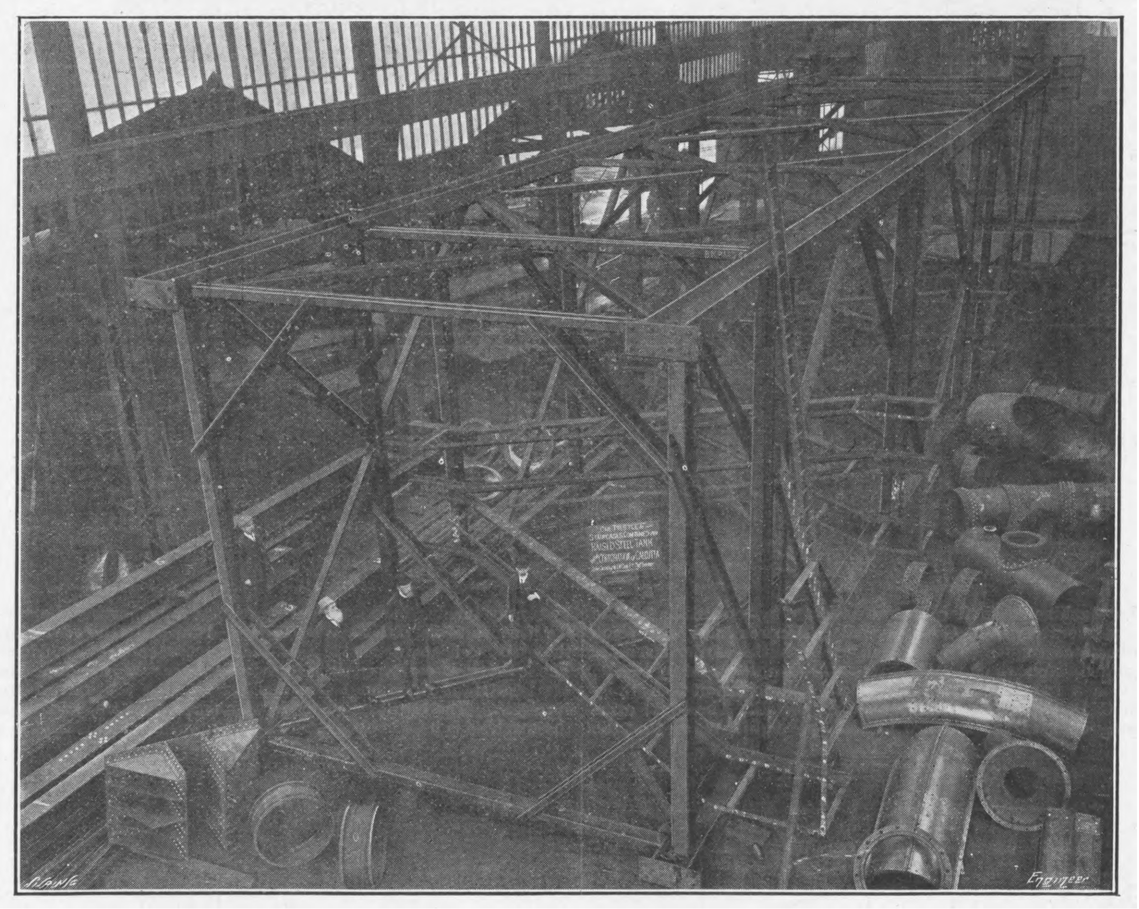


Fig. 2—ONE OF THE TRESTLES DURING CONSTRUCTION

The maximum load on each vertical member of the substructure of the tank will be 200 tons, thus giving a total load of 800 tons on each of the sets of four braced verticals. Under each member will be a shoe for distributing the load on the surface of the concrete to 6 tons per square foot. The load on the soil under the concrete foundations will only be about six-tenths of a ton per square foot, leaving a margin of safety even in bad ground such as exists in Calcutta.

The foundation at the Tallah Works where the tank is to be erected is a separate contract, and is on the grill reinforced concrete system. It consists of a bed of concrete 2ft. 6in. thick, reinforced at its base with a system of flat ties crossing each other at right angles beneath the supporting columns. Near the surface of the concrete bed a system of steel joists is to be built in, corresponding exactly to the system of flat ties below and upon these joists the bases of the columns will rest. The whole foundation forms a system of which the ties become the lower or tension members, and the joists and concrete take up the compression, spreading the weight over the whole area of the foundation. As an additional precaution a dwarf wall is to be constructed completely surrounding the foundations, and extending from the surface of the concrete to a depth of 4ft. below the foundation level. This wall will also be of concrete reinforced with expanded metal.

The tank forms part of a scheme to afford a present supply of 32 million gallons of filtered water per day, with provision for ultimate extension to 40 million gallons. The water will be raised up into the elevated reservoir by Diesel oil engines and pumps capable of delivering one-third of a million gallons per hour against a head of 125ft.

THE IRON, COAL, AND GENERAL TRADES OF BIRMINGHAM, WOLVERHAMPTON, AND OTHER DISTRICTS.

(*From our own Correspondent.*)

The Summer Quarterly Meeting.

THE July quarterly meeting of the Midland iron trade was held to-day—Thursday—the 8th inst., in Birmingham. At this time of the year the meeting is nearly always a quiet one, and the present was no exception to the rule; indeed, it seemed quieter than usual. Ordinary contracts were renewed according to custom, but there was no buoyancy, and it soon became evident that buyers intended to operate in a very conservative fashion, arranging for just what supplies were necessary for immediate requirements and going no further. Sellers endeavoured to brighten up the demand by making concessions, but this plan was only here and there successful. As a rule, consumers did not wish to commit themselves forward, not having much work in hand or in prospect, and prices all round being at a low level, there was not much inducement for producers to push business. Under these circumstances the gathering was devoid of strength and tone, and was one of the dullest quarterly meetings within memory. It is, however, hoped that trade will improve in the autumn, and when any inquiries were made for forward delivery quotations were based on that expectation. It is believed that the improved American position is bound to have a good effect upon British trade before long. Continental importations are also scarcely so marked as recently, which gives English makers a better chance.

Pig Iron.

The furnaces will soon be making larger outputs as the result of the new orders this week booked. In some branches—including good quality foundry irons—there was a slightly improved tone, and the makers did not need to press sales as much as of late, whilst quotations continued steady. Cold blast pig iron was quoted 110s., with a moderate demand for chilled roll making, cylinder casting, and some other purposes. For all-mine 80s. to 81s. was asked, whilst part-mine continued at 48s. to 49s. 6d., and common forge at 46s. It was reported on 'Change that Northampton sorts were being shaded to some extent, but the general quotation was still 46s. to 47s., with Derbyshire descriptions ranging from 47s. 6d. to 48s. 6d.

Manufactured Iron.

Business was very quiet in manufactured iron. The usual contracts were renewed, but beyond that nothing was done. Marked bars were quoted £8, with the I.W.R.O. brand of the Earl of Dudley £8 12s. 6d. Second grade bars of the "list" houses were quoted £7, whilst unmarked sorts averaged about £6. Galvanised corrugated sheets were reported in good request for foreign and colonial markets, and the quotation was maintained at £12 10s. in bundles, f.o.b. Liverpool, for 24 w.g. Plain sheets were quiet at—singles, £7 2s. 6d. to £7 5s.; doubles, £7 5s. to £7 7s. 6d.; and trebles £7 17s. 6d. to £8. For hoop iron there was not much demand at £6 17s. 6d., and the same may be said of gas strip at £6 5s. to £6 7s. 6d. Slit nail rods were in moderate inquiry and were quoted £7, whilst some fair transactions took place in rivet iron at from £6 15s. to £7.

More Movement in Structural Steel.

The general dullness of the market was relieved by more movement than recently being noticeable in structural steel. In this department engineers were more willing to operate than of late, and some fair contracts were entered into, quotations being maintained at figures which showed no weakening upon those prevailing during the past fortnight. Girder plates were quoted £5 15s. to £5 17s. 6d.; engineering bars, £6 7s. 6d. to £6 17s. 6d.; joists, £5 10s. to £5 15s.; and angles also about £5 10s. to £5 15s. A good medium quality of boiler plates was obtainable at about £7, and this grade was in good request. There was a moderate inquiry for partly finished steel, Bessemer sheet bars being quoted £4 12s. 6d., and Siemens £4 15s.

Dearer Tendency of Fuel.

A feature of the quarterly meeting was the dearer tendency of fuel, in consequence of the difficulties which in some parts of the Midlands have attended the coming into force of the Mines—Eight Hours—Act. Some of the Warwickshire pits, at time of writing, are idle, the men and employers having failed to come to an agreement with regard to "snap" time—*i.e.*, luncheon time.

Foreign Trade Improving.

Foreign trade in several branches is improving. The Board of Trade returns for June show the following cases of increase from June, 1908, to June, 1909:—Motor cars—including motor cycles, *chassis*, and parts thereof—from £86,832 to £131,151; cycles, and parts thereof—except motor cycles—from £105,499 to £131,264; steel bars, angles, rods, &c., from £154,008 to £192,673; iron—wrought—in bars, angles, shapes, or sections, from 7633 tons to 8767 tons; galvanised corrugated sheets, from 29,240 tons to 35,563 tons; hoops and strip, from £19,377 to £21,435; wrought iron, and manufactures thereof, from £70,211 to £84,813.

NOTES FROM LANCASHIRE.

(*From our own Correspondent.*)

MANCHESTER, Thursday.

OWING to the King's visit to Manchester, the Exchange was closed and but little business transacted.

BARROW-IN-FURNESS, Thursday.

Hematites.

THERE is an easier feeling in hematite iron this week, although it has not led to any material reduction in the amount of business doing. Smelters are fairly well supplied with orders, and for some time past they have managed to avoid any increase in stocks, except in the case of an odd parcel of warrant iron of 1000 tons which has gone into stock. The stocks now held only bulk at 12,377 tons, which is a very modest figure. Makers have in hand a moderate amount of business, and they anticipate further orders long before they have cleared their books of their present commitments. The present quieter feeling is not likely to last long, as the chances of new orders are encouraging, and many of those engaged in the trade are sanguine that ere long there will be a much stronger market. Evidences of this are forthcoming from various directions. At any rate, makers anticipate it will be necessary to increase the output of their works in the early autumn. Prices remain unchanged from last week. Mixed Bessemer numbers are at 58s. net f.o.b., with 60s. to 61s. 6d. for special hematites, according to specification; and warrant iron is at 57s. 1½d. net cash. Little or no business is being done in warrant iron. Special hematites are selling fairly well, and there is a growing feeling that this branch of the local trade is likely to increase, as many buyers are anxious to get deliveries of high-graded iron according to very rigid specifications. This class of iron is used largely for very special work, and in many cases by makers of the highest class of refined steel. The demand for spiegeleisen is not very large, owing to the steel trade being only partially employed. Charcoal iron maintains a steady sale. Scrap iron is not in large request. Iron ore of native qualities is not in large request, and at several of the mines there is not much business being done. There is, however, a steady trade at the mines where the highest grades of metal are obtained. Prices are steady at 17s. 6d., 13s. 6d., and 11s. for best, medium and ordinary sorts net at mines.

Steel.

There are a few orders in the market for railway material, and makers in this district are trying to get a share of them. They are keeping their mills fairly employed, but they do not hold a large number of orders. In merchant steel the trade doing is small, and the plate mills at Barrow are still at a standstill. It is difficult to run this plant at present prices, seeing also that the demand is not such as will enable makers to keep their mills going on something like regular time.

Shipbuilding and Engineering.

The only item of news in the shipbuilding department is the fast run made from Liverpool to Douglas by the Barrow-built turbine steamer Ben-my-Chree. She covered the distance of 72 miles this week at the speed of 25 knots. This makes her the fastest turbine Channel steamer in the country. No shipbuilding orders are reported.

Shipping and Coal.

The shipments of iron and steel from West Coast ports last week amounted to 7825 tons—iron 2160 tons, and steel 5665 tons—as against 10,038 tons in the corresponding week of last year, a decrease of 2213 tons. For the year to date the shipments aggregate at 308,439 tons, against 260,621 tons in the corresponding period of last year, an increase of 47,818 tons. Coal and coke quiet.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

The Eight Hours Act in Operation.

So far as the men are concerned, the new Act is at the present time working satisfactorily. The first week is being completed, but that period is not sufficient to afford a full idea of the effects on both employers and employed. Locally, a little disturbance has arisen with the boys, who to some extent in these matters show themselves masters of the situation. In one or two instances, however, a settlement has been effected with them, and will no doubt also be made in other directions. The dispute, where it has arisen, has been chiefly due to the complaint of the lads with regard to not being consulted when changes were made. What is known as "snap time"—or mid-day meal time—has been the principal feature in the trouble.

The Coal Market and the New Act.

Although there has been an element of unrest in the South Yorkshire coal market, consequent upon the introduction of the Eight Hours Act, there has been no material change in quotations in the week such as would certainly have taken place had the fear of a general stoppage of pits in the country been seriously entertained. In several directions values have, no doubt, somewhat hardened; but rates have not been advanced, and business has proceeded, with the exception of certain interruptions through local disputes, pretty much as usual.

House, Steam, and Gas Coal.

Early reports of the trouble in the distant coalfields seem to have had some effect on the demand for domestic fuel. Merchants received a considerable number of stocking orders, which usually are not expected to be placed before August and September. The metropolitan requirements were fully maintained, and more activity was perceptible in the country trade. The higher grades of house coal were most in request. Best Barnsley, at the pit, maintains former prices, from 11s. 6d. to 13s. per ton. Secondary sorts are not quite so much sought after, being more affected by the change in the weather, causing a little weakening, current prices being from 10s. to 11s. per ton. The principal feature of the coal trade continues to be the activity in shipping. Through the local disputes referred to, some coalowners have been able to obtain better prices, but this has only affected the market very little. The general rate in the open market is 9s. per ton, which is 6d. per ton above the contract rate. The railway companies are receiving full deliveries, and the export business continues brisk. The weight taken to Hull for the week ending 29th June last was 72,448 tons, as compared with 59,822 tons for the corresponding week of last year. Gas coal contracts are being steadily made, and will continue to be arranged until the end of this month. The basis is 6d. per ton, and in some instances 9d. per ton over last year's prices.

Small Coal and Coke.

In small coal there is a market for the quantity raised. The qualities sent to the textile districts are as much in request as ever, and the price is easily maintained at 4s. 6d. to 5s. 6d. per ton. Small slack for coking purposes makes from 3s. 6d. to 4s. 6d. per ton. A fairly active business is doing in coke; best washed, 10s. 6d. to 11s. per ton; unwashed, 10s. to 10s. 6d. per ton.

The Iron Market.

Stocktaking in the iron and steel trades is still proceeding, and will last for the most part of this month in several directions. Opportunity is thus afforded for those of the staff not employed in stocktaking being given their holidays. This, with the general apathy in business, makes markets very flat. Iron quotations continue unchanged. Hematites, West Coast, 68s. to 69s. per ton; East Coast, 64s. to 65s. per ton, both less 2½ per cent., delivered in Sheffield and Rotherham. Both the Lincolnshire and Derbyshire makers are well sold forward, and are consequently not pressing sales. Quotations:—Lincolnshire, No. 3 foundry, 50s. per ton; No. 4 foundry, 49s. per ton; No. 4 forge, 49s. per ton; No. 5 forge, mottled and white, 49s. per ton; basic, 50s. 6d. per ton; Derbyshire, No. 3 foundry, 50s. per ton; No. 4 forge, 49s. per ton. Lincolnshire and Derbyshire iron net, delivered in Sheffield and Rotherham.

Bar Iron, Hoops, and Sheets.

Makers of bar iron have been very inadequately employed of late, and signs of improvement are not yet perceptible. The June turnover is stated to have been the smallest of the year. The official price for bars is regarded as unremunerative. Quotations:—Bars, £6 10s. per ton; hoops, £7 10s. per ton; sheets, £8 10s. per ton.

Steel, &c.

The improvement in the call for steel of the higher grades for the United States is maintained, and there are reports of several other distant markets having ordered a little more freely. But the improvement is more in value than in volume, there being no advance in the general grades of steel manufacture. Some increased work for abroad in circular saws and other products is reported. The centres of agricultural engineering are good customers for the steel used in their specialities, more particularly in traction engines, threshing machinery, and similar manufactures. There is no change for the better, however, in railway steel. The marine material department remains languid. The heavy and light industries generally are as stated last week. New work all round would be exceedingly welcome.

Sheffield Trade with the United States—Increased Exports.

The exports from Sheffield to the United States for the quarter ended June 30th last include, for the first time, details from Barnsley, which have previously appeared under their own heading. The total value is £164,034. Deducting the distinctly Barnsley items, there remains a total of £150,657, being an increase of £54,863 over the corresponding period of last year. A very gratifying feature of the return is that exports of steel, sheets, bars, wire, &c.—which are all grouped in one section—have advanced to £115,233 from £66 629, thus showing an increase of £48,604. Cutlery has also improved—to £18,922 from £12,346, an increase of £6582. There are also increases in saw plates, sheep and garden shears, twist drills, umbrella ribs, measuring tapes, &c. Decreases are shown in edge and other tools, electro-plate, garden tools, grindstones, machinery, graining combs, platinum sponge, &c.

Personal.

Mr. Lewis J. Firth, of Ordsall Hall, Retford, is retiring from the board of Thomas Firth and Sons, Limited, Norfolk Works, Sheffield. Mr. Firth has been at Norfolk Works for thirty-five years, for the last twenty-four of which he has been a managing director. Mr. Firth, who is not retiring until next spring, retains his connection with the Firth-Sterling Company, Pittsburg, Pa., and Washington, D.C., of which company he is president. Mr. F. C. Fairholme, formerly one of the managing directors of Cammell, Laird and Co., Limited, Cyclops Works, Sheffield, has been offered, and has accepted, a seat on the Board of Thomas Firth and Sons, Limited, Norfolk Works, Sheffield.

NORTH OF ENGLAND.

(*From our own Correspondent.*)

Cleveland Pig Iron.

IT is possible this week to report more favourably about the Cleveland pig iron trade than has been the case for some weeks. Certainly traders are not quite so much "in the dumps" as they have been, the tone has become more cheerful, and prices of makers' iron are remarkably steady. The "bears" in Glasgow have tried hard to force the prices of Cleveland warrants down, but they have moved only to a very slight extent during the last three weeks, the top price having been 48s. 5d. cash buyers, and the minimum 48s. 0½d. It is evident that the bulk of the warrants are in strong hands, and that probably these are intending to hold them until the autumn, when one usually expects prices to advance. There is at any rate no pressure to sell warrants, neither are makers very keen to let their iron go at the present prices, though it is reported that some of them have considerable stocks. It is, however, possible that a good deal of the iron stocked in their yards is already sold, and is kept there for the convenience of the buyer. The approach of the holidays at the works of the consumers of Cleveland pig iron in Scotland and also in this district does not detrimentally affect the market. The Glasgow Fair holidays occur this month, and the Stockton race week holidays come about the middle of next month. The latter, however, do not interfere with trade so much as they used to do, because such a large proportion of the pig iron made is shipped, and the export business is carried on without stop. The price of No. 3 Cleveland G.M.B. pig iron has this week been kept at 48s. 3d. per ton for prompt f.o.b. delivery, No. 1 is at 50s. 9d., No. 4 foundry at 47s. 3d., No. 4 forge at 47s., and mottled and white at 46s. 6d., all for early delivery, and 6d. to 9d. per ton more is quoted for delivery up to the close of the year.

Hematite Pig Iron.

Consumers of hematite pig iron are giving out few orders, and the demand has not been so slack for years as it is now, nor is it likely to be any better until there is a substantial improvement in the shipbuilding industry of this district. The deliveries are not equal to the production, but none of the surplus is going into Connal's public store. The stock is being held by the makers, and in some cases is reported to be considerable, but there are no figures forthcoming to verify the statements, as ironmasters in this district no longer give any information about their stocks. But if there is not soon a revival of trade the blowing out of some of the furnaces will have to be reported, as makers cannot go on producing iron at a loss and stocking a proportion of their output. Ironmasters turning out hematite iron are fortunate if they can make the present selling prices cover the cost of manufacture. Mixed numbers of East Coast hematite pig iron for prompt delivery are quoted at 55s per ton, and for delivery up to the end of the quarter at 55s. 6d. Rubio ore is still to be bought at 16s. per ton c.i.f. Middlesbrough for immediate delivery, but most of the merchants keep their quotations at 16s 3d. Ironmasters are getting no relief in the price of coke, for it is again on the move upward, the easing which was reported towards the end of last month having disappeared since the heavy stocks which were then held at the collieries have been cleared away by the increased shipping demands, and now consumers have agreed to pay 15s. 6d. per ton for furnace coke delivered equal to Middlesbrough. Consumers were counting upon the average price of furnace coke dropping to 15s.

Realised Price of Cleveland Iron.

The public accountants, who are appointed by the Cleveland Ironmasters' Association, the Cleveland Blast Furnacemen's Association, and the North-Eastern Railway Company, to examine the books of the ironmasters, and ascertain the net average price realised for the No. 3 Cleveland pig iron delivered by them in the second quarter of the year, have announced that this average price was 47s. 6.71d. per ton, that showing a decrease of 1s. 4.16d. per ton on the figure reported for the first quarter of the year. That was somewhat disappointing, for no one expected the price to drop as much as that, when quoted prices rather improved than declined. In accordance with the sliding scale arrangement, the wages of the men engaged at the blast furnaces in the North-East of England are to be reduced 1¼ per cent., to take effect from 3rd inst., and rates for the carriage of ironmaking materials—ironstone, coal, coke, and limestone—over the North-Eastern Railway will be reduced 1 per cent. The realised price for the past quarter was 1s. 9.49d. per ton below that reported at the commencement of the year, 3s. 6.17d. below the price in the second quarter of last year, and 9s. 8.29d. below the best figure attained during the late boom, that being 57s. 3d. for the third quarter of 1907. It was the lowest price that has been reported since the first quarter of 1905. The average quoted price for No. 3 Cleveland pig iron during the second quarter of the current year was 48s. 3.4d. pe ton, as against 47s. 10.88d. in the previous quarter, the lowest quotation being 47s. 3d.—at the commencement of the quarter—and the highest 49s.—in the first fortnight of June.

Stock of Pig Iron.

Messrs. Connal and Co. have reported that the stock of Cleveland pig iron in their public store at the end of June was 237,822 tons, against 221,073 tons at the close of May, an increase of 16,804 tons during the month, and over the last quarter of 42,569 tons. The stock a twelvemonth ago was 48,350 tons, and every month since then an increase has had to be reported, the total increase for the year being 189,532 tons, which is at the rate of 16,000 tons per month, and it is more than two years since the stock was larger than it is now. At June 30th the stock consisted of 232,907 tons of No. 3, 4450 tons of No. 4 foundry, and 525 tons of other Cleveland iron not deliverable as standard. During the first half of the year 101,568 tons has been added to the stock. Makers' stocks have also been increasing, but there are no statistics available to show by how much.

Exports of Pig Iron.

The June exports of pig iron from the Cleveland district fell short of expectations, being particularly unsatisfactory so far as the oversea shipments were concerned. The total exports were only 105,203 tons, which did not come up to the average of the month for the past ten years. This average was 112,420 tons, so that last month's return was 6½ per cent. below the average; it was 8 per cent. less than in May, 13 per cent. less than in June last year, and 40 per cent. less than in June, 1907, which was the best June on record. The best month on record was April, 1907, with 177,627 tons, or 41 per cent. more than last month. The deliveries to oversea destinations only reached 63,049 tons, which was less than half the quantity reported in June, 1907. There were large decreases to Germany and the United States. As much as 62,000 tons have been sent to Germany in a single month, but last month the quantity was no more than 13,930 tons, against 33,491 tons in June, 1908, and 50,243 tons in June, 1907. North America needed only 2700 tons last month, against 48,516 tons in June, 1907. Deliveries were quieter to France, Italy, and Scotland. Of the 28,114 tons sent to Scotland, over 17,800 tons went from the Skinningrove Ironworks, or nearly two-thirds. Cleveland makers have not for many years done as active a business with Wales as was reported last month. The tin-plate manufacturers have bought pig iron in this district of late more freely than usual.

The Half-year's Iron Exports.

The shipments of pig iron from the Cleveland district during the first half of this year reached only 577,064 tons as compared with 705,294 tons last year, and 926,499 tons in 1907, the last being the largest on record. The deliveries last half-year were the worst that have been reported since 1905. The chief decreases were to Germany and North America. Germany received 75,878 tons last half-year, against 234,103 tons in the first half of 1907; and North America 27,480 tons against 216,887 tons in first six months of 1907. Scotland took 159,753 tons, against 206,230 tons in first half last year. These countries account for the greatest part of the decrease in business on export account.

Manufactured Iron and Steel.

Business in nearly all branches of the finished iron and steel industries of this district continues very slow, and the few works that are well occupied—those producing rails and sheets—are doing little more than completing old orders. Consumers are very dilatory in supplying the specifications for what they have bought, and seem to be in no hurry about the execution of their orders. The shipments of steel from the Tees were very good last month; they reached 51,169 tons, against 35,292 tons in June, 1908, and they mainly consisted of rails and sheets, the latter both plain and galvanised. The six months' shipments of steel were 253,711 tons, against 233,775 tons in the first half of 1908, but of manufactured iron only 60,174 tons were exported, against 71,408 tons in 1908. The exports were chiefly to South America, India, Japan, South and East Africa, and Australia. It cannot be reported that any alterations of quotations have been made this week.

Coal and Coke.

The steam coal trade has become decidedly quiet since the settlement of the Welsh dispute over the Eight Hours question, and quotations have fallen from 13s. to 11s. 9d. per ton f.o.b. for best qualities. Consumers hold off from buying, as they think it better to wait until prices have got back to normal rates. Production at the collieries is still kept up, and heavy exports are reported. The gas coal trade is well maintained, the price of best being 11s. per ton, with seconds at 10s. 3d., both f.o.b. The labour difficulties in Wales did not affect this branch. Coking coal is firm at 10s. per ton. The depression in the coke trade has passed away. A fortnight ago it was reported that heavy stocks of coke were held at most of the collieries in Durham, and prices became very weak, but a strong export demand having sprung up, almost all the stock has disappeared, and the market has become firm again. Consumers who were waiting to buy furnace coke at 15s. per ton delivered equal to Middlesbrough now find they have to pay 15s. 6d. per ton for it, and it is not easily got at that.

NOTES FROM SCOTLAND.

(*From our own Correspondent.*)

The General Business Outlook.

THERE is no improvement in the general position of business in the iron and steel trades of Scotland since last report. The settlement of the coal crisis in Wales has had a reassuring effect, but there is still considerable apprehension regarding the final issue of the dispute between the Scottish coalmasters and miners on the question of wages. This question has exercised a deterrent influence on business for several weeks past, and a settlement of it now could not have much effect on the state of trade during the remainder of the current month. The Glasgow Fair holidays begin next week, and will last practically till the end of the month, and they will be accompanied or succeeded by similar holidays throughout the industrial centres of the West of Scotland.

The Pig Iron Market.

There has been comparatively little business done in the Glasgow pig iron warrant market. Cleveland warrants have changed hands since last report at 48s. 1d. to 48s. 3d. cash, 48s. 2½d. to 48s. 6d. one month, and 48s. 4d. to 48s. 11½d. for delivery in three months. Notwithstanding increase in stocks, the tone of the market has been fairly well maintained. There is likely to be uncertainty, however, as to the position of the market so long as the present labour troubles are unsettled.

Scotch Makers' Iron.

The demand for special brands of Scotch makers' pig iron has been limited. Inquiries on English account would seem to indicate a continuance of fair business, but the demand on the part of Scotch users is quite unsatisfactory at the moment. Some confidence is expressed in the future condition of the export trade with the Colonies and South America, but the current shipments are disappointing. The total clearances at the Scottish ports in the past week amounted to only 3915 tons, of which 2026 tons were despatched abroad and 1889 tons sent coastwise. During the first half of the year the shipments have aggregated 143,906 tons, which shows a decrease of 11,860 tons compared with the quantity despatched in the first six months of 1908. There are 82 furnaces in blast in Scotland, compared with 77 at this time last year. Prices of makers' iron are generally well maintained. Monkland, No. 1, is quoted f.a.s. at Glasgow, 56s.; No. 3, 54s.; Carnbroe, No. 1, 57s. 6d.; No. 3, 54s. 6d.; Clyde, No. 1, 60s.; No. 3, 54s.; Gartsherrie, No. 1, 60s. 6d.; No. 3, 54s. 6d.; Calder, No. 1, 60s. 6d.; No. 3, 55s. 6d; Summerlee and Langloan, Nos. 1, 61s.; Nos. 3, 56s.; Coltness, No. 1, 88s.; No. 3, 56s.; Glengarnock, at Ardrossan, No. 1, 62s. 6d.; No. 3, 57s.; Eglinton, at Ardrossan or Troon, No. 1, 55s. 6d.; No. 3, 53s. 6d.; Dalmellington, at Ayr, No. 1, 58s. 6d.; No. 3, 53s. 6d.; Shotts, at Leith or Glasgow, No. 1, 60s. 6d.; No. 3, 55s. 6d.; Carron, at Grangemouth, No. 1, 63s.; No. 3, 56s. per ton.

Imports of English Iron.

The arrivals in the past week, at Grangemouth, of pig iron from Cleveland and district were 6544 tons, being 233 tons more than in the corresponding week of 1908. In the course of the past six months these imports have aggregated 230,856 tons, showing a decrease for the half-year of 5945 tons. It is understood that considerable imports were made in the early part of the year, in expectation of a steady, if not a very large, increase in the consumption. This anticipation has not been fully realised, and there has recently been a slackening in the amount of the import business.

The Hematite Trade.

The market for Scotch hematite pig iron has been very quiet in the past week. Consumers cannot look forward at present beyond a few days, as they expect their works to be laid off for the last half of the month. Merchants continue to quote 57s. 6d. for Scotch hematite pigs for delivery at the West of Scotland steel works; but it is alleged that consumers are not prepared to offer so much, their ideas being from 56s. to 56s. 6d. per ton.

Finished Iron and Steel.

There has been a little more inquiry in the steel trade. Some firms report a fair business in structural material of a miscellaneous description. It has also to be noted that shipbuilders' specifications have been coming to hand rather more freely, and this gratifying circumstance is to some extent attributed to the recent concessions in prices. Makers, on the other hand, have still to contend with a tendency on the part of merchants to underquote, although it is scarcely credited that this business can be carried so far as before. The makers of malleable iron are unequally employed, some of them being better supplied with orders, while others have to keep their works partly idle.

The Dispute in the Coal Trade.

The Scottish coalmasters met towards the end of last week, in order to consider the position of the wages dispute. While they were practically unanimous in the opinion that a reduction of wages is necessary under the present circumstances of the trade, they decided to defer taking that step until after the conference with representatives of the executive of the British Miners' Federation. Whatever may be the ultimate outcome of the dispute, consumers of coal have not been showing any special anxiety to secure supplies. Home consumption will be greatly reduced by holidays in the last half of the month, and the arrangement that has been reached in Wales will obviate any special pressure for shipments at the Scottish ports.

WALES AND ADJOINING COUNTIES.

(*From our own Correspondent.*)

The Coal Settlement.

THE settlement arrived at last week, though concluded with difficulty, was so well discussed from point to point that there is little fear of minor ruptures in future. Minor points:—Workmen engaged on the surface in handling the coal shall work half an hour per day beyond the coal winding time, either starting fifteen minutes before coal winding and working fifteen minutes afterwards, or, at the option of the owners, working half an hour after the winding. The only workmen intended to come under the operation of this clause are those who handle the trams between the cage, and the tippers, the screen men, slag pickers, and wagon men. Banksmen are excluded. The meal-time for underground day wage men, day and night, shall be twenty minutes. It shall be so arranged as not to interfere with the haulage and general working of the colliery, and in the case of all workmen connected with the winding—whether employed upon the surface or below ground—the meal-times shall be twenty minutes, and shall be so arranged as to secure continuous winding of coal without interruption during the shift. Where serious, but non-fatal, accidents occur an agreed number of men, but not more than twenty, to be selected by the management, may accompany the injured workmen out of the pit. No stopping for funerals shall take place except by arrangement with the management. A copy of the Conciliation Board agreement, together with a copy of this supplemental agreement, shall be placed in a contract book at each colliery, which shall be signed by or on behalf of the owners of such colliery, and also by each workman engaged thereat as one of the terms of the engagement between the owners and the said workmen.

Ending of the Coal Difficulty.

On 'Change this week one has been frequently encountered not only by the personality of the "old authority," but by his remark that I told you so. There were, it is admitted, a few grave doubters who feared that a general strike would be precipitated; but the hugeness of the calamity feared was the great security, and all the country now may be congratulated that the storm is over and the crisis past. The past week has been one of a good deal of upset. Prices of best steam coal had gone up to £1, and it was notorious that for small parcels larger prices had been received. With the good news of a settlement the collapse set in, and merchants have been glad to get what they could. Ordinary figures have been 18s. to 18s. 6d. for best steam.

Latest Cardiff Prices.

Matters are gradually settling down; men generally returning to work, but much depends upon the weather. Tonnage coming in not large, and it will be some time before owners and dealers operate with a free hand. Latest prices:—Best steam, 15s. to 15s 6d.; best seconds, 14s. 6d. to 15s.; ordinary seconds, 13s. 9d. to 14s. 3d.; best drys, 14s. 6d. to 15s. 3d.; ordinary drys, 13s. 3d. to 13s. 9d.; best washed nuts, 13s. 6d. to 14s. 6d.; seconds, 12s. 6d. to 13s.; best washed peas, 12s. to 12s. 3d.; seconds, 10s. to 10s. 6d.; very best smalls, 9s. 3d. to 9s. 9d.; best ordinaries, 7s. 6d. to 8s. 6d.; inferior sorts, 6s. 6d. to 7s.; very best Monmouthshire black vein, 14s. 6d. to 14s. 9d.; ordinary Western Valleys, 13s. 9d. to 14s. 3d.; best Eastern Valleys, 13s. to 13s. 3d.; seconds, 12s. 6d. to 12s. 9d. Bituminous coal: Very best households, 16s. 6d. to 17s. 6d.; best ordinaries, 14s. 6d. to 15s. 6d.; No. 3 Rhondda, large, 17s. 3d. to 17s. 9d.; brush, 13s. 3d. to 13s. 9d.; smalls, 9s. 6d. to 10s. 3d.; No. 2 Rhondda, large, 12s. to 12s. 6d.; through and through, 10s. to 10s. 3d.; smalls, 8s. to 8s. 6d. Patent fuel, 15s. to 15s. 6d. Coke: Special foundry, 24s. to 26s.; foundry, 18s. to 20s. 6d.; furnace, 16s. to 17s. Pitwood, 18s. 9d. to 19s. 3d.

Newport Coal.

As is usually the case after an upset, operations have been small comparatively and conducted cautiously. For a few days there will be a reduced tonnage to handle. Best coals retain their position. Steam coal: Very best Newport—black vein—large, 14s. 3d. to 14s 6d.; Western Valleys, 13s. 6d. to 14s.; Eastern Valleys, 12s. 9d. to 13s; other sorts, 12s. 3d. to 12s. 6d.; best smalls, 8s. 6d. to 9s; seconds, 7s. 3d. to 7s. 9d.; inferiors, 6s. 6d. to 7s.; best house coal, 15s. to 15s. 3d.; seconds, 14s. to 14s. 3d. Patent fuel, 14s. 6d. to 15s. Coke: foundry, 17s. to 19s.; furnace, 16s. to 17s. Pitwood, ex ship, 18s. 9d. to 19s. 3d.

Swansea Coal: Anthracite.

It is satisfactory to record that the settlement has been received with pleasure by all parties, though the district is to an extent non-associated. Anthracite coal: Best malting, large (hand-picked), 23s. to 24s. net; second malting, large, 21s. to 21s. 6d. net; big vein, large, 19s. to 20s., less 2½ per cent.; red vein, large, 13s. to 13s. 6d., less 2½ per cent.; machine-made cobbles, 23s. 6d. to 24s. net; Paris nuts, 24s. to 25s. net; French nuts, 24s. to 25s. net; German nuts, 22s. 6d. to 23s. 6d. net; beans, 18s. to 19s. net; machine-made large peas, 11s. to 12s. net; machine-made fine peas, 10s. to 11s. net; rubbly culm, 6s. to 6s. 3d., less 2½ per cent.; duff, 3s. 3d. to 3s. 6d. net. Steam coal: Best large, 15s. to 16s., less 2½ per cent.; seconds, 13s. 6d. to 14s., less 2½ per cent.; bunkers, 11s. to 11s. 6d., less 2½ per cent.; small, 9s. to 10s., less 2½ per cent. Bituminous coal: No. 3 Rhondda, large, 18s. to 18s. 6d., less 2½ per cent.; through and through, 14s. to 15s., less 2½ per cent.; small, 10s. 3d. to 10s. 6d., less 2½ per cent. Patent fuel, 10s. 3d. to 10s. 6d., less 2½ per cent.

Iron and Steel.

The iron and steel revival is still delayed. At Dowlais the mills only worked four days, and slackness was the cry in other quarters. Isolated cases of activity are shown. At Baldwin's, Landore, the yield of pig was quite up to the average. The slackness of the steel trade is indicated by the fact that about one-fifth of the furnaces are still idle. Prospects at Dowlais of large mass of heavy rails and steel sleepers are good. Most of the foundries and steel shops in the district have plenty to do; Swansea imported steel plates last week, and 527 tons of steel scrap. Few cargoes of iron ore are coming in. Latest price iron ore: Rubio, 15s. 6d. to 15s. 9d. A large import of steel from Bruges came to Newport this week. Latest prices iron, steel, Swansea, pig iron:—Hematite mixed numbers, 57s. 1½d. cash and month; Middlesbrough, 48s. 2d. cash, and 48s. 5d. month; Scotch, 54s. 3d. cash and month; Welsh hematite, 62s. to 62s. 6d., delivered; East Coast hematite, 60s. to 61s. c.i.f. Steel bars:—Siemens, £4 10s. per ton; Bessemer, £4 10s. Other quotations:—Copper, £59 cash and £59 16s. three months. Lead:—English, £13 8s. 9d.; Spanish, £12 18s. 9d.; spelter, £21 18s. 9d.; silver, 23¾d. per ounce.

Tin-plate.

A peaceful ending to the dispute is anticipated, and upon all sides a belief prevails that this industry will become more vigorous after the temporary difficulty. Shipments of tin-plate last week totalled 180,953 boxes; receipts from works, 116,705 boxes; present stocks, 190,858 boxes. Good work is being done at Llanelly. At the Wem Foundry Messrs. Richard Neville have just completed another massive fly-wheel, weighing 100 tons. A large steel plant is also to be laid down.

Latest Prices.

Ordinary Bessemer and Siemens, 12s.; C.A. roofing sheets, £8 7s. 6d. per ton; big sheets for galvanising, £8 7s. 6d. to £8 12s. 6d. per ton; finished black plates, £9 5s. to £9 10s; galvanised sheets, 24 g, £12 10s.; block tin, £131 17s. 6d. cash, and £133 7s. 6d. three months.

LAUNCHES AND TRIAL TRIPS.

H. V. HENRY, steel screw steamer; built by the Greenock and Grangemouth Dockyard Company, Limited; to the order of John Black and Co., of West-street, Glasgow, on behalf of H. R. Rood, of Seattle, U.S.A.; dimensions, 373ft. by 49ft. by 29ft. 3in.; to carry 6000 tons; engines, triple-expansion, 25in., 41in., 68in., by 48in. stroke, pressure 180 lb.; constructed by David Rowan and Co., of Glasgow; trial trip, July 3rd.

ANNABERG, steel screw steamer; built by Swan, Hunter and Wigham Richardson, Limited; to the order of the Deutsch-Australische Dampfschifffahrts Gesellschaft; dimensions, 400ft. by 52¼ft. beam; to carry 7500 tons; engines, triple-expansion; constructed by the builders; launch, July 5th.

HOLTBY, steel screw steamer; built by Ropner and Sons, Limited; dimensions, 358ft. 6in. by 50ft. 10in. by 25ft. 6in.; engines, triple-expansion, pressure 180 lb.; constructed by Blair and Co., Limited; launch, July 5th.

ETIENNE WATEL, twin screw shallow draught steel tug; built by Edward Hayes; dimensions, 60ft. by 10ft. by 3ft; engines, compound, 6in., 12in. by 8in. stroke, pressure 120 lb.; trial trip, recently.

NERO, steel screw steamer; built by Earle's Shipbuilding Company; to the order of Thomas Wilson, Sons and Co., Limited, Hull; dimensions, 250ft. by 35ft. by 18ft.; launch, July 5th.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

PECKETT AND SONS, of Atlas Locomotive Works, St. George, Bristol, are increasing the plant in their boilermaking department by the addition of two electric travelling cranes, and have also added to the same department a 200-ton hydraulic flanging press.

WE are asked by the Adams Manufacturing Company, Limited, of Bedford, to state that its works and offices will be closed from Saturday, July 31st, till Monday, August 9th, 1909. A small staff, however, will be in attendance to deal with matters of extreme urgency.

WE learn that the firm of Lewis Olrick and Co., known in connection with the Field boiler, has moved to more convenient offices at 16, Howick-place, Westminster, S.W., and has recently acquired the patent rights for a new glazing bar, and a combined superheater and water separator.

THE Witton-Kramer Electric Tool and Hoist Company, of Witton, Birmingham, informs us that it has recently acquired the entire goodwill of the business of Kramos, Limited, of Locksbrook Engineering Works, Bath, including this firm's patterns, designs, patents, and trade marks. The Witton-Kramer Company is carrying on the manufacture of similar apparatus and machinery to those of Kramos, Limited.

CONTRACTS.—The New Lowca Engineering Company, Limited, of Whitehaven, has secured an order for building a boat and equipping her with engine complete for passenger and mail service on the lakes in Ceylon.—Geo. Robson and Co., of Sheffield, have recently obtained an order for a complete clinker crushing and screening plant for the Rotherham Corporation; also an order from the Bradford Corporation for one of their patent portable electric grinders.—The contracts for the ironwork, coal conveying and coal sorting belt conveyors, to replace those destroyed at collieries in Dundee and Newcastle districts, Natal, during the Boer War, have been received by the Gilbert Little Company, Limited, Horton Works, Bradford.

NOTES FROM GERMANY, FRANCE, BELGIUM, &c.

(*From our own Correspondent.*)

Rheinland-Westphalia.

THERE is no marked change to report in the condition of the iron trade. Demand generally is moderate, but quotations have been well maintained, and in a few instances sellers have been asking increased quotations for immediate delivery; but these are exceptions, the majority of producers finding it rather difficult to obtain paying rates. Improving accounts can be given regarding the prospects and employment of the Steel Convention, the number of orders secured for the period June—September being 200,000 t. higher than for the corresponding period last year, although the inland railway orders are 100,000 t. lower than in 1908. As the amount of work secured on foreign account is just 107,000 t. higher than at this time last year, prospects may still be considered pretty fair. There is a specially good demand from America for rails; an improvement in the demand for sectional iron is also noted.

The Silesian Iron Market.

More work was reported in some departments, and a steady inquiry comes in for raw as well as for finished iron. Berlin bar dealers have raised the store prices from M. 11 50 to M. 12.50 per 100 kilos., subsequent to the reforming of the Union of Berlin Bar Dealers, which was dissolved some months ago. The Union has now decided to fix the price for steel bars at M. 125 p.t.; iron bars, M. 150 p.t.; while for iron plates M. 140 p.t. will be quoted. Until now M. 1.50 less per ton have been quoted, and prices were decidedly unremunerative. For the third quarter rates have already been raised M. 0.50 p.t. and more.

List Quotations.

The following are the current list rates per ton, free at works:—Raw spathose iron ore, M. 10.90; roasted ditto, M. 15.50; Nassau red iron ore, M 11.50, net at mines; spiegeleisen, 10 to 12 per cent. grade M. 63 to M. 66; white forge pig, Rhenish-Westphalian and Siegerland brands, M. 56 to M. 58; iron for steel making, M. 58 to M. 60; German Bessemer, M. 59 to M. 61; basic, free at place of consumption, M. 49 to M. 50; Luxemburg forge pig, free at Luxemburg, M. 44 to M. 46; foundry pig, No. 3, free at Luxemburg, M. 47 to M. 49; German foundry pig, No. 1, M. 58 to M. 60; No. 3, M. 57 to M. 59; German hematite, M. 59 to 61; good merchant bars, common quality, M. 97 to M. 103; iron bars, M. 122.50 to M. 125; hoops in basic, M. 120 to M. 122.50; common steel plates, M. 104 to M. 110; boiler plates, M. 114 to M. 120; sheets, M. 117.50 to M. 125.

The German Coal Market.

In the Ruhr district blast furnace coal shows a further decrease, and rumours are afloat of further reductions in quotations. Fairly large sales have been effected on the Silesian coal market, both local and foreign consumers purchasing freely. Present list rates are M. 12 to M. 13 p.t. for gas coal; steam coal, M. 10.35; best mixed sorts, M. 12.50 to M. 12 85; coal for coke making, M. 11 to M. 12; anthracite, M. 21 to M. 24 p.t.; blast furnace coke, M. 14.50 to M. 16.50; foundry coke, M. 17 to M. 19; best sorts for house fire purposes, M. 19.50 to M. 20 p.t.; briquettes, M. 10.50 to M. 13.75 p.t.

Austria-Hungary.

Buying has been slack on the iron market; there is no enterprising spirit, and demand is generally very limited. The majority of the works are only partially employed, with the result that quotations have weakened perceptibly. Pit coal as well as brown coal are in regular request.

Weak Quotations in Belgium.

Official reductions have not yet become known, but producers experience some difficulty in maintaining the former quotations. Under-quoting has increased, so that list rates are only nominal, makers willingly taking less in most cases. The number of orders received, both locally and on foreign account, has been decreasing. Prices for heavy plates maintain the firm tone of previous weeks, while those for sheets have lost much of their former stiffness. Steel castings are reported to be weak, owing to decreasing employment. The business in semi-finished steel has developed satisfactorily, and exports remain fairly extensive. The output in pig iron increases steadily. Imports in iron ore have advanced 17 per cent., or 245,234 t., during the first five months of the present year. The coal market in Belgium has maintained its satisfactory position, prices being firm. Coke meets with fair demand, and sales have been increasing during the week.

Iron and Steel in France.

There is no alteration in the conditions prevailing, and fairly good accounts continue to be given of the business done. Coal for engine and house-fire purposes is reported to be in steady demand, rates showing stiffness.

AMERICAN NOTES.

(*From our own Correspondent.*)

NEW YORK, July 1st.

AFTER a long season of uncertainty prices of pig iron have advanced, especially in basic and Bessemer, the supply of which is temporarily deficient. The occasion for this general improvement lies in the fact that many railway systems have entered upon a course of improvements, including the laying of track which has been neglected for nearly two years by some systems, the building of bridges which have been long contemplated, the construction of terminal facilities, and the construction of elevated roads in cities and suburbs. In addition to this shipbuilding has been helped, especially in the direction of coastwise building. Much of the commerce heretofore handled by railways is now provided for by ship lines between cities all the way from Boston to Galveston. Much merchandise intended for distribution in the south-western sections of the United States is now carried by ship from North Atlantic ports to Galveston or New Orleans, and there transshipped. The Atlantic shipyards have been large buyers of ship material, and they are being run to nearly full capacity. Finished products are selling freely for immediate delivery. Jobbers have very little stock. Mills have less. Bar mills are working to 80 per cent. of capacity. Sheet mills to 85 per cent., and tin mills are well filled up for the dull season. Open-hearth steel is scarce and hard to get. All mills are sold up, and prices are at least one dollar a ton more thirty days ago. Four sheet mills are to be erected as fast as the material and machinery can be had. All sorts of building material are in active demand, especially iron products entering. Nails, sheets, plain and corrugated, and all lines of wire products sell freely. The manufacturers of hardware are working full time for full deliveries. Copper exports averge over 1200 tons a day. Lake is 13¼. Exports for June, 30,000 tons. The domestic demand is more pronounced. New copper mines will be producing before the close of the year, and some of them will be of such value as to make an impression on the market. The domestic consumers have been accumulating copper stock for some time, and do not need to appear in the market. Heavier exports for July are looked for. The tin market is dull. Consumers are well supplied,

BRITISH PATENT SPECIFICATIONS.

When an invention is communicated from abroad the name and address of the Communicator is printed in italics.

When the abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent-office Sale Branch, 25, *Southampton-buildings, Chancery-lane, London, W.C., at* 8*d. each.*

The first date given is the date of application; the second date at the end of the abridgment is the date of the advertisement of the acceptance the complete specification.

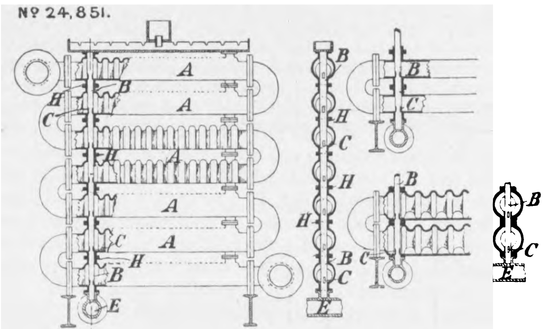
Any person may on any of the grounds mentioned in the Acts, within two months of the date given at the end of the abridgment, give notice at the Patent-office of opposition to the grant of a Patent.

STEAM ENGINES.

24,851. June 9th, 1909.—IMPROVEMENTS IN OR RELATING TO CONDENSERS, George William Amor, of 123, Longdale-road, Thornton Heath, Surrey.

This invention relates to condensers of the kind wherein steam is condensed in coils or rows of pipes, and the invention has for its object to provide improved means for draining such pipes. According to this invention a drainage pipe is passed vertically through the several pipes of a coil, the said drainage pipes being provided with drainage apertures at or near the bases of the several pipes. The drainage pipe, instead of being passed through the pipes, may be passed through the end connectors of the pipes or chambers which are disposed at the ends of the pipes for the purpose of collecting the water therefrom; in the last-mentioned arrangement the drainage apertures in the pipes will be coincident or nearly so with the lowest part of the end connectors or drainage chambers. The condenser is formed of a vertical coil of pipes A A with excentric corrugations and with a flat base; B is the vertical drainage pipe passing vertically through the several pipes A A and having at or near the base of each pipe A drainage apertures C C through which the water of condensation is drained away separately from each condenser pipe and conveyed by the drainage pipe B to a discharge pipe E. Flanges such as H may be provided upon the condenser pipes where the drainage pipe passes therethrough, and these flanges may serve as a means for securing the whole series of condenser pipes one to the other by jointing the flange or flanges of the bottom branches of the one pipe with the upper flange or flanges of the branches on the pipe below. By erecting the drainage pipe first the several condenser pipes can be conveniently threaded thereon and the erection of the condenser is thus facilitated. The top right-hand engraving shows the invention applied to a condenser having plain pipes, whilst in the two engravings below this corrugated pipes are employed having a longitudinal drainage gutter along the base. Two other engravings are given.—*June* 16*th*, 1909.

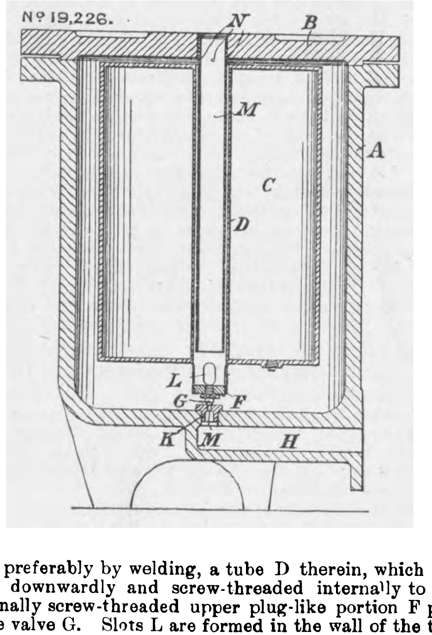
Nº 24,851.



19,226. September 12th, 1908.—IMPROVEMENTS IN OR RELATING TO STEAM TRAPS, Holden and Brooke, Limited, and John Percy Shepherd, both of Sirius Works, West Gorton, in the City and County of Manchester.

This invention relates to steam traps of the kind in which water of condensation, when accumulated to a sufficient extent, opens a discharge valve through the agency of a float, and it has for its object to improve the construction of such a trap. The trap casing A, cover B, and float C are conveniently circular in plan, and the central passage through the float is formed by suitably securing, preferably by welding, a tube D therein, which tube is extended downwardly and screw-threaded internally to receive the externally screw-threaded upper plug-like portion F pertaining to the valve G. Slots L are formed in the wall of the tube D, which terminate at their lower ends, at a level coincident with the outer periphery of the top or upper surface of the plug F. The valve proper is formed by a central downwardly projecting extension of a screw screwed into the plug F, and having conveniently a tapered lower end adapted, under the steam pressure, normally to seat itself upon the upper end of a bush K, and close a central discharge passage M extending therethrough, the said bush being secured in the bottom of the trap casing A to place the interior of the trap casing A in communication with the outlet H. M is the inlet pipe secured to the cover B and extending into the float tube, D N being holes at the top of the said tube M, whereby air is enabled to escape back through the trap into the steam pipe. —*June* 16*th*, 1909.

Nº 19,226.



19,625. September 18th, 1908.—IMPROVEMENTS IN AND RELATING TO STOP VALVES, Robert Cockburn, of Cockburns, Limited, of Cardonald, near Glasgow, Engineer.

This invention is a modification of or improvement on that described in the Specification of the Application for Letters Patent No. 4625 of 1908, and it has for its object to simplify the construction as hereinafter described. The engraving illustrates the application of the regulating device to a double-beat valve. As shown, the piston A connected to the main valve B B^1, which is similar to that described in the said specification, is fitted loosely within the liner C, or the liner C may be loosely fitted to allow escape of steam or other pressure fluid to the outer side A^1 of the piston, or to a space D in the valve cover, and thus produce equilibrium in the piston A, so that normally the pressure on the difference of areas of the valves B and B^1, if double beat, or the pressure on the area of the valve, if single beat, serves to keep the main valve B B^1 open. The space D in the valve cover communicates with the atmosphere by a passage E fitted with a spring-loaded valve F, whose spindle F^1 is adapted to be actuated by a manually operated lever G pivoted at G^1. On the spring-loaded valve being opened by means of the lever G, the steam or other pressure fluid acting on the outer side A^1 of the piston A is allowed to escape, and the internal pressure on the piston A forces the latter outward, and thereby closes the main valve.—*June* 16*th*, 1909.

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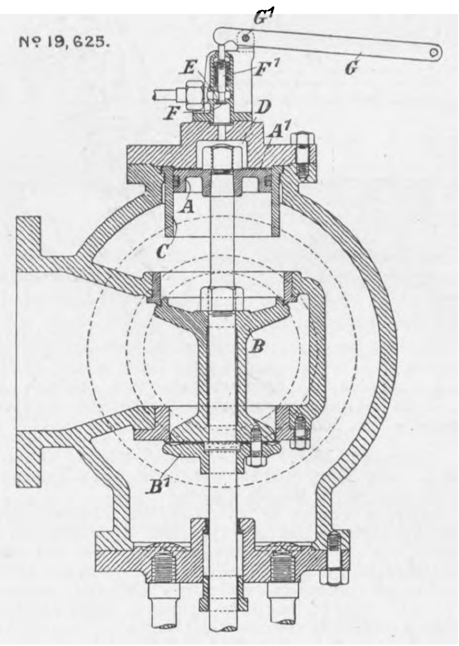
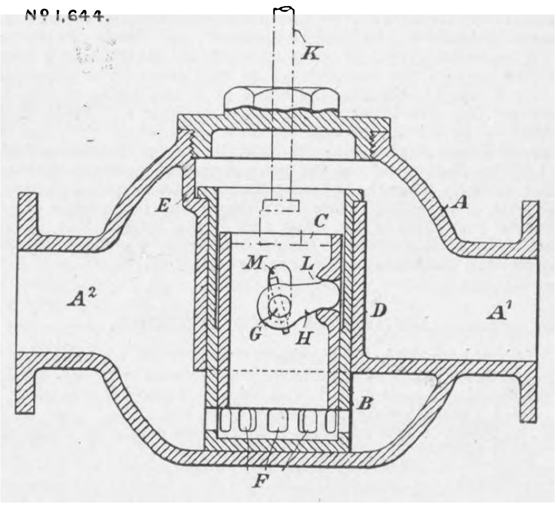


1644. January 22nd, 1909.—IMPROVEMENTS IN GOVERNOR VALVES FOR STEAM ENGINES, Henry Halford Ison, Charles Frederick Ison, Emily Bertha Forsyth, and Letitia Elizabeth Ison, trading as J. and E. Ison, of Ashby-de-la-Zouch, in the County of Leicester, Engineers, and Clarence Walter Allsop, of Avenue-road, Ashby-de-la-Zouch.

Referring to the engraving, A is the valve casing, which is provided with a steam inlet A^1 and steam outlet A^2, and formed with flanges or otherwise so constructed that it can be introduced into the length of a steam pipe, and B, C, are the outer and inner cylinders constituting the valve proper, the outer cylinder being fitted into a seat or socket D in the transverse partition E. At F the holes formed in the cylinder B are shown, which are designed to be more or less covered or uncovered by the lower end of the cylinder C, which slides in the cylinder B. Any suitable means may be provided for enabling the cylinder C to be moved by the governor, for instance, the spindle G, operated by the governor and passing through a stuffing-box in the side of the casing, can be provided on the inner end with a lever H, the free end of which enters a slot L in the said cylinder C, so that when the spindle G is rotated to a greater or less extent, the desired movement of the cylinder C will be produced. The hole M in the cylinder C, through which the spindle G passes, is elongated, as shown, so as to allow of the movement of the said cylinder relatively with the spindle; or, instead of operating the cylinder C as before described, the latter may have directly connected to it a rod K, as indicated in dotted lines in the figure, the rod being passed through a suitable stuffing-box, not shown.—*June* 16*th*, 1909.

Nº 1,644.



STEAM GENERATORS.

2003. September 4th, 1908.—AN IMPROVED REGISTER OR DAMPER FOR REGULATING THE PASSAGE OF FURNACE GASES THROUGH THE STEAM SUPERHEATER OF WATER-TUBE BOILERS, *Eugene Schneider, of Le Creusot* (*Saone et Loire*), *in the Republic of France.*

The present invention has for its object a register or damper constituted by movable shutters or blinds and serving to regulate the circulation of the hot gases passing through the nest of tubes of a superheater arranged between the water tubes of a water-tube boiler. The register or damper is constituted by movable shutters or blinds A^1 arranged in front—that is to say, on the side corresponding to running with the chimney in front—of the superheating tubes of the superheater forming the object of another application for a patent. These shutters carry at their ends trunnions movable in two lateral supports B^1 and each of them is connected with a vertical rod C actuated by a lever D operated by a rod E terminating in the driver's cab; the aperture of the shutters can be regulated by means of notches provided at the end of this rod or by means of a screw threaded rod provided with a hand wheel, nut, or some other convenient means not shown in the drawing. This

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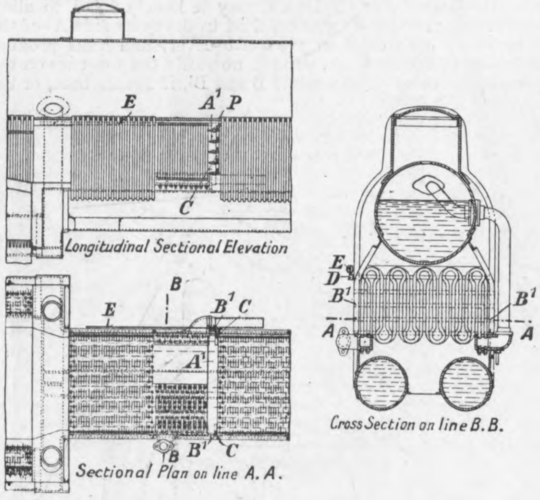
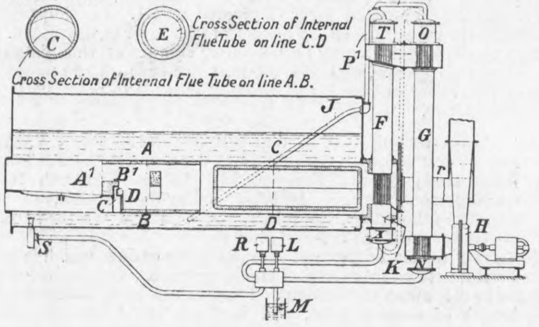

E
A¹ P
C
Longitudinal Sectional Elevation
B
B¹ C
E
A
A¹
B B¹ C
Sectional Plan on line A. A.
E
D
B¹
A
B¹
A
Cross Section on line B.B.

operation regulates the cross-sectional area available for the passage of the hot gases passing through the nest of tubes of the superheater.—*June 16th*, 1909.

27,269. December 15th, 1908.—IMPROVEMENTS RELATING TO BOILERS AND ECONOMISERS THEREFOR, John Thomas Nicolson, of Nantyglyn, Marple, Chester.

This invention relates to boilers of the internally-fired and cylindrical furnace and flue tube type, and of economisers for use therewith. The object is to increase the power and efficiency. An essential feature of the invention is the provision of flues or ducts for the hot furnace gases, that are long and narrow in the sense that the ratio of length to hydraulic mean depth, or the total heating surface to the cross sectional area, is not less than the minimum value 750 to 1. The internal cylindrical furnace and flue tube has within it, as shown, the grate A¹, the bridge B¹ (with an auxiliary air supply passage C¹), the combustion chamber D, and the fire-clay plug E. External to the boiler and at the rear of the same are arranged an evaporator F, an economiser G, a suction fan H, and an ash separating box K. The feed-pump L draws cold feed from a supply M, and forces same into the cold feed header N at the lower end of the economiser G through the nest of tubes in G, the hot feed header O, and thence either direct into the boiler by way of the pipes P P¹, or into the header X and thence through the evaporator F to the boiler. The circulating pump R draws water from the boiler at S and forces it into the header X at the lower end of the evaporator F. From X the water is forced up through the nest of tubes in F to the top header T, and thence into the boiler by way of the aforesaid pipe P¹. The discharges from the two pumps thus meet together, and they unitedly enter the boiler by the one internal pipe J, which is directed in an inclined manner as shown for the purpose of promoting circulation in the water area of the boiler. The by-pass flue way *r* leading direct to the chimney is for use when lighting up or when the fire is banked.—*June 16th*, 1909.

Nº 27, 269.

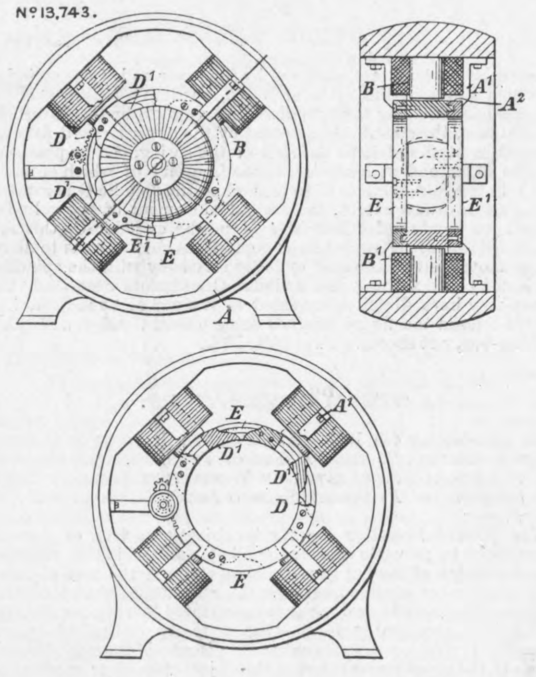

C
E
Cross Section of Internal Flue Tube on line C.D
Cross Section of Internal Flue Tube on line A.B.
P
T
O
P¹
J
F
G
A
C
A¹
B¹
C
D
B
D
r
S
R
L
K
N
H
M

DYNAMOS AND MOTORS.

13,743. June 29th, 1908.—IMPROVEMENTS IN OR RELATING TO DYNAMO ELECTRIC MACHINES, *Alvin Alexander Pifer, of* 10,303, *Westchester-avenue, N.E., and Charles Edward Frans Ahlm, of* 614, *Caxton-building, Cleveland, Ohio, U.S.A.*

The object of this invention is to provide means for regulating the speed of electro motors. In the form of machine illustrated, the frame A of the motor supports four pole pieces B, the coils B¹ for which are retained in position by brackets A¹ secured to the frame. At the inner extremity of each pole piece, next to the armature, are provided two pole-shoe sections D D¹ which are secured to and supported by rotatable diamagnetic rings E E¹. It will be noted that each shoe section is secured at one side to one ring, and guided by tongue and groove connection with the other ring. The alternate shoe sections are screwed to the same ring, and each ring is rotatably mounted in ways A² on the brackets A¹ so that they can be shifted angularly and retained in proper position. The pole shoe sections differ from the single plates hitherto used in the art in that, whereas the single plates were constructed to be moved between the armature and the pole of the magnet, the pole shoe sections are constructed so that they cannot move but half-way between, a construction which has advantages. It will be seen that movement of the rings and the pole shoe sections is absolutely independent of the pole pieces, since the rings and sections are not supported from or connected with and do not engage the pole cores in any manner. For the purpose of shifting the rings, each of them is provided with a short segmental rack on the periphery. The method of shunting the lines of force is obvious.—*June 16th*, 1909.

Nº 13,743.

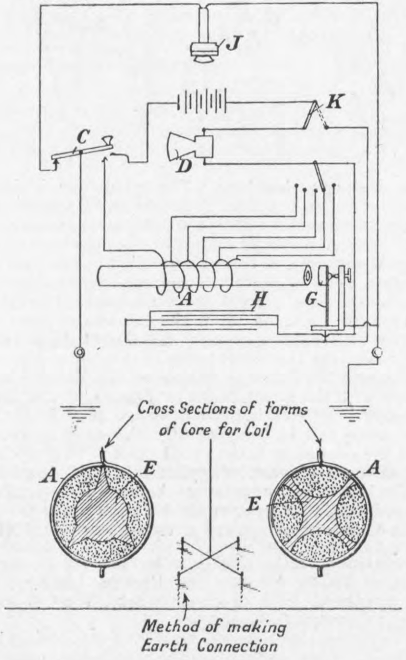


WIRELESS TELEGRAPHY.

12,140. June 4th, 1908.—IMPROVEMENTS IN AND RELATING TO WIRELESS TELEPHONY AND TELEGRAPHY, Alexander William Sharman, 4, Buckingham House, 111, Trinity-road, Upper Tooting.

This invention relates to an improved method and means for effecting telephonic and telegraphic communication between two or more stations without the employment of any insulated wire or artificial electrical conductor connecting such stations, in which the energy is transmitted by earth or water conduction, the method of producing momentary intense current impulses being by suddenly interrupting a low-tension current flowing between the ends of an inductance coil, such ends being also respectively connected to two or more separated earth or water contacts (the battery being excluded from the discharge circuit), whereby the "extra current" due to self-induction is utilised. The apparatus consists of a main electrical circuit, which includes a source of electrical energy, such as a battery of primary or secondary cells, an "impulse or self-inductance coil," having a winding A and a current-controlling device or electro-variable element D or G, such circuit being completed by a "signal switch key" C. The current-controlling device is shown in two forms, D and G, for telephony and telegraphy respectively. The "inductance or impulse coil" consists of a core or former E, containing iron, which should be in a finely divided or laminated state, wound with insulated wire of conducting material. For telephony, a microphonic contact D is used, preferably of the granular type, and of a high resistance, the switch K being in the drawn position. When the apparatus is used for telegraphy, the switch K is put over to the dotted position, and the current-controlling device G is used. This device G takes the form of an intermittent contact breaker, the said contacts being shunted by a condenser H. The "signal switch key" C used is similar in general construction to a single-current Morse key used in line telegraphy, and is provided with electrical contacts so arranged that in its normal position the receiving device, usually a telephone J, is connected directly to the two terminals of the apparatus called "impulse terminals." When the key C is depressed the telephone J is automatically disconnected. To the terminals L and K are connected the radiating or distributing earth contact wires.—*June 16th*, 1909.

Nº 12, 140.


J
K
C
D
A
H
G
Cross Sections of forms of Core for Coil
A
E
E
A
Method of making Earth Connection

SHIPS AND BOATS.

21,152. October 7th, 1908.—IMPROVEMENTS IN AND RELATING TO THE ELECTRICAL PROPULSION OF SHIPS, Siemens Brothers, Dynamo Works, Limited, of York Mansion, York-street, Westminster; and Carl Arnold Bernard Daniel Koettgen, of Ceres, Sundridge-avenue, Bromley, Kent.

This invention relates to means for varying the speed of ships' propellers electrically. It is proposed to obtain a step-wise variation of the motor speed with a fixed generator speed by arranging either the generator or the motor or both in known manner so that they can be worked with a number of magnetic poles which can be varied at will. If, for example, a generator is used, the number of magnetic poles of which can be varied in the ratio of 1 to 2, it is possible to obtain from this generator, at some fixed speed, currents which have frequencies in the ratio of 1 to 2 according to the number of magnetic poles used, and consequently the motor driven by the generator will have a speed range in the ratio 1 to 2. If, in addition, the motor is designed in known manner so that its number of magnetic poles can be varied at will, which is possible, for example, in the case of induction motors by winding the stator with special windings, then it is possible to obtain a still greater range of speed of the propeller shaft. For example, if the number of poles in both generator and motor can be varied in the ratio of 1 to 2, it is possible to get a variation of speed on the propeller shaft varying in steps proportional to 1, 2 and 4. Instead of using motors with a variable number of magnetic poles, the same result can be obtained by using two or more motors each with a constant number of magnetic poles and by connecting the motors to the generators singly or by the well-known cascade system. A combination of the cascade system with motors having a variable number of magnetic poles can also be used.—*June 16th*, 1909.

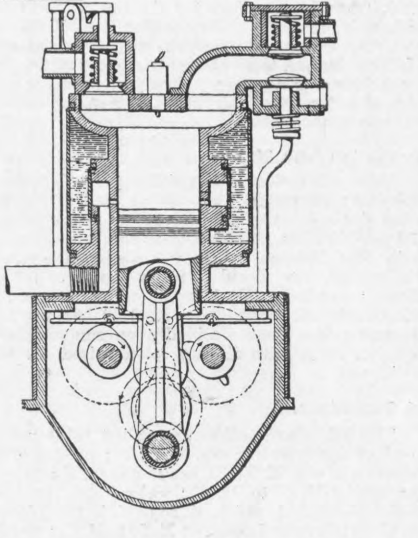
SELECTED AMERICAN PATENTS.

From the United States Patent-office Official Gazette.

923,491. EXPLOSIVE ENGINE, *R. W. Coffee, Richmond, Va., assignor to L. M. Keizer, Baltimore, Md.—Filed May 8th*, 1908. *Renewed March 20th*, 1909.

The patent is for an engine with a pair of cylinders having spaced peripheral flanges and formed in one. A closure plate held in peripheral grooves in the flanges encloses an exhaust chamber, the cylinders having ports from the explosion chamber to the exhaust chamber, and means formed with the cylinders to separate the exhaust chamber into separate sections—one for each cylinder. There are five claims.

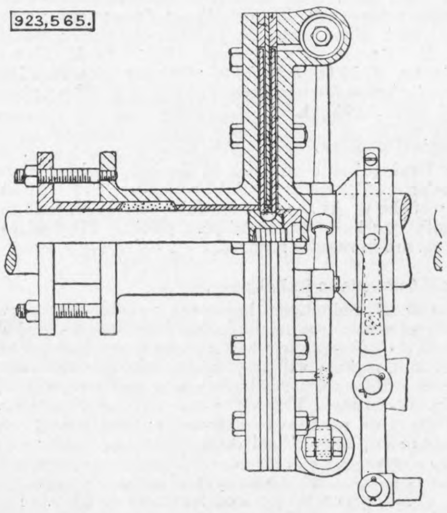
923,491.



923,565. FLUID-CLUTCH SPEED CONTROLLER AND POWER TRANSMITTER, *R. E. Newcomb, Holyoke, Mass.—Filed March 7th*, 1908.

This is a curious invention. The clutch consists of a number of interleaved discs very close together, one set on the driving, the other on the driven shaft. Into the spaces between the two a liquid under pressure is admitted, and the friction of this liquid on the discs does the driving. Presumably a thick liquid with a high frictional coefficient would be employed. There are eight rather long claims.

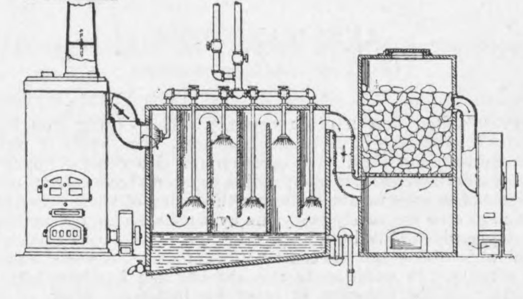
923,565.



923,846. PROCESS OF EXTRACTING NITROGEN FROM AIR, *O. P. Hurford, Chicago, Ill.—Filed September 15th*, 1906.

The process consists in burning all the oxygen out of the air admitted to a furnace. The resulting mixture of CO_2 and nitrogen is subjected to sprays of lime water to neutralise the acid and condense the steam as shown. There are three claims.

923, 846.



A STATEMENT of the general manager of the American Motor Car Manufacturers' Association, which has been published recently, is to the effect that the advance of the automobile industry in a decade has never been equalled by that of any other industry during a similar period. In 1898 there were 25 firms making cars in the United States; now there are 253, 100 of which turn out cars that are well known, and are factors in the market. The capital invested in the industry in 1898 was not more than 2,000 000 dols. (£400,000), while now, with kindred trades, sales rooms, garages, &c., the capital invested is close to 200,000,000 dols. (£40,000,000). Eleven years ago there was not more than 1200 cars in the country, while now the figures indicate that there are about 160,000 motor cars in the United States; as an example, there are 69,000 automobiles registered in New York State alone. Eleven years ago the production of the factories could not be calculated at more than 2 000,000 dols. (£400,000), while the output of self-propelled vehicles alone this year will not be less than 130,000,000 dols. (£26,000,000) in value, and the value of accessories and parts will run into many millions more.

THE MANAGEMENT AND EQUIPMENT OF AN EXPERIMENTAL TANK.

No. I.

One of the marked features of modern industry—perhaps the most marked—is an almost universal desire to obtain accurate scientific information regarding fundamental facts. To blend knowledge so obtained with practical experience in such a way as to obtain the highest possible efficiency in production and the greatest success in new development, is the aim of all who wish to keep in the forefront of progress. In no branch, perhaps, is this more evident than in shipbuilding and engineering.

The late Dr. Froude laid posterity under a heavy debt of gratitude when he conceived and carried into execution his idea of obtaining, by means of experiments on a small scale, information regarding speed and power of ships. His work was approved by the British Admiralty, and resulted in the establishment of the first experimental tank on business lines. Froude's work has become classical, and his methods have been closely followed wherever high-class shipbuilding is practised. No more complimentary statement can be made than to say, that for the speeds and powers with which he had to deal, his practice, in essentials, is still adequate. Modern developments have been so rapid, that modification and expansion have become necessary and inevitable; but where elaboration has taken the place of simplicity, it has not always been accompanied with marked success.

Experimental tanks may be regarded from two points of view. First as means of original research, and secondly as shipyard tools. If a tank be used solely for academic and research purposes, its management and arrangement will be somewhat different than if it is designed to serve the uses of a modern shipyard. As the latter case may be said to include the former, attention will be directed to this aspect of the case. Original research will always be demanded of such a tank to some extent, but the exigencies of immediate pressure, in a commercial concern, make the work so intermittent that the long-continued uninterrupted investigation necessary becomes almost impossible.

The normal work of a tank may be conveniently classed in three broad groups :—

(1) Designing of ship forms and propellers, with the manufacture and experimental testing of their models, made to scale. This includes recording and systematic docketing of all results obtained.

(2) Carrying out of speed and power observations, stopping trials, &c., on trial trips of completed vessels, so that comparisons of E.H.P. and I.H.P. or Shaft H.P. may be obtained, and a complete analysis of the progressive trials made.

(3) Estimating power and dimensions for new proposals from accumulated data, as a preliminary to actual test of a model if it be considered necessary to make one.

The general arrangement of the plant should be made to subserve these three ends primarily.

General arrangement of buildings.—It is presumed that models of ships are to be made of paraffin wax, and model propellers of an alloy in which tin, lead, and bismuth are blended in such proportions as to cool from the melted state without shrinkage. In hot climates it may be found necessary to use wood for ship models, but for moderate temperatures, paraffin is eminently suitable. It is practically non-absorbent of water, and so does not change weight when immersed for long periods. It melts at a comparatively low temperature, is easily cast, and can be worked by hand with ordinary joiners' tools or cutting machinery. Small alterations may be made to models, and damages repaired by a method of "burning on." The whole of the shavings during shaping, and finally the models after testing, go back to the melting-box, so that there is practically no waste of material. Most important of all, it lends itself to rapid handling, three days being sufficient to make and test a model for power.

In order to obtain the best arrangement of buildings, the first consideration must, of course, be the tank proper, or, as our American friends in Washington prefer to call it, the "basin." A great deal depends on the determination of design here. Certain things are essential, such as sufficient length to obtain a fairly long, steady run, and sufficient depth to be practically free of side and bottom effects on the resistance. There must be a free, uninterrupted water surface, not broken up by pillaring. The walls must be constructed to be water-tight, and to maintain their form under the water pressure, so that there shall be no deformation, except, perhaps, a little unavoidable settling. The point on which so much hinges is—How are the rails on which the towing apparatus runs to be situated? Are they to be hung from the roof girders, as in Dr. Froude's original tank, or are they to be bedded upon the side walls, as in the second installation for the Admiralty at Haslar, and in all those subsequently put down, with two or three exceptions?

It must be borne in mind that the width of the water surface is at the least 20ft., and at the most nearly 45ft., as at Washington, which has a beach to dissipate wave energy. If it be considered essential, as it seems to be by those who are concerned in recent tank construction, to bed the rails on the top of the walls, how much does that plan involve? As will be seen, a considerable amount.

First of all, the span of the moving carriage has to be something between 20ft. and 45ft.—suppose we say 30ft. For such a span it would seem almost imperative to use steel for construction. When Froude adopted the side wall rail system his span was only 20ft., and his carriage was constructed on the wooden box girder system. This gave him a weight of only 1¼ tons to accelerate, and was perfectly reasonable, although a wooden construction is open to criticism, where the atmosphere is so likely to be charged with moisture, and rigidity is desirable. When, however, those who followed him adopted a greater span, as at Berlin 34ft., Paris 32.8ft., Washington 44.6ft., &c., the problem became a serious one. By general consent a steel construction was demanded, with the result that, in place of a wooden carriage weighing 1¼ tons, as Froude had, the Paris carriage weighs 25 tons and the Washington carriage 32 tons. Berlin compromised the matter by carrying the rails on side pillars rising out of the water from the bottom of the tank, and so obtained a carriage of only 19.8ft. span, weighing 13.5 tons. This plan is reported to have proved unsatisfactory from want of rigidity of the rails, though there seems no good and sufficient reason why it should have done so if properly arranged. The pillars are, however, open to objection.

Now, the rapid and complete acceleration of these weights to any desired uniformity of speed becomes a matter of some difficulty, hence we find the Paris tank fitted with 100 horse-power as against 18 horse-power which Froude used, to obtain the same maximum velocity. Washington requires 200 horse-power but obtains a greater velocity. Berlin uses 20 horse-power to accelerate a mass of 13.5 tons to a higher maximum velocity than Froude obtained with one-tenth of the weight and practically the same power. Obviously the rates of acceleration must be very different. The acceleration problem is a serious one, involving as it does the loss of running length due to the deceleration also, at the end of each run; and the liability to serious error of result, not immediately visible to inspection, on the diagram.

We may take it for granted that the tank plant is to be electrically operated. In nearly all cases the carriage is driven by a motor, or motors, carried upon it and geared to the wheels. Now, in Dr. Froude's original design the carriage was towed by an endless wire rope, consequently the wear-and-tear of the wheels and rails was comparatively small. The wheels simply rolled on the rails, even when decelerating, for the brakes were not applied to the axles. Electrical methods make it easy to drive the carriage direct with motors carried upon it, but the fact must be faced, that the acceleration and deceleration of the weight has to be done through the friction of the wheels on the rails. If the weight be increased, and the power transmitted be correspondingly increased, we are sure to have considerable slip between the wheels and rails, especially if the drive be all accomplished on one pair of wheels. There may be consequently serious degradation of both surfaces. Means must be taken with a wide span to drive on both sides of the carriage, or there will be a tendency to rack at high speeds. These considerations make it a very moot point, indeed, whether or not it is desirable to place the rails on the side walls at all. It seems likely that substantial rails, suspended from strong roof girders designed to carry them by adjustable supports, or similar rails carried upon reinforced concrete brackets springing from the side walls, would obviate a great part of the difficulty caused by large span, and would conceivably give a cushioning effect to the vibrations set up in many cases.

The dimensions of the tank depend very much on the size of model intended for normal practice. For ordinary work 12ft. is a handy length for a model, but for screw propeller work this is sometimes rather small. The amount of money available for the plant has to be considered also. A length of 400ft.—450ft., with a depth of 12ft.—14ft., and a width of 25ft.—30ft., would suit all conditions likely to arise, if properly planned.

Having settled on the design of the main building, the arrangement of the shops and offices can be proceeded with.

Shops and offices.—It is convenient for rapid handling and adequate supervision to have all the secondary buildings together at one end of the tank, the shops being arranged sequentially. The casting-room should be arranged so that the building of the model core, and preparation of sections for moulding ship models, may be carried on simultaneously with the moulding of the clay in the casting boxes. Lying parallel to these boxes, if possible, should be the shaping machine, coming next in order, and followed by the finishing room. An overhead railway should traverse the whole, so that the model may pass directly from one to the other, and finally to the weighing machine and the tank proper for testing. All these should be in one compartment with no dividing walls.

The mechanics' shop is better arranged separately, and, if possible, on a solid foundation, so that the lathes, milling machines, grinders, &c., may be bedded on concrete for rigidity, and the noise of operation may not be pronounced in the adjoining offices. Stores must be provided for both joiners' and mechanics' departments.

Assuming that electric traction be adopted, room must be apportioned for storage batteries, the motor generator and switchboard, or for the particular generating plant that may be settled on. This will be referred to again.

The offices should be two or three in number: (1) A superintendent's room, with the usual appointments of a supervisory office; (2) drawing-office, where design work, plotting of results, calculations, &c., may be done; (3) tracing office in which analysis of diagrams, ruling of section paper for plotting, tracing of results, and general clerical work of a kind suitable for tracers may be conveniently carried on. There should be in addition a small record office and stationery store.

Provision must be made for ventilating the buildings and heating them during the winter months, because wide fluctuations of temperature cause deposits of moisture on the whole of the interior which are very objectionable.

The staff.—The number of persons on the staff of a tank is naturally in proportion to the scope and amount of the work expected of it. It should be large enough to meet all general requirements, and also to cope with any special press of work which may be needed in the shortest possible time. The superintendent should be a naval architect of experience, and should deal at first hand with all problems set for solution, make estimates of power, dimensions of propellers, &c., fixing and directing the general procedure to be adopted. He should have an assistant to consult with him and check his figures, relieve him of the personal direction of the drawing and tracing staffs, and see that the work decided upon is efficiently carried out. The drawing-office staff should be trained to operate the dynamometric apparatus, make observations, take records and speeds on ship trials, get out drawings for new ship forms or propeller designs, and make the necessary calculations for placing all the information on record in a permanent and easily applied form. The tracers should also be specially trained to do as much of the above as can conveniently be reduced to a system, make tracings, rule section paper by machine for plotting curves, analyse all diagrams of resistance, thrust, turning force, &c., make duplicates, and do clerical work generally.

One or two joiners undertake the making of the ship models and any woodwork necessary, and a couple of labourers do the rough moulding of the clay for them, keep the premises clean, the surface of the water skimmed, &c. The number of mechanicians or instrument makers depends altogether on the demand made of them, and will in a large modern shipyard be found to be a fluctuating quantity if other than model propeller making and maintenance of apparatus be asked of them. At the present time, with the developments of turbine machinery and high speeds generally, the problems to be solved by experiment become increasingly difficult, and instruments which sufficed for the original tasks set them have to be remodelled or re-designed. If this work be done by the staff—and it is usually better done when under continual supervision—the mechanics' shop must be manned by thoroughly good men, equipped with tools which allow of great precision being attained.

The instruments and machinery.—These may be separated into two broad groups—(1) Those which appertain to the actual manufacture and testing of models of ships and propellers. (2) Those which are used for obtaining records of performance and behaviour of full sized ships on trial. Taking the first group as that belonging properly to an experimental tank, whether it be regarded as a means of research or as a shipyard tool, we can conveniently make a further subdivision, *i.e.*, (1) making and testing of ship models, and (2) making and testing of propeller models. Testing of these is, of course, done both independently and in combination, as may be required for analytical or synthetical treatment of the problems being dealt with.

Making of ship models.—As has been stated above, the normal material for use in this case is paraffin wax. Provision has to made for melting and cleaning the wax. The melting boxes should be arranged at different levels, and are either two or three in number. Melting may be accomplished by any convenient source of heat; but steam coils, made of tinned copper, are as good as any. The top box has an outlet with a skimmer so arranged that the contents of the box may be drawn off at any level. When re-melting old paraffin models or paraffin shavings from cutting and finishing, there is unavoidably an admixture of foreign matter in the paraffin, which must be separated out. Water is run into the top box and heated by the coil. Paraffin is then added and melted. The melted paraffin floats on the top of the water, and the foreign matter either sinks to the bottom or floats as a scum. The scum having been removed, it only remains to use the skimmer in such a way as to allow the clean paraffin to gravitate to the lower boxes. The operation is repeated until enough paraffin is melted to allow of casting the model. The lowest box must, of course, be at a higher level than the casting trough, so that the wax may reach its final destination by means of gravity. Great care must be taken to prevent admixture of water with the paraffin, either from the washing-box when skimming, or by leakage from the steam coils in the lower boxes. Should any considerable amount of water be run into the casting trough, a sound casting will not be obtained, although provision should be made at the bottom of the mould to deal with a small amount.

The casting trough.—In a shipyard, economy of time will often be obtained by having two casting troughs. They may be made of wood or cast iron. The latter material is much to be preferred. It is convenient to fit substantial wooden rims to them, which should be accurately levelled, and upon which the necessary marks for fixing the position of the model beams, &c., may be permanently placed. The material used for the mould is china clay. The casting is an open one. Moulding sections made by the joiners are supplied to labourers, who mould the clay by them, only an approximation to the final model form being needed for the matrix. Simultaneously with this, a core made up of smaller sections, connected by open lath work, and covered with a linen cloth smeared with soft clay, is being constructed. The core being fixed in the clay mould, hot paraffin is run between them, the pressure on the sides of the core from the head of paraffin being balanced by the pressure of water run into the inside of the core. Allowance is made for the different densities of the two liquids, giving preference to the paraffin, so that if there be any leakage, it will be of paraffin into the water, and not water into the paraffin. A feeder is provided to make up shrinkage, which goes on for several hours. When the model has cooled, the core is removed, and the top faired off, either by a hand tool similar to a plane, working from the level top of the trough as a base; or if preferred, by an electric cutter guided from the same base. Beams are now fixed across the model, having holes in the centres of them; these are so spaced as to fit accurately two pins on the table of the cutting or shaping machine.

The shaping or cutting machine.—There is room for diversity of construction in this machine. Those in operation at different tanks at the present time vary a good deal in detail, but in essentials they are all similar. Briefly, the machine consists of a table upon which the model rests keel upwards, being held in position by two pins on the table, which are so placed as to fit the two holes in the centres of the model beams. This table is level, and adjustable by connected screw gear to any desired height. It is mounted upon wheels which run upon carefully levelled rails, laid in the direction of its length and the length of the model upon it. When the table is traversed over the rails by the gear provided for the purpose, the model is made to pass between two rapidly revolving cutters driven by electric motors. These cutters are carried upon a rigidly constructed transverse framework spanning the table and rails, and allowing of a transverse symmetrical motion of the cutters from the centre line of the table. The operator, usually one of the joiners, controls this transverse motion of the cutters by watching a tracing curve or "feeler" under which a drawing of the model is made to pass.

The drawing board fits accurately a cast iron frame having a machine cut rack, and pinion for traversing. Drawn upon it is the contour of the lines which it is desired to reproduce upon the model. The gear which traverses the table actuates the rack and pinion of the drawing board frame, and traverses it in the same direction, but at a speed bearing the same proportion to the speed of the table as the length of the drawing bears to the length of the model. The feeler is a piece of glass upon which a semi-ellipse is drawn whose axes bear the same relation to the diameter of cutters as the drawing bears to the model. Of course, where the length and breadth scales of the drawing are the same, the curve is a circle and not an ellipse. The movement of this "feeler" governs that of the cutters by means of a lever whose fulcrum is a roller which may be so adjusted as to divide the lever in the proportion of the breadth of the drawing to the breadth of the required model. It will thus be seen that when the table and drawing are being traversed, and the operator by a hand wheel keeps the elliptical "feeler" always tangential to the curve he desires to copy, the cutters must of necessity cut a corresponding curve on the matrix which is to form the model.

This operation is repeated for as many different water lines as it has been thought necessary to put upon the drawing, the table being set, before each cut, to the corresponding height from the keel line. This setting is done from a prepared scale attached to the table, over which a pointer indicates the desired positions.

There is obviously room for variation of design here, while adhering to general principles. For instance, the cutters, instead of being driven by bands from an electric motor on the top of the transverse frame, may be driven by separate motors directly on the cutter spindles. The table may be kept a constant height above the rails, while the cutters are raised or lowered to the required heights by means of screwed spindles. The table may be traversed by hand wheel and gearing, or piano wire drive as in Froude's original, or it may be driven hydraulically or electrically, and controlled by the foot of the same operator who guides the "feeler" over the lines on the drawing board. The drawing board may be arranged vertically or horizontally. In fact, most of the variations have been made in one or other of the existing machines. Only experience can prove which is the best combination in practice. It may be fairly asserted, however, that simplicity of construction should be always striven for where no sacrifice of accuracy is involved. The gain which may be made by substituting a power drive for the table and drawing board, instead of a hand drive, is very problematical. The time taken to cut the lines of an ordinary model with the machine is about one hour, where one man controls the tracer and cutters and an assistant traverses the table. Supposing the operator could cut the model in the same time, when controlling both motions, which is doubtful, the saving would be very small, because the time of cutting is a small proportion of the whole time taken to make the model.

A modification of this machine has been made at the Washington Tank. The lines cut on the model are transverse sections instead of horizontal water lines, and the cutters copy their motion from prepared sections and a follower. It is doubtful whether this method is an improvement upon the usual form; it was designed for use with wooden models.

Finishing the model.—After the model has been machine cut, it is finished by hand tools, then carefully scraped, and polished with sponge cloths. If the excrescences for carrying propeller shafts in the ship are to be reproduced on the model, this is usually done after the model has been tested for resistance in the naked condition. Careful measurements of depth and breadth are now made, and the model is accurately weighed and placed in the water. Ballast having been added to produce the correct displacement, a test is made to see that the draught and displacement correspond. Needle trimmers are arranged to break the water surface from below, when the draught is correct. The model is then placed under the dynamometer carriage.

SOLUTION OF FLIGHT PROBLEMS BY GRAPHICAL METHODS.

By M. B. LOGAN.

It often seems as if full use was not made of the experiments carried out by many whose results have been from time to time published in various journals interested in aëronautics. The cause appears to be a lack of a method sufficiently simple and clear. It is in this article that the author has developed such a method which he thinks will be of value to the designers and engineers.

The following are two problems that have been dealt with:—

Problem (1) Horizontal flight.
Problem (2) Rising and falling flight.

The conditions assumed for the development are namely:—

(1) That the air is motionless.
(2) That flight takes place at a uniform velocity.
(3) That the machine—aëroplane—is in stable equilibrium; that is to say, the forces meet in a point, and have a resultant zero.

PROBLEM 1.

Fig. 1 represents an aëroplane or flying machine, or aërocurve, moving at a velocity V on a horizontal path O Y, acted upon by the forces P, T, W, where P is the resultant pressure produced by the movement of the aërocurve through the air; T is the thrust of the screw or other means of propulsion, which force is supposed to have the same direction as the flight path; W is the weight of the machine or aërocurve, plus the extra weight carried; L and D are components of the resultant pressure P, viz.:—

D the drift, the force in the direction of the flight, and L the lift at right angles to that direction.

For condition (3) to be true it is necessary that L = W, D = T, *i.e.*, lift always to be equal to the weight of the machine; drift always to be equal to the thrust of propulsion. The angle α, the angle of attack made by the chord of the aërocurve with the horizontal.

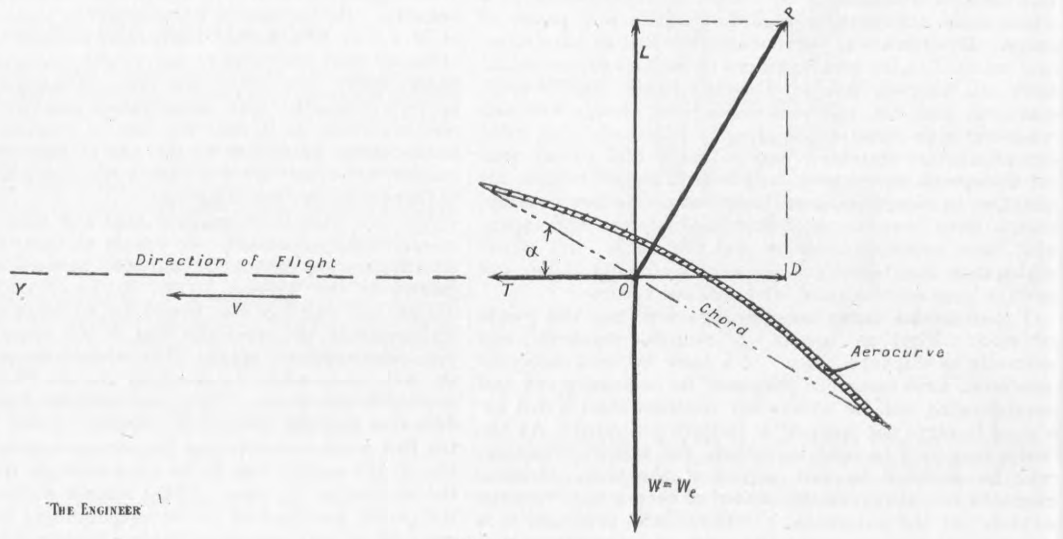


Fig. 1

Suppose Fig. 2 represents the curve found by actual experiment on an aërocurve,* the ordinates representing the lift and drift at constant velocity in units of force, and the abscissæ the angles of attack made by the chord of the aërocurve with the horizontal or direction of motion of the aërocurve or flying machine; these curves can be expressed algebraically as follows:—

$$\text{Lift in lbs. } L = K_l \times S \times V^2 \times f(\alpha)$$
$$\text{Drift in lbs. } D = k_d \times S \times V^2 \times \phi(\alpha)$$

Where S = surface of the aërocurve in square feet.
K_l and K_d † = experimental coefficients.
V = velocity of aërocurve or flying machine in miles per hour.
And $\phi(\alpha)$, $f(\alpha)$ = functions of the angle of attack.

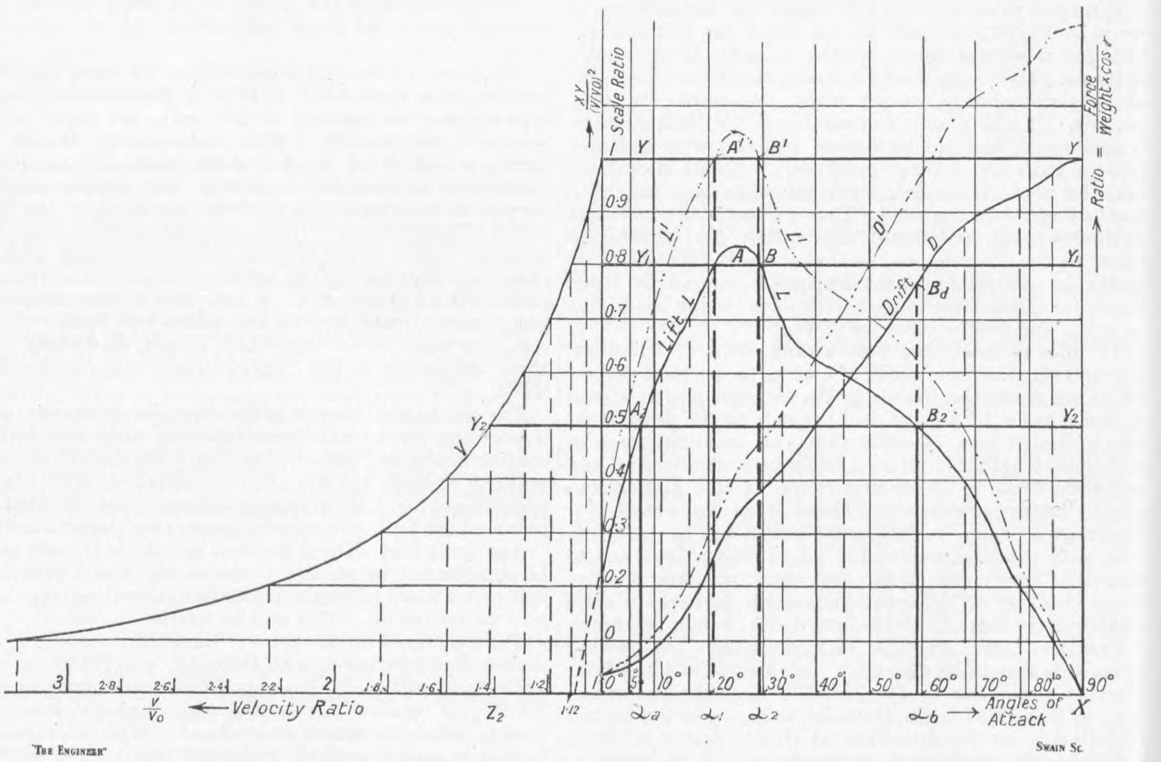


Fig. 2

For horizontal flight it is apparent that the lift must keep constant and equal to the weight of the machine W, and can therefore be written—

$$W = K_l \times S \times V^2 \times f(\alpha) = \text{constant};$$

$$\text{or } V = \sqrt{\frac{W}{K_l \times S \times f(\alpha)}} = \sqrt{\frac{\text{constant}}{f(\alpha)}}$$

which can be represented by a curve. Fig. 3 shows this curve.

The following is the method of obtaining the curve graphically:—

Curves Fig. 2 L and D show the lift and drift at any desired scale, provided that the velocity is suitably chosen; for simplicity's sake it has been thought advisable to choose such a scale that the ordinate X Y represents the weight of the machine complete, the velocity necessary for this condition being V_o, obtained from the equation

$$V_o = \sqrt{\frac{W}{K_d \times S \times \phi(90°)}}, \text{ where } \phi(90°) = 1.$$

It is clear that this velocity will not support the machine as the lift is insufficient at any angle at which the aërocurve is placed; however, if the velocity be increased from V_o to V_1, so that a lift is obtained, it will be found that there are two angles at which the aërocurve has a lift equal to the weight of the machine. To obtain these values increase the ordinates of the lift and drift curves in the ratio $\frac{(V_1)^2}{(V_o)^2} = 1.25$, which gives the dotted curves L′ and D′, and then the points A′ B′, where the horizontal line Y Y cuts the lift curve, give those two angles $\alpha_1 = 21°$, and $\alpha_2 = 29°$, for which the above condition, lift equals weight, is satisfied. These angles should then be plotted against the ratio $\frac{V_1}{V_o} = 1.12$. A series of points could thus be obtained, only the continual drawing of new curves would become too laborious; therefore the method employed here to obviate such tediousness is, instead of keeping the same scale, to decrease it in the ratio of

$$\frac{1}{\left(\frac{V_1}{V_o}\right)^2} = \frac{1}{1.25} = 0.8 = \left(\frac{V_o}{V}\right)^2.$$

The lift equal to the weight will now not be represented by the horizontal line Y Y, but by a new horizontal $Y_1 Y_1$, in which $\frac{X Y_1}{X Y} = \left(\frac{V_o}{V_1}\right)^2 = 0.8$; the points where this line cuts the original curve L will give the same angles as the dotted line gave. In this way the curve, Fig. 3, by taking various scales proportional to $\left(\frac{V_o}{V}\right)^2$, can be plotted out.

For simplicity of working it is advisable to plot another curve, Fig. 2, curve V, the abscissæ being the ratio $\frac{V}{V_o}$ and the ordinates $\frac{X Y}{\left(\frac{V}{V_o}\right)^2}$. To obtain the values of the angle of attack and the velocity ratio V/V_o, draw a perpendicular from any point Z_2 until it cuts the curve V in the point Y_2; draw a horizontal $Y_2 Y_2$, until this line cuts the curve L in A_2 and B_2; then from the two points of intersection drop perpendiculars $A_2\, a_a$, $B_2\, a_b$; these values of the angles a_a and a_b will indicate the angles of attack corresponding to that velocity ratio indicated at Z_2; the curve Fig. 3 has thus been obtained.

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* The curves given in Fig. 2 are actual test curves taken from the figures given in the *Scientific American* Supplement, November 14th, 1908, pages 308 and 309, curve C_{12}, Tables I. and II., on an aërocurve with a circular arch of 1 in 12.

† (K_d = 0.0034) as deduced from *Scientific American*, November 14th, 1908, for the curve considered in this article.

The principal fact that can be deduced from this curve is that by changing the angle of the aërocurve one can increase or decrease the velocity of the machine. At the angle for this particular aërocurve of about 25° the minimum velocity occurs; it might be remarked that this angle by no means is the best angle to fly at, as it will be seen hereafter.

Drift or thrust.—In Fig. 4 have been plotted the curves of drift against angles of attack, curve D, and also horse-power against angles of attack, curve H P. To obtain these curves, consider in Fig. 2 the value $B_2\, a_b$ equal to the weight at the angle a_b, and at a certain scale to which there is a corresponding velocity V_b; now $a_b\, B_d$ gives the drift at the same scale and

$$\frac{a_b\ B_d}{a_b\ B_2} = \frac{\text{Drift}}{\text{Lift}} = \frac{\text{Drift}}{\text{Weight}} = \frac{D}{W}$$

$$\text{Drift } D = \frac{a_b\ B_d}{a_b\ B_2} \times W;$$

therefore the drift in lbs. at any angle if W is introduced in lbs. can be obtained; however, to make the curves more general, the ratio $\frac{D}{W}$ has been plotted against the angle of attack, and is shown in Fig. 4.

$\frac{D}{D_o} = \frac{D}{W}$ has been called the drift ratio.

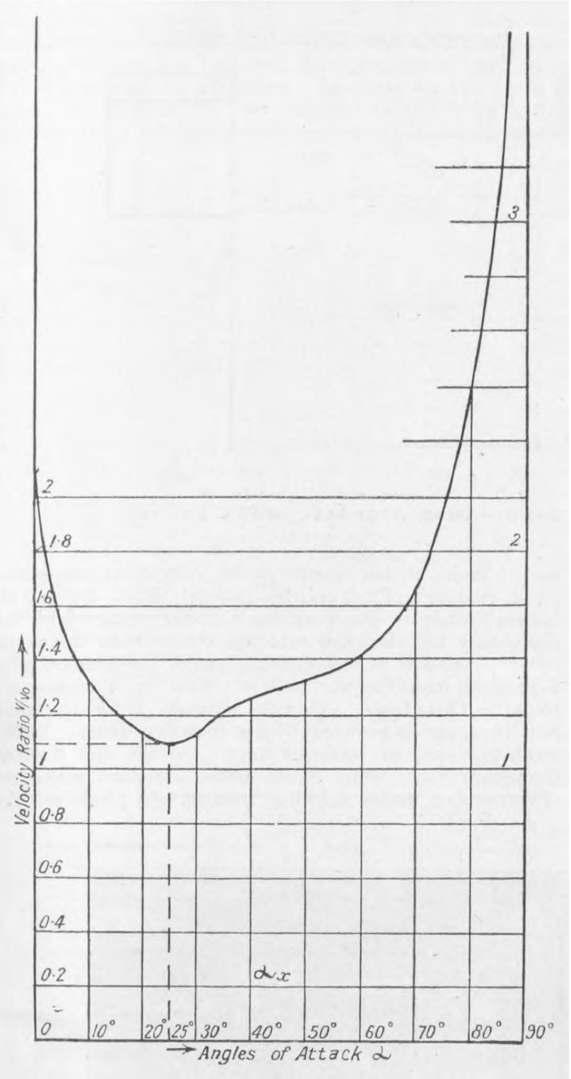


Fig. 3

Horse-power.—The horse-power necessary to drive the machine is obtained from the fact that

Power = force times velocity.

$$\text{H.P.} = \frac{F \times V}{375} \text{ H.P. in horse-power.}$$

F in lbs.
V in miles per hour.

At the velocity V_o we have a certain drift D_o, but D_o has been made equal to W, the equation can therefore be written as follows:—

$$H\,P_o = \frac{D_o \times V_o}{375} = \frac{W \times V_o}{375}$$

dividing each side of the equation by $H\,P_o$.

$$\frac{H\,P}{H\,P_o} = \frac{F \times V}{375} = \frac{375}{W \times V_o} = \frac{F}{W} \times \frac{V}{V_o} \text{ or } = \frac{D}{W} \times \frac{V}{V_o}.$$

$\frac{H\,P}{H\,P_o}$ has here been called the horse-power ratio, in the curve Fig. 4. $\frac{H\,P}{H\,P_o}$ has been plotted out against the angles of attack α. To obtain these values at a certain angle α_x, Fig. 4, the drift ratio D/W has been taken and multiplied by the corresponding velocity ratio at the same angle α_x, Fig. 3, the product giving the horse-power ratio required; by a series of points the curve has thus been obtained. It has one asymptote at the angle 90 deg., and probably another at the angle of 5 deg.

The minimum drift occurs at an angle of 2.5 deg., but not so with the horse-power, which occurs at an angle of 5 deg. It should be noted that neither of these angles corresponds even nearly to the angle of minimum velocity 25 deg., for here the horse-power is about 120 per cent. more than the minimum horse-power; the velocity, on the other hand, is 40 per cent. greater at minimum horse-power.

These facts are remarkable, insomuch that Professor Langley foretold them by practical experiment many years ago.

Fig. 5 shows curves that have been constructed from curves in Fig. 3 and Fig. 4, the variable α having been eliminated. They are horse-power against velocity ratio $\frac{V}{V_o}$ and drift against velocity ratio. These curves show very adequately that within certain limits the velocity can be varied considerably, *i.e.*, 15 per cent. above and below the speed for minimum horse-power, with very little change in the power needed; the change of speed being effected by simply changing the angles of the planes. The Wright Brothers have adopted a similar method by the deformation of their blades, which has very much the same effect.

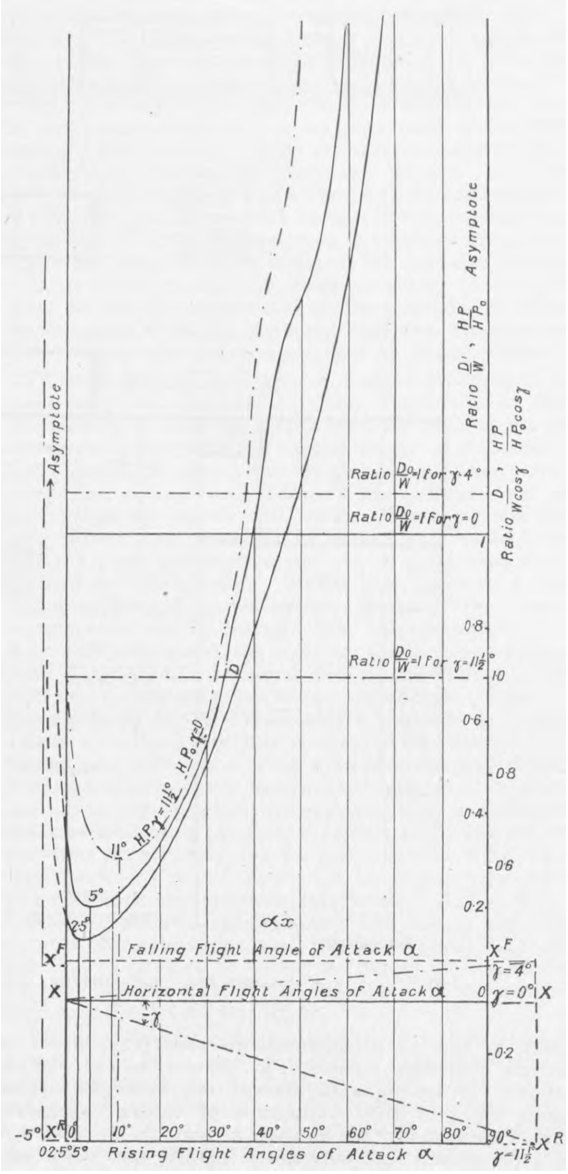


Fig. 4

Problem II.—Rising and Falling Flight.

This case is the generalisation of Case No. 1, horizontal flight.

α = as before, the angle of attack, *i.e.*, angle the cord makes with the line of flight O Y, Fig. 6.

γ = the angle the line of flight makes with the horizontal.

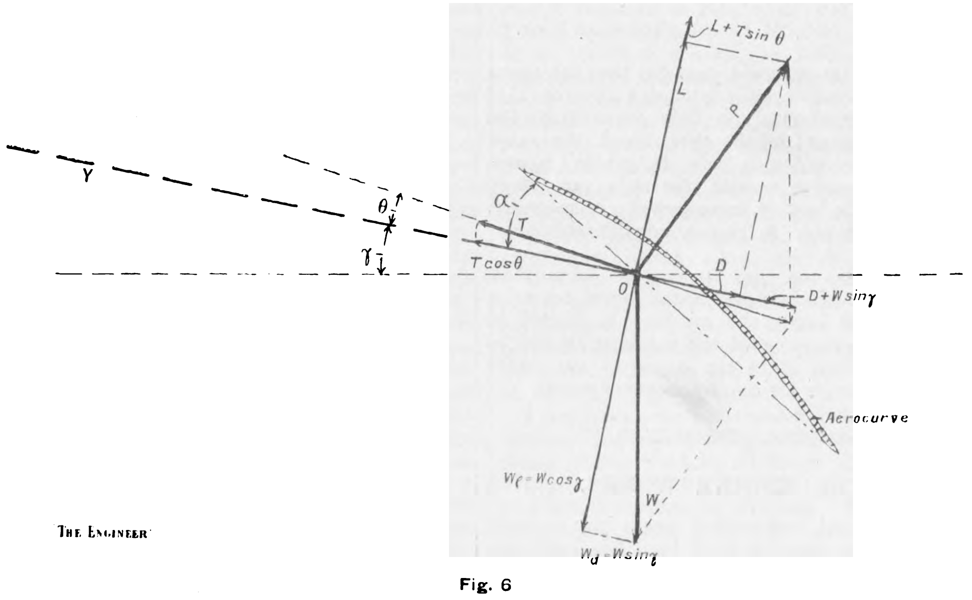
θ = the angle the direction of thrust makes with the line of flight.

P = as before, the total pressure or force produced by the speed V.

L = the lift, *i.e.*, force vertical to the line of flight.

T = thrust of propulsion.

W = weight of the machine.



The Engineer

Fig. 6

Considering the conditions necessary for uniform stable flight, viz.:—

$$W \cos\gamma = L + T \sin\theta \quad . \ . \ . \quad (1)'$$
$$W \sin\gamma = T \cos\theta - D \quad . \ . \ . \quad (2)'$$

These equations, by the introduction of the extra term in (1)' $T \sin\theta$, complicate the method considerably, as $T \sin\theta$ is a variable, the whole simplicity of the construction being due to the fact that lift is a constant; however, the author has deduced a way out of the difficulty, but it is not his intention to give the demonstration of it in this present article.

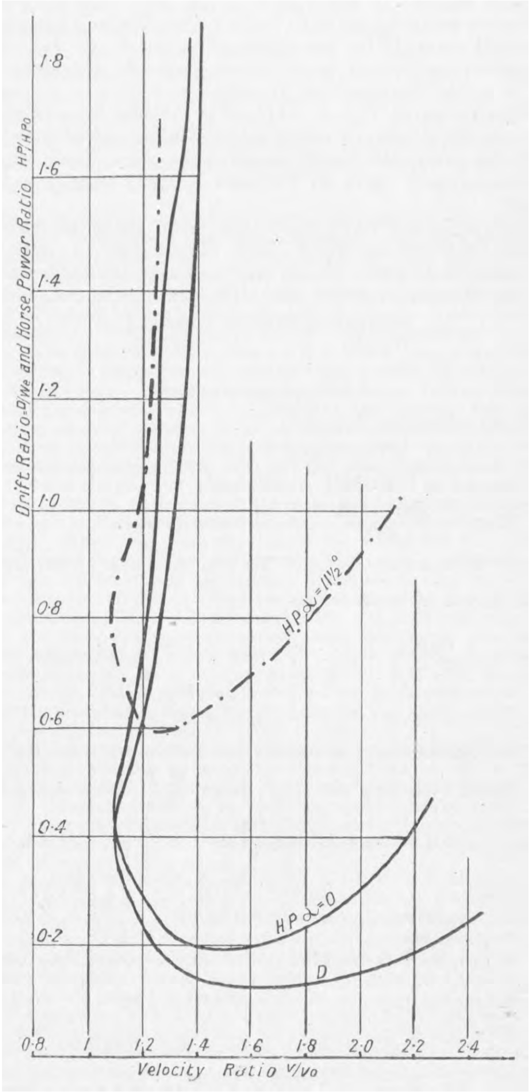


Fig. 5

Therefore to simplify these equations the force of propulsion is supposed to lie in the direction of flight.

$$\theta = 0 \quad , \quad \sin\theta = 0 \quad , \quad \cos\theta = 1,$$

the equations become

$$W \cos\gamma = L \quad . \ . \ . \ . \ . \ . \quad (3)'$$
$$W \sin\gamma + D = T \quad . \ . \ . \ . \ . \quad (4)'$$

Consider again Fig. 2, instead of taking the scale such that X Y equals the weight of the machine, suppose it equal to weight of machine times $\cos\gamma$, *i.e.*, X Y $= W \cos\gamma = W_l$, then curves Fig. 3 and Fig. 4 remain the same as before, only the scale has changed in proportion to $\frac{1}{\cos\gamma}$.

In Fig. 4 the ordinates from the abscissæ line X X do not represent the total force opposing the thrust, but only the drift component; to this has to be added a certain quantity $W \sin\gamma$, the weight component, the total thrust being given in equation (4)'. Writing again equation (4)' and dividing by the value $W \cos\gamma$, it becomes

$$\frac{T}{W\cos\gamma} = \frac{W\sin\gamma}{W\cos\gamma} + \frac{D}{W\cos\gamma} = \frac{D}{W\cos\gamma} + \tan\gamma.$$

The component $\frac{D}{W\cos\gamma}$ is represented by the curve already given—Fig. 4—the abscissæ being along the line X X. Adding on a quantity $\tan \gamma =$ constant, to the ordinates, the final curve is obtained, the abscissæ line being $X_R X_R$, the scale $\frac{D_o}{W \cos \gamma} = 1$ being indicated along the ordinate line, which passes through the $a = 90^\circ$ point.

Similarly to the construction in Problem I., the horse-power curve—here drawn for $\gamma = 11\frac{1}{2}^\circ$ $\tan \gamma = 0{\cdot}2$—can be deduced from the curve D—Fig. 4—at the new scale and curve from Fig. 3, it is shown by the curve H P, $\gamma = 11\frac{1}{2}^\circ$.

An interesting point to be noted here is that the angle of minimum H.P. has changed from 5° to 11°, this angle of minimum horse-power depends therefore on what angle the machine is desired to rise at or fall at.

The curve H P $\gamma = 11\frac{1}{2}^\circ$—Fig. 5—has been worked out to show the variation of the horse-power with the velocity ratio; the same remarks that were made on the corresponding curve in Problem I. apply equally to this case.

Example.—A calculation has been made to demonstrate the use to which such curves can be put, the example in question having approximately the same values as the Wright Brothers' machine, *i.e.*,

Supporting surface = 540 sq. ft.
Weight = 900 lb.

Horizontal Flight.

First calculate V_o and $H\,P_o$.

$$V_o = \sqrt{\frac{900}{0.0034 \times 540}} = 22.1 \text{ miles per hour.}$$

$$H\,P_o = \frac{900 \times 22.1}{375} = 53 \text{ horse-power.}$$

(1) *Minimum velocity.*—To find this look up the curve Fig. 3, the velocity ratio $= \frac{V \min}{V_o} = 1.1$.

$$\text{Since } \frac{V \min}{V_o} = 1.1 \therefore V \min = 1.1\, V_o \text{ miles per hour.}$$

$$= 1.1 \times 22.1 \quad ,, \quad ,,$$

$$V \min = 24.3 \quad ,, \quad ,, \quad ,,$$

The horse-power necessary for minimum velocity will be found by taking the H.P. ratio $\frac{H\,P}{H\,P_o}$ from curve H P Fig. 4, for the angle 25 deg., which is $\frac{H\,P}{H\,P_o} = 0.43$.

$$H\,P = 0.43 \times 53 = 22.8 \text{ horse-power.*}$$

(2) *Minimum horse-power* ratio is $\frac{H\,P \min}{H\,P_o} = 0.2$.

$H\,P \min = 0.2 \times 53 = 10.6$ horse-power, the corresponding velocity can be obtained from Fig. 3, $\frac{V}{V_o} = 1.51$.

$$V = 1.51 \times 22.1 = 33.3 \text{ miles per hour.}$$

Rising Flight.

In this example the $\gamma = 11\frac{1}{2}^\circ$.

$$\cos \gamma = 0.955,\ \sin \gamma = 0.191,\ \tan \gamma = 0.2.$$

$$V_o = \sqrt{\frac{900}{0.0034 \times 540 \times 0.955}} = 22.7 \text{ miles per hour.}$$

$$H\,P_o = \frac{900 \times 22.7}{375} = 54.5 \text{ horse-power.}$$

(1) *Minimum velocity*, $\frac{V \min}{V_o} = 1.1$.

$$V \min = 1.1 \times 22.7 = 25 \text{ miles an hour.}$$

The horse-power necessary for minimum velocity,

$$\frac{V}{V_o} = 0.7. \quad V = 0.7 \times 54.5 = 39 \text{ horse-power.}$$

(2) *Minimum horse-power* at $a = 10^\circ$.

$$\frac{H\,P}{H\,P_o} = 0.6. \quad H\,P \min = 0.6 \times 54.5 = 32.7 \text{ horse-power.}$$

Corresponding velocity,

$$\frac{V}{V_o} = 1.52. \quad V = 1.52 \times 22.7 = 34.5 \text{ miles an hour.}$$

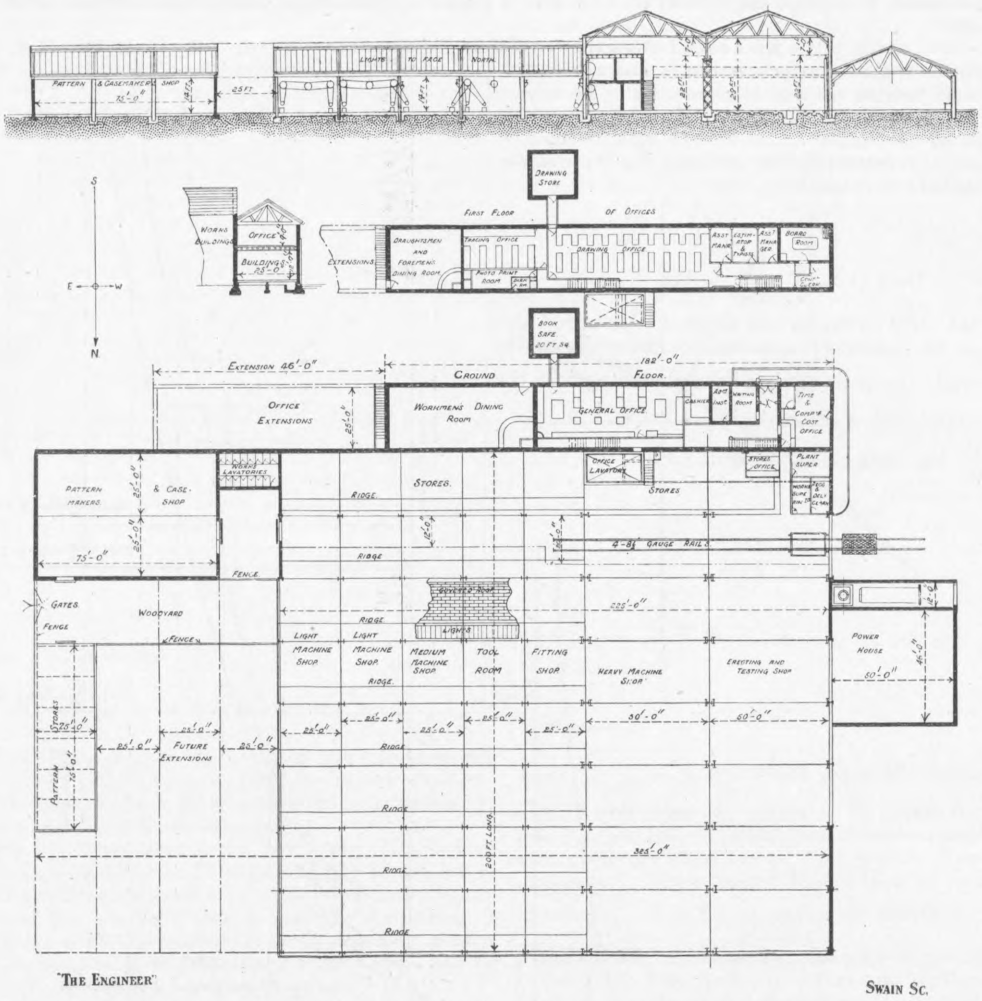
A remark should here be made, namely, that the speed which varies very little for an angle of 1 in 5 or 11½° corresponds very approximately to that obtained by the Wright Brothers machine; on the other hand, the rated horse-power of their motor is only 24, which means, firstly, either the machine cannot rise at a very steep angle on account of its lack of horse-power; or secondly, the motor is probably able to give a considerable overload.

From these curves can be drawn the facts that, firstly, in designing a machine the rated horse-power is dependent upon what angle the machine is desired to rise at; secondly, the balance of the machine should be such that at horizontal flight the angle of the chord should be about the angle for minimum horse-power.

A NEW OIL ENGINE WORKS.

A NEW and important engineering works has recently sprung into existence on a plot of land adjoining the Midland Railway Company's system at Hazel Grove, near Stockport, and within about 8½ miles of Manchester, which claims to be the chief centre of the internal combustion engine industry. Regular travellers by the Midland line must have remarked the speed with which the building operations were brought to completion, a little over twelve months only elapsing between the cutting of the first sod on a virgin piece of land and the opening of the shops. The factory has been erected by the firm of Mirrlees, Bickerton, and Day, Limited, exclusively for the building of the Diesel oil engine in its various types, and its chief features are due entirely to Mr. Charles Day, the managing director of the company, the services of an architect only being necessary to fill in the details of the plans, and to take out the quantities of materials employed. Although ample capital and practically unlimited space were placed at Mr. Day's disposal, he has not erred on the side of extravagance, either in point of size or ornamentation, preferring rather to provide buildings complete in themselves which are capable of dealing with present requirements without losing sight of the possibilities of future extensions should the growth of the business demand them. Although of a permanent and substantial nature, the works and offices are entirely devoid of ornate display and elaborate decorations, which, although pleasing to the eye, yield nothing to the general efficiency of the works as a whole.

The company has acquired 18 acres of ground, but only a comparatively small part of this space has as yet been covered. The buildings so far erected include a complete range of offices and a main block of workshops 200ft. long. The latter, divided into two longitudinal bays, each 50ft. wide, and five transverse bays 25ft. long. The latter have saw-tooth roofs with north lights, and the 50ft. bays have span roofs, with the eastern half glazed. All the glazing is done with wired glass. There is also a light and roomy power-house, pattern makers' shop and pattern stores, the latter being isolated from the main buildings, a workmen's dining-room, and fire-proof book safe and drawing store.



"The Engineer" Swain Sc.

Fig. 1—MIRRLEES, BICKERTON, AND DAY'S WORKS AT HAZEL GROVE

Turning our attention first to the offices, it will be seen from the plan—Fig. 1—that the entrance is at the western end, as is also the workpeople's entrance and exit door. Between the two is the time-office, which is glazed all round to give a full view of both passages at all times to the timekeeper. As these are the only means of ingress or egress for the whole of the works, we have here one important point in economical management. Turning to the right on entering the office building we come to the waiting-room, Admiralty inspectors' room, cashier's-office, and the general office. Beyond the general office is the workmen's dining room, which will ultimately be absorbed into the offices with the anticipated extension of the works. Out of the general office a passage leads to the bottom room in a rectangular tower. This tower is quite separate from the main buildings, and is secured by fire-resisting doors. In this room the store of books is kept. On the first floor are the board room, chief clerks' office, assistant managers' office, typists' room, drawing, tracing, and photo-printing room, and draughtsmen and foremen's dining room. From the drawing-office access is obtained by means of a fire-proof door and passage to the drawing store, which is situated above the book safe in the tower alluded to above. The drawing-office is well lighted and equipped, and has an unbroken view from end to end. When necessity arises for its extension, it will only be required to remove the partition separating the office from the foremen's dining room. The buildings are of red brick with stone facings.

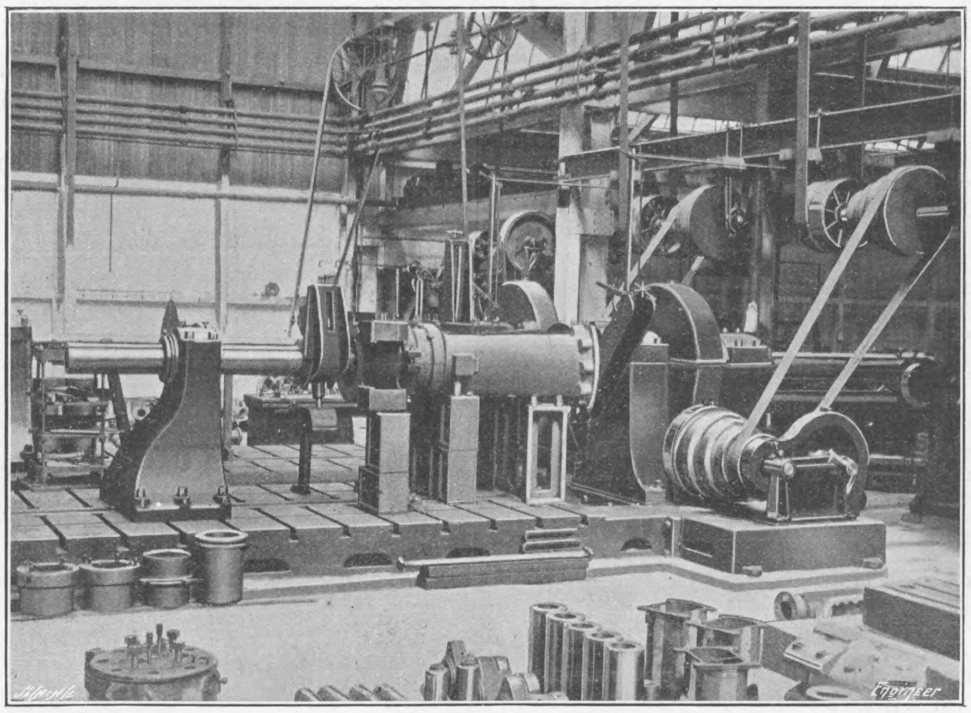


Fig. 2—MACHINES FOR BORING AND FACING ENGINE COLUMNS

Access to the works from the offices is obtained by another door adjacent to the time-office. On entering, the visitor is confronted with the two 50ft. bays, one of which is reserved for erecting and testing purposes, and the other for heavy machine tools. The other transverse bays are used as follows:—Fitting shop, tool-room, and machine shop. A line of rails direct from a siding on the Midland Railway runs well into the building and right up to the stores, which are arranged across the whole width of the shops. Each of the 50ft. bays is served by overhead electric travelling cranes, one of 20 tons and the other of 10 tons capacity. These were made by Mr. Joseph Adamson, Hyde. The alternate small bays are served by Royce's 2-ton overhead electric cranes. In the intervening bays the countershafts and pulleys for driving the machine tools are placed. All the line shafts are operated by electric motors made by Lawrence, Scott and Co., Limited, Norwich. These are controlled by means of Brookhurst electric starters, which effectually prevent the load being thrown on too suddenly.

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* The horse-power indicated does not represent the brake horse-power of the motor, to obtain which the H.P. calculated should be divided by the efficiency.

The machine tools in use include radial drills by Asquiths, boring machines by Richards, large lathes by Dean, Smith and Grace, small lathes by Clark's Machine Tool Company, Luton, Cincinnati milling machines, Herbert's semi-automatics, cam-milling machines by Heap and Co., Limited, grinding machines by the Brown and Sharpe Company, two spindle boring machines by Webster and Bennett, and special horizontal boring and facing machines by John Holroyd and Co., Limited, of Milnrow, for dealing with engine columns. These machines have been built to Mr. Day's own requirements. A pair of them is clearly shown in Fig. 2. The two headstocks are mounted on a common box bed-plate, to which the floor plates are bolted. The spindle sleeves carry large worm wheels driven by steel worms from a four-step cone pulley, taking a 6in. belt, and have excentric back gear. The worms run in oil baths. The sleeves are bored to take a 9in. spindle, and are flanged at the front end to receive facing heads capable of facing up to 7in. diameter.

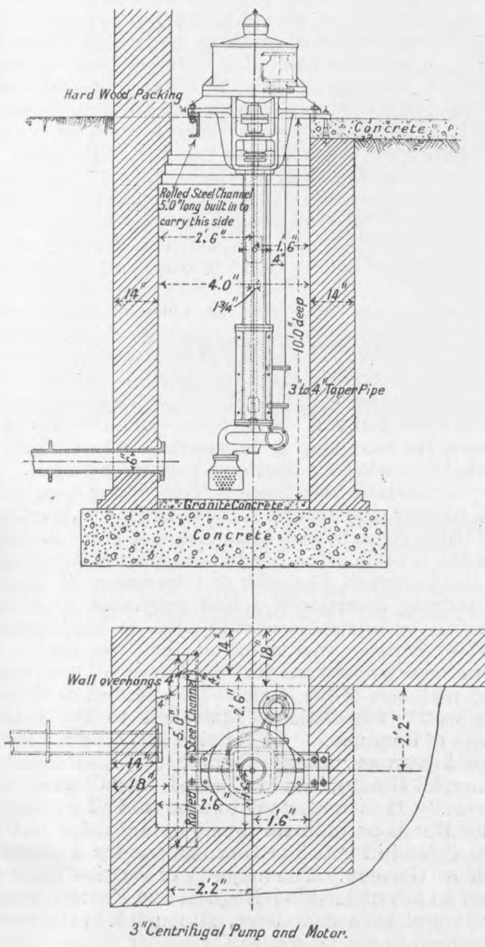

Fig. 3—ELECTRICAL PUMP

The spindle is driven by two keys, and has a traverse of 5ft., by means of a carriage sliding on a bracket bolted to the back of the headstock. The carriage has quick hand motion by rack and pinion, and slow hand feed by worm and worm wheel on the rack pinion shaft. Six power feeds, ranging from $\frac{1}{16}$in. to $\frac{15}{32}$in. per revolution in either direction, are provided by a 3-speed gear box and a pair of interchangeable wheels. To take the thrust of the spindle, ball bearings are provided, and all the feed gear wheels are of steel. The boring bars are secured to the spindle by taper socket and cotters, the outer end of each bar being also bored taper to allow of the insertion of an extension bar. The machine weighs about 25 tons, and occupies 30ft. by 20ft. of floor space. It will bore holes from 12in. to 48in. diameter, and the spindle speeds range between 1.48 and 18.13 revolutions per minute. The back gear ratio is 4 : 1, and the ratio of the worm gear 19.3 to 1, the countershaft speed being 200 revolutions per minute.

With the exception of the water used for drinking purposes and for the fire-extinguishing mains, which is supplied from the Stockport town's supply, the whole of the water required in the works for lavatories, water closets, circulating water for the permanent engines, testing stands, water brake, water electrical resistances, &c., is supplied from a reservoir to which all the rain from the roofs, &c., is drained. From this reservoir an electrically-driven centrifugal pump—Fig. 3—forces the water up into an overhead tank to give it the required head, the pump being started and stopped automatically as required by means of a float which actuates a switch on the electric mains.

The power required in the works for driving the machinery and supplying artificial light is mainly supplied by a Diesel oil engine, driving a 100-kilowatt continuous-current electric generator, made by the Lancashire Dynamo and Motor Company, direct. This supplies current at 230 volts pressure to a distribution board divided into panels, each with its own meter, in order to show the amount of power that the various departments are taking. The crude oil used for fuel is brought right up to the works in tank wagons on the railway, from which wagons it is delivered by an electrically-driven pump into a tank in the yard. When additional power is required it can be obtained either from another 100-kilowatt set in the shops, or from any generating sets which may be passing through the testing department. To enable the power from these extra sources to be made use of a cable can be switched into the main circuits on the distribution board. For lighting at nights Angold arc lamps, made by the General Electric Company, are used, these being arranged two in series. When the engines are not running accumulators supply the necessary current. Mr. Day, at the time of our visit, was arranging for a further source of power for running a small section of the works at night by means of a 20 horse-power set, in which the first Diesel engine built at Glasgow will supply the necessary energy. This set is being placed in close proximity to the time office, so that the night watchman can attend to it. From the foregoing it will be gathered that the whole of the power used in the works is provided by Diesel engines.

For warming the buildings, an Eclipse sectional boiler made by J. G. Wagstaff, Limited, Dukinfield, is used. Incidentally, it may be stated that the cost of the fuel consumed in providing the heat in winter is in excess of that required to supply the whole of the power. As a precaution against fire, Harlow's fire extinguishers are provided in the offices and works. These contain long reels of hose pipe, attached by means of a valve to the pressure main, and can be run out in quick time to the place of the conflagration. In the time office is a telephone exchange, by which the heads of the various departments can be brought into communication. As previously mentioned, the store for the tools and finished work is arranged across one end of the building. The tools and gauges are given out on the cheque system. As the operation of the Diesel engine depends to a large extent on remarkably fine clearances, all finished work has to pass through a close system of inspection while passing from process to process, and also when it finally reaches the stores, which are equipped with a measuring machine for testing the gauges periodically. The working drawings are all made of a uniform size and style, those intended for the use of the men in the shops being stored in a rack with ten divisions, numbered 0, 1, 2, 3, 4, 5, 6, 7, 8, 9. These numerals represent the last in the works number of the drawings, and facilitate search, all that a man has to do when he knows the number of the drawing required being to look in the division with the numeral corresponding to the last figure.

The engines are built in units of from 35 to 50 horse-power. For twice this power two cylinders would be used, and so on up to 200 horse-power. Great care is taken in the workmanship. One particular item which came under our notice in connection with a multi-cylinder engine being that after all the main bearings had been bored simultaneously, they were afterwards carefully scraped to fit a test bar, so that they were all absolutely uniform and in alignment. Another feature which came under our observation is worth mentioning. It refers to the construction of the fly-wheels. These are built up on a cast iron centre, which is keyed on the shaft. The keys are held in place by screw pins, and the rim or outer portion of the wheel is secured to the centre by bolts.

AMERICAN FOUNDRY PRACTICE AND DEVELOPMENT.

The foundry industry has a very general reputation for backwardness in development, and an adherence to old methods and customs, which detract from its efficient and economical administration. In this respect its progress is often compared most unfavourably with that of the machine shop. That these opinions are held, and have been to some extent justified, was acknowledged in some of the addresses and papers presented at the annual meeting of the American Foundrymen's Association, held at Cincinnati, in May. It was shown, however, that many important developments have been made and are progressing on both the practical and scientific sides of foundry work. The association is composed of some 750 representatives of foundry companies and of the foundry departments of large railway and manufacturing companies. They include foundry managers and superintendents, chemists and others. While a number of the papers and reports presented dealt with subjects of a more or less ordinary and commonplace character, there were others which dealt with larger questions of policy and practice. The association, for instance, has committees engaged in investigations as to the properties of moulding sands, the purchase of pig iron by specifications, and the development of industrial education for the masses of children in the public schools. Prominent among the subjects considered were:—First, the continuous melting and pouring of metal; second, the use of cast iron moulds; third, the development of the moulding machine; and fourth, the commercial application of the electric furnace to the steel foundry. Some notes as to those parts of the proceedings which were of special importance will be of interest.

CONTINUOUS MELTING.

The continuous system of melting consists in running the cupola all day and pouring the castings at frequent intervals, instead of leaving all the pouring to be done during the latter part of the afternoon. This practice is adaptable, of course, only to certain lines of work. It has been introduced to a very limited extent, but there is evidently a wide field for development in foundry practice along these lines. The Westinghouse Air Brake Company has adopted the system for its new foundry, and a paper describing its operation was read by Mr. S. D. Sleeth, the superintendent of the shop.

Before commencing work in the new foundry some experiments were made with the cupolas at the old foundry. The time required to run off the heat was 2½ hours, and the experiments were made to see how much longer the metal could be held in the cupola, and still kept hot. On the first day the blast was started half-an-hour earlier than usual; the same blast pressure was used, but the blast was shut off at intervals for five or ten minutes at a time. This gave satisfactory results. The next day the blast was started an hour earlier than usual, but this did not work so well. More coke was added, and this kept the metal hot, but the melting was slower. The following description is taken from Mr. Sleeth's paper:—

> When we started work in the new foundry we ran two cupolas, one in the morning and one in the afternoon. We were afraid to hold over the dinner hour. After running for some time in this way we decided to run one cupola all day. At eleven o'clock, or a little later, we added 200 lb. of coke for two or three charges, so that we would have an extra amount of coke to hold over the dinner hour. Our great trouble at this time was with the cupola man, as he insisted that the iron would freeze at the tapping hole, but we finally persuaded him that he would not be held responsible should this occur. We drained all the iron out at twelve o'clock, closing the slag hole with sand, stopping the tapping hole, and shutting all other openings tight, so there would be no draught. About ten minutes before starting time we tapped out all that was in the cupola and pigged it, then put the blast on full, so as to be ready when the starting whistle blew. Sometimes we have to pig 200 lb. or 300 lb. on account of the metal not being hot enough.
>
> We had at first two sizes of cupola—48in. and 60in. inside the lining. When the heats were heavy we would run the latter. In enlarging the plant we took out the 48in. cupola and installed two new cupolas having shells 90in. diameter, so that we could line them up to 78in. if required. We have them lined at the present time to 70in. When running full, *i.e.*, night and day, we melt 280 tons, running each cupola about ten hours. We have operated one cupola from Friday night at six o'clock until noon of the following day, closing down at 11 p.m. for one-half hour for lunch, and again at 6.30 a.m. for three-quarters of an hour for breakfast. This is rather hard on the lining, so we do not make a practice of it.
>
> We have tried a great many experiments with cupolas, but as yet have been unable to find any that will give better results than the double row of tuyeres—the upper row about 10in. above the lower. It is not necessary to keep the upper ones open all the time. Our blast pressure is about 11 ounces in the cupola bustle. We use a fan for blast. When running full we melt 10 lb. to 11 lb. of iron to 1 lb. of coke.
>
> In charging the cupola we are very careful to have the charge level. We charge the pig by hand and the scrap is dumped in from a buggy through a door above the regular charging door. All the charges are the same from beginning to the end of the heat. As the iron must come very soft and uniform we do not charge more than 4000 lb. at one time. For a smaller cupola the charge would naturally be less.
>
> To sum up our experiences, I would advise:—See that the coke bed is burning even all around, then charge just as you would for an ordinary run, allowing an extra amount of coke for the dinner hour. After running about one hour, open the slag hole and keep it open, except during the dinner hour. Use about 40 lb. to 50 lb. of limestone to one ton of molten metal—better to use too much than too little. Have the cupola shell large enough, as it is easy to put in an extra lining for smaller heats.

The continuous melting system is used also at a foundry in Louisville. Two cupolas are used alternately. These are 30in. diameter inside the lining, and are situated side by side. They are lined with fire-clay blocks guaranteed to stand a temperature of 3000 deg. Fah., and cement grouting is poured between the shell and the lining. The linings placed on November 2nd, 1907, are still in good condition. In addition to the smaller castings made by continuous melting, this foundry makes grey iron castings in moulds put up on the regular sand floor. These latter castings are poured in the morning, before the continuous process is started, everything being got ready the previous evening. The night watchman lights the cupola at 6 a.m., and the first iron is tapped at about 7.30 a.m.

As described in a paper by Mr. R. H. Probert, the charge consists of 100 lb. of coke and 500 lb. of iron. The iron is made up as follows:—100 lb. of machinery scrap, 150 lb. of re-melt, and 250 lb. of pig. The last three coke charges are usually 50 lb., 50 lb., and 25 lb. Limestone will average about 2¼ per cent. of the total iron charged. On a day's run of twenty charges, lime rock is commenced with the fifth heat and stopped with the fifteenth. This has been closely followed and no difficulty is experienced. The loss in melting is about 2½ per cent., deducting the finished castings and the scrap recovered from the total amount of iron charged. Slagging is commenced about 11 a.m. each day.

It is very important that the moulds should be kept in proper condition, so as not to cause delay in pouring and consequent holding back of the metal in the cupola to permit of continuous work. In this foundry permanent moulds of cast iron and steel are used, some particulars of these being given further on.

The cupola man must watch his charges closely, must not melt the iron down too fast, and must know the condition of the heat at all times. He must be in touch with the work on the foundry floor, and be ready to give or slack the metal as required. The slag is allowed to accumulate until it is just below the tuyeres, which arrangement gives cleaner iron and better results from the blast. The slag hole is opened just enough to let the slag run, and the slag is allowed to gather in a crust on the outside so as to act as a trough or trap, and prevent the escape of the blast with the slag.

In a discussion on these papers, Mr. G. K. Hooper mentioned a "continuous" foundry in which the completed moulds are carried to the cupula on trucks mounted on springs. There they are poured, and then run on to a cooling and dumping point. Some foundries have been using the continuous system for from fifteen to eighteen years. He advocated the use of belt conveyors for handling sand.

PERMANENT IRON MOULDS.

The use of cast iron moulds and cores in place of the universal sand moulds and cores is a somewhat remarkable development in iron founding, and is adaptable only to certain kinds of work. It has been introduced on a practicable and commercial scale in some cases with highly successful results. The moulds must be massive enough to absorb and retain the heat without injury, and must be open for the removal of the casting as soon as the iron has set. The cores, also, must be removed promptly before the casting contracts and grips the core, but this is easily accomplished.

At the Louisville foundry mentioned by Mr. Probert in the paper above noted, the moulds are set in square or rectangular frames supported on stanchions which have open bearings to receive the trunnions on the ends of the frames. The frames revolve freely on the trunnions, so that they can be turned to the position most convenient for pouring, in which position they are secured.

Some of the permanent moulds used in this foundry have the two parts hinged together, and are provided with a swivel clamp set into a lug in the side of the mould for fastening the two halves together. Others are not hinged, but have the parts fastened together with screw clamps or gibs and keys. The fastening must permit of easy and quick release, as the mould must be opened almost immediately. The moulds are machined on the contact faces, and on the bottom side that is fitted to the moulding frame; they are also drilled and tapped for the hinge pin. It is necessary, therefore, to make the moulds of an iron that will permit of the machining and still be tough enough to stand up to the molten metal that is continuously poured into them. If the moulds burn out quickly there is loss of time and money, a delay in the work, and the cost of new moulds. An iron suitable for this purpose analyses 2.15 per cent. silica, 0.086 per cent. sulphur, 0.41 per cent. manganese, 1.26 per cent. phosphorus, 0.13 per cent. combined carbon, and 3.17 per cent. graphitic carbon. Some of this metal had 7 per cent. of fine steel lathe turnings added in the ladle.

Mr. Probert remarked that with well-made permanent moulds giving effective pressure, as soon as the metal is poured into them the castings will be denser and stronger than if cast in the ordinary way. The pressure due to the iron would also give sharper and cleaner castings. A paper by Mr. Custer described in some detail his work in the development of permanent cast iron moulds, and his practice in the manufacture of pipe and pipe fittings by this system.

FOUNDRY CUPOLA PRACTICE.

Imperfect castings are attributed as a rule to moulding troubles, bad design, or an unsuitable mixture of metal; but Dr. Richard Moldenke, Secretary of the Association, presented a paper in which he suggested that—apart from causes easily seen and remedied—the fundamental difficulty may be found in the manner in which the stock is melted. The cupola melting tests made under his direction in connection with the Government fuel tests developed a number of points which could not have been ascertained in ordinary practice. In regard to coke, an arbitrary ratio of coke to iron is adopted in many cases, although a ratio that gives good metal in one case will very likely be unsatisfactory when a different grade of coke is used.

The cupola trials showed that the lighter grades of coke burned away so fast that the metal came prematurely to the lower portion of the melting zone, and was thus burned directly by the blast. The first heavy charge lowered the coke bed to a point which not only ruined the metal already melted, but also prevented the subsequent charges of coke from restoring the bed to its proper level. The burning of metal, therefore, continued, and a very bad melt resulted. With the heavier grades of coke it was necessary to wait some time before the heavy bed was burned low enough to begin melting, and this—followed by a heavy first charge to maintain the ratio—lowered the coke bed unduly, so that the metal was brought too close to the blast, and was burned. The trouble was aggravated in these cases by the fact that the subsequent coke charges were very small—too small to maintain the ratio, too large a proportion having gone into the bed and burned away without effect. The result was that the fuel became insufficient even to support the Bessemerising influence of the blast, and the bottom was dropped with a lot of unmelted pig iron remaining. Tests of such a wide range and on such a large scale could not have been made by any commercial foundry. Dr. Moldenke's conclusions are presented as follows:—

> As the upper part of the coke bed does the melting, and, being used up in so doing, is replaced by the small coke charge above, why then is the first charge made heavier than the rest? It seems unreasonable—in fact, absolutely incorrect. Think a moment—iron does not begin to melt until the coke has burned down to the proper point. It takes more coke burned away after melting starts to care for a big first charge than for a little one, such as the subsequent charges. Therefore, with the big charge, the coke bed has been lowered so much that the subsequent coke charge does not restore the bed to its original height; in fact, far from it. The second iron charge therefore does not begin to melt where the first one did, but much below it. The result is, burnt iron in both cases. This goes on for every succeeding charge, the latter end of each being too low, and near the blast, which at this low point contains a lot of unconsumed oxygen. Usually the intermediate coke charges are just a little large, and gradually the line of melting is brought back to where it should be, and hence the burning trouble is confined to the first part of the heat. One often hears that towards the end of a heat the iron comes slow, and by cutting the coke in the last charges a little, quicker results are obtained. This is simply due to the extra large coke charges bringing the bed above the melting line, and hence coke must be burned away to get the iron into the proper place again for melting.
>
> The conclusion that one must come to—if the reasoning is correct—is that the first charge shall be no larger than the others succeeding. The second thought that comes is the natural result of the first: If the unreasonable fluctuation of the melting zone produced by an excessively large first charge does damage to the metal, then why not make all the charges not only alike, but as small as it is possible to make them, in order to hold the melting line as constant as possible.
>
> Herein lies the change I suggest in cupola practice as it is carried on to-day. I have tried this method repeatedly in the last year with remarkable results, nearly all imperfections in castings being wiped out wherever (1) the charges were made very small, (2) the bed started off at the right height, and (3) the intermediate coke charges proportioned in such a way that uniform melting resulted throughout the heat. Of course, the chemical composition was correct, and charging and melting were accomplished with care.
>
> The bed may be accepted as of proper height when iron comes at the spout in seven to ten minutes, the latter time being preferable. The charges are made so small that the proportionate amount of coke between just covers them and no more, say from 2in. to 4in. in depth. The ratio of iron and coke is kept just the same as previously in starting off this way, except that after deducting the coke for the bed from the sum total of coke charged, all the iron and all the coke left is divided up into equal and small charges. After running awhile it will invariably be found that the coke can be reduced somewhat, as the small-charge system keeps the melting so uniform that the fuel formerly used in making slag and keeping it hot is applied for melting iron.
>
> The greater uniformity in the mixture attained by this small-charge method would alone commend it to the small jobber, who oftentimes has either no bull ladle, or a very small one, holding, say, half of a charge.
>
> My own suggestion for charging a cupola, especially for big melt heats, would be somewhat on the following line:—Have the cupola cut off, say, 6in. above the platform, and arrange a hood further up to draw off the gases. This, I believe, is done in England in some places. Have a large cylinder slightly smaller than the inside diameter of the cupola, and provided with a drop bottom. Place the charges for the cupola inside this cylinder, or several of them, laying the metal, scrap, and coke evenly and carefully. Do this in your metal yard. Then transport to the cupola, run directly over it by some overhead method, and drop the charges squarely into the cupola. This will reduce the platform labour to next to nothing, allow the charges to be weighed by crane scale overhead, and laid right, and mean only one handling in the yard. It would be mechanical charging in its best sense, and rather more effective than the present blast-furnace hoist. Moreover, charging could not well be made any cheaper.

It is interesting to note that Dr. Moldenke's ideas were supported by a paper presented at the same meeting by Mr. Knoeppell, a practical foundryman, in discussing "Modern Cupola Practice." He expressed the opinion that charges of iron should be uniform, from the first to the last. While more iron can be carried on the first charge, it would cause trouble by lowering the bed to such an extent that the coke charge coming down would not restore the proper height. The bed should be maintained at a uniform height, which could be done only by small and equal charges of metal with the proper proportion of coke between them. In long melts of high tonnage it might be advisable to build up the bed by adding extra coke at intervals. With small and equal charges the melting was more uniform and more rapid, giving hotter and better iron. With such charges a blast as mild as possible should be used.

The use of steel scrap in the molten metal gives higher strength to the metal, but the latter is nevertheless cast iron, in spite of the practice of calling it "semi-steel." The steel addition, by reducing the total carbon, reduces the shrinkage to a minimum. Strong and yet elastic irons may be made, but careful consideration must be given to the chemical composition of the irons used in the charge and to the process of melting. Some observations on this line were presented by Mr. C. R. McGahey.

In the production of malleable castings, where extremely hot metal is required, the reverberatory furnace has many advantages. In a paper on this subject, Mr. W. H. Kane stated that the cupola is cheaper for producing the iron, but that the inferior quality of castings due to the direct contact of metal and fuel more than offsets the greater cost of reverberatory furnace malleable castings. On the other hand, the open-hearth furnace is a cheaper producer, and gives a somewhat better metal, but it must be run continuously, and can be used only in very large works.

MELTING STEEL FOR CASTINGS.

The use of the side-blow converter for steel castings had a great vogue at one time in the United States, owing to the way in which it was advocated by those interested in its introduction. The results proved so very different from those claimed that there was a strong reaction against the use of the converter, but it is now being established on its merits, and overcoming the prejudices against it. In a paper on this process, Mr. J. S. Whitehouse stated that with ordinary care the steel produced in a converter was very uniform in carbon and silicon, more so than that made in an open-hearth furnace. The greatest variation seems to be in manganese, the temperature of the metal and the condition of the slag causing more of a variation than in acid open-hearth practice. The converter is often run for several weeks with very little variation in the percentages of the elements. An ordinary plant with a two-ton converter can produce 100 to 150 tons of good castings per month, blowing three times a week. He was pouring steel which has 1 to 1.25 per cent. silicon, and making castings which weigh about 30 lb.

The side of the open-hearth process was presented at the same meeting by Mr. W. M. Carr, who referred especially to its use in small sizes, with melting capacities of half a ton to two tons per heat. The basic open-hearth process permits of a mixture of pig iron and miscellaneous scrap of a lower grade and cheaper price than for other processes. The operating cost of the "miniature open-hearth" furnace is said to be less than that of any other type of steel producing unit or process making steel in equal quantity. The rolling type of furnace with cylindrical body is best adapted for the miniature furnace. The miniature open-hearth is not costly to instal, it is comparatively simple to operate, it gives results equal to standard open-hearth practice, makes hotter steel than the latter, and can show an equally low cost per pound of molten metal in the ladle. He is making castings so small that there are twenty to a pound, but this is in connection with larger castings which can be poured with metal at a lower temperature.

Dr. Stoughton expressed the opinion that there are great possibilities in the adaptation of the electric furnace as an auxiliary in steel foundries, being used to give a final treatment to molten metal for the production of high grade castings. Thus nine-tenths of the work of production would be done cheaply, leaving only one-tenth for the costly electric process. Then a foundry could make ordinary steel castings as its main product, but treat two or three heats in the electric furnace to produce a specially fine steel for special castings. He presented estimates of the cost of producing cast steel by different processes, the total cost per ton of metal in the finished castings being as follows:—

	£	s.	d.		£	s.	d.
Acid open-hearth process...	5	12	0	to	6	12	9
Basic ,, ,, ,, ...	5	10	0	,,	6	12	4
Acid open-hearth for small castings	6	2	8	,,	7	3	4
Basic ,, ,, ,, ,,	6	10	0	,,	7	11	4
Converter process	6	2	4	,,	6	15	2
Crucible process					14	5	6
Electric process—							
Current at ½d. per kilowatt-hour...					7	16	10
,, 1d. ,, ,, ...					10	12	0
,, 1½d. ,, ,, ...					13	7	4
,, 2d. ,, ,, ...					16	2	6
,, 2½d. ,, ,, ...					19	0	8

BRITISH ENGINEERS AND RUSSIAN TRADE.

IN view of the general slackness which characterises the engineering trade of this country, coupled with the more settled political atmosphere which prevails in Russia, the present would seem to be a favourable time for calling the attention of British engineers to the desirability of developing their commerce in the empire of the Czar to a greater extent than hitherto. In commerce, diplomacy, social intercourse, and finance, Russia is at the present time perhaps more favourably inclined to Britain than to any other country, and although the Russians prefer the products of this nation, it is a matter for regret that the amount of trade carried on between the two nations has not attained anything like the proportions which it should have done. Our manufacturers labour under no insurmountable disability which prevents successful competition with other nations, except, possibly, geographically. This is proved by the flourishing trade which already exists in many commodities. The Germans have captured the Russian markets largely for three reasons; first, their proximity to Russia, which enables their manufactures to be run into certain ports without unloading on the railways; second, their greater enterprise in the matter of credit giving, in which they are supported to a very considerable extent by the German banks; and third, the foreign merchants on the spot who act as their agents. Neither the German nor any other nation has any advantage over the British as regards the Customs tariff.

British engineers who wish to cultivate trade with Russia will do well at the outset to recognise two cardinal facts, the first being the necessity of the use of the German language, which is now the commercial language of the country; and the second, the need of adopting the metric system of measurement. With these qualifications as a foundation, the next step is to ascertain where there is any probable market for their own particular output. In this respect valuable assistance is forthcoming from three sources, namely, the nearest Russian Consulate, the Commercial Intelligence Branch of the Board of Trade, London, the Russian Section of the London Chamber of Commerce, or the Russo-British Chamber of Commerce, St. Petersburg. Having ascertained which provinces to attack first, it will be advisable next to write to the aforesaid for a list of Russian merchants of the First Guild. It should be here pointed out that in Russia all merchants must be members of the Guilds—first, second, or third—of commercial associations, equivalent to the British Chambers of Commerce. In Russian and Siberian towns these are known as "Bourse Committees," in Finland as "Commercial Unions," and in Poland as "Chambers of Commerce." It is important to note that all correspondence for Russia and Siberia should be in Russian or German, for Poland in Polish or German, and for Finland in Swedish or German. The majority of Russian commercial men do not understand English, and French is comparatively useless in commerce, although it is the recognised medium in official circles.

Considerable discretion has to be exercised in the appointment of travellers or agents. These should be able to converse and correspond in German and Russian, and it is absolutely essential that they should not also represent a rival firm of continental engineers. Otherwise the English firm may be used as a cat's-paw, and the results will be disastrous. Difficulties in visiting Russia and travelling from centre to centre only exist in the imagination of certain timid persons. A passport from the Foreign-office in London, with a certificate of identity, and the ordinary traveller's knowledge will ensure freedom of movement and from irksome officialism.

It is almost unnecessary to remind our readers to take all precautions in their dealings with Russian firms. Still there is much greater security now than formerly, for in recent years the Russian police have exercised vigilance in the control of the operations of foreign traders, while the Merchant Guilds are in official communication with the police. Information as to financial status can also be obtained from resident agents of the principal British banks and from other sources.

Finally, there is the matter of payment. This is the chief gulf which separates the British trader from the possible Russian customer, and which has been so effectively bridged by the German manufacturers, thanks to the ready assistance rendered by the State-aided banking institutions. The Russians, except in rare instances, have apparently not yet been able to grasp the advantage of "buying for cash." They prefer, must have, and are able to obtain from German exporters extended credit. Having already satisfied themselves of the *bonâ fides* of their customers, why should not the British engineers be able to meet their clients in a similar manner?

The Russian Consulates in London, Liverpool, Leeds, Manchester, and Hull, we are informed, are prepared to

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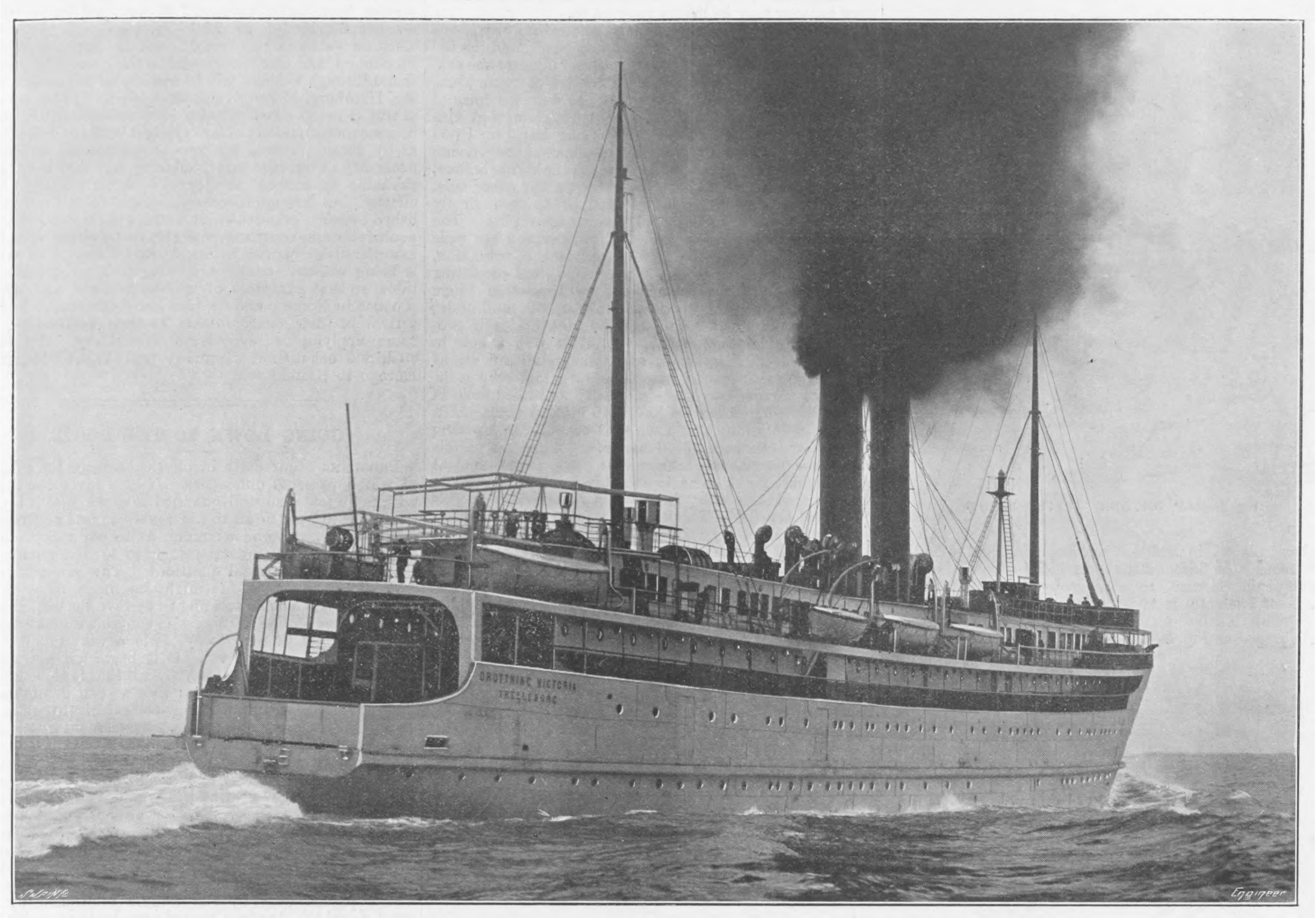


supply information gratis regarding passports, certificates of identity, commercial travellers' regulations, &c. We are indebted to M. R. Gaudin de Beaumont, Consul for Russia in Leeds, for suggesting this article, the materials for which have been obtained from independent sources.

IMPROVING TRADE.

ENGINEERS, with the Board of Trade returns before them for June, and for the first six months of the year, will not expect great things, but considering the state of business of late, will be thankful for small mercies. Taking, first, the aggregate exports of all kinds, it is noticeable that although the six months' shipments are still below those of the corresponding period of last year, yet the tide appears to be turning, for the figures for the single month of June represent, as compared with the corresponding month of last year, not a decrease but an improvement; and this same feature is characteristic of the shipments of some of the chief classes of engineering productions and allied goods. Should the autumn and winter returns, month by month, exhibit the same satisfactory tendency, the existing leeway will soon be made up, and 1909 may yet prove, as regards the foreign trade transacted, in no way behind its predecessor. We are glad to know that in several directions there are indications that the buying powers of some of the leading consuming markets, especially Australia, South America, and South Africa, are likely to be considerably strengthened between now and the end of the year. Although the aggregate export trade of this country for the six months compared with last year has receded by £13,059,045, being actually £176,934,350, yet the latter is still an immense half year's sum for any nation, and a country which can boast a trade of that magnitude in lean times cannot be in a very bad way. And as regards the single month, we see the turning of the tide in the right direction by an increase from £28,953,139 in June, 1908, to £29,717,975 in June, 1909, or an advance of £764,836. As regards machinery—including engines—the six months' exports, although they have amounted in value to the heavy sum of nearly 14 millions sterling—£13,899,993—are still below those of last year by £1,855,152; but when the single month's figures are looked at, it is found that as contrasted with last year, there is hardly any difference worth speaking of considering the extent of the trade, the June, 1909, shipments having amounted to £2,304,092, which is only below June, 1908, by £61,592, and is an amount on a trade of over two millions that cannot be considered at all large.

Altogether there are indications that the trade of the country is gradually beginning to mend, and we hope that if the convalescence is to be slow it will at any rate be sure. Included in the before-mentioned general totals, we notice with satisfaction the following among other items of improvement in exports, from 1908 to 1909:—Road locomotives (including steam rollers), for June, from £25,941 to £40,510; and for the six months, from £105,749 to £170,250. This includes a heavy improvement in the exports to South America for June from £26,735 to £89,349; and for the six months from £356,240 to £604,592; India, for June, from £42,014 to £68,060; for the six months from £235,527 to £240,729. Evidently railway construction in South America and India is doing well. Miscellaneous prime movers for June (*i.e.*, "other descriptions") rose from £176,892 to £180,943. Under this head Australia, Russia, South America, Spain, and several other continental countries, purchased much more freely than a year ago. The total value of prime movers (except electrical) for June advanced from £539,940 to £552,195; electrical prime movers of all kinds, for June, rose from £85,549 to £127,847; and for the six months, from £641,942 to £707,661. Agricultural machinery, for June advanced from £122,844 to £142,215; and for the six months, from £545,003 to £608,388. The single month's improvement under this head was due chiefly to increased buying by Europe, and also to a slight improvement in the South African demand. With regard to the longer period, the augmentation was due to larger orders than a year ago from Europe, South America, and South Africa. Boilers for June rose in value from £135,627 to £142,242, and machine tools for June from £36,890 to £66,306; whilst machine tools for the six months increased from £163,564 to £329,022. Mining machinery for June grew from £69,957 to £80,039. It is pleasing, also, to see the exports of motor cars, chassis, and parts rising in value for June from £83,993 to £125,600, and for the six months from £580,019 to £610,082. Iron and steel masters will be glad to see that the exports of iron and steel and manufactures thereof for June advanced in quantity from 335,503 tons to 351,268 tons; whilst the six months' quantity of 2,002,708 tons was only 74,187 tons behind the figures for 1908. Railroad iron and steel improved for June from 59,503 tons to 67,313 tons, and for the six months from 303,935 tons to 358,855 tons. Large increases stand also to the credit of the tube trade and the galvanised sheet trade, the members of both of which industries may well be congratulated. Altogether, the returns in several branches are by no means devoid of encouraging features, and they give promise of yet better times ahead.

A NEW RAILWAY TRAIN FERRY SERVICE.

No. I.

VERY considerable development in the transit facilities between Germany and continental Europe and the Scandinavian peninsular may be expected to result from the starting, on Wednesday of last week, of a new railway car ferry service between Sassnitz (Germany) and Trelleborg (Sweden), which is the joint enterprise of the German and Swedish Governments. Separating the two ports named is a 65 miles stretch of the Baltic, and for the past ten years the steamship connections on either side have been maintained by a fleet of modern vessels owned by the Swedish-German Steamship Company, of Malmo, and the Stettiner Dampfschiffs-Gesellschaft, and operated under subsidies from the respective Governments.

No country affords better scope for the development of the system of train ferries than does Denmark, not only for the purpose of linking up its own territory, but in providing through communication with Sweden and Germany, and by a reference to the map—Fig. 1—it will be seen that the Danish State Railways are at present operating no fewer than eight railway car ferry lines, the last to be started being that from Gjedser to Warnemünde, by means of which a daily through service is maintained between Berlin and Copenhagen.

Whilst the traffic between Germany and Sweden has shown considerable development during the past twelve years, yet the greater proportion has been consigned *viâ* Gjedser-Warnemünde, owing to the absence of the break of load previously necessary on the Sassnitz-Trelleborg route. Some three years ago the German Government accepted the proposals made by the Swedish State Railways for the establishment of railway car ferries in substitution for the steamship services between Sassnitz and Trelleborg. Each country will provide two vessels. Those for the German Government (the Deutschland and the Preussen) have been built at the Vulcan works at Stettin, whilst of the two for the Swedish Government, one, the Drottning Victoria, has been built by Swan, Hunter and Wigham-Richardson, Limited, at the Neptune shipyard, Walker-on-Tyne, and the other, King Gustaf II., will shortly be launched by the Lindholmen Company of Gottenburg. The train ferries have cost approximately £115,000 each.

In connection with the establishment of the new service special rolling stock has been introduced, and at the outset forty-five new passenger coaches, comprising sleeping, baggage, and mail vans, have been provided, of which number thirty have been built at various Swedish works for the Swedish State Railways. These vehicles are of the most modern design, and have cost about £3000 each. They are all built to suit the loading gauge of the

Prussian State Railways, which is somewhat less than that of the Swedish State Railways.

The scheme also involved considerable additions and improvements at the harbours at Sassnitz and Trelleborg and the construction of special train ferry basins and piers at both places, in addition to deepening and dredging operations. At Sassnitz the work is being carried out on behalf of the German Government by the firm of Habermann, of Kiel, and it is intimated that the alterations there will involve an expenditure of £230,000. At Trelleborg—see Fig. 3—the piers are being extended, new lighthouses have been erected, and the inlet deepened to 23ft. and the width of entrance increased to 167ft. The contract is being carried out by Messrs. Gunnerson and Co., of Malmo, and the dredging by the firm of Momberg, of Copenhagen. The cost of the new works at Trelleborg harbour is estimated to be about £120,000, and the scheme is being undertaken by the local authority, with special Government aid. As it is our intention to publish in a future issue a detailed description of the British built train ferry, and to reproduce a complete series of drawings and photographs, no lengthy reference will be made at the moment concerning the dimensions and design of the vessels. Those built at the Vulcan Works differ in a few respects from the Swedish train ferries, but all four boats are from the same general outline and have the same length (370ft.) and beam (51ft.) and other overall dimensions, consequently there is practically no difference in the lay-out of the quays and landing stages, and for the purposes of the present notice those at the Trelleborg harbour may be briefly referred to.

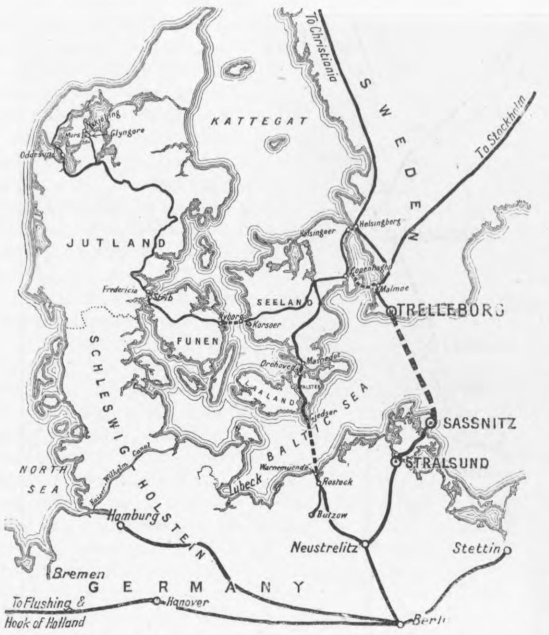
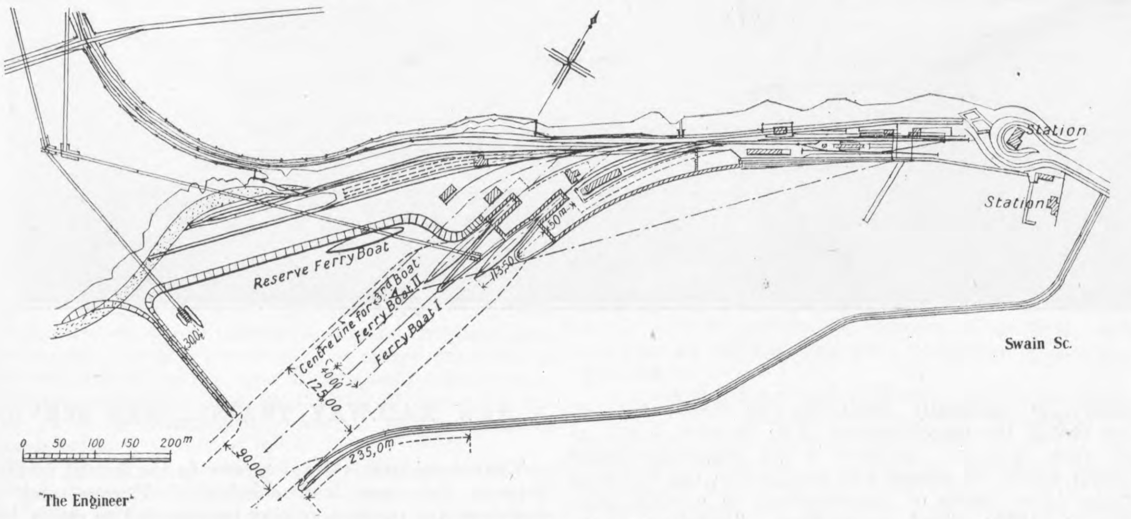


Fig. 1—MAP SHOWING TRAIN FERRIES

The appliances used for the transfer of railway trains may be divided into:—(*a*) the landing berth, and (*b*) the connecting link between the land railway line and the ship railway line. The landing berths consist of stone piers, lined with wooden piles, so as exactly to suit the form of the vessel. The wooden pile structure is connected with the stone piers by a series of iron spring buffers. Upon reaching the basin the ship strikes against the wooden piles on one side; these yield, owing to the spring buffers, and ricochet her gently to the piles on the other side, until the vessel is gradually brought to rest, firmly embedded in the structure of the wooden piles. The connecting link between the land railway and the rails on the ship consists of a bridge of steel construction, ordinary open girder work, 160ft. in length, and consisting of two portals, hinged at one end, with another hinge in the middle, so that the outer hinge only is used under ordinary conditions. At the sea side the bridge is provided with a large steel bolt, which fits into a hole in the stern of the ferry boat, and thus rigidly maintains strict alignment between the land rails and ship rails. The time occupied by the electrically-controlled hoist in raising the bridge from its lowest to highest point—18ft.—is about 2½ minutes, and the time occupied in lowering it the same distance is 30 seconds. When no vessels are in the basins the bridges are each maintained at their highest point, so as to be ready for lowering on to the stern of the train ferry when it arrives. In this portion of the Baltic Sea there is no tide of any importance, but there is a variation in the level of the water at Sassnitz and Trelleborg of about 7ft., on account of the winds.

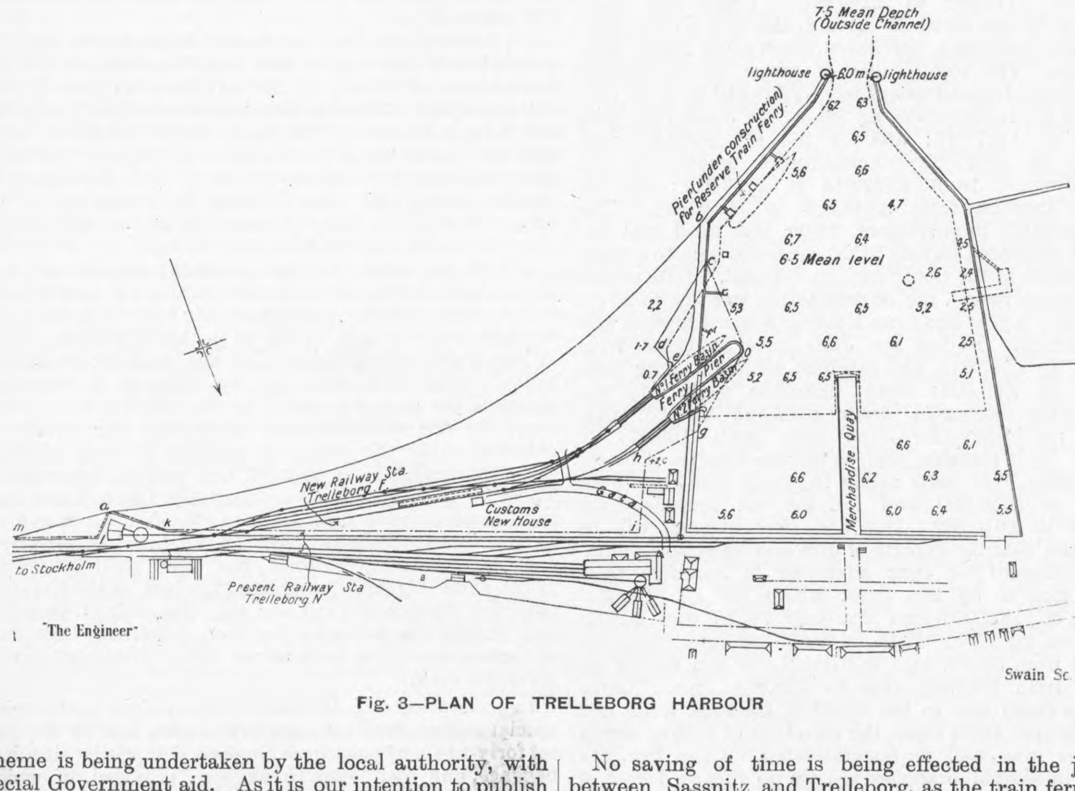
No difficulties have arisen in embarking or disembarking of the railway vehicles, and experience gained has already demonstrated the practicability of transferring eight heavy bogie coaches either from ship to shore or *vice versâ*, within a period of fifteen minutes from the time of arrival of the ferry at the basin or of the train at the landing berth. Pending the completion of the second ferry of the Swedish Government, the service is at present being performed by two of the train ferries, with the second German vessel held in reserve.



Swain Sc.

Fig. 2—PLAN OF SASSNITZ HARBOUR

No saving of time is being effected in the journey between Sassnitz and Trelleborg, as the train ferries are being allowed four hours to accomplish the distance of 65 miles. This is the same time as was the case with the subsidised steamship service. But already considerable improvements have been effected in the railway connections on both the German and Swedish State Railways, a saving of no less than two hours having recently been effected in the day and night boat trains as between Trelleborg and Stockholm, a distance of 650 kiloms. By leaving Berlin at 10.50 a.m., Sassnitz is reached at 4.27 p.m., Trelleborg at 8.47 p.m., and Stockholm at 8.59 a.m. the following day. The night service from Berlin leaves at 7.36 p.m., and the passenger reaches Stockholm at 7.18 p.m. the following day. Through carriages are now running between Berlin, Stockholm, and Christiania, and in the near future additional through vehicles will be introduced between Flushing, Hamburg, Hanover, and Stockholm. The advantages of this German-Swedish train ferry scheme will in time become more manifest so far as freight traffic is concerned, as, by dispensing with the two transhipments previously necessary at Sassnitz and Trelleborg, not only have considerable reductions in journey times already been effected, but through merchandise rates have been established between practically all stations in the Scandinavian peninsular and Germany, and also many of the important manufacturing centres in Austria and Italy. The traffic is being worked strictly according to a published time table, so that exporters of timber, fish, and agricultural produce in Norway and Sweden know the precise hour of arrival of their consignments at their destination, the same applying to exports of machinery, chemicals, coal, and coke from Germany and the continent of Europe to Scandinavia.



Swain Sc.

Fig. 3—PLAN OF TRELLEBORG HARBOUR

GOING DOWN TO THE ROOTS.

PROBLEMS occur daily in physical science the solution of which presents difficulties. It is a favourite theory with not a few men well qualified to speak that it is only necessary to "get down to the roots" to find satisfactory explanations. This is as much as to say that we have only to go to fundamental principles to find answers to all manner of physical questions. The proposition is exceedingly plausible. It might be made by a skilful speaker at a scientific meeting to deceive the very elect—at all events for one evening. It contains a great deal of truth, and yet in many ways it is a vain thing of no weight or power whatever. It is based on the wholly untenable postulate that we know all that is to be known about fundamental principles; that we can define them; and that the definitions are competent to establish adequate concepts in our minds. An elementary example may be given here of the use which may be made of a fundamental principle. This, as tersely put, runs in treatises on mechanics:—"What is gained in speed is lost in force." The gearing has to be designed for a crane to lift a given weight. The designer is puzzled as to the proportions of his wheels and pinions. Then he remembers that the handle of the crane passes over a given distance per revolution, and the available effort on this handle is 100 lb.; next, he can see that the distance passed over by the handle multiplied by 100 must equal the distance passed over by the weight multiplied by the number of pounds in the weight to be lifted. A due allowance is made for friction, and the proportions of the wheels and pinions and chain barrel may be almost said to settle themselves. Cases of the kind, however, stand on far too humble a plane to affect the more important aspects of physical science.

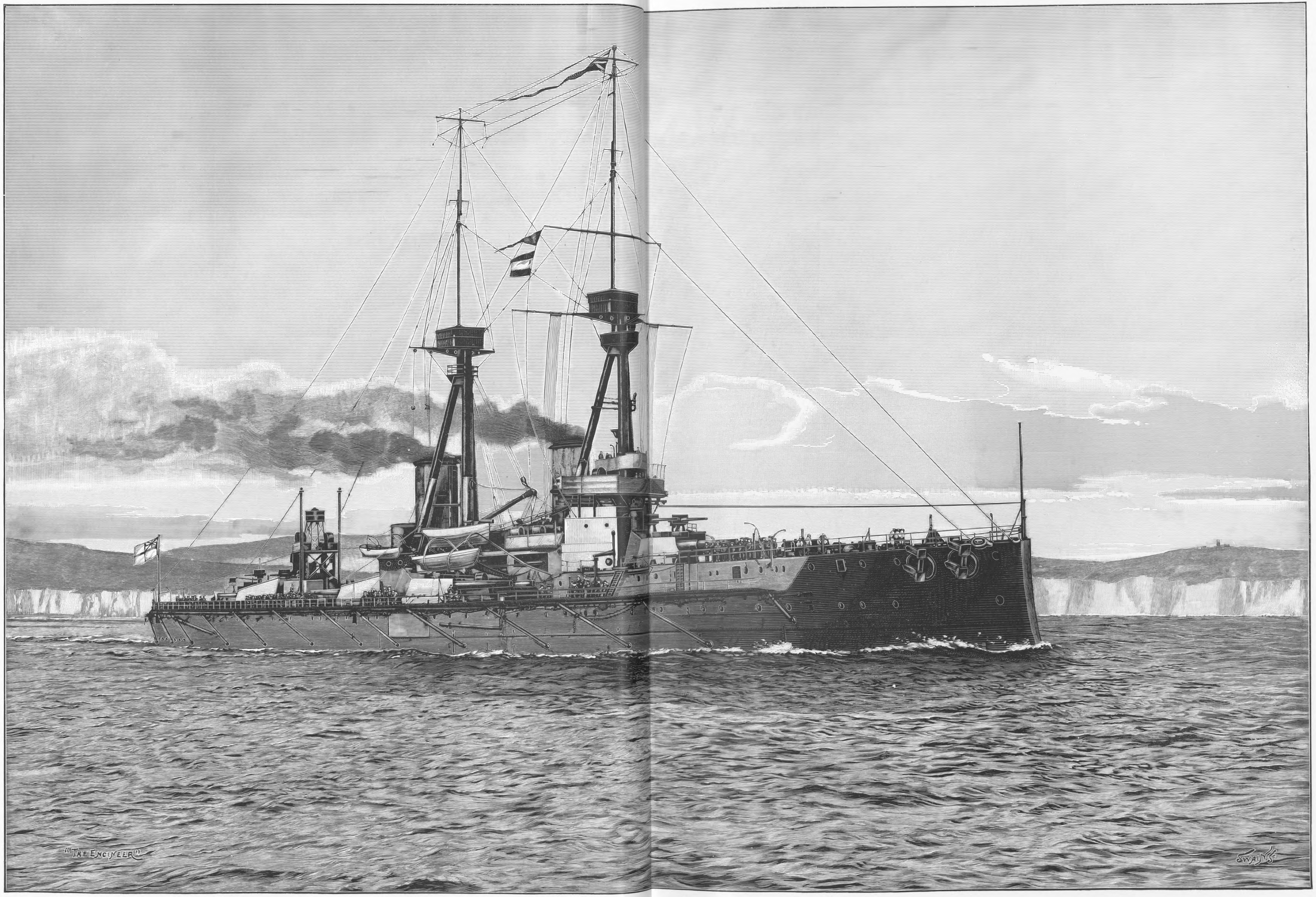
The fact is that we are more ignorant about fundamental principles than we are about anything else in the world of science. We know a little, and we believe that we know a great deal; and we go on most courageously doing things which come all right in the end, though we do not really understand how or why. The success which comes of our half knowledge plays an excellent part in that it stimulates us to renewed exertion, which would not be made if only we had nothing but fundamental principles to deal with. We do not see the roots nor care to see them; but the engineer does the world's work all the same. For the rest, we have only to read the books of the most eminent physicists to see that the world knows little or nothing about fundamental principles or their operation, and probably never will. Take for example explosives. It matters not of what kind, cordite, a mixture of hydrogen and oxygen, what we please. There is no doubt a fundamental principle lying at the root of the violent action which takes place when a spark is applied. What it really is no one knows. The chemist's explanation takes us but one step on a road apparently without end. But he makes very good explosives all the same. What we call a fundamental principle is in truth nothing more than a deduction from numerous experiences; and a new experience may in a moment blow the accepted fundamental principle to the winds. The "fundamental principle" closely approaches in its characteristics to what used to be called, until wiser counsels prevailed, a "law of Nature." Nature has no laws.

It is because men turn so frequently to what they term fundamental principles that so many apparently endless discussions arise. It is, for instance, only necessary to raise a question in dynamics or thermodynamics to set people by the ears. Two plain individuals, A and B, discuss a point; then a third man C comes in and says A and B are both wrong, because they have not gone to the root of the matter. If they had they could have seen what the truth is. Then enters D, who says that C has got hold of an entirely erroneous view of the fundamental truth. Probably all four are right, only they are right for different reasons. If only it was possible to settle fundamental principles and the method of their application once for all, their discussion might perhaps be simplified, and knowledge might perhaps abound. But no knowledge of fundamental principles can be of any value unless it gives accurate concepts which will not clash, but will work into and with each other.

Interesting discussions proceed in the correspondence columns of THE ENGINEER now on one topic, now on another. It is easy for anyone who follows the arguments to see that much of the apparent contradiction

HIS MAJESTY'S FIRST-CLASS BATTLESHIP BELLEROPHON

CONSTRUCTED AT RTSMOUTH DOCKYARD


"THE ENGINEER"
SWAIN SC.

which exists is due to lack of definition. The disputants are looking through glasses out of focus, and their vision is dimmed. An argument which began about the screw propeller has settled down into one about kinetics. Each party invokes fundamental principles to prove that he is right, and all the time there is no fundamental principle. There are certain fundamental conditions definitions, and everything turns on the understanding of the conditions and the formation of accurate concepts of the things with which they deal. One question has taken the following form. Is the work done on a gun equal to the work done on the projectile fired from it? Before any attempt can be made to supply the answer it is essential that the word "work" should be so defined that we can form an accurate concept of its nature. Work has been defined as the overcoming of a resistance by a pressure. But this, although admirable as far as it goes, does not go far enough to be of any utility. Take, for example, the case of the gun and the shot. It is clear that the powder does the same work on the gun and the shot in so far as it exerts the same pressure for the same time on both. "There is," writes Clerk Maxwell, "a maxim which is often quoted, that 'the same causes will always produce the same effects.' To make the maxim intelligible, we must define what we mean by the same causes and the same effects, since it is manifest that no event ever happens more than once, so that the causes and effects cannot be the same in all respects. What is meant is that if the causes differ only as regards the absolute time or the absolute place at which the event occurs, so likewise will be the effects." A direct application of the proposition is that the gun and the shot have had precisely the same momentum imparted to them, which means simply that the mass of the gun multiplied by its velocity will give a numerical quantity precisely equal to that obtained by multiplying the mass of the shot by its velocity. Put in precise phrase, "the change of momentum in a body is numerically equal to the impulse which produces it, and is in the same direction." Here we have what may be termed a fundamental principle, which is so far from giving help that it constantly misleads. Change of momentum is taken not only to represent work done, but the amount of work done, and this last is confused again, and mixed up with the concept of power. It is this last that is supposed to be wasted on the water sent astern, in other words, in slip. But it is well to speak of one thing at a time. Let us for the nonce drop work and speak of power.

An engine winds from the bottom of a pit 50 tons of coal in an hour. Another engine lifts 200 tons of coal in two hours. The work done by the second is four times that done by the first engine. But because the time is doubled, the horse-power of the second engine is not four times as great as that of the first engine, but only twice as great. In this way it will be found that the power expended in any unit of time varies directly as the foot-pounds, and V^2 does not come in at all. To use another illustration. A train running at thirty miles an hour is stopped by the application of the brakes, and runs, say, half a mile. Let the speed be sixty miles an hour when the brakes are applied as before. The train will run two miles, but it will take double the time to traverse the distance. The work done by the brakes in any unit of time will be in the latter case just twice as much as it was in the former case. Is the power expended by the brakes precisely analogous to that expended by engines driving a screw propeller? Is the horse-power wasted on the water measured in terms of time precisely proportionate to the velocity imparted to the water? How is time to be measured when dealing with propellers? At moderate speeds the resistance of a ship varies as the square of her velocity. Therefore the power varies as the square. A ship burns 1000 tons of coal going to America at 8 knots. Next voyage she is driven at 16 knots. But instead of burning 4000 tons of coal on the trip, she only burns 2000 tons, because the run is made in half the time. If we take coal by the hour, the cost might be prohibitive. If by the run, the consumption may involve no commercial impossibilities. It by no means follows that because work varies as the square of a velocity, that the total power expended in attaining a given result must vary in the same proportion.

Returning to our gun and projectile, it is clear that if gravity and the resistance of the air did not come into play then the projectile would go on for ever in one direction and the gun would proceed in the opposite direction. But let us introduce a new condition and see where we are. This condition is the arrest of the shot and the gun. The velocity imparted to the gun multiplied by its mass must equal the velocity imparted to the shot multiplied by its mass, the momenta of the pair being equal; but the power of overcoming a resistance within a defined space varies for both equally as the square of the velocity. In this sense, and under these conditions, the work done on the shot is greater than the work done on the gun. Let us regard this as a fundamental principle, and try to apply it to the solution of at least one aspect of the propeller question. That is what Rankine did. But it is obvious that it leaves the points in dispute very much where they were. The thing sought for is thrust moving forward at a given velocity, and it is obtained by moving a body of water backwards at a given velocity. It is argued that so long as the thrust is obtained it is the measure of the work done. But it may be argued, we do not care about the work, only the power concerns us. On the other side, it is held that the faster water is pushed astern the greater is the waste, which is in any case inevitable. The reply is that the fundamental principle does not apply, and the apparently unanswerable argument is brought forward that in practice there does not seem to be any such relation between the velocity of the water driven astern —as Rankine's proposition would involve—and the power expended. Here the reference to fundamental principles as a means of settling a dispute has hitherto entirely broken down.

Turn now to steam. It is only necessary to mention the word to call up memories of life-long disputes. No reference to fundamental principles can settle these, because there are no generally accepted principles. Our ignorance of everything connected with steam and its formation is dense. It may be supposed that there is some fundamental principle involved in the manufacture of steel. So far as can be seen, however, none has been discovered which will enable required results to be obtained with absolute certainty. It would be quite easy to extend the list of controversial topics which cannot possibly be settled by reference to fundamental principles, and this is particularly true of all that concerns motion, because metaphysics are deeply involved for all but the shallow thinker. Take, for example, the following splendid passage from Clerk Maxwell's "Matter and Motion."—"As there is nothing to distinguish one portion of time from another, except the different events which occur in them, so there is nothing to distinguish one part of space from another, except its relation to the place of material bodies. We cannot describe the time of an event except by reference to some other event, or the place of a body except by reference to some other body. All our knowledge, both of time and place, is essentially relative. When a man has acquired the habit of putting words together without troubling himself to form thoughts which ought to correspond to them, it is easy for him to frame an antithesis between his relative knowledge and a so-called absolute knowledge, and to point out our ignorance of the absolute position of a point as an instance of the limitations of our faculties. Anyone, however, who will try to imagine the state of a mind conscious of knowing the absolute position of a point will ever after be content with our relative knowledge."

Or consider the following passages from Mach's extraordinary work on the "Science of Mechanics." "As soon, therefore, as we—our attention being drawn to the fact by experience—have *perceived* in bodies the existence of a special property determinative of accelerations, our task with regard to it ends with the recognition and unequivocal designation of this fact. Beyond the recognition of this fact, we shall not *get*, and every venture beyond it will only be productive of obscurity. All uneasiness will vanish when once we have made clear to ourselves that in the concept of mass no theory of any kind whatever is contained, but simply a fact of experience. The concept has hitherto held good. It is very improbable, but not impossible, that it will be shaken in the future, just as the conception of a constant quantity of heat, which also rested on experience, was modified by new experiences."

"We have attempted in the foregoing to give the law of inertia a different expression from that in ordinary use. This expression will, so long as a sufficient number of bodies are apparently fixed in space, accomplish the same as the ordinary one. It is as easily applied, and it encounters the same difficulties. In the one case we are unable to come at any absolute space; in the other a limited number of masses only is within the reach of our knowledge, and the summation indicated can consequently not be fully carried out. It is impossible to say whether the new expression would still represent the true condition of things if the stars were to perform rapid movements among one another. The general experience cannot be constructed from the particular case given us. We must, on the contrary, *wait* until such an experience presents itself. Perhaps, when our physico-astronomical knowledge has been extended, it will be offered somewhere in celestial space, where more violent and complicated motions take place than in our environment. The most important result of our reflexions is, however, *that precisely the apparently simplest mechanical principles are of a very complicated character, that these principles are founded on uncompleted experiences—nay, on experiences that never can be fully completed, that practically, indeed, they are sufficiently secured in view of the tolerable stability of our environment, to serve as the foundation of mathematical deduction; but that they can by no means themselves be regarded as mathematically established truths, but only as principles that not only admit of constant control by experience, but actually require it.* This perception is valuable in that it is propitious to the advancement of science."

After all has been said, it is on relative knowledge, and not on roots or fundamental principles that mankind have to rely for existence, for comfort, for luxury, for development. In an address at Birmingham some months ago Sir Alexander Kennedy touched on these very points, and we make no excuse for giving two long quotations:—"Can any one," he said, "with a reasonably developed sense of proportion imagine that our most modern ideas of atomic motions, of an electronic Universe, of an all-pervading ether like transparent platinum, of radio-activity, of a huge multiplicity of so-called 'elements,' are likely to be thought one whit nearer the essential facts of the universe by the undergraduates of the thirtieth century than are the 'images' and the curiously shaped 'first beginnings' of Lucretius by ourselves! We have many more means of observation than the ancients had, we are familiar with a great many more phenomena, and we are better trained in observing them. Our scientific men work out hypotheses which fit in with the observed phenomena, and are infinitely useful as starting points for further investigations and questionings of nature. But those great thinkers, by whose originality and industry and genius the theories have been worked out, have always been the very last to suggest that they have reached finality, or even that they have got in sight of ultimate truth at all." And again: "One is tempted to think that perhaps beings in other worlds have senses which let them comprehend a fourth dimension—hidden, alas! from us, and even less intelligible than sight to one born blind—and that in this may lie the whole secret of the understanding of the open mysteries before us. But when we remember that the whole sum of human knowledge does not enable us yet to answer one single fundamental question about the origin and meaning of the Universe, about the every-day things around us, the rocks and the trees, the clouds and the wind and the light, we may be the less inclined to take our own little ideas as forming a standard of right for all others, our own prejudices as settling every social question, or to hold our brethren to excommunication for heresy, whether of the theological or the scientific or the political variety, because their 'doxy' is not our 'doxy.'"

So far as can be seen, dig as deep as we may, we cannot get down to the lowest root. What we call fundamental principles are, in most cases, merely accepted arbitrary definitions—the result of accumulated experiences, no doubt, and in the main sufficient for our purposes. Our ignorance of the nature of steam is great; but it has not prevented the production of steam engines. We seem to know no more now than we did fifty years ago about the fundamental principles of marine propulsion; but we have the Mauretania and the Indomitable. Controversies will proceed; more or less acrimonious discussions will take place; and the peace maker, standing afar off, will call his gods to witness that if only the disputants would refer their quarrels to the arbitration of fundamental principles they would find rest, and still the answer will come. There are no fundamental principles, eternal, immutable, imperial, *known unto men*, that can be constituted into a universal court of scientific arbitration.

THE NEW QUEENBOROUGH-FLUSHING STEAMERS.

ON the 3rd inst., the Fairfield Shipbuilding and Engineering Company, Govan, launched the twin screw steamer Oranje Nassau, the second of three vessels it is building for the Stoomvaart Maatschappij Zeeland, of Flushing. The first of the three, the Prinses Juliana, was launched on May 22nd, and is rapidly being completed for service. The last of the three, which will be named Mecklenburgh, is being built with remarkable speed. The hull occupies the blocks vacated five weeks ago by the Prinses Juliana, and already the plating is well forward. The three vessels have been specially designed for night service between Flushing and Queenborough, and are 363ft. in length over all, 45ft. 4in. in extreme breadth, 25ft. 10in. in depth to upper deck, and of about 3000 tons gross. There are five decks—lower, main, upper promenade, and boat—and ten water-tight bulkheads extending to the height of the main deck. Two funnels with a fore-and-aft rig give the vessels a smart appearance. Special features in the design are the large number of one-berth cabins, the minute subdivision of the hull by water-tight compartments, and the provision of submarine signalling and wireless telegraphy apparatus.

The first-class dining saloon is on the main deck, and it extends the whole width of the ship immediately abaft the engine casing. The smoking-room at the fore end of the houses on the upper deck is accessible from the dining saloon by two alley-ways and a stair. Immediately abaft, and opening off the entrance hall, is the "imperial suite" of rooms, consisting of a large sitting-room, a bedroom, and a bath-room, all furnished and finished with exceptional taste and skill by Messrs. Mutters and Son, of the Hague. There are also two suites on the upper deck amidships, each consisting of sitting-room, bedroom, and bath-room. Of the 246 first-class passengers, sixty will have single-berth cabins, and the majority of the others two-berth. A group of two-berth cabins forward on the main deck is reserved for ladies. Aft there are berths for 110 second-class passengers.

The propelling machinery of these fine vessels consists of two sets of inverted, direct-acting, triple-expansion engines, each set having four cylinders and four cranks. The engines are balanced on the Yarrow, Schlick and Tweedie system, and have been specially designed for quiet and steady running at high speed. Steam is supplied by four double-ended boilers, adapted for forced draught on an improved arrangement of Howden's hot-air system, with open stokeholds.

The connection of the Fairfield Company with the Stoomvaart Maatschappij Zeeland extends back to the time of the formation of that shipping company over thirty years ago. All the vessels have been built by the Govan firm. Of the steamers in the existing fleet, one was built in 1883, two in 1886, one in 1887, and three in 1895. The three at present being constructed will easily rank as the finest in the fleet, and should further popularise the Flushing-Queenborough route. In replying to the toast of "Success to the Oranje Nassau," proposed by Mr. Alex. Gracie, of the Fairfield Company, at the luncheon following the launch, Mr. De Meester, managing director of the Zeeland Company, referred to the long association of his company with the Fairfield yard. It started as a shipping concern in 1876, and from the outset was convinced that success would only be achieved if it had first-class steamers built by first-class firms. The Fairfield Company had built all the steamers of the fleet. The number of passengers showed a steady increase from year to year. In the first year the number carried was 11,000, while last year it had risen to 134,000. Altogether the number of passengers carried by these Fairfield-built boats numbered about 3,000,000. Another fact upon which they might congratulate themselves was that not a single accident had taken place on any of these steamers.

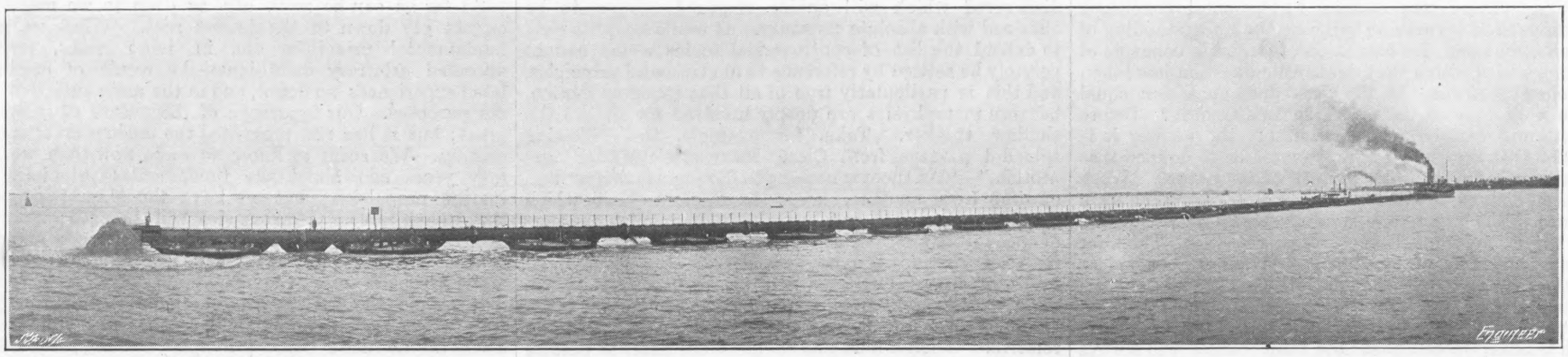
SOCIETY OF ENGINEERS.—The third vacation visit of the present session took place on Wednesday, July 14th, 1909, when by the courtesy of Mr. A. L. C. Fell, chief officer of the London County Council's tramway department, and of Mr. J. H. Rider, electrical engineer, facilities were given for a party of members and associates of the Society, with their friends, to inspect the Greenwich generating station, of which a description has already appeared in our columns.

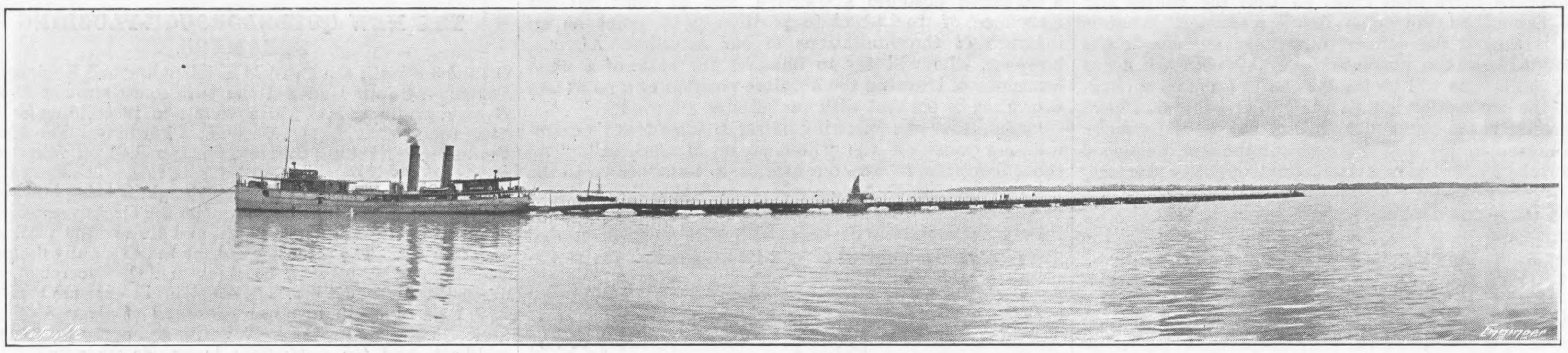
MANCHESTER GEOLOGICAL AND MINING SOCIETY.—By the courtesy of Messrs. G. H. Hill and Sons, consulting engineers to the Ashton, Stalybridge, and Dukinfield (District) Waterworks Joint Committee, members of the Manchester Geological and Mining Society have been invited to visit the works on Wednesday, 21st July next, and to inspect the trenches:—1.0, train from Manchester (Exchange) to Mossley; 1.30, car from Mossley to Roaches, thence by the contractors' car to the Chew Valley works.

UNIVERSITY COLLEGE.—The following awards have been made at University College, London:—Archibald P. Head Memorial Medal, 1908-09: R. A. Pfleiderer. Engineering Diplomas: H. F. Anns, civil; E. E. Baily, civil and municipal; S. M. Hitchcock, electrical; J. W. Mason, civil; S. G. Nottage, electrical, with distinction; B. J. Pfleiderer, mechanical; R. A. Pfleiderer, mechanical, with distinction; A. C. Russell, mechanical, with distinction; A. M. Sims, civil and municipal; A. T. C. Sutton, civil and municipal; F. L. Thompson, civil and municipal.

SAND PUMP DREDGER AND PIPE LINE AT RANGOON

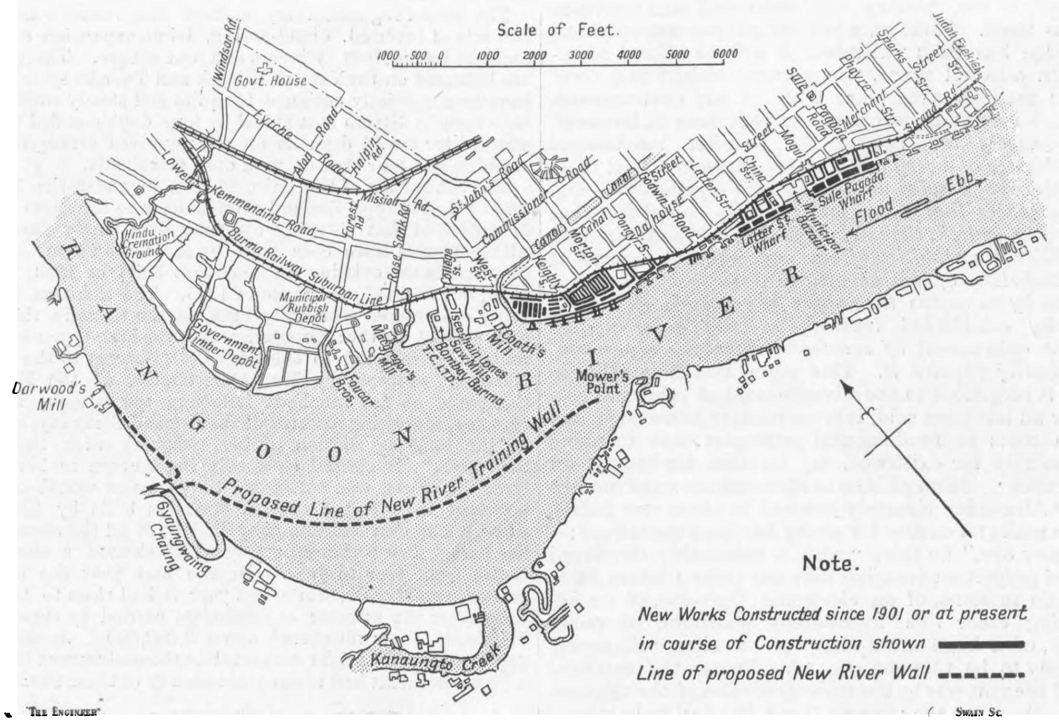
WILLIAM SIMONS AND CO., LIMITED, RENFREW, ENGINEERS





NEW PORT WORKS AT RANGOON.

THE fact that the Irrawaddy is navigable for 500 miles from the sea is largely responsible for the rapid development of the trade of Rangoon. The modern history of Rangoon as a port really dates from the creation of the Port Trust in 1880. The Commissioners who then assumed control showed themselves alive to the possibilities in the way of attracting trade, and spent considerable sums in giving improved facilities for the growing traffic, which by the year 1900 had increased to the annual value of nearly nineteen millions sterling. It was felt, however, that while the Commissioners had done much, there was an urgent call for the provision of additional facilities, and memorials were presented to the Government on the subject. The effect of these representations was to place the administration of the port on a new basis, and Mr. George C. Buchanan, M. Inst. C.E., was appointed chief engineer and chairman of the Port Trust in succession to the Government official who had previously had the work included in his other duties as chief engineer of the province under the Public Works Department.


Scale of Feet.
1000 500 0 1000 2000 3000 4000 5000 6000
Windsor Rd.
Govt. House
Lower
Fytche
Alan Road
Road
Halpin Rd.
Mission Rd.
Kemmendine Road
Burma Railway Suburban Line
Hindu Cremation Ground
Forest Rd
Rose Sarik Rd
St. John's Road
Commissioner Road
Canal
Municipal Rubbish Depot
Government Timber Depot
College St.
West Str.
Keighly S.
Morton Str.
Canal
Pongyi S.
Dalhousie
Street
Godwin Road
Latter Str.
Street
China Str.
Mogul
Sule Pagoda Road
Phayre Str.
Merchant Str.
Sparks Str.
Street
Judah Ezekiel Str.
Strand Rd.
Latter St. Wharf
Municipal Bazaar
Sule Pagoda Wharf
Flood
Ebb
Foucar Bros.
McGregor's Mill
Steel Bros. Saw Mills
Tsee Shain Lones T.C. Ltd.
Bombay Burma
Booth's Mill
Darwood's Mill
Mower's Point
RANGOON RIVER
Proposed Line of New River Training Wall
Gyaungwaing Chaung
Kanaungto Creek
Note.
New Works Constructed since 1901 or at present in course of Construction shown
Line of proposed New River Wall
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SWAIN SC.

Fig. 1—MAP OF RANGOON, SHOWING PROPOSED RIVER TRAINING WALL

The first task undertaken by Mr. Buchanan was that of drawing up a scheme of improvement works, which was subsequently put in hand, and which is now about to be supplemented by additional works which possess somewhat novel features. There are special points in connection with the river traffic from Rangoon which should be referred to before dealing with the new port works. Rangoon is on the Rangoon River, and there are several waterways which give communication to the main channel of the Irrawaddy. These include the Bassein Creek, which permits the passage of the large cargo steamers; the Twante Canal, which is navigable by smaller river steamers and cargo boats; and the Pahnlaing River, which joins the Irrawaddy at Yandoon. The latter waterway has to a great extent become silted up, and is available for small boats only; and the Twante Canal also requires to be dredged and deepened if it is adequately to serve the needs of the increased traffic, and work in this direction is to be undertaken in the near future.

Turning to the consideration of the harbour scheme, it should be noted that Rangoon has no wet docks. The river itself, in which heavy moorings have been provided, takes the place of wet docks, and serves all the requirements of the export trade, cargo being delivered from boats while the vessels lie at their river berths. The import trade is accommodated at special wharves, and the scheme completed at the beginning of last year really constituted a remodelling of the port. The river traffic is now accommodated at jetties, and new import wharves have been built to serve the needs of the increasing seagoing trade. The scheme provided a new depôt for the inland trade, and included the revetment and reclamation of the foreshore, the construction of a new port road 60ft. wide, and the building of three pontoon landing-stages. We dealt with this work on page 56 of our issue of January 17th, but we may here repeat that each landing-stage is 204ft. long by 42ft. broad, and is formed of fourteen separate iron pontoons 40ft. by 10ft., joined to each other by iron girders and connected to the shore by two bowstring girder bridges, 108ft. long by 13ft. broad. Transit sheds have also been built, aggregating 40,000 square feet of floor space, and a large area of ground behind them has been reclaimed, in view of future requirements. Considerable difficulty attended the building of the new import wharves, owing to the unstable nature of the river bed and the lack of suitable foundations. The works comprise a retaining wall 2720ft. long, reclaiming 15,000 square yards of foreshore, the wall being 10ft. 6in. at the base, and built of concrete and brick founded on piles driven 40ft. below low water. The new import wharves, 1300ft. and 1800ft. long respectively, consist of seven transverse rows of rolled steel screw-piles 7in. diameter, averaging 70ft. long, with screws 4ft. 6in. in diameter, the whole being braced together and surmounted by a steel superstructure with ferro-concrete decks. Brick and iron transit sheds have been erected behind the wharves, having an aggregate floor area of 308,000 square feet. It is proposed ultimately to have a depth of 28ft. below low water mark of spring tides alongside the main wharves.

The central power station for the hydraulic machinery contains two compound surface-condensing steam pumping engines, to which a third is now being added, and four force pumps of the plunger type, capable of pumping 200 gallons of water per minute at the accumulator pressure of 700lb. per square inch. The accumulator has a plunger 18in. diameter by 23ft. 6in. stroke, and boiler power is provided by two Cornish boilers each 20ft. long by 5ft. 6in. diameter. For working the wharves, thirty-two movable hydraulic cranes, capable of lifting a load of 35 cwt. through a height of 70ft., with a radius of jib of 42ft., are provided, and a further installation of four 10-ton cranes and a 40-ton steam floating crane is contemplated. The total cost of these works was about £700,000.

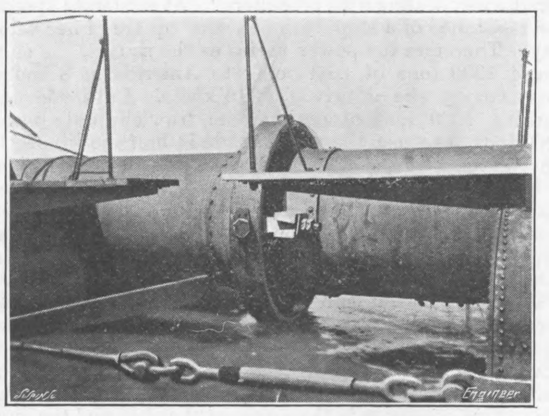


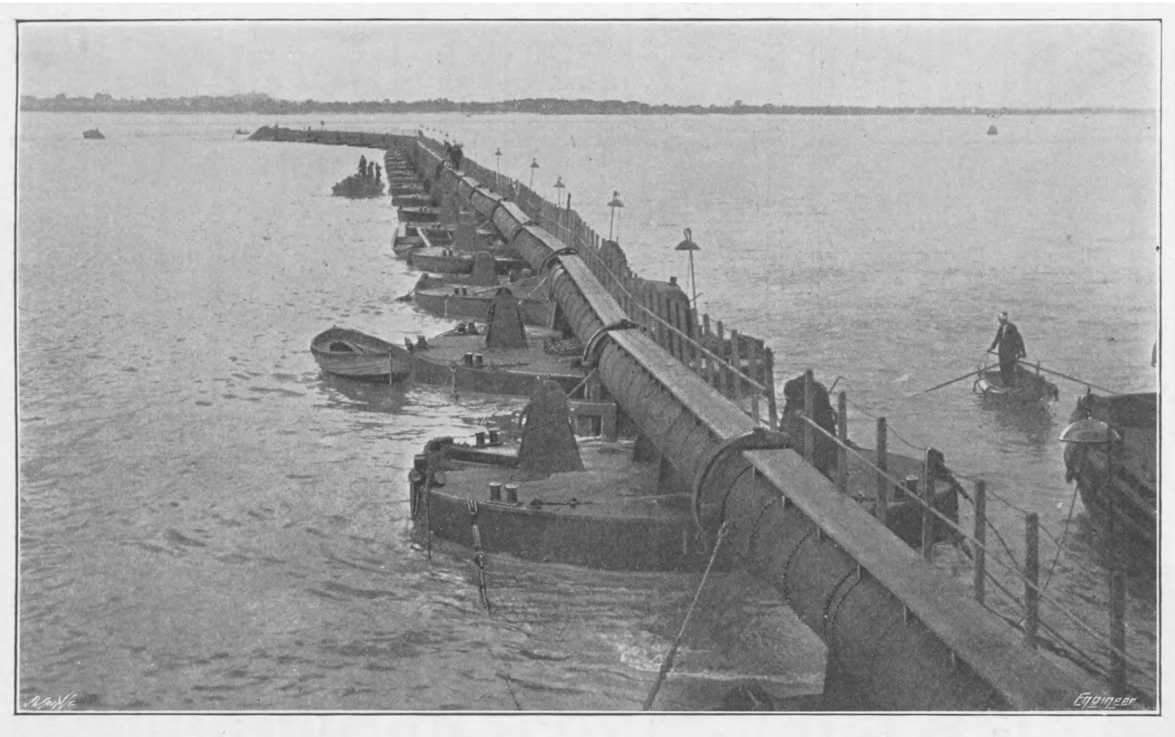
Fig. 2—BALL AND SOCKET JOINT IN PIPE LINE

The new scheme, the extent and character of which is indicated on the plan, Fig 1, and which has just been approved, has been rendered necessary owing to the manner in which the river immediately above Rangoon has eroded the right bank. To such an extent has this eroding process continued that the river now has a width of 6000ft. just above the town compared with 2500 in the harbour. The deep water channel has also been diverted to the opposite bank, and a serious shoaling in the harbour is threatened. Mr. Buchanan first reported on the case in 1903, and proposed the bold scheme of bringing the river back into its old course by building a training wall 2½ miles long in a depth of water ranging from 10ft. to 70ft. below low water, and with 4-knot current running on both flow and ebb, the view being that this would not only have the effect of bringing the river back into its original bed, but would

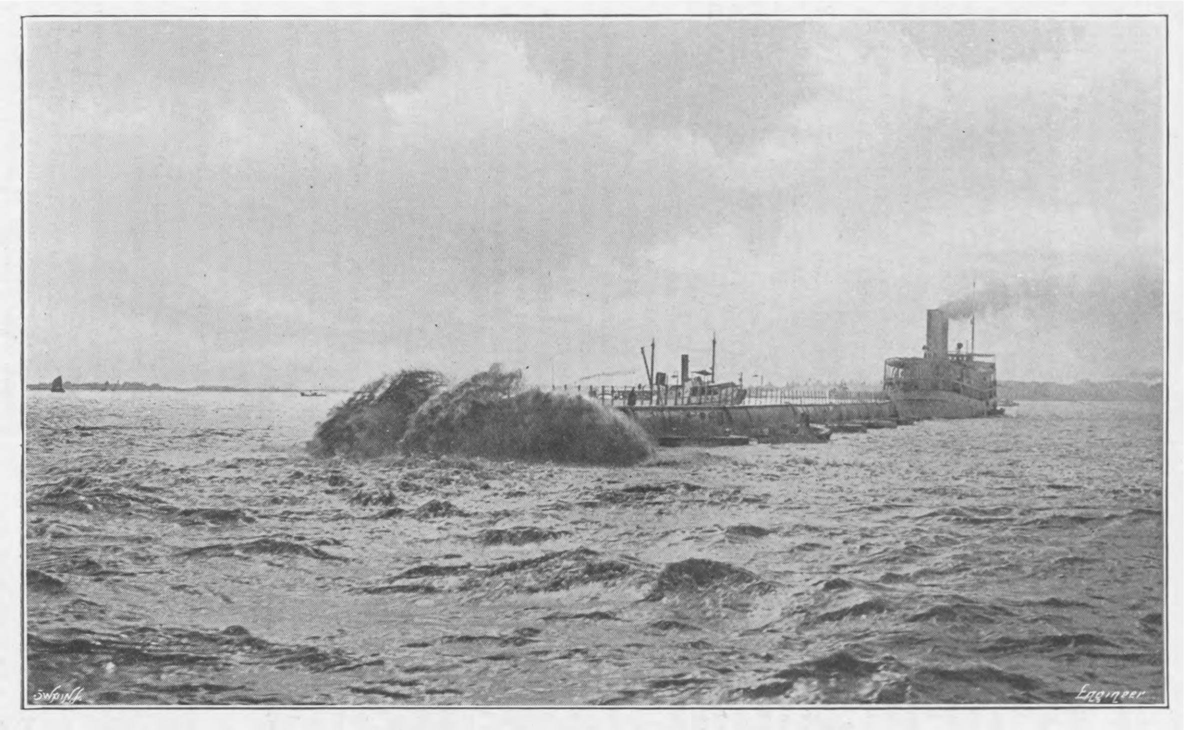
THE SAND PUMP DREDGER PELICAN AT WORK AT RANGOON

WILLIAM SIMONS AND CO., LIMITED, RENFREW, ENGINEERS

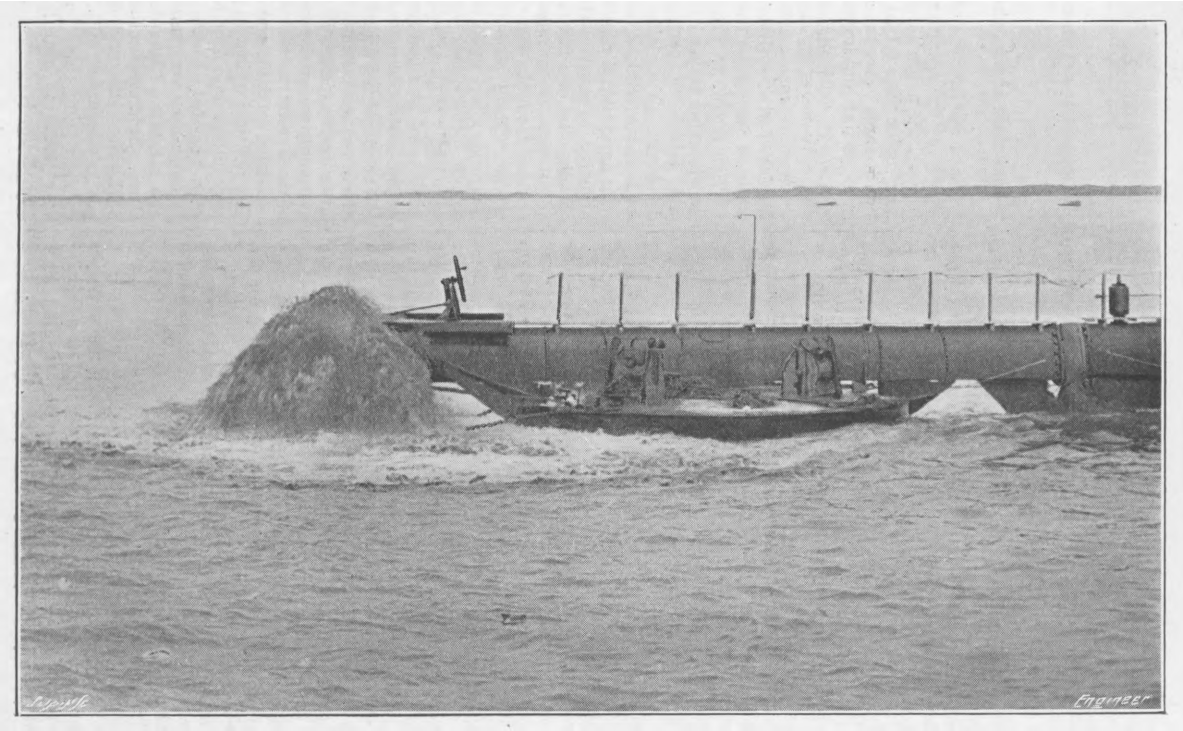
(For description see page 58)



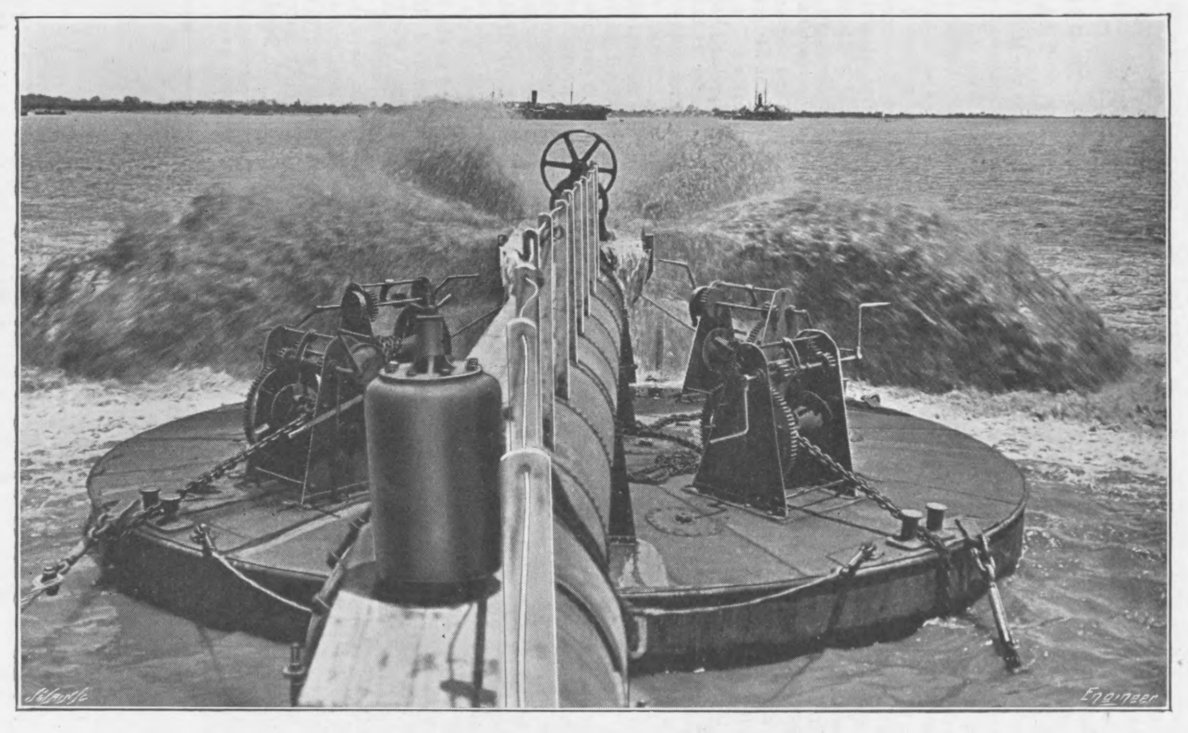
VIEW ALONG PIPE LINE FROM THE DREDGER



DREDGER AT WORK PUMPING THROUGH PIPE LINE



DISCHARGING END OF PIPE LINE



FINAL PONTOON AND DISCHARGING END OF PIPE LINE set up a natural scouring process which would keep the berths and the channel generally from the danger of silting up. Such a scheme was not, however, to be lightly undertaken, and expert opinion was obtained at a later date, Messrs. P. W. and C. S. Meik being called in to report. Finally, Mr. Buchanan submitted a complete scheme worked out in collaboration with Messrs Meik. This scheme was referred to Government, and made the subject of reports by various committees, and was also reported on by Dr. Corthell, the American expert. Ultimately it has, with small modifications, been accepted by the Government of India, and work is to commence at once.

The main idea of the scheme is as follows:—A cut will be made through the "Chalon" shoal above Rangoon, and for this purpose one of the largest suction pump dredgers in the world has been built by Simons and Co., and is now at work. The dredger, which we described at the time of her launch in our issue of May 15th, 1908, and is further illustrated in Fig. 3, is of the twin screw type, 208ft. in length, 36ft. beam, 14ft. depth, with a draught of 10ft. 6in. The speed under ordinary working conditions is 9 knots. The dredger is equipped with two sets of pumping engines, each of 1050 I.H.P., and the vessel is fitted with a suction pipe for dredging from a depth of 35ft., and can deliver 80,000 cubic feet of sand and silt per hour through a pipe 42in. in diameter, and 3000ft. in length.

There are special features in the design of the pipe line, which is illustrated on page 59, which call for attention. The line is carried on a series of pontoons of 26ft. diameter, spaced 50ft. apart centre to centre. The novelty in the pipe line is in the joint employed between each pair of pontoons to permit of lateral and vertical movement in the line of pipe. An engraving of the joint is shown in Fig. 2. Formerly either rubber or leather jointing was employed for pipe lines of this character, but owing to the heavy nature of the service such joints had a very short life, and the necessity for frequent removal was constantly hanging up the plant. In the present instance, therefore, use has been made of a ball-and-socket joint of cast steel, the design adopted being claimed to give maximum freedom of movement in every direction, while providing an absolutely water-tight joint, special packing being employed for this purpose on the outer edge of the joint. This ball-and-socket design was first employed by Simons and Co. in the pipe line working at Bombay, and the satisfactory behaviour of the joint in service there led to its adoption for the pipe line now in service at Rangoon. The joint has been modified in some slight details from its original form, and has probably not yet reached finality in design. We are enabled to give the outside view of it in Fig. 2, but at present are not at liberty to enter into details as to its construction.

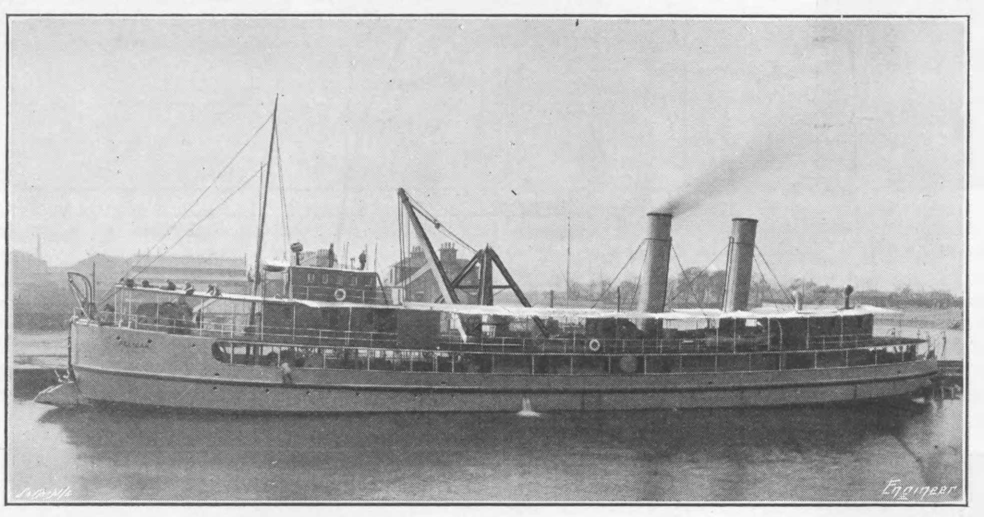


Fig. 3—THE SAND PUMP DREDGER PELICAN

The dredger has hitherto been working on the Hastings shoal below Rangoon, the object being to deepen the main channel up to the port, so that the largest steamers may gain access to the wharves without discharging part of their cargo lower down the river, as has been necessary hitherto. This preliminary dredging work, now practically completed, will enable vessels drawing up to 28ft. of water to get up to Rangoon at all states of the tide without unloading.

The next step will be to put the dredger and pipe line at work on the Chalon shoal. The proposed channel runs parallel to the training wall, and at a distance of some 900ft. to 1000ft. from it. Simultaneously with this work the training wall is to be built. For this purpose timber dolphins will be erected along the line, and lighted at night. Fascine mattresses will be laid along the whole length of wall, loaded with granite stone, sunk in position, and covered with a 5ft. layer of granite. The wall will then be built by tipping granite rubble on the central line from self-discharging hopper barges until low-water mark, above which it is proposed to erect a block wall, 5ft. high, and a pitched slope made thereon to high-water mark. Four million bundles of brushwood, 7ft. long and 6in. diameter, will, it is estimated, be required for the mattresses and 2 million tons of granite. A feature of the scheme is the quarrying and deposition of the granite. Large quarries have been opened up on a desert island called Kalagouk, situated 135 miles from Rangoon, off the Tenasserim coast. Here a town of 1000 inhabitants has sprung up, and the very latest quarrying machinery is in course of erection, whilst the transport from the shore to the hopper is to be carried out by means of a specially designed Lidgerwood cableway, guaranteed to load 1000 tons per day. By the building of wall and the removal of the shoal the harbour will have its capacity doubled. The work will be under the immediate supervision of Mr. Buchanan, with whom Messrs. Meik will be associated as consulting engineers.

EFFECTS OF THE WAR SCARE ON THE IRON TRADE IN AUSTRIA.

Now that the last war clouds have disappeared from the Balkan horizon, and the annexation of Bosnia and Herzegovina has been finally completed, Austrian industrial and commercial interests are beginning to ask how much Baron Aehrenthal's adventurous policy has really cost them. They know, so far at least as they can learn, that the actual military expenditure has amounted to something like 30 millions sterling. But what the further direct and indirect cost to the monarchy's export and home trade will amount to they find very difficult to estimate. It is, in fact, utterly impossible to decide what proportion of the loss in trade has been due to the war scare, and what to the general depression in business, the abnormally long and cold winter, and other incidental causes.

Statistics, which have just been issued by the Ministry of Commerce, for 1908 show that whilst imports increased 30 million kronen (£1,250,000), exports decreased 132 million kronen (£5,500,000). Of this decrease about a million sterling was in semi-manufactured goods, and the remainder in manufactured goods. It appears that this falling off was very generally distributed among the various industries; in fact, out of twenty-five classes of trade only three showed an increase in exports over 1907. The iron trade suffered considerably, the exports of iron goods having fallen off about a million and a-half sterling, or nearly 40 per cent. Part of this must, however, be put down to the lower prices in the iron market.

With regard to the iron trade generally, one of the largest manufacturers said that the home industry had been very depressed, but it was by no means certain that it would have been much better if there had been no war scare. As a matter of fact, only those industries were directly affected by the political conditions which have a large trade in the Orient. Austria's iron exports to Turkey are not very large, consisting chiefly of small wares, and of these a few shiploads were returned. With Servia the loss was considerable, particularly in materials of war, the export of which to Servia had been forbidden.

Asked whether the steel and iron trades had not benefited greatly by the Austrian Government's extensive preparations for war, the manufacturer replied that the orders given were far smaller than might be supposed, because during the past two or three years the authorities had been steadily engaged in increasing and improving the arms, munition, and military equipment generally, so that when it came to the pinch it was only necessary to make supplemental purchases, and these were comparatively small. The artillery corps had been furnished with entirely new cannon which had been manufactured during the past three years.

With regard to army supplies it may be mentioned that the electrical trades have fared better, as the field telegraph and telephone services are being greatly increased and developed. Very large orders have also recently been given for field travelling kitchens.

In agricultural machinery, a highly important branch of industry in Austria-Hungary, the manufacturers are also complaining of a falling off in trade. But here again they admit that it is impossible to tell whether business has suffered from the war scare, or from the abnormally severe winter. Many people believe that the political uncertainty had little effect upon this branch, but that prospective customers were rather waiting to see how sowing operations were likely to be affected by the weather. Of course the war crisis came at a bad time, just when landowners and farmers would usually be considering their orders for next season.

The managing director of one of the largest agricultural machinery manufactories in the empire said that the business situation, especially with regard to the Balkans, was extremely unsatisfactory. Orders from Servia unaccompanied by cash remittances were refused by all the factories, the unsettled conditions there rendering business very hazardous. The political upheaval in Bulgaria too rendered business there very uncertain. The long-drawn-out Turco-Bulgarian crisis, with repeated threats of mobilisation, had made Austrian business men very cautious with regard to orders from the new kingdom. But doubtless matters would soon improve there. Roumanian landed proprietors had taken advantage of the war crisis and disturbed conditions as an excuse for not paying their bills. And as in addition the country had suffered from three bad harvests in succession, nobody was very keen to sell farm machinery in Roumania. In Macedonia trade was not much better for the Austrian manufacturer, the Greek merchants in many places refusing to buy at all, preferring to have prices quoted "local England."

In Austria, on the other hand, the head of a large English factory said that there was a considerable anti-English feeling very generally prevalent, on account of the hostile attitude displayed by the British press towards Austria's annexation policy.

This view was rather confirmed by one of the leading importing agents in Vienna, who said that he had heard many expressions of annoyance at England's stand against Austria. His own trade, which is practically confined to machinery, was, he said, very bad, perhaps worse than at any time in the last forty years. The imports had dropped considerably, especially machinery for the textile trades, as these had been seriously affected by the Turkish boycott. The home trade was also bad. A few more inquiries were being received now for machinery and factory equipment, and it was possible that things would improve. But throughout the winter and spring business had been extremely dull.

Incidentally, this gentleman deplored the falling off in his business with English firms. He said they were constantly losing orders to the Germans, who were much more ready to meet the special requirements of their customers, not only in technical details of manufacture, but also as regards terms of payment. He added that in more than one case recently the Germans had secured large orders by underbidding their English rivals considerably.

After all, the Austrian iron men have one consolation, that if business is bad with them, it is worse in Germany. The balance-sheets which have just appeared of the Austrian Alpine Montan Company and the Prague Iron Industrial Company, and the German Laura Hütte show that the Austrian works fared much better than the German. Whilst prices in Germany have fallen nearly 40 per cent., in Austria they have gone down only 15 per cent., partly due to Austria's trade being principally domestic, the exports being relatively small. It is also due to the differences in dividend policy. In good times the Germans paid the highest dividends possible, whilst the Austrians increased their dividends too, but were always careful to carry over a part of the profits.

The big Austrian works claim that they would have done much better, but that the Ministry of Finance diverted large sums which were set apart for expenditure upon the State railways, to meet the immense demands of the military authorities in the winter.

Generally speaking, the prospects for the iron industry in Austria are regarded at the present moment as none too favourable. It is thought that there may be some improvement in the building trades soon which would tend to relieve the situation somewhat. Later on the Government will be forced to expend large sums on the State railways both for rolling stock and rails.

However, the Austrian shipbuilding trades are reported to be in a satisfactory condition. This is the more remarkable in view of the stagnation in this industry existing in other countries. The Austrian Lloyd works have all their slips occupied at the present time. Besides this they are getting ready to build two large passenger steamers for the Alexandria service. Among the vessels now being built are four Levant steamers and a double-screw vessel for the Albanian service. The Lloyd works will easily beat their output for last year, which itself constituted a record in their history.

The Stabilimento Tecnico's yards at San Marco are fully occupied with the building of warships, and the works at San Rocco have two steamers for the Austrian Lloyd's Dalmatian service, and two other ships in course of building. In the docks at Monfalcone two more steamers for Dalmatia are being built, whilst the yards at Martinolich have work enough for the whole year.

The new Austrian Lloyd steamers for Alexandria, which are to be ready in September, 1911, will have a speed of 18 knots, and will be equipped with the most modern comforts. They will have accommodation for 180 first-class, 100 second-class, and 60 third-class passengers. As Austria furnishes Egypt with large quantities of provisions of various kinds, the ships will be fitted with unusually large storage refrigerators.

These new fast boats will bring Alexandria within three days of Trieste, forming the quickest connection between the African continent and Europe. The Austrian railways are planning to run a new train between London and Trieste, making the journey in 36½ hours, and the complete travel from London to Alexandria in 4 days 8½ hours.

H.M.S. BELLEROPHON.

With this issue we give a two-page engraving of H.M. first-class battleship Bellerophon. We have frequently referred to this vessel, and we need only here repeat that she is an improved Dreadnought, having a greater displacement, *i.e.*, 18,600 tons, as compared with 17,900 tons. She is 520ft. long on the waterline and 526ft. long overall. She has a beam of 82ft., and a maximum draught of 29ft. Her machinery consists of Parsons turbines, built at Fairfield, and of 23,000 horse-power. The Bellerophon has four propellers, and carries ten 12in. guns. She was built at Portsmouth.

The Recently-completed Metropolitan Tower in Madison-avenue, New York, is the loftiest inhabited building in the world. It has a base measurement of 75ft. by 85ft., is faced with white marble, and rises to a total height of 700ft.

Geologists' Association.—There will be excursions of this Association to the Ordnance Survey Office, Southampton, to-day, to Northwood and Croxley Green on Saturday, 24th inst., to Leicester on Thursday, September 2nd, to the New Railway, near Brill, on Saturday, September 11th, and to Taplow and Burnham Beeches, on Saturday, September 18th.

Scientific Exhibition.—Another Scientific Exhibition, on similar lines to that which proved successful in 1907, is to be held at the Royal Horticultural Hall, Westminster, S.W., in October next. The exhibits will include engineering models, electrical and scientific apparatus, lathes and light workshop appliances, model aeroplanes, and technical education equipment. Many firms have already taken space, and a very interesting display is assured. An attractive feature will be the exhibits in the competitions for model and scientific apparatus making, several events for both amateur and professional workers having been arranged, for which prizes are being offered. Full particulars may be obtained from the organisers, Messrs. Percival Marshall and Co., 26-29, Poppin's-court, Fleet-street, London, E.C.

RAILWAY MATTERS.

THE Norwegian Störthing have voted a sum of about £3,205,000 for the construction of new railways.

THE 3000-kilowatt turbo-alternator set for the Pinkston power station of the Glasgow Corporation tramways has now been got to work, and is at present being run under the superintendence of the contractor.

ONE and a-quarter millions of money are to be spent and 527 miles to be added to the railway mileage of the Transvaal. This is equivalent to an extension of one-third of the existing railway system in the Colony.

THE last spike of the prairie section of the Grand Trunk Pacific has been driven at a point west of Wainwright. The line will thus be open for construction trains from Winnipeg to Edmonton, a distance of 792 miles, and for public traffic before the harvest.

IN the block signals, manual control type, which the Baltimore and Ohio Railroad is about to install between Hicksville, Ohio, and Millers, Ind., each outlying switch will be equipped with a telephone, and also each block station, so that engine-drivers can communicate with the nearest block office at any time.

THE Board of Trade have recently confirmed the Burry Port and Gwendreath Valley Railway (Light Railway) Order, 1909, authorising the reconstruction and working as a light railway of certain parts of the railways of the Burry Port and Gwendreath Valley Railway Company, in the county of Carmarthen.

THE South American Railway Congress, which will meet at Buenos Ayres during the International Exhibition of Railways and Land Transport to be held there from May to November, 1910, will consider, among other matters, questions relating to the most convenient gauge, systems of signalling, motor car service, and electrification of suburban trains.

WORK on the new railway which, when completed, is to connect Bergen with Christiania, was resumed in the spring of 1908, as soon as the snow was cleared. The more exposed cuttings were screened during the summer and no serious hindrance to traffic has since been reported on the line. It is hoped to complete the section from Gulsvik to Kroderen by the autumn of this year and then to declare the railway open in its entire length.

A HYDRO-ELECTRIC railway, 100 miles in length, is, the *Electrician* states, to be commenced shortly, through the Okanagan Lake district in British Columbia. Starting from Vernon, the main line will follow the west side of the lake to Summerland, and there will be a branch, forty miles long, on the east side of the lake to Kelowna. Electrical energy will be generated from waterfalls in the neighbourhood. It is stated that the construction will be completed by the end of next year.

THE *Gaceta de Madrid* of 28th June, according to the *Board of Trade Journal*, contains a notice to the effect that Mr. Juan de la Cruz Pérez Ortega has applied to the Dirección General de Obras Públicas, Madrid, for a concession for the construction and working of a railway (secondary) from Pedro Abad, through Bujalance and Porcuna, to Martos. The ultimate award in respect of this contract will, no doubt, involve the purchase of a substantial quantity of steel rails and other materials which may have to be obtained wholly or in part out of Spain.

THOUGH only recently completed to the Pacific Coast, the Chicago, Milwaukee and Puget Sound Railway has already begun, says the *Engineering Record*, to replace the timber trestles by steel structures or to fill them in. The timber trestles are new and of substantial construction, and the changes are stated to be due to the policy of the company of freeing its main line from all structures of this character, thus decreasing the risk of fires, which might cause serious delays to traffic. Some of the tunnels were originally lined with timber, and these are now being lined with concrete.

IT is understood that the railway companies have received satisfactory assurances from the Chancellor of the Exchequer as to exemption from the taxes on undeveloped lands and minerals. The unused lands of the railway companies were bought and paid for, always at a high price, just as the other lands bought by the railway companies were purchased, for railway purposes, and it does not alter the position that all of them have not hitherto been used for such purposes. Moreover, railway companies do not work the minerals under their land, because, for one reason, they require the support of the underlying ground for their traffic.

AT a meeting of an electric traction company recently a shareholder made an interesting suggestion with regard to the need for a new coin. It was pointed out that the tramways of the company, like many motor omnibus and other public transport undertakings, are working on an almost negligible margin of profit, owing to the low standard of fares. There are many practical difficulties in the way of raising fares, one being that the farthing is not a convenient coin for use on tramways, while an increase from one penny to three half-pence would be excessive. It was stated that if passengers paid a penny and a fifth instead of a penny the tramways would be placed on a sound financial footing.

IT is stated, says the *Scientific American*, that the Union Pacific Railway is planning to plant its right-of-way from the Missouri River to the Pacific with alfalfa. At each edge of the right-of-way also will be planted a row of pine trees alternating with elms, there being a tree at intervals of every two rods. As the alfalfa becomes green early in the spring and remains so until late in the autumn, the ornamental effect should be decidedly pleasing. Furthermore, it is claimed that the grass and trees will furnish, in certain localities, a decided protection against snow-drifts and washouts. It is stated that the Chicago, Milwaukee, and St. Paul Railroad proposes to do similar planting and grassing between Ottumwa and Kansas City.

THERE is much interesting matter in the report of the Block Signal and Train Control Board to the Interstate Commerce Commission, giving the American view of European methods. One section of the report, the *Railway News* states, deals with devices or systems which have to do with the safety of railway operation. It is pointed out that while English roads evidently have, as a whole, the best of signalmen, a number of companies have, nevertheless, introduced electric control apparatus by which the men at the opposite ends of a block must co-operate in giving a clear signal. Whether from a knowledge of errors which have occurred but which have caused no collisions and have not been made public, or from the desire to provide all possible safeguards, which, no doubt, is the real reason, these roads have taken action further to protect passenger services.

ACCORDING to the *Railway Times*, Sir Charles Metcalfe, who left England in March in connection with the further extension of the Cape to Cairo Railway, has just returned to England from the Congo. He states that 60 miles of earthworks have been completed beyond Broken Hill, and that the rails are being laid at the rate of one mile daily. It is expected that the railway will be at the frontier itself by the end of the year. There will then be direct through rail communication of some 2150 miles from Capetown and of 1450 from Beira. With a railway from Albert Edward Lake to the north end of Tanganyika, and a line from the existing system in North-West Rhodesia through North-East Rhodesia, to develop that region, which is all 5000ft. to 6000ft. above sea level, travel by rail or steamer will be possible the whole distance from Alexandria to Capetown.

NOTES AND MEMORANDA.

IN British Columbia platinum is found in many of the alluvial gold workings, where it can be saved as a by-product. The saving of it in a small way is, however, attended with so much trouble that it has been practically neglected and no appreciable production made recently.

A NEW astronomical compass, which will be of great use to explorers and others, and by which the time may be told without any elaborate calculations, has been exhibited by the British Astronomical Association. The little instrument has already been adopted in India for military purposes.

ACTING in the House of Commons for Mr. Lloyd George, Mr. Hobhouse stated that benzol manufactured in this country was not liable to the petrol tax. This being the case this spirit should be obtained retail for about 8d. per gallon, or less, and its use would prove to be a decided saving in the cost of motoring.

A WIRELESS telegraph station at Copenhagen was recently opened to the public. This station is used for the exchange of messages between ships and the shore, and communication, under normal conditions, is possible over a distance of 187 miles. All Danish telegraph offices accept messages for transmission by wireless telegraphy.

IT is said that a new supply of radium has been discovered in Portugal by Thomas H. V. Bower, a member of the American Institute of Mechanical Engineers. A certain stream, the name of which is not disclosed, was reputed to have therapeutic properties. Mr. Bower followed the stream to its source, and discovered that it ran over a bed of uranium phosphate.

THE water supply of Nice has been sterilised for over a year by a plant of the Otto type, which was described by Dr. Beunat in a paper before the recent International Congress of Applied Chemistry in London. The plant has a rated capacity of 1000 c.m. of sterilised water per hour, but has not been operated at that rate, owing to the shortage of the supply. A current of 20,000 volts and 500 periods is used.

THE next big engineering project on the Great Lakes will be the damming of the Niagara River opposite Buffalo and Fort Erie for the purpose of raising the level of Lake Erie. The International Waterways Commission, which has been working on the problem for several years, has nearly completed its report, and, it is said, will recommend that the dam be built by the Canadian and the United States Governments.

THE owners of a St. Abbs fishing boat have made the important discovery that a net dyed as nearly as possible the hue of the sea, instead of the traditional brown, yields much larger results in the matter of fish caught. The discovery was, says the *Western Morning News*, put to the test a short time ago, when, out of a fleet of sixty-five boats, the boat with its nets dyed blue made far and away the largest catch. The dye used is bluestone. The discovery has aroused much interest among the fishermen.

PEAT, as it comes from the bog, contains from 85 to 95 per cent. of water. According to Dr. Ekenberg, it appears that the peat contains a hydrocellulose which is of the nature of a jelly. If the peat is subjected to pressure the hydrocellulose passes through very much as soft soap might, and without separating the water from the peat. If, however, the peat is heated to about 320 deg. Fah., this jelly is immediately destroyed, and most of the water can be separated by a pressure of about 240 lb. per square inch.

THE steamer Conqueror at Leith has been chartered by Dr. W. S. Bruce, Edinburgh, the leader of the recent Scottish National Antarctic Expedition, for the purpose of undertaking another expedition to the Polar regions. The expedition, it is expected, will be ready to sail in a little more than a fortnight. The present intention is that the expedition will be away for two or three months. Important observations in the neighbourhood of Spitzbergen are premeditated, Dr. Bruce being a recognised authority on that region.

IT would appear that individual oxygen generators, each capable of sustaining the life of a man surrounded by noxious gases or the deadly fire-damp for almost an hour, will be soon supplied to all coal miners in the United States, if experiments now being conducted at the laboratory Geological Survey in that country prove successful. Officials in charge of the laboratory and testing station are of the opinion that an inexpensive oxygen generator which every miner could afford to own can be made, and they expect in a short time to have practical models completed.

A PATENT recently issued, says the *Electrician*, describes a method of improving steel produced in electric furnaces. The steel, previously refined in a basic electric furnace, is passed into a crucible with an acid lining and allowed to settle. A mechanical readjustment takes place, the steel taking up silicon, which, it is claimed, has a favourable influence on the internal structure of the steel. In addition, the production of iron alloys or the addition of modifying agents can be easily controlled. The latter is accomplished by passing the unalloyed steel into the crucible before adding the modifying constituents.

THE *American Machinist* for June 24th contains an article on the "oxhydric" process of cutting metals. The apparatus described consists of a preheating nozzle, delivering mixed oxygen and hydrogen, which is used continuously to heat the metal to the required temperature, while immediately following it, and set at an angle such that both streams of gas strike the metal at the same place, is a second nozzle, delivering pure oxygen only. This cuts the metal by oxidising it without melting, and blows away the oxides by the force of the blast. The result is a cut which may be fairly compared with that made by a cutting tool, while the heating is so local that the properties of the material cut are not affected beyond about $\frac{1}{64}$in. of the cut surface.

IT is stated in a consular report that milking machines have now been introduced into Denmark. Amongst these, one is described as being a thoroughly efficient machine, though it works on the principle of continuous suction. The actual time taken by this machine was 20 minutes for 15 lb. of milk. Other machines working by combined pressure and suction occupy, on the average, about eight minutes per cow. An Australian milking machine is also reported as having given satisfaction. The cows adapt themselves very quickly to it, and no udder disease has been noticed in places where the milker has been employed. A man with two double machines can milk fifty cows in two hours—that is to say, that the machine is three to four times as quick as the ordinary hand-milking method.

A PAPER recently read before the American Institute of Electrical Engineers by Mr. J. N. Dodd discusses the general considerations which enter into the proportioning of auxiliary poles, and gives a method for testing and adjusting the poles for the correct strength. The author develops the ordinary electro-magnetic formula for calculating the flux density at the auxiliary pole-face, and quotes Arnold's formula for the width of the pole-face are:—Pole arc = $Br + T - b$, where T = slot pitch, Br = brush thickness reduced to armature diameter, b = commutator segment thickness reduced to armature diameter. The author considers the voltage distribution curve at the commutator, and states that for perfect commutation, if the mechanical conditions are correct, the voltage under the brush should be zero. The method of testing proposed is based on this, and consists in measuring the voltage between two adjacent segments under the centre of the brush, which should be zero when the auxiliary poles are correctly adjusted, when perfect commutation should occur.

MISCELLANEA.

IT has been decided to build at Christiana a floating dock which is to accommodate vessels up to 4000 tons deadweight.

DENMARK no longer imports her supplies of cement from the United Kingdom, but exports cement abroad in considerable quantities.

THE armoured cruiser Indefatigable, now under construction at Devonport, continues to make excellent progress, over half the normal launching weight of the vessel having been placed on the blocks.

THE Mersey Docks and Harbour Board's new dredger, the Leviathan, is lifting from the approaches to the Mersey 300,000 tons of sand a week, and already 2ft. have been added to the depth of the water at the bar.

THE total number of persons emigrating from Norway during 1908 was 9597, out of whom 8600 were Norwegians, 846 Swedes, and 151 other nationalities. The majority of the emigrants went to the United States.

THE Parahyba, the sixth of the ten destroyers ordered by the Brazilian Government from Yarrow and Co., Limited, of Scotstoun, ran an official full-speed trial a few days ago on the Skelmorlie mile. She attained a speed of 27.29 knots.

FROM the returns compiled by Lloyd's Register of Shipping, it appears that, excluding warships, there were 308 vessels of 745,705 tons gross under construction in the United Kingdom at the close of the quarter ended 30th June, 1909.

BEFORE the end of the year it is proposed that a joint Commission of naval and military experts shall visit Hull and the Humber to examine such land defences as exist at the present time, and to determine how far these need to be strengthened and what new ones require to be built.

THE City Council of Cincinnati has passed an ordinance by unanimous vote that on May 1st, 1910, to continue until October 1st, 1910, the clocks in that city are to be turned ahead one hour, thus giving workpeople an additional hour of daylight in the evening for recreation or other purposes.

THE Admiralty are determined to bring the night firing of the fleet to the highest attainable standard of efficiency, under present circumstances. This is evidenced by the fact that the hull of torpedo boat No. 100 at Devonport is to be fitted up as a target, so that an exhaustive series of experiments can be carried out by gunnery experts.

THE *Board of Trade Journal* states that the *Bulletin Commercial* (Brussels) of 3rd July contains an announcement to the effect that the Chilian Government have instructed Mr. G. H. van Mourik Broekman, Professor in the University at Santiago, to prepare plans for the construction of a sea port at San Antonio on the Chilian Coast.

THE question of improving the present telegraph communication between India and Burma has been under consideration, but, says *Indian Engineering*, we learn that the idea of laying a cable between Madras and Rangoon has been abandoned. It is expected that with the construction of a bridge at Sara it will be possible to improve the existing arrangements.

THE meeting of the British Association, which opens in Winnipeg on August 25th, will be the third which has been held in the Dominion. The first Canadian meeting took place in 1884 at Montreal; the second thirteen years later at Toronto. The fact that the third is to be held at Winnipeg may be regarded as significant of the enormous development of the West during the past few years.

THE notices recently issued by the committee of the International Aëronautical Exhibition at Frankfort show that many valuable prizes have been placed at its disposal, including one by the German Emperor; three prizes are also offered for the best cinematograph films of natural flight. A series of scientific lectures will be delivered, dealing, among other things, with the physics of the upper air.

THE Argentine gunboats Parama and Rosario have left the Elswick Shipyard, and proceeded down the Tyne, where they have been docked, and taken in their stores of powder and explosives. The crews have arrived from Buenos Ayres at London in a Government transport. The vessels will be handed over shortly by the builders, when they will leave for the Argentine, making the voyage out in company.

ANOTHER section of the Panama Canal has been completed. It is situated near Matachin, just below Gamboa, where the Chagres River intersects the canal route. At this point the river makes a deep bend, and it was necessary to cut through this bend to provide a channel for the canal. The cutting is about half a mile long, 500ft. in width, and has an average depth of about 45ft. As soon as the rails are removed from the section, the Chagres River will be turned and allowed to flow through it, and the present bed of the Chagres will be used as a dumping ground.

NEGOTIATIONS are in progress among the Clyde operative engineers for a reduction of one hour in the working week of fifty-four hours. The proposal emanates from the Glasgow District Committee of the Amalgamated Society, who contend that their members should have a fifty-three hours' week, as prevails on the North-east Coast, without any wages deducted. The demand has not yet been laid before the employers, and the Glasgow District Committee are meantime endeavouring to secure joint action with the three other committees in the Clyde district.

THE aërial torpedo for life-saving, invented by Col. Unge, has been again tested on Sir W. G. Armstrong, Whitworth and Co.'s range at Silloth, on the Solway shore. The apparatus is designed to throw a lifeline from a ship in distress either ashore or to another vessel. The torpedo, the cradle from which it is discharged and the line fit in a box 4ft. long and about 18in. in width and depth. The torpedo is discharged from the cradle either by fuse or electric ignition of a charge of gunpowder. The tests showed that the torpedo could be sent with perfect accuracy a distance of 380 yards.

THE *Diario Oficial*, Montevideo, of 15th May, publishes the text of a Bill, under the terms of which the Finance Committee of the Montevideo Port Works are empowered to apply the sum of 300,000 pesos (about £64,000) to the lighting of the harbour, the acquisition of land, and various complementry works. The *Diario* of 18th May publishes the text of a contract between the Legislature and the Empresa Constructora del Puerto de Montevideo, by which the executive authorities are empowered to utilise a sum not exceeding 1,375,000 pesos (about £290,000) for the carrying out of harbour works, including quay extensions and important dredging operations.

TENDERS have been recently advertised for by the Navy Department of the United States for the construction of the highest tower wireless telegraph system yet devised. It is proposed to build at Washington a concrete tower which will rise 600ft., overtopping the Washington Monument by 45ft. Installations will also be made on board the various vessels of the fleet, so that it will be possible to telegraph 3000 miles seaward and from vessels to land a distance of 1000 miles. The Navy Department has been working on the scheme for about two years. An appropriation of 70,000 dols. for the construction of the tower and of 100,000 dols. for the purchase of wireless instruments is available.

THE NEW ENGINEERING LABORATORIES AT THE MANCHESTER UNIVERSITY

(For description see page 66)

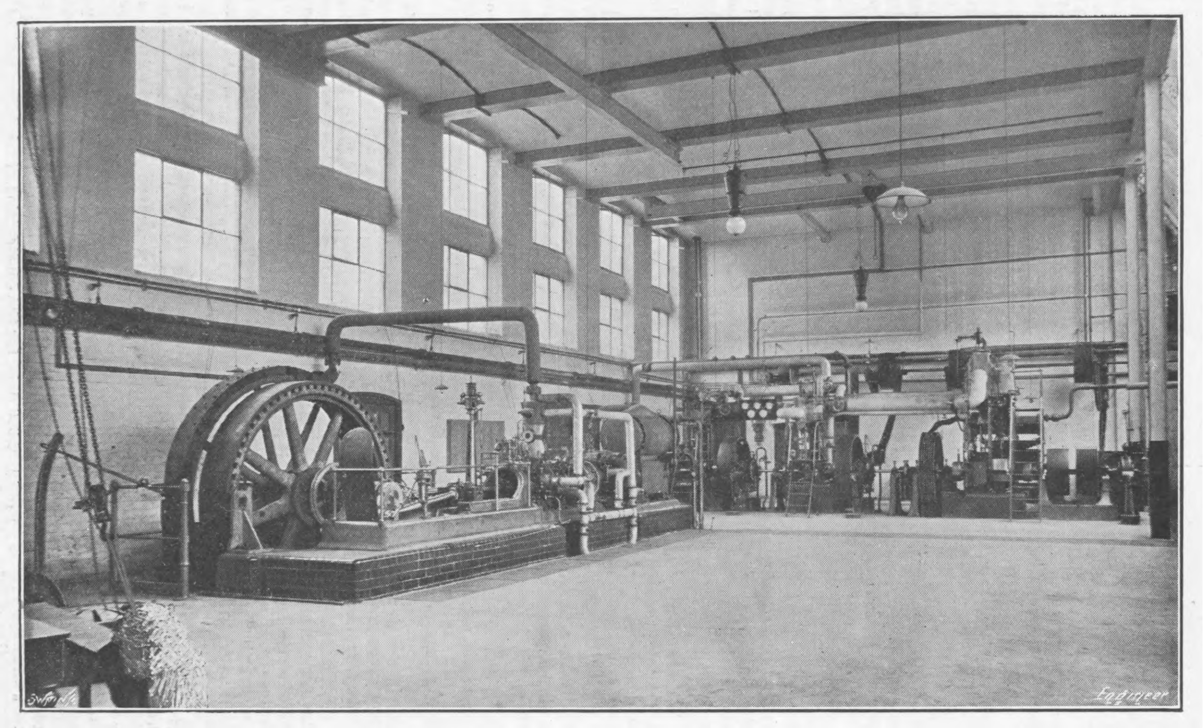


Fig. 5—THE MAIN ENGINE ROOM

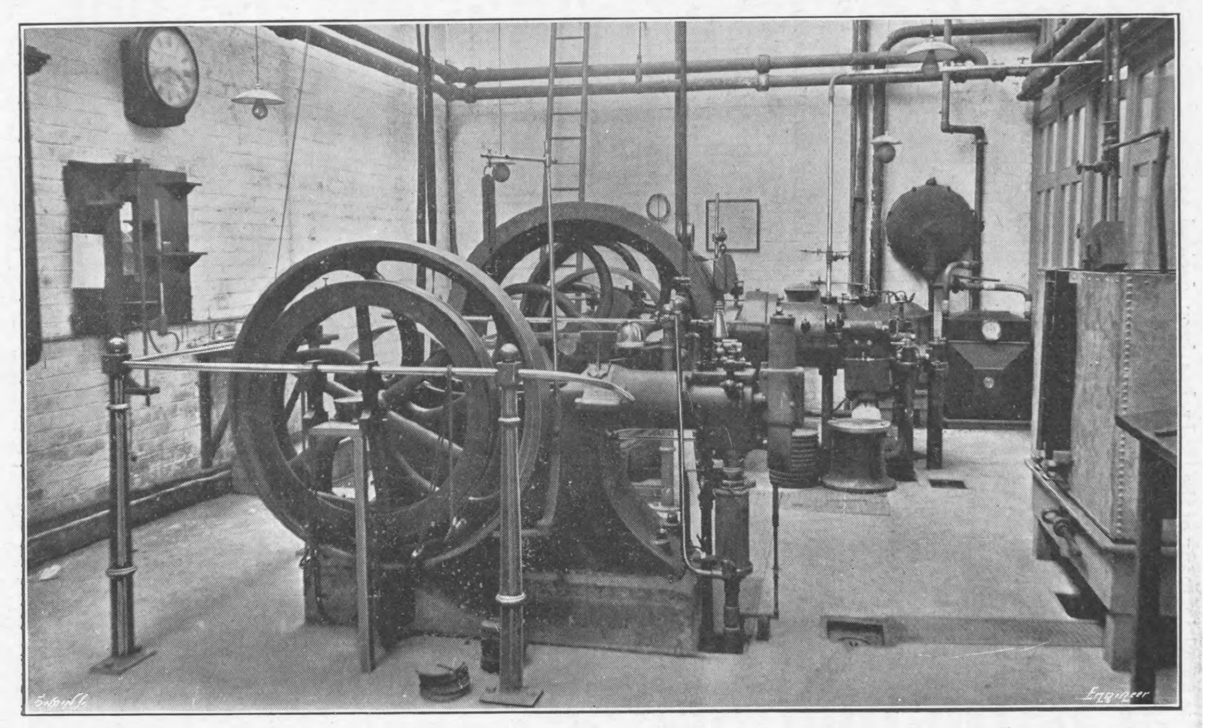


Fig. 6—GAS ENGINE ROOM

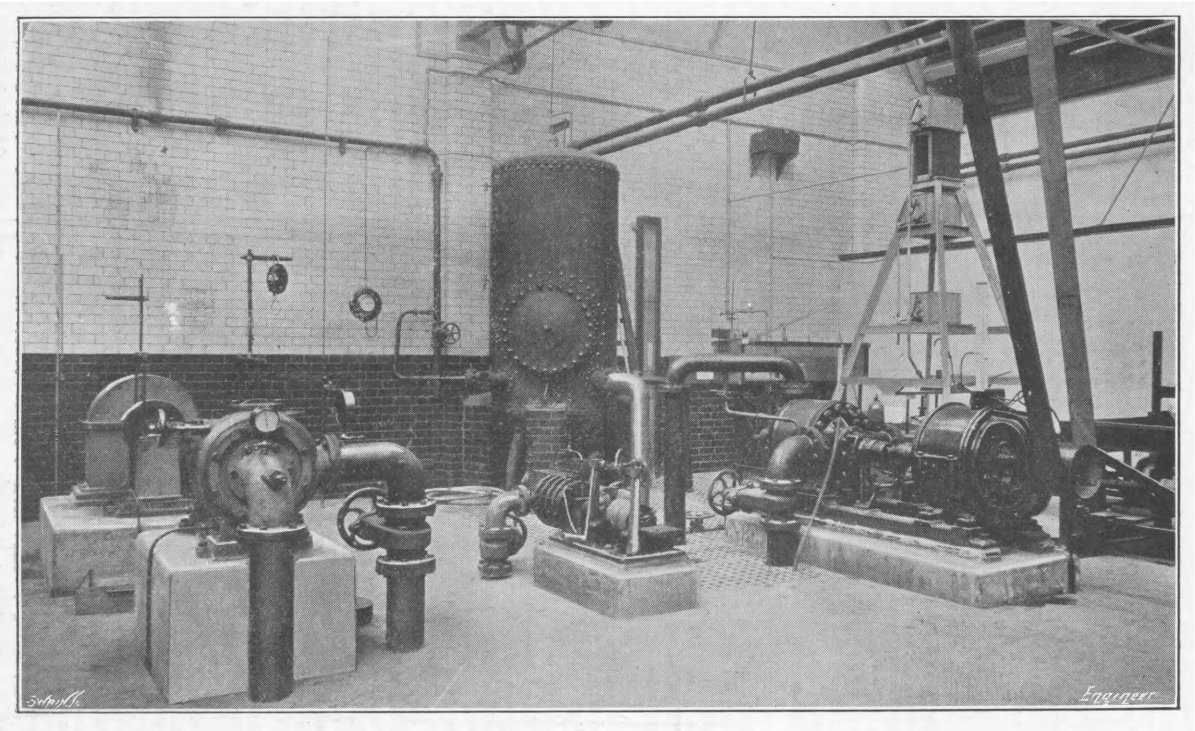


Fig. 7—HYDRAULIC LABORATORY

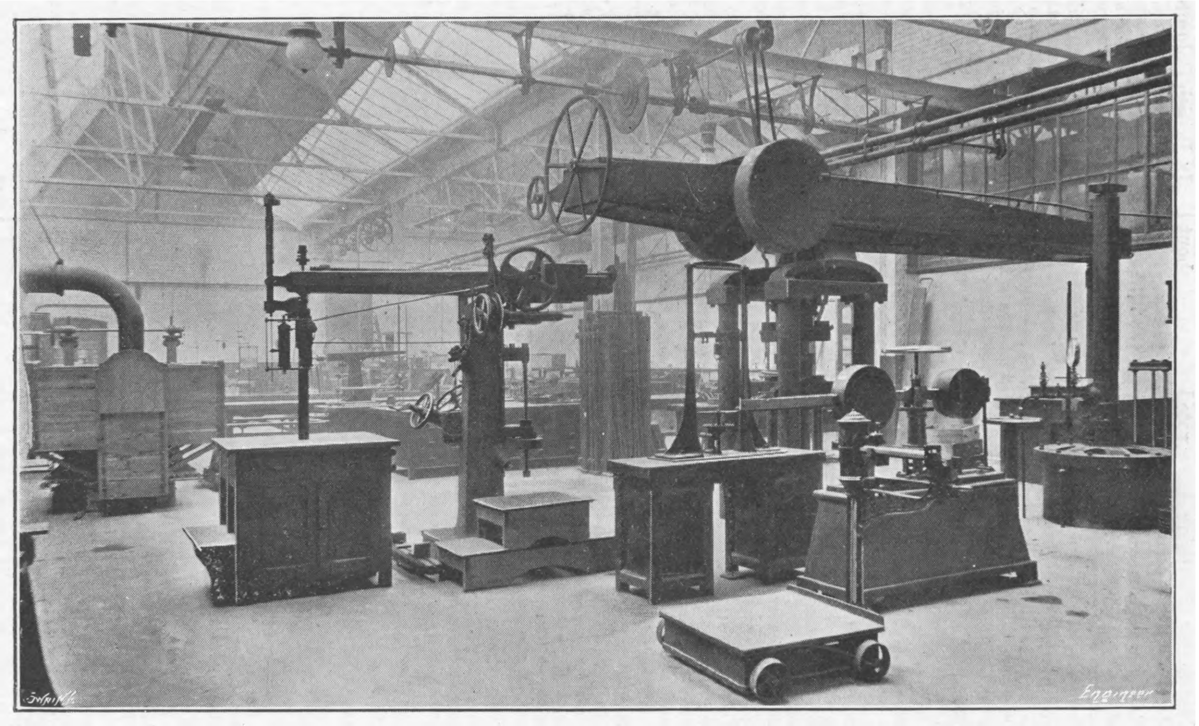


Fig. 8—TESTING MACHINES

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Letters relating to Advertisements and the Publishing Department of the Paper are to be addressed to the Publisher, Mr. Sydney White; all other Letters to be addressed to the Editor of The Engineer.

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PUBLISHER'S NOTICES.

⁂ *With this week's number is issued, as Supplements, a Two-page Engraving of his Majesty's First-class Battleship Bellerophon and the Index to Vol. CVII. Every copy as issued by the Publisher includes copies of these Supplements, and subscribers are requested to notify the fact should they not receive them.*

H.M.S. VANGUARD.

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TO CORRESPONDENTS.

☞ *In order to avoid trouble and confusion we find it necessary to inform correspondents that letters of inquiry addressed to the public, and intended for insertion in this column, must in all cases be accompanied by a large envelope legibly directed by the writer to himself, and stamped, in order that answers received by us may be forwarded to their destination. No notice can be taken of communications which do not comply with these instructions.*

☞ *All letters intended for insertion in* The Engineer, *or containing questions, should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

☞ *We cannot undertake to return drawings or manuscripts; we must, therefore, request correspondents to keep copies.*

REPLIES.

J. B. (Croydon).—It all depends upon the point of reference. Relatively to any point on the vehicle itself all points on the rim are moving at the same speed. Relatively to earth the touching point is obviously at rest and the top point is moving twice as fast as the centre.

Climbing.—The usual and the simplest plan is to connect the loaded trucks at the top of the incline by a rope passing over a pulley with the empty trucks at the bottom. You could, of course, use such an electric arrangement as you suggest, but it would, we fear, be found very costly for one thing, and for another a rope does not make a good driving rail. You would do well to look up descriptions of telpherage, which has features somewhat similar to your suggestion.

INQUIRIES.

LEAD LINING.

Sir,—Can any of your readers give me the name of a firm which is in a position, by means of electricity or other process, to line cast and wrought iron tanks with chemically pure lead to a thickness of one-eighth of an inch?

A. B. C.

July 14th.

THE ENGINEER.

JULY 16, 1909.

Scotch Miners and their Wages.

The refusal of the Scottish miners to permit the question in dispute between them and their employers to be referred to the independent chairman of the Conciliation Board need cause no surprise. If the State is prepared to set common sense at defiance by enacting that all mines are to be worked on one uniform principle as far as hours of labour are concerned, regardless of the widely varying natural conditions of the different seams and districts, we need not wonder at the miners, or their leaders, disregarding the fluctuations of trade, or the laws of supply and demand. For a good many years now it has been the custom in the mining industry, failing a mutual agreement between the men and their employers, to refer wages disputes to the judgment of the independent chairman of the Coal Trade Conciliation Board. This convenient method of arranging wages by independent judgment, based upon trade circumstances, is to be abandoned by the Miners' Union, just as the equally convenient method of arranging working hours in the different districts according to natural conditions has been abolished by Act of Parliament. And, to quote the words of Mr. Smillie, the public will, in case of rupture, "be made to feel the pinch."

Briefly, the position is this: Under the Conciliation Board arrangement the wages of the Scottish miners are based upon the standard of 1879. The present demand of the owners for a 12½ per cent. reduction is not, therefore, a 12½ per cent. reduction on the actual wages of the moment, but on the rate of wages prevailing thirty years ago—say, 8 per cent. on actual wages. During the last trade boom wages went up to a level exactly 100 per cent. above the 1879 standard. By stages they have come down, in sympathy with the price of coal, to a level only 50 per cent. higher than the standard. With depression still prevalent, and with coal prices falling still lower at the very moment when the new Eight Hours Law is adding to the cost of mining, the colliery proprietors feel justified in making a request for a further reduction of wages, which would, however, still leave the rates 37½ per cent. above the standard, as it is called. When this demand was considered by the Conciliation Board, there was failure to arrive at an agreement. That was not, perhaps, unnatural; but the curt refusal of the men's representatives to state their case before the independent chairman and then abide by his decision, in accordance with established precedent, is too high-handed to allow of any excuse. For a long time there has been an agreement existing between the owners and the men that 37½ per cent. above the 1879 standard was to be regarded as the absolute minimum—this means, roughly, 5s. 6d. per day—but that there was to be no maximum. Last year, however, the Scottish Miners' Union advanced the claim that under no circumstances should wages be permitted to fall below 50 per cent. above the standard—that is the 1879 rates plus 50 per cent., or, roughly, 6s. per day. With the Eight Hours' Law in prospect, involving a curtailment of the daily *per capita* output of coal, the owners did not consent to the men's proposal to raise the minimum from 37½ to 50 per cent. above the standard. Shortly afterwards, upon the occasion of the annual conference of the Miners' Federation at Chester, the delegates of the Scottish Union reported to their English colleagues the agitation they were conducting with a view to raising the minimum to a 50 per cent. increase, and the Conference passed a resolution pledging the support of the entire Federation for the Scottish miners in any efforts they might take to enforce such a minimum. It is this pledge which is stimulating the Scottish leaders in their present policy. They hope that, if their local strength is not sufficient to enforce their demand for the recognition of a 50 per cent. minimum, that the power of the Miners' Federation, expressed in the terms of a great national coal strike, or the threat of such a deplorable contingency, may prove ample for their purpose. Regardless of the industrial exigencies of the nation, the working hours of the miners have been limited by law. As a natural, or inevitable, corollary we are about to see at least the attempt to establish a wage rate by trade union effort regardless of the demand for, or the price of, coal. Not only that, but it is sought to raise the minimum wage in face of reduced hours of labour and acute trade depression.

Seeing that this is a wage dispute, that the driving force behind the minimum wage movement—and, indeed, the Miners' Union—is becoming largely, if not mainly, socialistic, and that its instigators rely chiefly upon the Socialist Press and platform for their support, we may venture to call attention to the misleading statements concerning miners' wages put forward by the Socialists. As we write we have before us a copy of a leading Socialist journal, the *Clarion*, containing a special article on "Scottish Miners' Wage Reductions." In this article it is stated that "the colliers have never had high wages. . . . They have never had more than 2s. 6d. a ton of coal. At present they have only about 2s. 1d. a ton. At present in Glasgow the price of coal is 19s." This was written in August, 1908. This is a fair sample of the declarations about miners' wages which are continually being made by Socialists, and readily believed by the thoughtless section of the public. Indeed, it is a stock argument with Socialists that miners' wages only average 2s. per ton of coal. But what is the fact? The average annual output of coal in this country is less than 300 tons per worker employed; therefore, if the miners only get 2s. a ton, they get considerably less than 600 shillings in a whole year—considerably less than £30 in fifty-two weeks. In other words, the average wage is not more than about 11s. per week per man. Such is a sample of the misrepresentation upon which modern labour movements in general, and miners' movements in particular, are now conducted.

Workshop Accuracy.

In a letter published in our last issue, Mr. Van den Kerchove raised a question which must always remain of absorbing interest to mechanical engineers. Our correspondent, as we may remind our younger readers, was one of the pioneers of workshop accuracy, and whatever he has to say upon precision of workmanship must be listened to with respect. Years ago, when interchangeability was unknown to the average engine builder, and when every part was made and fitted by highly skilled hand labour to its corresponding part, Mr. Van den Kerchove was developing at his works in Ghent and Mr. Willans at his works at Thames Ditton a system of manufacture which was, for the time, of almost incredible accuracy. At each works there was to be seen what we may describe as a show experiment, as it was performed before visitors to impress them with the high standard of workmanship attained. At Ghent two such pieces as a shaft and a crank web were taken. The shaft was pressed into the web at a certain hydraulic pressure; it was then removed, and the experiment repeated with the same pieces several times in succession, but between the gauge pressure for the first and last pressings the difference was always quite small, showing that the shaft had been turned and the boss bored with an accuracy which permitted this severe test without damaging the metal. At Willans and Robinson's the usual experiment was to place a cylinder on a surface plate and put a piston into it. The piston could be spun round readily by hand, but the air did not escape past it, even when it was violently forced down.

It is getting on for twenty years since such tests were first shown as wonders of accuracy, and now-a-days they could be repeated in a hundred works. But quite recently a new marvel of fine workmanship has attracted attention. Little more than a year ago, we believe for the first time in this country, there were exhibited at a soirée of the Royal Society, a set of plain gauges, made by Mr. Johansson, which beat for accuracy anything before made. They were small cubes and parallelopipeds of tool steel which were correct in their measurements within a plus or minus tolerance of .0001 mm. per ten millimetres of length. Such gauges are now made up in sets for workshop use, and it is possible with 102 gauges to make 40,000 different measures without exceeding an error of one one-thousandth part of a millimetre. It is of these extraordinary gauges Mr. Van den Kerchove spoke in the letter to which we have already referred, and on them he makes, by inference, a comment which must have occurred to many other engineers. Is such high accuracy required for ordinary mechanical engineering? With his machine he secures an accuracy within about one two-hundredth of a millimetre, or a fifth of that secured by Mr. Johansson. We have little doubt that the bulk of engineers will agree with Mr. Van den Kerchove that such accuracy as this is quite sufficient, and largely because but few of them can pretend to anything like even the degree of precision he mentions. But it is to be borne in mind that there is a vast difference between accurate gauges and accurate workmanship. It has been generally agreed that errors of certain dimensions must be allowed for, and tables of tolerances have been drawn up by our Standards Committee. But whilst we are forced to admit tolerances in the work produced, we want none in the gauges if we can avoid it. When we prescribe a limit of plus or minus x we want to know that we actually have that limit, and have not to add on some fraction for the error of the gauge itself. This, we take it, is the ideal to which Mr. Johansson's gauges approach. They aim at being absolutely accurate themselves, but the work produced with their help may have whatever tolerance, whatever degree of error, it may be economically wise to permit. What degree of accuracy is the best is a matter for each engineer to decide. Mr. Van den Kerchove takes the standard of one two-hundredth part of a millimetre; most engine builders will be content with a lower standard. But, on the other hand, instrument makers and fine tool makers require even a higher degree of correctness. The question of interchangeability again affects the standard of accuracy. In certain appliances it is necessary that a number of different members shall be interchangeable. For example, in a die-head it is essential that four or five different sets of dies should fit the same guides or slots without slackness or tightness. In such cases a very high degree of precision is required, but when it is a matter of replacing a broken piece, as for example a connecting-rod, it is doubtful if anything like high accuracy is economically valuable. The probability is that the piece has been at work for many years, and its departure from its original dimensions is quite likely to be appreciable. If a part exactly of the original size is fitted will it be satisfactory? Each case of that kind must be decided for itself. Interchangeability as a rule is adopted now-a-days, not so much with the intention of replacing broken parts as with the object of reducing the cost of manufacture by getting rid of hand labour, and by enabling a large number of similar pieces to be manufactured by separate machines, with the certainty that any two that should pair properly together will do so within the prescribed limit. Accurate gauges help us to get nearer to that ideal by removing one source of error, and on these grounds the precision of Mr. Johansson's gauges finds its value.

There is one very extraordinary fact about these gauges on which we must say one word. When Whitworth devised his system of making surface gauges, and was able to produce true flat surfaces with comparative ease, it was demonstrated that if two such plates were put face to face they adhered by the pressure of the atmosphere on their backs. We cannot recall at the moment if the actual load per square inch which two such plates could support was ever absolutely measured, but it was accepted as an obvious fact that it could not be more than 15 lb. or so. That conclusion appears to be disproved by the adherence of surfaces far finer than anything produced by Whitworth, and used absolutely dry and free from grease, which we fancy his never were. In a paper he presented to the Société Française de Physique a few months ago, Mr. Spanberg mentioned the case of two surfaces prepared by Mr. Johansson's method with exceptional care. The area was 3.17 square centimetres, and it supported for forty minutes a load of 37 kilos. Then the supporting hook broke, but the pieces did not separate. This is at the rate of about 166 lb. per square inch, or more than eleven times the atmospheric pressure. What may be the cause of this extraordinary adhesion remains, after many discussions, yet to be definitely ascertained. It is at present vaguely defined as molecular attraction. It will no doubt be thoroughly investigated some day; the first step in such an inquiry would be to prepare a number of surfaces of different material, and ascertain if the attraction was constant per unit of surface for all materials.

The Manufacture of Armour Plate.

The requirements of the world in the matter of armour plate naturally vary according to the shipbuilding programmes of the principal countries concerned for the time being, and the fluctuating demand must consequently cause a certain amount of rolling mill plant to lie idle for a longer or shorter period unless the makers are either provided with national work of almost constant character, or are able to secure orders for foreign account in connection with the construction of warships. Armour plate plant is, however, primarily established for the supply of material for national needs; it has been laid down in Great Britain either on the promise or the anticipation of Government orders, and it is therefore the duty of the Government of the day to afford as large an amount of work to the makers as is possible in the interest of both parties, and as far as is consistent with the minimum needs of national security from the standpoint of naval strength. But how does this theory work out in practice? The First Lord of the Admiralty, on the motion to go into Committee of Supply on the Navy Estimates late in March, referred to the supply of guns, mountings, and armour, and stated that it would tax the resources of our great firms if we were to retain our supremacy in rapidity and volume of construction of battleships. A few days previously, in the course of the statement issued in explanation of the Navy Estimates for 1909–10, it was mentioned that power was asked for in the current financial year for the ordering, collection, and supply of guns, mountings, armour, and materials for the four contingent battleships other than the four large armoured ships definitely included in the programme for the year. It was added that three months' notice in advance ought to be given to contractors to ensure the completion of the vessels within two years from the date of the order of the hull, and if an exceptionally heavy demand were made on the firms, a much longer notice would be required. If in the meantime the necessary intimations have been made to contractors, the equipment will be available when the hulls have reached the stage of readiness for reception, but one important firm has recently reported that no orders had been received for heavy gun mountings, and much valuable plant was consequently idle.

The circumstance that the armour plate makers are prepared to assist the Admiralty as far as possible in advance deliveries is illustrated by what occurred in the financial year 1907-08, when the sum of £986,000 was allocated in the Navy Estimates to the purchase of armour plate. This total included certain sums for armour for the battleships Bellerophon, Temeraire, and Superb, which were the first vessels of the kind to be laid down for construction in a period of two years. According to correspondence on the subject between the Admiralty and the Treasury in March, 1908, as recorded in the Dockyard Expenses Accounts for 1907·08, the experience gained under the new circumstances of a shorter term for building showed that for economical construction it was essential that armour should be manufactured during the financial year to an extent exceeding the provision in the vote. Although the contracts were so drawn that the armour made in excess of the vote need not be paid for in the financial year concerned, the Admiralty regarded it as a sounder policy to do so when the contractors made the armour to meet Navy desires as distinct from rolling it to suit their own convenience. The value of the excess output in that year was represented by £190,000, and as a surplus of a similar amount was available from under-expenditure under other headings, the Treasury sanctioned the transfer of the sum in question from one batch of accounts to the other. The correspondence, of course, does not indicate what would have happened if a surplus had not been at hand from other sources, and this may therefore be left to conjecture. At any rate, the exchange of letters reveals the fact that the armour plate makers are ready to respond to the wishes of the Admiralty, whilst the latter's proof of more economical building by the adoption of this policy prompted the inclusion of a more liberal provision for armour plate in the estimates for the succeeding financial year. The saving effected by the Admiralty is naturally due to having the material on the site of the hulls in readiness, and at the same time it is also of advantage to the plate makers to turn out a larger tonnage, and thus tend to reduce the standing charges. It is possible to conceive that a substantial enlargement of the policy of forward ordering might lead to a reduction in the cost of armour plate to the purchasers and to a further economy in ship construction, as the larger the output of armour the less is the prime cost per ton, whereas orders merely given at irregular intervals have to bear the whole of the charges, which are consequently reflected in the sale prices.

The comparatively small volume of orders placed by the British Admiralty with domestic makers of armour plate in recent years forms a remarkable contrast to what has taken place in Germany during the same period, and which is to continue during the next six years. Since the Reichstag approved the scheme of naval expansion several years since and sanctioned an amplification two years ago, everything has proceeded with mechanical precision; the placing of contracts or the conclusion of agreements in connection with the projects being merely within the province of the Government or the Admiralty without the intervention of the Treasury or of Parliament. Thus in the case of armour plate, which came up for consideration two or three months ago on the discussion of the extraordinary Naval Estimates before the Budget Commission, it appeared that contracts were concluded with the armour plate makers in 1905—the Krupp Company and the Dillingen Works—for deliveries extending over three years, but in 1907 the contracts were extended until 1915. The agreements also provide that it would only be possible for the Admiralty to place orders with any other firm if the latter's tenders were 5 per cent. less than those of the existing contracts; that any diversion of work could not take place before 1913, and that even then this could not occur if the present contractors would undertake to deliver either at the same quotation as a possible competitor, or at a price not higher than 5 per cent. These conditions, which have conferred upon the plate makers a fairly constant supply of orders over a number of years, have merely served to strengthen the position of the firms in this particular branch, notwithstanding the statement attributed to Admiral von Tirpitz, Secretary to the Admiralty, that he would give support to a competitive plate manufacturer in so far as he could do so loyally in relation to the present contractors. It is perhaps news to learn, on the authority of the Admiral, that efforts were made to induce other home firms and also foreign makers to submit tenders for the supply of plate, but it is scarcely surprising to hear that the endeavours were unsuccessful. It was a foregone conclusion that foreign firms—if the experience of the Midvale Steel Company in a competition in Italy two or three years ago were not on record to act as a deterrent—would abstain when they knew beforehand that national considerations alone would prevent their securing contracts for plate in any other country, and in Germany in particular. But if the mere invitation to foreign firms resulted in the reduction of Teutonic prices by 30 per cent. the Admiral must be satisfied with his attempt to test a market which in reality is purely confined to the respective countries of manufacture.

THE WORK OF RECOIL.

By Sir GEORGE GREENHILL.*

You have revived a controversy which lasted for nearly fifty years between Descartes and Lobnitz during the second half of the seventeenth century. Consult Mach's "Mechanics and its Development," Chapter III.

The answer depends on the meaning you give to the words momentum and energy.

The consensus of expert opinion has decided and agreed to call $w \frac{v^2}{2g}$ the energy, and $w \frac{v}{g}$ the momentum, of a body weighing w tons, moving with velocity v f/s, the energy being reckoned in foot-tons, and the momentum in second-tons, to coin by analogy a new compound word in dynamics.

If a force of F tons acts on a weight of w tons, through x feet, for t seconds, and gives it a velocity v f/s,

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[* With the object of settling the dispute on recoil which is now proceeding in our columns, we have asked Sir George Greenhill, whose authority on such matters is unchallengable, to settle the question by a clear and concise statement. This he has done, in a way which can leave no doubts in our readers' minds.—Ed. The E.]

$$F\,x = w\,\frac{v^2}{2\,g}\text{ (foot-tons)},\ F\,t = w\,\frac{v}{g}\text{ (second-tons)}.$$

When a gun is fired, the thrust of the powder gas, F tons, acts for the same time t on the gun as well as the shot; so that if the gun weighs W tons, and recoils with velocity V f/s,

$$F\,t = w\,\frac{v}{g} = W\,\frac{V}{g},$$

and the momentum of the shot and gun are equal, and in opposite direction.

But while the shot advances x feet, the gun recoils a distance of y feet, very much smaller, and

$$F\,x = w\,\frac{v^2}{2\,g},\ F\,y = W\,\frac{V^2}{2\,g}.$$

$$\frac{x}{y} = \frac{w}{W}\ \frac{v^2}{V^2} = \frac{w\,v}{W\,V} \times \frac{v}{V} = \frac{v}{V} = \frac{W}{w},\text{ since } w v = W\,V.$$

If the length of travel of the shot along the bore is l feet,

$$x + y = l,\ x = \frac{W}{W + w}\,l,\ y = \frac{w}{W + w}\,l.$$

Take the case of a 12in. gun, cited in Lieut. Dawson's lecture, with a muzzle velocity of $v = 3000$ f/s and a muzzle energy of 53,000 foot-tons; this tells us that the weight of the shot is $w = 850$ lb.

The gun with the recoiling parts weighs about 50 tons, W = 50 tons = 112,000 lb.

Now, the momentum of recoil of the gun is equal to the momentum of the shot, so that if the gun recoils with velocity V f/s,

$$W\,\frac{V}{g} = w\,\frac{v}{g},\ \frac{V}{v} = \frac{w}{W} = \frac{850}{112{,}000};$$

$$V = \frac{850 \times 3000}{112{,}000} = 20\text{ f/s, about};$$

and this is sufficient to lift the gun vertically—

$$\frac{V^2}{2\,y} = 6.25\text{ft.}$$

$$\frac{\text{The energy of the gun}}{\text{The energy of the shot}} = \frac{W\,V^2}{w\,v^2} = \frac{V}{v} = \frac{20}{3000} = \frac{1}{150},$$

so that the energy of the gun $= \dfrac{53{,}000}{150} = 353$ foot-tons.

Or, otherwise, the energy of the gun

$$= W\,\frac{V^2}{2\,y} = 50 \times 6.25 = 312.5\text{ foot-tons};$$

(these results ought to be the same; the discrepancy is due to taking round numbers).

The length of the bore travelled is $l = 50$ft., about; so that

$$y = \frac{850 \times 50}{112{,}850} = 0.38\text{ft., or 4.56in.};$$

$$x = \frac{112\,000 \times 50}{112{,}850} = 49.6\text{ft., say 50.}$$

The force F represents the average thrust in tons on the base of the shot, or on the face of the breech-piece—

$$F\,y = W\,\frac{V^2}{2\,g};$$

$$F = W\,\frac{V^2}{2\,g\,y}$$

$$= 50 \times \frac{400}{64 \times 0.38} = 820\text{ tons},$$

and the average pressure in tons/inch² in a $d = 12$in. gun is—

$$\frac{F}{\frac{1}{4}\,\pi\,d^2} = 7.25\text{ tons/inch}^2,$$

about half a maximum pressure of 14 tons/inch².

$$\text{Also, }\frac{x}{t} = \frac{F\,x}{F\,t} = w\,\frac{\frac{v^2}{2\,g}}{w\,\frac{v}{g}} = \frac{1}{2}\,v,$$

the average velocity of the shot up the bore; so that

$$t = \frac{2\,x}{v} = \frac{2 \times 50}{3000} = \frac{1}{30}\text{ second.}$$

The energy of the gun and shot are equal only when the weights are equal; but in that case there would be no holding the gun; and the recoil would damage the ship to the same extent as the target is destroyed by the shot.

But weighting the gun up to about one hundred times the weight of the shot reduces the energy of recoil and its velocity to one-hundredth, comparable with the shot, and so the recoil becomes manageable, and can be absorbed by a buffer.

The Dowe bullet-proof cuirass employed the same dynamical considerations, in the reverse order; but as Dowe was a German tailor, the inference was that he used a magic cloth, till Maxim showed that there was a steel plate inside, and if this plate and the rifle were of the same weight, the blow passed on by the plate was the same as the blow received on the shoulder by firing the rifle.

LITERATURE.

The Design of Plate Girders and Columns. By Professor W. E. Lilly, M.A., M.E., M.I. Mech. E., M. Inst. C.E., Ireland. Chapman and Hall, Limited.

THE first portion of this book, referring chiefly to plate girders, has appeared before, an earlier impression bearing the date 1904. The appendices dealing with the design of columns and describing some experiments on model plate girders are new to the volume, but have previously been published as papers contributed to the Institution of Civil Engineers of Ireland, and to *Engineering*. The first part, which is included under the heading "Design of Plate Girders," is grouped into six divisions. The first three deal respectively with "The Strength of Iron and Steel," "Bending Moments and Shearing Forces," and "The Theory of Bending and Distribution of Stress," and although attention must be called to the comparatively large number of errors in the text and diagrams, many of which would puzzle readers new to the subject, these chapters are otherwise simply and excellently arranged from the point of view of the elementary student. The author arrives at the conclusion "that in the design of plate girders it is sufficient to assume that the flanges resist the bending moments, and the web resists the shear, and that it is uniformly distributed over the cross section, the lines of stress being inclined at 45 deg." In practice it is not unusual to adopt $\frac{3}{8}$in. as a minimum thickness for webs, as thinner plates are liable to be dangerously diminished by corrosion, and offer difficulties arise in designing rivet connections of sufficient strength. For this reason the shear stress, dependent on the thickness, is generally below the working limit, while the stress due to bending, which is independent of the web thickness, remains a varying quantity between the full value of the unit stresses in the flanges and zero at the neutral axis. The condition, therefore, in practice is not such that the stress in the web, due to bending, can be neglected in comparison with the shear stress. The fourth sub-section is headed "The Design of Plate Girders," and is principally devoted to a consideration of the action of a stiffened web plate in resisting shear. The unstiffened web plate is first considered as a double system of lattice bars close together. The shear is resolved into the principal stresses acting at 45 deg. to the axis of the girder, and half the thickness of the web is assumed to resist the thrust and half the tension. In this way a working stress is developed equal to half the safe shearing stress. Professor Lilly adopts the view that, with the addition of stiffeners, vertical or inclined, these largely resist the thrust, leaving the web plate practically in tension only. This view, it will be seen, is hardly borne out by the experiments on model plate girders described at the end of the book. The author claims that this method of treating the web shows a marked saving of material as compared with girders as at present designed, and yet errs on the side of safety, because the unit stress has been halved. It is scarcely possible for both these claims to be true, and the former is not confirmed by the practical example given in the book. This is of a girder 60ft. in span and 7ft. 6in. deep; in one design the stiffeners are 7ft. 6in. apart throughout, and for half the length of the girder the web is of $\frac{1}{4}$in. plate. Few engineers would care to leave this large area 7ft. 6in. square of $\frac{1}{4}$in. plate unstiffened, particularly after noting the result of the experiments already referred to, in which all the webs, no matter how well stiffened, buckled at stresses not greatly above the working stress, and this girder actually weighs a trifle more than would one designed to carry the same load according to the practice of some of our railway companies, which certainly does not err on the side of lightness, and allows nothing thinner than $\frac{3}{8}$in. plate to be used.

Following the chapter on "The Design of Plate Girders" is a section describing "Standard Types of Superstructure," these being extracted from Mr. J. P. Conradi's paper contributed to these columns in 1895. Many of these types are still used in modern practice as they stand, but all the floors are of plate, and no mention is made of jack arch floors for railway purposes, though this class of superstructure finds considerable favour now-a-days. Another paper referred to is that by Mr. Farr on "Moving Loads," published in the "Proceedings" of the Institution of Civil Engineers in 1901. The loads for the design of cross girders, varying from 19 tons when these are 5ft. apart to 25 tons when 10ft. apart, require to be raised to 21 tons and 30 tons respectively to include the heaviest modern locomotives. The last two sections deal with the weights of plate and open-web parallel girders. As the author points out, the results obtained are principally of theoretical interest. By the addition of various arbitrary percentages practical expressions are obtained for the weights of girders and the economic ratio of depth to span. It would appear that the constants in the formula for the weight of plate girders require checking, as the use of it to find the weight of the girder designed as an example gives a result of about 9 tons, whereas the actual weight is more like 11 tons.

The book cannot be considered as a practical guide to girder design, and in fact very few of its pages are devoted to this purpose. More generally the object has been to endow a theory which has been used by engineers as a broad basis for proportioning such parts of plate girders as would otherwise depend on experience, with the virture of being able to solve the complete problem of plate girder design, but the author's arguments are by no means convincing, neither are they confirmed by the practical experiments.

The first appendix is a paper on "The Design of Columns and Struts," which contains a remarkably complete analysis of the various formulæ which have been proposed to determine the strength of columns. The influence of the properties of the material in determining the constants to be used has been investigated by a valuable series of experiments carried out by Professor Lilly, on $\frac{1}{2}$in. diameter solid round columns of various lengths and materials. Tensile tests have also been made to determine the values of Young's modulus and the yield points. The results of the experiments have been plotted as a series of curves giving the breaking loads for varying ratios of length to radius of gyration. The author has also investigated the influence of the shape of the cross section by experiments on small specimens of commonly occurring section, and has given approximate values for the constants to be used with a modified form of the Rankine Gordon formula which takes variation of section into account.

A second paper treats of the "Economic Design of Columns," and describes experiments made upon steel tubes of various diameters and thicknesses to determine the relation between the conditions under which failure takes place from primary flexure of the column as a whole, as against secondary flexure of the walls of the column. Formulæ have been developed to determine the proportions of economic columns which will offer equal resistance to both primary and secondary flexure.

The last paper describes some tests of model plate girders designed to determine the loads causing distortion of the web when unstiffened and also with stiffeners, vertical and inclined, at various distances apart. The web invariably buckled at loads not greatly above the working shear stress, as one would expect with such thin plates varying in thickness from $\frac{1}{64}$in. to $\frac{3}{64}$in.; but these results seem conclusively to prove that Professor Lilly's theory of the struts resisting the resultant thrust and the web the resultant tension, is not realised to any great xteent in practice.

SHORT NOTICES.

Vectors and Vector Diagrams Applied to the Alternating Current Circuit. By W. Cramp and C. F. Smith. London. Longmans, Green and Co., 39, Paternoster-row, London, E.C. Price 7s. 6d. net. — Electrical engineers and electrical students who have to deal with alternating current problems should possess a thorough knowledge of vectors and vector diagrams, for with their aid the relationship existing in alternating current circuits can readily be expressed. The present book deals with the subject from an entirely electrical standpoint, and the idea throughout has been to link up vector diagrams with the corresponding algebra. It deals with examples of the use of vector diagrams in connection with the theory of transformers and of single and polyphase motors, &c., and many interesting problems are considered. The authors have introduced a somewhat different system of notation to that adopted by Mr. Steinmetz. Instead of employing the letter j to denote the perpendicular component a distinguishing mark is for each component. Components of a vector along the axis of reference are marked with a single dash (′), and components perpendicular to the axis have a double dash (″). An advantage of the system of notation adopted by the authors is that j is employed only as an operator, and accordingly always precedes the expression whose direction it changes. The dashes indicate units, and are consequently placed after the symbol denoting the magnitude of a vector. The book is one which should prove useful to those who are studying the design of alternating current machines and apparatus.

The Design of Highway Bridges and the Calculation of Stresses in Bridge Trusses. By Milo S. Ketchum. London: A. Constable and Co., Limited, 10, Orange-street, Leicester-square, W.C. Price 16s. net.—This book, which is an American publication, gives a brief course in the calculation of the stresses in bridge trusses, which is followed by a systematic discussion of the details and design of highway bridges. Both the algebraic and the graphic methods of calculating stresses in bridge trusses are described in detail. The author points out that the calculation of the stresses in highway and railway bridges are similar, but problems in the design of the two types are very different, due to the different requirements and conditions. There are twenty-two chapters and an appendix relating to general specifications for steel highway bridges. A point worthy of mention is that the author has discussed in detail the cost of the different parts of highway bridges. Another feature of the book to which attention may be called is that in Chapter IX. twenty-four problems are given in the calculation of stresses in bridge trusses.

Sanitary Law and Practice.. By W. Robertson, M.D. (Glasgow), &c., and Charles Porter, M.D., B.Sc., &c. London: The Sanitary Publishing Company, Limited, 5, Fetter-lane, London, E.C. Price 10s. 6d. net.—A considerable amount of new matter has been added to this second edition, whilst the old information has been revised, and in some instances re-written. The sections which have been re-cast include those on tuberculosis prevention, sewage treatment, meat inspection, and several others. Some new illustrations have also been introduced, whilst the less useful have been omitted. In order to permit of the inclusion of the new matter without unduly increasing the bulk of the book the size of the print has been slightly reduced.

LOSS OF A SUBMARINE.

WE have to record with the greatest regret the loss of a submarine, with, it is feared, no less than eleven of her crew. The vessel, C 11, in company with others of the Portsmouth flotilla, and accompanied by the parent ship Bonaventure, was making her way from Grimsby to Lowestoft preparatory to taking part in the naval review in the Thames next week, when the steamer Eddystone, bound for Hull, ran into her and sank her. The two commanding officers and a seaman, who were presumably on watch at the time, were saved, but the remainder of the crew, it is feared, has been lost. Two other submarines, in avoiding the steamer, collided and suffered some damage, but without loss of life.

The official statement was issued by the Admiralty on Thursday afternoon. It says:—"The Secretary of the Admiralty regrets having to communicate that Messrs. Farrar, Groves and Company's steamer Eddystone, bound for Hull, was in collision with submarine C 11 at 11.45 last night, four and a-half miles north-west of Haisborough Light, off Cromer, and the submarine sank in consequence. Salvage operations are proceeding. The battleships Victorious and Cæsar and cruiser Bonaventure, with tugs and other vessels and salvage appliances, are now at the scene of the wreck."

At the close of question time in the House of Commons yesterday, Mr. McKenna said:—"The wreck has been located by sweepings four and a-half miles north-west of Haisborough Lightship, off Cromer, in fifteen fathoms of water. The Commander-in-Chief at the Nore, who had previously despatched assistance on receipt of the news, has been directed to undertake salvage operations. Two battleships and two salvage lighters and several torpedo-boat destroyers, are on their way to the scene of the wreck. C 17, another submarine, which was also in collision with another submarine at the same time in trying to avoid the steamer, has been badly damaged, and is being towed to Sheerness. No lives were lost on C 17, but I regret to have to inform the House that in C 11 eleven men were drowned, and only three were saved—Lieutenant Brodie, Sub-Lieutenant Watkins, and able seaman Stripes."

NEW ENGINEERING LABORATORIES AT MANCHESTER UNIVERSITY

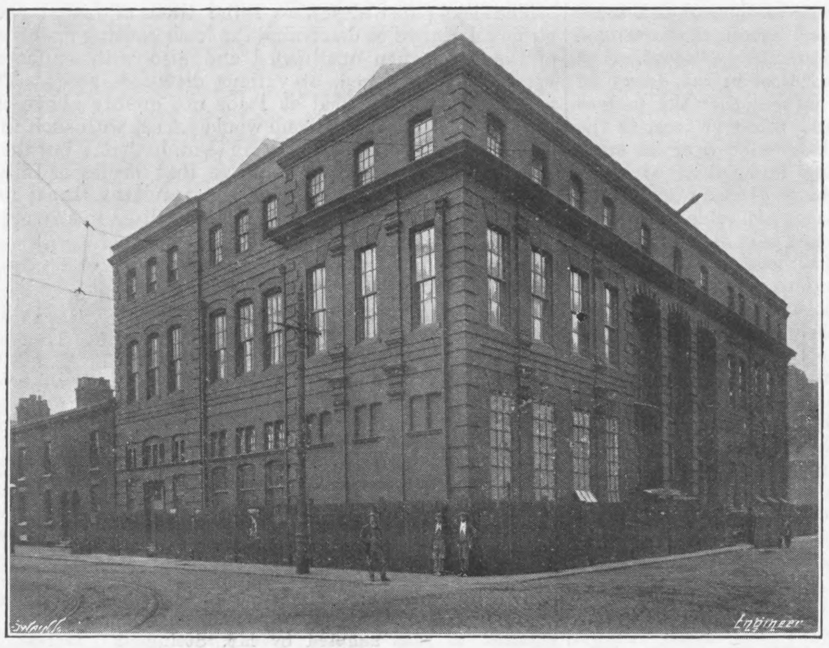


Fig. 1—THE NEW BUILDING

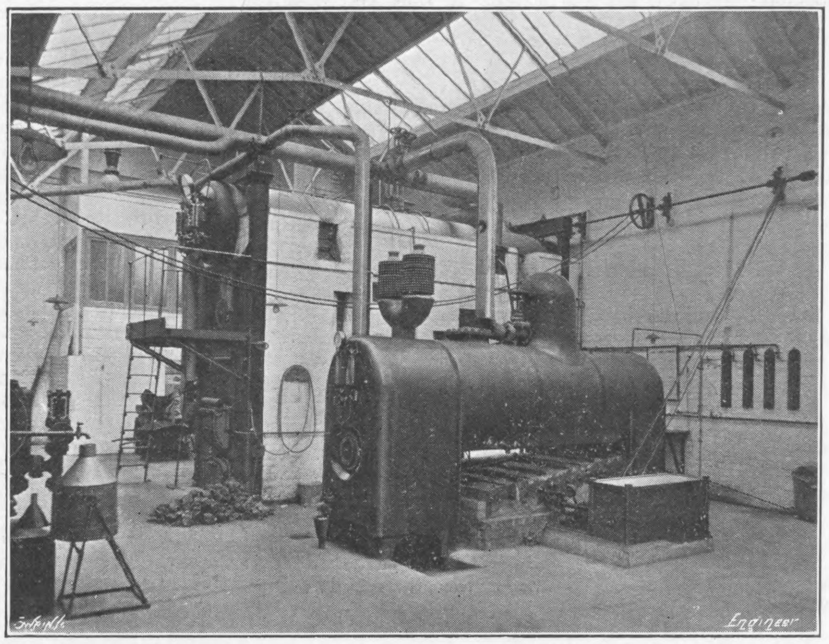


Fig. 2—THE BOILER ROOM

NEW ENGINEERING BUILDINGS OF THE MANCHESTER UNIVERSITY.

IT is not surprising that an institution which had as its sponsors such eminent men as Joseph Whitworth, Charles F. Beyer, William Fairbairn, and John Ramsbottom, should have a prosperous career. Without a doubt these great engineers foresaw when—largely due to their enterprise and generosity—the Professorship of Civil and Mechanical Engineering at Owens College, Manchester, was established in 1866, that this was only the preliminary step in the foundation of a school of engineering which would make its presence felt all over the world. With the by no means princely sum of £9505, subscribed by local engineers, the chair of engineering was founded, and in 1868 the trustees were fortunate enough to secure the services of Professor Osborne Reynolds, then Fellow of Queen's College, Cambridge, as Professor of Civil and Mechanical Engineering. With such a leader, with such generous patrons as Whitworth and Beyer, and with a field such as the youth of Lancashire provides, it would have been remarkable if success had not attended the enterprise. As a matter of fact, the engineering department of Owens College was recognised early in its career as being quite equal to the work it had taken up. However, until 1873 the engineering department consisted of a lecture-room, drawing-office, and a private room for the professor. A three years' course of instruction had been organised, including lectures in surveying, mechanism, hydraulics, the steam engine, descriptive geometry, and practical work in surveying and mechanical drawing. Engineering certificates were awarded on the successful completion of the course, and one of the first awards made was to J. J. Thomson, now Sir Joseph Thomson, Professor of Physics in the University of Cambridge. In 1873 the college was transferred from Quay-street to the present buildings in Oxford-street, and a much-needed extension of the accommodation for the engineering students took place.

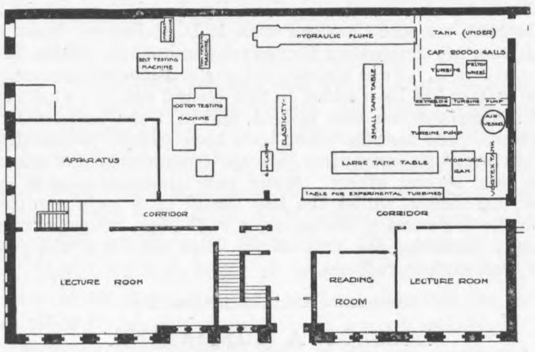


Fig. 3—HYDRAULIC AND TESTING LABORATORY

In 1880 the Owens College became the first college of the Victoria University, and in 1886 the legatees of Sir Joseph Whitworth contributed a sum of money sufficient to provide the laboratory accommodation which Professor Reynolds maintained was essential to the complete education of the engineer. The building was named the Whitworth Engineering Laboratory, and Messrs. Mather and Platt contributed liberally to its equipment. When it was opened in 1887 it was one of the earliest institutions in which systematic courses of instruction were given in conjunction with a three years' course of lectures in engineering—features which have since been copied elsewhere. Further equipment and an extension were provided in 1896, the cost of which was defrayed by Manchester engineering firms. Much original research has been carried out in the Manchester School under the guidance of Osborne Reynolds. As early as 1876, Reynolds constructed a two-stage radial flow reaction steam turbine, which ran at the remarkable speed of 12,000 revolutions per minute, and was perhaps the first practical attempt at steam turbine construction. Here also Reynolds designed his multi-stage high lift centrifugal pump, and later took up the problem of the accurate measurement of power for which he devised transmission and absorption dynamometers. Work was also carried out on the transmission of heat in boilers, on the laws of rolling friction, and the efficiency of screw propellers. During later years Reynolds devoted his studies largely to the determination of the critical velocity of water, theory of lubrication, and research on the thermodynamics of the steam engine and turbine.

The increase in the number of students rendered the provision of further accommodation necessary, and in 1907 Professor Dunkerley was instrumental in persuading the authorities to take steps to provide an entirely new building, which was formally opened by Sir Alexander Kennedy yesterday, and, together with its contents, forms the chief subject of this article.

The building, of which we give a general view in Fig. 1, is situated near the main buildings at the corner of Coupland and Higher Chatham-streets. The general scheme comprises four adjacent buildings. The main block, a three-storeyed building, contains lecture rooms, tutorial rooms, drawing-offices, research room, &c.; Figs. 3 and 4 represent ground plans of the hydraulic and testing laboratory and the thermodynamic laboratories, which are connected by a covered way. As will be observed from Fig. 4, the thermodynamic laboratories are sub-divided into three sections, namely, the steam engine room, the boiler-house, and the internal combustion engine-house. Two steam engines are at present in position, the first of which is an old favourite triple-expansion vertical engine capable of developing 100 brake horse-power. It was built by Mather and Platt, Limited, and was originally erected in the first laboratory. It is fitted with Meyer valve gear, and is loaded by means of three Reynolds hydraulic dynamometers. A surface condenser with air pump is provided, and the latter is worked from the low-pressure crosshead. The engine is constructed so that it can be used as a single-cylinder, compound, or triple-expansion engine, condensing or non-condensing, with the cylinders and receivers jacketed or otherwise. The engine will be seen in the illustration Fig. 5, page 62, and it is interesting to record that the low-pressure engine was used by Professor Reynolds in his re-determination of the mechanical equivalent of heat, an experiment which is even now included in the laboratory course. In conjunction with Mr. Moorby, Professor Reynolds, with a Froude dynamometer brake, found that 777 foot-pounds of energy per British thermal unit is its value when the range of temperature of the water acted upon is from freezing to boiling points. The second machine is a horizontal compound tandem Corliss engine with surface condenser, built by Pollit and Wigzell, Limited. It is provided with cylinder and receiver jackets so arranged that any or all of them may be used as required. It may be worked condensing or not, and its power is absorbed and measured by a modified Appold brake. The speed may be varied between 70 and 140 revolutions per minute, being controlled by a Whitehead governor, and the engine develops 150 brake horse-power at 100 revolutions with steam at 250 lb. per square inch. Both engines are shown in Fig. 5. It is proposed to install shortly a Zoelly steam turbine and a Diesel engine.

The boiler-house shown in Fig. 2 contains two boilers, a Babcock and Wilcox and a locomotive type, with electrically-driven feed pump and Green's economiser. The Babcock boiler is designed to work at 250 lb. pressure, and has a superheater. Its grate area is 17 square feet, and the heating surface 794 square feet, while it is capable of evaporating about 2500 lb. of water per hour under normal conditions. The locomotive boiler has 242 square feet of heating surface and 5 square feet of grate area, and can evaporate 800 lb. of water per hour. This boiler forms a self-contained unit with its economiser. A Green's economiser with a battery of thirty-two tubes is used in connection with the Babcock boiler. Either boiler can be worked with natural or forced draught, and provision is made for analysing the flue gases, while fuel calorimeters enable the value of the fuels to be ascertained. The plant has been so arranged that the feed-water may be taken from the condenser, the town's mains, or from experimental hydraulic mains. It may be passed direct to the boiler or through the economiser, and either engine may take steam from either boiler. The steam may be saturated or superheated.

The internal combustion engine-house—Fig. 6—contains a small Crossley oil engine specially arranged for testing purposes, and a 30 horse-power gas engine with suction producer, which has been presented by the National Gas Engine Company, Limited. It is designed to work with either town's or producer gas, and is fitted with both magneto and tube ignition. For varying the clearance in the cylinder the connecting-rod is built so that metal plates can be inserted between the rod and the big end; and Dugald Clerk's cam disengaging gear is provided for carrying out experimental work on the variation of the specific heat of the cylinder contents. The power is absorbed by means of a Prony brake, while the exhaust gases pass through a cooler provided with a water jet before they reach the atmosphere. Arrangements are made for measuring the amount and heating value of the fuel used, the gas generated in the producer, and the effect of moisture on the working of the producer.

The hydraulic testing department is shown in Fig. 7, and covers about 5000 square feet. Water is supplied from a tower tank 110ft. above the laboratory floor, through an 8in. main, the discharge being steadied by an air vessel with a capacity of 1600 cubic feet. From this the supply is delivered to the tables, turbines, and the flume. The air vessel will also be useful for experimenting on the discharge through orifices, and provides a means of obtaining an artificial head up to 250ft. The hydraulic plant includes a 24in. Pelton wheel, a 9in. inward flow pressure turbine by Gunther's, and a small Reynold's quadruple compound inward flow turbine, said to be the only one in this country. After being used the water is measured in a series of three calibrated underground tanks of a total capacity of 20,000 gallons. Each turbine can be loaded by a hand brake, and may be worked under any head up to the maximum available. The water is returned to the upper tank by a motor-driven Mather-Reynolds two-stage turbine pump capable of lifting 240 gallons per minute. This pump has a variable range of speed between 700 and 1500 revolutions per minute, and may be worked against any head from 10ft. to 200ft. The quadruple pump may be used to raise the pressure from 110ft. to 200ft. An experimental flume 3ft. wide by 2ft. 6in. deep and 35ft. long, supplied with water either from the upper tank or from the pump, permits of work being carried out on the flow of water in open channels, and over weirs and dams of various sections. The hydraulic appliances further include a hydraulic ram and Barker's mill, all the necessary appurtenances for investigating the flow of liquids at velocities above and below the critical, and for work on disc friction, jet discharge and flow through orifices.

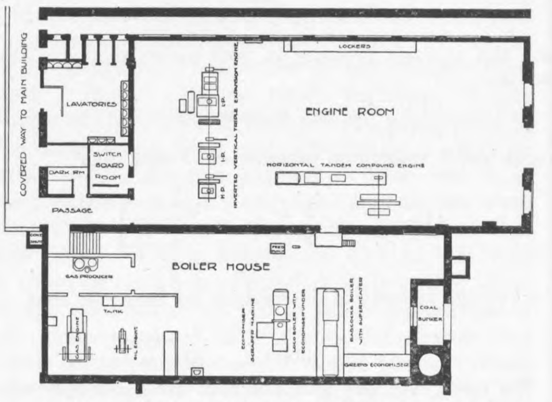

COVERED WAY TO MAIN BUILDING
LOCKERS
LAVATORIES
ENGINE ROOM
L.P.
I.P.
H.P.
INVERTED VERTICAL TRIPLE EXPANSION ENGINE
SWITCH BOARD ROOM
DARK RM
HORIZONTAL TANDEM COMPOUND ENGINE
PASSAGE
FEED PUMP
BOILER HOUSE
GAS PRODUCER
TANK
GAS ENGINE
OIL ENGINE
ECONOMISER SCRAPER MACHINE
LOCO BOILER WITH ECONOMISER UNDER
BABCOCK BOILER WITH SUPERHEATER
COAL BUNKER
GREENS ECONOMISER

Fig. 4—THERMODYNAMIC LABORATORIES.

Fig. 8 shows fairly clearly the principal contents of the elasticity and testing section. The machines include a 100-ton Buckton machine fitted for compression, tension, and cross-breaking; a 5-ton machine by the same makers, which is provided with an autographic recorder familiar to readers of THE ENGINEER; a cast iron cross-breaking machine; a cement tester, and machines for testing materials subjected to alternating stresses or to sudden impact, which have been constructed in the laboratory. There is also accurate apparatus for determining the moduli of elasticity and rigidity for testing springs and for the elastic vibrations and deformations of structures.

The workshop is a well-lighted and equipped room above the engine-house. It contains a number of useful machine tools, such as lathes, planing and shaping machines, and is driven by electric motors, the current being derived from the town's supply. The two electric motors are of 6 horse-power, and drive the two line shafts by Renold's silent chain; the line shafts running at 200 revolutions per minute as against 1000 revolutions of the motors. There is also in course of equipment a research laboratory—a large room on the second floor of the main block. The drawing department occupies the whole of the second floor of the main building, and comprises two well-lighted rooms, 80ft by 33ft., and 56ft. by 24ft. These two rooms will accommodate 150 students, and are lighted throughout by incandescent electric lamps.

The following are the members of the engineering staff:—Beyer Professor and Director of the Whitworth Laboratory, J. E. Petavel, D.Sc., F.R.S., A.M. Inst. C.E., A.M. Inst. E.E.; Senior Lecturer in Engineering and Director of the Drawing-offices, C. B. Dewhurst, M.Sc. (Manchester), Assoc. Inst. C.E.; Demonstrator and Lecturer in Hydraulics, A. H. Gibson, D.Sc. (Manchester), A.M. Inst. C.E.; Senior Instructor in Drawing and Assistant Lecturer, Cecil H. Lander, M.Sc. (Manchester), A.M. Inst. M.E.; Demonstrator A. Robertson, M.Sc. (Manchester); Junior Instructor and Demonstrator, R. Cotton, M.Sc. (Manchester); principal skilled assistant, Thomas Foster; Demonstrator and Lecturer in Electro-Technics, Robert Beattie, D.Sc. (Durham), M.I.E.E.

The illustrations are reproductions of photographs supplied by Mr. E. Ward, of Manchester.

FRENCH SUBMARINE MANŒUVRES.

IN May-June last some important manœuvres were carried out by a flotilla of French submarine craft of the latest type. The idea was to obtain experience as to the tactical value of a squadron of submarine vessels; as to the respective value of the submarine and of the submersible; and to make observations as to the endurance of the ships' crews. As regards the first of these three, the experience gained was hardly sufficient for any definite decision to be arrived at, or at all events for the problem to be definitely solved, though sufficient data were obtained to serve as a basis for more complete trials at a future time. Regarding the second and third, however, satisfactory conclusions were reached.

The first manœuvre carried out was the stoppage of a narrow sea, such as the Straits of Dover. During the night of May 3rd the submersibles Pluviose and Ventose, with the submarines Emeraude and Opale, left Cherbourg for Calais, and each took up its assigned position. The Ventose was on the Calais section, whilst the Pluviose was off Cape Gris-nez. The Opale and the Emeraude were in the open sea, and patrolled right up to the English coast. On May 4th, at 10 in the morning, the cruisers Léon Gambetta, Marseillaise, and Friant, with some destroyers, left Dunkirk, and set a course for Cherbourg. They were at first in the section under the supervision of the Ventose. Unfortunately, the Léon Gambetta, which was sailing in advance of the other two, found that an English cruiser, accompanied by two destroyers, was right ahead of her. The commander of the submersible mistook the English for the French vessel, and took up his position in order to torpedo the former. When but two hundred metres from the British cruiser he rose to the surface, and signalled that the torpedo had been fired. He soon found out his mistake, and then had to dive suddenly in order not to impede the cruiser. While this was going on the French destroyers took the opportunity of firing on the submersible, and putting it theoretically out of action. The French cruisers then changed direction at good speed, and at once fell foul of the Pluviose, which made good use of its opportunity, and succeeded in getting some torpedoes home. The unfortunate submarines Emeraude and Opale did not sight anything, and the whole flotilla rendezvoused at Cherbourg, the manœuvres not having yielded any very definite results.

On the 10th May the flotilla left Cherbourg for L'Orient. It was lovely weather during the whole of the voyage, and at times a speed of 15 knots was made by the submersibles, but towards the end of the trip the Opale had one of her engines put out of action by an accident to the electrically-driven pumps, and L'Orient was not reached until thirty-four hours after the start. The intervening period to the 20th was occupied by resting and by putting the boats in the best possible trim.

Some further manœuvres were then undertaken off L'Orient. It was assumed that an enemy had taken possession of Quiberon Bay, and had established himself there, disembarking troops on the island of Groix and on Belle-Ile. He was bombarding the forts and blockading L'Orient. The submarine vessels were told off to counteract the operations of the enemy by any means possible. According to the original plan the enemy was to be represented by the cruisers Leon Gambetta, Marseillaise, Dupetit-Thouars, and Friant, with nine destroyers. Unfortunately, owing to the strike of the Post and Telegraph servants, the orders could not be got through, and only the cruisers Leon Gambetta and Friant were present during the first three days of the operations, though the others joined for the last four days. On the other hand, there were only three instead of four submarine boats, because the Opale's machinery could not be repaired in ime.

The submarine flotilla was hence at a disadvantage—first because its numbers were one short, and next because its chances of success were lessened on account of its only having two adversaries instead of four to proceed against. The results achieved are hence all the more interesting. During the seven days of the manœuvres, working day and night, while under way and at anchor, the three submarine vessels made 44 successful discharges of torpedoes without being once seen by their adversaries. During this period of seven days the weather was very variable, and there was a change from a flat calm to a heavy sea, which gave opportunities for testing the qualities of the different craft.

The result of these operations has been to prove to the satisfaction of the French authorities that it would not be possible for a hostile squadron to venture to blockade a port in the manner attempted on the occasion under consideration. The risks would be too great.

On June 5th the submarine flotilla left L'Orient to carry out the final phase of the manœuvres. The idea was for the vessels to blockade a hostile port for three days and then to return to the point whence they started. Cherbourg was taken to represent the hostile port, but in order to allow the crews to return to their port of station it was decided to run, after the blockade, to Dunkirk and back, instead of returning to L'Orient. The blockade was to be of a rigorous nature, but the submarine boats were not to venture within two miles of the coast, which was deemed to be defended by lines of automatic torpedoes or mines.

Only the Emeraude, Ventose and Pluviose were able to take part in these operations, as it had not been possible to repair the Opale's machinery in time for her to sail with the others. The three boats therefore undertook the task of blockading Cherbourg. They attacked every vessel coming out, although the larger warships were accompanied by destroyers. They were almost constantly submerged by day, and only came to the surface at night time in order to re-charge their accumulators by means of their surface engines. In spite of continuous day and night patrols, the destroyers from the port were never able to sight any of the submarines, which succeeded in carrying out twelve attacks.

At the termination of the three days' blockade, the journey Cherbourg-Dunkirk-Cherbourg was made at an average speed of 11 knots by the Pluviose and Ventose, and of 9 knots by the Emeraude. On their return to their station it was found that no accident had taken place, and the crews, although tired, could, if necessary, have gone on another trip.

These manœuvres were more severe than any that have as yet been carried out by French vessels of this class, and it is understood that they will be continued during the coming winter. They have satisfied the French marine authorities that the submarine vessels can no longer be considered as defensive implements only; they have shown themselves capable of proceeding to some distance so as to blockade a port and to contribute largely to its destruction.

Hitherto the naval experts in France have never agreed as to the relative value of the submersible and the submarine. It would appear that, as a result of the manœuvres above referred to, this question is practically solved. The submersibles showed themselves much superior to the submarines as regards their seagoing qualities, for they made better weather than torpedo boats; moreover, they sailed submerged as well as the submarines, and in consequence of some improvements which have been made to them, the Pluviose and the Ventose actually submerged themselves more quickly than the submarine Emeraude. At full speed in fine weather the Pluviose attained 15 knots to $9\frac{3}{4}$ knots by the Emeraude, whose lines do not apparently lend themselves to obtaining the full value in speed from the power with which she is provided. The submerging tests were carried out by all the boats at the same time on a signal being given by an escorting vessel on which were the umpires. As a result, the mean time taken by the Pluviose was 2 min. 45 sec., and by the Emeraude 3 min. 55 sec.

The *personnel*, according to all reports, behaved exceedingly well. At the blockade of Cherbourg they remained for three days entirely cut off from the rest of the world, only making a preconcerted signal at 7 o'clock each evening at a given place, this being done in order to set the minds of the men's families at rest. It is evident that the submarine is a much more habitable craft than it used to be for such manœuvres as we have outlined to be possible, and we gather that in similar vessels now under construction the accommodation is to be as good as it is on torpedo boats.

During the operations off L'Orient the Ventose came across a boom, which the squadron of cruisers at anchor had rigged up for their protection; by diving, however, it readily passed the obstruction.

The particulars of the two types of submarine vessels which took part in the manœuvres may be summarised as follows:—

	Pluviose (submersible).	Emeraude (submarine).
Length between perpendiculars	51.12 m.	44 65 m.
Extreme breadth	4.97 m.	3.90 m.
Depth	3 12 m.	3.60 m.
Displacement, awash	398 tons	390 tons
Displacement, submerged	505 tons	420 tons
Indicated horse-power, planned	600	600
Indicated horse-power, actual in trials	700	720
Speed, full power, awash	12.5 to 15 knots	10.6 knots
Speed, full power, submerged	8 knots	9 knots
Radius of action, awash	1000 miles	1600 miles
Number of torpedoes	7	7
Crew	23	21
Reserve of buoyancy	27 per cent.	7 per cent.
Boilers	2 (Du Temple)	—
Engines	2 triple-expansion 3 cylinders	2 Diesel
Propellers	2	2
Fuel	—	—
Electric motors	2 = 440 h.p.	2
Designer	M. Laubœuf	M. Mangas

The general aspect of the Pluviose is not very different from that of the other vessels designed by the same naval architect. The crew space is similar to that in an ordinary torpedo boat. The captain has a cabin to himself, the chief officers another, while there is separate accommodation for the petty officers and men. Some excellent results have been obtained with her steam propelling engines. Her armament consists of one torpedo tube in the bows, which by the way has been done away with in similar boats now under construction, and two Drewski tubes on each side. These are adjustable so as to allow a variation in aim of several degrees on each side of the centre. The Pluviose was begun in 1905, and launched in 1907.

The Emeraude is like a whale with a box on the top of it. When it is rough she has to be continuously submerged, which, of course, detracts from her speed. Her two outstanding qualifications are that she is a good plunger, and has a wide area of action. During a six hours' full power trial she only consumed 300 grammes of fuel per indicated horse-power per hour. The armament is very different from that of the other vessels of her class which went before her. There are two torpedo tubes forward and two aft. Aim has, of course, to be taken by manœuvring the vessel. She was begun in 1904 and launched in August, 1906, and her cost was 1,600,000f., say £64,000.

A French naval constructor, in view of the recent manœuvres, makes the following deductions regarding the submersible of the future:—It will be, he thinks, what may be termed a "submersible destroyer," having a mean speed of 20 knots on the surface and 15 knots when submerged. She will have a radius of action sufficient to permit her to accompany a main squadron, if need be, on a lengthy cruise. Alone she should be capable of proceeding to great distances along an enemy's coast; of following a hostile squadron, or of placing herself so as to bar its way. The greater her radius of action, the higher her speed when submerged, the nearer she will be, he adds, to being a perfect instrument of offence and defence. She must, he continues, be driven by steam turbines, "which alone will allow her to attain a high speed, and to preserve it as long as there is any petroleum in the bunkers."

MODELS OF EARLY RAILWAY COACHES.

THREE remarkably interesting models of early railway coaches have lately been lent by the Lancashire and Yorkshire Railway Company to the South Kensington Museum, and are now on view in the Machinery Section. The first of them is on a scale of 1 : 6, and represents the "Experiment," 1825, stated to have been "the first passenger carriage ever used on a railway." Had the vehicle been intended for locomotive traction, the statement would have been correct, but, in fact, it was meant to be worked by a horse, and horse-drawn passenger vehicles had been used on the Kilmarnock and Troon Railway in Scotland ten or fifteen years earlier. The model consists of a body similar to that of a stage coach of the period, with the difference that both ends are exactly alike, so that it could be driven either way without being turned. The frames, 12ft. long overall, are of wood, of stout square section, with four cross braces of the same size sufficiently near the centre to admit the horse at either end. The wheels are of cast iron apparently, 34in. in diameter, on a base of 51in., and have ten straight spokes. The body has no quarter-lights, nor any roof lamp. At each end is what must have been in the original a "boot" or locker for parcels, &c., but in the model these compartments seem to be solid. They are supported by two turned legs resting upon the outer cross brace. The right-hand wheel on each side has a wooden brake block, applied by a long iron rod with a handle reaching up to the box seat. Behind the latter is another seat, rather longer, making four rows of seats outside, so that the vehicle would carry about twenty outside and six inside passengers. There are no springs, which we will hope were not missed. There are three steps on each side to get up by, besides another on each side of the "boots." The body is painted black, with a gilt panel on the boots, but the frames are yellow, with horizontal black stripes. The height from the rail level to the centre of the roof is 7ft., the width outside being 5ft. 3in. The body, of course, was "first-class; the outside seats "second-class."

Although a horse-drawn railway coach, called "Experiment," began running between Stockton and Darlington on October 10th, 1825, within a fortnight of the opening of the railway, it is doubtful if it was like the vehicle here shown. At any rate pictures are in existence of an omnibus-like structure, having three windows on each side, and a door at one end, which was probably the predecessor for a short time of the vehicle just described. The latter, however, may certainly be called the first railway coach, for such it literally was.

Both the other vehicles are to a scale of 1 : 8, and represent coaches of the Manchester and Leeds Railway, 1839. This line, which ran from Manchester to the North Midland Railway at Normanton, was practically the nucleus of the present Lancashire and Yorkshire Company. One model shows an open third-class, the other a closed second-class carriage, and both are quite representative of their period. The third-class is simply a rectangular box, with sides 4ft. high, having hand rails round the top, except on the doors. The length, inside, is 16ft. 9in., and the width 7ft. There are no seats of any kind. A number of holes in the floor are thoughtfully provided to let out the rain water. The springs are rather long, but seem to consist of only one or two plates; the shackles or links are also unusually long and appear to be much too weak. The four wheels are 37in. in diameter, on a base of 8ft.; they have eight thick straight spokes without any taper. Two doors are on each side, with an iron step to get in by, besides a low footboard. Dark green is the colour adopted, with red springs. Bad as these vehicles were, it must be remembered that no company was bound to provide any third-class accommodation at all till Mr. Gladstone's Cheap Trains Act was passed in 1844, and some did not. The Manchester and Leeds Company, however, provided an unusual amount of it from the very first, though the quality, as we have seen, left a good deal to be desired. The people who used these vehicles were known as "wagon passengers," being the class which had previously used the stage wagons on the turnpike roads.

The second-class coach has three compartments, with glazed windows and half-doors, shutters being provided for closing the upper half of the doorways. A seat for one passenger, or possibly for two rather slim ones, is fixed on each end outside. In some cases the guard used one of these seats and had the brake handy, but there is no brake in the present instance. Bearing springs are used, and there are luggage bodies or dog lockers under the two double seats, with folding doors on the outside. The roof is very nearly flat, and carries no lamps, nor are there any outside. Occasionally, in those days, lamps were fixed outside between the compartments, at any rate on first-class coaches. The vehicle is painted black above and dark green below the middle line, the springs red, the panels also red. No padding is provided on the seats; the two double ones have half-backs carrying an iron upright supporting the roof. As to dimensions, the body is 13ft. long, 5ft. 8in. high inside, and 6ft. 10in. wide. The wheels are of the same kind as in the third-class, and at the same distance—8ft.—apart.

In both vehicles the drawing and buffing arrangements are the same, and of a very feeble and unmechanical design. Solid buffer heads of turned wood are mounted on a separate beam supported by the main frames. Behind this beam is placed a long transverse plate spring secured to the ends of the underframe. The buffer frame slides in guides on each side of the main frame, but it seems much too weak, and looks as if it would jam in the guides—at any rate, if the shock came on a curve. There is a central hook and side chains, but no screw coupling; the side chains are attached to the bottom of the coach. To reach the outside seats six steps are fixed on each end, to allow for getting up from either side, three only being wanted at a time. There is also a footboard, which really formed the first step, and is quite low enough to permit anyone to get in from the rail level.

It is a pity there is not a model first-class of the same date to compare with these interesting vehicles, but possibly one will be forthcoming sooner or later.

LETTERS TO THE EDITOR.

(*We do not hold ourselves responsible for the opinions of our correspondents.*)

LATENT AND SENSIBLE HEAT.

Sir,—For the reasons stated in my letter of June 18th I decided to investigate the heat in saturated steam. As Regnault's steam tables are universally accepted, I started the investigation with absolute and supreme faith in Regnault, but as I had confidence in the conclusions A, B, and C, it seemed to me there must be some unknown something which enabled steam to contain more heat.

I need not describe all the theories formed to account for the extra heat which I felt absolutely certain was in steam, and which theories when argued to their logical conclusion proved fallacies, but there were two theories which I considered worth experimental investigation. (1) Could heat be used up in internal work during condensation? (2) Could there be some unknown form of heat in steam—something similar to X-rays in electricity?

I shall not describe how I convinced myself that (1) was a fallacy, as it will serve no useful purpose, but I spent weeks and weeks in trying by experiments to isolate this supposed unknown form of heat. At last, however, I devised an experiment which convinced me that there is no unknown form of heat in steam, so the only logical conclusion I could arrive at was that Regnault must have made some practical mistake in his measurements of the total heat in saturated steam.

As the experiments which convinced me that there is no unknown form of heat in steam provide evidence in regard to what is the exact value of the latent heat of steam, and also show why Regnault obtained a lower value than Despretz in their experiments at atmospheric pressure I think I am justified in describing them.

During the attempts to isolate this supposed unknown form of heat it became evident that, if it did exist, it must be able to pass through glass and water without having any heat effect on either the glass or the water. I therefore decided to reverse the usual positions of the steam and condensing water—that is, instead of surrounding the steam by the condensing water, surround the condensing water by the steam. I need not describe the argument which convinced me that, if steam is condensed under these conditions, the unknown heat, if it existed, would be unable to escape through the steam.

I filled a heavily lagged vessel with steam and kept the temperature always at 212 deg. Fah.

The thermometer used to measure the temperature was checked against a Beard and Thompson standard thermometer, with a National Physical Laboratory certificate. The very greatest care was taken to have only steam present, the air being removed by allowing the steam to blow off through a small hole in the cover for about ten minutes. The gas flame under the vessel was then adjusted till the temperature just remained steady, and the steam was prevented from blowing off. I next placed in the body of the steam, and as near the centre as possible, what for want of a better name I called a test bob. The test bob was a brass tube, plugged at each end, and after it was filled with water the top plug was screwed up steam-tight. The water, before it was placed in the test bob, was boiled to remove all air, and care was taken to see that no air remained when the top plug was screwed up. The test bob was hung vertically in the steam by a piece of dry string attached to a wooden plug in the wood cover. As the test bob was at the room temperature, viz., about 58 deg. Fah.—this varied in different experiments—when placed in the steam, and its final temperature was 212 deg. Fah., the steam temperature, the steam condensed on the brass walls, and as the test bob was coned at the bottom, the water as it formed ran down and dripped off. The temperature of the steam was taken as near the point of condensation as possible. To catch the condensed water, a small glass beaker was placed in the steam space, well above the water from which the steam was generated. The beaker was supported by a little brass table, and the table was supported by two brass roads, attached to a removable brass ring placed in the cover, and the beaker was tied by cotton to the brass rods. To prevent the beaker, table, and brass rods causing condensation, they were heated to about 230 deg. Fah. in a gas oven before being placed in the steam space. The gas jet was kept as low as possible, not simply to prevent the steam blowing off, but also to prevent any priming, and thereby guard against an accidental splash of water reaching the beaker. The heat gained by the test bob was calculated and also checked by actual measurements.

This is the point. As the test bob and the condensed water were both at 212 deg. Fah. at the finish of condensation, and this is the temperature of the water from which the steam is generated, the heat gained by the test bob must be the latent heat of the steam condensed, as shown by the weight of water condensed.

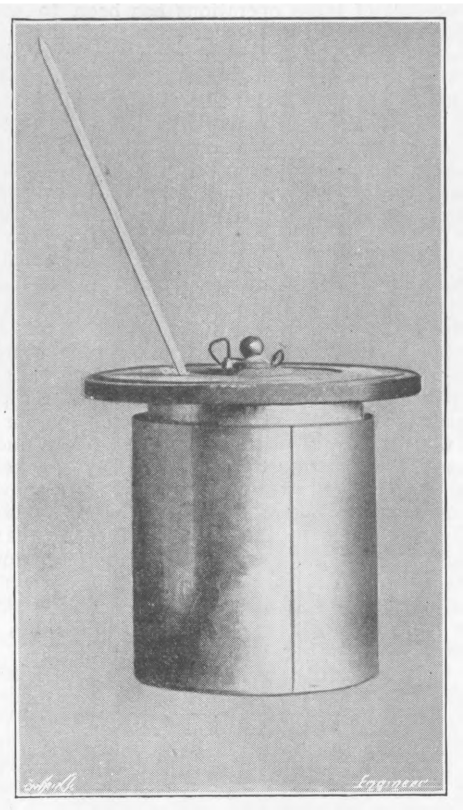
It will be noticed that this way of measuring the latent heat is an absolute method, as no corrections of any kind are required.

I made the latent heat at 212 deg. Fah. 971.9, and this I afterwards found agreed closely with the 972 arrived at by both Despretz and M. Brix, when they worked independently; when working together their value was slightly different.

I should like to call particular attention to the fact that the steam was allowed to condense just as it pleased. If Regnault's and Despretz' experiments at atmospheric pressure are compared, it will be seen that whilst Regnault adjusted the rate of condensation by the cocks R and R_1, Despretz allowed the steam to condense just as it pleased. I am convinced that this is the reason why Regnault's value is 965.7, that is, 6.3 h. units lower than Despretz.

When I realised the possibility of Regnault having made a mistake, I tried to find his Memoir, but as I failed to do so, I devised a method of measuring the total heat in saturated steam at above atmospheric pressure.

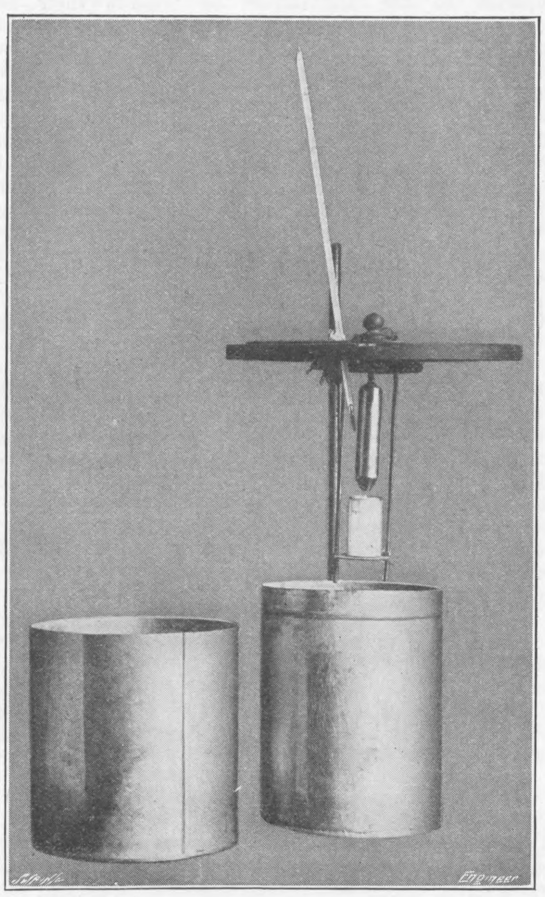
I may mention that before I tried to find the suspected unknown form of heat in steam, I wrote down the conditions which I thought necessary to measure the total heat in saturated steam. They were as follows:—(1) At the moment when condensation commences the steam must be saturated steam. (2) Saturated steam is steam in contact with the water from which it was produced, and in the same condition as when it left the surface of the water. (3) No air must be mixed with the steam. (4) The steam must be neither wet nor superheated. (5) It would be advisable to have a definite commencement and finish of condensation. (6) If possible the water formed by the condensing of the steam should be at the same temperature as the original water, so as to measure the latent heat only.



APPARATUS CLOSED

Put briefly. To get accurate results the steam when it starts condensing must be saturated steam, and not wet or superheated steam, and it must be only steam at the temperature, density and pressure at which it was produced.

For the words "at which it was produced," I afterwards substituted "necessary to make it dry saturated steam," as it is my firm conviction that when steam is actually produced, that is when it leaves the surface of the water, it never is absolutely dry saturated steam.



APPARATUS OPEN

I should like to describe my experiments at above atmospheric pressure in another letter, as I wish at the same time for special reasons to deal with the great James Watt's investigation of the heat in steam at below atmospheric pressure.

James Watt confirms Carnot and Southern, and his experiments show where Regnault made his mistake in his experiments at below atmospheric pressure, just as Southern's experiments show Regnault's mistake at above atmospheric pressure, and Despretz' experiments Regnault's mistake at atmospheric pressure.

Not only do James Watt, Despretz and Southern contradict Regnault's total heat in saturated steam, but Fairbairn and Tate's experiments show where Regnault made his mistake in arriving at his saturated steam volumes. Fairbairn and Tate also confirm Carnot and Southern.

The truth is, the accepted saturated steam volumes are not really saturated steam volumes; at above 26 lb. absolute they are superheated steam volumes, and at below 26 lb. absolute they are wet steam volumes. The accepted saturated steam volumes are too large at above 26 lb., the error increasing as the pressure increases, and the accepted volumes are too small at below 26 lb., the error increasing as the pressure decreases.

I should like to prove this statement formally, after I have dealt with James Watt's investigation. I am confident it provides the chief explanation why no definite conclusions have been arrived at in regard to cylinder condensation and the utility or otherwise of jackets.

Owing to the accepted saturated steam volumes being too large at above 26 lb. abs., if an engine receives saturated steam a missing quantity will be found, although actually no missing quantity exists.

Frank B. Aspinall.

Blackheath, July 14th.

Sir,—I have been greatly interested by your leading article of May 20th on "The Tyranny of Scientific Dogma," and by the correspondence in your columns on the subject of "Latent Heat in Steam."

Apparently most of the values of steam at present accepted depend on the experiments carried out by one man, *i.e.*, Regnault, and his figures are adhered to despite the fact that practice is constantly casting doubts upon them. Your correspondent, "G. B. D.," shows that there is something radically wrong somewhere in our ideas concerning the heat in steam, and Mr. Aspinall points out that Regnault never carried out in practice what he stated was a *sine quâ non*. I have been surprised that up to the present no one has come forward in support of our present values and theories. Do not they bear the investigation which, from my own experience in practice, certainly seems necessary? I would not have trespassed upon your space with this letter had I not wished to see this matter thrashed out.

London, W., July 12th. Interested.

MARINE PROPULSION.

Sir,—I have taken an interest in the correspondence on the above subject, and would like to make a few remarks on the question which has now arisen. As the question at issue is of first importance in dynamics, I think it can easily be settled by quoting reliable authority. The first authority I quote is Sir Isaac Newton. Referring to the letter of your correspondent "L. S. C." of April 27th, he gives a mathematical deduction from the third law of motion. To put it a little differently, but exactly to the same effect, $M\,V = m\,v$ is the third law of motion, but this equation may be expressed in different ways, *e.g.*, $\frac{M}{m} = \frac{v}{V}$ (2) or $\frac{M}{m} \times \frac{v}{V} = \frac{v^2}{V^2}$ or $\frac{v}{V} = \frac{m\,v^2}{M\,V^2}$; substituting value of $\frac{v}{V}$ from (2) $\frac{m\,v^2}{M\,V^2} = \frac{M}{m}$, that is, energy of bullet : energy of gun :: mass of gun : mass of bullet. This is the third law of motion, and whoever denies this ratio denies the accuracy of this law of motion.

The late Professor Rankine is the next authority. Referring to the article on the Ballistic Pendulum in Rankine's A.M., a bullet strikes a ballistic pendulum $\frac{b\,v}{g} = \frac{B\,V}{g}$ expresses momentum of bullet before striking = momentum of pendulum, block, and bullet after striking, and $\frac{b\,v^2}{2g} = \frac{B\,V^2}{2g}$ their actual energies.

I omit the ratio $\frac{l}{r}$, which is constant for the same pendulum and line of flight of bullet, and does not affect the point at issue. He then remarks: "The energy of the combined mass after the collision being $\frac{B\,V^2}{2g}$ and less than that of the ball before collision in the proportion $\frac{b}{B}$ (b being weight of bullet and B that of pendulum block + bullet) an amount of energy denoted by this proportion disappears in producing heat and molecular changes in the ball and in the soft mass in which it is lodged." In the same way when the gun is attached to the pendulum, the energy of the exploding powder is $\int P.d.s = \frac{b\,v^2}{2g} + \frac{B\,V^2}{2g}$ (B being weight of gun and pendulum) the two terms are distributed in the ratio $\frac{B}{b}$.

Rankine further states, "In the preceding calculation momentum and energy produced in the explosive gases are not considered, but it is very doubtful whether any attempt to take them into consideration—hypothetical as it must be—adds to the practical correctness of the result."

The next authority is the ballistic pendulum, which exactly corroborates Sir Isaac Newton and the late Professor Rankine.

I am much astonished at Sir Wm. Anderson's statements; there appear to be as many mistakes as words in the few lines you quote. He states, "The work being external there must be as much work in the recoil." This is the very reason why there must not be as much work in the recoil unless the weights are equal. He then implies that momentum and work are the same and that the energy of the bullet and recoil energy of the gun are equal because action = reaction. A bullet strikes a target and falls to the ground. The action of the bullet is equal to the reaction of the target, but the work performed on the target is practically nothing, and the actual energy of the bullet disappears and reappears as heat energy in the bullet. He makes Newton state that velocity is proportional to the impressed force. Newton's second law of motion implies that a force is proportional to the rate of acceleration it produces, and is exactly expressed by the change of momentum it produces in one second. This last equation is what some people call Rankine's formula when applied to marine propellers.

I think the confusion this discussion has got into is due to the interminable volubility of Mr. Preidel and "X." These gentlemen make mistake after mistake in elementary mechanics, and when these mistakes are pointed out, instead of rectifying the errors, dart on to other subjects.

A. R.

July 10th.

Sir,—I am greatly obliged for your quotations from the lat Sir W. Anderson's book *re* the work of action and reaction. Seeing that those quotations bear out my arguments from the logical point of view, you will, perhaps, permit me saying that this does not necessitate $\frac{m\,v^2}{2g}$ equalling $\frac{M\,V^2}{2g}$, which is your conclusion.

According to Lineham, "In every system the total energy, however changed in form, remains constant. . . . . Stated generally, Kinetic Energy + Potential Energy = Constant." As the above formula, "our old friend" only ascertains kinetic energy, potential energy varies with masses within the radius of gravity, it seems clear that M retains much more potential than m whilst $\frac{m\,v^2}{2g}$ represents more kinetic.

I am, however, open to be convinced by any highly qualified person like H. Barnes—your correspondent from last week—on the following conditions:—

As he adopts with "T. S. C." that work alone varies inversely as the masses, which, by the way, is equal to saying that it equals velocity, I should want him to demonstrate to me *ad oculos* on *terra firma*—not on the pinnacle from which he observes the creation of energy out of nothing—that he can transmit, or give from his muscles, the same amount of kinetic energy on to a mass of, say, one ton, which I will give on to a mass of 1 lb. To do equal work on unequal masses through imparting velocity. To make it more demonstrative we shall select the direction outwards from the centre of gravity from our globe. I shall fully agree to calculate "work done" on formula $\frac{m\,v^2}{2\,g}$.

I feel now fairly certain that your correspondents, "T. S. C." and H. Barnes fail to appreciate the expression "Action and Re-action." I recommend them to consult "Encyclopædia Americana" or a good dictionary.

Amongst a number of others, I found the following from Professor J. Clerk Maxwell a very good statement:—"Action and reaction are the partial aspects of a stress. We have already used the word 'stress' to denote the 'mutual' action between two portions of matter. This word was borrowed from common language, and invested with a precise scientific meaning by the late Professor Rankine. As soon as we have formed for ourselves the idea of a stress, such as the tension of a rope, or the pressure between two bodies, and have recognised its 'double' aspect as it affects the two portions of matter between which it acts, the third law of motion is seen to be equivalent to the statement that all force is of the nature of stress, that stress exists only between two portions of matter, and that its effects on these portions of matter —measured by the momentum generated in a given time—are equal and opposite."

As, consequently, action and reaction can be changed *ad libitum*, it will take more than one "T. S. C." or H. Barnes to ascertain which is the work of action and which that of reaction, as anyone can always quite properly say the opposite. Hoping that this will not lead any more "slender qualified," "muddled" individuals "on the ice."

London, July 12th. W. PREIDEL.

SIR,—Perhaps some of the difficulty your correspondents find is due to their implicit faith in text-books. Those who have prepared pupils for various elementary examinations know full well that many statements made in sundry text-books are not correct.

It will suffice here to take one point. If $m\,v = M\,V$, then $\frac{m\,v^2}{2g}$ is certainly not equal to $\frac{M\,V^2}{2g}$, except in the single case where $m = M$ and $v = V$. This is obvious to anyone with a knowledge of algebra, but it is at once seen without algebra by putting $m = 1$, $M = 4$, $v = 4$, and $V = 1$. From the first relation, $4 = 4$; from the second, $4 = 16$.

Apart from the momentum of the gases from the powder, and the fact that the recoil of a gun is not unimpeded, the relation $M\,V = m\,v$ holds for the case of a gun and its projectile. The relation $\frac{M\,V^2}{2} = \frac{m\,v^2}{2}$ does not hold, since $\frac{m\,v^2}{2}$, the kinetic energy, is equal to the force multiplied by the distance through which it acts; and as the length through which the gun recoils is small compared with the distance passed over by the shot while it is in the gun, the energy imparted to the gun is far less than that imparted to the shot.

The usual expression for kinetic energy is $\frac{m\,v^2}{2}$, not $\frac{m\,v^2}{2\,g}$; $\frac{m\,v^2}{2\,g}$ has no meaning unless m be taken as a force, but when meaning a force it is better to use w, since palpably a weight is a force. The relation between the two is $w = g\,m$.

The term "pound" is commonly used in two senses—either to mean a mass or a quantity of matter, or to mean a force, *i.e.*, the force with which that quantity of matter is attracted to the earth. In many text-books the difference is ignored, and hence much confusion arises. F. R. S.

July 15th.

BRITISH LOCOMOTIVE PRACTICE OF TO-DAY.

SIR,—The discussion on the locomotive question appears to be waning in interest. It seems a pity that such an important question should be allowed to die out when there are numerous readers who must have had wide practical experience in the working of the locomotive, and who could give valuable assistance towards clearing up this much discussed problem were they to join in the discussion. Personally, I know of no improvement having been effected in the economical working of the simple engine during the past forty years, the slight economy in fuel consumption brought about by compounding the locomotive not being worth the extra complication.

Some of your correspondents appear to lay stress on the perfect balancing of the locomotive. The primary object of compounding was, however, not that of producing a perfectly-balanced engine, but to enhance its power and to economise in fuel consumption, so as to meet the ever-growing demand for more power. The problem to solve should therefore be to ascertain the cause of the apparent failure of the compound locomotive, which, although more economical than the simple engine, is in some cases being reconverted to simple.

I have to confess that during my forty years career I wasted a considerable sum of money in the search after fuel economy, under the impression that this could be attained by increasing the number of steam expansions in the cylinders. I find, however, that such is not practicable unless the cylinder capacity is at the same time enhanced. I feel sure it is only necessary to follow up this clue to bring about a radical improvement in locomotive practice, indeed, if it does not solve the problem. For instance, if we compare the economical working of any compound with that of the simple engine, we shall find that the economy of the former bears a relation to its enhanced cylinder capacity over that of the latter. Let us now assume that an increase of 100 per cent. in cylinder capacity is added to a locomotive. it must be obvious that there must be an enormous increase in power, or correspondingly a considerable reduction in steam, and consequently fuel consumption when retaining the original power, for assuredly it must act in a locomotive equally as well as in marine or stationary practice; therefore all that is necessary is to design a locomotive with cylinders having a liberal increase in capacity, so as to at once lead to that economy in fuel consumption which we have been in search of for so many years.

In my previous letters on this question I have explained how this can be done. I shall be glad if any correspondent will now point out in what manner I am deceiving myself, or trying to mislead others into the belief that such a radical improvement can be effected in the modern locomotive.

Argaith, Dumbreck. JOHN RIEKIE.

SELF-OPENING DIE HEAD FOR CAPSTAN AND TURRET LATHES.

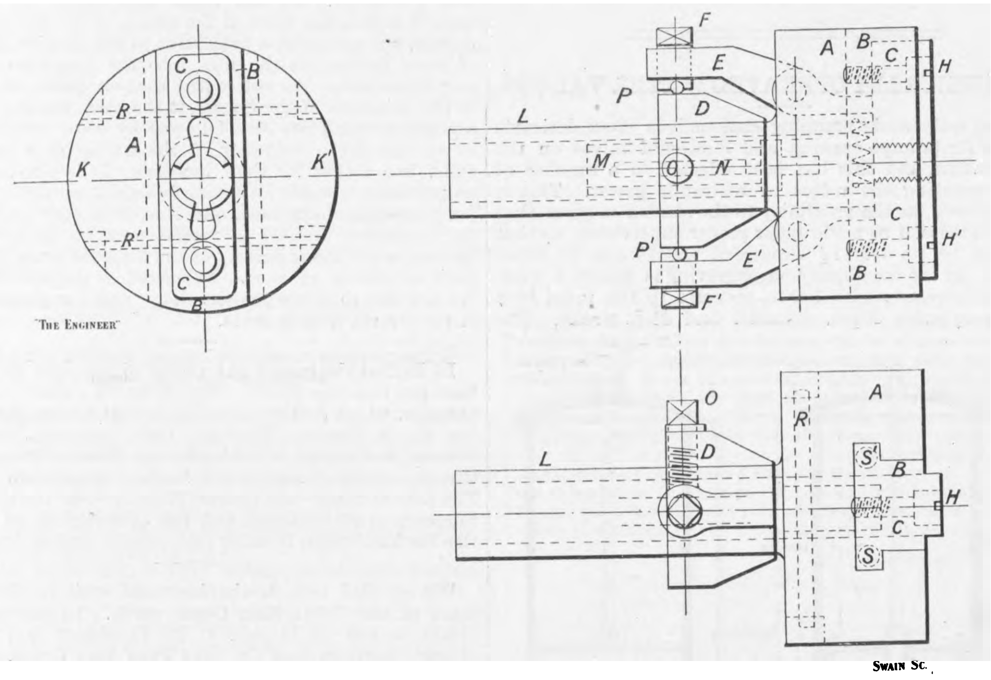
SIR,—The accompanying sketch, Fig. 1, shows a very simple, compact, strong and efficient die head, which I designed for use in capstan and turret lathes in place of the geometric and solid round die supplied with the lathes. There are no complicated or delicate parts to get out of order, and the screw dies are much easier to grind than the round die.

A is the body—mild steel made from a scrap piece of steel cut off a crank—and milled out with T slot to receive the shoes. B B are shoes milled out with end mill to receive screw die. C C are screw dies ranging in size from ⅛in. to ¾in. diameter. E E are two bell-crank levers (cast steel) pivoted on pivots R and R^1, and provided with two set pins $F\,F^1$ for adjusting size of cut or die. $H\,H^1$ are set pins holding dies in shoes $B\,B^1$. $S\,S^1$ are two small spiral springs —which are shown in two left-hand views—to assist the die opening when the levers E E are released by the cone D. D is hardened cast steel cone for holding dies in position while cutting, M is hardened steel stop which is attached to cone D by set pin O, and working in slot N in the shank L, L shank turned to fit capstan.

To operate the die head, the cone D is pressed up by finger in position as shown, and the levers $E\,E^1$ are adjusted by the set pins $F\,F_1$ until the dies are correct size to gauge, and the stopper M set to correct length it is desired to screw. The cut is then put on, and when the stock presses against the end of the stop M, the cone D is forced back and releases the levers $E\,E^1$ and the set pin $F\,F^1$—which have a ¼in. hardened steel ball in the end P P—run down the cone and release the die, when the die head can be instantly withdrawn.

The die head is very simple to work, and consisting of very few parts, is very easy to set and cheap to make. I made six of these die heads for use on capstans and turret lathes working on brass and steel, at an average cost of 26s. each, and they gave every satisfaction.

July 14th. H. MAPLETHORPE.



SELF-OPENING DIE HEAD

JET CONDENSERS.

SIR,—Referring to your interesting leader on the above subject, the last generation, as you state, were very much alive to the importance of obtaining high vacua. The writer was familiar as a boy with two compound jet-condensing engines used to drive a flour mill, one being of the beam type with vertical bucket air pump, whilst the other was horizontal and fitted with a double-acting plunger pump. The beam engine ran at 60 revolutions per minute, and the horizontal at exactly double this speed; 28in. to 28½in. of vacuum were regularly carried in both condensers, 29in. being occasionally reached, and as the gauges were of the mercury type these figures may be taken as accurately representing the pressure in the condensers.

Another interesting feature about these engines was the situation of the high-pressure cylinders, which were placed inside the low, the latter having ring pistons with two rods.

The present generation of engineers is inclined to favour the carrying of a lower vacuum for the sake of increasing the temperature of the feed-water, 25in. to 26in. being customary.

Obviously there is a point above which it will not pay to go owing to the size of the air pumps necessary, and the difficulty of getting the steam through the exhaust ports fast enough, this latter feature being accentuated in the high-speed engine; but theory, and, in the writer's opinion, practice, both show a saving in fuel up to at least 28in., provided that the exhaust passages are of the proper size. It must be remembered that only 10 to 20 per cent. of the heat returned to the boiler in the hotter feed-water is transformed into useful work by the engine, whereas a higher vacuum has a direct effect upon the low-pressure piston, the only losses incurred being the extra load on the air pump and the throttling in the exhaust passages.

This matter could easily be settled by experiment, and some of our newer technical colleges possessing the necessary apparatus might well devote their attention to the subject.

W. O. HORSNAILL.

Ipswich, July 7th.

THE FIRST FOUR-CYLINDER "BALANCED" COMPOUND LOCOMOTIVE IN AMERICA.

SIR,—As a matter of historical accuracy, it would be interesting to know which was the first "balanced" compound locomotive built in America. My own opinion—it is open to correction—is that Mr. Geo. S. Strong's 4-4-2 four-cylinder "Balanced Compound No 1" was the first of its kind in the United States. The cylinders of this engine were all in line with the smoke-box, and the four connecting-rods drove on to the leading coupled axle. The revolving masses were counterbalanced by means of weights connected to the hubs of the wheels. The engine was built for the Pittsburg, Fort Wayne, and Chicago Railroad, but in what year I am uncertain—probably in 1896—seeing that Mr. Strong filed a patent relating to such an engine in January, 1895.

The four-cylinder "balanced" arrangement, however, does not appear to have "caught on" in the States till 1902, in which year the Baldwin Locomotive Works turned out their first engine of the type in question, since which a fairly large number of "balanced" compounds have been constructed in America. Previous to his compound "No. 1," Mr. Strong had designed other engines, which, so far as I know, were two-cylinder simples, and which, therefore, were not balanced in the sense in which the word is applicable to four-cylinder locomotives in which the reciprocating parts balance one another on either side.

F. W. BREWER.

London, N., July 10th.

THE MIDLAND INSTITUTE OF MINING, CIVIL, AND MECHANICAL ENGINEERS.—The annual meeting will be held at the Institute Rooms, St. James's-chambers, Church-street, Sheffield, at 3.30 p.m., on Thursday, July 22nd, next. The following paper will be read, or taken as read:—"Some Notes on the Working and Testing of Lock Coil Winding Ropes," by Mr. James Elce. The following papers will be open for discussion:—"Coal Dust to Date and its Treatment with Calcium Chloride," by Mr. Henry Hall, and "Damage to Surface Buildings caused by Underground Working," by Mr. W. Hay.

ELECTRIC LIGHTING ACTS, 1882 AND 1888.—With reference to the regulations made by the Board of Trade under the Electric Lighting Acts, 1882 and 1888, for securing the safety of the public and for ensuring a proper and sufficient supply of electrical energy, we are informed by the Board of Trade that regulations having recently been made by the Home-office for the generation, transformation, distribution, and use of electrical energy in premises under the Factory and Workshop Acts, 1901 and 1907, the Board have found it necessary to amend their regulations, so as to avoid overlapping between the regulations of the two departments. Some copies of the new regulations made by the Board of Trade have been sent to us, from which we note that from July 1st, 1909, except as to so much of any electrical station as was constructed before the 1st July, 1908, they take the place of the regulations previously made by the Board, and will after the 1st day of January, 1910, entirely supersede the last-mentioned regulations. Four forms have been sent to us which differ from one another as regards regulations for ensuring a proper and sufficient supply of energy in order to meet the different cases. Form 1, L A (P), is for a local authority in the provinces; 2, C (P), for a company in the provinces or in the City of London; 3, C (L), for a company in London, except as to the City; and 4, L A (L), is for a local authority in London.

AERONAUTICAL ENGINEERING.—The authorities of the Northampton Polytechnic Institute, Clerkenwell, E.C., have decided to establish at their institution a pioneer course of aëronautical engineering. It is proposed to put this course on the same footing as the already existing engineering courses of the Institute, and to extend it over several sessions if necessary. The work of the first session, which will commence towards the end of next September, will be divided into (1) Workshop calculations, (2) aëronautical lectures, (3) aëronautical drawing, (4) aëronautical laboratory work. The lectures in workshop calculations will deal with such mathematics as are necessary for a thorough understanding of the aëronautical lectures, in which will be examined the properties of the atmosphere, especially in the way they are affected by changes of temperature and pressure, the formation of air currents, the measurement of wind velocity, the laws of air resistance, &c. These lectures will also set forth the principles of both the airship and flying-machine, and explain many calculations connected with them. The most interesting, however, if not the most important, part of the first year's work in the proposed course of aëronautical engineering will be the laboratory work. The laboratory, which will be fitted with the necessary apparatuses, will be supplied with motive power by a 75-kilowatt electric motor, and in it experiments will be made to determine the laws of air resistance, and to test certain formulæ, such as those of Duchemin and Yoessel upon which the science of aëronautics is built. Numerous experiments will also be made to find the thrust under different conditions, and the efficiency of screw propellers of various diameters, pitches, cross sections, number of blades, &c. This first course of aëronautical engineering will be an evening one, and students of this branch of engineering will be required to devote at least six hours a week to its study.

THE EDUCATION OF ENGINEERS.—In concluding an address before the graduating class of the Missouri School of Mines recently, Dr. Calvin M. Woodward, Dean of Washington University Engineering Schools, said:—"I wish you personal success in a very high sense, and to that end I wish to impress upon you two things. I do not mean that you should study your work, go to the bottom of every problem you have to solve. You will do that anyway, if you are made of sound material capable of intense stress and a high elastic limit. The two things I emphasise are these:—(1) An inflexible determination never to endorse what you believe to be bad engineering. Let the temptation be ever so great, the bribe ever so fascinating, stand like a rock. Let the wind blow, let the rain descend, stand your ground! Some years ago I wrote in an album as a 'Maxim for Conduct': 'In matters of sentiment go with the stream; in matters of principle stand like a rock.' Carry that away with you. (2) Cultivate the graces and refinements of really good society. Acquire—unless you have it already—a perfect mastery of your mother tongue, and in leisure hours make yourself familiar with the masterpieces of literature and art. For ten or twelve years the late Professor John B. Johnson and I were members of a fortnightly club that studied the books which were well worth studying and discussing, from Homer to James Russell Lowell. Professor Johnson felt, and I feel, that those hours were full of the greatest profit and the keenest pleasure. Your influence in the world and the pleasure of your life will depend partly upon your engineering skill, but more upon your manners, your speech, and your breadth of culture. Too often in the past the engineer has been associated in the popular mind with a smoky chimney, greasy machinery, and bad English. Accordingly a recent writer, in urging a more generous course of study for technical students, says:—'It will be a sorry epitaph, that one was born a man and died an engineer.' Let your epitaph be:—'Here lies one who was born a common man and who died a great engineer.'"

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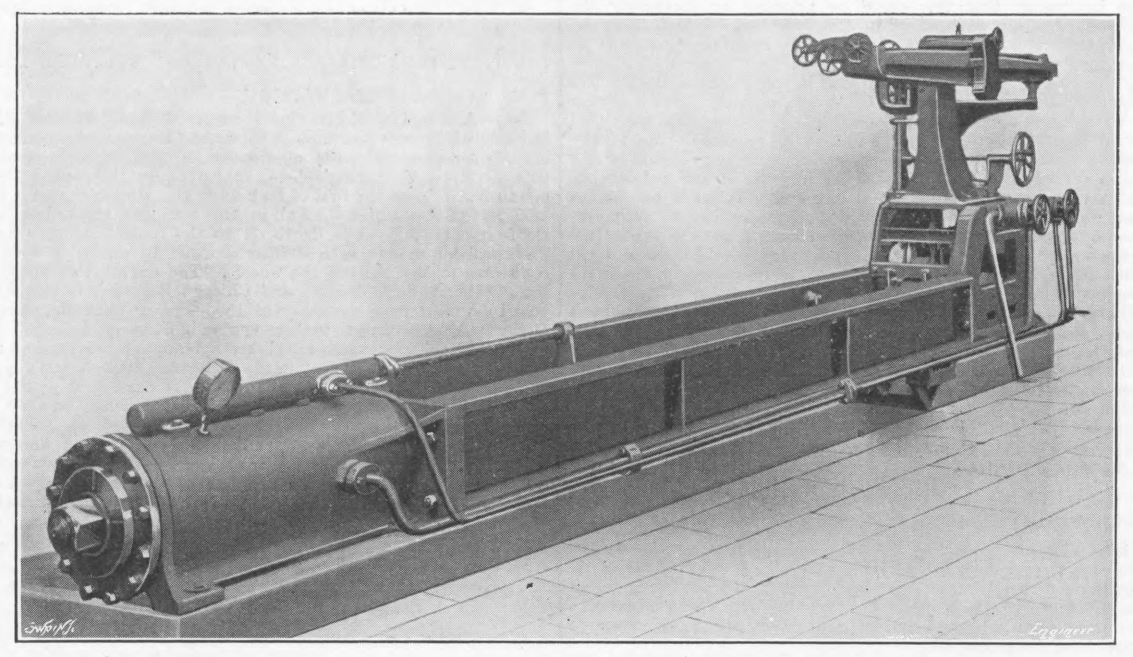
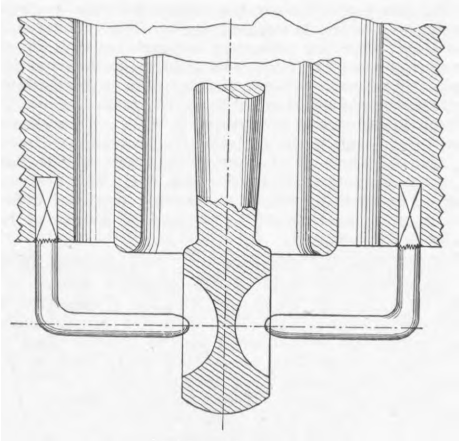


50-TON HYDRAULIC TESTING MACHINE.

THE hydraulic testing machine of which we give an illustration herewith has been built by the firm of Samuel Denison and Son, Limited, Hunslet Foundry, Leeds, for the Taikoo Dockyard and Engineering Company, Hong-Kong. It has been specially designed for applying proof loads to chains, wire ropes, rivets, and metal specimens, and has a capacity of 50 tons, the stress being applied to the object under test by means of a hydraulic ram and cylinder placed at one end of the machine. The water pressure required is 1000 lb. per square inch. The ram has a massive forged steel rod passing through it, with an open jaw end and pin secured by a nut, a forged steel central jaw with turned cotter being provided to take the other end of the object. The ram has a stroke of 36in. The recording end of the machine is carried on a cast iron base plate having box-pattern side frames mounted on it, and carrying the intermediate levers. The proof load is indicated by a steelyard graduated up to 50 tons, and carried above the side frames. The poise weight is moved along the steelyard by means of a screw operated by a hand wheel and suitable machine-cut gearing. The hydraulic control valves are fixed to the front of the machine frame. The side girders of the machine are of cast iron, with internal longitudinal rise to support a flooring, and a cast iron block plate is provided to carry the side girders and secure them to the floor. The clear length between the pulling jaws of the machine is 10ft. The ram is returned automatically to its normal position after each test by means of a subsidiary ram fixed on the main cylinder. The machine has been supplied with a complete equipment of links, dies, die boxes, blocks, &c., adapted to the various uses to which the machine is required.

A NEW SPARKING PLUG.

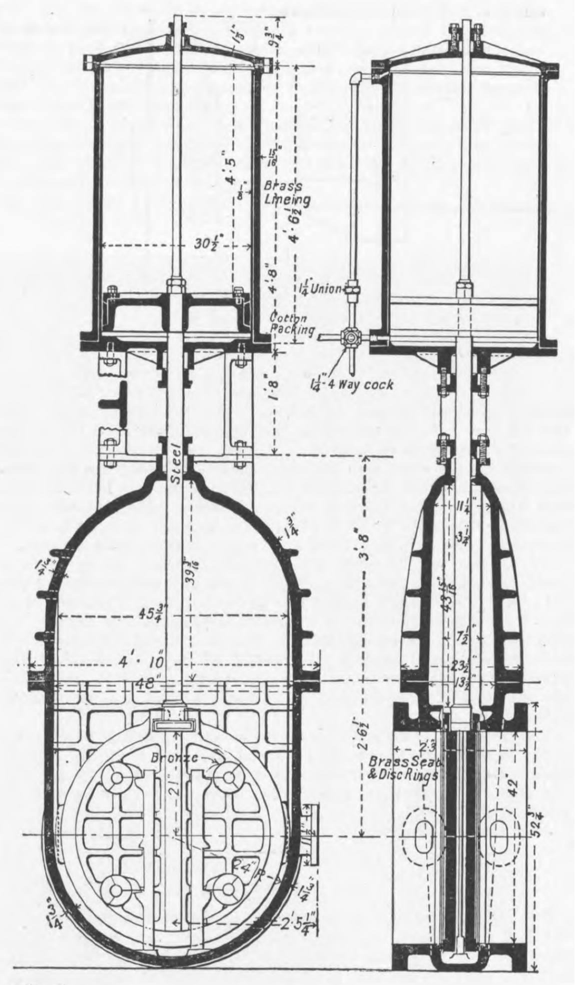
IN the majority of the sparking plugs with which motorists are familiar the sparks which ignite the explosive mixture in the cylinder pass across a gap between two points, which are liable to become fouled by soot and oil. In the latest form of plug one of these points is replaced by a cup-shaped recess by means of which the calorific property of the spark is claimed to be greatly intensified owing to the cup acting as a condenser. The accompanying sketch explains very clearly the arrangement of the electrodes of the "cup" plug, which is made by the Low Accessories and Ignition Co., Limited, 15, Great St. Helens, London, E.C. It will be observed that sparks are produced in two directions, and a detonative effect is produced by the shape of the cup. Experience has shown that the radius of the cup which gives the best results is 1.25 mm., or a little more than the maximum possible jump of the spark. Another feature of the plug is that there is not the usual screwed gland by which the porcelain is liable to be unduly stressed. On this account it should therefore be capable of withstanding rough usage. We have tested one of these plugs for some time in a four-cylinder motor car engine, and its operation was quite satisfactory. In order to verify the makers' claim we have passed current through the electrodes while these were immersed in lubricating oil, and there was no perceptible diminution in the strength of the sparks—a special advantage when used with heavy grades of fuel. The plug is substantially made, the body being of nickel steel highly finished.



SPARKING PLUG

HYDRAULICALLY OPERATED WATER VALVES.

AT large waterworks pumping stations it is often desirable to provide for prompt opening and closing of valves on the lead-out mains, and this has been effected in a number of cases by operating the valves by hydraulic power. This is reasonably safe, as the proximity to the station ensures that the operations will be made under proper supervision, so that there need be no fear of dangerous shocks due to water hammer. In the accompanying engraving is shown a 42in. gate valve operated under 100 lb. pressure in the main by a hydraulic cylinder 30½in. diameter and 45in. stroke. The cylinder is lined with bronze. The cylinder pressure is 40 lb.



"THE ENGINEER" Swain Sc

HYDRAULICALLY OPERATED WATER VALVE

The gate or valve is of the double-disc parallel-seat type. In opening, the first movement of the stem releases the cams between the discs, thus allowing the discs to close together and clear the falls before the travel of the gate commences. This prevents any grinding of the valve upon its seat. In closing, when the valve has completed its travel, the further movement of the stem operates the cams, which thus spread the discs apart and force them against their seats. A by-pass is provided, and is fitted with a 5in. gate valve. This valve has been built by the Kennedy Valve Company, of New York. It is obvious that the hydraulic cylinder can work at any angle with the vertical, which is most convenient. Frequently it is placed horizontally. Valves of this class are also operated electrically.

SHIPBUILDING NOTES.

AN interesting launch took place on the 5th inst. from the yard of Messrs. Osbourne, Graham and Co., Sunderland. The vessel in question—the Monitoria—is for the Ericsson Shipping Company, Newcastle, and is, with an important exception, as our readers may remember, an ordinary type of cargo steamer of dimensions 280ft. by 39ft. 10in. by 20ft. The exception referred to consists of two depressions of circular form which are worked in the hull of the vessel in the vicinity of the load and light lines. These depressions are about 12in. in depth, and extend for nearly the whole of the vessel's length, tapering gradually into the ordinary hull structure at the ends of the vessel. Looking at a section of the vessel, the side appears, therefore, corrugated, and is supported by a rather complicated arrangement of framing, consisting of ordinary bulb angle frames extending from the deck to the margin plate, together with supplementary frames of angle section, which afford local support to the corrugations in the shell plating. The two structural considerations which appeal to the observer standing on the tank top are the complexity before referred to, and, of course, the expense attendant upon it, and also the element of added longitudinal strength and local stiffness represented by the circular grooves. As regards the reason for so eccentric a departure as it appears at first sight from the ordinary well-known outline of the small cargo steamer, it is stated that the presence of these grooves in the positions indicated will, in actual practice, effect considerable economies of power. This, it is stated, has been demonstrated by experiments extending over a considerable period. We cannot see any ground for this expectation in the theory of the subject, and the result of the trials, when compared with the performance of the sister vessels, of which Messrs. Osbourne, Graham have built a number, will prove very interesting.

ON Friday, the 2nd inst., the revised rules of Lloyd's Register were despatched to the subscribers, and it has therefore been possible to make some detailed examination of the new provisions. On the whole they appear to have been framed with a due sense of the merits of the various types of vessels, and also with a perception of the relative importance of these factors which enter into the questions of strength and durability. We notice first that no reduction is allowed in the thickness of the frames at the ends, thereby approving a practice which has been followed by some owners. There is no case for a reduction of the frames of a vessel at the ends, but rather for their increase. It is also noticed that no provision is made for fitting bridges upon shelter decks, as has sometimes been done, and that it is very probable that an increasing number of vessels may be built with such bridges, since the ingenuity of the designer tends to take that path in which he is not hampered by definite regulations. We are glad to notice the simplicity and increased efficiency of the riveted attachments.

IN Belfast the last of the Orient liners—the Orvieto—has been put into the water. The Orvieto is a sister vessel to the Otranto, which had so successful a trial a fortnight ago. On the Clyde Messrs. Fairfield have launched the Oranje Nassau, the second of the high-class Channel steamers which they are constructing for the Zeeland Steamship Company. The first of these—the Prinses Juliana—was the subject of a reference in this column, and the construction of the third, the Mecklenburgh, is being very rapidly pushed forward.

WE are glad to note the increased activity observable in some of the North-East Coast yards. In addition to the orders booked by Messrs. J. L. Thompson and Sons, and Messrs. Bartram and Co., the Tyne Iron Company effect a restart of their works with the construction of a shelter deck steamer 360ft. in length. Messrs. Sir R. Dixon and Co. have also been commissioned to build two shelter deck vessels 360ft. in length, fitted with the well-known top-side tanks associated with the name of that builder, and Messrs. Ropner have booked two orders of 5000 tons each. It is to be hoped that these orders, which alone among recent contracts indicate any renewed demand for the construction of merchant tonnage, may yet further increase.

THE Vespasian, a vessel 293ft. by 39ft. by 21ft. 1in., and of the ordinary tramp type, is one which will engage the attention of not a few engineers and shipbuilders in the near future. This vessel, which has been bought by the Parsons Marine Turbine Company for experimental purposes, recently sailed from the Tyne with a coal cargo for Mediterranean ports. On board is a competent staff who will be engaged in collecting, in a scientific manner, information regarding the general efficiency of her present reciprocating machinery. After full information has been obtained, these engines will be replaced by turbine machinery specially designed for economical working at low speeds. The object, of course, is to collate the two sets of data, and whatever may be the ultimate outcome of the comparison, Messrs. Parsons deserve nothing but praise for undertaking it in so thorough a manner.

INSTITUTE OF MARINE ENGINEERS.—Visit to the Imperial International Exhibition on Saturday, July 24th, when Mr. Robert Balfour, member, will read a paper on "Refrigerating Installations, with special reference to the Arrangements necessary when Narrow Limits of Temperature are required," in the Congress Hall, near the Cascade, at 7 p.m. The Hon. William Hall-Jones, High Commissioner for New Zealand, will preside.

PARIS-ORLEANS RAILWAY.—From the Art Publishing Company, Oswaldestre House, 34 and 35, Norfolk-street, Strand, W.C., we have received an excellent little booklet describing the various historic and romantic parts served by the Paris-Orleans Railway, comprising an extensive district which constitutes one of the most fertile portions of France. Besides being of value to the tourist, it also appeals to engineers and others interested in railways, for a considerable amount of information is given regarding the rolling stock, &c., of the Paris-Orleans Railway. A chapter is devoted to the primitive methods of travel in France in the days of Napoleon I., and the comfort and luxuries that the Paris-Orleans Railway Company is offering to travellers at the present time by its extensive system. Considerable space is devoted to the Pyrenees with their picturesque slopes stretching to the Atlantic Ocean in fan-like shape, and those districts known as the Auvergne and the Cantal with their volcanic ranges, peaks, and valleys. The book is admirably illustrated, and constitutes most useful and interesting publication.

AUSTRALIAN NOTES.

(*From our own Correspondent.*)

Dredging the Northern rivers in New South Wales.—Heavy work is still being undertaken in keeping the rivers from shoaling. A proposal has been further considered for the construction of a breakwater at the Clarence River. The Engineer-in-Chief for Harbours and Rivers recommends that a dredging experiment be carried out, as was done at Natal, South Africa, by dredging a hole in the vicinity of the bar, in order to stop the drifting sand. It is considered advisable to have this work done at once. The above tables are given showing the work done during the past year by the dredges in the service of the Harbours and Rivers Department.

Combined Grab and Sand-pump Dredge Expenditure.—Year ending 30th June, 1908.

Dredge.	Where working.	Material lifted.	Tons lifted.	Hours dredging.	Expenditure.	Cost per ton.	Cost per hour dredging.
					£ s. d.	d.	£ s. d.
Gamma	Cook's River	Sand, mud, stone	45,756	390	577 15 6	3.03	1 9 7
Delta	Myall River, &c.	Sand, clay, and shell	125,520	1531	2077 17 9	3.97	1 7 2
Eta	Moruya River	Sand and shingle	148,464	1498	1522 2 9	2.47	1 0 4
Theta	Camden Haven	Sand	142,160	1479	1661 2 4	2.80	1 2 6
Sigma	Tweed River	Sand, mud, and clay	67,150	2671	1652 1 6	5.90	0 12 4
Rho	Bellinger River	Sand	80,317	12[illegible]9	1660 12 3	4.9[illegible]	1 5 7
Tau	Nambucca River	Sand, shell, gravel	129,263	1439	1901 8 11	3.53	1 6 5

Grab Dredge Expenditure.—Year ending 30th June, 1908.

Dredge.	Where working.	Material lifted.	Tons lifted.	Hours dredging.	Expenditure.	Cost per ton.	Cost per hour dredging.
Beta	Myall River	Sand and mud	32,619	1185	951 5 10	7.00	0 15 1
Iota	Nambucca River	Gravel	9,092	459	425 11 11	11.23	0 18 6
Mu	Richmond River	Sand and gravel	23,540	1242	1109 4 5	11.31	0 17 10
Nu	Newcastle	Rock, sand, clay	38,000	4147	1507 19 11	9.52	0 7 3
Omega	Clarence River	Hard sand	19,850	742	244 5 1	2.95	0 6 7
Upsilon	Newcastle	Sand, stones, &c.	57,215	3278	1574 19 5	6.61	0 9 7
No. 52	Richmond River	Hard sand and weeds	14,710	1291	649 8 0	10.59	0 10 1

Ladder Dredge Expenditure for Twelve Months ending 30th June, 1908.

Dredge.	Where working.	Material lifted.	Tons lifted.	Hours dredging.	Expenditure.	Cost per ton.	Cost per hour dredging.
Samson	Newcastle	Mud and sand	499,880	2398	3347 5 5	1.80	1 7 6
Newcastle	,,	Mud and sand	489,250	2078	4480 18 2	2.44	2 3 1
Hunter	,,	Sand and stone	144,280	1930	2930 0 4	4.87	1 10 4
Minos	Clarence River	Mud, sand, and clay	185,220	1767	2179 2 9	2.93	1 4 7

Sand-pump Dredge Expenditure for Twelve Months ending 30th June, 1908.

Dredge.	Where working.	Material lifted.	Tons lifted.	Hours dredging.	Expenditure.	Cost per ton.	Cost per hour dredging.
Glaucus	Newcastle	Sand	1,051,000	1035	4439 4 9	1.01	4 5 9
Neptune	,,	Sand and mud	263,000	616	2804 7 11	2.56	4 11 1
Juno	,,	Sand	205,000	649	2735 16 3	3.20	4 4 3
Jupiter	,,	Sand	360,000	470	6792 8 9	4.53	14 9 0
Castor	,,	Sand, mud, clay, shell	625,101	2165	5648 3 6	2.17	2 12 2
Antleon	Northern rivers	Sand	250,750	597	5952 12 5	5.70	9 19 5
Tethys	,, ,,	Sand, shell, and shingle	374,090	811	5919 3 5	3.80	7 6 0

STEAM TURBINES FROM THE USERS' POINT OF VIEW.*

BRIEFLY, the present situation of the steam turbine industry is a battle for supremacy between the Impulse and Reaction types, and while the partisans of each type claim all sorts of wonderful advantages which the other does not possess, yet the following statements are put forward as representing the point of view of a user who has studied the problem from all sides.

(1) All turbines must fulfil a certain law of combination of blade speed, and number of running rows.

(2) Steam expanding between boiler pressure and condenser must generate a certain velocity, and this velocity must be imparted to the revolving mass in small increments as in the Parsons machine, entailing many rows of blades, or in larger increments, as in the Zoelly or Curtis machines, or in one increment as in the Laval.

(3) The fewer the rows of running blades, the higher must be the speed at which the blades run, and consequently the higher the speed of the steam impinging on the blades.

(4) The Impulse type turbine runs at a much higher speed at blading than the Reaction type, and necessitates particular attention being given to the design of the wheels and blades, owing to the greater stresses that prevail.

(5) The Impulse type turbine lends itself to a more mechanical-looking construction than the Reaction type.

(6) The Reaction type, as illustrated by the best Parsons type, is more economical than the Impulse type.

(7) For speeds of 3000 revolutions per minute and below 1000 kilowatts the Impulse type is better than the Reaction.

(8) For speeds of 1500 revolutions per minute and up to 3000 kilowatts the Reaction type has, up to the present, proved most satisfactory.

(9) For speeds of 1000 and 750 revolutions per minute, and up to the largest sizes likely to be used, there is absolutely no evidence that the Impulse type can compete in reliability or economy with the Parsons type.

Turbine outputs and speed.—Too little attention is given nowadays to selecting an efficient combination of power and speed, although the latter is such an important point, from every point of view. Take two instances:—1, 750 kilowatts on 50 cycle; 2, 1500 kilowatts on 40 cycle.

Case 1.—The periodicity being 50, only two speeds can be considered, viz.:—3000 revolutions per minute with a two-pole machine, or 1500 revolutions per minute with a four-pole machine. Many engineers have selected the slower speed in putting down their installations, but there is no argument in reason which can be given against the higher speed of 3000 revolutions per minute, as the high speed set will be:—(1) More economical by about 10 per cent. (2) Take up less floor space. (3) Be about 15 per cent. cheaper in first cost.

The same remarks apply to case 2, where of the two speeds of 2400 revolutions per minute and 1200 revolutions per minute, it is an uncommercial proceeding to put in the slow-speed set.

A very good rule to follow, and one which should be insisted on, is:—Choose the size of your unit to suit the highest speed that the periodicity will allow, and here the assistance to be obtained from external fan cooling of the generator should not be overlooked, because the higher the speed at which the set is run, the greater the benefits which will be obtained from a turbine installation.

At Sunderland, we have a 1500 revolutions per minute Willans-Dick, Kerr combination, installed to carry a load of 2000 kilowatts continuously, and 2500 kilowatts for two hours, and the economies effected by this plant have been most pronounced, as is very practically exemplified by the fact that with the present normal works day load, amounting to about 2300 kilowatts on the turbine, two boilers will easily steam the turbine, but upon changing over to three modern high-speed reciprocating engines of about 700 kilowatts capacity each, it is impossible to hold the steam without substantial assistance from a third boiler, and we always hold additional boilers banked against the contingency of a failure of the turbine plant.

For direct-current turbo sets, the merits of the Tandem machine must not be lost sight of. For a given size unit, the advantages accruing from tandem machines are many; for instance:—(1) By putting in tandem generators, the speed of the set can be increased by about 75 per cent. with all the attendant advantages, as already pointed out; (2) the electrical portion being divided into two, there is only 50 per cent. of the machine out of commission should troubles of any sort arise.

Turbines v. reciprocating engines.—It is often a subject of some concern to an engineer to decide at what size of unit it becomes advisable to adopt turbines in preference to reciprocating engines; a general statement which has been made very frequently is, that above 750 kilowatts as a unit use turbines, below 750 kilowatts use engines. It is, however, impossible to draw any definite line of demarcation, as so much depends upon the available conditions, and the requirements. For instance, the temperature and quantity of circulating water affects the situation very seriously, and must be taken into consideration, as regards both capital and running costs, before any decision can be arrived at. Every case calls for a detailed investigation, which it will repay to make thoroughly. There is, however, not the slightest doubt that with the higher speeds at which it is now possible to run turbo-generators, the proposition of turbines *versus* engines will soon disappear, and it will be a case of turbines only; in fact, it is even now difficult to prove a case for the reciprocating engine under any ordinary conditions. The Brush Company, who have made a speciality of small turbo-generator sets, give the following typical figures for a 300-kilowatt plant. Steam consumption in pounds of steam per kilowatt hour with steam at 160 lb. per square inch:—

	Dry steam.	With 100 deg. superheat.
Reciprocating engine, 26in. vacuum	24	20½
Turbines, 28in. vacuum	22	19¾

while the capital cost of the two plants complete with condensers is practically the same.

Granting that capital and steam costs are equal upon so small a unit, and taking into consideration the undeniable advantages the turbine has in cost of oil and general upkeep, it does indeed appear that the reciprocating plant has only a small field left, except upon sites where the facilities for obtaining cooling water are exceptionally bad.

Selection of conditions for turbine installation.—This can be summed up in few words.

(1) 150 lb. per square inch steam pressure	Because at pressures above 150 lb. per square inch, the volume becomes small and leakage percentages are increased, with only a small gain in B.T.U.'s available.
(2) 150 deg. superheat	Because there is no appreciable gain in plant over-all economy above 150 deg. superheat.
(3) Highest possible speed ...	Already commented on.
(4) Best vacuum possible	Because it is the strongest feature in turbine working, and it will pay to maintain as high a vacuum as possible.

Condensing equipment and vacuum.—As mentioned above, the condensing plant is the most important detail of the plant, and yet, how often is it neglected, or, one should say, not paid sufficient attention to. A vacuum should be selected with an equivalent temperature about 25 deg. above the available temperature of circulating water, and this gives a commercially obtainable and maintainable vacuum. Having once obtained this, see that it is always maintained. If a vacuum of 28½in. can be obtained, never let it drop to 27½in., which it will easily do with a little inattention and neglect of glands, joints, sluice and automatic valves, &c. &c.

As regards types of condensing plant in use, this again depends on circumstances. There are three main types:—(1) Surface, (2) Low level jet, (3) Barometric. 1. Surface can be subdivided as follows:—(*a*) Ordinary, viz., generally consisting of surface condenser, air pump and circulating pump. (*b*) Parson's augmentor surface, which is as in (*a*) with the addition of a steam jet and auxiliary condenser, which allows smaller cooling surface, and less circulating water to be employed. Further, the hotwell temperature is higher than with (*a*). This is, in the writer's opinion, undoubtedly the best form of surface condensing plant. (*c*) Counter-current, an arrangement of (*a*) with compartment drainage. From the point of general works economy, as a rule, the capital cost of surface condensing plant will be rather higher than either jet or barometric condensers.

2. Jet condensers are made in many highly successful ways, and require, if anything, rather more power than surface plants.

3. *Barometric condensers.*—A very satisfactory form of plant, provided every precaution is taken to prevent air leakage, and ample passage way given to steam and water. The power taken for pumping is, however, slightly in excess of other types of condensing plant, but from the writer's experience it makes a very satisfactory installation. A great point is the uniformity of the vacuum which can be maintained owing to the absence of cooling surfaces which become dirty and therefore inefficient. In some cases no air pump is installed, but where a high vacuum is essential a really powerful dry air pump is necessary.

Reliability of turbines as prime movers.—Sunderland experience has shown the Willans-Parsons turbine to be absolutely trustworthy. For over sixteen months the bulk of the work has been done by the 2000 kilowatt turbine plant of this make, running at 1500 revolutions per minute, and during the year ending March 31st last, the total units generated in the works were 9,207,227, of which no less than 8,009,000, or 87 per cent. of the whole output was generated by the one turbine plant.

This turbine has, with very few exceptions been put on load every Sunday at noon, and has run through without any stop until the following Sunday at about 1 a.m. During the night the load drops, as a rule, to about 400 kilowatts, and the day peaks have been about 2300 kilowatts: when this has been exceeded, one or more 700-kilowatt reciprocating sets have been paralleled. Throughout the day the work has consisted of about three-quarters shipyard and one-quarter tramway load, and it is of a very fluctuating character.

Maintenance of turbine plant.—The writer is of the opinion that maintenance costs on steam-turbine plant—consisting of turbine, alternator and condensing plant complete—should not exceed, say, £100 per annum per 10,000,000 units generated, and if careful record were taken in some of the larger turbine works, and fair maintenance debits were allocated against units generated, it would be found in many cases less than this amount. As a matter of fact, the maintenance of the Sunderland 2000-kilowatt plant for the year ending March 31st last, including opening the turbine twice to measure clearances, came to less than £35, and while it is true that the set was under the contractor's maintenance, a detailed and careful check was taken of all that was done to the plant, including the renewal of exciter brushes, &c., and the figure given is a liberal allowance of what it would cost the corporation to do the same work, although the contractors will have expended more than this, by reason of men's travelling expenses and out-money. The Sunderland turbine exhausts into a barometric condenser, and it is probable that the maintenance costs would be greater upon a surface condensing plant. As regards wear upon the turbine itself, it appears to be negligible, and most careful examination has failed to reveal any signs of blade erosion.

Exhaust steam turbines.—The advantages of the application of the exhaust steam turbine do not appear to be fully appreciated, even at the present time. As compared with a high-pressure turbine, an exhaust steam set requires about double the steam, and the gain due to high vacua is more than twice as great. The machine can be of robust construction owing to there being no necessity for fine clearances, and, moreover, the temperature distortions are small. The Impulse type can be of very simple construction for exhaust steam working, but does not, upon the other hand, lend itself so well to economical working as the Reaction type, as it works with higher steam velocities, and if the steam is wet, as is usual, the friction losses due to this cause are high.

Economies to be obtained from turbines.—Sunderland experience shows the cost of working with turbine plant to be much lower than with reciprocating engines. The writer has already dealt with maintenance costs, and as regards steam consumption it has been argued against the steam turbine that it does not maintain its economy, but the following experience of the writer's shows that good results can be maintained after the hardest work. The 2000-kilowatt Willans-Parsons set installed at Hylton-road was tested on setting to work, and again on the expiration of one year and two months' work, during which time the plant ran over 9000 hours, and generated over nine million units. The steam consumption on a 27½in. vacuum was 17.07 lb. of steam per unit on one test, and 17.1 lb. of steam per unit on the other. As regards oil, which was logged separately from the other plant, the total cost for the year ending March last was, for the turbine £13 8s., and for the turbine auxiliaries £18 8s. 6d., a total of £31 16s. 6d., equivalent to .000953 of a penny per unit generated. It would be difficult to claim such a record of maintained economy for any prime mover other than the steam turbine.

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* Abstract of paper read by Mr. Alfred S. Blackman, Borough Electrical Engineer and Manager, Sunderland, before the Incorporated Electrical Association.

YIELD OF WATER, RAINFALL, ETC., ON A MOORLAND WATERSHED.*

By S. HUTTON, Surveyor and Water Engineer, Exmouth.

THE noting of the yield of watersheds has up to the present not been universally carried out, and the figures and particulars given will be therefore, though over a comparatively small area, of service in calculating for gravitation water schemes for towns, say, up to 15,000 population. The water supply of Exmouth is derived by gravitation from two distinct watersheds within five miles of the town and one mile inland, west of the English Channel. The areas deliver their waters into an impounding reservoir of 12½ million gallons capacity, the Squabmoor area direct and the Bicton area by a pipe line.

Details of watersheds.—The two watersheds are respectively known as the Squabmoor and Bicton areas. The acreage of the former is 351 acres, 202 of which is common, 75 acres plantations, and 74 acres pasture and arable land. The Bicton portion comprises 290 acres, entirely common land. In addition to these two areas are two smaller portions, one of which is 41 acres, surrounding and draining straight into the reservoir; the other is an area of 35 acres on the town side of the reservoir, and which partially drains straight into the trunk main by two connections, and partially back into the reservoir. The water from the 41 acres is always available, but from part of the 35 acres only when the reservoir drops 3ft. below T.W. level.

Geological features.—The general formation consists, first of all, on the surface, a layer of sand and gravel. Below that there comes about 100ft. of sandstone, more or less of the nature of very loose materials with pebbles in it. Down below that there are the impervious red marls of permian formation. These rocks—the permians and pebble beds—are inclined at an angle dipping eastward, and the valleys of the areas are cut through the superficial pebble beds into the impervious marls below. The rain which falls on the pebble beds sinks into the top surface readily, and gradually finds its way through until it comes to the marls—which are practically at the surface in the valley itself—and these pay out into the stream. These beds are therefore practically storage areas, and hold up the water for months, paying it out in remarkably equable flows, most especially from the Bicton watershed.

Elevation.—The highest point of the Bicton area reaches the 550 contour, and the water is intercepted as low as 270 O.D. The summit of the Squabmoor area is 500 contour, and the top water-level of the reservoir is 264.20 O.D.

Rainfall evaporation and yield.—The period over which these observations of rainfall and yield were taken was for three years, September 1st, 1904, to August 31st, 1907. The evaporation from water surface was taken for the two later years of the above period.

Rainfall.—The true test of the capacity of a watershed and upon which the amount of storage depends is stated by authorities to be its yield in three successive dry years; that is, three years in which the rainfall averages only 80 per cent. of the average rainfall over a long series of years. Further, the driest year that can possibly happen is one in which only 66 per cent. of the average rain falls. At the purchase arbitration in 1901 Dr. Sowerby Wallis, in absence of actual figures on the watershed itself, said, by averaging a large number of stations in the vicinity, that the result showed the rainfall for the Exmouth watersheds to be as follows:—

No. 1.	Average over a long series of years	35in.
No. 2.	Average over the three driest successive years	28in.
No. 3.	In the driest year	23in.

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* Abstract of a paper read before the Incorporated Association of Municipal and County Engineers at its thirty-sixth annual meeting, June, 1909.

As regards the second of these estimates, the figures worked out as follows:—

Year ending August 31st, 1905	24.44in.
,, ,, 1906	28.03in.
,, ,, 1907	25.05in.
Average for the three years	25.84in.

The average of three dry years for these watersheds is thus somewhat well established, and as the 35in.—No. 1—was fixed by Dr. Wallis after very careful calculation, it seems open to question whether it is safe in all cases to rely on as much as 80 per cent. during the three driest successive years, the case under notice giving about 74 per cent. It is, however, possibly a question of locality rather than upsetting a well-relied-upon rule, as the rainfall of the Dewsbury watersheds, near Penistone, Yorks—which waterworks the author was associated with some nine years ago—give an average over forty years—1862 to 1901—of 49 88in., with the average of three driest successive years 41.16in , 82.3 per cent.; the driest year, the first of the three driest under notice, gives only 30.25in., 62 per cent , against the rule of 66 per cent.

In passing from the subject of rainfall, it will be, perhaps, wise to say why I have finished the period under review at the 31st of August. In most cases it seems to be the rule to end the periods at the end of the year—December 31st. I think, however, that the period of years of dryness should end with the summer season, not three months after, as rain might fall in the autumn period, which, though perhaps balancing up the rainfall, is of no use for a drought in the summer just immediately passed. This point is, of course, very much open to argument, but in a case where the storage is small there is something in it.

Evaporation.—Evaporation from the water surface was recorded in the two later years on a standard tank 6ft. by 6ft. by 2ft. deep, sunk into the ground, and by referring to Table I. it will be seen that it almost could be taken as the amount lost, as there is not much difference between the actual yield, plus evaporation, and the actual rainfall. It does not follow that the two should agree, as, on a watershed of gravel, percolation is fairly quick, and an increase over the rainfall is shown when the yield and evaporation are added together.

TABLE I.—*Squabmoor Area*, 351 *Acres.*

Year ending	Yield.	Daily average.	Rain.	Evaporation.	Rainfall yielded. Actual.		Consumption. Population 11,300 normal, Summer season 14,000.	Remarks.
					In.	Per cent.		
	Gallons.	Gallons.	In.	In.				
August 31st, 1905..	57,327,005	157,060	24.44	—	7.22	29.54	—	—
,, 1906..	50,431,593	138,169	28.03	22.11	6.33	22.58	—	—
,, 1907..	30,521,893	83,622	25.05	19.54	3.85	15.37	—	—
Bicton Area, 290 *Acres.*								
August 31st, 1905..	60,924,996	166,918	25.31	—	9.27	36.62	—	—
,, 1906..	55,680,984	152,551	27.99	22.11	8.48	30.30	—	—
,, 1907..	49,798,582	136,434	25.03	19.54	7.59	30.32	—	—
Whole Watershed, 717 *Acres.*								
August 31st, 1905..	124,702,412	341,649	24.87	—	8.08	32.49	106,140,395	Surplus
,, 1906..	114,468,431	313,612	28.01	22.11	7.42	26.49	104,621,000	Surplus early part of year
,, 1907..	92,780,852	254,195	25.04	19.54	5.72	22.84	99,967,500	Draw on storage

Yield.—The yield from the watersheds was ascertained by pretty accurate measurement, the Bicton area—290 acres—being by a Deacon meter, and the Squabmoor area—351 acres—over a 15in. notch gauge. The first year, with 24.44in. of rain, though the driest, followed after a wet year, and owing to the holding-up capacity of the pebble beds, the total yield was 124,702,000 gallons. The second year, with 28.03in. of rain, produced 114,460,000 gallons. The third year, again very dry, and the pebble beds thoroughly drained by the two previous dry years, with 24 77in. of rain, produced 92,780,000.

Proportion of rainfall yielded.—There are many books which state what may be expected from a catchment area, but there are some vital governing circumstances on this point. One cannot very dogmatically say that 20, 30 or 50 per cent. of the rainfall may be available, as there is in every case the evaporation to be deducted; this does not follow the rainfall exactly, but is more stationary than the yield. The point illustrated is this:—On a watershed with 50in. of rain one can expect, and will get, a larger percentage of yield than on an area where there is only 25in. of rain.

Yield, Bicton area.—On referring to Table I., it will be seen that the first year gives a yield of 36.62 per cent. of the rainfall, the second year 30.30 per cent., and the third year 30 32; the large amount for the first year was influenced by the rain of the previous year, as close personal observation of this area shows that no floods to any extent come off; in fact, the writer has been on the watershed after several hours' steady rain, and there has been no appreciable increase in the streams, which, owing to the very small storage reservoir, is most fortunate, and a valuable asset to the waterworks.

Yield, Squabmoor area—Table I. shows that the first year gives a yield of 29.54 per cent. of the rainfall, the second year 22 58 per cent., and the third year 15.37 per cent. This watershed showed a much larger falling off than the Bicton area, though the geologists describe it as a similar ground; yet I can hardly agree that it is. It gives off larger flows in wet weather, and drops much lower in dry weather. There are, however, a few circumstances that might explain the matter:—First, two large country mansions derive their supply from the stream—by pumping—before it reaches the reservoir; secondly, there is a fair length of metalled roadway across the watershed; and, thirdly, there are 78 acres of cultivated land and pasture. These disturbing elements do not account for a large percentage. There is a geological fault through the valley running right out to the sea. This might serve as a reason, but I am not sufficiently expert as a geologist to express a firm opinion.

The figures given in the table show the net results obtained, which have entailed an immense amount of labour in arranging, summarising, &c. Each day's delivery had to be worked out separately. The figures for the whole watershed include the two ungauged areas of 41 acres and 35 acres, and are arrived at by adding to the consumption the overflow gauged at the reservoir, or by deducting from consumption the amount drawn from storage.

CATALOGUES.

JOSEPH ASH AND SON, Rea-street South, Birmingham.—This firm has sent us its latest price lists of tanks, cisterns, and riveted hot-water cylinders.

THE BALDWIN LOCOMOTIVE WORKS, Philadelphia, U.S.A.—Record No. 66, which has reference to the Baldwin smoke-box superheater, has reached us.

H. AND C. GRAYSON, Limited, 21, Water-street, Liverpool.—This is a little pamphlet giving particulars of this company's standard engines for petrol or paraffin.

THE MACHINE TOOL COMPANY, Limited, London-road, Nottingham.—From this company we have received a catalogue dealing with new and second-hand machine tools.

CLAYTON AND CO., Union Works, Huddersfield.—A well got up pamphlet has been sent to us, which contains descriptions and illustrations of the standard types of "Karrier" cars for commercial purposes.

JOHN RUSSELL AND CO, Limited, Walsall.—A little booklet which contains useful information on flanges and branches, welded-on pipes for steam pipe installations; also hydraulic data, &c.

KYNOCH, Limited, Lion Works, Witton, Birmingham.—This company has sent us a booklet dealing with Kynoch steel castings. It contains illustrations and particulars of various kinds of castings as turned out by this company.

THE CARL SCHENCK COMPANY, Darmstadt.—This is a well got up pamphlet, dealing with the Schenck's patented conveyor for curves and twists. The conveyor is fully described and illustrated, and the pamphlet also contains some testimonials.

THE HUDSON ECONOMISER COMPANY, Gloucester House, 2, Bishopsgate-street Without.—A new catalogue has reached us. It deals with the Hudson system of feed-water heating, &c. The catalogue is well got up, and it should prove of interest to steam users.

J. CHRISTOPHER AND SONS, 39, Clerkenwell-road, London, E.C.—This is a catalogue dealing with power transmission appliances, such as pulleys, shafting, and so forth. It also has reference to engineers' stores and hoisting appliances. The catalogue contains over 160 pages.

W. H. A. ROBERTSON AND CO., Lynton Works, Bedford.—This is a catalogue which has reference to auxiliary rolling mill machinery. It is a well got up little publication, and contains much information which should prove of interest to those associated with rolling mill work.

KOLIN BROTHERS: Agent, H. SPANNAGEL, Broad-street House, New Broad-street, London, E.C.—This firm has just issued a supplementary catalogue containing illustrations of its latest productions. It gives illustrations of some large gas and steam engines, a tin-plate bar mill, electrically driven shears, an air compressor, a plate straightening machine, &c.

REVY PHILLIPS AND CO., Limited, Bridge House, 181, Queen Victoria-street, London, E.C.—A sectional catalogue has been sent to us which deals with cooking apparatus. We have also received two pamphlets. One has reference to the "Reliance" automatic boiler, and the other deals with the "Revy" patented silent boiling nozzle for heating or boiling water or other liquids.

BABCOCK AND WILCOX, Limited, Oriel House, Farringdon-street, London, E.C.—A tasteful little booklet to hand from this company has reference to this company's manufactures. It illustrates the various types of Babcock boilers, and gives particulars relating to them. It also deals with steel chimneys, feed-water heaters, steam and water piping, a gravity bucket conveyor, and cranes of the jib and overhead travelling types.

THE KEY ENGINEERING COMPANY, Limited, 4, Queen Victoria-street, Mansion House-buildings, E.C.—From this company we have received a circular dealing with the Key system of interior wiring. The principal feature of the Key system lies in the use of special joint-boxes, fitted with terminal blocks, by means of which any of the various connections and inter-connections required in standard wiring can be made without the use of a soldering iron, and, it is claimed, with much less risk of moisture permeating the insulation of the cables.

HALL AND PICKLES, 64, Port-street, Manchester.—The third edition of this company's catalogue is more than an ordinary catalogue, for it deals not only with the properties of individual sections, but shows at a glance their values in different combinations and enables a selection to be quickly made of the combination best suited for a specific purpose. The tables which the catalogue contains have been specially compiled for use by architects, engineers, and others associated with the design of constructional steel work. Two plates given at the end should prove particularly useful. The first shows at a glance the strength of girder webs, and the second provides aready means of comparing the economy of different types of stanchions. The catalogue iswell bound, and it is printed on good paper. It constitutes a useful reference book.

IT is claimed in England that William Murdoch was the first to extract gas from coal and to apply it for lighting purposes. The French have put in a claim on behalf of their fellow countryman, Philippe Lebon, but it is admitted that whereas Murdoch's discovery was made in 1792, Lebon did not discover coal gas until three years later. The Belgians, on the other hand, have, by the recent researches of M. Boghaert Vache, established that coal gas was in reality discovered in 1783 by Jean Pierre Minckelers, a Belgian physician. It seems to have come about in this wise. The Duke of Arenberg, who was an enthusiastic balloonist, requested three professors of the university of Louvain to find a gas lighter than hot air and less costly than hydrogen. Professor Minckelers was one of the scientists employed, and he had the good luck to extract the gas wanted from coal. In the middle of November of 1783 the first balloon inflated by coal gas ascended from the park of the Castle of Arenberg, at Heverle, near Louvain, and this important event has just been commemorated by the commune of Heverle by a balloon festival under the auspices of the Belgian Aëro Club.

THE IRON, COAL, AND GENERAL TRADES OF BIRMINGHAM, WOLVERHAMPTON, AND OTHER DISTRICTS.

(*From our own Correspondent.*)

Structural Steel Improved.

ENGINEERS recently have been placing more orders for structural steel, with the result that the position of makers is improved. Girder plates are quoted £5 15s. to £5 17s. 6d., angles £5 10s. to £5 15s., and mild steel engineering bars £6 7s. 6d. to £6 17s. 6d. The Patent Shaft and Axletree Company, of Wednesbury, is understood to have secured an order for China, in the face of severe competition, for 3500 tons of bridgework, which it is anticipated will be completed about the end of September. Sir Alfred Hickman, Limited, are credited with the intention of still further extending their works by laying down machinery for rolling plates and other heavy descriptions of steel.

Pig Iron Maintained.

Producers are better placed for work now that quarterly contracts have been renewed, and since fuel has a tendency towards greater dearness rather than—as usual in the summer—in an opposite direction, smelters are able to maintain quotations somewhat better than recently. At the same time some very low figures are occasionally named for Midland brands, such as 45s. or 45s. 6d. for Derbyshire foundry sorts, and 45s. 9d. for Lincolns. These rates are probably, however, exceptional. Open market quotations continue:—Staffordshire cinder forge, 46s.; part-mine, 48s. to 49s. 6d.; best all-mine, 80s. to 81s; cold blast, 110s.; Northamptons, 46s. to 47s.; and Derbyshire, 47s. 6d. to 48s. 6d.

Galvanised Iron: Increased Exports.

Although the home demand for galvanised sheets is quiet, the foreign and colonial inquiry is well maintained, and the Association quotation is continued at £12 10s. f.o.b. Liverpool for 24 w.g. in bundles. Satisfaction is expressed at the way the shipments are keeping up. The advance from last year to this year has been as follows for June:—From 29,240 tons to 35,563 tons, and from from 192,118 tons to 231,494 tons, and from £2,682,435 to £406,865 to £497,289. The advance for the six months has been £3,204,013. The Argentine Republic, Australia, South Africa, and Canada have all been purchasing better than last year throughout June. With reference to the six months, the following are the chief increases in quantities:—India, from 47,041 tons to 49,668 tons; the Argentine Republic, from 34,146 tons to 48,796 tons; and Australia, from 26,984 tons to 39,505 tons.

Other Descriptions of Manufactured Iron.

The best bar makers are well engaged, and still quote £8, with £8 12s. 6d. for Earl Dudley's "L.W.R.O." brand. Merchant and common bars are quiet and rates are elastic, the prevailing £6 quotation for the former being little more than nominal. Plain sheets, singles, are £7 2s. 6d. to £7 5s. For rivet iron £6 15s. to £7 is asked; and for gas strip, £6 5s. to £6 7s. 6d.

Warwickshire Coalowners.

At a meeting in Birmingham on Tuesday between the Warwickshire Coalowners' Association (which comprises 15 collieries) and the representatives of the miners, it was decided to refer the current dispute as to "snap" time to the Board of Trade for arbitration, work to proceed as usual meanwhile, and the men to be allowed, as a temporary concession, 20 minutes for "snap" time instead of the 15 minutes at first proposed.

NOTES FROM LANCASHIRE.

(*From our own Correspondent.*)

MANCHESTER, Thursday.

Business Still Slow.

THE attendance on the Iron Exchange on Tuesday was rather above the average, but business in pig iron was decidedly slow. Indeed, so far as this centre is concerned, the market was quite featureless and disappointing, especially to merchants. So far as the future is concerned, owing to the fuel question, there is absolutely nothing being done; but for prompt delivery merchants were competing strongly for the few orders which were being given out. As compared with last week, Middlesbrough is about 6d. lower, but other English, as well as Scotch, brands show little change. Owing to demand on spot for pipe making, Derbyshire iron keeps steady. Forge rules in buyers' favour.

Finished Iron and Steel.

There is little change in finished iron or structural steel. Foreign billets are dearer, and prices approximate more nearly to English than has been the case for a long time.

Copper, Lead, and Tin.

Manufactured copper was in quiet inquiry, and the tendency of prices was of a downward character. Lead: Sheets rather lower. Tin: English ingots were about 10s. lower as compared with last week.

Quotations.

Pig iron: Lincolnshire No. 3 foundry, 52s. to 52s. 6d.; Staffordshire, 51s. to 51s. 6d.; Derbyshire, 52s. 6d. to 53s.; Middlesbrough open brands, 56s. 9d. to 57s. Scotch: Gartsherrie, 58s; Glengarnock, 57s. 6d.; Eglinton, 56s. 9d. to 57s.; Dalmellington, 56s. 9d. to 57s., delivered Manchester; West Coast hematite, 58s.; East Coast ditto, 55s. 6d., both f.o.t. Delivered Heysham: Gartsherrie, 56s.; Glengarnock, 55s. 6d.; Eglinton, 54s. 9d. to 55s.; Dalmellington, 54s. 9d. to 55s. Delivered Preston: Gartsherrie, 57s.; Glengarnock, 56s. 6d.; Eglinton, 55s. 9d. to 56s.; Dalmellington, 55s. 9d. to 56s. Finished iron: Bars, £6 10s.; hoops, £7 12s. 6d.; sheets, £7 15s. to £8. Steel: Bars, £6 5s.; Lancashire hoops, £7 5s.; Staffordshire ditto, £6 17s. 6d. to £7; sheets, £7 17s. 6d. to £8; boiler plates, £7 2s. 6d.; plates for tank, girder, and bridge work, £6 to £6 5s.; English billets, £4 12s. 6d. to £4 17s. 6d.; foreign ditto, £4 10s. to £4 15s.; cold-drawn steel, £9 5s. to £9 10s. Copper: Sheets, £71; tough ingot, £61 10s. to £62; best selected, £61 10s. to £62 per ton; copper tubes, 8⅜d.; brass tubes, 6¾d.; condenser, 7¾d.; rolled brass, 6d.; brass wire, 6¼d.; brass turning rods, 6⅜d.; yellow metal, 6d. per lb. Sheet lead, £17 12s. 6d. per ton. English tin ingots, £129 10s. to £130 per ton.

The Lancashire Coal Trade.

There was a rather better attendance on the Coal Exchange on Tuesday, and speaking generally the tone was rather more cheerful in character than has been the case for some time past. Probably this is to be attributed to the diminished supplies from Yorkshire, Staffordshire, and other centres, owing to the disputes prevailing there. Of course, house coal was quiet, but for slack and steam coal the demand was better. Prices, however, showed no change.

BARROW-IN-FURNESS, Thursday.

Hematites.

There has again been much inactivity in the hematite iron trade this week, and business is not nearly so spirited as it has been of late. There has been a shrinkage in prices. Makers are quoting nominally 58s. net f.o.b., and warrant iron sellers are lower at 56s. 9d. net cash—a drop of 4½d. on the week. The indications rather point to a further shrinkage in prices, as some of the sources of the demand which has recently been experienced are expected to restrict their order sheets for the supply of metal. There is not the trade with makers of steel which was expected some time ago, and although a better business has been done of late with the Colonies and the Continent, it has not developed into a large trade, and it is not expected to do so until there is something like a general revival in trade. Stocks of warrant iron have shown an increase this week by 500 tons, and there was a similar increase in the previous week. Stocks now stand at 13,377 tons. It is not improbable that they will soon be further increased, but if much tendency in shown in that direction makers will at once begin to reduce their output of metal by putting some of their furnaces out of blast. There are now 26 furnaces making iron in the district, and they are producing a large yield of metal. Special hematites are in good demand, and ferro-manganese has a steady sale, but spiegeleisen is quiet. Iron ore is in small demand at 17s., 13s. 6d., and 11s. for best, medium, and ordinary classes net at mines. There is not much activity at native mines. Foreign ores are coming in more slowly.

Steel.

There is not a brisk trade being done in steel, and makers are apprehensive they will not be liable to maintain even the somewhat restricted output of metal which they have produced during the past few months. Rails are quieter. Merchant steel is in small demand, and ship plates are not being inquired for.

Shipbuilding and Engineering.

There is nothing new in shipbuilding, except as regards the airship which is being built at Barrow for the Admiralty, as to which great secrecy is being observed.

Shipping and Coal.

The shipping trade is again quiet. The exports of iron and steel this week from West Coast ports have amounted to 13,495 tons—iron 5290 tons, and steel 8205 tons—as against 17,386 tons for the corresponding period of last year, a decrease of 3893 tons. For the year to date the shipments aggregate at 321,932 tons, against 278,007 tons in the corresponding period of last year, an increase of 43,925 tons. There is less being done in coal and coke and prices are a shade easier.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

The Pit Lads' Dispute.

SINCE our last report settlements have been effected in some instances, and several others are to be referred to arbitration. The situation, however, still continues, at the time of writing, somewhat uncertain and disturbed. There have, in fact, been settlements and unsettlements, owing to the lads changing their minds. A considerable number are still out, possibly owing in part to the fine weather and the disposition at this time of the year to make holiday. Otherwise, so far as the men are concerned, the Eight Hours Act is being worked with very little friction, both employers and employed being desirous of giving the new statute a thoroughly fair trial.

House and Steam Coal.

The present spell of warm weather, combined with the holiday season, is rather thinning the orders for domestic fuel. Orders from London are not quite so numerous, and a similar condition prevails locally. No change, however, has taken place in prices, which remain at 11s. 6d. to 13s. per ton, at pit, for best Barnsley; secondary sorts, from 10s. to 11s. per ton at pit. Steam coal continues in very fair request, as is usual at this season of the year for the shipping trade, the demand being accentuated owing to the stoppage caused in several directions by the pit lads. Business done in the open market is generally at 9s. per ton, which is 6d. per ton above the contract rate.

Small Coal and Coke.

The demand for small coal is quite equal to the output. For qualities used in the cotton and woollen localities the request continues firm, and prices remain at 4s. 6d. to 5s. 6d. per ton. Of coking smalls there is a decided scarcity, as many of the idle pits have coke ovens, and supplies sufficient to keep them going have been somewhat difficult to get. Prices are from 3s. 6d. to 4s. 6d. per ton. Coke fairly well called for. Best washed, 10s. 6d. to 11s. per ton; unwashed, 10s. to 10s. 6d. per ton.

The Iron Market.

Stock-taking operations are still being carried on at the local works, and business consequently is very quiet. The demand for hematites is, if anything, a little weaker, but no alteration has been made in official quotations, nor in those for Lincolnshire and Derbyshire iron. A few contracts are being renewed as they fall out, but otherwise markets remain flat. Quotations:—Hematites, West Coast, 68s. to 69s. per ton; East Coast, 64s. to 65s. per ton, both less 2½ per cent., delivered in Sheffield and Rotherham. Lincolnshire, No. 3 foundry, 50s. per ton; No. 4 foundry, 49s. per ton; No. 4 forge, 49s. per ton; No. 5 forge, mottled and white, 49s. per ton; basic, 50s. 6d. per ton. Derbyshire, No. 3 foundry, 50s. per ton; No. 4 forge, 49s. per ton. Both Lincolnshire and Derbyshire iron net, delivered in Sheffield and Rotherham. The Derby and district iron trades remain as previously reported. The Staveley Coal and Iron Company, Limited, have booked an order for 6000 tons of castings for the Lincoln new waterworks scheme.

Bar Iron, Hoops, and Sheets.

Position and quotations unchanged. Bars, £6 10s. per ton; hoops, £7 10s. per ton; sheets, £8 10s. per ton.

Steel and other Industries.

More small orders for steel are being received at the present time than have been current for the past few weeks. These apply to the steel manufactures generally, and are more particularly in respect of small forgings and railway purposes. For the United States the call for high-speed steel formerly noted, is maintained. The home demand is not likely to get very active until the engineering establishments of the country are better employed. The steel manufacturers are anticipating greater activity a little later on. There is more business in files, both on foreign and home account. In circular saws steel for agricultural engineering works, and other kindred purposes, a fairly good business continues to be done. We cannot hear of any change for the better in the important department of marine material. It is not expected that there will be any decided change until the season is much further advanced.

Sheffield and the Check Weighing Bill.

At a meeting of the Council of the Sheffield Chamber of Commerce, held on the 12th inst., the president, Mr. A. J. Hobson, reported as to the deputation appointed to wait upon the Home Secretary on the subject of the Check Weighing Bill. He attended as representing the Sheffield Chamber of Commerce, and Mr. W. F. Beardshaw on behalf of the Iron Trade Association. It was decided that a memorial setting forth the views of the Chamber should be prepared and sent to the Home Secretary, after being submitted to the special committee of the Chamber appointed to consider the Bill. Copies of the memorial are to be sent to all the local members of Parliament.

Cammell, Laird and Co., Limited.

A meeting of the shareholders of Cammell, Laird and Co., Limited, Cyclops Works, Sheffield, was held on the 12th inst., Colonel Sidebottom presided. Two resolutions were submitted. The first was:—"That the scheme for the transfer to a new company of the businesses of the Workington Iron Company, Limited, the Harrington Iron and Coal Company, Limited, and the Moss Bay Hematite Iron and Steel Company, Limited, and the Cumberland properties of Cammell, Laird and Co., Limited, of which printed copies have been sent to the shareholders, and of which another copy has, for the purpose of identification, been signed by the chairman of this meeting, be, and the same is hereby approved." The second resolution authorised the directors of Cammell, Laird and Co., Limited, to enter into any agreements necessary to carry the said scheme into effect. Both resolutions were carried unanimously without discussion. Meetings of the 4 per cent. debenture-holders, and of the 4½ and 5 per cent. debenture stockholders were subsequently held, and the resolutions submitted at all these meetings were also unanimously carried.

NORTH OF ENGLAND.

(*From our own Correspondent.*)

Cleveland Iron.

A SLIGHT improvement in business was reported early this week, but has hardly been maintained. However, it is remarkable that prices are so well maintained in the face of adverse statistics, especially those relating to the stocks. It is evident that warrants are held in very strong hands, for the actual trade that is being done would not keep No. 3 up at so high a figure as 48s. There is another unsatisfactory feature, and that is the trouble in the Scotch coal trade, for a general strike must cause a stoppage of the foundries, and they will then need little Cleveland iron. Scotland is the best customer for the produce of the Cleveland ironmasters, and if the consumers there cease to require it prices can hardly be kept up, for in the present state of trade it will be practically impossible to find other markets for the iron. In that case some of the Cleveland furnaces will have to be blown out. The outlook is not good, and there does not seem to be much probability of an early improvement. Some of the makers on Tuesday advanced their quotations for prompt f.o.b. deliveries of No. 3 Cleveland G.M.B. pig iron to 48s. 3d. per ton, but the rates have fallen back to 48s. No. 1 is at 50s. 6d., No. 4 foundry at 47s., No. 4 forge at 46s. 9d., and mottled and white at 46s. 3d. for early delivery, and 6d. per ton more is asked for delivery up to the end of September.

Hematite Pig Iron.

Makers of hematite pig iron in this district give rather gloomy accounts of their business, and it must be acknowledged that the position for them is a very unsatisfactory one; indeed, they feel the depression probably more than those engaged in any other branch of the iron and steel trades. It can quite well be believed that the business is an unremunerative one, for hematite iron is low in price, while the cost of materials is high in comparison, and the latter will continue dear as long as the demand is maintained. It will soon become necessary to blow some of the furnaces out, especially as too much seems to be made. Although the surplus is not going into the public stores, there is no doubt that iron is accumulating in makers' hands, and they are not likely to go on long producing iron at a loss to put into stock. A reduced output of pig iron would tend to cheapen the cost both of ore and coke, and that is what is urgently wanted, as the price of pig iron itself cannot be advanced. Mixed numbers of East Coast hematite pig iron have been sold this week for prompt delivery at 54s. 9d. per ton, which is about the lowest price this year, but the general quotation is kept at 55s., with 55s. 6d. for autumn delivery. For Rubio ore the price is maintained at 16s. 3d. per ton c.i.f. Middlesbrough, but there is very little buying, and the quotation is practically a nominal one. Coke is rather dearer, there being no longer any surplus make, and the stocks at the collieries have been cleared off. Furnace coke is at 15s. 6d. to 16s. per ton delivered equal to Middlesbrough.

Exports and Stock of Pig Iron.

The shipments of pig iron from the Cleveland district are poor, especially to the Continent of Europe; they are short of expectations, though this is a period of the year when the exports of pig iron are generally quiet. Up to 14th they reached 41,769 tons, as compared with 51,602 tons last month, 51,259 tons in July last year, and 59,199 tons in July, 1907, all to 14th. Connal's stock of Cleveland pig iron continues to increase, and it is somewhat surprising that in the circumstances the prices of Cleveland pig iron are held up so well. There are nearly 200,000 tons more Cleveland iron in the public stores than was the case a year ago, and this is not a season when we may look for any material reduction. A year ago under 48,000 tons of Cleveland pig iron were held by Connal's, on Wednesday last the quantity was 244,796 tons, and the increase this month has been 6914 tons. The stock consisted of 239,911 tons of No. 3; 4450 tons of No. 4 foundry; and 435 tons of other Cleveland pig iron not deliverable as standard.

Middlesbrough's Trade.

The statistical report of the Middlesbrough Chamber of Commerce states that at June 30th there were fifty-three blast furnaces in operation at that port, or five fewer than at the end of the second quarter of last year, and that the estimated output of pig iron for last quarter was 527,000 tons, or 43,000 tons less than in the second quarter of 1908, but that was more than the market required, seeing that 42,569 tons were added to the stock of Cleveland pig iron at Connal's, and it is believed that the makers also considerably increased their stocks. Altogether during the last half-year 101,568 tons of pig iron have been added to Connal's store, the increase being 74 per cent. The shipments of pig iron during the first half of this year from the port reached only 505,727 tons, against 631,259 tons in the first half of last year, and 856,243 tons in the first half of 1907, the last being the largest of any half-year on record. The exports of steel, however, showed a considerable increase, whereas those of manufactured iron declined. The shipbuilding returns were worse than those of the corresponding period of last year, notwithstanding that then the strikes at the shipyards were in progress. Exports of ground basic slag and salt showed substantial increases. A good deal of sulphate of ammonia, which is a by-product of the coke manufacture in this district, is being sent away, chiefly to the Continent.

Cleveland Miners' Wages.

The owners of the Cleveland ironstone mines have claimed a reduction of 2½ per cent. in the wages of the miners, and the men will give their answer in a few days. This is a natural result of the decline in the realised price of No. 3 Cleveland pig iron, which has brought the blast furnacemen's wages down 1¾ per cent. The new Miners Eight Hours Act has adversely affected the working hours of the Cleveland miners on the Saturdays. The Home-office has, however, undertaken to introduce a short Bill to amend the Act in the interests of the Cleveland ironstone mining industry.

Manufactured Iron and Steel.

Business is very slow in nearly all branches of the finished iron and steel trades, and the majority of the firms cannot keep their mills fully occupied. More especially is this so among the plate, angle, and bar makers; but no alterations in quotations are to be recorded. Steel ship plates are at £5 15s.; steel boiler plates, £6 15s.; iron ship plates, £6; steel ship angles, £5 7s. 6d.; iron ship angles, £6 15s.; packing iron and steel, £5 5s.; steel hoops, £6 10s.; steel strip, £6 7s. 6d.; steel sheets, £7 7s. 6d.; all less 2½ per cent. f.o.t. Galvanised and corrugated iron or steel sheets are in fair request at £12 10s. per ton, less 4 per cent. f.o.b. 24 gauge in bundles. The rail mills are fairly well occupied, but have found buyers lately very backward about giving out specifications. The quotations for heavy steel rails are about £5 5s. per ton net f.o.b. It has been announced that the wages of the steel millmen at Consett and other steel works which work to the same sliding scale will remain the same for the current quarter as they have been in the past, there having been not enough change in the realised price of steel plates in the last quarter to justify any change.

Shipbuilding.

Trade continues disappointing in the shipbuilding industry, and the improvement which a short time ago seemed likely to be experienced has not materialised. Prices of new vessels are low enough—too low, indeed, to do more than cover the expenses, but shipowners are slow about giving out further orders, chiefly because the outlook is so bad in regard to freights, the rates being almost the lowest on record. It is reported that Messrs. Swan, Hunter and Wigham Richardson, of Wallsend, have secured the order for the construction of the big floating dock which the Admiralty have decided to put in Jarrow Slake for the accommodation of British war vessels. The order, however, is not yet booked, but it is believed that it will be given to the firm named. The dock will be placed at the east side of Jarrow Slake, and there will be provided facilities for removing the structure to other parts of the river in case of emergency. Among the orders that have just been booked may be cited two by Messrs. Robert Thompson and Son, Southwick—one a steamer of 2600 tons deadweight, and the other of 5100 tons—the engines for both to be supplied by Messrs. Blair and Co., of Stockton. Sir Raylton Dixon and Co., Middlesbrough, have also booked orders for two large cargo boats, and Irvine's Shipbuilding Company, West Hartlepool, are to build a cargo steamer of 6350 tons for Messrs. Millburn and Lund, of Whitby. It is reported that the contract for the last named works out at £5 5s. per ton.

Coal and Coke.

The trouble in the Scotch coal trade is causing more activity in the coal and coke business of this district, and has already brought about a sharp rise in steam coal prices, best qualities having gone up again to 13s. per ton, f.o.b.; seconds to 11s.; and smalls to from 5s. 6d. to 6s. 6d., according to quality. Bunkers are dearer, 9s. 9d. to 10s. 3d. being now quoted. Coke is firmer, the stocks at the collieries having been cleared off, and the price of furnace coke has been raised to 15s. 6d. per ton, delivered equal to Middlesbrough.

NOTES FROM SCOTLAND.

(*From our own Correspondent.*)

The Mining Labour Crisis.

CONFERENCES with the object of averting a strike in the Scottish coal trade have been unsuccessful, and the coalmasters issued notices intimating a reduction of wages to take effect from 26th current, while the miners have given intimation that they will cease working from that date. The number of workmen affected is given as from 80,000 to 90,000 employed at the collieries; but should the strike occur, of which at present there is every likelihood, a scarcity of coal is certain to lead to a great amount of additional enforced unemployment, aggravating the depression already existing in many quarters, and entailing much privation on the community. The question involved is not merely that the colliers are contending for a minimum wage of not less than 6s. per day, which the reduction now sought by the coalmasters would reduce to 5s. 6d., but the men seek to alter the basis and scope of the sliding scale in such a way as to render much more difficult the problem of working the collieries profitably. The dispute has occurred at the beginning of the annual trade holidays, and has caused less excitement on that account, but it has already thrown the iron and other markets into a state of collapse, and arrested any improvement that was being experienced in trade.

The Iron Market.

In former times a crisis like that which has occurred in the coal trade has generally had an exciting effect on the pig iron market, but on the present occasion speculative interests in warrants are of small account, and the market has been extremely dull, with no business whatever being done at some of its meetings. Since last report Cleveland warrants have changed hands in small quantities from 48s. 3½d. to 47s. 11d. cash, 48s. 0½d. for delivery in seven days, 48s. 2d. one month, and 48s, 7d. to 48s. 9d. three months.

Scotch Makers' Pig Iron.

There has been a quieter business in Scotch makers' iron. The home demand has been curtailed because of the trade holidays, and the foreign shipments and takings on English account are on a moderate scale. Prices do not show much alteration. Monkland, No. 1, is quoted at Glasgow, 55s. 6d.; No. 3, 53s. 6d.; Carnbroe, No. 1, 57s. 6d.; No. 3, 54s.; Clyde, No. 1, 60s.; No. 3, 54s.; Gartsherrie, No. 1, 60s. 6d.; No. 3, 54s. 6d.; Calder, No. 1, 60s. 6d.; No. 3, 55s. 6d.; Summerlee and Langloan, Nos. 1, 61s.; Nos. 3, 56s.; Coltness, No. 1, 88s.; No. 3, 56s.; Glengarnock, at Ardrossan, No. 1, 58s. 6d.; No. 3, 53s. 6d.; Eglinton, at Ardrossan or Troon, No. 1, 55s. 6d.; No. 3, 53s. 6d.; Dalmellington, at Ayr, No. 1, 58s. 6d.; No. 3, 53s. 6d.; Shotts, at Leith, No. 1, 60s. 6d.; No. 3, 55s. 6d.; Carron, at Grangemouth, No. 1, 63s.; No. 3, 56s. per ton. There are 82 furnaces in blast in Scotland, compared with 74 at this time last year, and of the total 40 are making ordinary, 37 hematite, and 5 basic iron. It is understood that because of holidays a number of furnaces may go on slack blast, but if the colliers' strike takes place and is of any continuance a proportion of the furnaces is likely to be damped out altogether.

Hematite Pig Iron.

Since last report one furnace has been taken off hematite iron, and there are now 37 producing that quality of iron, compared with 38 in the preceding week and 40 at this time last year. Merchants have reduced the price 6d. per ton, and now quote 57s. for Scotch hematite, delivered at the West of Scotland steel works. Cumberland warrants are quoted 56s. 7½d., without business being recorded. The requirements of steel makers will now be considerably reduced owing to holidays.

Pig Iron Shipments.

The shipments of pig iron from Scottish ports in the past week amounted to 4988 tons, being 1293 tons more than in the corresponding week of 1908. The arrivals at Grangemouth of pig iron from Cleveland and district were 7503 tons, being 1403 more than in the same week of last year. There is a prospect of both exports and imports of pig iron being materially reduced by the labour troubles to which reference has already been made.

Finished Iron and Steel.

The makers of finished iron were busy in the early part of the week at several of the works finishing up orders, but the current demand is quiet. There has been a little more business in steel. One or two fair orders for shipbuilding material are reported to have been secured, and there has also been a little more life in miscellaneous goods. Comparatively few of the orders coming to hand are of a pressing description. Inquiries from abroad have been somewhat more encouraging.

The Coal Trade.

The coal shipments in the western district of Scotland show a considerable decrease, while an increase has occurred at East Coast ports, where there is a greater amount of contract business in hand, and shippers are accordingly anxious to get away as much coal as possible in case of there being a reduced supply later, if the colliers go on strike. In the Glasgow market there has been comparatively little excitement so far, there being a reduced demand for manufacturing purposes on account of the annual trade holidays, which have just commenced, and are likely to continue till the end of the month. There has been no scarcity of coal. In some districts the colliers are taking the advice of their leaders and continuing at work during the usual holiday time, postponing their holiday until near the end of the month, when their strike notices will expire. At Glasgow Harbour the shipping prices of coal are nominally unchanged. In some districts in and prices have begun to advance, the increases mentioned running from 6d. to 1s. 8d. per ton. These increases are the result of the anxiety of some manufacturers, chiefly in the soft goods trades, desiring to be insured against a stoppage of their works from a scarcity of coal. There is, of course, some hope that the calamity of a general strike may yet be averted. The mining community has not yet quite forgotten the awful distress that attended the last great strike in 1894, which continued for nearly four months.

WALES AND ADJOINING COUNTIES.

(*From our own Correspondent.*)

Last Week's Coal Trade.

IT is an interesting fact, that in some parts of the district the arrangement of terms and resumption of work at the coal mines has been followed by steadier trade. For instance, in the non-associated district of colliers it was but an ordinary feature to have a week of three or four days, but since the settlement regular work has been the rule. A belief evidently exists in the existence of a better understanding between employers and workmen. Last week it was noticed that the continuance of labour troubles, and the Scotch difficulty, had a tendency to keep up quotations, and now the August holidays in front are likely to strengthen this. Bituminous coals remain steady. Pitwood clings to 19s., and may be higher.

Latest Coal Prices, Cardiff.

The tendency of the coal trade is distinctly upwards. Best Admiralty have been well booked up to the middle of August, and 17s. has been an ordinary figure. The recovery in prices after the stagnation of June has been decided, and it is not unlikely but that higher prices will prevail. Latest prices:—Best Cardiff steam coal, 16s. 6d. to 17s; seconds, 15s. 6d. to 16s.; ordinary large steam, 14s. 6d. to 15s.; drys, best, 15s. 6d. to 16s.; ordinary, 13s. 6d. to 14s.; best Monmouthshire black vein, 14s. 6d. to 14s. 9d.; Western Valleys, 14s. to 14s. 3d.; Eastern Valleys, best, 13s. 6d. to 13s. 9d.; other classes, 12s. 6d. to 13s.; best house coal, 17s. 6d. to 18s.; other sorts, 14s. 6d. to 16s. 6d.; No. 3 Rhondda, 17s. 9d. to 18s. 3d.; through, 13s. 6d. to 14s.; No. 3 smalls, 9s. 6d. to 10s.; No. 2 Rhondda, large, 12s. 9d. to 13s.; through, 10s. to 10s. 6d.; smalls, 8s. 9d. to 9s.; best washed nuts, 14s. to 15s.; seconds, 13s. to 13s. 6d.; best washed peas, 12s. 6d to 13s; seconds, 11s. to 12s.; best small steam, 9s. to 9s. 6d.; seconds, 7s. 6d. to 8s.; other smalls, including drys, 6s. 6d. to 7s. Patent fuel, 14s. 6d. to 14s. 9d. Coke: Ordinary foundry, 17s. 6d. to 20s. 6d.; special foundry, 24s. to 26s.; furnace, 15s. 6d. to 16s. 6d. Pitwood, 20s. to 20s. 3d.

Newport, Mon., Coals.

Few authorities expected the firm tone which has begun to prevail, and, if this should continue, better prices are certain. August bookings are becoming common. Mid-week figures were:—Best black vein, 14s. 3d. to 14s. 6d.; Western Valleys, 14s. to 14s. 3d.; Eastern steam, 12s. 9d. to 13s. 3d.; other sorts, 12s. to 12s. 6d.; smalls, best, 8s. 9d. to 9s.; seconds, 8s. to 8s. 3d.; inferiors, 7s. to 7s. 6d.; through, 11s. 3d to 11s. 6d.; other sorts, 10s. 3d. to 10s. 6d.; nut coals, best washed, 12s. 6d. to 13s.; other sorts, 11s. 9d. to 12s.; smithy coals, 11s. to 11s. 3d.; house coal, best, 15s. to 15s. 3d.; seconds, 14s. to 14s. 3d. Patent fuel, 14s. 9d. to 15s. Pitwood, 19s 6d. to 20s. Coke: Furnace, 16s. to 16s. 6d.; foundry, 19s. to 19s. 6d.

Swansea Coal: Anthracite.

Little forward movement took place this week; if anything, a slightly easier price occurred with large coals; machine coals firmer; all kinds well maintained. Latest:—Large hand-picked malting, 23s. to 24s. 6d. net; seconds, 21s. to 22s. net; Swansea Valley big vein, 19s. to 20s., less 2½; red vein, 12s. 6d. to 13s., less 2½; machine-made cobbles, 22s. 3d. to 23s. net; French nuts, 24s. to 25s. net; German nuts, 24s. to 25s. net; beans, 18s. to 19s. net; screened beans, 10s. to 11s. net; machine-made peas, 12s. to 13s. net; rubbly culm, 5s. 3d. to 5s. 6d., less 2½; duff, 3s. to 3s. 3d. net. Other coals: Best large steam, 16s. 6d. to 17s. 3d., less 2½; seconds, 15s. to 15s. 6d., less 2½; ordinary large, 12s. 6d. to 13s. 6d., less 2½; through bunkers, 10s. 6d. to 11s., less 2½; small, according to quality, 7s. 6d. to 9s. 6d., less 2½. Bituminous: No. 3 Rhondda, 17s. 9d. to 18s. 6d., less 2½; small, 9s. 9d. to 10s. 6d., less 2½. Patent fuel, 13s. 9d. to 14s. 3d., less 2½.

Swansea Industries.

The ending of the great dock undertaking at Swansea adds considerably to the interest attached to the present state of Swansea trade. At the harbour meeting on Wednesday this was given with force by Lord Glantawe in seconding the adoption of the Finance Committee's minutes. In doing so he gave some gratifying details, commenting in particular upon the large increase that was taking place in tin-plate shipments. Holland, he said, had become a recognised customer, and had shipped 740 tons in excess of last year. Roumania, which had become one of their best customers, took 2000 tons more, and the Straits Settlements took 1000 tons, as against no shipments in the corresponding month. The shipments to China had more than doubled. Japan took 2100 tons more, Brazil 900 tons more, and even the United States 522 tons more. The total increase, 144 per cent., spoke very well indeed, especially with regard to an industry which was said to be in a dying condition a few years ago. It was encouraging to observe, he continued, that they were on the eve of better prospects in trade. The American accounts showed that prospects were generally good, the weather good, and it was supposed that the shipments from there would be largely in excess of those of last year.

Working by Naked Lights.

Mr. Martin, Inspector of Mines for the Southern District, has issued his report up to December, 1908, commenting on the Blaenavon colliery explosion, by which three lives were lost, and pointing out the necessity of adoption where the irregularity continues. He has now had notice of the adoption of the lamp in the Varteg deep black vein collieries.

Inspection of Pits.

He does not think that the miners who are detailed for the examination of pits give sufficient attention to the timbering. He thinks that the systematic attention to the practice on the Continent is well deserving of attention both by employers and men. He distinctly advocates the manner in which the examination is carried out in the eastern part of Monmouthshire, where the whole mine is examined in one day. Two men having been appointed from each examiner's district, they are unaware of which day they are to examine until told on demanding their lamps at the lamp cabin, as the check weigher decides it without giving them any warning. One of them in each district is changed each time, so that continuity with the previous examination is maintained. The same man, therefore, makes two examinations, and in this way a more reliable result is attained than by two men going round day after day for a week or ten days.

Iron and Steel.

There is no change in the character of trade, and even the renewals which at one time seemed on the increase have lessened in volume. At Dowlais there was a reduced make owing to the need for urgent repairs at the Bessemer department. The furnaces stopped at six on Friday morning and the mills at six were compelled to inaction. Steel rails and sleepers will very likely resume a fuller make. Blaenavon imported nearly 3000 tons iron ore this week; 750 tons pig came from Middlesbrough, and 1700 tons steel from Bruges. Iron ore continues at 15s. 6d. to 15s. 9d. Latest prices: Pig iron, mixed numbers, 56s. 7d. for cash and month; Welsh hematite, 60s. to 61s. 6d. c.i.f.; East Coast hematite, 59s. to 60s. 6d. c.i.f.; steel bars, £4 8s. 9d. to £4 10s., Siemens and Bessemer. Other quotations: Copper, £58 1s. 3d. cash, £58 17s. 6d. three months; lead, £13 1s. 3d.; spelter, £12 18s. 9d.; silver, 23⅝d. per oz.

Tin-plate.

Trade continues brisk. Nearly 100,000 boxes were received from the mills last week. A good demand exists for tin-plates. Large orders expected from the United States next month. The new plant, which it has taken two years to lay down at the Midland Tin-plate Works, Morriston, is now complete, and in a short time four mills will be in operation. The new sheet mills at the Upper Forest Works are within a couple of months of being finished, and are regarded as among the best works in Wales. Men are now agitating for abolition of Sunday work. Latest prices:—Ordinary Bessemer and Siemens, 11s. 10½d.; C.A. roofing sheets, £8 5s. to £8 7s. 6d.; big sheets for galvanising, £8 7s. 6d. to £8 10s.; finished black plate, £9 5s.; galvanised sheets, 24 g., £12 10s.; block tin, £130 17s. 6d.

Direct Labour Defeated at Cardiff.

Cardiff, on the eve of the construction of the fourth reservoir at the Beacons, has had an interesting discussion and conflict in the Council. The Waterworks Committee recommended that the Council themselves should construct the new reservoir. In the discussion that followed forcible arguments were used both in favour and against by several members of unquestioned ability. The adverse motion which was carried was that the report and recommendation be referred back to the committee, with the recommendation that the work should be carried out by contract, and that estimates be advertised for. It was argued for the construction of the reservoir by direct labour, that in the construction of two other reservoirs the contractors came to grief over the matter. To this it was added that tenders be obtained from reputable firms, with an estimate from the waterworks engineer for the consideration of the Council.

NOTES FROM GERMANY, FRANCE, BELGIUM, &c.

(*From our own Correspondent.*)

From Rheinland-Westphalia.

THE position all round is the same as before, quietness prevailing in all the principal departments. Pig iron remains in fairly good request, but sales are not extensive. Latest accounts from the Düsseldorf 'Change report quotations for crude iron to have been reduced as follows:—Spiegeleisen, M. 1 p.t.; iron for steel making, M. 3 p.t.; German Bessemer, M. 3 p.t.; Luxemburg forge pig and German foundry pig, M. 1 p.t. The production in pig iron is statistically shown to have been higher this year than in the year before, but this does not indicate a general improvement in demand, a large part of the production having been stored. When in 1908 the Pig Iron Convention was dissolved, a number of consumers began to purchase freely at the strongly reduced quotations, and many sales are said to have reached up to the end of the present year, and in June some orders for foundry pig have been placed for 1910 already, also at the low rates at present prevailing. Makers of pig iron appear to have given up all hope of a re-forming of the Pig Iron Syndicate, and are trying to find a market for their output at almost any price. The blast furnace works of the Siegerland are reported to have got a large order for 10,000 tons of spiegeleisen for America, to be delivered in the last quarter of this year. This is the first large order since the American crisis. Inquiry and demand in the German finished iron industry have been moderately active. Here and there manufacturers have tried to realise better prices, refusing to do forward business at the present low rates, but competition is far too strong to allow a number of smaller mills to influence the condition of prices. Though bars have been in good demand, most of the fresh orders have been booked at M. 95 and M. 100 p.t., free Rhenish-Westphalian works, while in South Germany M. 90 to M. 92 p.t. is taken. The wire industry is reported in a favourable condition. Steel wire for home consumption is quoted M. 127.50 to M. 130 p.t. The Convention of Prices for Wire and Wire Nails is going to be turned into a syndicate shortly. A fair amount of business exists in the plate trade.

Production of Pig Iron in Germany.

According to statistical accounts given by the Union of German Iron and Steel Masters, output of pig iron in Germany, including Luxemburg, was for June of this year 1,067,421 t., as against 1,090,467 t. in May, 1909, and as against 956,425 t. in June, 1908. Production in the different sorts of pig iron was as follows:—Foundry pig, 219,259 t., as compared with 167,562 t. in June, 1908; Bessemer, 28,602 t., as against 29,787 t; basic, 685,657 t., as against 626,643 t.; steel and spiegeleisen, 75,765 t., as against 75,633 t.; forge pig, 58,138 t., as against 56,800 t. in June, 1908. Output from Germany to June of present year was 6,252,489 t., as against 6,049,721 t. for the corresponding period the year before.

Coal and Coke in Germany.

No change worth noting has taken place on the Rhenish-Westphalian coal market, but the tone generally was more firm than previously. Shipments in coal to South Germany, as well as to Holland, have been satisfactory. On the Silesian coal market some large contracts were booked last week. The tone generally is healthy and firm.

Dulness in Austria-Hungary.

Very few orders come in, and Government work is scarce. To assist the Hungarian shops, contracts for sixty-two locomotives of different types have been granted by the Hungarian State Railways to the Government factories. In coal a steady business is being done and deliveries have continued regular. The Town Council of Teplitz has resolved to effect a reduction in the railway tariffs for brown coal from Bohemia to Vienna.

Fluctuating Tendency in Belgium.

Owing to a decrease in orders, the position of prices in Belgium has become weak, and a further easing down can be noticed. Firm rates are quite an exception. The merchant iron branch is, perhaps, more depressed than any other, orders decreasing from week to week. Basic bars are quoted £4 8s. f.o.b. Antwerp. Demand and inquiry in the plate trade continue satisfactory, but the business done is most unremunerative, for German competition increases, causing quotations to weaken. Sheets are more neglected than heavy plates. Export rates for plates are £4 19s. to £5 1s. for export, while for inland contracts 130f. to 140f. p.t. are quoted, which is equal to an average decrease of 2.50f. p.t. against last month. Foreign trade in bars is extremely depressed; girders meet with tolerably good demand on home account, while little is done for abroad. With regard to the pig iron market, more firmness can be perceived of late. Foundry pig and basic show much stiffness at 68f. and 67.50f. p.t., while the prices for forge pig have been easier than last month. There is next to no demand for scrap iron. Coal sells moderately well, and the current rates are willingly paid.

AMERICAN NOTES.

(*From our own Correspondent.*)

NEW YORK, July 8th.

THE building of another structural steel mill is projected to be undertaken at South Buffalo, New York, on Lake Erie. Main building 400ft. by 200ft.; capacity 40,000 tons a year. The demand for structural material has been quite heavy all through the spring months. June was the best month on record, the business amounting to 150,000 tons. Although prices are fractionally higher since June 30th, except in case of options, orders have been flowing in and mills are now in better shape for orders than for almost two years. One source of demand that stimulates production is bridge building for railroads. A vast amount of work was postponed for various reasons. It is now coming forward. It is probable that much new work will be taken at old figures. The tariff schedule relating to steel has been so manipulated that there will be no reduction in duties and no possibility of any increase in importations. Final conferences will be held in a few days, and if the present monopoly rate is not upset by the House Committee the steel manufacturers can defy competition from abroad, even if it ever did hurt them. Large purchases of raw material continue to be made for steel manufacture. The southern pig iron furnaces have sold up their output for three months at least, some further. Prices have hardened enough to encourage some northern furnace companies whose sales have been interfered with by vigorous southern competition. The rail mills also have begun to book large orders for fall delivery. Car builders have secured large orders within ten days for steel cars, and their inquiries are now in the market for large lots of plates and bars. The car-building industry is perhaps the most active one, and railroad companies are re-equipping their lines with most substantial cars and of large capacity. The recent heavy exports of copper have placed the copper market in a good condition. This condition, however, can be maintained only by a continued heavy European and Asiatic demand. Production is continued on a large scale. No local improvement is expected for a few weeks, as domestic consumers ordinarily are not large purchasers during July and August. Tin arrivals for the past week have been light, but there are large stocks afloat.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

WE are informed that, by mutual agreement, the firm of Burnham, Williams and Co., of Philadelphia, has been dissolved, as of this date, and that its entire property and interests in the locomotive business have been sold to the Baldwin Locomotive Works.

MR. JAMES TURNBULL, of 3, New-street, Birmingham, has been appointed by the "Auto" Recorder Company, Limited, Kent-street Works, Leicester, its agent in the Birmingham district for the sale of its "Auto" CO_2 recorder for boiler flue gases.

AT the Wirral and Birkenhead Show held on the 13th, 14th, and 15th inst., Blackstone and Co., Limited., of Stamford, were awarded a gold medal for their new crude oil engine in class A for the best engine in the show. Their light type portable oil engine gained the silver medal in the same class. They were also successful in winning a gold medal offered for the best new implement in the show, with their new patented side delivery rake, and an improved type of their swath turner was awarded a first prize silver medal.

CONTRACTS.—Lobnitz and Co., Limited, Renfrew, have completed the shipment of the third gold dredger which they have built this year fitted with their patented propulsion screen. This device is designed to take the place of the usual sluice box or revolving screen and elevator in gold dredgers. This dredger has been built to the order of the Syndicat Mana for French Guiana.

YELLOW RIVER BRIDGE.—In our issue of July 9th we stated that the Yellow River bridge was in the hands of the Nürnberger Bridge Building Company; we should have said the Brückenbauanstalt Gustavsburg, which is a branch of the Maschinenfabrik Augsburg-Nürnberg A.G.

A GOOD EXAMPLE of the economy often accomplished by chemical investigation and discovery is furnished in the case of ultramarine. Many years ago, when this was made by powdering the mineral lapis lazuli, it sold for more than its weight in gold. Now that the chemist has discovered how to make the same material from such cheap substances as kaolin, sodium sulphate and carbonate, charcoal, sulphur, and rosin, the price is only a few pence per pound.

HULL COAL TRAFFIC.—The return of the Hull Chamber of Commerce and Shipping for June enables us to see the business done for the half-year. The figures show that the coal received from all sources at Hull during June reached a total of 568,160 tons, as compared with 510,352 tons in June of last year. During the half-year the total was 2,706,064 tons, as compared with 2,936,464 tons for the corresponding period of 1908. There is thus an increase of 57,808 tons on the month, and a decrease of 230,400 tons on the half-year. The coastwise exports during June amounted to 70,177 tons; for the six months, 410,832 tons. The weight of coal exported abroad during June was 330,339 tons, compared with 331,832 tons for June of last year; for the six months, 1,354,816 tons, compared with 1,250,243 tons for the six months of 1908. North Russia was the principal foreign customer on the month, taking 106,669 tons, compared with 99,693 for June of last year. Holland was second for the month with 51,178 tons, compared with 46,453 tons. Sweden and Germany are third and fourth for the month with 41,502 tons and 38,687 tons, comparing with 51,053 tons and 42,436 tons respectively. For the half-year Holland ranks first with a total of 239,141 tons, as against 195,088 tons for the half-year of 1908. North Russia is next with a total of 234,522 tons, compared with 231,928 tons; Germany is third with 217,492 tons, compared with 215,431 tons; and Sweden fourth with 172,140 tons, compared with 171,636 tons. To Austria during the half-year has been sent a total of 55,098 tons, compared with 7928 tons for the corresponding half-year of 1908. The coal trade with France from Hull last month amounted to only 13,865 tons, compared with 29,784 tons in June of last year; for the six months, 67,755 tons, compared with 101,991 tons. Of the contributing collieries to Hull, Denaby and Cadeby Main, as usual, head the list. From these collieries were sent to Hull last month a total of 97,080 tons, compared with 56,672 tons for June of last year; for the six months, 436,920 tons, compared with 232,096 tons for the corresponding period of 1908. Manvers Main is second with 32,352 tons for the month, against 30,160 tons for June of last year; for the six months, 146,680 tons, against 142,712 tons for the corresponding period of 1908.

BRITISH PATENT SPECIFICATIONS.

When an invention is communicated from abroad the name and address of the Communicator is printed in italics.

When the abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent-office Sale Branch, 25, Southampton-buildings, Chancery-lane, London, W.C., at 8d. each.

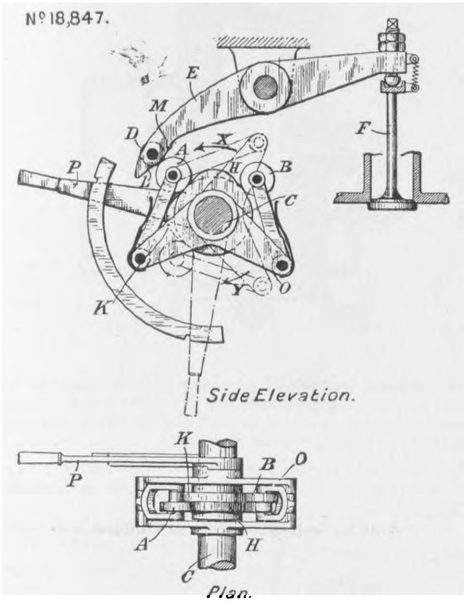
The first date given is the date of application; the second date at the end of the abridgment is the date of the advertisement of the acceptance the complete specification.

Any person may on any of the grounds mentioned in the Acts, within two months of the date given at the end of the abridgment, give notice at the Patent-office of opposition to the grant of a Patent.

INTERNAL COMBUSTION ENGINES.

18,847. September 8th, 1908.—Improvements in Valve Gear for Reversible Internal Combustion Engines, *Siegfried Barth, of 43, Brend-amour-strasse, Düsseldorf-Obercassel, Germany.*

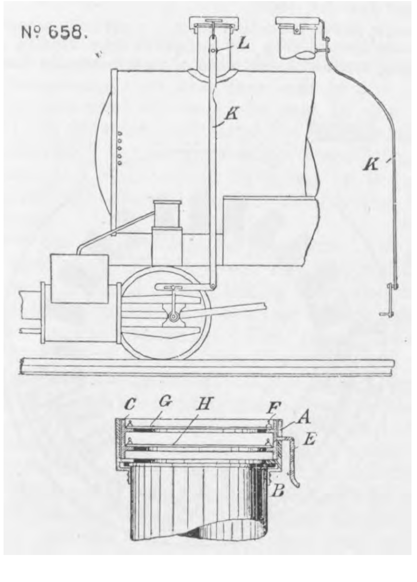
In order to cause the operating cams to act at the proper moment for forward running or reverse running, a roller A or B is provided for each operating cam, each of these rollers being mounted on an arm jointed to a bell-crank lever mounted on the cam shaft C. Of these rollers A and B, the roller A acts upon the cam for forward running and the roller B on the cam for reversed running. As shown in the bottom engraving, the rollers A and B are staggered relatively to each other in such a manner that they are able to act on one and the same roller D of the operating lever E acting upon the valve stem F. With this object the roller D is made as wide as the combined width of the cams H and K, mounted on the cam shaft C. By this means the result is attained that the roller A for forward running and also the roller B for reversed running are able to act at the proper moment on the operating lever E. The roller D serves mainly for avoiding sliding friction. By means of the roller D only rolling friction is produced. In order that the reversal of the rollers A and B upon or against the operating lever E may take place with as little shock as possible the end of the operating lever E which carries the roller D is provided with slide faces L and M chamfered wedge fashion. The reversal of the bell-crank lever O, and therefore of the rollers A and B for forward running and for reversed running Y is produced by means of a lever P mounted on the cam shaft C, the roller A being caused to pass from its operative position into the position R indicated in broken lines, while the roller B occupies the place previously occupied by the roller A directly in front of the roller D of the operating lever E. Modifications of the invention are dealt with, and there are two other illustrations.—*June 23rd*, 1909.



LOCOMOTIVES.

658. January 11th, 1909.—Spark Catcher for Engines, *Heinrich Wikelski, of Sandhofen, Prussia.*

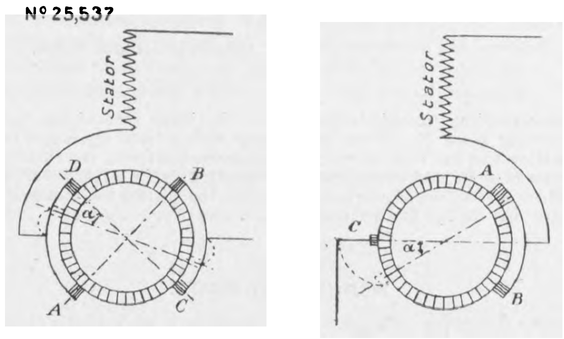
The spark catcher constructed according to this invention is shown in the accompanying engravings. A circular metal box A is fixed upon the chimney by means of arms B. This box contains a frame C adapted to be partially rotated by means of an arm E which projects through a horizontal slot in the wall of the box. Two perforated discs G H of metal rest upon annular projections of frame C, and they are arranged so that the perforations of the upper disc G are placed above the parts of the lower disc H, which are between the perforations of the same. Handles F serve to adjust the perforated discs in frame C. The arm E of frame C is bent at right angles, and hinged to the upper end of a rod K, the other end of which is linked by means of a connecting-rod to the piston-rod of the engine, or to some other moving part of the same. The rod K is pivoted upon an axle L fixed upon the outer surface of the chimney. When the engine is running, rod K is continuously moved forward and backward, so that its upper end—the rod pivoting around axle L—communicates a continuous reciprocating motion to the frame C, whereby the sparks which flow up the chimney are kept back. Any particles of fuel which should be dragged along by the smoke will be retained by the metal discs G H.—*June 23rd*, 1909.



DYNAMOS AND MOTORS.

25,537. November 26th, 1908.—Improved Means for Starting and Regulating Compensated Electric Repulsion Motors, *Allmänna Svenska Electriska Aktiebolaget, of Westerås, Sweden.*

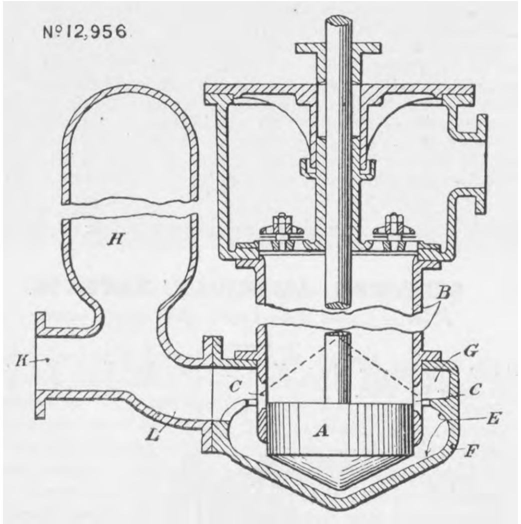
This invention relates to a device for facilitating the starting and regulating of the speed of compensated electric repulsion motors. The regulating effect aimed at is obtained by adjusting the magnetising brushes into different positions in relation to the axis of the stator winding in such a manner that the starting torque of the motor is regulated, or the relation between the static and the dynamic induction in the short-circuiting circuit of the rotor existing before the adjustment is changed, and a variation of the speed thereby is effected. The left-hand engraving illustrates the application of the invention to the connection invented by Latour, in which the magnetising current is supplied to the rotor through brushes A—D and B—C respectively, short-circuited in pairs. In this form every other of the short-circuited brushes is made adjustable in relation to the other brush of the same pair. If this motor is to be provided with commutating windings, it is suitable to arrange those brushes diametrically opposite each other adjustable that, depending on the direction of rotation, carry the smallest current. The result of displacing the brushes will here be somewhat different to that in the usual compensated repulsion motor, inasmuch as, besides the direction of the axis of the fields, also the number of turns of the latter is changed. The right-hand engraving illustrates the application of the invention to the connection of the compensated repulsion motor invented by Arnold and la Cour, which, in a two-pole arrangement, has a pair of short-circuited brushes A B, and one magnetising brush C, generally arranged at an angular distance of 120 deg. In this arrangement the regulation of the speed is effected by displacing the magnetising brush in relation to the short-circuited brushes, as is indicated by dotted lines at the brush C.—*June 23rd*, 1909.



PUMPING AND BLOWING MACHINERY.

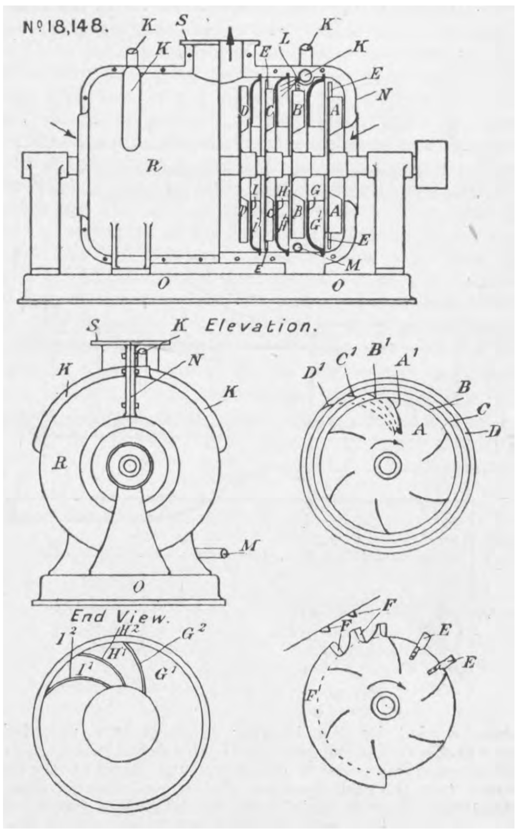
12,956. June 17th, 1908.—Improvements in or relating to Air or Vacuum Pumps, the Edwards Air Pump Syndicate, Limited, and Frank Lander Rowe, of 3, Crown-court, Old Broad-street, London.

According to this invention, instead of forming the reservoir for the air or vapour as an annular chamber around the barrel, the pump suction, in proximity to the inlets to the pump barrel, is provided with an air or vapour reservoir, which is preferably so disposed that air or vapour driven away from the pump barrel by the descending bucket will be guided, or given a tendency, to flow into the reservoir, and that air or vapour flowing from the reservoir when the barrel ports are open will have an unobstructed passage towards the said ports. The accompanying engraving illustrates in central vertical section an air or vacuum pump of the Edwards type constructed according to this invention. A is the pump bucket, B the barrel, and C the inlet ports thereto. E is the inwardly inclined wall of the casing F forming the bottom of the pump, which will guide through the ports C water displaced by the descending bucket, and G the passage around the inlet ports, which passage affords ample space for the flow therthrough to the ports C of the air and vapour. H is the air reservoir, which is connected, as shown, with the upper part of a length of pipe K forming part of the suction pipe leading from the condenser or other vessel. As will be seen from the drawing, the pipe K is formed with a curved portion L, which tends to divert air and vapour driven away from the pump towards the reservoir H, and away from the condenser or other vessel. Instead of the air reservoir H being connected to the air-pump suction pipe K, it may in some cases be connected to any convenient part of the casing F.—*June 23rd*, 1909.



18,148. August 29th, 1908.—Improvements in Turbine Blowers and Exhausters, Richard James Hodges, of 14, Devonshire-square, Bishopsgate, London.

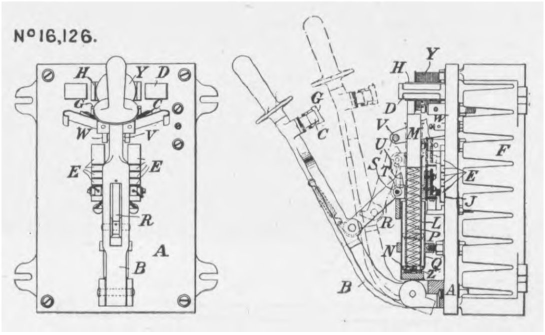
In the engraving, A B C D are the four rotor wheels increasing in diameter, but decreasing in volumetric capacity, successively in the direction of compression, the curvature of the blades also increasing on each wheel in succession, as shown at A^1 B^1 C^1 D^1. Radial blades of propeller form are attached to and project beyond the periphery of the rotor discs, as shown at E E, or they may be formed by notching the rotor wheel discs, as shown at F F. Between each of the rotor wheels are dished annular division plates G H I formed with curved guide blades G^1 H^1 I^1 on their hollow sides. In order to cleanse or cool the hot air, gases, or the like, during compression, water ducts K K are formed in the upper portion of the casing walls. These ducts are perforated by numerous holes, forming nozzles L, and are so arranged that jets of water traverse the gas issuing from the periphery of the rotor wheels, and then impinge against the division plates, thus forming a spray in the guide vane annulus, after which it escapes by drains at the bottom of the case at M. By this arrangement the water jets are prevented from striking the rotor wheels, thereby obviating shock, and greatly economising the driving power. To facilitate cleaning the machine when used for dusty or tar laden gases, or the like, the outer casing is formed in two halves, which are bolted together at the longitudinal vertical joint at N, and the driving shaft which carries the rotor wheels supported by separate pedestals from the bed-plate O.—*June 23rd*, 1909.



SWITCH GEAR.

16,126. 29th July, 1908.—Improvements in Starting Switches for Electric Motors, Edmund Garside, of 64, Sotheby-road, London.

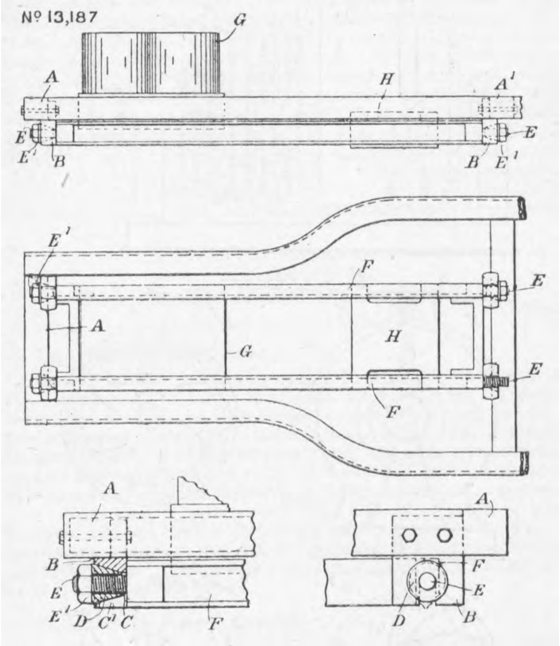
Upon a base A a switch arm B having contacts C to make contact with the main terminals D is pivoted. This switch arm when unrestrained falls under the action of gravity into the open position. Upon the base A is also arranged a series of resistance contacts E connected with a series of resistances enclosed in the casing F. The arm B has an armature G which acts with the poles H of the electric magnet Y mounted on A, so that the main switch is held in the closed position so long as the magnet is properly energised. Over the contacts E the moving bridge contact J can slide. The contact J is mounted on a tube L which at its upper end slides on a cylindrical stem M while at the lower end the piston N with valve Z is arranged, a spiral spring P being contained within the tube L so as to force the piston N in a downward direction. During this movement the resistances are being gradually cut out of the motor circuit. The piston N is contained within a cylinder Q supported on the base A. To the arm B is pivoted a detent R having a recess S at its outer end to engage with the roller T, pivotally mounted on the sliding contacts J, the angle contained by the detent R and arm B being such that when the switch is being closed, J is moved so as to raise it into the upper position on the contacts E until nearing the end of its stroke, the bevel edge U of the detent R comes in contact with a pin V mounted on the bracket W, whereby the recess S is withdrawn from the roller T, just as the switch closes. When this takes place the sliding contacts J are forced downwards slowly by the spiral spring P under the control of the liquid beneath the piston N. If the switch arm B is not drawn back sufficiently far to properly cause the detent R to engage the roller T in order to be in a position to put the resistances into the circuit, the bevelled end of the detent R passes to the rear side of the pin V and prevents the main switch being closed.—*June 23rd*, 1909.



MOTOR CARS AND ROAD TRAFFIC.

13,187. June 20th, 1908.—Improvements in Motor Road Vehicles, Henry George Kingstone, motor engineer, of 38, Somerfield-road, Finsbury Park, London; George Swale Alefounder; and Samuel King, mechanical engineer, of 9, Elphinstone-street, Highbury, London.

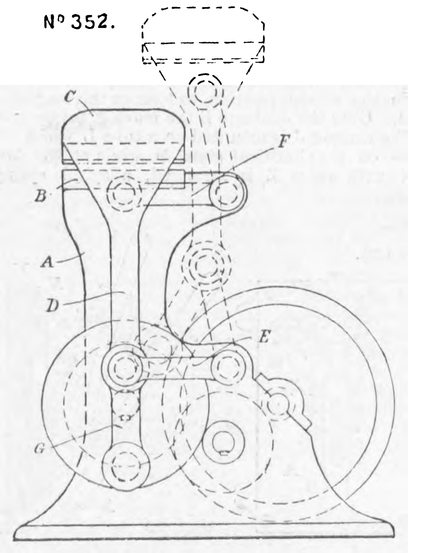
The object of the present invention is improved means for connecting the detachable frame to the main frame, whereby the two parts may be securely and accurately fitted together and yet may be very readily detached. On two of the cross bars A A^1 of the main frame are rigidly fixed hanging brackets B B. Two of these are fixed on one cross bar A and two on the other A¹ in two parallel lines. These brackets are preferably formed with a main hanging part and a horizontal part or thicker part, and fit against one side and underneath the cross bars A A¹ to which they are riveted or bolted. Each bracket B terminates at the lower end with a horizontal aperture C of conical form, which is slotted out at the bottom C¹ to form a fork. In each conical aperture C is placed a cone D which has an opening through its centre to receive the end of a rod E which is screw-threaded and has a nut E¹ acting to force the cone D into aperture C. On the two paralle side members F F of the detachable frame, carried by the hanging brackets, are mounted the motor proper G, and the gear-box H. To detach the engine G it is first necessary as usual to disconnect the levers on the steering column from the parts operated thereby and the universal joint behind the gear-box, after which the detachable frame F F may be removed by unscrewing the four nuts E¹ and sliding the cones D endwise out of the conical apertures C. The parallel rods E may then be lowered through the forks of the brackets B, carrying with them the complete engine.—*June 23rd*, 1909.


Nº 13,187

MACHINE TOOLS AND SHOP APPLIANCES.

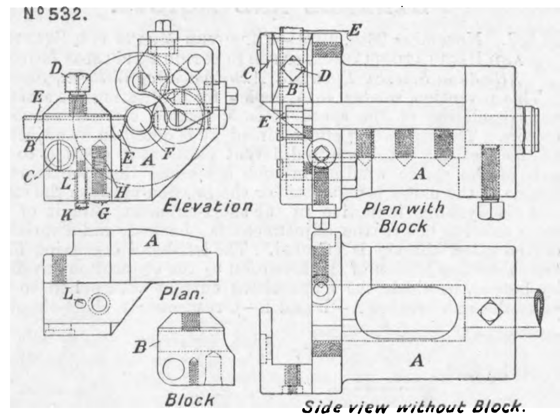
352. 6th January, 1909.—IMPROVEMENTS IN PRINTING, BLOCKING AND STAMPING PRESSES, Herbert zur Nedden, 51, Compton-road, Highbury, London, N.

In the construction of this press the bed is fixed rigid to the drawrods and is kept rigid in parallel position to the platen during the period of pressure. The accompanying engraving shows the construction of the press. The machine frame A carries the stationary platen B as well as the necessary driving gear and cog-wheels. The bed C is rigidly fixed to the drawrods D, with which are connected two rods E and F. These rods are arranged swinging on the drawrods on one end and the other end is arranged on the frame A of the machine. On the lower end of the drawrods is fixed a swinging crank G, the other end of which is connected with a revolving gear wheel, causing the bed of the machine to ascend and descend. On account of the guidance of the two rods E and F the bed is always kept in a parallel position to the platen, which is of special importance during the period of pressure, so that an even impression is produced in any part of the pressing surface whether the stamping tool is fixed in the centre or not. By fitting a roller inking arrangement at the back of the bed, the press can be used for colour embossing.—*June 23rd*, 1909.


Nº 352.

532. 8th January, 1909.—IMPROVEMENTS IN AND RELATING TO TOOL HOLDERS FOR USE IN MACHINE TOOLS, *Erik Walfrid Ericsson, of Nos.* 20-22, *Rue des Petits Hôtels, Paris.*

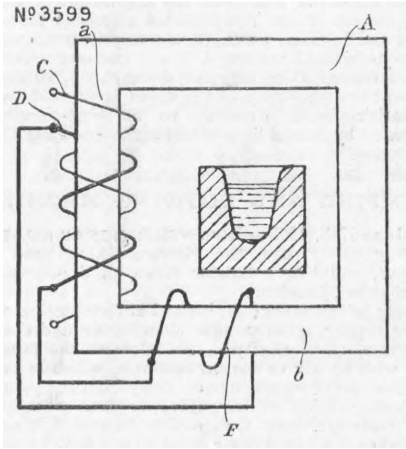
This invention relates to tool holders for use in machine tools, more especially in screw-making and other similar automatic or semi-automatic machines, in which a piece of work, while being rotated, and in some cases at the same time fed forward and withdrawn axially, is to be operated upon by a cutter or other working tool carried in a holder on the machine. Fulcrumed on the screw spindle C, within the tool holder proper A, between suitable vertical guide faces of the tool-holder, is a block B, into which a cutting tool such as E is inserted, a tightening screw D serving to secure the cutting tool in the adjusted position in the block. During the cutting operation the edge of the cutting tool lies approximately at a level with the centre of the piece of work F. When on completion of the operation the work slide of the machine recedes, carrying the piece of work with it, the resistance exerted on the edge of the cutting tool by the piece of work ceases, whereupon the spring H, secured in the tool holder proper A by means of the screw G, acts on the tool-carrying block B from below, thereby causing it to be automatically swung upwards into the position shown in dotted lines in the elevation. In this position the edge of the cutting tool E is no longer in engagement with the piece of work, the latter now being completed. The extent of angular movement of the tool-carrying block B on its fulcrum C may be varied by suitable means, such as a screw K freely extending with its shank portion through an elongated opening L in the tool holder A, and engaging with its threaded-end portion in a corresponding threaded opening on the lower face of the tool-carrying block B. When on starting with a fresh operation the cutting tool has been moved into engagemement with the rotating piece of work, the resistance of the shaving or chip being worked off from the piece of work acts to return the cutting tool automatically into the full line position shown in elevation.—*June 23rd*, 1909.


Nº 532.

MISCELLANEOUS.

3599. February 13th, 1909.—IMPROVEMENTS IN ELECTRICAL INDUCTION FURNACES, *Carl Grunwald, of* 38, *Essenerstrasse, Bredenerg, Prussia.*

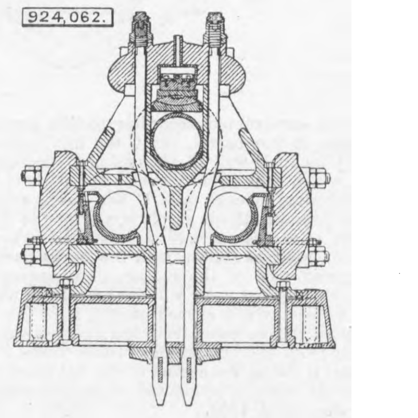
This invention relates to an electrical induction furnace characterised by the fact that upon the part *a* of the transformer yoke A which is surrounded by the primary winding C there is arranged an auxiliary winding D, the ends of which are connected with two points of a limb winding of tho transformer yoke A, and between which, when the furnace is working, a tension is produced which is directed in opposition to the electromotive force induced in the auxiliary winding D, and is less than this by such an amount that there is produced in the auxiliary winding D a strength of current which suffices for the counterbalancing of the electro-dynamic effects arising between the primary winding C and the melting bath, the circuit, which is traversed by the current induced in the auxiliary winding D, being so arranged that the electro-dynamic actions which arise between the melting bath and that part F of this circuit D F which lies outside the auxiliary winding are without any noticeable action upon the equilibrium of the melting bath. The ends of the auxiliary winding D are joined to a second auxiliary winding F, the number of turns in which is less than that of the first-mentioned auxiliary winding D.—*June 23rd*, 1909.


Nº 3599

SELECTED AMERICAN PATENTS.

From the United States Patent-office Official Gazette.

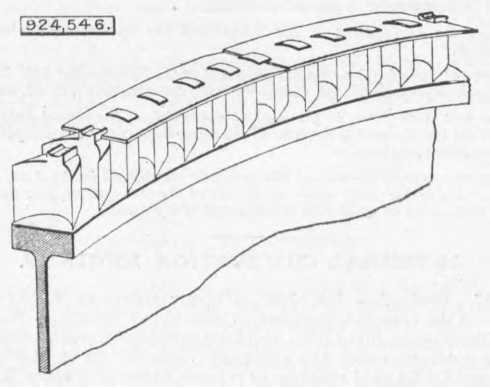
924,062. CRUSHING MILL, *N. A. Helmer, New York, N.Y.—Filed October 1st*, 1908.


924,062.

This patent is for a sugar mill, the special feature of which is the method employed for setting the top roll. The drawing explains itself. There are six claims.

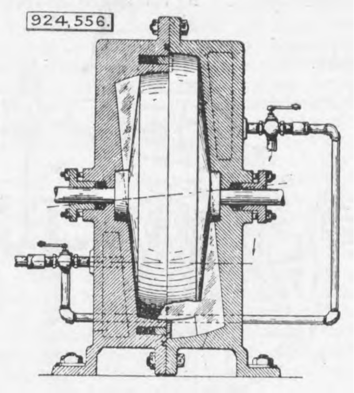
924,546. TURBINE, *W. L. R. Emmet, Schenectady, N.Y., assignor to General Electric Company, a Corporation of New York.—Filed February 24th*, 1902.

In a turbine, the combination of a plurality of vanes, a sectional covering for the ends of the vanes, each section being provided with a plurality of openings registering with the vanes, and tenons which pass through the openings and are riveted over to hold the sections in place. This patent is peculiar in that there are no fewer than thirty-two short claims.


924,546.

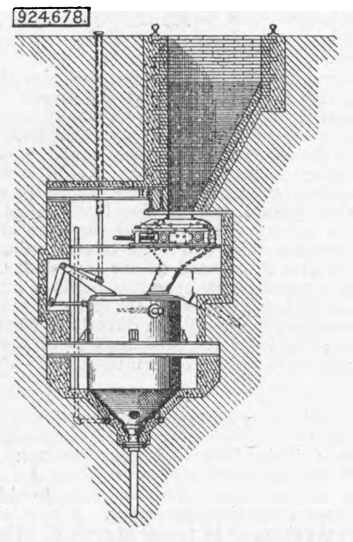
924,556. ROTARY ENGINE, *T. Jorgensen, Martinez, Cal.—Filed November 16th*, 1908.

This patent is interesting in that it is for a comparatively novel mechanical motion. The first claim is for a rotary engine, a casing having an internal diagonally disposed circular chamber, a central shaft, a two-part rotor carried by the shaft within the chamber and a vane or piston movable in the rotor to follow the contour of the chamber. There are seven claims.


924,556.

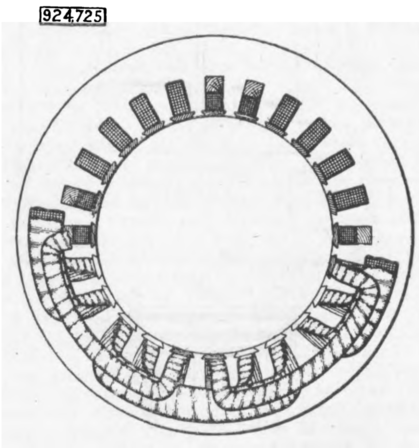
924,678. DEVICE FOR DISPOSING OF ASHES AND CINDERS FROM LOCOMOTIVES, *T. S. Leake, St. Louis, Mo.—Filed May 2nd*, 1908.

This is a running shed appliance. The ashes and cinders and clinkers are passed between rollers, and water is driven in on the crushed material by compressed air. There are thirteen claims.


924,678.

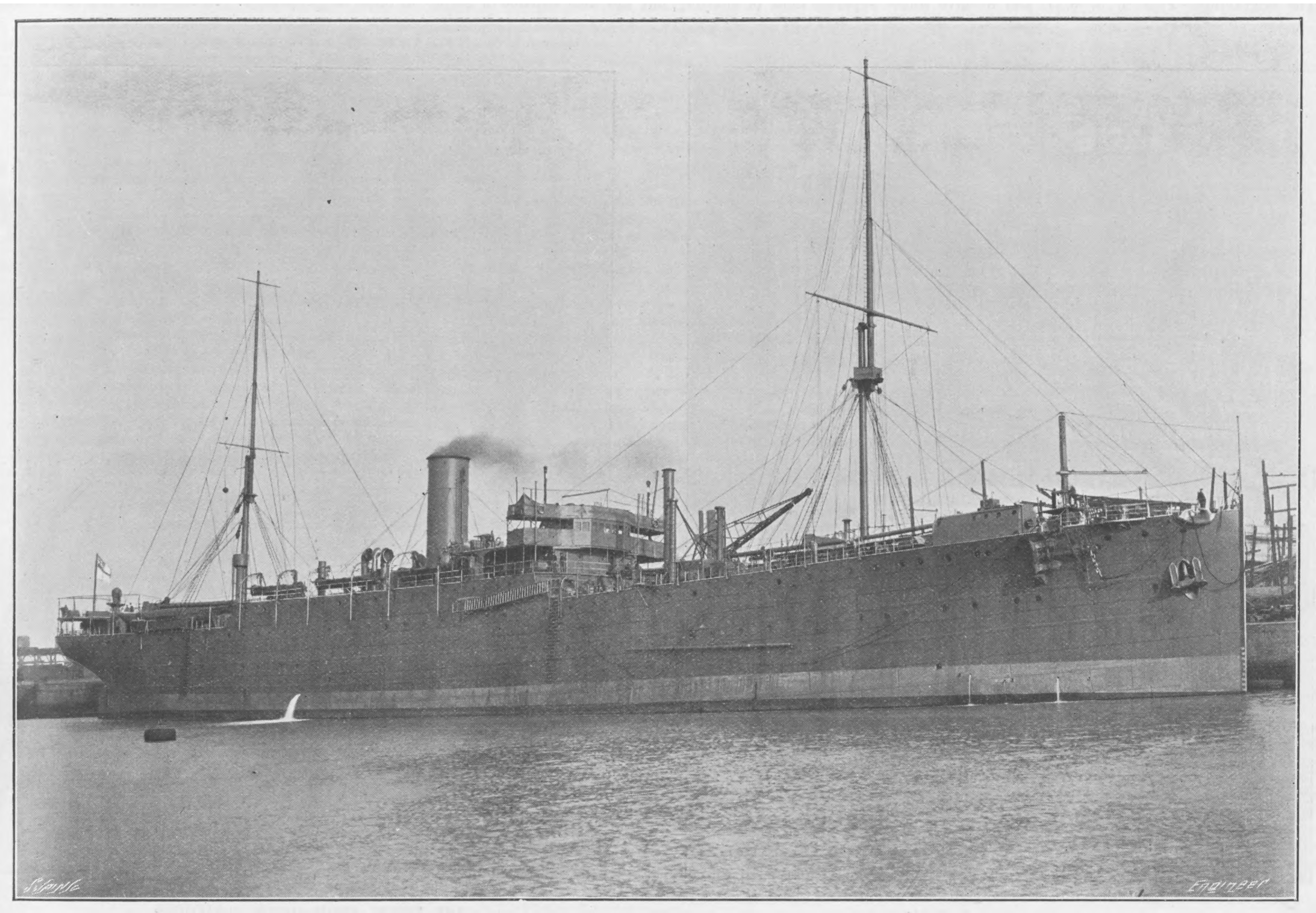
924,725. SINGLE-PHASE MOTOR, *S. R. Bergmann, Lynn, Mass., assignor to General Electric Company, a Corporation of New York.—Filed June 5th*, 1908.

In a single-phase induction motor, a primary member formed with uniform open slots, a low-resistance main winding distributed in and filling certain of said slots, a high-resistance starting winding located in the tops of the remaining slots, non-magnetic means for filling the bottoms of the latter slots, wedges of magnetic material closing the slots occupied by the main winding, and wedges of non-magnetic material for the slots occupied by the starting winding. There are two claims.


924,725

H.M.S. CYCLOPS, FLOATING REPAIR SHOP FOR THE NAVY.

THE Admiralty some eighteen months or so ago took delivery of H.M.S. Cyclops, a floating repair ship, which has been built by Sir James Laing and Sons, Limited, of Sunderland. The Cyclops, which was laid down in July, 1905, to the order of Messrs. T. P. Royden and Company, Limited, of Liverpool, and launched in October, 1905, under the title of Indrabarah, was sold to the Admiralty in December, 1905, and in the January following Sir James Laing and Sons were successful in their tender for the conversion of what was originally designed to be a merchant vessel into a floating workshop for the Navy. The Cyclops replaces the Assistance, which went aground some few years ago, and has a length between perpendiculars of 460ft.; a breadth, moulded, of 55ft.; a depth to shelter deck, moulded, of 40ft. 11¾in.; and a displacement of about 11,500 tons.



HIS MAJESTY'S REPAIR SHIP CYCLOPS

As will be seen by the engraving below, which gives a perspective view of the vessel, she is of the shelter-deck type with a long bridge amidships and a short after bridge. The bold sheer both fore and aft, together with the height of the masts, give her a somewhat imposing appearance. In this same view will be noticed the peculiar method which has been adopted for the stowing of the sheet anchor, and amongst other features here noticeable are the size of the bow fairlead, the number of lifting derricks on the deck, and the unusually high masts—180ft. from water-line—which are fitted to take the Marconi system of wireless telegraphy. At the fore end of the upper deck are enormous steel hawse pipes cast in one piece with the shell and deck flanges; large lug plates, shackles and slips for securing the anchors when heaved up, and a large sheave and cathead for bringing up the sheet anchor, together with other fittings required in the handling of the vessel.

Taking now the views in the Supplement. In Fig. 1 will be seen vertical uprights towards the left, which are utilised for a spar rack capable of taking spars about 72ft. in length, which are converted into sheer legs or used for other purposes whilst repairing. The steam windlass seen in the foreground is of Clark, Chapman and Co.'s extra large type. There are also eight large winches, supplied by the same firm, which are used for the moving of material on this deck, and two similar appliances are fitted on the boat deck. Behind can be seen the portable water-tight hatches, and over all is seen the funnel of the smithy, on each side of which are two derrick posts, which also act as air shafts, and between these is situated the wireless telegraphy house. At the back of this view may be seen the steering screen, which is of unusually large dimensions, and above this again is the navigating bridge, showing distinctly the semaphores used in signalling. This bridge is intended only for use in fair weather, and on account of its unusual height it commands a very wide and extensive view. At the after end of the upper deck—Fig. 2—the principal features are the large derrick worked by two electrical boat hoists, each tested to 36 tons, with all blocks and gear in place. It is of interest to note here that some of the blocks have been tested to 120 tons, owing to the peculiar strains to which they are likely to be subjected. The large 40ft. steam pinnace and 42ft. sailing launch are stowed on chocks in position, and on the port side are 56ft. repairing chocks for use when overhauling other boats. A portable forge and circular saw are also conveniently stowed on this deck. The upper deck is 476ft. over all, and on this deck there are two three-pounder guns.

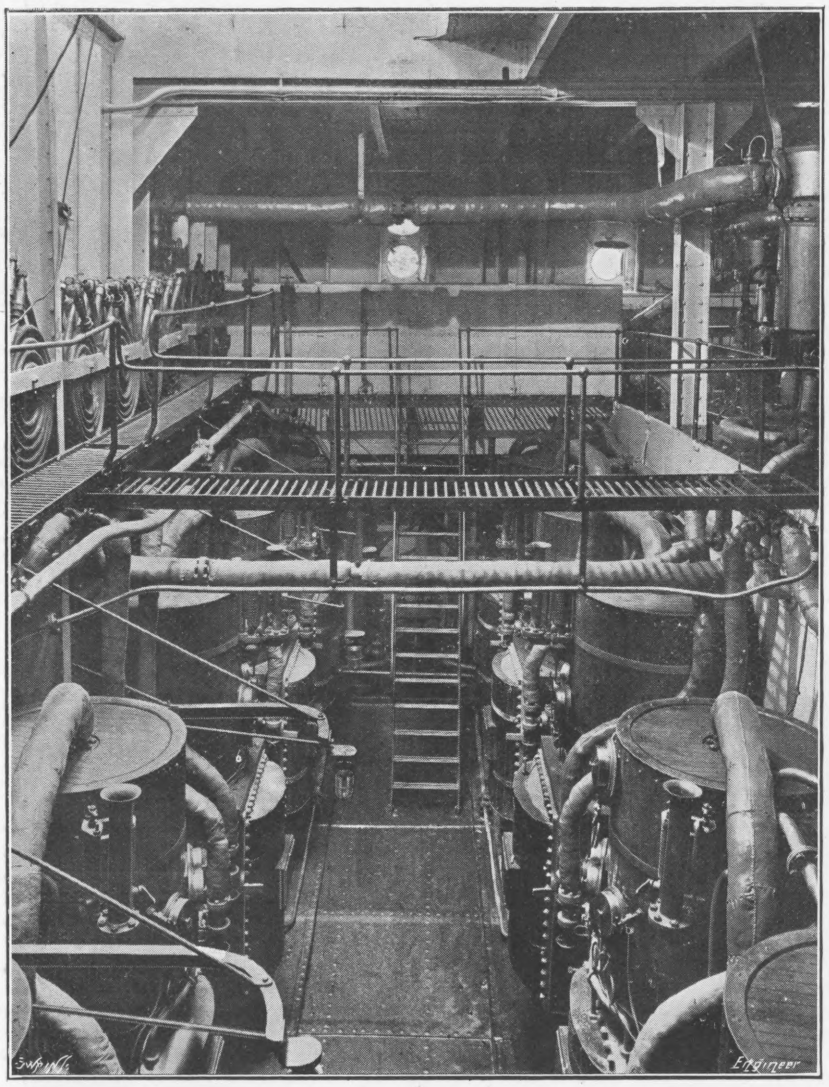
On the boat deck are six boats, including a steam pinnace, two whalers, two lifeboats, and a gig. These are all hung on davits, and the falls are carried to winches aft, an arrangement facilitating quick despatch in hauling them out of the water. On the boat deck are six three-pounder guns. The whole of the coaling arrangements are on this deck, and comprise two hatches, 8ft. by 18ft., in the casings which supply the centre and wings of the bunker, and in addition several small hatches are fitted at the sides for trimming purposes—the whole of the arrangements having been designed so as to permit of the ship being coaled with the maximum facility and despatch. At the fore-end of this deck is the captain's accommodation, centred in one large deck-house, containing a suite of rooms for the captain and his servant. The dining room is a spacious and well-lighted apartment, with walls enamelled white; the fittings are of mahogany, and on the floor is a heavy Brussels carpet laid on the top of special corticine. In one corner of this room is a serving window communicating with the pantry, which latter has every modern fitting. The day cabin is somewhat smaller than the dining cabin, but is furnished equally well. The entire suite is heated by electrical radiators, and in addition there are handsome enclosed stoves burning coal. Electric bells afford communication with the pantry, and also the ship's sentry, and speaking tubes are fitted from the day and sleeping cabins to the steering screens. Immediately opposite the sleeping cabin is a bathroom fitted with hot and cold water and a shower bath, along with the usual lavatory conveniences. The captain's galley is situated a little aft of the deckhouse, and a lift affords communication to the officers' wardroom below. On the bridge deck—36ft. by 55ft.—there is built a large charthouse, fitted with drawers for charts, instruments, &c., and a large upholstered sofa with lockers underneath, heated with an electric heater. In front of the charthouse is the steering screen in which is fitted the steering pedestal actuating the steering engine aft, a large standard compass, rolling indicator, engine-room telegraphs, telephones communicating with various parts of the ship, and an electrical helm indicator which shows the position of the helm in the event of a failure of any part of the control machinery.

On each side of this deck there is a three-pounder Hotchkiss quick-firing gun, a night lifebuoy, which is released by a trigger, and which on reaching the water gives out a light, so that it can be easily seen in the dark, and the latest type of Kelvin's sounding machine for registering the depth of water. Above the bridge deck is situated the navigating bridge, reached by a wide ladder on either side of the chart-house. In the centre of this deck is a revolving chart table, on which the charts are shielded from the weather, and immediately behind is a searchlight capable of being placed on either side of the deck. In front of the chart table is a Kelvin compass, from which a speaking-tube communicates with the wheel below, and by means of a grating hatch the men below are visible. In the front rail are fitted two semaphores, and close to these are the keys for working flashing lamps on the mastheads, and there are also two spring balance lanterns fitted on the after rail. In the upper deck, or in the space below the boat deck, is the accommodation for the officers and warrant officers and the offices in connection with the workshops. The ward room, 21ft. by 20ft., is of interest, inasmuch as it is said to be the largest in the service. This room is situated in the centre at the fore end, and seats about ten people at the main table, whilst at one end there is, curtained off, another table for the officer of the watch, so that his duties may not be unduly interfered with. Immediately opposite the ward room on the starboard side is the ante-ward room.

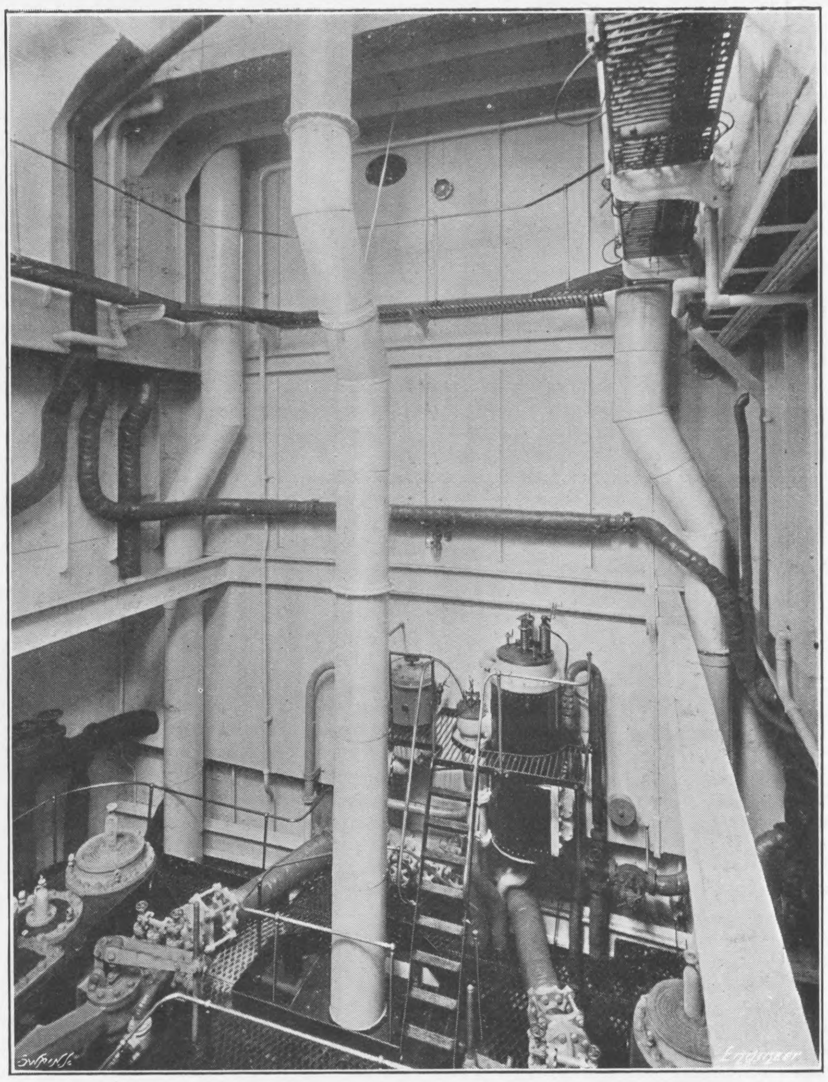
On either side of the ship, on the upper deck, are arranged cabins and anterooms, as frequently in this vessel officers from other ships are likely to be quartered on board whilst superintending repairs. In addition to the usual baths and lavatories, and pantries, there are four large offices, one for the engineers, one for a drawing-office for the ship, and others for the carpenter's and paymaster's departments.

On the main deck at the fore end is the mess deck or crew space. The mess tables hang from the deck, and portable forms are provided. At night the tables are turned up, and the hammocks fastened to hooks above. Above each of these messes are racks for boots, hats, and ditty boxes. The space is well lighted and ventilated by large sidelights. In addition to the galley there is a large electric bakery, containing a large steam-pipe bakery oven, which is said to be the first of this type to be used in the Navy, dough troughs, electrical dough mixer, and cooling racks for bread. Messrs. Moorwood and Sons, Sheffield, were the contractors for the bakehouse machinery. The wash places for the various ratings are of ample size, and fitted in the most sanitary manner possible. The wash basins of enamelled iron are arranged in a hinged tray, which fits into a galvanised trough. Each basin is supplied with a tap from which fresh water may be drawn. In one part are shower baths of salt water which drain on to the floor. The floors are all covered with Terazzo paving, which is an artistic arrangement of marble chips, and are drained to one large scupper at the corner. A Watsonia heater, capable of supplying a continuous flow of hot water, is also fitted in each bathroom for the use of the crew. The sick bay is in this part of the ship, and is fitted with four swinging cots and additional hammocks for accommodation of a total of fourteen. A large dispensary is provided, and amongst its fittings is an operating table.

On the port side amidships is the armourers' shop, 26ft. by 10ft. The whole of the machines are belt-driven off a main shaft, which is run by a motor placed outside the shop. The machines consist of one 5in. gap bed and screw-cutting lathe, one small shaping machine with 6in. stroke, and a small 3½in. lathe. Stowed just outside the shop is a portable forge which folds up into the smallest space possible, and an anvil mounted on a large block. Vice benches are arranged round the shop with various types of armourers' tools close at hand. Adjoining is the electricians' workshop, 36ft. by 10ft., and containing cotton covering machines for electric wire, tape-winding machines, a machine for winding armatures, two Pittler lathes, and a vertical drill. This shop is capable of dealing with almost any class of work likely to occur in the upkeep of an electrical plant. An overhead trolley with a 10 cwt. carrying capacity gives communication with all the other workshops on this deck. In Fig. 3 can be seen the cotton covering machine in the background, the rest of the machinery being behind the wire gauze. In the foreground can be seen the pipe testing machine, capable of testing pipes of large diameter at pressures ranging up to 2000 lb. on the square inch. On the right of this is the manual pump, worked by forty men, and connected by a spindle through the deck to a 9in. Downton pump, which drains the ballast tanks and bilges, or will draw from the sea.



THE DISTILLING ROOM



THE ENGINE ROOM—UPPER PLATFORMS

The engravings—Figs. 4, 5, 6, 7, and 8—give some idea of the light machine shops where all classes of machines suited for light engineering work are installed. Fig. 5 shows the general arrangement of this shop. It will be seen that although little space has been wasted, yet there is ample room between the machines for handling work. On the right of the picture can be seen an 8in. centre lathe, and in continuation are two 6in. centre lathes, whilst on the immediate right of these is a small Pittler lathe. On the left of the picture behind the bench can be seen a fair sized slotting machine, by Smith and Coventry, Manchester, and at the rear there is a double emery grinder, a universal grinder, and a large grindstone. On the other side of the main deck, close to the electric cables, is a 5 horse-power motor, which drives part of this group. In addition to these machines—although not shown in the engraving—there are a large vertical drill, and also a capstan lathe, by Alfred Herbert, Limited, capable of being worked at about sixteen different speeds, whilst no fewer than six tools can be fitted in the capstan head at one time, thus facilitating the speed at which work can be turned out. Fig. 4, whilst giving another view of this shop, affords a better idea of some of the many machines. Seen towards the left of Fig. 8 is a large lathe with 15in. centres, and placed next to it a smaller lathe with 10in. centres, both by John Lang and Son, of Johnstone. Both these machines are belt-driven, and the main shafting runs at about 150 revolutions driven by a 12 horse-power motor. At the back of the picture is a marking-off table of large size, whilst behind is an exceptionally fine machine for bevel wheel cutting, by Smith and Coventry, Manchester, and in addition to these there is a small horizontal milling machine placed between the hatchways, and not seen in any of the pictures. Fig. 6 gives a continuation of this shop, and shows in the foreground a horizontal drilling and boring machine, capable of taking large work, and behind this a vertical milling machine with movable table by W. Muir and Co., and close to this a shaping machine, all these machines being driven off shafting run by a 5 horse-power motor. Fig. 7 gives a view of the pattern shop, showing a wood turning lathe, sensitive drill, circular saw—by Thomas Robinson, Rochdale—with table movable so as to get any angle, and also a large band saw. In addition, there are large stores for the stowage of patterns, and working benches close to the machines fitted with instantaneous grip vices. In the rear of the picture are frames for erecting Belleville boilers. Under the deck can be seen the overhead runaway used for transporting weights from one part to another. Light is gained in this shop by having all the hatches, which are trunked up, fitted with large panes of plate glass, and sidelights of large diameter fitted in about every second frame space.

Large stores are arranged in different places on this deck for tools and spare gear, and there is a special room for the stowage of spare armatures, and another for the rotary converters in connection with the wireless telegraphy apparatus. In the fore end of the main 'tween decks is the boiler shop—38ft. long by 53ft. wide—which is a very lofty space affording about 11ft. headroom. The machinery in the boiler shop is driven off two large 12 horse-power motors, which are connected up to two separate lines of shafting, but are also capable of being run in tandem by means of a belt connecting the two lines of shafting. In view Fig. 9 is shown a large set of rolls by Craig and Donald, Johnstone, for bending plates, at the end of which is a special attachment for rolling angle iron sections. The rolls are driven by means of crossed and open belts. The raising and lowering of the top roll is worked by hand through a screw gear. Next to this machine is a vertical radial drill, by W. Muir and Co., and in close proximity is a smaller set of rolls for light plating. On the other side of the ship is a large punching machine, with shears for plates, and bar sections, also by Craig and Donald. A large slab is placed in a convenient position for bending purposes, and a grindstone is also fitted. An overhead railway similar to that in the light machine shop is fitted in the boiler shop.

Fig. 10 gives an idea of a corner of the smithy, 140ft. by 55ft. This shop is of unusually large dimensions, as a considerable quantity of iron is required for the handling of large-sized forgings, &c. The most prominent feature is the large forging press, by Greenwood and Batley, Limited, Leeds, seen on the right-hand side. Behind this machine is the plate furnace, which will take a plate 8ft. by 4ft. The flue of this furnace runs the full length, and is eventually taken into a large uptake in the centre of the ship. On the left is one of the many 15 cwt. electrically-driven cranes, which is fitted with a traversing gear so that forgings may be regulated in the press or at the fires. A large slab for working plates can be seen just behind the crane. In the shadow is one of the six forges, which, like the furnace, were supplied by Allday and Onions, of Birmingham. These forges are hooded and have hinged plates on each side, so that they may be enclosed if desired. The blast for all these fires is from a Roots blower placed in one corner, with an automatic regulating valve, so that if some of the fires are out of use the others will not receive too great a blast. On the blast pipe are fitted two connections for portable hoses, one for a pot fire, which can be placed anywhere in the smithy, and one for a small portable forge. A folding forge is also supplied to this department for placing on other ships under repair. By the side of each of the permanent forges is an anvil and a tool rack, whilst water and coal bins are close beside each of these. The whole of the smoke uptakes are led into one long flue, which is eventually carried up the same funnel as gases from the plate furnace. Stowage for a large quantity of coal is provided in one corner, and about 3000 fire-bricks for repair to furnaces, &c., are stored in another convenient spot. Racks sufficiently large for carrying bars and sections of all kinds are fitted round the ship's side.

The next shop of importance is the heavy machine shop—Fig. 11. This shop, 38ft. by 55ft., is for dealing with the heavier items in the engineering department. It will be seen that the machinery is of a much heavier type than elsewhere. The lathe by Loudon Brothers, Johnstone, is a large gap bed type, with a face plate 7ft. diameter, capable of turning up very long shafts, &c. The horizontal boring machine—also by Loudon Brothers—seen on the extreme left, is suitable for boring cylinders or other large castings. In the centre is a radial drill by W. Muir and Company, with the working arm of some length. On the right is a vertical boring machine, fitted with two tools, which have a very fine adjustment, the table, on which the work is placed, revolving. In addition to the machines seen in the engraving there are a side planing machine by Richards and Co , Ltd., Manchester, who also made the vertical boring machine, which adjusts itself automatically, and a band saw for sawing steel. These machines are driven off two 12 horse-power motors, which drive the main shafting, and which are capable of being run together by either or both of the motors by means of a belt connection. In the view a very good idea of the arrangements for oiling and attending to shafting is obtained by reference to the gratings, which extend right round the whole shop. The spare gear with which each machine is supplied is fitted against the bulkheads and against the frames. Working benches with vices are fitted here and there, and tools' stores occupy spaces against the ship's side.

The foundry, illustrated in Fig. 12, is situated at the aft end close to the engine-room, and is fully equipped to deal with brass and iron castings of considerable size. On the starboard side is a cupola for iron made by Thwaites Bros., capable of running one ton of molten metal at one charging. The charging door is a few feet above a platform at the height of the main deck, and close at hand is storage for coke and scrap iron, &c. The blower—one of Roots' patent—is worked off a motor direct coupled, and can be run at two speeds, so as to control the melting of the metal. The floor around the cupola is covered with fire-bricks, so that when the clinkers are drawn the decks will not buckle with the heat. The spaces at the sides of the ship are filled with about 100 tons of moulding sand to the depth of about 8ft., and this forms an excellent floor for the moulders. The larger of the cranes shown in the picture is electrically driven, and is used for handling the molten metal from the cupola to the moulds, and generally for the transit of weights from one part to another. From our view it can be seen that this crane—provided by Thwaites Brothers—is fitted with a traversing gear, and is also mechanically turned, the turning gear being on ball bearings. On the port side is a core stove for drying cores, and at the foot of this are six brass fires ranging from 100 lb. to 300 lb. capacity each; they have natural draught, and the flues run into the funnel from the core stove. A 3ft. loam mixing machine is fitted at the after end, and driven by a 5 horse-power motor. A light crane, worked by hand, is fitted to deal with the weights on this side of the shop. In addition to these machines there are moulding troughs, ladles for handling the metal, crucibles of various sizes fitted round the sides of the ship, and mould-boxes and tools of all sorts stored between the tunnels below. Space is also provided for coal, coke, and pig metal.

The carpenters' shop, 60ft. by 48ft., situated at the aft end on the main deck, is fitted with all the most modern machinery for wood working. There is a large floor space, and the whole shop being lofty and well lighted is very suitable for this class of work. In the view—Fig. 13—can be seen a wood-working lathe which is mechanically driven, but which, in the event of a breakdown, can be worked by the foot. On the right of the picture is one of Craig and Donald's small punching and shearing machines for light steel work. Two other machines are the saw sharpener and a pillar drilling machine. On the left hand in the shadow is a grindstone, either belt-driven or turned by hand, and close to this is a circular saw and an automatic cutter and grinder. On the starboard side is a planing machine of 30in. width. These three last mentioned machines were supplied by Ransome and Co., of Newark and London. The machines are all belt-driven off one main shaft, which is driven by a 12 horse-power motor. All round this shop are benches fitted with instantaneous grip vices, and stowed away in one corner is a nest of glue pots heated by steam. There is considerable space for the storage of timber, and large racks are also fitted at various positions in the workshop. In addition to the machines mentioned, several hand machines, such as a mortising machine, a mitreing machine, and other smaller tools are here to be found. Spare gear for each machine is provided and stowed close at hand. Below the carpenter's shop is the coppersmith's shop, which has four fires suitable for heating purposes, &c. The blower is fitted in one corner and is of a similar type to those elsewhere in the ship, and from one of the blast pipes is a hose connection fitted for a ring furnace, which is in the centre of the shops. In the foreground of Fig. 14 is a block suitable for bending material. The most prominent machine is one by Taylor and Challen, Limited, of Birmingham, for circular shearing. In the centre is shown a pipe-bending machine by Clarkson and Beckitt, of Glasgow, capable of dealing with various size pipes up to a maximum of 6in.; whilst towards the right of the same view is seen a sensitive drill. Underneath the floor of this shop is the storage for pipes, bars, &c., and there is here a coke bin for feeding the fires. Round the sides are fitted pipe racks suitable for any length of pipes.

In addition to the foregoing shops, there is a plumbers' shop with benches and one open fire, and also a painters' shop close by. With the single exception of the coppersmiths' shop, all the shops in the 'tween deck are provided with two-ton electric cranes. The power for driving all the workshops and for lighting the ship is generated in a house close to the engine-room, and Fig. 15 gives a general idea of the arrangement of the dynamo-room. The generating plant, supplied by the Sunderland Forge and Engineering Company, Limited, consists of four dynamos capable of giving 600 ampères at 105 volts. The steam supply is led off one main steam pipe, which is passed through a distributing box and then through four separate reducing valves, working at 150 lb. pressure direct to the dynamos. The exhaust is taken up into the main funnel when exhausting into the atmosphere, or it may be diverted to the winch condenser. Spare armatures are provided, and are ready to hand in the event of a breakdown. In connection with each dynamo is a circuit-breaker of double-pole type, fitted with a time limit, and arranged to open the circuit or both poles simultaneously with a reverse current through the dynamo armature. Each power circuit is controlled by a double-pole circuit-breaker, and each lighting circuit by a double-pole linked quick-break switch. The switchboard, which is placed in a separate compartment, is of very elaborate construction. The cables are heavily insulated and have an outer covering of lead, and are all carried on plates—suitable to the width of the cables—on the underside of the beams. From the switchboard the cables are taken to section boxes, and these feed the water-tight distributing boxes from which the lamps are run and controlled, and no branching of cables outside these boxes has been allowed. The motors are of one type, and have slot wound armatures, only two powers being used for the machine shops, namely, 12 and 5 horse-power. An idea of the number of cables running to the switchboard can be gained from Figs. 3 and 5, which show some of the leads, whilst at least four times as many enter the switchboard room. Electric lifts are fitted in every workshop, either for passenger traffic or for lifting material. They are enclosed in a trunk of expanded metal, and in Fig. 12 may be seen part of one of the lift trunks. Each lift is electrically driven, and the motor and controller is close at hand. Pushes for controlling them are placed at each landing, and also inside the cage. Each door has a mechanical and also electrical lock, which is in action until the cage stops opposite to that door, and under no circumstances can any of the other doors be opened whilst the cage is in position, and, further, the lift cannot be worked until every door—including those on the cage—is closed. Consequently the likelihood of accident is reduced to a minimum. For use in the event of one of the lifts sticking in the trunkway, a rope ladder is provided to enable the occupants to descend to the bottom of the trunk. The whole of the workshops, magazine stores, &c., are ventilated by mechanical means provided by Mechan and Sons, Glasgow. Electrically-driven supply fans are fitted in convenient positions, and air lines are carried from these into the various compartments and louvres have been fitted into same. In compartments where a good deal of smoke is given off, additional exhaust fans have been provided, and the speed is such that the smoke is visibly drawn into the uptake. A view of one of the exhaust fans is seen in Fig. 16, and the supply fans are very similar. Hose connections can be fitted to these air lines, so that enclosed spaces such as tanks may be ventilated. In addition to the mechanical ventilation, ordinary cowl ventilators are fitted to the holds and two large wind sails to each hatch. Fig. 16 also shows the air compressor, together with the storage tank made by the Consolidated Pneumatic Tool Company, Limited, London. This compressor is for supplying the power to the pneumatic plant, and is worked at a pressure of 100 lb. per square inch. The pneumatic installation in the Cyclops is one of the features of the ship, and lines of compressed air are carried to all parts of the vessel, and cocks fitted in accessible places for fixing flexible tubes, even to the extent that a line can be taken over the side to any ship repairing alongside. Pneumatic power is used for the caulking and chipping hammers, and also in the drilling and riveting operations.

The distilling plant fitted on the Cyclops is capable of supplying the whole Fleet with fresh water. In the distilling-room, which is close to the dynamo-room, there are twelve distillers by Messrs. G. and J. Weir, capable of turning out 300 tons a day. One of the views on page 78 shows the distiller-room, and shows the mass of pipes fitted in conjunction with the many pumps, &c., required for this plant. On the top of the gratings stowed away are spare coils for each distiller. An ice machine, which is on the ammonia principle, and capable of turning out 200 lb. of ice per day under tropical conditions, is fitted in a special house on the shelter deck.

The propelling machinery of the Cyclops, made by Richardsons, Westgarth and Co., Limited, consists of two sets of triple-expansion engines, with cylinders 20in., 33½in., and 56in. by 45in. stroke, steam being supplied by four single-ended boilers, 15ft. diameter by 12ft. long, arranged with Howden's system of forced draught, and working at a pressure of 200 lb. per square inch. The cylinders with valve casings are arranged in line over the crank shafts, the valve gear being of the link motion type, with steam reversing gear acting on the "all-round" principle. Each condenser forms part of the main framing of the engines, and is provided with an independent centrifugal pump driven by high-speed steam engines in duplicate. The air pumps, which are of the Edwards design, are worked by levers from the low-pressure engine, the feed and bilge pumps being connected to the same crosshead. In addition to the feed pumps on the main engines, a set of Weir's independent feed pumps, with contact feed heater, are provided, the feed water being filtered both on the suction and discharge side of the pumps. The shafting is of ingot steel throughout, and the propeller shafts are fitted with continuous gun-metal liners cast in one piece. The propellers are of the detachable bladed type, each fitted with three manganese bronze blades, and arranged so that the pitch is adjustable. Mechanical tell-tales are worked from the ends of each of the crank shafts, so that the number of revolutions may be seen at a glance, and the direction of rotation is also indicated on a dial on the bridge deck. In addition to the main condensers there is a large auxiliary condenser of the "Contraflo" type, fitted complete with separate centrifugal pump and Weir's direct-acting air pump. Other engine-room auxiliaries include two large ballast donkeys, fresh water and sanitary pumps, Morison's evaporator, &c. The scantlings of the engines throughout are very substantial, and the whole of the machinery has been designed with a view to a high rate of piston speed.

EXPERIENCE WITH SUCTION GAS PRODUCERS.

No. I.

A LARGE number of suction gas plants has been erected in Great Britain during the last five years, and in combination with suitable gas engines this method of producing power is admitted to be the most economical for all purposes up to 200 or 250 brake horse-power, and for plants of still greater power it is proving a severe competitor to the steam engine and boiler. Suction gas plants require only a small amount of attention, and generally give satisfaction; but in some few cases they have not run so well a few weeks after use as they did when first started by the maker. This is usually due to some small matter not being understood by the attendant, or to some cause which cannot be easily seen by an inexperienced workman owing to the plants being closed up when at work. The following notes of actual experience in the manufacture and working of suction gas plants may assist engineers who have not the wide experience of the well-known gas engine makers, but who have sometimes to advise upon the buying, running, &c., of gas engines and suction gas plants.

GAS ENGINES.

Almost all the well-known types of gas engines and suction gas plants can be made to work together, but for unskilled users it is an advantage to obtain the engine and plant from one firm. This will ensure the engine having been correctly adjusted to suit the gas from the plant, the engine can be tested with suitable gas before leaving the maker's works, and it will prevent the shirking of responsibility for efficiency and good working which generally occurs when the various parts of a power plant, the success of which depends upon the proper working together of these parts, are obtained from different makers.

In specifying the power of the engine it must be remembered that gas engine makers generally state the power that can be obtained at their works under the very best conditions of working, with the engine new and adjusted by trained men to give its maximum efficiency. A margin should always be allowed between this and the power required in every-day working, or a stipulation should be put in the contract that on a test of several hours' duration the engine must give the specified load when using only 85 per cent. of the maximum number of explosions. Thus in an Otto cycle engine running at 160 revolutions per minute the maximum number of explosions possible is 80, and 85 per cent. of this equals 68 explosions or "fires" per minute. This will leave a margin for losses due to leaky piston, dirty valves, poorer gas caused by an inferior load of coal, clinker, &c., and will be ample for power plants working under varying loads; when the engine has to drive pumping machinery, or do similar work in which the load is always at or near its maximum for eight, ten, or twelve hours per day, an even larger margin should be given, depending upon the conditions, and it is advisable in such cases to obtain the advice of an expert engineer.

In comparing offers for engines the price should not be the only consideration, but it should be taken in conjunction with the size and details of the engines offered. Careful attention should be given to all points, including:—Diameter of cylinder; length of stroke; compression pressure, which should be about 130 lb. to 160 lb. per square inch; revolutions per minute; size of crank shaft and its bearings; and methods of lubrication. The engine should be fitted with magneto ignition, preferably with variable timing arrangement.

Though the magneto-ignition arrangements have been considerably improved during the last two or three years, they are still liable to occasional failures; these generally occur at starting, and are usually due to damp deposited on the sparking points of the ignition plug, whilst the engine has been standing, or to failure of the insulating material or wires carrying the current. The first trouble can generally be overcome by taking out, cleaning, and warming the ignition plug. In one case of difficulty with the plug the engine driver, who lived close to the engine-house, used to withdraw the plug every evening, and leave it in his "oven" all night. The plug was put in place again just before starting the engine. This plan quite cured the trouble in starting; but such treatment is hardly necessary in ordinary work, as failures are very few. In another case an officer in the R.E. had a spare plug supplied for each of the engines under his charge, which could be quickly fitted if the first one failed, and thus minimise the time lost in starting the engine.

Existing gas engines.—When the suction gas producer first appeared the users of existing gas engines then at work on town's gas naturally wanted to avail themselves of this cheaper method of working, and many old engines have been supplied with suction plants with more or less success, the principal objections being that the same power cannot be obtained from an engine using producer gas as can be obtained by the use of town's gas, and an old engine seldom has the margin of 20 to 25 per cent. over its maximum power demand that is necessary to work successfully with producer gas. This loss of power may be partly avoided by increasing the compression pressure, but when this is done there is a risk of putting too heavy a load on the crank shaft, which has not usually been made too strong, and an increased stress will generally cause breakage at an early date.

Engines not designed for use with producer gas usually have the compression too low; the gas valves and passages are also too small to pass the quantity of producer gas necessary for efficient working, which is from four to five times the amount of town's gas used in the same engine. In some engines the gas valve has been increased, and the passages opened out to a larger size, but in many cases this is not possible.

In a certain small engine of about 6 brake horse-power the gas inlet could not be enlarged, and the firm supplying a gas plant put an extra gas connection into the air supply pipe; this was not properly controlled by the governor, and allowed gas to find its way into the air box, causing noisy explosions. The air also passed through the connecting pipe and mixed with the gas in the scrubber, with the inevitable result of an explosion, which blew the flexible top off the scrubber, luckily without injuring anyone, though it caused considerable alarm. This arrangement was obviously wrong, and as the engine was altogether too small to show any economy by the use of suction gas, the plant was taken away, the engine put back to its original condition, and set to work again on town's gas. The change should never have been made, and was only done to show "sales" by agents who took no responsibility as to working.

Leading gas engine firms are very careful about supplying suction gas plants to their old engines; some firms absolutely declining to do it, and others only doing so when the engine is of recent manufacture, has ample margin of power, and can be altered to high compression and magneto ignition; which really means making it equal to a new engine. In most cases, the wiser and safer policy has been adopted of recommending the purchase of a new engine, which can be supplied of ample power, and being specially built for suction gas is sure to give satisfaction.

In some cases old engines are worked successfully on suction gas, but they have ample margin of power over the work to be done, and the latter is not subject to much fluctuation. Under these conditions a skilled engineer can get a plant to work even when using the tube ignition employed with town's gas, but such conditions rarely occur, and with low compression a small drop in the heat value of the gas will cause missfires and sometimes stoppages of the engine. The economy also suffers in such cases, and a small increase in first cost to secure a new engine will generally prove more economical in the end.

Several of the plants supplied to existing engines have been made by inventors who had not much experience with gas engines, but whose faith in their plants working under any conditions, favourable or otherwise, is more remarkable than justifiable. One inventor undertook to supply a suction plant and alter an old engine which he was shown, to work with the plant. The engine proved to be of the slide type, quite twelve years old, with about 50 lb. compression, and had been left in the open air for a year or two. In another case it was agreed to supply a plant to provide gas for an existing gas engine driving a small mill, which, up to that time, had been using town's gas. The plant was set to work, and considering the low compression—65 lb. to 70 lb. per square inch—worked well, but the miller complained of the power being too small, only reaching 75 to 80 per cent. of what he had previously obtained with town's gas. When he was informed that he could not expect so much power with suction gas, he replied:—"Your agent, ——, said I would get the same power, and Mr. ——, the patentee, has confirmed it." On looking up the correspondence it showed that in their anxiety to secure an order, these gentlemen had given a written undertaking to do what both should have known was impossible. It was afterwards explained that they hoped by careful timing of the engine, resetting and cleaning the valves which were not in the best of condition, to get the engine through a satisfactory power trial. The plant had to be taken away and the engine again worked by town's gas, causing considerable expense to both parties.

In another case where the engine was only five or six years old, working on a steady load, and with ample margin of power, the plant did well. The consulting engineers had, however, insisted on having two means of ignition on the engine, viz., by magneto, and also by retaining the old gas heated ignition tube; when started on suction gas the engine would always fire its charge from the tube ignition, but often missed ignition when using the magneto; this trouble was found to be due to the long distance the sparking plug was placed away from the cylinder and the small size of the passage for the gas; when this was remedied the engine worked equally well with either ignition in use. The makers of the engine, who also supplied and fitted the magneto, first claimed this difficulty to be due to poor gas, although the engine worked well with the same gas when fired by tube ignition, and it was some time before they would even admit that their arrangement was faulty.

Another plant to supply a 40 brake horse-power converted oil engine gave considerable trouble when first erected, principally because defective workmanship allowed air to leak into the plant in several places. When the generator was replaced by another of more suitable size and design the plant worked well, but after running about three months the fire would not keep alight overnight, and there was much difficulty in finding the reason. At last it was found to be caused by a bird's nest having been built in the waste pipe!

The manager of this engine claimed to get 42 brake horse-power with this plant at a cost for coal of under 5d. per hour, including stand-by losses, which was very much less than he previously paid for coal used by a semi-portable steam engine and boiler doing the same work. The figures of coal cost were based on twelve months' working, but it is probable that the horse-power was overstated, and did not average above 30 to 35 brake during working hours. The success obtained with a low compression of about 70 lb. per square inch was obtained by having a cylinder of ample size, a regular load during the working time, and proper attention to cleaning, &c.

To show the short-sighted carelessness of some gas engine owners, mention may be made of a gas engine working at a foundry which it was proposed to run by a suction plant; on examination the engine was found to be smothered in sand, and the piston and cylinder were leaking so much that most of the charge found its way past the piston rings. The owners would not agree to protect the engine in any way nor have the cylinder rebored and a new piston fitted, although the gas bill must have been very heavy. Needless to say, no attempt was made to work this engine with suction gas; the owners were promptly notified that it was not suitable for any kind of gas in its existing condition.

THE MANAGEMENT AND EQUIPMENT OF AN EXPERIMENTAL TANK.

No. II.*

The dynamometer carriage.—We have already published descriptions of the dynamometric apparatus—THE ENGINEER, October 2nd, 1908—and there is no need to describe it in detail here. Briefly, it consists of a rigid framework on wheels, running upon rails accurately laid and planed. It is driven by a motor or motors acting through one or more of its axles. The current from the generator is communicated to the motor either by an overhead trolley system or by a third rail. The dynamometric apparatus carries a lever very much in principle like a scale beam arranged vertically. The upper end is held by a spring, and the lower end is furnished with means for towing the model, the fulcrum being as nearly frictionless as possible. Springs may be changed and initial tension adjusted to suit the particular resistance to be measured. The motion of this lever is magnified by another, carrying a penrod, by which its position is recorded on a paper wrapped upon a revolving drum. Needless to say, the levers and penrod are carefully balanced, and the moving parts arranged to give a minimum of friction. The model is guided along its course when running by balanced guiders, suspended from the framework of the carriage. Calibration of the spring is made in the ordinary way. Elaborations of this simple method have been made with a view to reduce the amplitude of the oscillations of the lever and to obtain a more regular diagram. Electrical control of the spring tension, acting automatically when the movement exceeds a certain prearranged small amount, has been adopted, but "the game seems hardly worth the candle."

At Washington and Uebigau this system has been used, but even with the small amplitude of motion allowed—a fraction of a millimetre—there is a tendency to hunt, which has led to "damping" having to be resorted to. A system by which the main portion of the resistance is balanced by a weight, and the residuum measured, gives the advantage of an open scale of measurement, but the same object is attained, if necessary, by using a back balance weight applied to the dynamometer lever. From practical considerations, where speed of output is essential, and a junior operator usually makes the resistance experiments, the simpler the apparatus the better. Time, and speed over the rails, are registered electrically by ordinary recognised methods. Diagrams are often needed to show the amount of "squat" which a vessel has at trial draught and speed. These are obtained by means of vertical penrods, marking upon vertical "trim cylinders" covered with paper, at either end of the carriage.

The relations of speed and resistance of model to those of the ship are, of course, based upon Froude's law. Speed varies as the square root of the dimensions, and resistance varies as the cube of the dimensions for similar forms, subject to surface friction correction.

The processes briefly sketched, up to the point of obtaining the resistance of a given form, and hence deducing the E.H.P. of the ship, without excrescences, may be accomplished, when necessary, within three days of receiving a drawing of the form decided upon. Rapidity of despatch is of first importance where a tender has to be sent in within a specified time, for practically everything depends upon the E.H.P. necessary to fulfil the conditions.

The propeller carriage.—If it is desired to test a proposed type of propeller, or to compare two or more types behind the ship model, then the model, if of a twin, triple, or quadruple screw ship, must be fitted with excrescences similar to those of the ship. Meantime, unless suitable types of propellers are to be found among those in stock, new ones must be made. There are three methods of making them:—(1) Casting blades and boss in one. (2) Casting blades and boss separately, and combining them afterwards. (3) Cutting the pitch from a rough matrix by a specially designed machine.

The first method is the usual one, the latter will probably be found to be an improvement in accuracy and despatch. The propeller moulding machine consists of a plane bed-plate, surmounted by an arched casting. The propeller spindle is fixed in centres between the two, in a vertical position. Upon this spindle slides a "strickle" with a sharp edge, which can be set horizontally or inclined, according to whether the propeller is to be "ordinary" or "coned back." Two hollow vertical posts are fitted on the bed-plate, at such a distance from the spindle as to leave room for a normal model propeller to be moulded inside the circle passing through their centres. These hollow posts are slotted, and by means of screwed rods inside them, a nut can be made to move up or down each slot to any desired position. To these nuts is screwed a circular strip of metal, in such a way that the top edge can be made to represent a helical curve of definite pitch. The centres of the vertical screwed rods subtend an angle of 90 deg. at the centre of the propeller spindle, so that by setting one of the nuts a distance equal to one-fourth of the pitch above the other, the top edge of the brass strip represents the pitch-line. Clay is now built up on a wooden platform fixed to a horizontal disc on the spindle, which is divided according to the number of blades the propeller is to have. The strickle is made to slide down the top edge of the circular metal strip, and so sweeps out the true pitch surface. The direction of inclination of the strip determines whether the propeller is to be right or left-handed. Having got the clay moulded, a plaster of Paris cast is taken of it. When this has set, the clay is taken out and the plaster cast put in its place on the spindle. The blades are now moulded in clay on the plaster of Paris pitch surface, a metal boss being on the spindle as before. A second plaster cast is taken of this, and the clay blades and boss removed. From the pair of moulds when stoved castings are got, having the driving side of the blades accurately pitched. This pitch surface is only lightly touched up, but the blade is thicknessed by filing away the back to the required sections.

The propeller carriage differs very much from the dynamometer carriage, in that it is designed to measure two separate sets of forces. The efficiency of a propeller is measured by the relation which the turning power it absorbs, bears to the thrust power it exerts; so it is necessary to measure both thrust and turning force. The method adopted for obtaining screw results follows directly upon the resistance tests described above.

After the ship model has been fitted with shaft-tubes, &c., further experiments are made to obtain "resistance with bosses." The propeller carriage is now connected to the dynamometer carriage by a towing rod having a fine adjustment. Instead of the propellers being attached to the model, as they are in a ship, they are carried upon shafts which are a part of the propeller carriage, and in such a way that they are in their right position relatively to the ship model when test runs are being made, but wholly disconnected from it. When the propellers are run behind the model, it is at once seen that the resistance has been thereby increased. This is the result of interference with the stream line flow of the water round the ship by the suction of the propellers, and its effect is called the "augmentation of the resistance." This augmented resistance, subject to surface friction correction, represents the thrust which must be exerted by the propellers, when they are supposed to be driving the model.

Froude's original propeller carriage was designed to record the thrust, by a delicately balanced swinging frame which carried the propellers, and was in principle not unlike the dynamometer which measures the model resistance. Turning force was measured by a band dynamometer, so arranged as to record the difference in tension between the driving and following parts of the band. Revolutions being also automatically recorded, the turning power was easily obtainable. Deductions were made for the idle power absorbed by the apparatus running under similar conditions to those of the experiment. Care was taken to pass the turning force bands over pulleys, whose centres were exactly in the plane of suspension of the swinging frame, so that the turning force had no moment to affect the thrust record. This instrument has been described in detail many times. Its drawbracks are that the speeds of band, and the forces to be dealt with in modern turbine work, having become so much larger than was originally contemplated, it is more and more difficult to obtain results with accuracy. Moreover it makes no attempt to differentiate between the propellers under test, that is to say, it gives a lump thrust and a lump turning force, and the difference of efficiency between, say, the side propellers and the centre propeller, of a triple screw steamer in association is unobtainable. For single screw, and even for twin screw problems, this feature was not a serious one, but triple and quadruple screws demand a separate analysis of the propeller results. Consequently we see the design of the propeller carriage being altered in recent establishments. In the tank at Dresden (Uebigau), for instance, the carriage has been fitted with two swinging frames, registering separate thrusts, and the turning force of each shaft is measured by a small spring torsionmeter independently. This complicates an instrument already difficult at times to handle with rapidity and accuracy, but complication is not only unavoidable, but absolutely demanded by the new conditions of marine engineering.

The method of operation is to run the carriages at a constant speed, corresponding to the speed of the ship for which information is required. Every endeavour is made to make this speed vary as little as possible during the experiments. During the runs, the ship model is extending the resistance spring, and is also trimming by the stern, and the propellers are exerting their thrust and extending the thrust spring. Due allowance must be made for these movements in setting the relative position of the two carriages, fine adjustments being provided for the purpose. Experimental runs are made at constant speed, but with variations of the number of revolutions of the propellers; and the various forces are recorded. When a complete set covering the required conditions has been made and plotted, the revolutions necessary for the speed are obtained by noting where the net thrust curve crosses the net corrected augmented resistance curve. This is the condition where the thrust forces exerted by the propellers, exactly balance the resistance forces demanded by the ship model. Revolutions of ship propeller and model propeller vary inversely as the square root of the dimensions, and from this the corresponding revolutions for the ship propeller are obtained.

The run is thus completely analysed, the various items recorded being speed, revolutions per minute, augmentation of resistance, thrust, and shaft horse-power, and hence efficiency of propellers. If it be desired to measure the wake, the ship model is removed and the propellers run in open water at such a speed that the same thrust is obtained at the same revolutions per minute as before. This is done by trial and error, and the difference of speed is the wake in the region of the screws. Thrust and turning power are calculated from the forces measured at this speed. In practice it will be found that corrections have sometimes to be applied to both revolutions and power, and these are found by similar experiments made with models of previously built and tried ships of the nearest type to that under consideration.

Electrical equipment.—As has been already pointed out, the electrical power necessary depends almost wholly on the type adopted when designing the span of the rails, and the consequent weight of carriages to be accelerated. The power at present provided in various tanks varies between 8 and 200 horse-power. The latter power is very much greater than is necessary, if care be used to keep down the moving weight in the design, while the latter probably leans a little to the small side. So the actual amount of power must be contingent on the previously decided type of carriages. The Ward-Leonard system is employed in several tanks with success. In the Paris tank the current is taken directly from the city supply, and it is reported that there is no great inconvenience caused by variations of the voltage. Obviously this is a very doubtful plan to adopt. It is better to use a battery of cells designed to give the necessary voltage, say, 200 or 240 volts normally, with a margin of cells to make up losses during discharge. A motor generator driven from a convenient source, such as the shipyard or town supply, serves to charge the cells during the hours when the tank is not running. When it is in operation, to drive the carriage, this generator is driven from the cells with a constant voltage, and supplies current to the motor or motors on the carriage. Thus there is no chance of possible variation from outside sources. If an overhead trolley system of distribution be adopted, the wiring should be so arranged that the resistance due to the cables is a constant at all parts of the tank, otherwise there will be an added resistance when the carriages are at the end of the tank furthest from the generator. In some tanks the speed is wholly controlled by introducing varying amounts of resistance in the armature coils of the driving motor. The range of speeds in a tank being so considerable, this method is open to objection, unless a large surplus of power be provided. A better plan is to introduce change gears and to limit the variation of the driving motor speeds. By this means the greatest portion of the maximum power of the motor is always available, and accumulation troubles are reduced to a minimum. Electrical brakes are fitted on both axles, which come into action when the current is broken by the automatic knock-off switch at the end of the run.

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* No. I appeared July 16th.

Problems occur occasionally in ordinary shipyard work where ships of moderate speed have to do their service running in more or less shallow water. Similar cases crop up when high speeds are in question, greater actual depths then becoming relatively shallow. In order to investigate these cases, it is convenient to have a permanent or semi-permanent means of reducing the depth of the tank while keeping the surface level unaltered. A false bottom adjustable to varying heights, and extending for 100ft. or 150ft. of length, is usually sufficient, and may be arranged for, according to circumstances.

The normal conditions for tank work are, of course, clean surfaces of hull, and smooth water. It is sometimes desirable to know the effect of waves upon resistance. A simple transverse wooden plane arranged below the surface, and suspended pendulum-wise at one end of the tank, may be oscillated by hand, or by mechanical means, at suitable regular periods, to produce any desired wave length corresponding to the sea conditions under consideration.

Without going into further detail the above sketch describes in general outline the equipment necessary to carry out model experiments. There are many other subsidiary operations which require special pieces of apparatus, but these are simple, and means to cope with them will readily suggest themselves. For instance, paddle-wheel experiments are carried out essentially in the same way as screw propeller experiments, with the necessary modifications to suit the case. An important experiment in this connection is the reading of the profile of the wave on the side of the model of a paddle steamer; and more important still is the necessity of accurately observing the change of level of the water surface in the region of the paddle-wheel, caused by the waves generated in running. Transverse sections of these are constructed from observations made, and this determines the height of the centre of shaft necessary to give correct immersion of the paddle floats.

Rolling extinction diagrams may be taken to obtain the effect which bilge keels of varying dimensions and positions have in reducing rolling.

The directive effect of varying types, dimensions, and angles of rudder is easily obtained by a modification of the after guider on the dynamometer truck. The guider is then arranged so that the side pressure may be taken up by a spring adjustment, the force necessary to keep the model in a fore-and-aft position being thus determined. These and other problems have to be dealt with as occasion demands.

Ship trial records.—The second group of instruments comprises those that have to do with observing and recording the performances of actual ships on trial. It will be apparent that much benefit is likely to accrue to all concerned when the staff which makes the model experiments and calculations has also to deal with the actual ship performances, and the point need not be laboured.

The method of obtaining speed and revolutions, up to a comparatively recent date, was by stop watches and revolution counters. This method is, of course, still used, because the results are immediately available at the moment. Where high speeds are in question, and guarantees have to be obtained, small differences of time become important. Every precaution should be taken to make the stop watches as accurate as possible. They should be rated every day by a standard clock and the variations registered and corrected. Before a trial they should be specially rated over the time which elapses during the run on the measured knot, and kept fully wound. With all the care possible, however, stop watches are apt to be irregular, either from lag in stopping and starting the stop mechanism, or from position error.

In addition to the ordinary method, a speed-recording machine is now used. This machine, which is placed in a quiet cabin, has a continuous paper made to pass under a row of electric pens all in a transverse line. The paper drum is driven by clockwork or other means at any required speed. Two well-made, specially rated clocks actuate two of the pens, and record half-seconds, with a break at intervals for convenience of counting. Other pens are connected by temporary wiring to make-and-break arrangements on the propeller shafting or counters. Another is connected by a double wire to the bridge, for the use of the observer who is officially taking the speed. He is supplied with a stop watch for use in the ordinary way, but it is fitted with an electric contact maker at the push of the stop mechanism. When approaching the mile, this observer on the bridge warns both the engine-room staff and the operator at the recording machine by signal. The latter immediately starts his driving clock and the rest is automatic. When the mile-posts are in line the observer starts his stop watch in the ordinary way, the action simultaneously makes an electric contact, which causes a movement of the corresponding pen on the speed recorder. Thus a complete record of the time and revolutions on the measured mile is obtained. The electric current actuating the pens is supplied from a small storage battery, or rather from two batteries, for the machine is wired in duplicate so as to obviate a chance of breakdown. It has the great advantage of giving a permanent record of the whole run. The time clocks are not touched in any way, there being no need of stop work to record the time elapsed on the measured mile, because it is recorded on the diagram.

This machine may be used to obtain a complete record of a stopping trial, such as is sometimes asked for by owners of a new turbine steamer. In addition to the pens of the speed machine already mentioned, another pen records the revolutions of a drum secured at some convenient place on the extreme after end of the deck. This drum has wound upon it a long length of fine cord previously measured. The end of this fine cord is joined to a sufficient length of a stouter cord, which is in turn fastened to a float suspended from a beam over the rail.

To take the record, the ship is set to run at the speed from which the stopping trial is desired, and a warning signal is given to the operator of the speed machine, who starts his driving clock. At an agreed upon second signal, the "reverse" is given on the engine-room telegraph, the stop-watch on the bridge is started, which makes an electric contact on the diagram, and the float is dropped from its suspension simultaneously. The float is so made and weighted as to offer the maximum of resistance to passage through the water, consequently the cord attached to it revolves the drum as it unwinds. Meantime, the revolutions of the propellers are lessening and finally begin in the astern direction. When the ship has been brought to rest, the watch is again stopped and the speed recorder also stopped. The diagram obtained is a complete permanent record of all the particulars; time to come to rest, distance run—which is known from the number of revolutions of the drum and its circumference—time elapsed before the engines are reversed, and rate of reversal. The distance run may be checked by measuring either the length of cord which has run out, or the amount remaining on the drum. Curves giving a graphic record of the stopping trial are plotted from careful analysis of this diagram.

The only reliable method of obtaining the actual power developed in a marine turbine is by means of torsionmeters on the shafting. Whatever the type of torsionmeter, or torsion recorder, adopted, the observations or records, may be fittingly taken by the tank staff, whose business it is to do similar work. If vibration experiments are wished for, these records are obtained by some form of vibrometer, and may also be undertaken by the same staff.

THE WORKING OF INDIAN RAILWAYS.

AN uninterrupted record of eight years of financial prosperity to the Government of India as the result of the working of the State and guaranteed railways has now been checked by a year of net loss which exceeds in its amount that which occurred either in 1898 or 1899 or in both these years in combination. It is necessary to remember that the Indian financial term ends with March in each year, whilst the calendar year is used by the Indian Railway Board in reporting on the administration of the railways, but this circumstance does not make any alteration in the fact that a serious loss was incurred either in the twelve months ended with March, 1908, or in the year which terminated with last December. According to a White Paper which has just been issued from the India-office, and which contains a memorandum relating to the accounts of the Government of India for 1907–08 and the estimates for 1908–09 and 1909–10, the gross earnings of the railways in 1907–08 declined below the Budget estimate by £2,414,000 in consequence of unfavourable harvests and general commercial stagnation, and the working expenses, on the other hand, increased by £1,410,000. The causes of the augmentation are to be found, among others, in the rise in the price of coal, large expenditure on grain compensation allowances to servants entailed by high prices, and increased outlay on wages following on the recent labour troubles. In addition, unusual activity was manifested in the improvement and renewal of the lines, which the railway companies considered necessary for the safety and efficiency of the railways, and for the execution of which the lightness of the traffic afforded a favourable opportunity. The unsatisfactory conditions which are thus registered down to the end of March also prevailed during the remainder of 1908, judging from the administration report of the Indian Railway Board on the working of the State and guaranteed railways down to the close of last December. The report, which sets forth in figures what was only intimated in the statement introducing the Budget last March, indicates that the working of the railways, after meeting all charges, resulted in a loss of £1,500,000 to the public Exchequer in 1908. The net earnings on the open lines afforded a return of 4.33 per cent. as contrasted with 5.86 per cent. in 1907. The latest returns of the railway companies themselves, which have just been published for the second half of 1908, also confirm the effects of the economic depression and the growth in working expenses, as ten out of fifteen companies experienced a considerable diminution in net receipts, and eleven of them an expansion in operating expenses.

The conditions which have led to the present position of the Indian railways are believed to be both of an exceptional and of a temporary nature. In the course of his financial statement to the Government of India last March, Sir Guy Fleetwood Wilson remarked that it would be futile to conceal how serious an anxiety the recent activity in repairs and renewals had caused in the face of a heavy decline in the revenue, and he added that it would clearly be necessary to relax the pace at which these improvements were being carried out. Apparently, the words "recent activity," apply to a period of several years in the case of expenditure incurred in purchases for Government account and the cost of labour in connection therewith, whilst the past two years only come into consideration in relation to the companies. The circumstance may be illustrated by reference to the recent Bluebook, containing the tables respecting the trade of British India in 1907·08, and the four preceding years. It is shown, for instance, that the private imports, as distinct from those included under the heading of Government stores, amounted to £4,800,000 in 1907·08, as compared with £2,772,000 in the preceding year, and the former total was also slightly in excess of the whole of the imports in the previous three years. Out of the value in 1907·08 the sum of £3,264,000 represented coaches and wagons and locomotives and tenders, the balance being composed of rails and fastenings, iron and wooden sleepers, and other constructional materials. When, however, we come to the imports of Government stores, it is indicated that a very considerable diminution took place in the year in question, although the amounts devoted to the acquisition of locomotives, coaches and trucks, and materials for construction, were of large dimensions in each of the four preceding years. The value under these headings was £1,791,000 in 1907·08, as contrasted with £2,889,000 in 1906·07, £3,410,000 in 1905·06, £2.803,000 in 1904·05, and £2,823,000 in 1903·04. It would, therefore, seem that without waiting for the ascertainment of the actual financial results for 1907·08, the Government, on the one hand, had already very largely restricted the expenditure on the purchase of rolling stock and materials, whilst, on the other, the companies enjoyed greater freedom of action in requisitioning similar stock and materials in the identical year.

The revised Budget Estimates for 1908·09, according to the financial statement of the Government of India, show an estimated decrease of £3,674,000 in the net earnings of the railways, although this computation does not necessarily imply that this represents a loss or that there will be a repetition of the deficit in 1907·8, especially in view of Sir Guy Wilson's statement that the railways could not again be allowed, even temporarily, to become a net burden on the general taxpayer. On the other hand, the Budget Estimates for 1909·10 depend upon an increase of over £3,000,000 in the net earnings of the railways. In the circumstances, it is scarcely surprising that the Secretary of State for India, in sanctioning the Estimates for the current year, decided not to approve any augmentation in the amount of the capital expenditure, which remains at £10,000,000, as in each of the two previous years. Out of this total, the sum of only £233,000 has been allocated to the construction of new lines, £1,099,000 to railways in course of construction, and the balance to the lines already in operation. The appropriation of £10,000,000 for the current financial year falls considerably behind the amount which was suggested by the Home-office Committee on Indian railway finance and administration, presided over by Sir James L. Mackay. The Committee, whose report was published in June, 1908, recommended that the Government of India should be authorised to prepare the annual railway programme on the basis of a capital expenditure of £12,500,000, this being, in their opinion, an annual rate of expenditure which there was reasonable hope of maintaining, even in difficult times. In the meantime, however, the condition of the Indian railways has become so unsatisfactory from the State point of view that there is little hope of an increase in the provision for capital outlay in the near future until an improvement can be recorded. At the same time, the fact must not be overlooked that the Indian railways yielded the formidable sum of over £9,500,000 as net revenue to the State during the eight years ended with 1907, and that the expenditure on renewals and improvements in the past two years should be reflected in increased economy in working in the course of future years.

THE MINES OF COLOMBIA.

THE Republic of Colombia is not popularly known in this country, but events are tending to bring that country and its affairs into greater prominence. Should the Isthmus of Panama be cut successfully, as is probable, and that within a short time, Colombia will become quite prominent in the world's affairs, and some of us will have to turn to geographical study, only to find Colombia on the north-west of the South American continent, the Isthmus of Panama being a part of the territory comprised in the country. Very recently Mr. Stronge, the British Minister at Bogotá, the capital of Colombia, has reported very succinctly on the mines and minerals of that country, and as such an official report has not been made since 1894, some account of its contents will prove of interest. Only a few notes on this brief account of these mining regions can be given here, and those who pursue this subject should seek information at first hand. The compilation of the report was apparently a work of some difficulty.

The Tolima Mining Company, which works the Frias Mines, is one of the most important in the country. These mines are near to the town of Honda, on the Magdalena River, and some 600 miles from the sea coast. They are at an elevation of about 4000ft., and the climate is excellent. The district had been worked by the Spaniards to 100ft. below the surface, but the works were re-discovered in 1868, sold to the present company, and work has been continuous since. The workings are about 240 fathoms below the adit level, or 254 fathoms from the surface. There are levels and cross-cuts for about 8.5 miles, apart from shafts, winzes, and rises, which measure 1.9 miles. Operations were interrupted during the revolution of 1899-1902, owing to lack of labour and materials. The mine at Frias is now in good order again, and has been developed to a depth of 300ft., and provision has been made for deeper working by surface water power, and by powerful engines and additional air-compressing machinery. The mines are of the bonanza type, and the pockets of mineral vary. Exploratory workings are being carried on at the bottom of the main shaft by means of compressed air, which supplies power for pumping and hoisting, and provides good ventilation for the deep workings.

The ore treatment consists of a simple sorting, crushing, and concentration by means of Cornish rolls, Green's jiggers, classifiers, and round buddles. Power is supplied by a series of "ditches" or waterways, in all some 20 miles in length, the main ditch having a capacity of 5000 gallons per minute. The ditch is 18in. in diameter, working under an effective head of 370ft., and with a normal supply it produces about 250 horse-power. At a lower level the waterways give 100 horse-power more, bringing the total to about 350 horse-power. Among the machinery there are three overshot water-wheels, 34ft. to 40ft. in diameter by 4ft. breast, and one 22ft. in diameter with 6ft. breast, which drive the ore-dressing machinery, a Cornish pump, and a four-cylinder 18in. by 6ft. stroke direct-acting air compressor. There are five Pelton wheels of various diameters, which work a dynamo, four air compressors, the main winding engines, hoist, stone breakers, two lathes, planes and drilling machines in the mechanics' shop, and the circular saw and wood planer in the saw mill and numerous pumps of the Cameron pattern, Holman winding engines, and other machines. From this mining property, since 1868 to 1907, fine silver amounting to 8,910,950 ounces, valued at £1,456,316, has been exported.

In the same department of Tolima are the mines of Santana and La Manta, leased from the Government by the Anglo-Colombian Investment Company. The mine now worked is El Porvenir, which is equipped with a 10in. by 16in. coupled air compressor (Schram), driven by a 3ft. Pelton wheel under a head of over 400ft. There is also a double cylinder 6in. by 9in. hoisting engine, a Cameron pump of a capacity of 50 gallons per minute, and an aërial tramway capable of 5 tons per hour.

The Obdulia mine is owned and worked also by the Anglo-Colombian Company. The plant is not unlike that of the El Porvenir mine, and so we proceed here to describe the treatment of the ore at these two mines. Sorted wet at pit-head over gratings, the waste ore is dumped, and the milling ore taken by aërial tramways to the mill, as also the slimes resulting from the washing, which are allowed to settle in tanks. At the mill the ore is fed to a 16in. by 9in. stone-breaker, falling from this to a 5 mm. trommel, whence the fines pass to jigger trommels, the coarse stuff being delivered to a revolving picking table from which the solid pieces are taken by women and boys, and the waste is eliminated further. This table feeds the 30in. crushing rolls, which discharge into a 5 mm. trommel; the ore which is not sufficiently fine to pass this mesh being returned by a bucket elevator to the rolls. After leaving the 5 mm. trommel the ore passes to 4, 3, 2½, and 2 mm. trommels, and two hydraulic classifiers successively, the overflows feeding to six four-compartment Green's jiggers, with 5½, 4½, 3½, 3, 2, and 1½ mm. sieves respectively. The slimes are classified hydraulically and fed to three Green's vanning tables. The chatts (seconds) are taken from jiggers to an elevator which delivers them to 24in. crushing rolls, and after further crushing they are treated over jiggers and tables as described already. Save the passing of the chatts to the elevator, the whole process is automatic. About one ton of shipping ore is produced for every ten tons sent to the mill.

The report gives a very brief indication of the geological character of this highly mineralised district of Tolima. The lodes are in metamorphic schists of a variable character. There are alluvial deposits, nearly always auriferous, covering the schists. The principal metals found are iron pyrites, blende and galena, silver, native and as argentite, pyrargyrite, and stephanite. Two lodes of scheelite ($Ca\ W\ O_4$) have been found. The timber supply is found to be ample as a rule, but companies are warned that cutting without planting must lead to difficulty by and by. The description of a large number of mines, some at work and others abandoned for want of capital in that hilly country, is of great interest, and particularly is it so to find the native miners in so many of those districts extracting gold by washing in the creeks and rivers of North Tolima. The difficulties of transport are still very great in Colombia, throughout, and the freight for silver from Honda on the Magdalena in Tolima to the United States or to England amounts to about £5 per ton, exclusive of insurance and other charges. But both in North Tolima, in which the above mines are situated, and in South Tolima minerals have been found, such as cinnabar, asphalt, petroleum, and others, including copper, which make it highly probable that many new gold and silver properties will be opened up in Tolima during the next few years. Except in such a case as the Frias mine, the country has only been scratched, but it has to be acknowledged that difficulties will have to be overcome, and many attempts have failed to prove a commercial success.

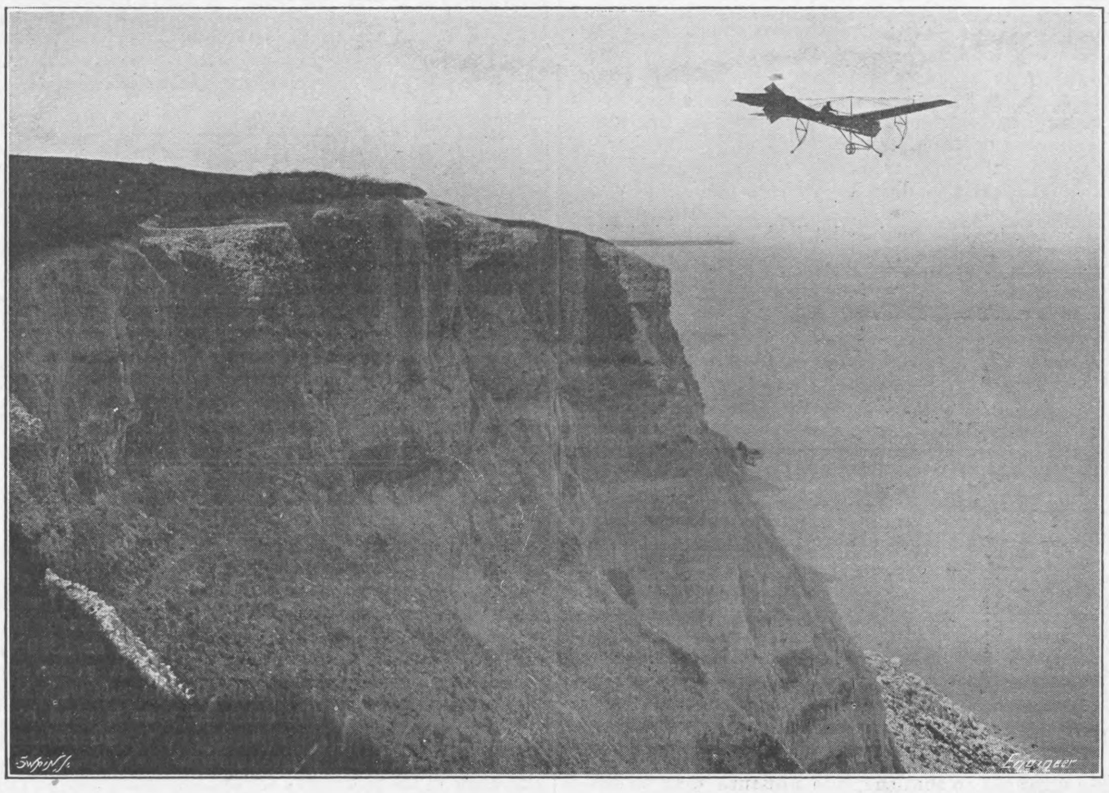
The British Minister proceeds to give a bird's-eye view of mining in all the chief departments of Colombia. He thus reviews the position in Antioquia, which is contiguous to Tolima; in Cauca, the Pacific coast State; in Magdalena and Bolivar, the northern States; in Boyaca and in Cundinamarca, the highland States to the east and north-east of Tolima; and of Bogotá, the capital. In the district of Manizales, in the State of Antioquia, draining to the Magdalena River, the whole is traversed with gold veins. Exploration of value is still much needed. Extraction of gold is done by a rough wooden stamp mill, placed by the reef near a stream, which becomes the motive power. The metal is crushed; the heavier concentrates are caught in blankets, and the free gold washed out of these concentrates by hand, no mercury plates being used. A number of mines are equipped with local made or imported Californian mills, driven by Pelton wheels. The reef mines are classified into two groups—viz., those in which metallic sulphides, galena, zinc blende, and iron pyrites predominate, and those in which the gold is found in a more or less free condition in quartz reefs. Owing to the configuration of the ground, the heavy expense of shaft sinking and of employing pumping plant is almost unknown, and the reefs in Antioquia are worked from drives in the hillside.

In various parts of Colombia other mines are common, and are being worked by primitive methods, while mineral of many kinds is found in most of the States which have been named. Coal and salt, copper and platinum, are among the minerals, in which the country is rich, which await a more effective method of recovery. In the case of some of these minerals, such as salt and coal, fine deposits are known, but, speaking generally, a thorough survey seems to be required in most parts of the country.

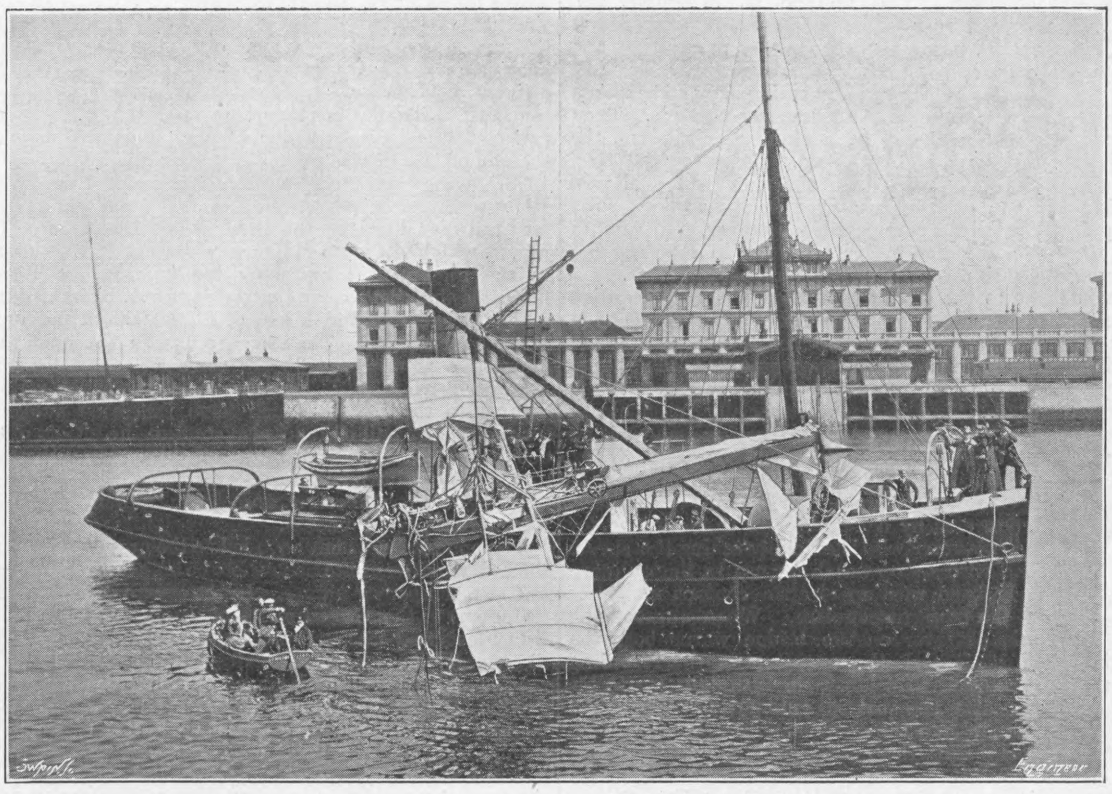
The Minister adds some general remarks on the State of Colombia from a mining and financial point of view. Particularly does he emphasise the pressing necessity of better communication and transport. Some railways are in construction and others projected, but the country is so mountainous that transport must always be difficult. Machinery has to be sent to most mines on mules, and packages should not exceed 125 lb. gross weight. Climate and labour are problems of some gravity. Though Colombia is in a tropical latitude, her altitude in mining parts is high, and many of the mines are in a temperate and a few in a cold climate. There are parts, such as the Chocó, in the State of Cauca, which are torrid districts, quite unsuitable to Europeans. Speculators have not sent the right men out to Colombia. There can be no question of the attraction of its mineral wealth generally, but first-class engineers should be sent out, and they should, if possible, have some knowledge of Spanish; they should, and all agents sent out also, be placed in financial touch with some London banker who does business in Colombia and is known there. It should be known also that French capital is now largely used in Colombia, especially on the Pacific coast, but used under British-formed companies. Those who are personally interested in such an account as this of the British Minister at Bogotá on the mines and minerals of Colombia will also welcome the summary of the mining law of Colombia which he appends to his report.

THE ATTEMPT TO FLY ACROSS THE CHANNEL.

AFTER a delay of several days, during which the weather conditions were unfavourable, Mr. H. Latham on Monday of this week made the first attempt to cross the Channel by aëroplane. Sangatte, the French terminus of the abandoned Channel Tunnel, was chosen as the starting point, the aëroplanist intending to land at Dover. In the early part of Monday morning the weather conditions were regarded as suitable for the attempt, and at a quarter to seven, having made all the necessary preparations, Mr. Latham ascended in his machine, and after executing a wide circle round Sangatte, headed for Dover. The French torpedo boat Harpon, lent by the Government for the purpose, and other vessels, accompanied the aëroplane on its voyage across the Channel.



MR. LATHAM STARTING HIS FLIGHT



THE AEROPLANE BROUGHT BACK BY THE TUG

After accomplishing a distance of about eight miles, or about one-third of the total distance, the machine was seen to be gradually descending in a long straight line to the surface of the water. The fall took place gently, and the aëroplanist experienced little danger, as the machine floated readily until the torpedo boat came alongside and rescued him. The aëroplane itself was damaged, but was taken on board by a tug, and the party returned to Calais.

The flight thus failed in its main object, but sufficient was done to demonstrate the possibility of success and the suitability of Mr. Latham's type of machine for this particular purpose. Flying overseas is attended with difficulties which are not met with in other circumstances. As an instance of this, it may be mentioned that there are, more or less always, over any large stretch of water vertical currents of air which must naturally render the conditions of the problem of flight somewhat more complicated than in their absence. At the same time some authorities maintain that Mr. Latham was making his attempt at too low an altitude—according to his own statement he never rose more than 400ft. above the sea-level—as they believe that the atmospheric currents are more uniform and steadier at a greater height. But they admit that these heights are beyond the reach of any type of machine at present in existence. On the other hand, Mr. Latham believes in the possibility of overcoming these difficulties by driving his machine at a sufficient speed, and in this connection he claims to have travelled at from 40 to 45 miles an hour on Monday.

The aëroplane—Antoinette IV.—used by Mr. Latham is of the monoplane type, and was designed by M. Levavasseur, of the Antoinette Company. It was fitted with a 50 horse-power eight-cylinder petrol motor, special care having been bestowed on the cooling details. In previous examples of aëroplanes one of the chief sources of trouble has been in connection with overheating of the engine. When water is employed for cooling purposes it has, of course, to be reduced in quantity to the least possible amount on account of its weight. This in turn demands an efficient radiator, and so adds to the total weight. In the Antoinette IV. the water from the cylinder jacket is carried direct to a radiator forming part of the framework of the aëroplane, and is then withdrawn by means of a pump and discharged into the water tank.

The exact cause of Monday's failure has not been as yet clearly stated. Mr. Latham himself attributes it to defective carburation, and believes that the salt in the air had an important bearing on the matter. It appears that from some unexplained cause the engine suddenly stopped, and despite efforts made to start it again it failed to do so. It was later admitted that the tuning-up of the machine had not been carried out as thoroughly as was necessary. As far as the actual flight is concerned, Mr. Latham has expressed his entire satisfaction with the machine, and is confident of ultimately succeeding in flying the Channel. It is intended to repair the damaged machine, but in the meantime it is reported that Mr. Latham will make a fresh attempt next week in a machine of similar construction to that he has already used, but with a much more powerful motor.

THE LONDON COUNTY COUNCIL'S TRAMWAYS ACCOUNTS.

THE accounts in connection with the London County Council's tramways for the year ending 31st March last have just been submitted to the Council by the Highways Committee. At this date the Council's tramway system extended over a length of 127⅝ street miles, this figure being made up of 85⅝ miles of electric lines and 42 miles of horse lines. The whole system is worked by the Council with the exception of a short length of ⅜ mile double line in Archway-road, Highgate, which is worked by the Metropolitan Electric Tramways, Limited, and a length of about ⅜ mile—double and single lines—in the Lea Bridge-road, which is worked by the Leyton Urban District Council.

The capital expended on the undertaking up to the 31st March last was £9,483,561 18s. 1d., of which £1,068,971 2s. 2d. represents expenditure during the year 1908-9. The total debt repaid to the same date amounted to £1,074,345 4s. 11d. out of revenue, and £282,519 12s. 8d. from the proceeds of sales of horses and old materials, &c. The debt outstanding was £8,126,697 0s. 6d., or, deducting £83,558 for the value of surplus land, £8,043,139 0s. 6d.

The total receipts from the undertaking during the year and the working expenses are shown in the following statement:—

	Electric traction.			Horse traction.			Total.		
	£	s.	d.	£	s.	d.	£	s.	d
Total receipts	1,572,251	8	7	275,199	1	7	1,847,450	10	2
Working expenses ..	896,286	4	7	305,402	0	2	1,201,688	4	9
Surplus on working ..	675,965	4	0	30,202 (deficiency)	18	7	645,762	5	5

After deducting debt charges, income-tax, and other sums from this figure of £645,762 5s. 5d., there remained a balance of £107,570 7s. 2d.

It will be remembered that in 1908 the Council decided that a provision of two-thirds of a penny per car mile on the total car mileage run on the electric tramways in each year should be made, and that the question of the adequacy or otherwise of this provision should be again considered at the expiration of five years. Provision at this rate for the year 1908-9 amounts to £88,785, and the balance of the £187,585 which remained has been also transferred to the renewals fund towards the deficiencies for past years. Had provision on the present basis been made in each of the years of electrical working, the fund would, with interest accumulations, have amounted at 31st March last to £285,632—after taking expenditure into account—as compared with £264,837 on the fund at that date. The shortage was, therefore, £20,795.

A further decision of the Council come to in 1908 was that a general reserve fund should be established to provide for general contingencies, and that to form a nucleus of this fund the sum of £34,634 should be transferred to the fund. This amount of £34,634 is made up of £30,772—the total of the renewals reserve fund on 1st April, 1904, in respect of the horse system, together with the interest accumulated to 31st March, 1908. Interest was added during the year 1908-9, and the fund at the end of last March amounted to £35,270.

The total operating expenses for electric traction amounted during the year dealt with in the accounts to 6.74d. per car mile run, as compared with 6.79d. per car mile in 1907-8. The working expenses with horse traction worked out to 10.24d. per car mile. Considerable loss was sustained during the reconstruction of horse lines for electric traction, as not only were some of the routes entirely closed, but sections of other routes had to be closed, and this disorganised the whole traffic on important through routes. A further length of 17 miles of electrically-worked tramways were put into operation during the year.

The total numbers of passengers carried and of car miles run during the year were as follows:—

	Electric traction.	Horse traction.	Total.
Number of passengers	344,705,937	68,207,904	412,913,841
Number of car miles	31,962,784	7,156,688	39,119,472

Of the total number of passengers 24.22 per cent. were carried at ½d. fares; 48.04 per cent. at 1d.; 9.29 per cent. at 1½d.; 9.89 per cent. at 2d.; 1.49 per cent. at 2½d.; 2.15 per cent. at 3d.; .17 per cent. at 3½d.; and .04 per cent. at 4d. The number of exchange tickets amounted to 4.71 per cent. The average fare per passenger on the electrified lines was 1.07d., as against 1.08d. in 1907-8; and on the horse traction lines .93d., as against .96d. in 1907-8. It is pointed out, however, that the average fare per passenger on the whole system was 1.05d., the same as in 1907-8.

Taking the results of the electric system by itself the surplus on working is equal to 42 99 per cent. of the gross receipts, as compared with 43.17 per cent. in the previous year. The total receipts obtained from the working of the electric lines averaged 11.81d. per car mile, as against 11.95d. per car mile in 1907-8. The net result on working is equal to 5.07d. per car mile, as against 5.16d. per car mile during the previous year.

SHIPBUILDING NOTES.

IT is a common practice now-a-days to print extensive descriptions, in the technical Press and elsewhere, of the ocean liners which are built from time to time, illustrated by photographs of their saloons, lounges, &c. The naval architect, however, who looks at his profession in the proper light, will feel an equal interest in all types of steamers, the construction of which make demands on his invention and his skill. And certainly the problems involved in the construction of a modern high-class cargo steamer will bear comparison as regards complexity and difficulty with those involved in the construction of the passenger steamers referred to. If we should desire to see perhaps the highest expression of modern shipbuilding in this respect, we should not do better than examine any of the later vessels of Messrs. P. Henderson and Co.'s fleet, the last addition to which—the Henzada—was launched from Denny Brothers' yard recently. The Henzada is the latest of a long line of vessels which are well known to travellers to Rangoon, all of which have been constructed by Denny's. In these vessels may be witnessed all the main developments that have taken place in recent years—increase of dimensions from 360ft. in length to well over 400ft., the removal to the largest possible extent of all obstructions in the cargo holds, and arrangements for maximum facility of loading and discharging cargo.

SPEAKING of types of vessels reminds one of that particular type to which some reference was made in this journal last week, in the notice that then appeared of the train ferry steamer Drottning Victoria. This vessel, built by Swan, Hunter and Wigham Richardson, is of special interest in respect of the fact that she is intended for sea service in the Baltic, bridging the gap between Sassnitz and Trelleborg. This particular type of vessel, of course, is not at all a novelty, no less than twenty-two railway ferries being at present in use in Denmark amongst the islands which form so considerable a part of that country. Where the sounds or channels are too broad to be bridged, the railway ferry system became a necessity, in order to obviate frequent loading and unloading. Many of these vessels are designed for comparatively high speeds, and are specially strengthened to act as ice-breakers. Those interested in the subject will find full information regarding this most interesting example of ship construction in a paper read by Mr. Harold M. Olsen before the Institution of Engineers and Shipbuilders in Scotland on 23rd March of this year.

THE usual quarterly return compiled by Lloyd's Register of Shipping has now been published, and shows the number and tonnage of vessels under construction in the United Kingdom up to the end of June. An analysis of the return reveals some interesting features. If warships be excluded, it appears that there were 308 vessels under construction on 30th June of 745,705 tons gross tonnage. This is 166,000 tons less than that under construction at the end of last quarter, and it is also considerably less than that under construction twelve months ago. It is to be hoped that the recent increased activity in British shipbuilding ports, evidences of which are noticed from time to time in this column, will make it possible for a different story to be told at the end of September. We notice that the Clyde at present enjoys a good lead in the number of vessels actually being built, the total for that river, including Glasgow and Greenock, being 108 of over 260,000 tons gross. Newcastle has 43 ships of 116,787 tons and Sunderland, we note, has 28 of 60,785 tons.

THE record breaking feats of the Mauretania become monotonous. On her recent voyage to New York she again broke the record by 58 minutes, and her average speed works out, for the whole voyage, at 25.84 knots, as against 25.62 previously. It is to be hoped that the Lusitania will soon share her sister's success, and that the recent alteration to her propellers, similar to that already effected to those of the Mauretania, will conduce to that end.

IT would be difficult to over-estimate the beneficial influence of the Clyde Trustees in promoting the prosperity of the port of Glasgow and of those shipbuilding and engineering interests connected with it. For a long series of years, both as regards dock accommodation and depth of channel, they have pursued a policy of intelligent anticipation of the needs of the port, and it is to this policy that much of the phenomenal expansion characteristic of Clyde industries is due. It is evident that this policy will be pursued in the future by the care and thought which has recently been given to the proposal to construct a large new graving dock there. This scheme has been under the consideration of a Special Committee for some time, and a definite proposal has now been made to construct the dock at Renfrew, which proposal has now been submitted to the Admiralty. Glasgow is not particularly rich in graving docks, and it cannot be doubted that this proposed addition to their number will prove a most valuable accession to the resources of the port. A wise discrimination has been exercised in the choice of the site, which has been selected so as to minimise, as far as possible, the subsequent dredging, which will almost certainly be necessary.

AMERICAN ENGINEERING NEWS.

An embankment building machine.—In American railway construction the use of dump or tip wagons is very generally adopted for making embankments. Sometimes these are small fan-wheel wagons, and sometimes large 20-ton bogie wagons tipped—sideways—by air cylinders controlled from the engine cab. End tipping is very slow, and various arrangements of travelling bridges, temporary timber trestle bridges, &c., are employed to allow of dumping entire trains at one time. In one arrangement the construction tank terminates by a circular loop on a travelling timber frame at the "tip," the wagons being tipped to fill the sides or end of the embankment as they pass slowly around the loop. An arrangement employed recently for a rock embankment 80ft. high and 1200ft. long, in changing the line of the Delaware, Lackawanna, and Western Railway, is a cableway parallel with the line of the embankment, and carrying at one end a platform with a line of rails for the tip wagons. This platform is shifted forwards along the cableway as the work progresses. The construction railway is of 3ft. gauge, and the locomotive backs its train slowly out upon the platform. As each wagon reaches the edge it is tipped sideways, so that only empty wagons run out on the farther end of the platform. The tower at the farther end is fixed. The one at the end where the tipping is done is slid forward occasionally, so as to shorten the span and raise the cables, which otherwise would drop below the level of the top of the embankment. The two cables are 2½in. diameter, 12ft. apart, About 1000 to 1200 cubic yards per day are being deposited in this way, the rock coming from an adjacent cutting.

A combined bridge and market.—The ancient practice of erecting buildings on bridges, as in the case of Old London Bridge, for example, has a modern application at Monterey, Mexico, where a bridge has been built to span the Santa Catarina River, and carry a market house. A wooden building on a steel bridge was destroyed last year by fire. The new building is of concrete, on a bridge of armoured concrete. The bridge has two arched spans of 74ft. 3in., with a rise of 8ft. 6in. above the springing line, which is at high-water level. The width is 52ft., composed of a central roadway 19ft. wide, and two rows of stalls or compartments 16½ft. deep. The stalls are about 10ft. wide, separated by concrete partitions, the upper ends of which carry the roof. The height is 10½ft. at the sides of the bridge, and 25ft. at the centre of the roadway, the roof over the roadway rising like a lantern roof above the sloping roofs over the stalls. The length of the building is 200ft. The concrete is composed of 1 part Portland cement, 2½ parts sand, and 5 parts river gravel, with blocks of rough stone embedded in the concrete. The steel reinforcement consists of ¾in. rods spaced about 12in. apart in the longitudinal rows, and 4ft. apart in the transverse rows. The concrete of the arches was deposited in longitudinal ribs, the spandril walls being formed monolithic with the outer ribs. Earth filling was rammed in place to the level of the roadway. The deflection at the crown on removing the centres was only $\frac{3}{32}$in. The building was not erected until after the arch centres had been struck, thus avoiding the liability of cracking due to settlement of the arch. The walls are 3in. thick, with horizontal and vertical steel rods. The roof is reinforced with a sheet of expanded metal, and rests on concrete purlins, which were cast in moulds on the ground and set in place when hard.

Autographic records of machine output.—There is a very general extension of the use of autographic records of the work of machines and machinery in American manufacturing plants. These recording instruments not only show the actual course of the work, but enable comparisons to be made with former records, while they have an important moral effect on the workmen. For instance, a recording gauge of steam pressure in a boiler plant will have an important influence upon the fireman, who will be more careful to see that he maintains the desired pressure. At an oil factory, great difficulty was experienced in keeping a uniform temperature in the tanks, in spite of frequent readings with an indicating thermometer. The introduction of recording gauges served not only to check any carelessness on the part of the men—as any fall in temperature could be traced—but it also assisted the men in maintaining the temperature, as it showed at once any tendency to change, which could be remedied at once. In some cases the recording instruments are at a distance—in the office of the manager or superintendent—but the men know that this impartial machine is recording an exact history of their work. At a factory of india-rubber goods, an instrument records the heat of the vulcaniser and the length of time the goods remain in the vulcaniser. Paper-making companies have recorders whose diagrams show the exact time and duration of each process on a machine and the time the machine was at rest. At the South Chicago Steel Works recording pyrometers in the superintendent's office show continuously the temperature of the entering hot gas and outgoing top gas at each blast furnace. The same furnaces have indicating pyrometers to show the furnacemen the exact conditions at any time. The opening and closing of the valves on the regenerator is also recorded by marks on the diagram.

A 200-ton railway weighing machine.—At the goods yards and sorting yards of American railways, track scales or weighing machines of large capacity are required owing to the great sizes and loads of the wagons. This is especially the case where there is a heavy coal traffic, as the wagons must be weighed quickly and accurately. The law makes the railway originating a shipment responsible for delivering the full shipped weight at destination, and there is frequent controversy over the weighed loads as between the railway and the consignee. In order to ensure accuracy for its own purposes and to convince its customers of this accuracy, the Pittsburg and Lake Erie Railway has installed an exceptionally massive and powerful weighing machine having a nominal capacity of 200 tons, with ample safety under a considerable overload. The wagons are passed over the scale at a speed of five miles per hour, and the weight is automatically registered and recorded. A special device prints the weights directly upon the way-bills. The rails are fastened by bolted clips to cast iron chairs or pedestals resting upon the scale girder, each girder consisting of a pair of rolled steel joists. A framing of other joists supports a deck of ¼in. steel plate. The rail joints at the ends are not opposite, but so arranged that the load comes simultaneously upon the first bay on one side and the second bay on the other. The platform is 67ft. long, with an effective length of 53ft, and the scale pit is deep and large enough to enable a man to walk among the beams and make the necessary inspection, adjustments, &c. The rails are on a gradient of 1 in 200 to facilitate the movement of the wagons, but the scale itself is level, the gradient being obtained by packing blocks under the rails. A pair of dead rails is provided for the use of wagons that are not to be weighed. Ordinarily railway weighing machines are 30ft. to 60ft. long and of about 150 tons capacity.

Motor wagons for use in a factory.—The handling of goods through the shops and grounds of a large works calls for the use of various systems of transportation. Trucks, travelling, overhead, and jib cranes, telpher systems, works railways, &c., are used in various combinations. One of the plants of the General Electric Company, U.S.A., had a works railway of 3ft. gauge, with wagons pushed by men. The enlargement of the works made it necessary to extend the railway, or find some other system. The original railway had to carry about 175 tons per day, with average loads of six tons, and an average run of 700ft. But only about 50 tons would have to be carried by the extension, and the cost of equipping an electric railway would have been disproportionate to the work. The original line was equipped with electric storage battery locomotives, thus cutting the cost of transportation to about one-third of that by hand. For service beyond the range of this railway two four-ton four-wheeled electric lorries or motor wagons are used, which have the advantage of serving any part of the works. Other lorries will be used as needed. The railway has two ten-ton locomotives or motor trucks, and a number of five-ton platform wagons. In studying out this works transportation system careful analysis of the cost by different methods was made, including an electric railway for the entire works, horses and wagons in addition to the original manual-power railway, and motor lorries in addition to the electrification of this latter railway. The cost of equipment, cost of working, repair and maintenance, the amount of material to be carried, the distance hauled, &c., were all covered by the analysis. This showed electric traction to be cheaper than manual power on the railway, and electric lorries to be cheaper than horses and wagons for the remainder of the works.

THE NEWBURGH AND NORTH FIFE RAILWAY

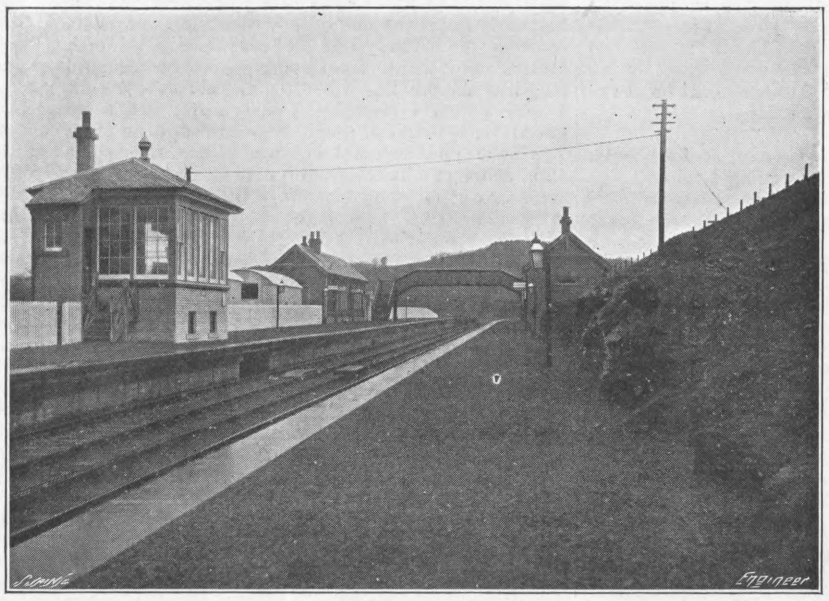


Fig. 1—LUTHRIE STATION

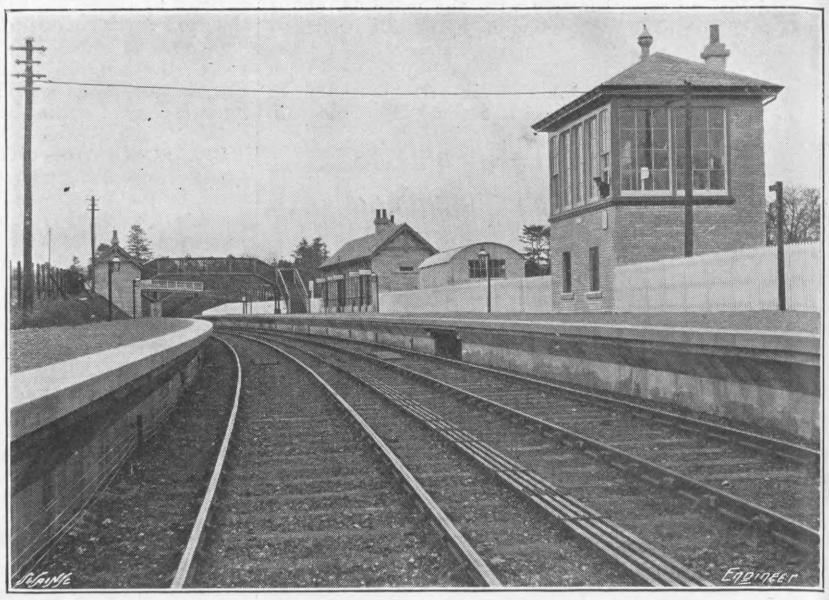


Fig. 2—KILMANY STATION, LOOKING WEST

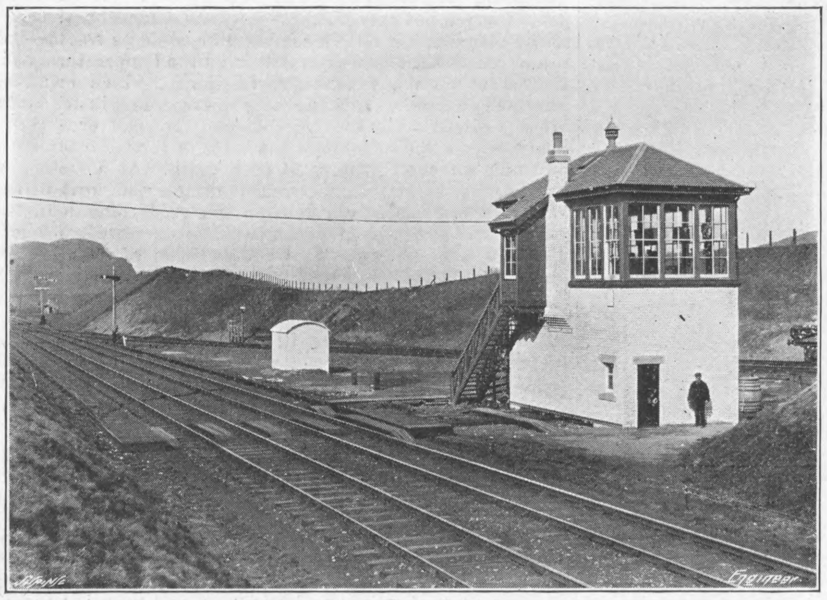


Fig. 3—GLENBURNIE JUNCTION FROM THE EAST

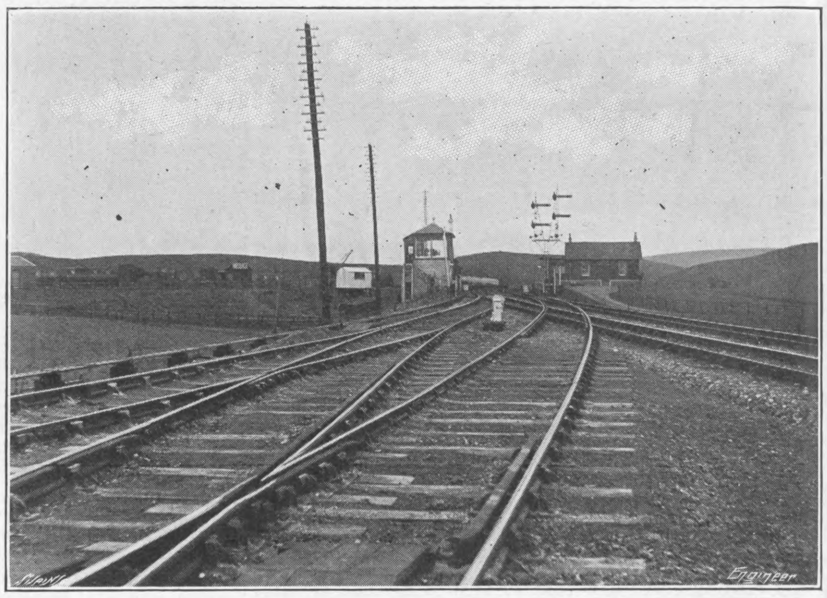


Fig. 4—ST. FORT, NORTH JUNCTION

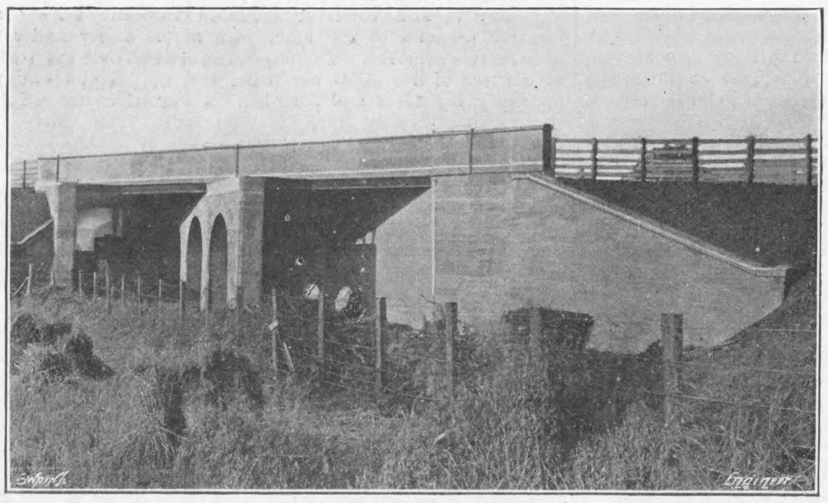


Fig. 5—LINDIFFERON PUBLIC ROAD BRIDGE

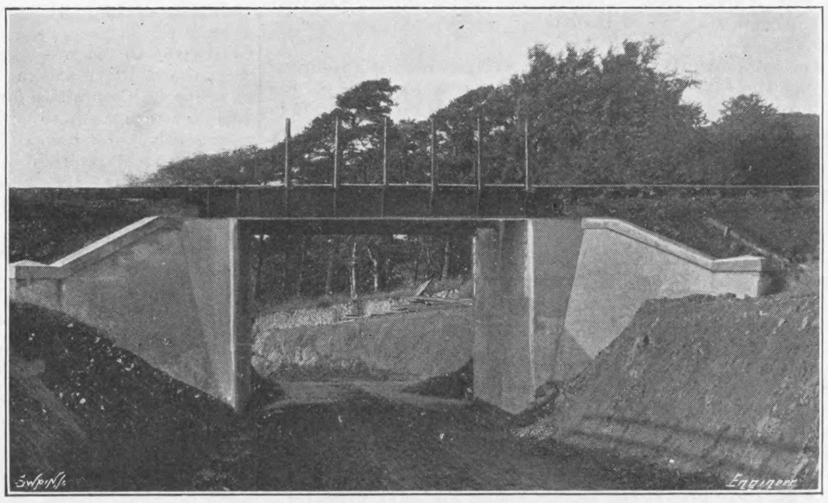


Fig. 6—DUNBOG ROAD BRIDGE

NEWBURGH AND NORTH FIFE RAILWAY.

THE Newburgh and North Fife Railway, which is 12 miles 69 chains in length, with a short loop 35½ chains long at the St. Fort or eastern end, branches off, as will be seen from the map, Fig. 8, from the Ladybank-Perth line of the North British Railway at Glenburnie Junction, about 1½ miles south of Newburgh Station, where the public road from Grange of Lindores to Newburgh passes under the Perth line. The line immediately enters a sand cutting about 30ft. deep, and then runs eastwards to Lindores, crossing at a point 37 chains from Glenburnie Junction, the Newburgh and Lindores public road by a skew steel lattice girder bridge, the skew span being 66ft. 1in. and the two girders 78ft. 7in. long, with built-up cross girders. Thirty-six chains further on the line passes under an elliptical concrete arch occupation bridge leading to Guilds Quarry.

About a mile from the junction is Lindores Station, consisting of a single platform, booking-office, waiting-rooms, offices, and station-master's house, and also siding accommodation. Thirty-one chains further on the railway crosses the Kinnaird public road by a plate girder bridge with a skew span of 55ft. 1in., having three steel girders with rolled joist cross girders. Twenty-four chains distant the line enters a rock cutting 41 chains in length, having a maximum depth of 23ft. 6in., and a little beyond the second mile-post the road leading to Dunbog House is crossed by a steel girder bridge of 15ft. span.

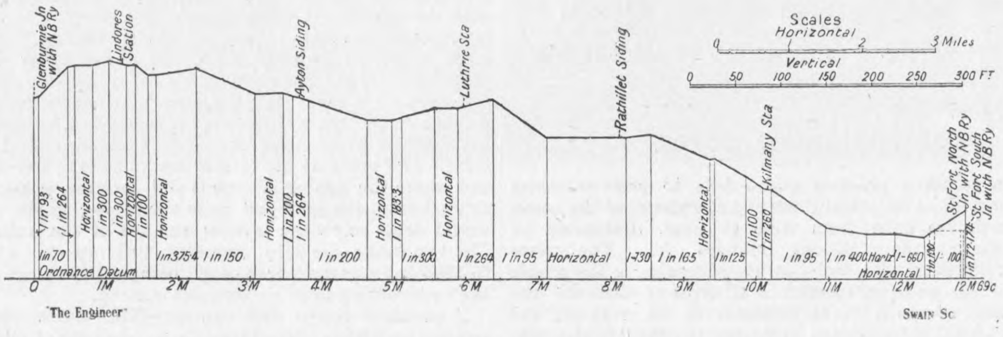
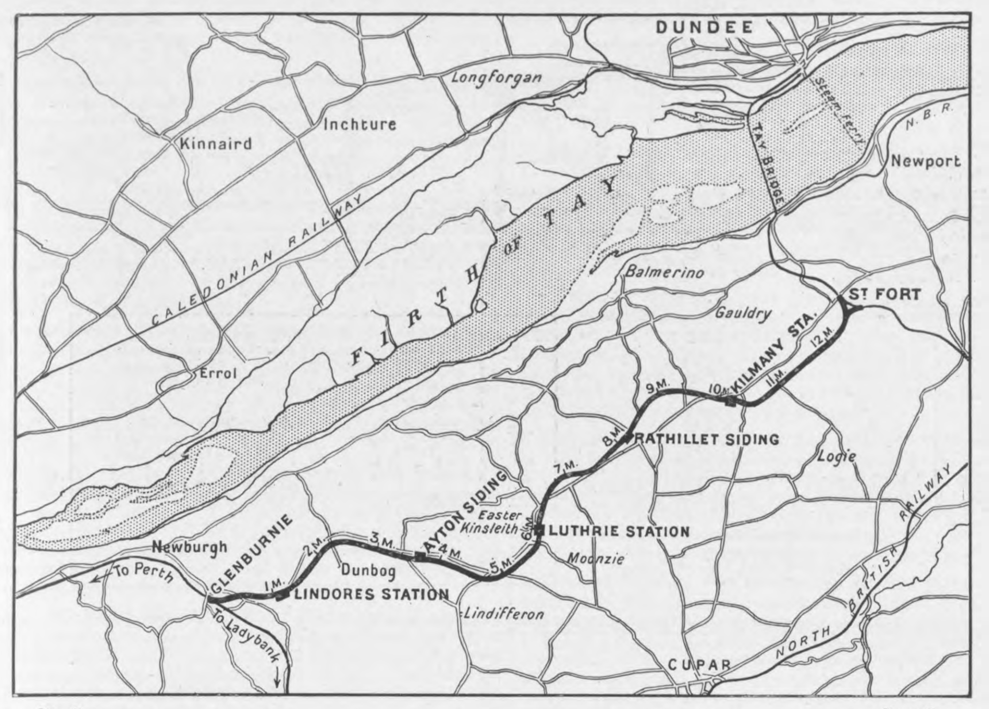

Glenburnie Jn with N B Ry
Lindores Station
Ayton Siding
Luthrie Sta
Rathillet Siding
Kilmany Sta
St Fort North Jn with N B Ry
St Fort South Jn with N B Ry
Scales
Horizontal
0 1 2 3 Miles
Vertical
0 50 100 150 200 250 300 FT
1 in 93
1 in 264
Horizontal
1 in 300
1 in 300
Horizontal
1 in 100
Horizontal
Horizontal
1 in 200
1 in 264
Horizontal
1 in 183·3
Horizontal
Horizontal
1 in 100
1 in 260
1 in 70
Ordnance Datum
1 in 375·4
1 in 150
1 in 200
1 in 300
1 in 264
1 in 95
Horizontal
1-730
1 in 165
1 in 125
1 in 95
1 in 400
Horiz
1-660
Horizontal
1 in 100
1-100
1 in 172·174
0 1M 2M 3M 4M 5M 6M 7M 8M 9M 10M 11M 12M 12M 69c
"The Engineer"
SWAIN Sc

Fig. 7—PROFILE OF THE LINE

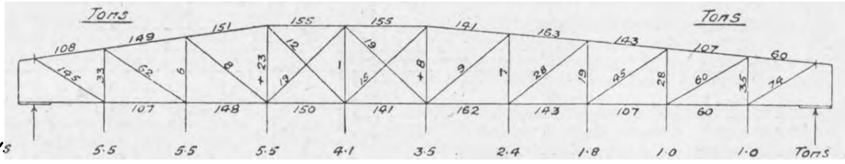
The line then closely follows the public road eastwards to Ayton Smithy—3 miles 55 chains from the start—where there is a goods siding for the convenience of the neighbourhood. One mile 7 chains farther on the line passes under the Lindifferon public road by means of a skew overbridge with concrete parapets, consisting of two skew spans of 34ft. 10in. each, with a centre pier between, which, along with the abutments, are extended far enough to enable rolled joists to be taken across at right angles to the centre line of the railway to support the whole of the roadway. These joists have only to span 15ft. to 16ft., and are filled in between with brick jack arches. At 4 miles 77 chains the railway also passes under the public road between Newburgh and Cupar by a bridge similar in all respects, but slightly smaller than that just referred to.


DUNDEE
Longforgan
Inchture
Kinnaird
Steam Ferry
TAY BRIDGE
N.B.R.
Newport
CALEDONIAN RAILWAY
FIRTH OF TAY
Balmerino
Gauldry
ST FORT
KILMANY STA.
Errol
9M.
10M.
11M.
12M.
RATHILLET SIDING
7M.
8M.
Logie
AYTON SIDING
Easter Kinsleith
LUTHRIE STATION
Moonzie
Newburgh
GLENBURNIE
1M.
2M.
3M.
4M.
5M.
Dunbog
To Perth
LINDORES STATION
Lindifferon
To Ladybank
CUPAR
NORTH BRITISH RAILWAY

"THE ENGINEER" SWAIN SC.

Fig. 8—MAP OF THE LINE

The next work of importance is a rock and soft soil cutting about 32ft. deep, which starts at 5 miles 60 chains and terminates at the sixth mile-post, at which point Luthrie Station is situated. Two and a-half chains from the commencement of the cutting the road from Moonzie to Kinsleith crosses the line by a single-span steel girder bridge with concrete parapets.


Tons
Tons
108
149
151
155
155
191
163
143
107
60
195
33
62
6
8
+23
12
19
1
19
15
+8
9
7
28
19
45
28
60
35
74
107
148
150
191
162
143
107
60

Dead Loads	5·5	5·5	5·5	4·1	3·5	2·4	1·8	1·0	1·0	Tons
Live " (B.M. only) *	18·7	13·7	18·7	12·0	8·0	5·1	3·5	–	–	..
Total – B M. only	24·2	24·2	24·2	16·1	11·5	7·5	5·3	1 0	1·0	..
Live Load * (Shear only)	22·1	22·1	22·1	14·2	10·5	7·3	4·2	–	–	..
Total – Shear only	27·6	27 6	27·6	18·3	14·0	9·7	6·0	1 0	1·0	..

* These loads about 10% high

"The Engineer"

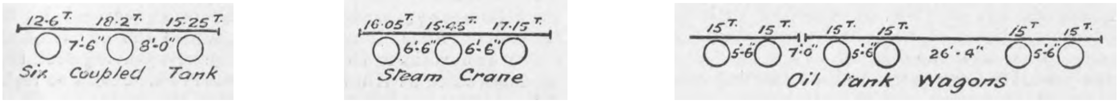
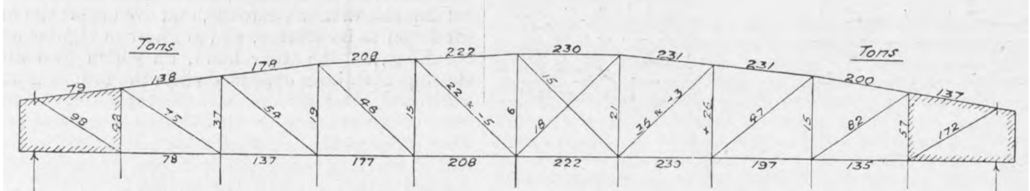

12·6T 18·2T 15·25T
7'·6" 8'·0"
Six Coupled Tank
16·05T 15·45T 17·15T
6'·6" 6'·6"
Steam Crane
15T 15T 15T 15T 15T 15T
5'·6 7'·0" 5'·6 26'·4" 5'·6
Oil Tank Wagons

Fig. 9—DIAGRAM OF LOADS AND STRESSES IN THE LINDORES BRIDGE

Luthrie Station consists of two platforms and siding accommodation, booking-office, waiting-rooms, usual offices, footbridge, station-master's house, and siding accommodation. At 6 miles 28 chains the Luthrie public road is crossed by a lattice girder skew bridge with a skew span of 81ft., and consisting of two steel girders 97ft. 3in. long and 10ft. deep, with built-up cross girders. This bridge is practically an enlarged edition of the Lindores public road bridge.


Tons
Tons
79
138
179
208
222
230
231
231
200
137
98
22
75
37
59
19
48
15
22 & -5
6
15
18
21
35 & -3
+26
47
15
82
57
172
78
137
177
208
222
230
197
135

Dead Loads	1·5	1·8	3·0	4·0	5·0	7·0	7·0	7·0	7·0	Tons
Live " * (B M only)		–	8·1	9·2	13·2	20·7	20·7	20·7	20·7	..
Total – B.M. only	1·5	1·8	11·1	13·2	18·2	27·7	27·7	27·7	27·7	..
Live Load * (Shear only)	–	–	9·2	10·3	14·7	23·6	23·6	23·6	23·6	..
Total – Shear only	1·5	1·8	12·2	14·3	19·7	30·6	30·6	30·6	30·6	..

* These loads about 10% high

"The Engineer"

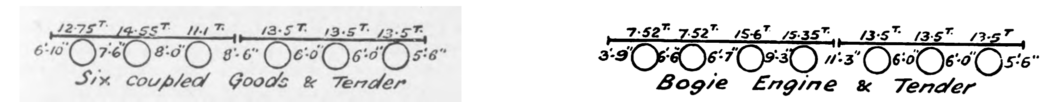

12·75T 14·55T 11·1T 13·5T 13·5T 13·5T
6'·10" 7'·6" 8'·0" 8'·6" 6'·0" 6'·0" 5'·6"
Six coupled Goods & Tender
7·52T 7·52T 15·6T 15·35T 13·5T 13·5T 13·5T
3'·9" 6'·6" 6'·7" 9'·3" 11'·3" 6'·0" 6'·0" 5'·6"
Bogie Engine & Tender

Fig. 10—DIAGRAM OF LOADS AND STRESSES IN THE LUTHRIE BRIDGE

The difficulties to be overcome in connection with it were the sharp skew—25 deg. 35 min.—and the small amount of head room available. Owing to the skew only five cross girders extend right across, and it was necessary that these should be as deep as possible and very efficiently connected to the main girders in order to give sufficient lateral stiffness to the whole bridge. These objects were secured by making the five centre girders deeper than the rest and carrying them up through the floor to within a couple of inches of the undersides of the rails, and further by slinging the cross girders to gusset plates extending the whole depth of the main girders, which gussets run down into and form part of the web of the cross girders. The bridge has proved exceedingly stiff under test; the deflection of the centre of the main girder—one side of the bridge only being loaded, no rails being laid on the other side —was $\frac{9}{16}$in. The weights are light for the work done. Of course, owing to the skew, the maximum bending moment does not occur in the centre of the girders, and this was taken account of in the profile, which is not generally done. Diagrams of stresses in both the Lindores and the Luthrie bridges are given in Figs. 9 and 10. We have been given the following particulars regarding the calculations for bending moments and shear under live loads

For Calculation of Bending Moment.

I. Six-coupled tank controls spans between ...	0ft. and 11ft.
II. Steam crane (20-ton) controls spans between	11ft. and 24ft.
III. Oil tank wagons contro's spans between ...	24ft. and 48ft.
IV. Six-coupled goods engine and tender controls spans between	48ft. and 70ft.
V. Bogie engines and tenders' controls spans between	70ft. and upwards.

For Calculation for Shear.

I. Six-coupled tank controls spans between ...	0ft. and 6ft.
II. Steam crane (20-ton) controls spans between	6ft. and 22ft.
III. Oil tank wagons controls spans between ...	22ft. and 30ft.
IV. Six-coupled goods engine and tender controls spans between	30ft. and 70ft.
V. Bogie engines and tenders controls spans between	70ft. and upwards.

The different types of loads are shown diagrammatically under the engravings. Various construction details of the Luthrie bridge are given in Figs. 12 and 13.

The Rathillet policies are next traversed, at the north-east boundary of which is situated Rathillet siding, 8 miles 10 chains from Glenburnie Junction. This siding, like that at Ayton, has been constructed for the convenience of the neighbouring district. At 8 miles 20 chains from Glenburnie Junction a cutting 32ft. deep is entered, and just before the ninth mile-post the farthest point from the high road—about half a mile—is touched, the course of which has been followed more or less closely from the commencement up to the eighth mile-post. From the ninth mile-post to the termination of the line the course of the Mottray Water, which runs into the Eden near Leuchars, has been followed.

Between 9 miles 50 chains and 10 miles 15 chains another cutting is met with having a maximum depth of 26ft., and at 9 miles 69 chains the Newport public road crosses the line by a bridge similar to, but rather larger, than the Lindifferon public road bridge. At 10 miles 10 chains is Kilmany Station, consisting of two platforms equipped with the usual offices, foot-bridge, and siding accommodation.

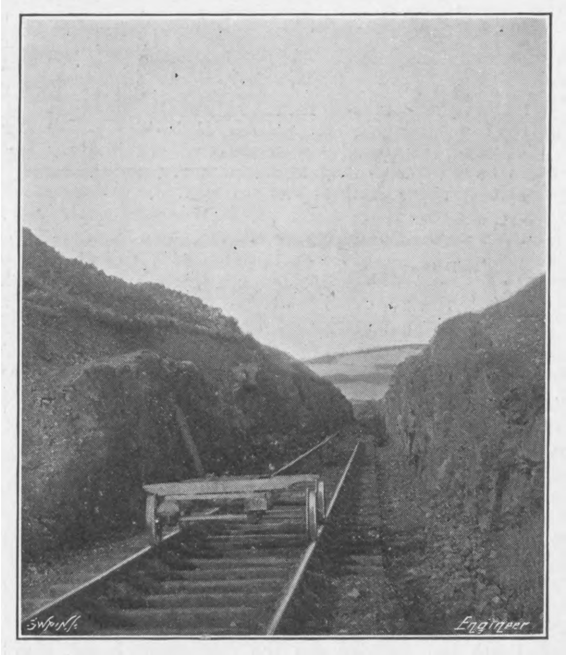

SWAIN SC.
Engineer

Fig. 11—A CUTTING IN ROCK

After leaving Kilmany the line runs in a north-easterly direction, and at 10 miles 77 chains the Logie public road crosses over the line by a bridge of two concrete arches with a centre pier having a square span of 16ft., and between 12 miles 25 chains and 12 miles 40 chains a cutting of light, dry sand and very side-long ground, with a maximum depth at the centre line of 20ft. is passed through, and then curving to the north the line joins the main line of the North British Railway to Dundee at St. Fort Station, 3 miles 60 chains distant from Leuchars Junction Station and 4 miles 50 chains from Dundee Tay Bridge Station.

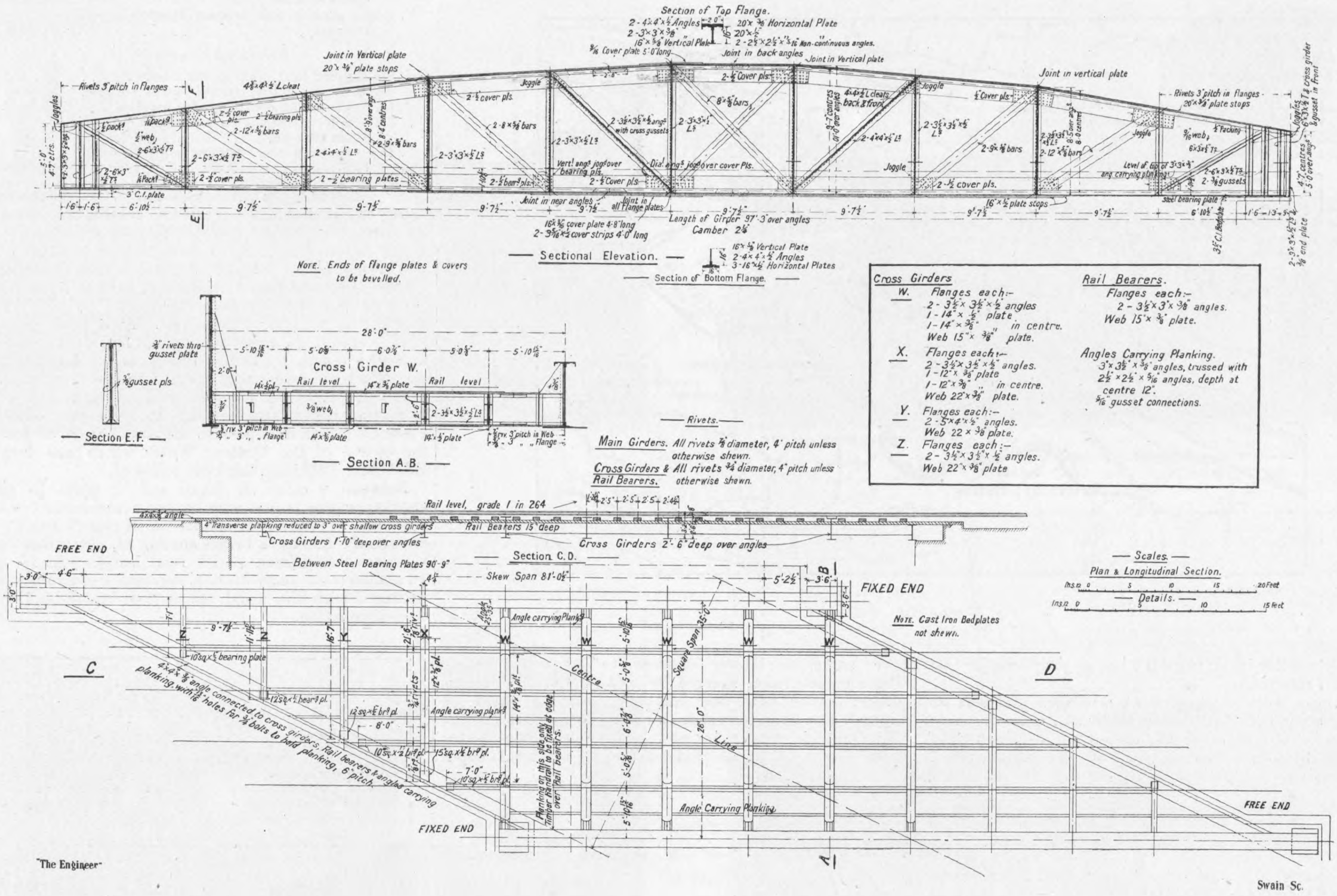
The short loop mentioned in the beginning of the article branches off from the main line at a point 2 miles 22 chains east of Kilmany Station and joins the main line south of St. Fort station, and is intended to provide for a through service to St. Andrews and East Fife generally.

Owing to the proximity of the line to the public road and the winding nature of the Fernie Burn and Mottray Water, there is the large number of forty-three bridges and culverts, twenty-two of which are steel, and nine of masonry having spans of 6ft. or over, on the line, all the abutments and wing walls being built of concrete. Where arches are employed they are generally built of concrete if the angle of the skew is 60 deg. or less, as at Guilds Quarry and Logie public road bridges; but where the skew is greater brick has been employed.

For a cross-country line the gradients may be considered easy, the ruling gradient being 1 in 70, and that only for about a quarter of a mile at Glenburnie Junction. There are also two stretches of 1 in 95, one about half a mile long between the sixth and seventh mile-posts, and the other about three-quarters of a mile long between the tenth and eleventh mile-posts. Other than these, there are no gradients less than 1 in 100. A profile of the line is given in Fig. 7. The line has been constructed as a single line, with rails weighing 84 lb. to the yard and correspondingly heavy chairs and fastenings in order to carry the heaviest North British rolling stock; but the bridges have been built and sufficient land acquired for a double line when the traffic calls for such. At each of the three stations on the route the platforms are 450ft.

long, in order to accommodate summer excursion traffic, and all the station buildings are built of "Brandem" brick, which gives them a pleasing appearance. The yards are fully equipped for goods traffic, and at each station there is a comfortable house for the agent.

The trains are being run on the Tyers train tablet system, while the line itself is being worked by the North British Railway under agreement with the Newburgh and North Fife Company. The North British Railway owns the Newburgh Station, which it has recently constructed. That company also laid in, as is customary, the junctions of the Newburgh Company's line with its own lines at Glenburnie and St. Fort, and installed the telegraphs and Tyer's train tablet equipment on the Newburgh line at the request of the Newburgh Company's contractors.

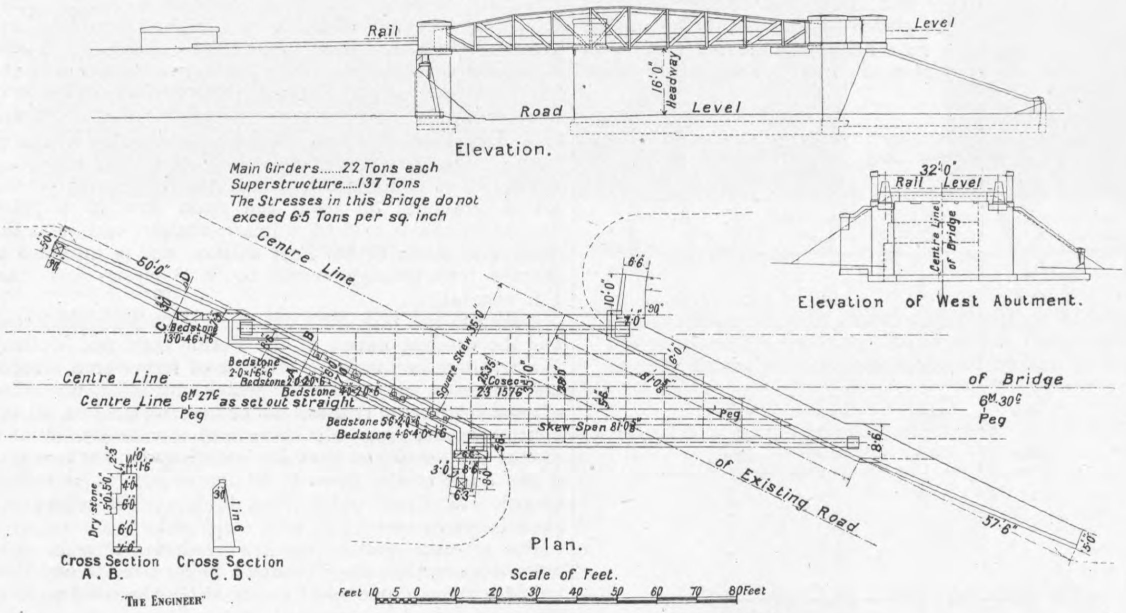

Section of Top Flange.
2-4×4×½ Angles
2-3×3×⅜
16×⅝ Vertical Plate
20×⅜ Horizontal Plate
2-2½×2½×5/16 Non-continuous angles.
9/16 Cover plate 5' 0" long
Joint in back angles
Joint in Vertical plate
Joint in Vertical plate 20×⅜ plate stops
Rivets 3" pitch in Flanges
Joggles
4⅝×4×½ L cleat
2-½ cover pls.
2-½ bearing pls.
2-12×⅝ bars
2-8×⅝ bars
2-9×⅝ bars
8×⅝ bars
Joggle
Vert! angs jogd over bearing pls.
Dia! angs jogd over cover Pls.
Joint in near angles
Joint in all Flange plates
16×9/16 cover plate 4' 8" long
2-3 5/16×½ cover strips 4' 0" long
Length of Girder 97' 3" over angles
Camber 2¼
Joint in vertical plate
Level of top of 3×3×⅜ ang. carrying planking
steel bearing plate
3½ C.I. Bedplate
3" C.I. plate
1'6" 1'6" 6' 10½" 9' 7½" 9' 7½" 9' 7½" 9' 7½" 9' 7½" 9' 7½" 9' 7½" 9' 7½" 6' 10½"
Sectional Elevation.
NOTE. Ends of flange plates & covers to be bevelled.
16×⅝ Vertical Plate
2-4×4×½ Angles
3-16×½ Horizontal Plates
Section of Bottom Flange.
¾ rivets thro' gusset plate
⅜ gusset pls
28' 0"
5' 10 15/16" 5' 0⅝" 6' 0⅞" 5' 0⅝" 5' 10 15/16"
Cross Girder W.
Rail level
14×⅜ plate
14×½ plate
⅜ web
2-3½×3½×½ Ls
Section E.F.
Section A.B.
Rivets.
Main Girders. All rivets ⅞ diameter, 4" pitch unless otherwise shewn.
Cross Girders & Rail Bearers. All rivets ¾ diameter, 4" pitch unless otherwise shewn.
Cross Girders
W. Flanges each:-
2-3½×3½×½ angles
1-14×½ plate
1-14×⅜ " in centre.
Web 15×⅜ plate.
X. Flanges each:-
2-3½×3½×½ angles.
1-12×⅜ plate
1-12×⅜ " in centre.
Web 22×⅜ plate.
Y. Flanges each:-
2-5×4×½ angles.
Web 22×⅜ plate.
Z. Flanges each:-
2-3½×3½×½ angles.
Web 22×⅜ plate
Rail Bearers.
Flanges each:-
2-3½×3×⅜ angles.
Web 15×⅜ plate.
Angles Carrying Planking.
3×3½×⅜ angles, trussed with 2½×2½×5/16 angles, depth at centre 12".
5/16 gusset connections.
Rail level, grade 1 in 264
4×4×⅜ angle
4" Transverse planking reduced to 3" over shallow cross girders
Rail Bearers 15" deep
Cross Girders 1' 10" deep over angles
Cross Girders 2' 6" deep over angles
Section C.D.
FREE END
FIXED END
Between Steel Bearing Plates 90' 9"
Skew Span 81' 0½"
Square Span 35' 0"
Centre Line
28' 0"
Angle carrying Planks
Angle Carrying Planking
Z Z Y X W W W W W
C D A B
4×4×⅜ angle connected to cross girders. Rail bearers & angles carrying planking, with 13/16 holes for ¾ bolts to hold planking, 6" pitch.
Planking on this side only timber handrail to be fixed at edge over rail bearers.
NOTE. Cast Iron Bedplates not shewn.
Scales.
Plan & Longitudinal Section.
Ins. 12 0 5 10 15 20 Feet
Details.
Ins. 12 0 5 10 15 Feet

"The Engineer"

Swain Sc.

Fig. 12—DETAILS OF THE LUTHRIE BRIDGE

The railway provides a short North British route between Perth and Dundee and the Forfarshire coast, also between Perth and St. Andrews and East Fife; it will enable the North British Company greatly to improve its service to the places mentioned, passengers to the Forfarshire and Fifeshire coasts from Perth, and north and west thereof, having at present either to change stations at Dundee, or to travel *viâ* Ladybank, which involves changing trains twice and is a long round.


Rail
Level
Road
Level
16' 0" Headway
Elevation.
Main Girders......22 Tons each
Superstructure.....137 Tons
The Stresses in this Bridge do not exceed 6·5 Tons per sq. inch
Centre Line
50' 0"
Bedstone 13' 0×4' 6×1' 6
Bedstone 2' 0×1' 6×6"
Bedstone 2' 0×2' 0×6
Bedstone 4' 0×2' 0×6
Bedstone 5' 6×2' 0×6
Bedstone 4' 6×4' 0×1' 6
Square Skew 35' 0"
Cosec 23 1576
Skew Span 81' 0½"
Centre Line of Bridge
Centre Line 6M 27C as set out straight
Peg
6M 30C Peg
of Existing Road
57' 6"
Plan.
32' 0"
Rail Level
Centre Line of Bridge
Elevation of West Abutment.
Dry stone
1 in 6
Cross Section A.B.
Cross Section C.D.
Scale of Feet.
Feet 10 5 0 10 20 30 40 50 60 70 80 Feet

"THE ENGINEER"

Fig. 13—DETAILS OF THE LUTHRIE BRIDGE

The company was incorporated by Act dated August 6th, 1897. The contract for the construction of the line was let on May 31st, 1906, and the first sod was cut on July 3rd following. The line was passed by the Inspector of the Board of Trade on January 12th, formally opened by the directors, engineers, and others on the 13th, and finally opened to the public on January 25th last. The engineers jointly responsible for the line are Messrs. Thomas Meik and Sons, Edinburgh, and Mr. Walter Beer, of Westminster, Mr. J. F. J. Reynolds having acted as resident engineer. The various engravings which we give in Figs. 1 to 6 and on page 88 show different types of bridges on the line, and various views of stations' &c.

THE REBUILDING OF SAN FRANCISCO.

THE annual report of H.M. Consul-General at San Francisco—Mr. W. B. Hearn—contains some interesting information concerning the rebuilding of the city since the great earthquake and fire of 1906, in particular with reference to the extensive scheme of harbour improvements which was commenced soon after the disaster.

In the year 1908 over seven million sterling was spent in buildings and alterations, and the new structures in the business quarter of the city are immeasurably better than those which existed before the fire, and Chinatown, formerly a nucleus of filth, is now a model of cleanliness. On June 1st, 1907, the water front of San Francisco included 10,600 lineal feet of sea wall, nearly the whole of which is situated between Mission-street and Jones-street. Since that date an additional length of 1000ft. has been completed, and a length of 600ft. is under construction. The whole of the sea walling, with the exception of a small portion at the ferry building at Market-street, has been constructed on the same plan. A trench about 100ft. in width is dredged to a hard bottom, and a core or filling of stone "rip-rap" tipped therein. The core is faced on the water side and capped with rock pitching of from one to four cubic feet, the stones above low water being hand packed. The tidal rise at San Francisco at springs does not exceed 5ft. The method of construction hitherto adopted is not entirely satisfactory, the free percolation of the water through the bank carrying away the filling material behind. In addition, difficulties have arisen owing to the settlement of the foundation. It is now proposed to construct a sea wall impervious to water and on a securer foundation. Of the twenty-eight piers on the water front, about one-half are constructed on creosoted timber piles. All these are old structures and are in bad condition. The remaining piers, which are of later construction, are carried on piles encased in reinforced concrete cylinders, a system of construction which has been found much more satisfactory than the old method.

In November, 1908, the property of the San Francisco Dry Dock Company, including five docks, was acquired by the Bethlehem Steel Company, which is also the owner of the Union Ironworks in the city. A large new graving dock is to be constructed at Hunter's Point, where also extensive repair shops will be erected by the Steel Company.

The fire of 1906 destroyed 28,000 buildings, since when 18,422 building permits have been issued, and it is estimated that a sum of over twenty-seven millions sterling has been expended on the erection of the new structures, including over seven millions in 1908. It is noteworthy that permits to the value of under four millions have been issued since the fire in respect of Class A buildings, which include the absolutely fireproof, earthquake-proof, steel and stone structures, with wire-glass windows, automatic metal doors, and metal interior fittings. The old Class A buildings, so far as is known, withstood the earthquake without damage, and even after the fire were in a condition to be refitted, and are now in regular use. Class C buildings, on the other hand, on which over nine millions sterling have been expended since the fire, consisting of brick walls and steel girders, and corresponding to the common style of construction in British cities, suffered some damage from earthquake, and were totally destroyed in the fire. The cost of building construction in San Francisco decreased to a marked extent towards the middle of 1908.

The report also contains some particulars of the great electric generating station at Las Plumas on the Feather River, which has been under construction since 1906, when the Great Western Power Company commenced the driving of a tunnel through the bank of the river, where it forms a horseshoe bend about 20 miles north of Oroville in Butte County. This work was completed in December, 1908. The neck of the bend is about 15,000ft. across where the horseshoe begins, but the difference in level of the river between the two ends of the bend is more than 500ft. The tunnel, which will carry the entire flow of the river to the generating plant, has been cut three miles through a mountain. In that distance it has a drop of 75ft., but from the lower end of the tunnel to the turbines there is a plunge, equivalent in all to a drop of 540ft. The tunnel is lined throughout with concrete. The complete plant is to consist of eight turbo-generating machines of 18,000 horse-power each. Four of these were put in operation at the opening of the power station. Already £2,000,000 have been expended on the electric power plant at Las Plumas. It is stated that this installation will be the largest electric generating station in the world, being capable of continously producing 144,000 horse-power, which exceeds even the output of the Niagara plant. Power is being furnished by the company to the new Cowell Cement Works in Contra Costa County by an overhead transmission cable, 150 miles long, supported by steel masts.

RAILWAY MATTERS.

After a period of short time full work has been resumed at the Midland Railway Locomotive Works, Derby, and at various divisional works in other parts of the system.

The Renard train, which is running just now as a feeder to the Oudh and Rohilkand Railway between Sambhal and Moradabad Station is to be taken off that run and worked instead between Nagina and Bijnor, in the same district. The train will consist of motor and three carriages, and will carry passengers only.

The negotiations for the unification of the Mexican and the Mexican Southern Railway systems have come to an end in consequence of the Interoceanic Railway Company of Mexico having submitted proposals for a lease of the Mexican Southern undertaking. The board of the latter company are now considering these proposals.

According to a consular report from Germany, orders in the home market for locomotives have been scarce and prices less satisfactory than formerly. The incomes of the State railways are less than in former years, so that they have reduced their orders for locomotives to a minimum for the present. The export trade in locomotives has improved of late.

The new transcontinental railway across the lower part of the North American continent, which connects the port of Tampico on the Atlantic with the port of Manzanillo on the Pacific, was to have been 1031 miles in length, but the Government has decided to build a cut-off between Guadalajara and Aguascalientes, which will reduce the route across the continent to about 800 miles.

The Santa Fé Railway Company proposes to electrify the line over Raton Pass for a length of thirty-eight miles, between Trinidad, Colo., and Raton, N.M. For this purpose, says *Power*, 15,000 electric horse-power will be required for twenty-four hours' consumption in hauling goods and passenger trains through the Rocky Mountains. The change from steam to electricity will involve an expenditure of about 1,500,000 dols.

The new Mexican-Pan-American Railway has already been opened, states the *American Machinist*, and the line is in active operation from San Jeronimo on the Tehuantepec Railway to Tapachula, in Chiapas. The extension of that line will be continued to Port San Benito on the Pacific coast. There is also planned a new railway, passing through parts of the States of Coahuila and Chihuahua, with a length of about 375 miles.

Several American railways are experimenting with mechanical stokers for locomotives. In very few cases have accurate tests been taken, and those that have show results unfavourable to the stoker. Where the firing is well within the capacity of one man without mechanical aid there does not appear to be much reason for installing mechanical stokers, although in America it is hoped that they will help to abate the black smoke nuisance.

The entire railway system of the State of Rio Grande do Sul, Brazil, with the exception of the Brazil Great Southern Railway, is now in the hands of Belgians, who are lessors of the lines, and are actively engaged in making important extensions. The number of miles in operation is about 690, and will soon be increased to 1000. A connection is being formed with the São Paulo Railway, and has already made some progress from the other end.

To permit two steamers to pass from the Wisconsin River to the Mississippi River, near Prairie du Chien, Wis., a railway bridge on the Chicago, Burlington, and Quincy Railway was raised by breakdown cranes a few weeks ago. There is no navigation on the Wisconsin River, but the two steamers were sent down to enter service on another route. The railway crosses the river near its mouth, and a 65ft. span was raised about 6ft. to clear the steamers' funnels.

The Chemin de Fer du Midi, one of the largest railways in France, has awarded the first of its contracts for the electrification of its main line from Bordeaux to Toulouse. The line to be equipped is more than 250 miles long. The single-phase system at 15 cycles will be used. The order for electrical equipment for the first section of the line, which should be in operation in about a year, was divided among a number of electrical manufacturing companies.

The plans for the proposed underground postal railway in Vienna are now under consideration, says *Electrical Engineering*. This railway will, if constructed, connect up the chief post-office with sixty-four sub-stations and nine railway stations in the city. Letters, newspapers, and parcels will be carried on trains of eight cars, running every twenty minutes. The trains will carry no motorman, but will be operated from the stations, and will travel at a speed of about 20 miles per hour.

By far the heaviest goods train ever hauled by one locomotive on any railway in the United States, and probably in the world, says the *Iron Age*, has been moved over the Pennsylvania Railroad, between Altoona and Enola. On June 22nd a single locomotive, built at the company's Altoona shops, pulled a train of 105 steel cars, loaded with 5544 tons of coal, for 127 miles in 7 hours and 12 minutes, or at an average speed of 17.6 miles an hour. The entire train, including engine, weighed 7644 tons, and stretched along the line for 3600ft. That part of the line over which the test was made from Altoona to Enola presents at no point a greater gradient than 12ft. to the mile.

For the Great Northern locomotive exhibit at Shepherd's Bush Mr. Ivatt has restored one of Mr. Patrick Stirling's celebrated single express engines, removing it from stationary engine duty and restoring it as it was in 1870, when it was built. This engine was No. 1, and has single driving wheels 8ft. 1in. in diameter and outside cylinders. As originally built it weighed only 70 tons, with the tender, and had a total heating surface of 968 square feet. The brake power was given by hand brake on the tender wheels, wooden blocks being used. Alongside this engine is shown No. 1442, one of Mr. Ivatt's huge Atlantics, weighing 110 tons with the tender, and having a total heating surface of 2500 square feet.

Work has not yet commenced on the Hangchow-Ningpo part of the line which, when completed, will connect Hangchow with Shanghai on the one side, and with Ningpo on the other, though some preliminary surveys have been made, especially in connection with bridging the Ch'ien T'ang River. A difference of opinion appears to exist, says a consular report, between the board of directors and the engineer in charge of the survey as to the best site for the bridge. The Shanghai-Hangchow portion is being constructed from both ends by two Chinese companies, the Kiangsu Railway Company and the Chekiang Railway Company, each being engaged on the sections within their respective provinces.

The survey of the route of the projected railway from Fort Augusta, in South Australia, to Kalgoorlie, on the Western Australian goldfields, 1070 miles in length, has, says the *Railway Times*, been completed. The report of the survey parties is favourable. No serious engineering difficulties are anticipated, and the cost will be comparatively low. The bulk of the country which the new line will traverse is by no means of a desert kind. The construction of the proposed line will be an important step in the development of Australia, as it will furnish transcontinental communication from east to west, linking up the railways of the eastern and southern districts, and considerably expediting the transport of European mails.

NOTES AND MEMORANDA.

It has been suggested that painting steel sheets while they are hot would be of great advantage in preserving the metal.

The Dreadnoughts now being laid down by the United States Government are to be equipped, it is reported, with armour and deck plates made of vanadium steel. This is a departure from the Krupp plates hitherto generally used.

In a new process for making a substitute for india-rubber, the materials used are animal refuse capable of yielding gelatine, oils, sulphur, chromates, and sodium stannate, the addition of the last-named salt being the distinguishing feature of the process.

Application was recently made for protection of an invention to produce ammonia from the atmosphere by means of aluminium. Nothing is yet known of the details of the process, but from the titles of the three applications it is gathered, says the *Chemical Trades Journal*, that the aluminium and nitrogen are first caused to combine to form nitrides of aluminium which afterwards are converted into ammonia.

Writing to *Stahl und Eisen*, a German manufacturer states that he has succeeded in making satisfactory high-speed steels with powdered ferro-tungsten. The steel contains 0.85 of tungsten, 0.45 silicon, 0.45 manganese, 0.30 carbon, 0.25 aluminium, calcium, and magnesium, and 0.01 of sulphur. The powdered ferro-tungsten alloys more readily than tungsten metal, and there is less segregation and piping.

Since the beginning of the year two accidents have occurred to reinforced concrete reservoirs in Oklahoma, which have attracted considerable attention from engineers in that part of the country. These accidents, the *Engineering Record* states, were at Guthrie and Oklahoma City, the two principal cities of the State. In one case it is admitted that in an attempt to secure maximum economy too light sections were employed.

The suitability of the Quebec Bridge piers for the new bridge now being designed has been questioned. The *Engineering News* states that the new design demands a bridge much heavier than the old, and the three members of the Board of Engineers are unable to agree upon the ability of the masonry piers to carry this increased load. It will be remembered that, so far as external investigation could show, the piers of the Quebec Bridge were not at all damaged in the fall of the superstructure.

A Swiss experiment for the transformation of crude oil into liquid gas is reported by the American Consul at Zurich to have met with great success. The product is a transportable liquid, which is simply evaporated as used, and can be used for lighting, heating, cooking, soldering, and welding purposes. The gas is non-poisonous, while its installation cost is said to be low, and manipulation simple and without danger. The new gas is competing successfully with coal gas and electricity.

In a recent report of the Illinois State Highway Commission it is recommended, says *Ferro Concrete*, after careful study and actual experience throughout the State, that all highway bridges of 50ft. span and under shall be constructed in ferro-concrete on the grounds that this is "the most permanent form of construction known to engineers to-day." The report proposes that all highway bridges up to the span mentioned should be replaced within the next two years by ferro-concrete structures.

Some experiments have recently been made in the Hall at the Trocadero, in Paris, where M. Gustav Lyon has been for some time past engaged in devices to suppress the echoes. The points of reflection of the echoes were ascertained mathematically and by observation. When all the surfaces which caused the echoes were localised, layers of soft cloth were hung at a distance of a few inches from one another and at about a foot from the reflecting surface. From M. Lyon's investigations, it became clear that in great halls the surfaces farthest removed from the auditors should be absorbent, while those placed near them should be reflecting.

From some experiments conducted by Professor Turner at the University of Birmingham, some new observations have come to light pertaining to the subject of transparency in metals. The only metal hitherto associated with transparency has been gold; but from the investigations of Professor Turner it has been discovered that silver and copper also possess this quality when subjected to the proper treatment. While the observations are of no known practical utility they have attracted attention in scientific and artistic circles, as the colour effects transmitted by the metals under such conditions are said to be of striking interest.

The chief purpose of the sound-proof room at the University of Upsala is the ensuring of perfect freedom from sounds from outside. By building it on platforms of thick lead and cement, and by constructing its walls of many thicknesses of felt, cork, asbestos, and other bad conductors of sound vibrations, the principal object was attained. The room is so quiet that the beating of one's heart or the creaking of one's muscles is at once heard on taking up a position within its closed doors and windows, and the only defect of it as a laboratory for acoustic experiments is that ventilation is absent, and no one can remain in it for more than an hour at a time.

In some metallurgical and chemical operations steam is admitted to large vats or tanks for the purpose of agitating, and, in some cases, heating their contents. In special cases, the consumption of steam for this purpose is enormous. It is often possible to obtain better results by mixing air with the steam. This may be accomplished by using an ordinary injector. To ensure the proper working of the device, the steam is first turned on, then the valve of the injector gradually opened until the desired amount of air is obtained. By the use of this device, better agitation is secured, the contents of the tank or vat suffer less dilution, and there is a large saving in the amount of steam used.

About a year ago considerable prominence was given to the approaching scarcity of commercial timber. Recent official estimates show that consumers have no reason to abate their efforts for the conservation of forest resources throughout the world. These indicate that in the United States the annual forest growth is less than one-third of the consumption. In New Haven County, for instance, it is stated that for the year 1907, the timber cut was 120,000 cords, while the annual growth on all types of forest land reached the total of only 70,000 cords. The net reduction of 50,000 cords a year means that supplies of merchantable timber in the country will be exhausted in roughly twenty years.

The Annual Report on Factories and Workshops issued by the Home-office states that in 1905 and 1906, certain European countries decided to prohibit the use of white phosphorus, but the United Kingdom, Sweden, Norway, and Belgium did not see their way to similar action. Departmental investigations, made in 1907, showed that "strike anywhere" matches could be made without white phosphorus, though patent rights prevented universal adoption. In 1908, match manufacturers and the holders of patent rights in phosphorus substitutes agreed to favour the prohibition of white phosphorus, provided that importation of white phosphorus matches were prohibited, and that the Home-office settled binding terms by which anyone might use the patented substitutes. This solution was accepted by the Home-office, and accordingly the White Phosphorus Matches Prohibition Act was passed, which comes into force on January 1st, 1910.

MISCELLANEA.

By an enactment of December last a law comes into force this month in Austria containing a section somewhat similar to Section 27 of the British Patents Act of 1907, by which patents in Austria will be revocable at the expiration of three years from the date of publication, without any notice, if the patentee neglects to work the patent in Austria to an adequate extent.

In connection with the special Monday morning service from the Northern Coast of France to London, we have been informed that Boulogne will be left at 8 50 a.m., and Charing Cross will be reached at mid-day. One of the South-Eastern and Chatham Railway Company's new turbine steamers will be employed on this run, and will do the trip from Boulogne to Folkestone in 1½ hours.

During the past six months coal exports from the United Kingdom have increased by just 400,000 tons, but Italy alone practically accounts for the whole of this with an increase of 370,000 tons. The Italian State Railways are, however, known to be storing coal, while the consumption of the country has not materially increased. Up to the end of June, 1907, the imports of British coal into Italy were 4,106,000 tons; this year they stand at 4,550,000 tons.

The first of a group of three water-power stations on the rivers Toce and Devero, in Northern Italy, has recently been put to work. The equipment, says *Electrical Engineering*, has a capacity of 20,000 horse-power, and the output is taken over a 50,000-volt transmission line to a main sub-station, from which a ring of feeders, at a lower pressure, supply further distributing sub-stations. The two other large stations, when complete, will be connected up to the same main sub-station.

Following the decisions contained in the report of the Stores Committee made in June, 1906, a lengthy resolution has been issued at Simla regarding the rules for the purchase of Government stores. It has been agreed to modify the existing procedure in order to give preference to local articles when their quality is equal to that of foreign goods. The new rules are adopted purely as an experiment, and are subject to revision if the quality of the goods deteriorates or the cost to the Government increases.

At a meeting recently of Ayr Town Council it was unanimously agreed, at the request of the Ayr Auld Brig Preservation Committee, to make a contribution to complete the preservative works, the funds left in the hands of the Preservation Committee being insufficient. The outlay thus far has been about £9240, and the funds in hand are now reduced to £700, while the estimated expenditure still necessary is over £1000. Mr. Wilson is acting as engineer, and Mr. Morris as architect and archæological expert.

The first sod of the new Loch Arklet works for increasing the Loch Katrine supply of water to Glasgow was cut recently by the Lord Provost of that city. A dam of concrete faced with masonry is to be constructed at the lower end of the loch, which will enlarge the area of water to a length of 2½ miles, with a slightly greater width than at present. At the upper end of the loch there will be an intake basin leading to an aqueduct tunnel half a mile long through the hill which separates Loch Arklet from Loch Katrine.

The Statistical Report for May, issued by the Mines Department of the Transvaal, shows that of the total number of workpeople in the mines—gold, coal, diamond, &c.—23,087 were whites, 201,609 were coloured, and 7710 were Chinese. The Chinese are employed only at the gold mines in the Witwatersrand area. The outputs from the mines for the month are shown to be of the following values:—Gold, £2,656,789; silver, £6878; coal, £76,441; other metals and minerals, £41,454. The last includes tin ore to the value of £22,459.

The Austrian army authorities have been testing motor lorries, fitted with six-cylinder engines of 100 horse power, for the transport of heavy siege-mortars—the 24-centimetre type. Two such pieces of artillery can be transported by a lorry at the rate of nearly ten miles an hour. Each vehicle is fitted up with a drum and cable arrangement for winding where the ground is unsuitable for trailing the load. According to reports, the trials have proved highly satisfactory, and the War-office will propose that the next Budget include an amount to cover the price of several machines of the kind.

The British Aëroplane Club has an interesting scheme on hand for utilising the Stadium at Shepherd's Bush for a series of competitions for aëroplanes and model flying machines of all kinds. Before finally fixing the arrangements provisionally come to with the proprietors of the Stadium, the club is anxious to ascertain whether sufficient support is likely to be forthcoming to justify them in making the necessary large outlay. All experimenters in the cause of the conquest of the air who have actual working models are being invited provisionally to enter them for the various tests of speed, stability, and so on.

The new patent law in the United Kingdom, says a consular report from Düsseldorf, is looked upon with great dissatisfaction in that district, owing to the blow dealt to German patent holders. There is no doubt that a great number of German holders of patents are affected. A very large majority are trying to sell their patent rights in the United Kingdom to British companies, while a few are erecting works of their own in the United Kingdom. To do this it has been necessary to raise the capital required to float a new company, which under the present state of the money market is an unusually difficult matter.

The chief centre for the manipulation of semi-precious stones in Germany is in the Rhine Province. Both at Oberstein and Idar an important industry has been created, which had its inception in the cutting and dyeing of native agate, the chief deposits of which are now exhausted. At present imported stones are handled chiefly, these coming principally from England and South America. Although agate only was dressed and coloured in the early years of this industry, at present all classes of stones are prepared for market. In this, however, the art consists not only in forming the rough stone, but in giving it colour as well.

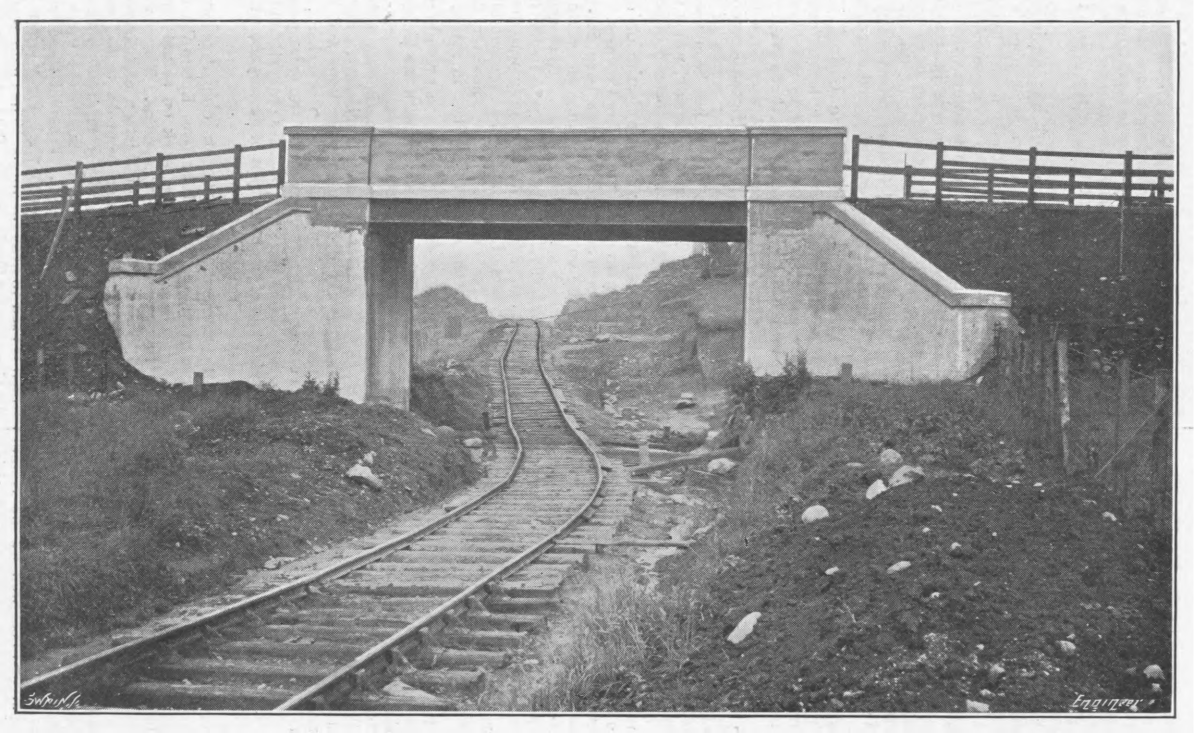
Some important experiments are about to be carried out at Portsmouth in connection with the harbour defence. The destroyer Ferret is being strengthened to ascertain the possibility, while steaming at full speed, of cutting through an obstruction of wire netting stretched across a channel. For this purpose the Ferret is in dry dock, having her bows and hull strengthened. The plates at the bows are to be made sharp, so as to facilitate the cutting of the steel hawsers of the entanglement which will be stretched across the upper reaches of Portsmouth Harbour. The Ferret is one of the older type of destroyers, with engines of 4400 indicated horse-power.

An exhibition of women chainworkers is a special feature of the Sweated Industries Exhibition now being held at Earl's Court. The women work on actual forges, exactly like those in their domestic workshops. These women begin their working lives at the age of thirteen or fourteen, and in a little time, as learners, can earn from 4s. to 5s. weekly. This wage gradually rises, and a fully competent worker can sometimes make 10s. a week. More frequently the wage is 7s. or 8s., and probably the average is less. From all these sums a deduction of 1s. to 1s. 6d. is made each week for "breeze"—the small coal which is used to heat the forge. The chain trade is scheduled in the Government Trade Boards Bill, and a great betterment of the position of the workers is expected from its operation.

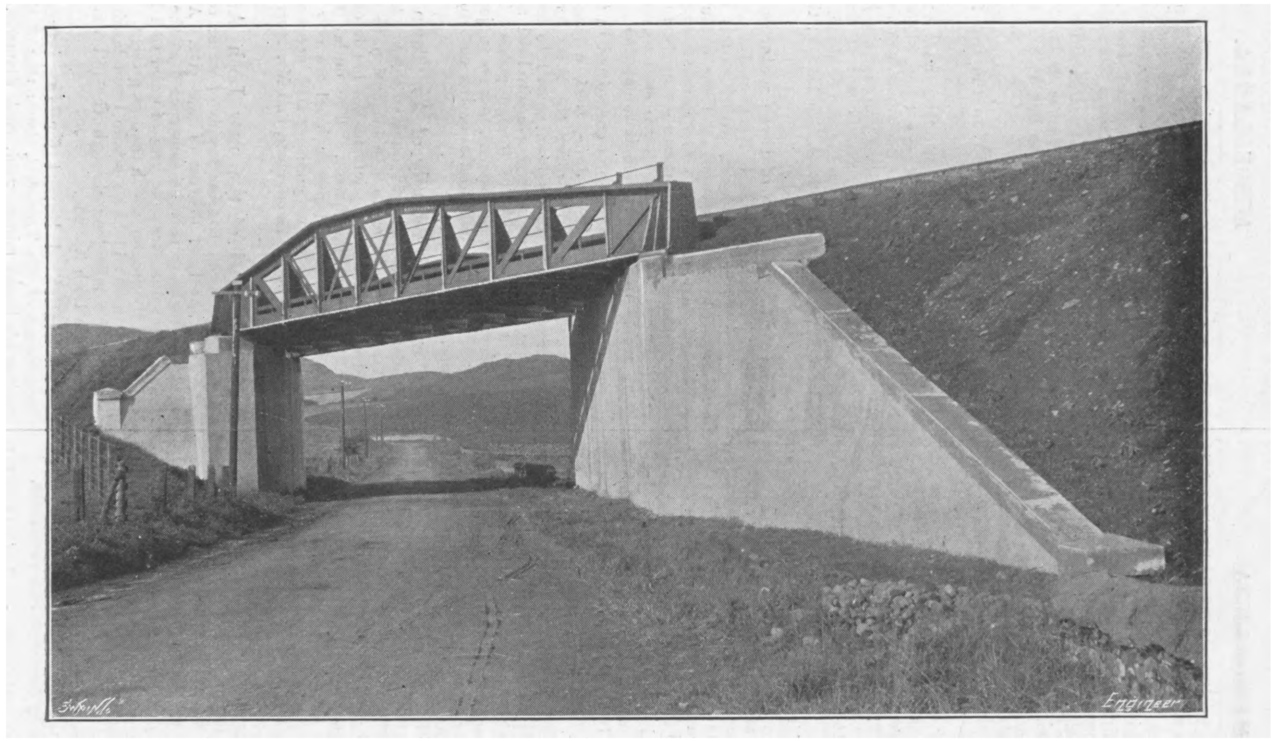
BRIDGES ON THE NEWBURGH AND NORTH FIFE RAILWAY

MESSRS. THOMAS MEIK AND SONS, EDINBURGH, AND WALTER BEER, WESTMINSTER, ENGINEERS

(For description see page 84)


Swain Sc.
Engineer

KINSLEITH ROAD BRIDGE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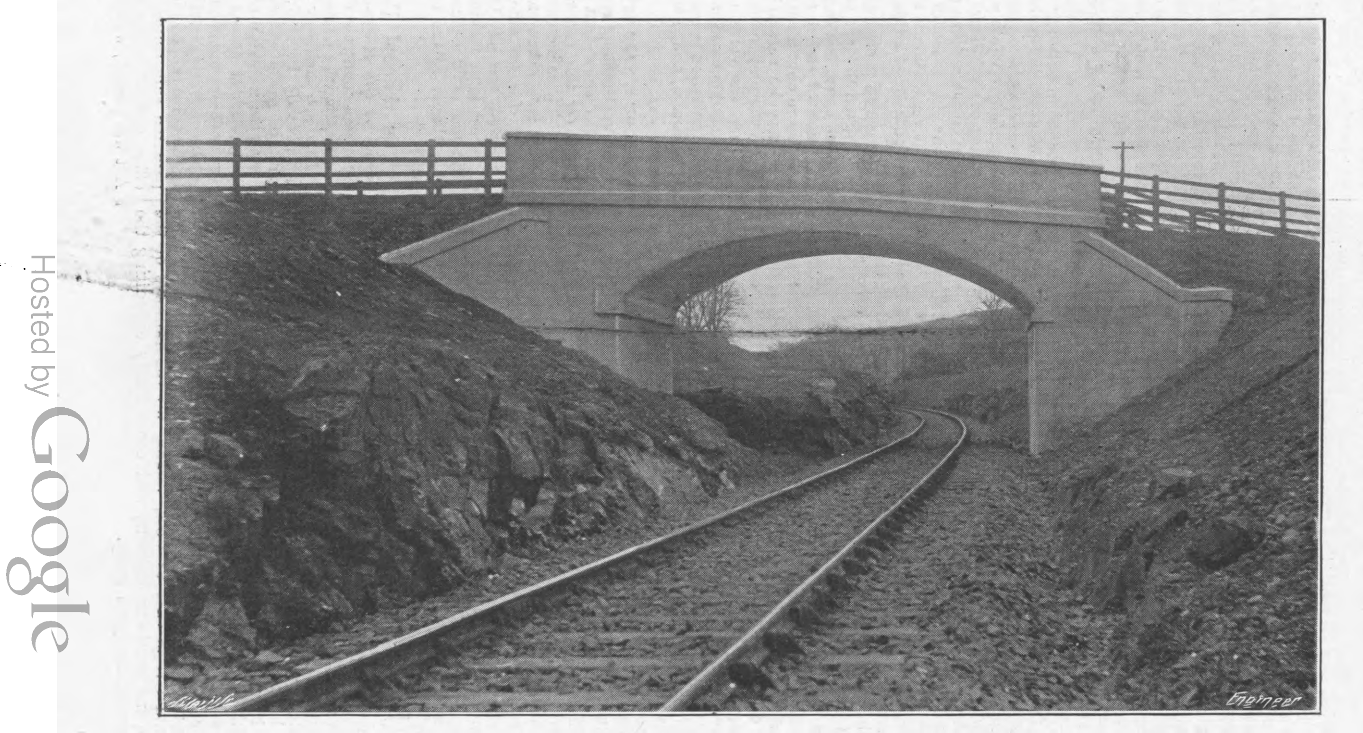
LINDORES BRIDGE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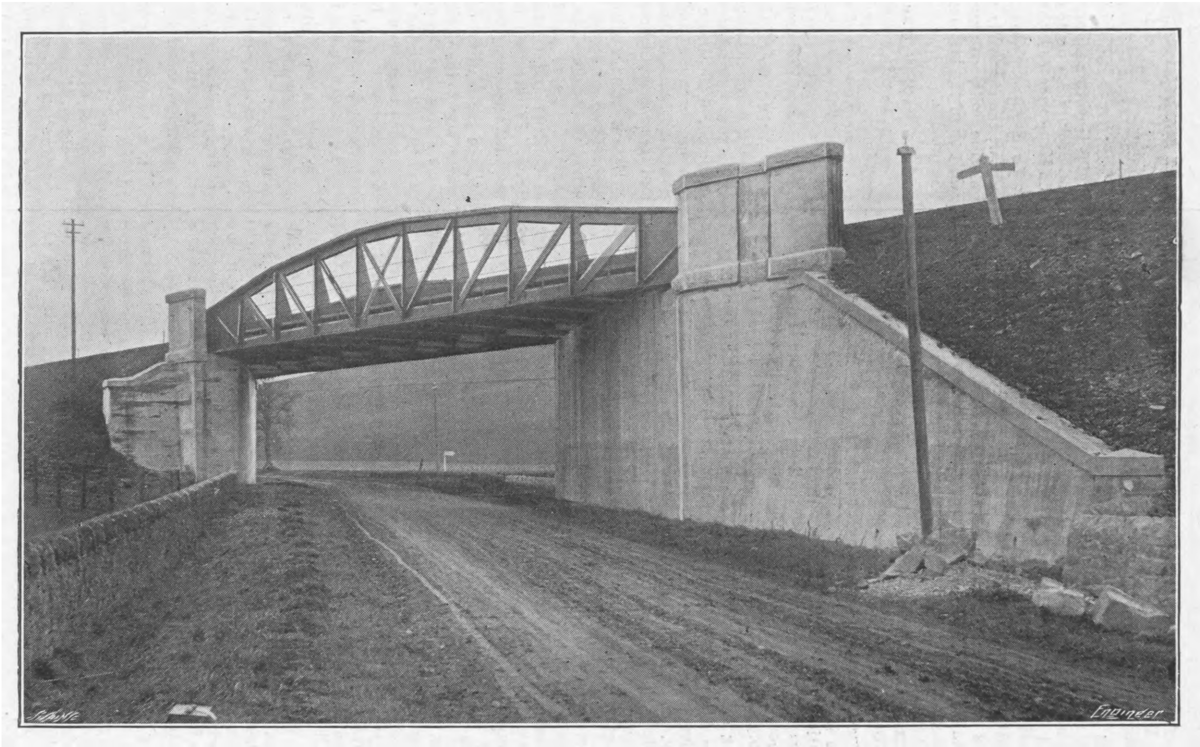
GUILD'S QUARRY BRIDGE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LUTHRIE BRIDGE

HIS MAJESTY'S REPAIR SHIP CYCLOPS

SIR JAMES LAING AND SONS, LIMITED, SUNDERLAND, BUILDERS

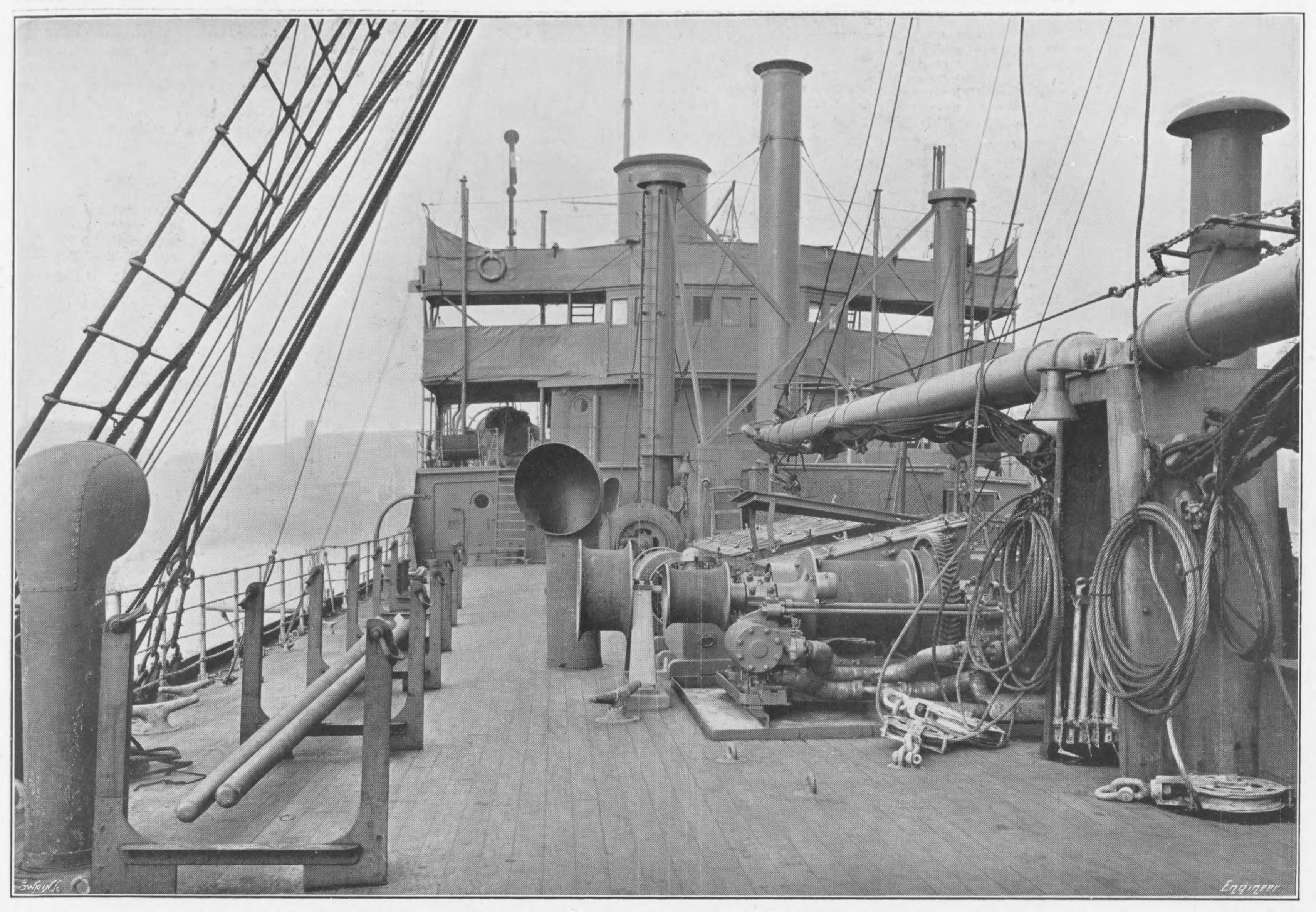

Fig. 1—UPPER DECK, LOOKING TOWARDS THE BRIDGE

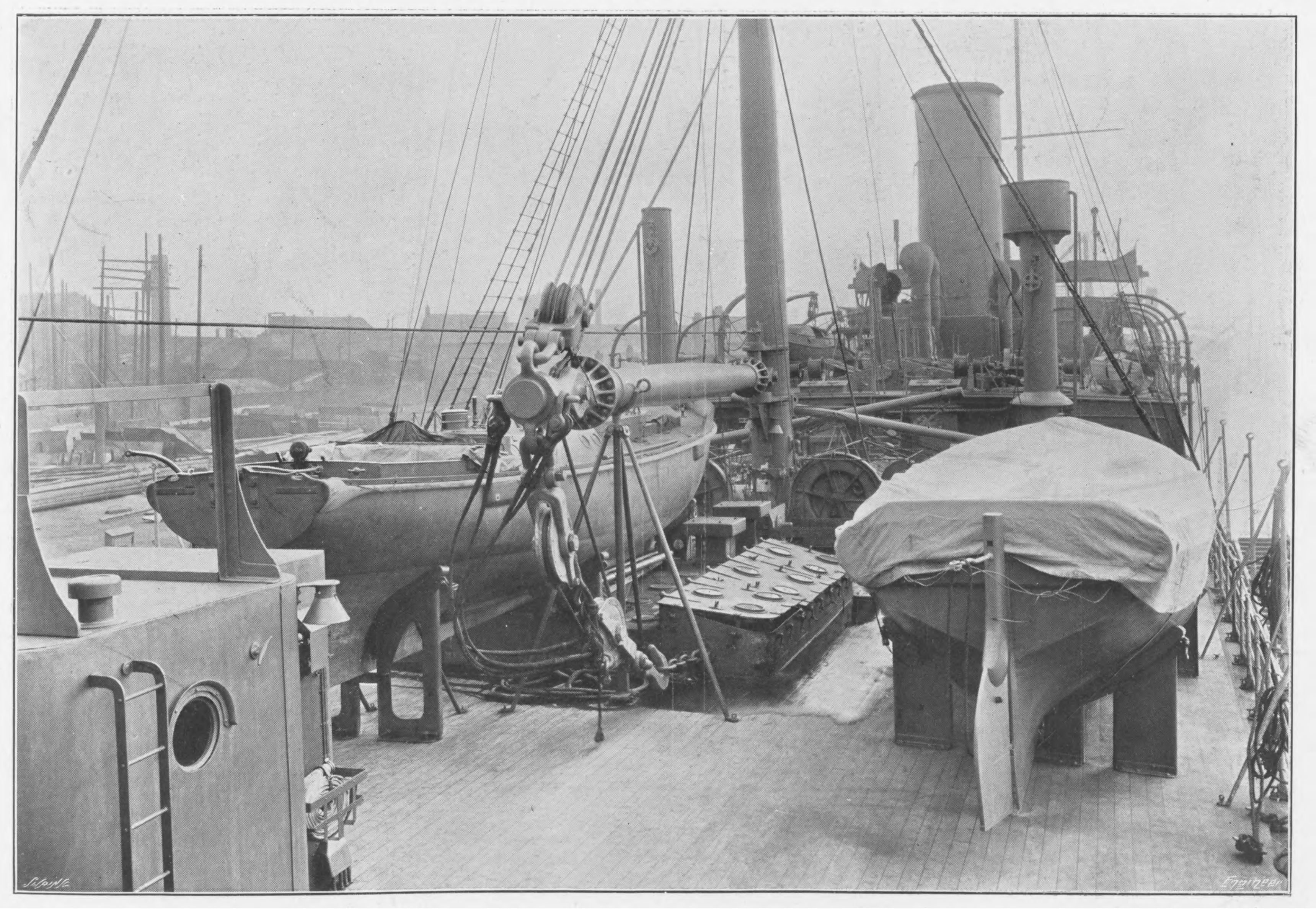

Fig. 2—AFTER END OF UPPER DECK

HIS MAJESTY'S REPAIR SHIP CYCLOPS

SIR JAMES LAING AND SONS, LIMITED, SUNDERLAND, BUILDERS

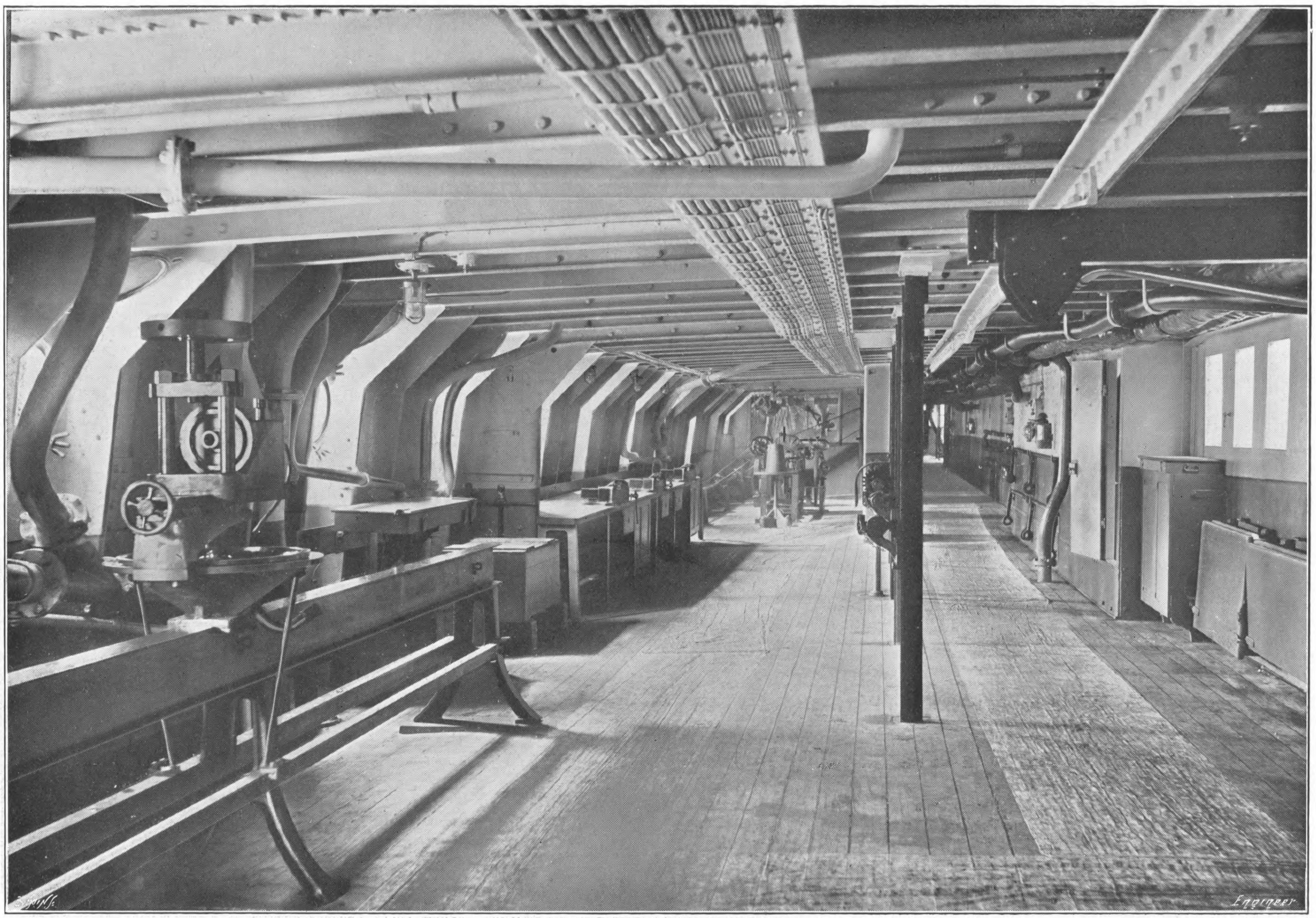

Fig. 3—ELECTRICIANS' WORKSHOP

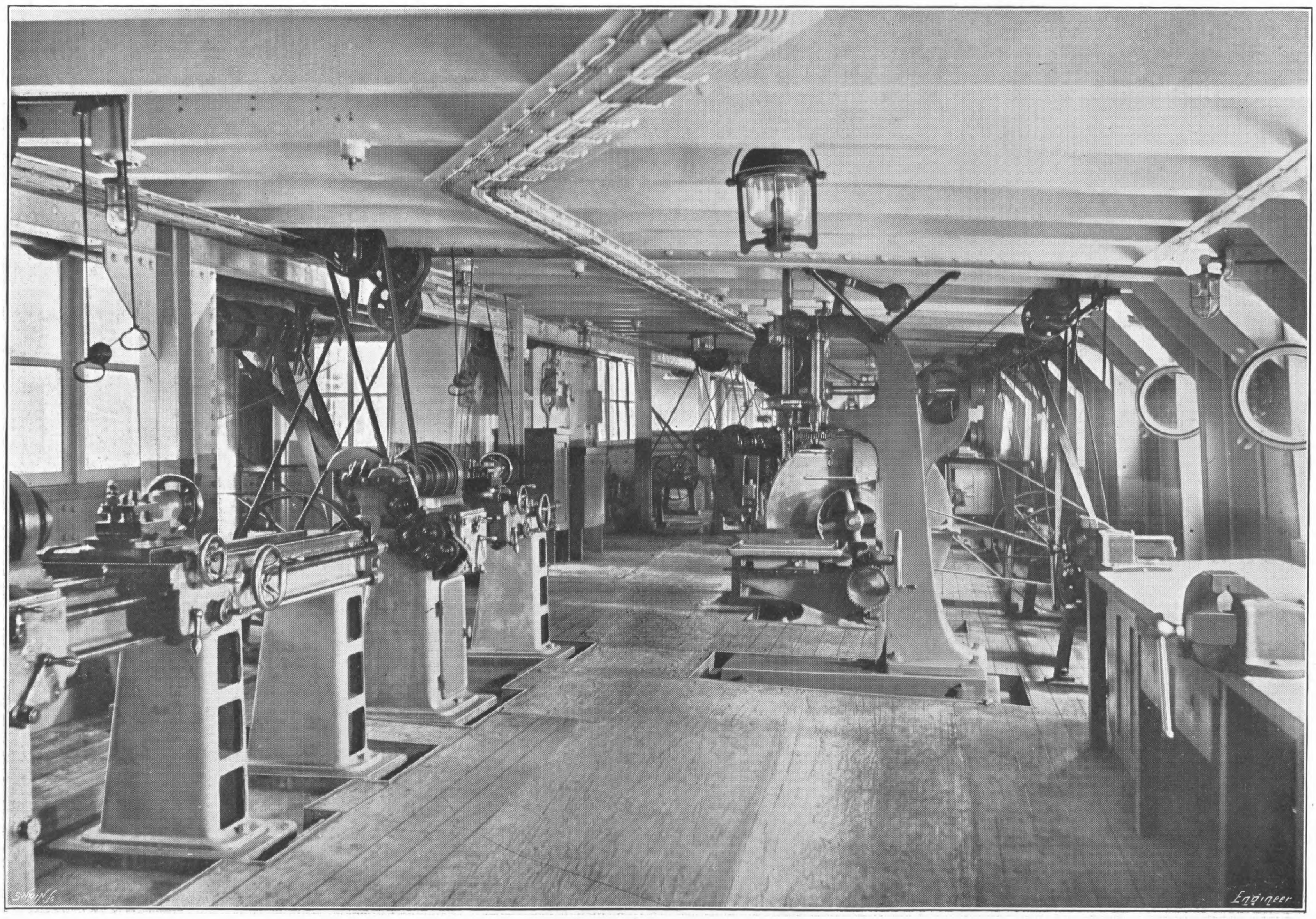

Fig. 4—THE LIGHT MACHINE SHOP

HIS MAJESTY'S REPAIR SHIP CYCLOPS

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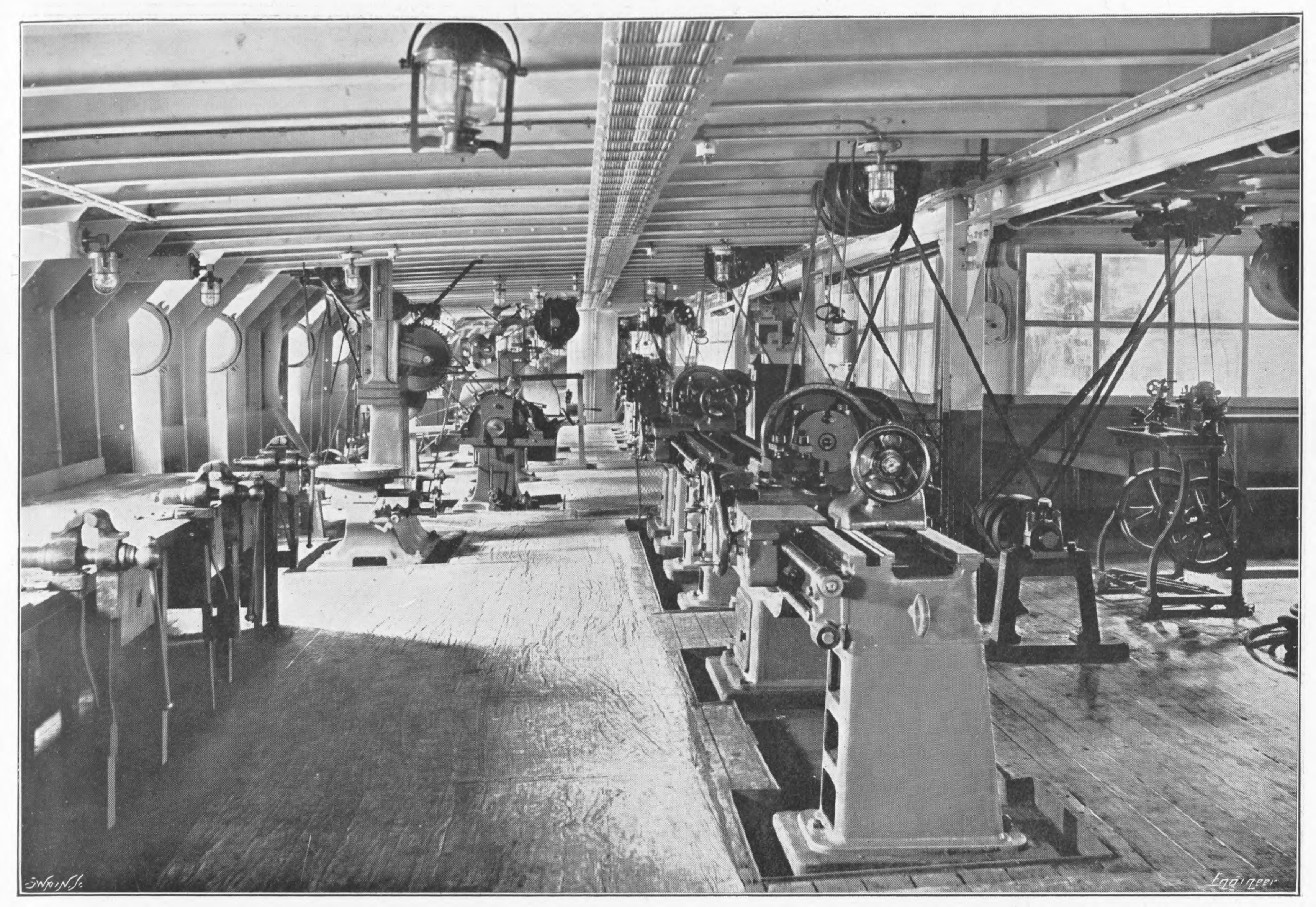
Swain Sc.
Engineer

Fig. 5—THE LIGHT MACHINE SHOP

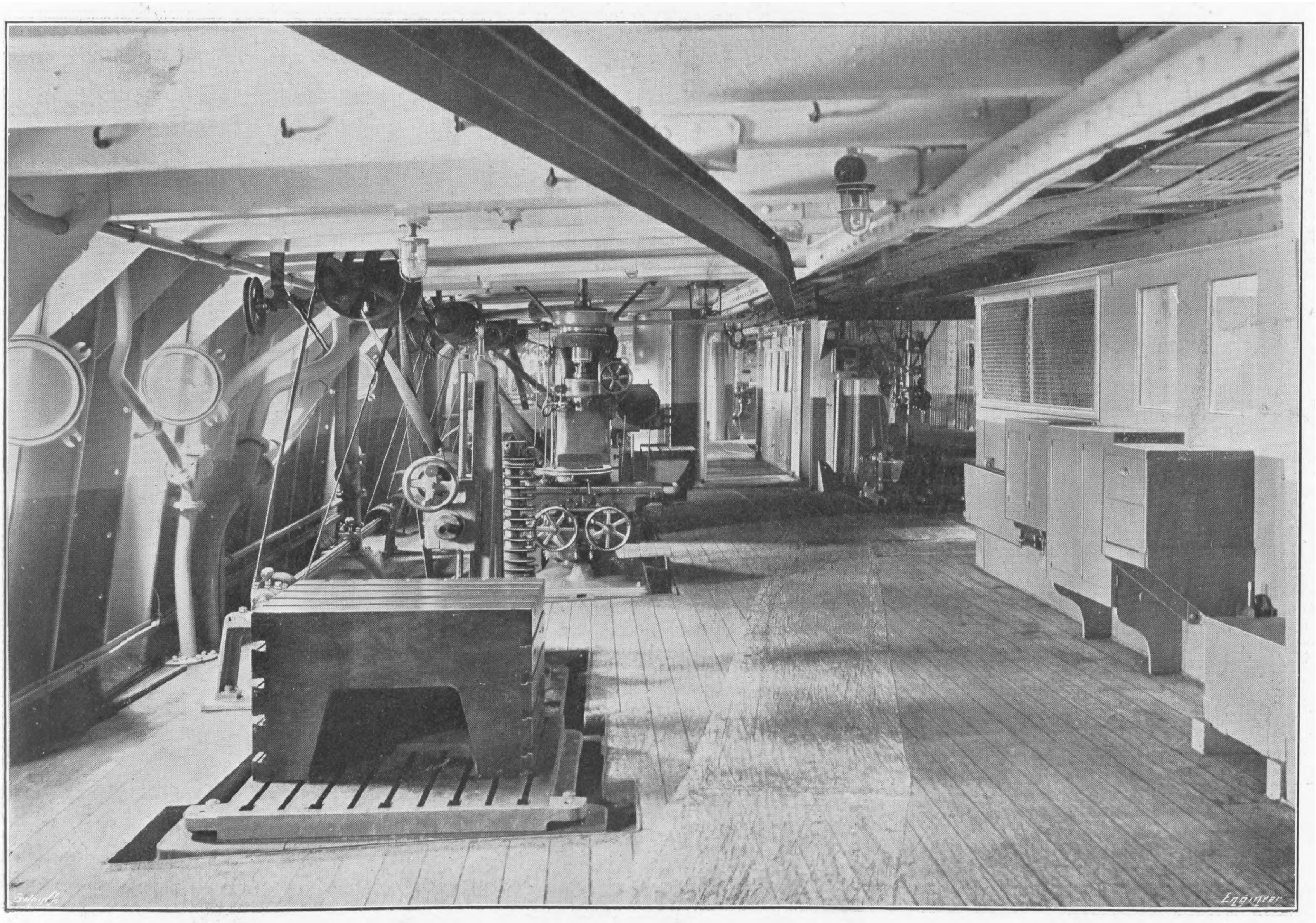
Swain Sc.
Engineer

Fig. 6—LIGHT MACHINE SHOP

HIS MAJESTY'S REPAIR SHIP CYCLOPS

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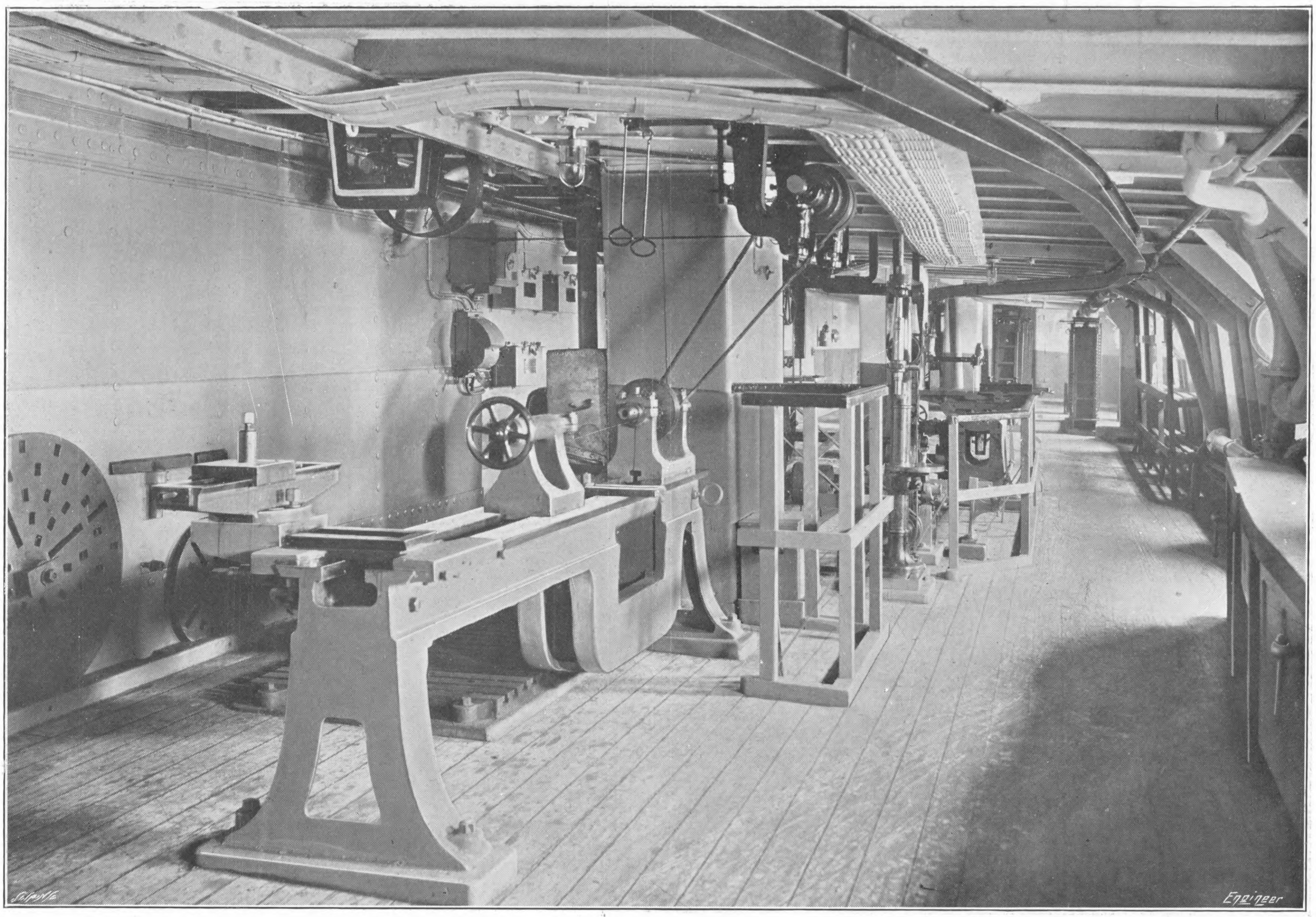

Fig. 7—PATTERN SHOP

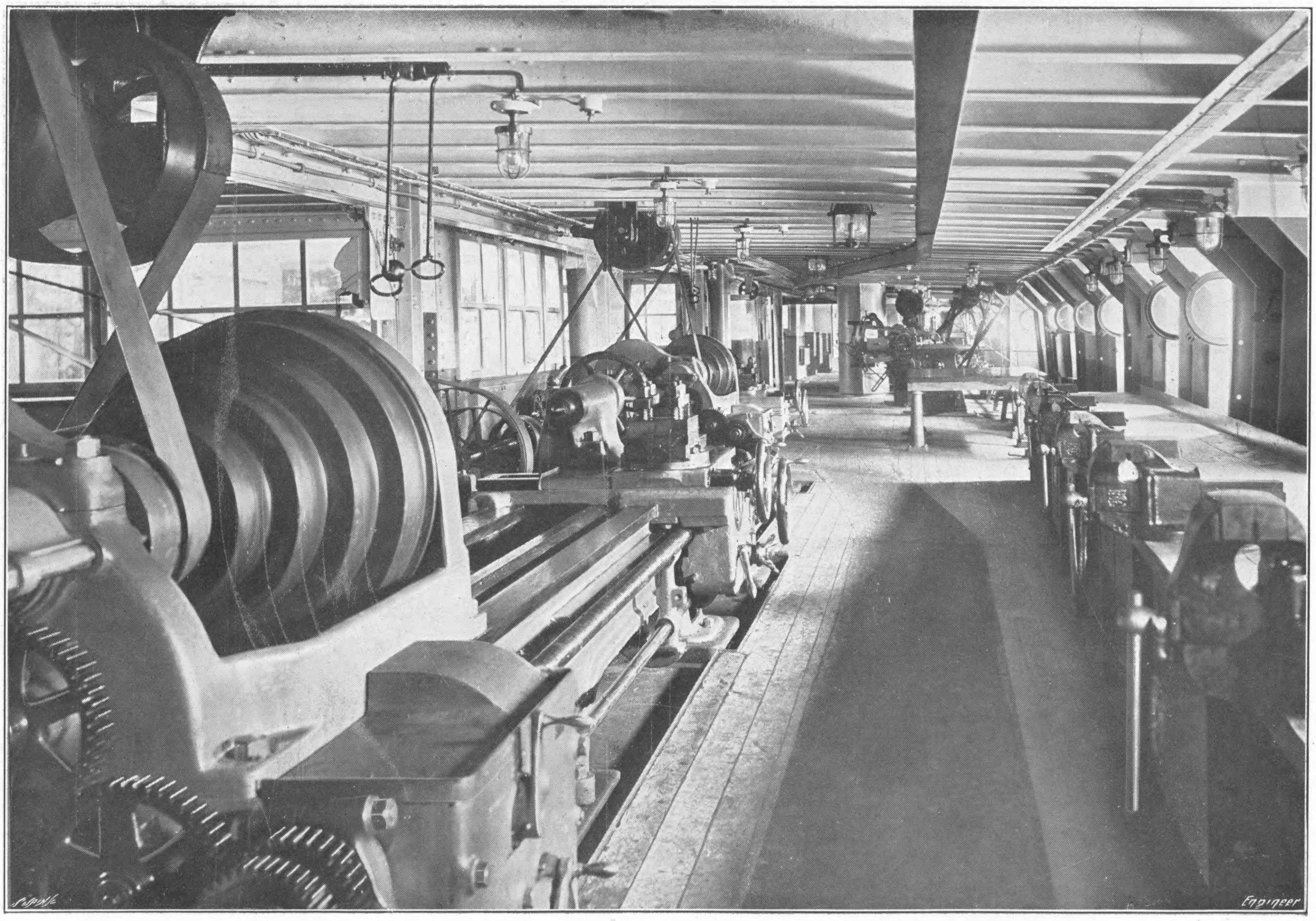

Fig. 8—TURNING AND FITTING SHOP

HIS MAJESTY'S REPAIR SHIP CYCLOPS

SIR JAMES LAING AND SONS, LIMITED, SUNDERLAND, BUILDERS

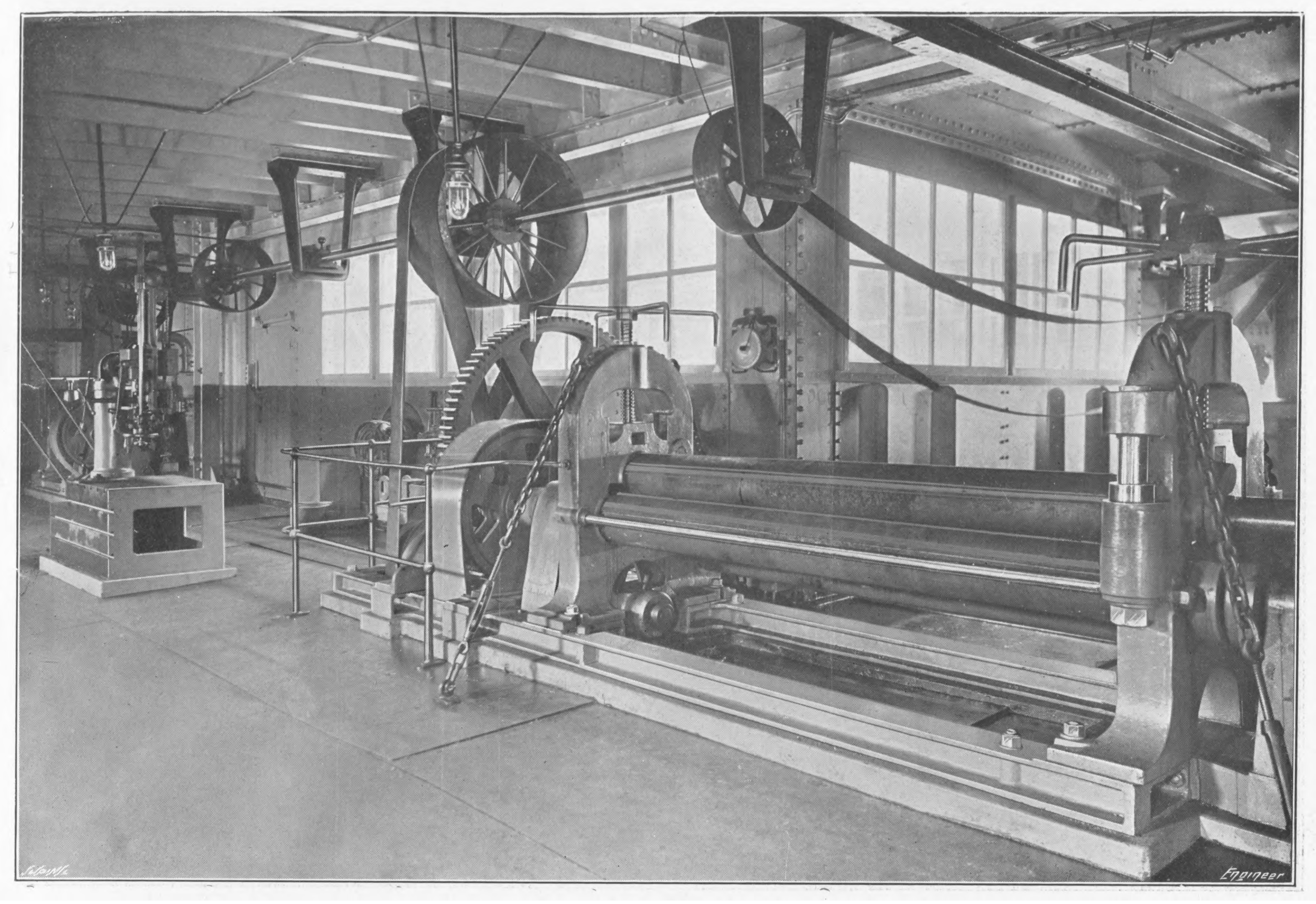

Fig. 9—PLATE BENDING ROLLS

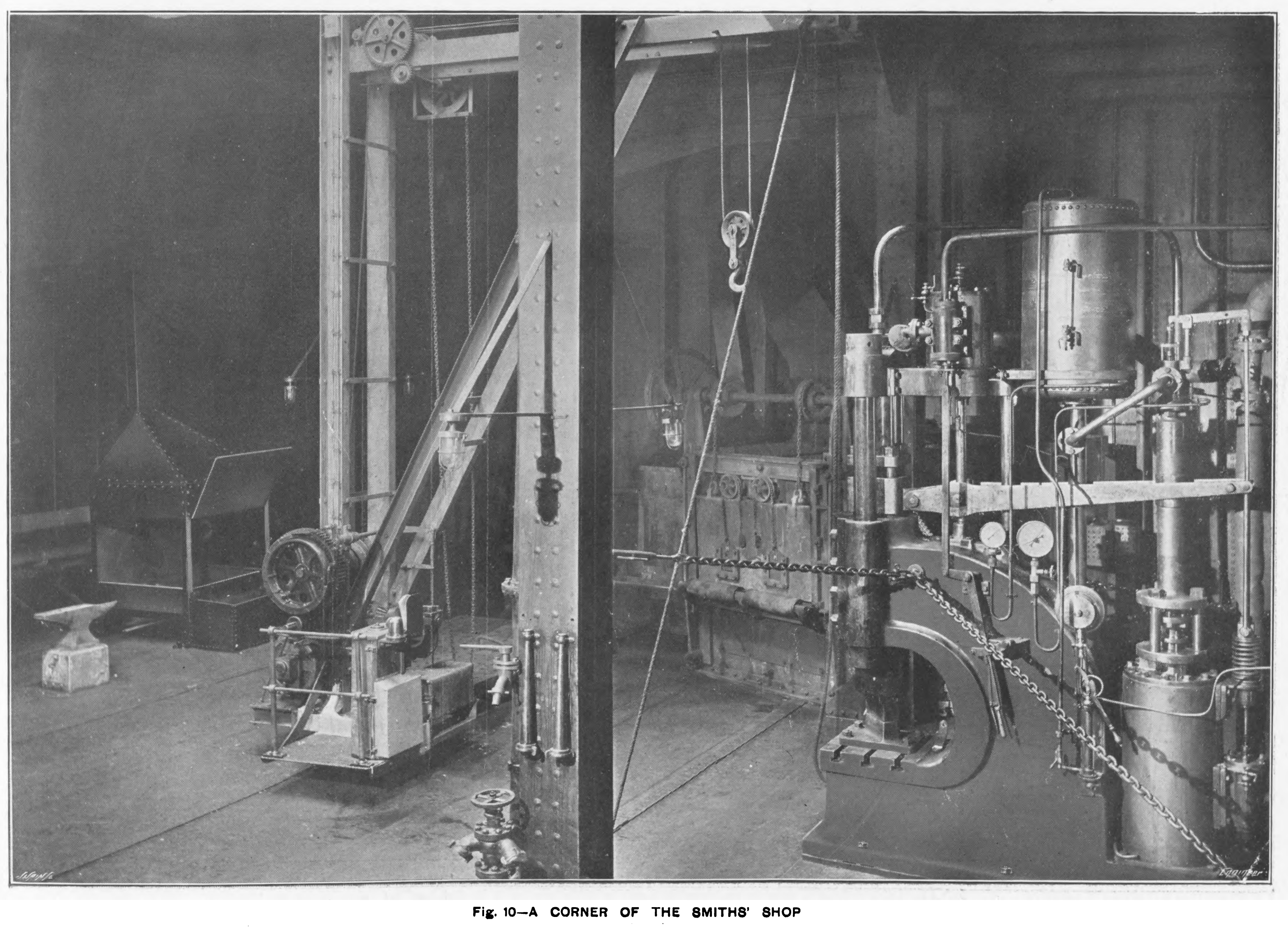

Fig. 10—A CORNER OF THE SMITHS' SHOP

HIS MAJESTY'S REPAIR SHIP CYCLOPS

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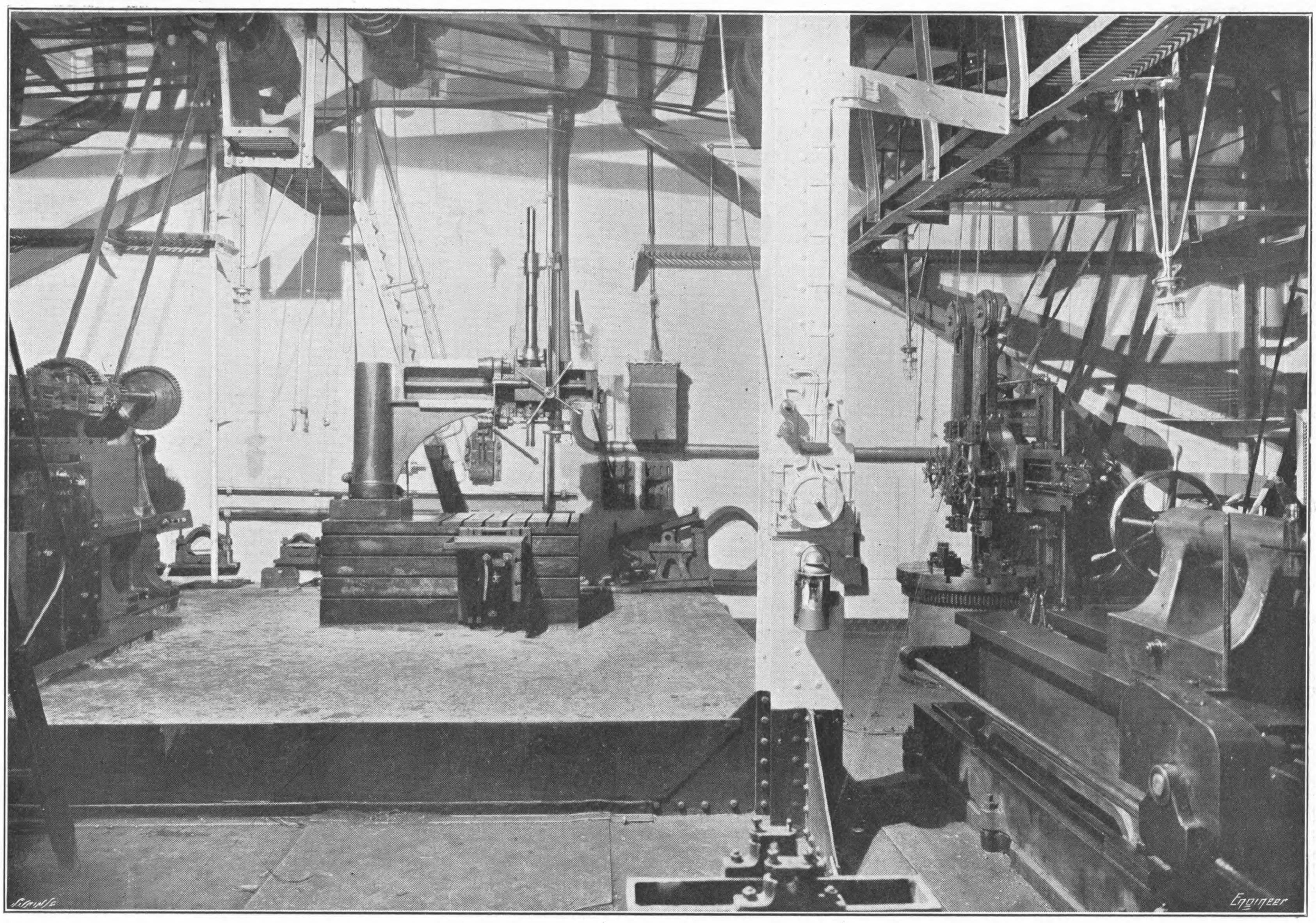

Fig. 11—HEAVY MACHINE SHOP

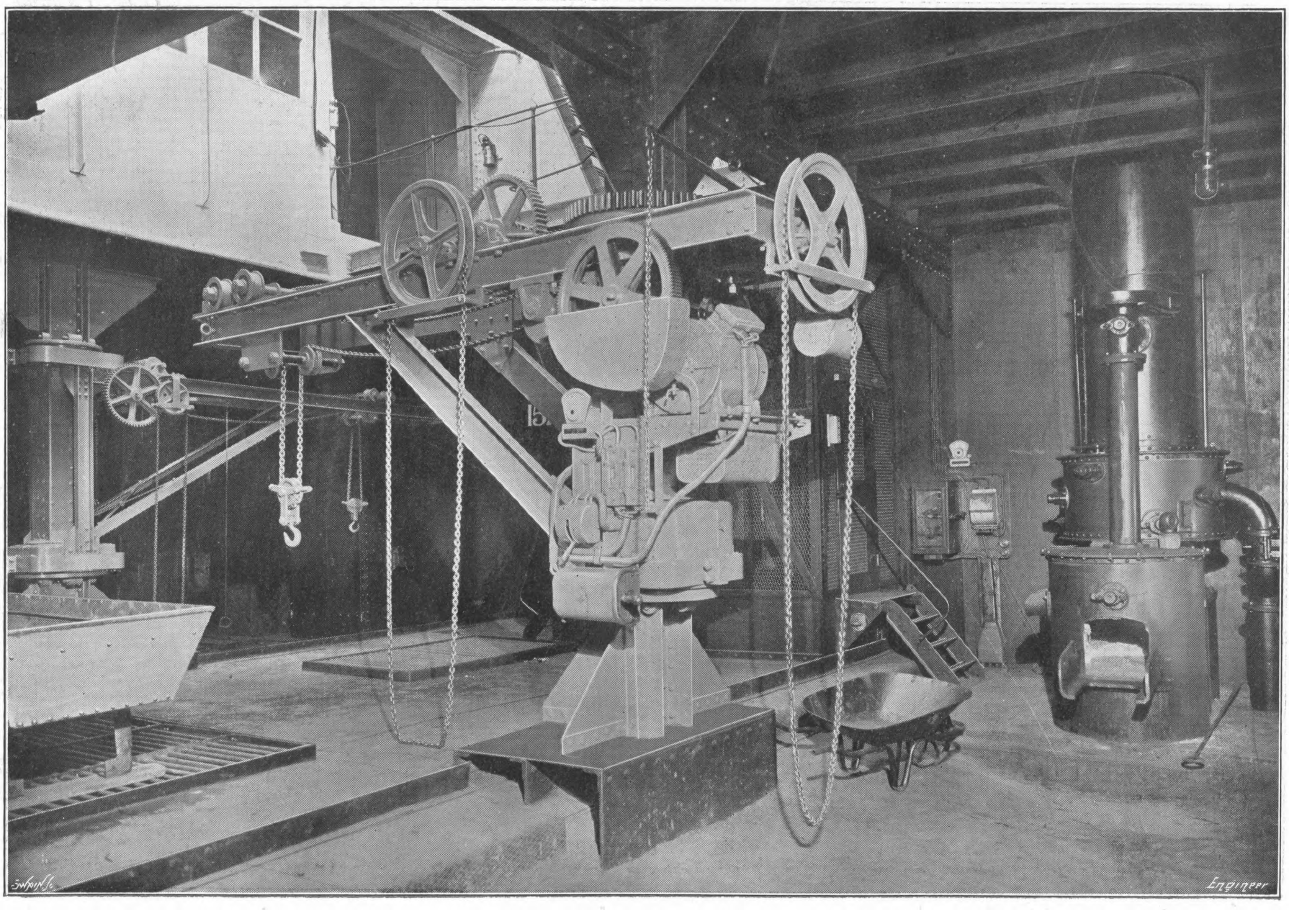

Fig. 12—THE FOUNDRY

HIS MAJESTY'S REPAIR SHIP CYCLOPS

SIR JAMES LAING AND SONS, LIMITED, SUNDERLAND, BUILDERS

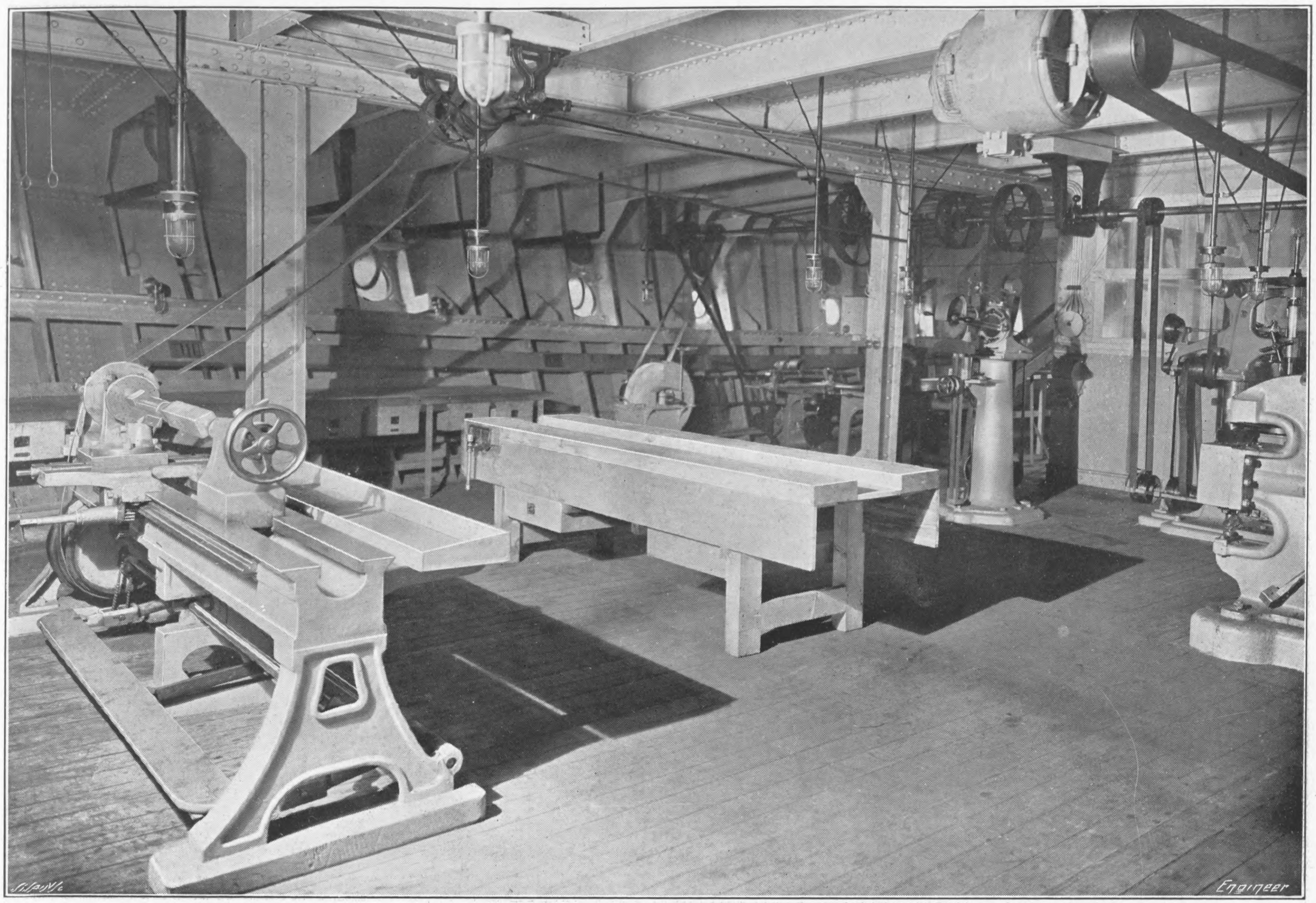

Fig. 13—THE CARPENTERS' SHOP

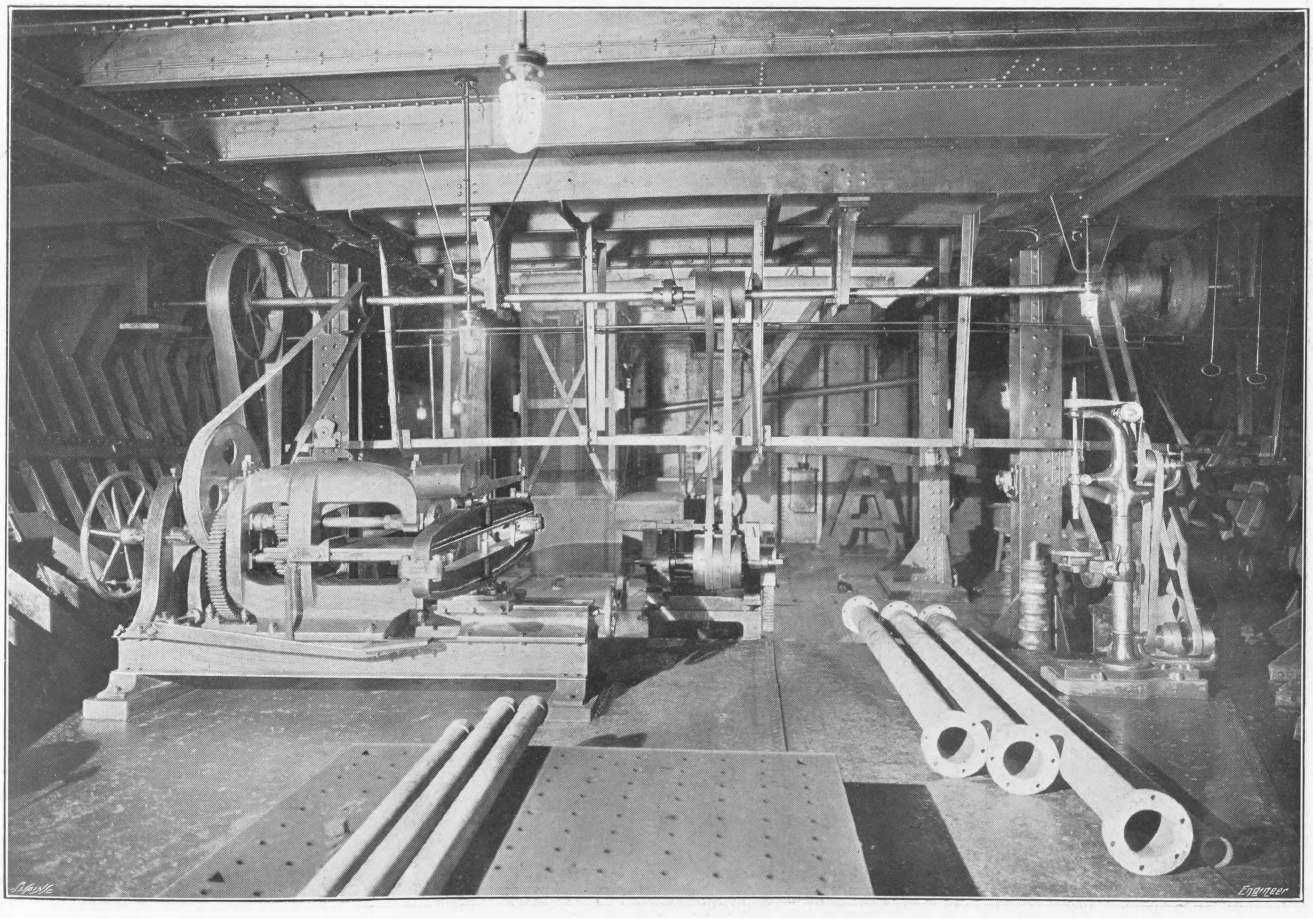

Fig. 14—COPPERSMITHS' SHOP

HIS MAJESTY'S REPAIR SHIP CYCLOPS

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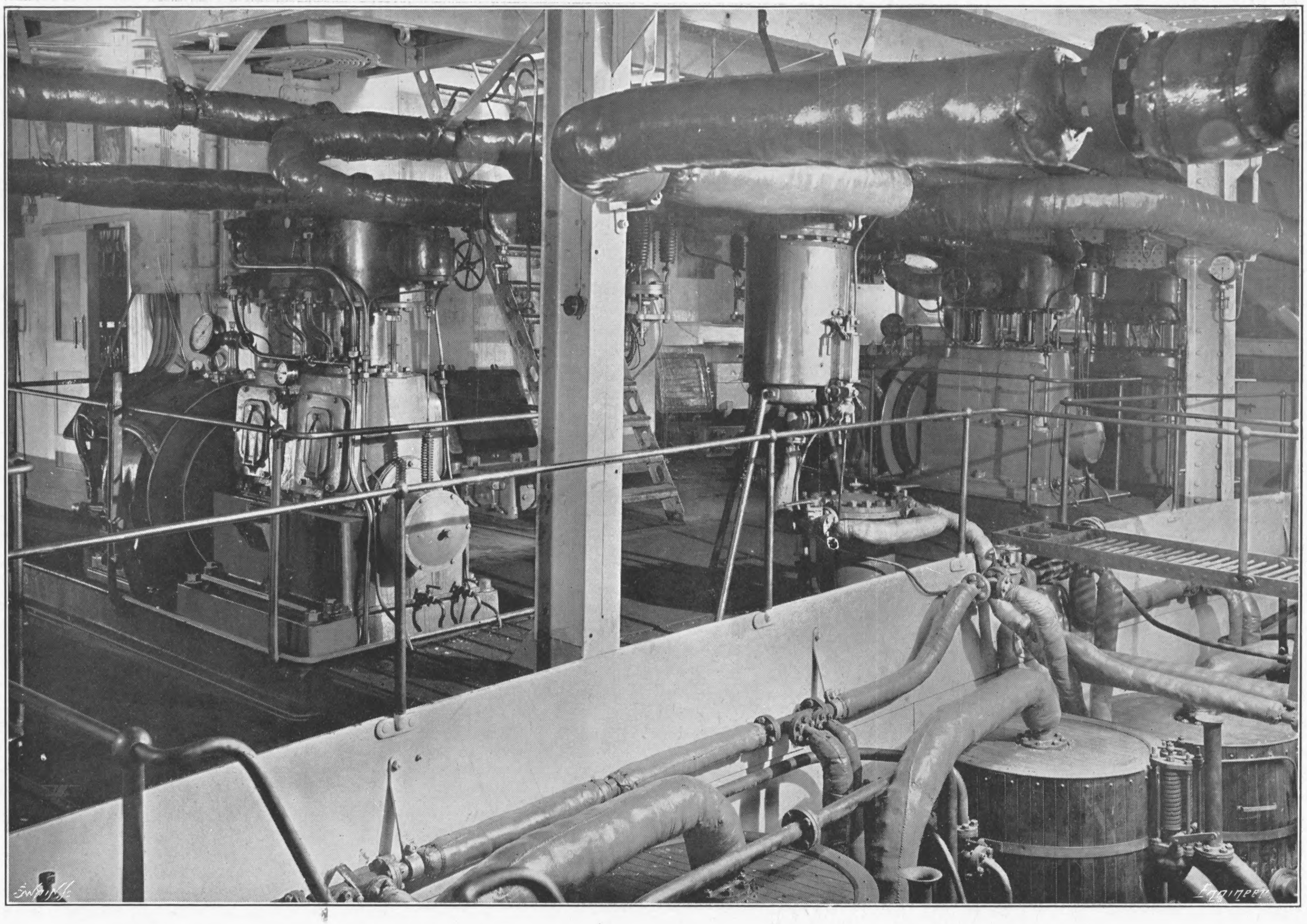
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Fig. 15—DYNAMO ROOM

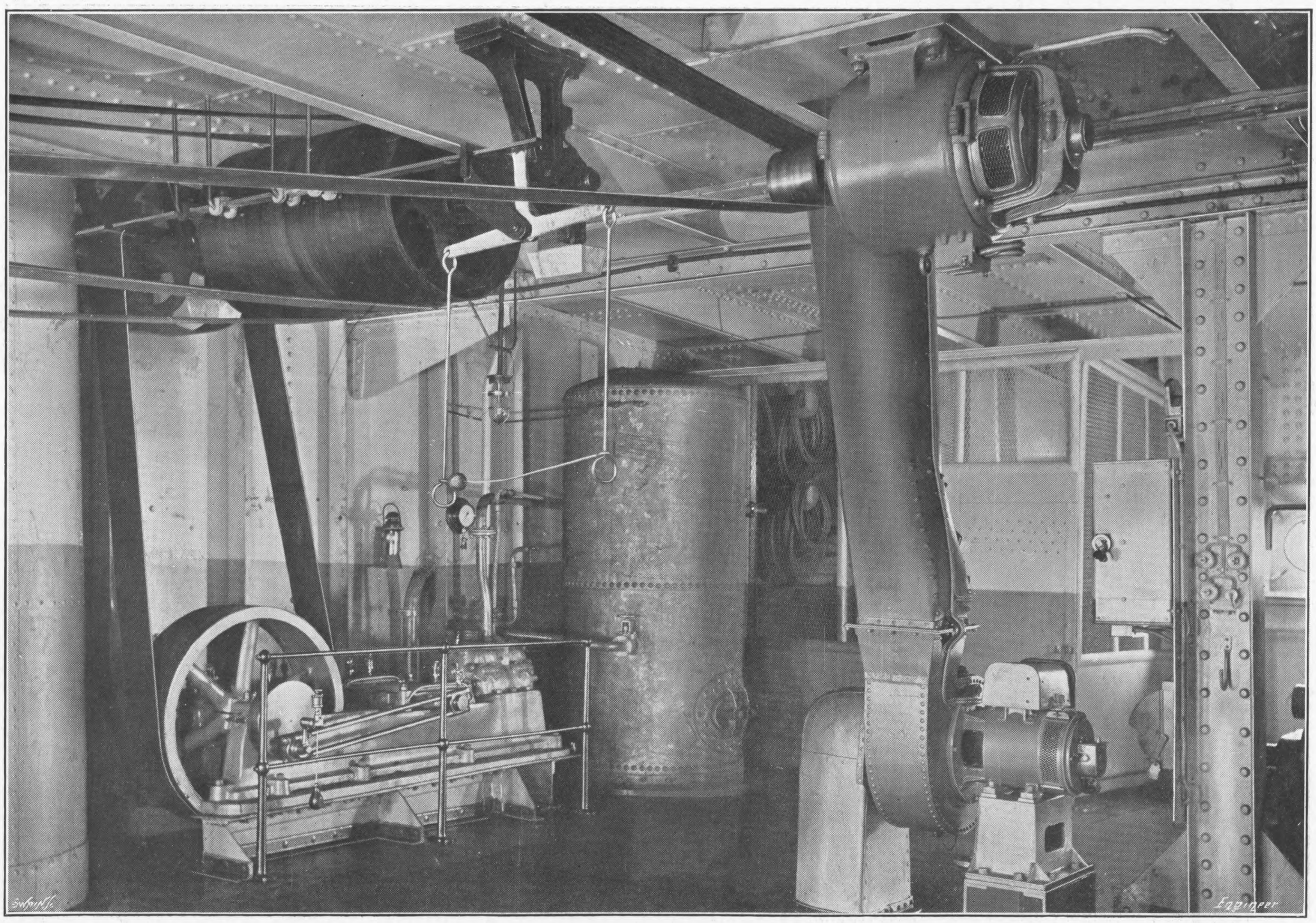
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Fig. 16—AIR COMPRESSOR AND SMOKE EXHAUST FAN

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TO CORRESPONDENTS.

☛ *In order to avoid trouble and confusion we find it necessary to inform correspondents that letters of inquiry addressed to the public, and intended for insertion in this column, must in all cases be accompanied by a large envelope legibly directed by the writer to himself, and stamped, in order that answers received by us may be forwarded to their destination. No notice can be taken of communications which do not comply with these instructions.*

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INQUIRIES.

CARSON'S PATENTED SMOKE-BOX DOOR.

SIR,—Can any of your readers tell me the address of the makers of Carson's patented smoke-box door? L.
July 19th.

DEATH.

On the 18th inst., JOHN ALFRED BOOTH, Director from its incorporation of the firm of Joseph Booth and Bros., Limited, of Union Foundry and Ironworks, Rodley, Leeds.

THE ENGINEER.

JULY 23, 1909.

The Coal Trade Crisis.

UNLESS an eleventh-hour settlement of the dispute between the Scottish miners and their employers is arranged as a result of the conference at the Board of Trade offices yesterday afternoon, under the presidency of Mr. Churchill, we are on the eve of a great industrial upheaval. What the immediate outcome of this conference may be, we make no attempt to forecast with accuracy—we hope and believe that both parties sufficiently realise the gravity of the issues involved as to spare no effort, consistent with honour, to avoid an open conflict—but we may recite briefly the circumstances which have led up to the crisis, call attention to the insidious doctrines which are influencing the promoters of the strife, indicate the possible grounds of negotiation for compromise, and suggest means of avoiding in future even the threat of a great national strike over the matter of a few pence in the wages of about one-tenth of the men engaged in the industry.

The cardinal point in the Scottish dispute has been narrowed down to what is termed the "basis price" of coal. The agreement which the Miners' Union is seeking to set aside, or alter, is that when the average selling price of coal is 7s. 1.45d. per ton the day's wage shall be 6s.; that with each increase of 4d. per ton in the price of coal there shall be a rise of 3d. per day in wages, or 6¼ per cent. on the standard, which is 4s.; and that wages shall move downward by the same scale, but in no case shall they fall below 37½ per cent. above the "standard," or, in other words, below 5s. 6d. per day. For more than a year the Miners' Union has been contending for a 50 per cent. minimum, or 6s. a day, instead of the 37½ per cent., or 5s. 6d. a day, minimum. This point the employers have not conceded, so there is no agreement that wages shall in no case fall below 6s. Indeed, the owners contend, and have offered documentary evidence to prove, that prices warrant a wage no higher than 5s. 3d. a day, and with this proof available they have felt quite justified in asking for a reduction to the hitherto agreed minimum of 5s. 6d. Stimulated by Socialist agitators who are going about declaring that a great national coal strike will lead to the nationalisation of the mines and a great improvement in working conditions, and by the promise of support from England and Wales, the Scottish miners are preparing to strike for the enforcement of a 6s. minimum. This figure, the leaders tell us, is the lowest possible limit of a "living wage." What is or is not a "living wage" for a miner we will not attempt to argue; but we are entitled to point out that as recently as five years ago the Scottish Miners' Union agreed that, in times of depression, 5s. 6d. per day would be regarded as a "living wage." That was the minimum agreed upon in 1904. Now, in 1909, with low prices, acute depression, widespread unemployment, and a crying need of industrial revival to mitigate the sufferings of our vast army of workless men and women, the Scottish miners refuse to honour their pledge of 1904—they refuse even to arbitrate upon the matter. It is here that impartial public opinion will condemn the miners, and it is here that a certain type of politician ought to cease to countenance the preachers of a spurious gospel of socialism which, if not arrested, will further sap the manhood and honesty of our workers, and weaken, if not destroy, our industries. Unscrupulous persons are telling the miners that rather than have a national coal strike the public and Parliament will demand the State acquisition of all the mines, and that they—the miners—have only to threaten such a strike to have all their demands conceded. Personally, most of our miners' officials are moderate men, but, unfortunately, these men are ceasing to be leaders, and are becoming the followers of that rapidly growing section of the miners which is being inoculated with the virus of a Socialism.

The present demand of the Scottish Miners' Union to have the minimum wage put at 6s. instead of 5s. 6d. means a permanent addition to the cost and the price of coal—which, in turn, means a further handicap upon our manufacturing industries—regardless of the fluctuation of trade, and in addition to the increased cost involved in complying with the new Eight Hours Law; for when the owners contended that the price of coal warranted them in seeking a reduction of wages to 5s. 6d. per day, the Union replied that the "basis price" must be so altered that the current price would permit of the 6s. wage being continued. How flimsy is the foundation of this demand, and how nicely the "basis price" is adjusted in the interests of labour already, may be gathered from the fact that in some cases as much as 2¾d. is absorbed by the miners in increased wages out of every 3d. in the rise of price. As a matter of fact, spread over the whole country, the miners' share will equal fully half of any advance there may be in price. Roughly, the output of coal in Scotland averages 1½ tons per working day per man. Thus, when price rises by 4d. per ton, the value of the product of one day's work is increased by 6d. Out of this 6d., under the sliding scale arrangement, the men get 3d. When to this fact we add that in an ordinary year, or on an average spread over a number of years, the mine worker takes fully two-thirds of the pit-mouth price of coal, leaving only one-third for rents, royalties, rates, taxes, upkeep of plant and equipment, and profits all told, it will be seen that our miners are not a badly paid class of men.

So far as a settlement of the dispute of the moment is concerned, we may venture to hope that proposals for negotiation and solution may be found either in the offer of the Union to consent to a 5s. 9d. minimum instead of 6s., in view of prevalent depression, and of the owners to concede this in view of signs of a coming revival in trade, or in the offer of the owners to grant the 6s. minimum on condition that they are permitted to retain a somewhat larger share of the advances in price when trade revives than they have hitherto enjoyed under the sliding scale. Surely something can be offered by one party or the other that will smooth out the difference which threatens the none too robust industrial health of the country. And something must be done in the future to avoid even the threat of such a strike as now menaces us. If the State can lay it down by law that grown men shall work only under such and such conditions, regardless of what they and their employers may wish to arrange, then the State can also lay down by law that no men, or combination of men, shall dislocate the nation's industries without just and proven cause.

The Future of the Submarine.

THE lamentable accident to submarine C 11 has has again brought prominently before us the risks attendant on the use of these craft, and is the second case of disaster due to a quality which is at once one of their weak and strong points—viz., lack of visibility. The quality is a valuable one for attacking purposes, but when associated with limited vision and slow speed it becomes also a source of danger to the submarine. The history of any new branch of engineering introduced into the Navy has generally been in its early days a history largely blotted over with accident and failure. Electricity, high-pressure steam, forced draught, water-tube boilers, high-speed machinery, breech-loading guns, cordite—all have claimed their due proportion of victims in the earlier stages of their development, and it may be that the submarine is passing through the same stages where accidents can be traced to lack of experience or to the want of some provision or apparatus which can only be brought to perfection by the tedious process of trial and error. In short, if the accidents—and it must be acknowledged that there are many—which have taken place in submarines are to be reduced to the same relative proportions as in other vessels of the fleet, it will be necessary to distinguish between those qualities which contain radical defects in principle and those in which a due degree of perfection can be attained by improvement in detail. The submarine has now been with us for the best part of a decade; the crews are thoroughly trained and frequently exercised, so that we ought to be beyond the stage when accidents are attributable wholly or in part to lack of experience.

The cause of the accident to C 11 appears primarily to have been of a simple nature. She was not seen by the vessel which ran her down, and the submarine was unable, for some cause still to be explained, to get out of the way. The Bonaventure, which was conveying the flotilla, presumably carried the usual lights, showing that she was acting as a convoy, and the night was dark. The situation was therefore as free as possible under the circumstances from adverse conditions. The doubt is immediately raised as to whether the submarine from its nature ought to proceed in close formation, especially at night. Accidents have happened, and more frequently been narrowly averted, by merchant vessels getting "mixed up" with a fleet of large ships which can easily be seen, and it would seem that the chance of accident with a flotilla which cannot be seen is imcomparably greater. We know that in this case not only was one submarine sunk, but two others were in collision in endeavouring to avoid the steamer. The flotilla of which C 11 was a unit was proceeding on the surface, but even thus submarines show very little above the water, and at night they are difficult to distinguish even in clear weather, unless one is specially on the look out for them; and from this cause the ordinary rules of the road can hardly apply, and it will generally be necessary for the submarine to take the initiative in getting out of the way. This course may be rendered more difficult when submarines are in close formation. In saying this we have no desire to prejudge the present case, many features of which will not be known till after the official inquiry; but we desire to point out that the future of the submarine as an effective fighting unit depends largely on its being able to take care of itself. In avoiding collision, apart from the personal element, there are two main factors, speed and manœuvring power, and when running submerged there is the additional factor of range of vision. Submarines are now fitted with double periscopes, but even with two of these instruments, the steersman has not the same range of vision nor the same perception of distance as when using the naked eye, and with periscopes alone the submarine will always labour under a disadvantage. By an extension of the method of submarine signalling it may, however, be possible in the future to fit recording instruments in the boat which will show the distance and direction of any approaching vessel. When steaming—this is hardly the right word for vessels propelled by petrol engines, and the submarine men themselves call it gassing—on the surface these vessels are navigated from the top of the conning tower, and when not seen by an approaching vessel they must rely on their running power and speed. No results have been published of the turning circles of these craft, but from their shape they should be very quick, except that they are steered by hand, and in the larger and latest boats the work of pulling the helm hard over at full speed must be considerable. As these boats have electric power, no doubt an electric steering motor will be fitted if found necessary or desirable. It is in the speed of the submarine, both on the surface and submerged, that the greatest obstacles to development will be met. The latest boats of the C class have a full speed on the surface of about 13 knots, and about 9 knots when submerged, and they will prove no exception to the general rule that the power required goes up very rapidly as the speed increases, more rapidly than the cube; for larger engines and motors mean a larger boat.

We suppose the submarine could not have attained to its present state of development without the aid of the internal combustion engine, and to it we must look for further progress. The petrol engines at present fitted represent about the limit of size which can be attempted with the conditions prevailing on board these craft. The diameter of the cylinders is already larger than of any petrol engine used on shore, and cannot be increased without risk of such troubles as pre-ignition, to which there is always a tendency in engines using petrol with cylinder dimensions much less than in other forms of internal combustion engines. The number of cylinders employed together on one shaft would also seem as large as consistent with efficiency, having in view the increase of complication in a confined space. Increase in power can thus only be secured by a change of type of engine, or by fitting more than one screw shaft. It is generally known that the experimental boat D 1, now being built, which is much larger than the C class boats, is to have twin screws. What type of engine is to be fitted has not been stated. The difficulty about increasing the speed when submerged is mainly one of weight, as there are no practical limitations to the size of battery which can be employed, or the number of hours it can be made to run without requiring recharging. Any improvement, however, of the electric battery as regards weight for output will allow a greater weight to be provided in the main engine for working on the surface. It will be seen what a disadvantage the necessity for carrying an electric battery is from the point of view of speed, when we consider that the weight of a destroyer's machinery works out at about 40 per cent. of the total displacement, whereas in a submarine the weight which can be allotted to the main propeller machinery is less than 20 per cent. of the displacement, while the batteries and motors weigh nearly double this. The combination of batteries and petrol engines is also a source of danger, though experience in the details of the fittings and care in manipulation has reduced this danger to a minimum. Many men have been working on the design of a heavy oil engine for this craft, but the conditions are so onerous, and the difficulties as compared with petrol are so great, that up to the present no satisfactory solution has been found; but inasmuch as the dangers and disabilities of the use of petrol will increase rapidly in larger sized cylinders than those at present attempted, it would appear that the development of the oil engine using safer kinds of petroleum is an essential factor in the development of the submarine.

The Failure of Rails in the United States.

So many lives are lost, so many people are maimed, so much property is destroyed by the breaking of rails in the United States, that it is not remarkable that permanent way excites, and receives there an attention almost without a parallel in this and other civilised countries. Precisely why rails should break so often is the vital question. Are the breakages due to the construction of the road, defects in the locomotives and cars regarded as vehicles, or to the inferiority of material or slovenly methods of manufacture? The American Society for Testing Materials held its twelfth annual convention at Atlantic City from June 29th to July 3rd, and among the subjects discussed none was of more general interest than the failure of steel in service, brought forward by Messrs. Henry Fay and R. Wint, in the shape of a report on studies of broken steel rails made at the Massachusetts Institute of Technology; and by Mr. R. Job, of Philadelphia, who read a paper describing an investigation of defective open-hearth steel rails. The first report referred altogether to the results of microscopic investigations. The general conclusion is that cracks always start in manganese sulphide, from which in crescent shape they extend into the metal. Silicate of manganese was a contributory cause. One of the failures studied was that of a split rail on the Burlington road. Slag pits were plentiful, and both sulphide and silicate of manganese were found. All this is in effect to say that sulphur in any shape should be kept out of rails; although so far as is known its usual effect is to make iron or steel red and not cold short. The author's deductions are that specifications should call for lower sulphur; that more time be allowed between the manganese additions and the pouring of ingots; that ingots be bottom poured; and that there be more refining of the metal, by the employment of the electric furnace or otherwise.

The discussion which followed was principally remarkable for a revolt against the exaggerated importance attached to the use of the microscope. Dr. Dudley is a very eminent American authority on metallurgy, and he holds that the microscope is apt to give very erroneous impressions concerning what are really quite unimportant defects. Professor Howe called attention to the pitted appearance of one sample shown on the screen, and said that if the steel contained as much slag as the etched and magnified specimen indicated the rail would have been rejected for being plainly under weight. He suggested that in mirror polishing of steel, so-called pits are found that do not explain themselves, and that may really be remains of old file marks. Mr. Bostwick said that in the Carnegie Steel Company's experience, where abnormally large percentages of sulphur and manganese had been deliberately used in steel for certain purposes, there had been none of the manganese sulphide phenomena which Dr. Fay had emphasised. Another speaker made the point that microscopic investigations often disclose the thing for which the investigator is hunting. It is beyond question that the discovery and application of new methods of ascertaining the properties and characteristics of iron and steel have in the past always been followed by a usually undeserved value being attached to them. Thus, when the tensile testing machine was first employed by the late David Kirkaldy, it was held by most people that nothing more could possibly be required—a view, we may add, never held by Kirkaldy himself. In the same way, again, the impact test was held by some persons to be all but final. Each and all such things have their uses and their values; and so it is with the microscope. Yet few things can be more deceptive to the inexperienced. We are apt to take a microscopic section representing, perhaps, the $\frac{1}{150}$th of a square inch as being really a section of a bar $1\frac{1}{2}$in. square, and to regard an infinitesimal fissure as a serious flaw. It is well that a word of warning should be uttered now and again by those whose sense of proportion has not been deadened, and who are able to speak with authority.

It cannot be said that Mr. Job's investigations have done much, or, indeed, anything to clear the ground. The general result is that if a rail is of good material and properly made, it will not break. But that has been known from the first. It seems to be clear that there is no panacea in open-hearth steel. Indeed, it is easy to see that bad as a Bessemer rail may be, there may be nothing to choose between it and an open hearth rail. The fact in favour of the latter is that whereas with some steels it is impossible to make a good Bessemer rail, it can be made in the open hearth furnace. The facts have been put with an almost brutal simplicity by Mr. Job: "As as been pointed out repeatedly, the name "open hearth" is no talisman for production of rails certain to give good service, and it is well known that rails of this method of manufacture are subject to the same general defects which may be found in Bessemer rails, and hence require equal care during the process of manufacture."

The most interesting deduction that is to be drawn from his paper is that cracks do not under any circumstances begin in sound metal, but always in congenital flaws, or holes or splits, either existing from the first in the ingot or developed during the process of cogging or rolling. This conclusion, if justified by many experiences, may be taken as definite proof that it is not the material, but the method of manufacture that is chiefly responsible for broken rails in the United States. Let us suppose, for example, that a rail contains too much carbon or phosphorus—that, in a word, it is "too high," and consequently brittle. Now, if that rail is thoroughly well made, having a considerable factor of safety, it may be worn out by years of service without failure; whereas a much better rail, chemically speaking, badly made, may break after a very short life. Here, for example, is a statement made by Mr. Job:—"An open hearth rail had broken in service into about forty pieces, derailing a train, but fortunately causing no loss of life. A critical examination was made to determine the exact cause of the failure. In the preliminary investigation we found that a blow-hole began near the receiving end of the rail, about $\frac{1}{2}$in. below the top of the head, parallel with the surface of the latter, and extended clear to the running-off end of the rail. Within a short distance from the start the unwelded seam spread from one side of the head to the other, with oxidised surfaces. In the unbroken rail no defect could have been visible, and even after the fracture the only sign of defective condition upon the contour of the unbroken pieces was a faint line like a roll mark along the side of the head, generally covered with mill scale. When the fracture came evidently the $\frac{1}{2}$in. layer upon the top of the head cracked, throwing the end against the opposing wheels, and thus causing the derailment, the remainder of the rail being ground into pieces by the force of the impact and the pounding of the wheels." This statement deserves very careful consideration. We see that the failure began in a blow-hole, and Mr. Job would apparently have us believe that apart from this the rail was sound and of good material. No deduction can, we think, be more irrational. The rail must have been brittle throughout, or it could not possibly have been "ground up into forty pieces" as stated. There was nothing, however, about the chemical composition of the metal making for intense brittleness. The carbon was a shade over 1 per cent.; phosphorus, .031; manganese, .758; sulphur, .025; but segregation was held to have taken place, and the whole rail was unsound and badly made. Speaking of flaws, it is worth adding that Mr. Job has found that when defects lie a quarter of an inch or so below the rail table good service may be had until this thin layer of sound metal has been worn away; which reminds us of the old box-pile light iron rails that were at one time long ago made in Wales. Three bars about half an inch thick, 10in. wide, and 5ft. or 6ft. long were set up on a table as a trough. This was filled with puddle bar croppings, scrap iron, "anything that was cheap," and a fourth plate was put on top, and the whole held together with hoop iron band. It was then raised to a welding temperature and passed through rolls at a high speed and a light draught. The edges of the box were thus welded up, and the whole was then rolled off into a rail. So long as the outside lasted the rail stood, but as soon as the top was worn away the rail went to bits.

We have from first to last the old story repeated and emphasised. It is not so much what takes place in the furnace as what occurs in the rolling mill that determines the quality of the rails. On the other hand, it must be kept in mind that no rail rolling mill can remedy radical defects in the billets supplied to it. Unless the ingots are properly cropped and cogged or squeezed the rails must be defective. It is to be feared that the doctrine "use up and buy more" is not unknown in permanent way practice in the United States. It may answer with locomotives, but it is quite too dangerous for application in rail practice.

The French Navy.

THE long debate upon the report of the Commission of Inquiry into the condition of the navy has culminated in the defeat of the Clémenceau Ministry after one of the most dramatic sittings in the Chamber of Deputies for many years past. Since the appointment of the Commission of Inquiry there has been a latent hostility between that body and the Cabinet, for the reason that the Commission sought to drive home the responsibility for the marine's shortcomings to the Ministers themselves, while the object of Government has been to hush up the inquiry and to avoid any scandal, which must inevitably result from the Commission's inquiry. To M. Clémenceau must be given the credit of adopting radical measures by appointing M. Alfred Picard as Minister of Marine, and instructing him to draw up what our French friends call a "balance sheet" of the navy preliminary to organising the marine upon a more satisfactory basis; but M. Picard's report, while revealing an alarming state of things, left so much to suggestion that the majority of the Parliament, under the leadership of M. Delcassé, felt it was desirable to carry out an independent inquiry with a view to ascertaining who were responsible for the existing state of things.

We have already dealt fully with the Commission's reports, and the debate in the Chamber of Deputies during the past three or four weeks has merely consisted of a recapitulation of the shortcomings thus revealed, without anything new being brought forward. The Ministry made a first mistake in trying to stop the debate by proposing to hold it over until after the vacation, but Parliament and the country generally have become so seriously alarmed that it was decided to continue the debate in order to arrive at some solution without delay. During the last few sittings the interest of the debate turned upon the defence of M. Camille Pelletan and M. Thomson. No man has been accused of doing so much harm to the navy during his ministry as M. Camille Pelletan, who allowed himself to be swayed by a policy which at the time only received half-hearted support, and is now universally condemned, and carried out this policy in opposition to the Conseil Supérieur de la Marine and the best naval experts of the day, even going to the extent, it was alleged, of refusing to consult them upon certain important questions. M. Pelletan was a professional politician who allowed his enthusiasm, based upon an amateur knowledge of naval matters, to outrun his discretion. He proved himself, indeed, to be utterly unfit for the position he occupied, and yet politics are so closely associated with public services on the other side of the Channel that M. Pelletan was able this week, by a marvellous oratorical effort, to save his own reputation by throwing ridicule upon the Commission. The effect of his speech was, however, subsequently lost when Parliament felt that the debate was dragging along unduly without getting nearer to fixing the responsibilities upon the Cabinet. The climax came when M. Delcassé summed up the position and drew a retort from M. Clémenceau, which was followed by a dramatic passage of arms when the debate was unexpectedly brought to a close by a vote of confidence in the Government being lost by a majority of 36. The Clémenceau Ministry therefore resigned, and the question of the navy has entered upon a new phase. For the moment nothing is known of the probable composition of the new Cabinet, although it may be taken for granted that M. Alfred Picard, who is quite independent of party influence, and has already done enormous and valuable work during the few months he has been Minister of Marine, will be requested to continue tc look after the destinies of the navy.

The fall of the Cabinet is perhaps the best possible solution of the naval problem that could be arrived at. The field has been cleared of the irritating question of responsibilities, and it may be expected that as soon as the new Cabinet is formed Parliament will proceed at once to discuss the naval estimates, which amount for 1910 to 341,500,000f. This is an increase of 7,650,000f. upon the estimates for the current year. There is an augmentation of 2,277,000f. upon naval constructions to be devoted principally to the rapid termination and equipment of vessels already on the stocks or afloat. A number of first-class torpedo boats having been withdrawn from service, their total has been reduced from 225 to 195, and as it is intended to provide each division of four torpedo boats with a destroyer, the number of the latter vessels is to be largely increased, and during 1910 it is proposed to build ten of about 750 tons displacement and a minimum speed of 31 knots. It is not intended to ask grants for the construction of big units pending the preparation of a shipbuilding programme which is to become the object of a Naval Defence Act, and Parliament will not be asked to vote money until the plans of the vessels are complete, as experience has shown that it is only possible by such means to carry out a shipbuilding programme rapidly and at the smallest possible cost.

LITERATURE.

Fighting Ships.—Founded and Edited by Fred T. Jane. Twelfth year of issue. 1909. London: Sampson Low, Marston and Co., Limited.

EVERY book on naval matters is doubly welcome this year, for we all hope to find in each new volume some definite answer to the questions which have filled the air for months past. Amongst such productions Mr. Jane's book has made for itself a place of no small consequence, for although in the increasing mass of material with which it deals it is practically impossible that it should be absolutely accurate in all its details, it is, we believe, rarely, if ever wrong in general matters. We therefore refer to its pages on our own and the German navy with no little interest. With regard to our own, Mr. Jane is able to help us but little. Under the heading latest ships we find "Neptune, 20,000 tons 540 × 86 × — feet. Armament ten 12in., sixteen 4.7in. (1908·09 Estimates). Projected, four or eight sisters (1909-10 Estimates). Also three battleships offered by the Colonies." This is not very illuminating, and we know now, what Mr. Jane did not know when his book was in the press, that some of the projected sisters will almost certainly be sanctioned before the year is out, and that so far only one Colonial offer has been accepted. We may notice, however, that nothing is said about the provision of 13½in. guns, which we believe to be unfounded rumour, based on the fact that some of our ordnance firms have, with an eye to the future, got plans of such guns pigeon-holed. There is at the present moment not the slightest reason for advancing the size of the guns and upsetting the advantages of uniformity.

When we turn to German ships we find the plan of the six vessels which are now being built. They are shown with four turrets, and in each turret three 12in. guns. The author remarks that this design is liable to alteration, but the sketch plan is from an official model. The three guns per turret does not strike one as a good plan, and it is difficult to see why it should have been adopted in preference to the Dreadnought arrangement. Possibly the object is to save weight, as the vessels are to have exceptionally small draught, not more than 24½ft.

The volume as a whole keeps growing, and it has improved considerably since its first issue appeared twelve years ago. For one thing, there are now no fancy pictures of vessels, all the tone blocks being reproductions from photographs, some of which are very effective, whilst others are too small to be of much service. There are several minor errors; we may direct attention to one or two, so that Mr. Jane may correct them in a later issue. On page 434 the silhouette marked D is obviously not the Sarmiento, which is an Argentine ship, but the Baquedano. The name alone wants altering. We notice that the same photograph does duty for the Russian destroyers Savitny and class and the Chilian Capitan Orella. The photograph appears to be actually a portrait of the Som. The differences between the vessels are not very noticeable, but it might be worth putting the little mistake right. There are a few more errors of the same order, but, taken altogether, the volume is wonderfully correct, and its utility is unquestionable.

At the end we find an interesting review of "The Progress of Warship Engineering," by Charles de Grave Sells. But who could think of reading an article in a book of this size and shape?

SHORT NOTICES.

Railway Rates. By the late Joseph Horrocks. London: Swan Sonnenschein and Co., Limited, 25, High-street, Bloomsbury, W.C. Price 21s.—The nieces and executrices of the author have, at his dying request, published this "method of calculating equitable rates and charges for merchandise carried on railways," the result of "many years of patient labour." It is suggested that the work may prove to be of use to the authorities who are seeking to reform the present system; but we fear that it is labour in vain. The question of equitable rates is not assisted one little bit by this ponderous work, wherein certain proportions of the debitable charges are laid down, often arbitrarily, for the various duties that the railways perform, and then numerous tables and examples are given showing the amounts to be charged according to weight and to distance. These tables are nothing more nor less than a ready reckoner. More might be said, but it would be a waste of space, and it will suffice to say that the book is a disappointment.

Retaining Walls. By T. E. Coleman. London: E. and F. N. Spon, Limited, 57, Haymarket, S.W. Price 5s. net.—Some of the information given in this volume originally appeared in the form of a series of articles in the *Builders' Journal.* The book is intended to serve as a practical guide for students and others interested in the general design and construction of ordinary retaining walls. First the author considers the theory of stability, then he goes on to consider failure by overturning and crushing, the distribution of pressure on bed joints and failure by sliding. A separate chapter is devoted to the theory of earth pressure and the centre of pressure for retaining earth. Other sections of the book deal with the theory of water pressure and wind pressure, arched retaining walls, the bearing power of soils, strength and weight of building materials, &c. The book is written in simple language, and the use of complicated formulæ and advanced mathematics has been avoided as much as possible.

Marine Engineering. By A. N. Somerscales. Glasgow: J. Munro and Co., Limited. Price 12s. 6d. net.—Marine engineers preparing for the Board of Trade examination should find this book of considerable value, and at the same time the information which it contains should prove useful to engineers in charge of engines and boilers, &c., on land. Part I. of the book gives short essays on physical and engineering subjects; Part II. deals with the solutions of questions in mensuration, &c., and Part III. gives the proofs of rules and formulæ. There is also an Appendix giving tables and examination papers. The book is written in a clear and concise manner, and the reader should have very little difficulty in following the author's instructions. It is a book which appeals to practical men who are not well versed in theory.

Electro-Magnetic Ore Separation. By G. Godfrey Gunther. London: The Hill Publishing Company, Limited, 6, Bouverie-street, E.C. Price 12s. 6d. net.—This book, which hails from America, contains a good collection of information on the magnetic separation of ores, and those interested in the subject should find it useful. Magnetism applied to ore dressing is the title of the first chapter. Next the author deals with principles of magnetic separation and preparation of the ore for treatment. Then he goes on to consider separators for strongly magnetic minerals and separators for feebly magnetic minerals. Other sections of the book deal with the concentration of magnetic ores, the separation of pyrites and blende, the separation of siderite from blende, and the separation of miscellaneous ores and minerals. The illustrations are good.

Gas Engine Theory and Design. By A. C. Mehrtens. London: Chapman and Hall, Limited, Henrietta-street, Strand. Price 10s. 6d. net.—This book was originally prepared for the use of the mechanical engineering students at the Michigan Agricultural College, but it is also intended for men who operate gas engines and those who desire to know something of the theory. A point about the book worthy of mention is that the illustrations are very clear, and the various drawings and diagrams are devoid of unnecessary complication. There are twenty-one chapters, and at the end of the book there are some tables giving the physical properties of materials, properties of fuel gases, volumes and specific heats of gases, strength of materials, &c. As the title implies, the work is also intended for the use of gas engine designers.

Railroad Structures and Estimates. By J. W. Orrock. London: Chapman and Hall, Limited, Henrietta-street, Strand, W.C. Price 12s. 6d. net.—The author's object is to cover in brief and concise form the numerous subjects that enter into the engineer's estimates of railway building, as to general construction and cost, on a business rather than a technical basis. The various sections deal with track material, fences, gates, sign-posts, road crossings and guards, culverts, bridges, buildings, water stations, shop specifications and contracts, and estimates. Being an American book, all prices are given in dollars, and it is also naturally confined to American practice.

BOOKS RECEIVED.

A First Dynamics. By C. S. Jackson and W. M. Roberts. London: J. M. Dent and Co., 29 and 30, Bedford-street, W.C. Price 5s.

Electrical Installations. By Rankin Kennedy. New edition. Vol. IV. London: The Caxton Publishing Company, Clun House, Surrey-street, W.C. Price 7s. 6d. net.

Cane Sugar and its Manufacture. By H. C. Prinsen Geerligs. Manchester: Norman Rodger, office of *Sugar Cane*, Mossburn-buildings, Altrincham. Price 12s. net.

NEW FIRE AND BOILER FEED PUMP.

A BOILER feed pump in combination with a powerful fire pump, designed to be of service in places where it is desired to effect a saving of space in the boiler-house or engine-room, has been designed and constructed by Merryweather and Sons, Limited, and is illustrated herewith in Figs. 1 and 2, one of which shows a perspective view and the other drawings. This plant can be employed for regular use as a feed pump or can be put into action for fire-extinguishing work without delay.

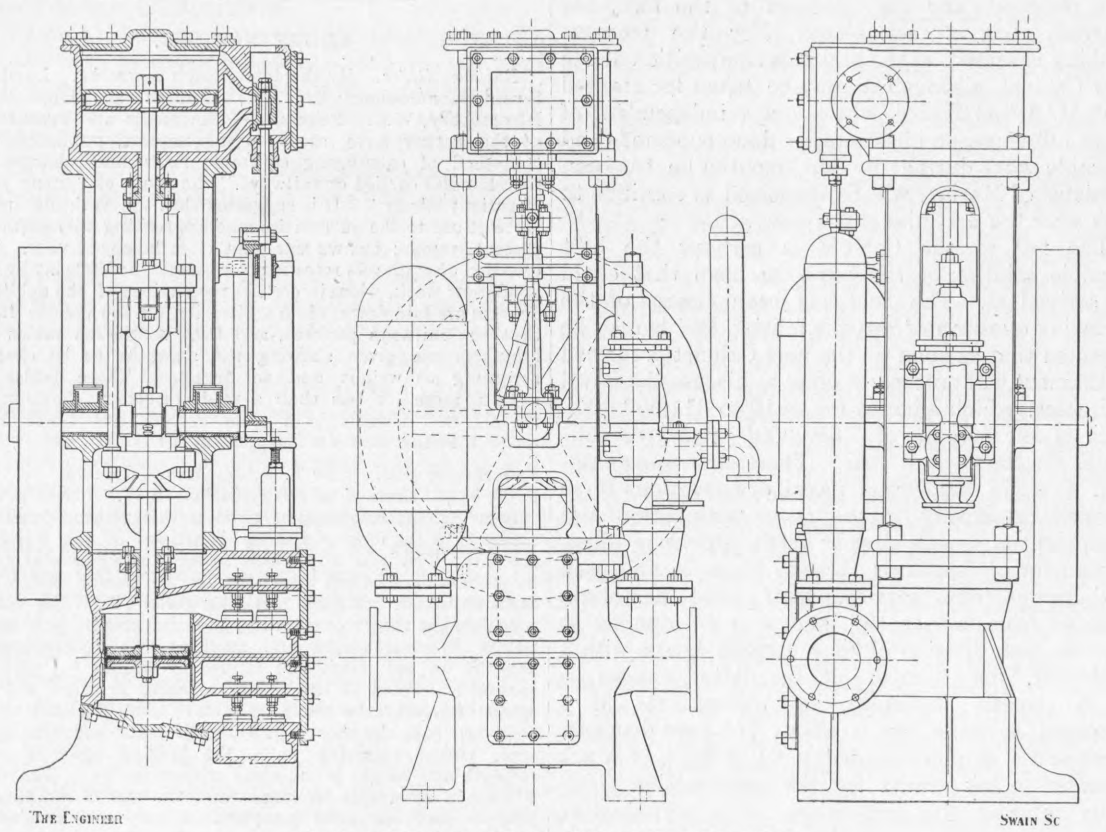


Fig. 1—COMBINED BOILER FEED AND FIRE PUMP

The fire pump has a capacity of 600 gallons per minute, and can be connected to a system of fire mains having outdoor or indoor hydrants or both. As shown in our illustrations, the engine consists of a steam cylinder of 16in. diameter inverted over the fire pump, which is 10in. in diameter with an 8in. stroke. A cast iron distance piece connects the steam with the pump cylinder. Two similar crossheads of cast steel work on guides formed on the distance piece. One crosshead is connected by a steel piston-rod to the steam piston, the other to the manganese bronze pump rod. Two turned steel stays hold the two crossheads at a fixed distance apart. A connecting-rod with a gun-metal end of the marine type, and a crank shaft fitted with a heavy fly-wheel, are also provided.

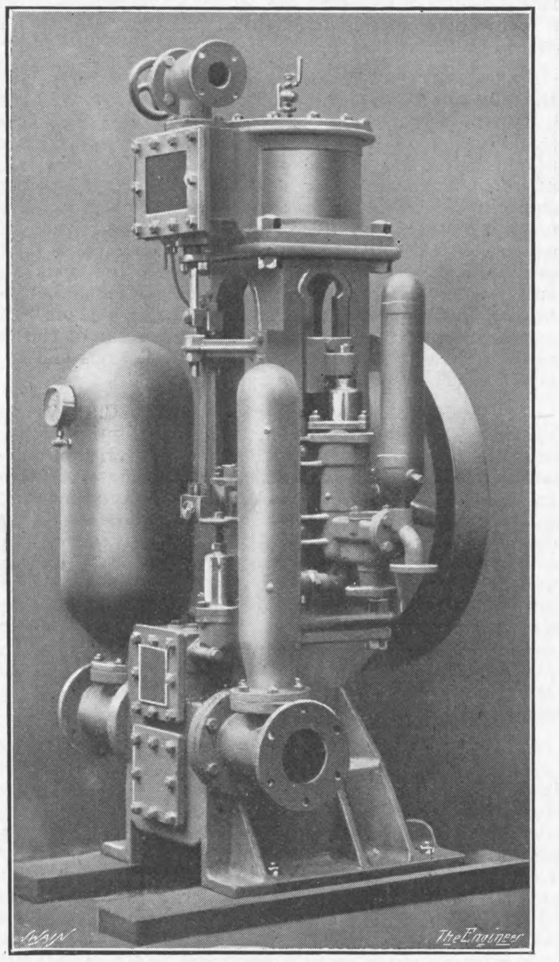


Fig. 2-BOILER FEED AND FIRE PUMP

The fire pump is of cast iron, and is double-acting. Its liner, valve seats, and plunger plates are of gun-metal. The valves are of special fire-engine type, of india-rubber with gun-metal backs. They are arranged under two covers, and access may be obtained to them in a few seconds without disconnecting any part of the engine. Fitted to the fire pump is an automatic relief valve, which can be set to any required pressure, so as to provide a means whereby any sudden excess caused by closing the hydrants or hose outlets while the pump is running may be relieved. Disengaging gear is provided for throwing the fire pump out of gear when using the feed pump. This disengaging gear is exactly similar to the type which has now been in use for some years on Merryweather's motor steam fire engines, and consists of a cone and screwed nut by means of which the pump rod can be readily detached or connected to the bottom crosshead.

The feed pump is 4in. in diameter with an 8in. stroke, and is of sufficient capacity to supply a 200 horse-power boiler working at 180 lb. steam pressure. It is of cast iron, with a gun-metal liner, bronze piston-rod, and metal valves suitable for hot water. The pump is mounted on an angle bracket cast on the distance piece of the engine, and is driven direct from the upper crosshead by means of a strong angle bracket bolted to it. For examination or repairs the feed pump can be bodily removed without disturbing any part of the engine or fire pump. When running the feed pump only, steam is supplied to the engine through an automatic pressure reducing valve, thus ensuring economy. A valve can be provided by means of which a small jet can be obtained direct from the feed pump should occasion arise, thus affording a ready means of dealing with a small outbreak of fire without the necessity of coupling up the main fire pump. This, of course, would only be a makeshift, and should the fire assume larger proportions the main pump would have to be brought into action.

All parts of the engines and pumps are made interchangeable with others of similar type. Lubricators, drain cocks, and other necessary fittings are provided.

THE S.S. BERBICE AND KAROOLA.

THE Berbice, the first of the two new twin-screw steamers for this service ordered by the Royal Mail Company from Harland and Wolff, Limited, left Belfast on Thursday, the 8th July, for Southampton, whence the new vessel will sail in due course for the West Indies. The Berbice is a very interesting vessel, and although smaller than the large ocean steamers which the Royal Mail Company has added to its fleet during recent years, is nevertheless a vessel of the most approved design and the latest type. She is a twin-screw steamer 313ft. long by 38ft. 3in. beam, and about 2500 tons, with two sets of quadruple-expansion engines on the "balanced" principle. The principal decks are of steel, and the vessel has been constructed on the same principles as the largest ocean liners.

The Berbice will carry a large number of first and second-class passengers, also deck passengers, whose comfort has been studied in every possible way. The state-rooms are large and airy, and provided with electric fans. The first-class cabins are in white enamel, which has both a cool and attractive appearance. The second-class cabins are also in white. The first-class dining saloon on the main deck extends the whole width of the ship. The sidelights are of large diameter and arranged in pairs, thus ensuring ample ventilation, while the provision of jalousie shutters will afford protection from the sun. The ventilation will be assisted by large electric fans. The bridge deck will be entirely devoted to first-class passengers, the lounge being at the forward end and a verandah at the after end, the latter serving as a semi-enclosed smoking-room, cool and comfortable in every way. Both these apartments have large opening teak wood windows, both port and starboard, and wickerwork furniture. The second saloon accommodation on the main deck, with the dining saloon at the after end, is also of a superior character, and the promenading space for this class, as also for the deck passengers, will likewise be found ample. The Berbice has electric light throughout, and is also provided with refrigerating plant and insulated chambers.

The advent of this vessel into the service emphasises the wide extent and importance of the ramifications of this long-established and historic company. As is well known, the Royal Mail Steam Packet Company is the oldest transatlantic steamship company in existence, having been established by Royal Charter in 1839. Throughout the seventy years of its career it has maintained and extended its imperial connection. Established for the conveyance of mails from England to the West Indies, and later on to South America, it has been represented on these important trade routes by some of the leading steamers of their day, and the vessels put on the route during the last few years are truly floating palaces. The company's passenger routes now include not only the West Indies and South America and other American ports, but the Mediterranean, Egypt, Ceylon, Australia, New Zealand, and other parts of the globe.

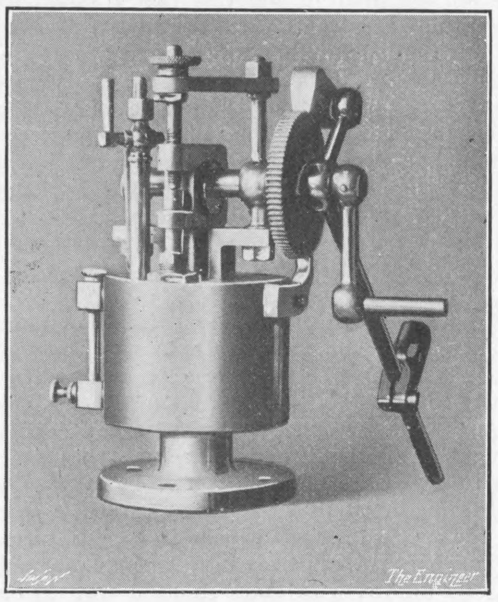
On the same day the twin-screw passenger and cargo steamer Karoola, built by Harland and Woolf, Limited, to the order of McIlwraith, McEacharn and Co. Proprietary, Limited, of London and Melbourne, left the builders' works at Belfast, and after adjustment of compasses and a satisfactory trial trip, proceeded to Glasgow, whence she will sail for Melbourne at the end of the month. The new vessel, which is 436ft. long by 56ft. 3in. beam, and about 7500 tons, has been specially designed for the Australian trade, and the employment of steamers of this class round the coast of Australia is a significant indication of the great development in the trade and intercourse of our Australian Colonies. The Karoola, besides having accommodation for a large number of first, second, and third-class passengers, has also every facility for the rapid loading and discharge of cargo, for which the vessel has large capacity. The engines are of the builders' quadruple-expansion "balanced" type, and the ship is fitted throughout with electric light, fans, &c.

The first-class dining saloon, situated on the main deck, is a handsome apartment, with parquetry floor, sidelights arranged in pairs, and the tables arranged on the popular restaurant style. The room is panelled and framed in oak, relieved with carving, the ceiling finished flat, and the furniture is oak. The first-class main staircase is in oak, the entrance being into the after part of the lounge. The first-class lounge is on the bridge deck forward, and has a fine dome skylight overhead. The first-class smoke-room, on the same deck, is arranged with bays, with a skylight overhead. The first-class state-rooms are nearly all arranged on the tandem system. The second-class saloon, on the main deck, is a spacious apartment. The second-class lounge is on the bridge deck, while the second-class smoke-room is on the boat deck aft. The second-class state-rooms are also arranged on the tandem system. The third-class accommodation includes a dining saloon and a general room.

The vessel is constructed on the cellular double bottom principle, and divided into water-tight compartments. She is fitted with Harland and Wolff's steam steering gear, and all the arrangements for working ship and cargo are of the latest type. In addition to the general cargo arrangements and refrigerated space, the vessel is fitted for the carriage of cattle or horses forward on the main deck.

FORCE FEED PUMP LUBRICATOR.

A NEW force feed lubricator, called the "Silver Star," is being placed on the market by W. H. Bailey and Co., Limited, Manchester. It is made with one, two, three, and four feeds, and in four sizes. The illustration shows the single-feed pattern. It has a simple ram pump for each feed, the pump being driven from a cam shaft actuated by a lever, pawl, and pinion from some reciprocating part of the engine. The stroke of the pump is variable, and can be regulated while the lubricator is in operation by the simple adjustment of the thumb screw shown, while the delivery of the lubricant can be tested by turning the handle of the three-way cock, when the oil will be by-passed. The whole of the working parts, pump, valves, &c., can be readily removed for inspection by simply unscrewing a nut at the bottom of the chamber and disconnecting the delivery pipe. The lubricator is substantially constructed, and contains no complex mechanism which is liable to get out of order.

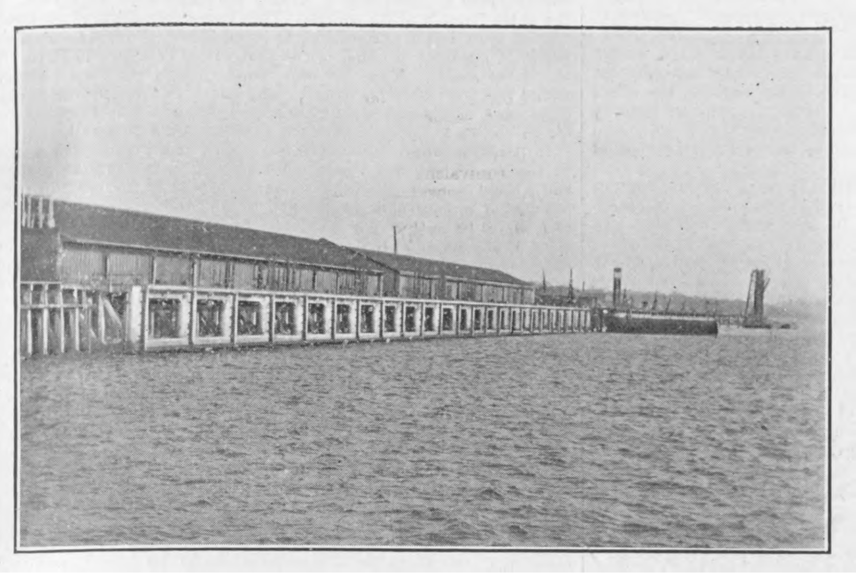


THE SILVER STAR LUBRICATOR

FRUIT CARRYING STEAMER.—In the description of the fruit carrying steamer Tortuguero, which appeared in our issue of the 9th inst., we stated that the engines of this vessel were fitted with Dearn's pistons. Through a printer's error the name was spelt wrongly. It should, of course, have been Deam's pistons.

THE BRITISH FOUNDRYMEN'S ASSOCIATION.—The sixth annual convention will be held in the Medical Theatre of the University Buildings (late Masons' College), Edmund-street, Birmingham, on August 3rd, 4th, and 5th next. The headquarters of the Association will be at the Imperial Hotel (late Acorn Hotel), Upper Temple-street, off New-street, Birmingham, where rooms have been secured for the sole use of the members. During the continuance of the meeting several papers will be read and discussed and various works visited.

FERRO-CONCRETE WHARVES AT DUNDEE



FERRO-CONCRETE WHARF CONSTRUCTION.

AN interesting piece of ferro-concrete work in connection with harbour maintenance is now in progress at the eastern wharf of the Dundee Harbour, where the last portion of three lengths of wharf, one being 410ft. long, the second 380ft., and the third 310ft. long, is being converted from timber piling to Hennebique ferro-concrete. The first two lengths have been completed, while the third is now in hand. It is well known that since the advent of the teredo and other destructive marine worms in British tidal waters the cost of maintaining timber structures has steadily increased to such an extent that timber is now recognised by harbour engineers and wharf owners as being out of the question from a financial point of view, the economical remedy for decay provided by ferro-concrete being largely made use of.

A little while ago Mr. J. Hannay Thompson, M. Inst. C.E., made a report to the Trustees of the Dundee Harbour upon the condition of the eastern and western timber built walls, and from this report certain particulars may be drawn. The eastern wharf was constructed in 1892, and is, therefore, only seventeen years old. It includes some sheet piling and main piles at the back, these having formed part of an original dredging wall built in 1882. These piles, probably owing to their situation, have not been so seriously injured by the marine worms as other parts of the structure, but Mr. Thompson reported that the main gauge piles and wallings, which also form part of the wharf, had been practically destroyed. Moreover, it was found in the same wharf that water washing through the timber sheet piling drew away part of the filling from behind, and caused subsidence and collapse of floors in the sheds built at the quay level. Although as far as can be expected the main piles of the wharf seemed to be in fairly good condition, the heads were found to be seriously decayed in places where the deck planking and beams have been removed for repairs. The deck beams were unsound, the lower walings and filling pieces were also untrustworthy, and the struts had seriously deteriorated. The decking was also in such a state as to require constant repair. The general situation was that by continuing to repair the wharf its life might be prolonged for a few years more; but maintenance being a cumulative cost rendered the wisdom of this course extremely doubtful.

In the same report it was pointed out that the Camperdown West Wharf, built in three sections, each about 380ft. long, twenty-seven, twenty-four, and eighteen years ago respectively, was also in a bad condition, the piles and walings of the round head being much decayed and the deck beams and struts unsound. In the main portion of the wharf the heads of the piles, the lower walings and filling pieces, the deck beams, and their struts were in an untrustworthy condition, and the deck planking, particularly at the east end, was almost completely perished.

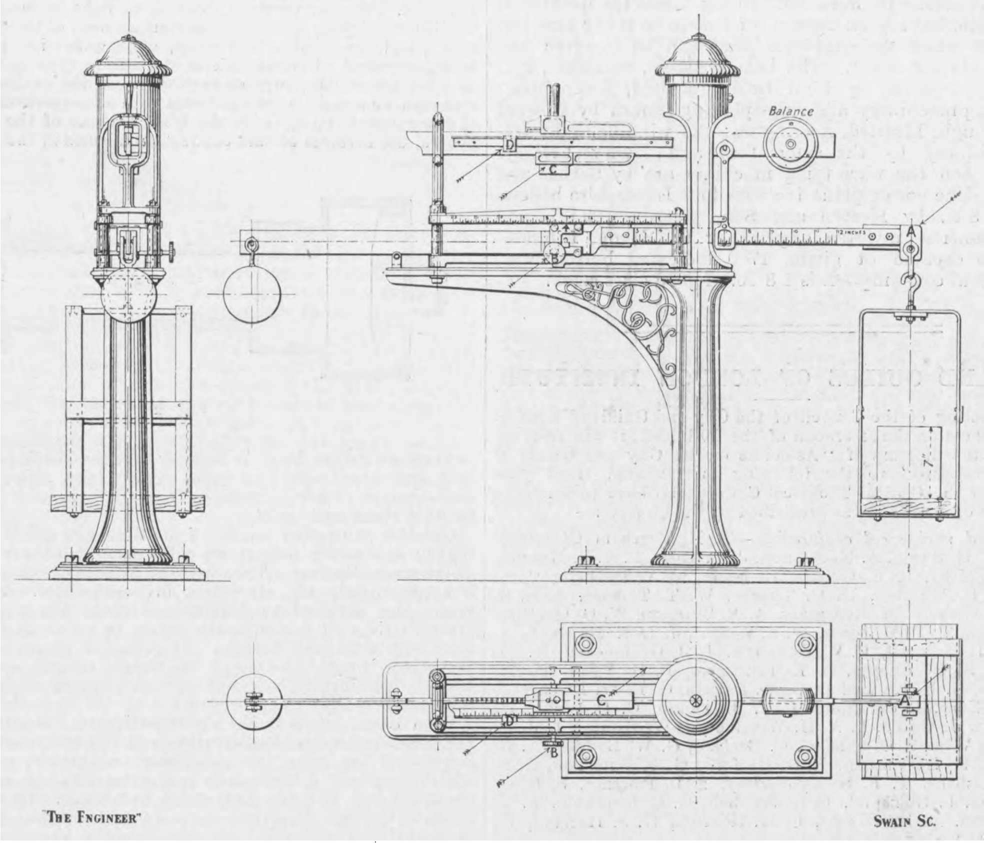
It will be seen, therefore, that Mr. Hannay Thompson's report constituted a serious indictment against the use of timber for the purposes of harbour work, and the report went on further to recommend the use of Hennebique ferro-concrete, and the construction of a range of three-storey ferro-concrete sheds. This proposal was adopted by the Dundee Harbour Trust, and the work has proceeded to the stage reported above. We illustrate in our engravings the general appearance of a section of these wharfs as now constructed. The effect of this scheme will be to reduce the annual maintenance bill, and also to add very largely to the shipping accommodation and the facilities for dealing with cargo in the port.

THE PENNSYLVANIA NEW TERMINUS AT NEW YORK.

THE Pennsylvania Railroad has completed the construction of its tunnels under Bergen Hill and the Hudson River into its station at Seventh-avenue and Thirty-third-street, New York City. The final inspection has just been made by Mr. Samuel Rea, second vice-president of the Pennsylvania Railroad Company, and Mr. Charles M. Jacobs, chief engineer of the North River Division, and the work has been pronounced in condition to proceed with electrification, signalling, and track laying. This will be undertaken immediately and pushed forward as vigorously as possible. The Hackensack portal is situated 6 1 miles from the junction with the main line at Harrison, just east of Newark, N.J. A temporary track has been laid on the embankment from Harrison to the portal, and materials for the track laying will be carried over this line and into the tunnels, thus avoiding the inconvenience to the public of having this material carted across Manhattan Island. Thus culminates the construction work on the first two tunnels to be built for trunk line service under the Hudson River. The first excavation was begun May 12th, 1905. The north tunnel was joined on September 12th, 1906, and the south tunnel on October 9th, 1906. The tunnels under Bergen Hill were connected on May 7th, 1908, and April 11th, 1908, respectively. These two tunnels, which are 23ft. in excavated diameter, are lined with 2ft. of concrete, and, therefore, are of 19ft. interior diameter. They extend from the Hackensack portal under Bergen Hill to Weehawken shaft, a distance of 1.2 miles, and from the latter shaft to Ninth-avenue, New York, 1.4 miles. The construction of the tunnel was described in THE ENGINEER for April 12th, 1907, and the new terminus in the issues for July 19th and 26th, 1907.

A CALCULATING SECTION WEIGHER.

IN the rolling of wrought sections it is essential that the rolls be so adjusted that a given section may not exceed nor be less than the standard weight; this weight generally being expressed in pounds per foot, or in some cases—notably that of rails—in pounds per yard. The common method of procedure is to saw off a short portion of the length of section after it has come from the finishing rolls, to weigh this short length, and to calculate the weight per foot or yard by proportion. Sometimes it is necessary to repeat this operation several times until the rolls are set to give the proper weight per foot. To facilitate this operation the firm of Henry Pooley and Son, Limited, of Temple-street, Birmingham, has recently put upon the market the machine illustrated herewith. It consists of a delicately balanced, graduated, movable arm A, from one end of which is suspended a cage to receive the specimen lengths. The arm is graduated from 3in. to 12in. in $\frac{1}{16}$in. divisions, and it is connected to a weighing steelyard, thus dispensing with loose weights. This steelyard is usually graduated up to 125 lb. in one ounce divisions. It will be seen that the arm A is provided with a travelling carriage which is moved by a screw B. As the travelling carriage is moved to or from the supporting pillar a variable stress is put upon the weighing steelyard. If the cage contains a piece of joist 3in. long, and the arrow on the carrier which moves the arm A is opposite 3in. on the scale above, the same stress will be put upon the steelyard as if a piece of joist, say 12in. long, was in the cage, and the arrow on the carrier opposite 12. To use the machine the specimen length is accurately measured, and the sliding lever A is then moved by means of the screw B, until the arrow head is opposite the figure corresponding to the length of the section to be weighed. The specimen is then weighed in the ordinary manner by moving the carriage C and minor poise D, the weight indicated being the weight per foot of the specimen in the cage. In the illustration a joist 7in. long is shown in the cage, and it will be seen that the arrow on the travelling carriage is pointing to the figure 7 on the bar above. These machines are said to be remarkably accurate, the greatest error found in those which have already been made being 4 drams.



CALCULATING SECTION WEIGHER

MANCHESTER ASSOCIATION OF ENGINEERS.

YESTERDAY—Thursday—a large party of members of the above society, under the guidance of their President, Mr. J. H. Stubbs, paid a visit of inspection to the cotton mills of the Monton Mill Company, Limited, and the Eccles Spinning and Manufacturing Company, Limited. In the first-named mill the visitors had an admirable object-lesson in the treatment of cotton from the opening of the bales as they arrive from the cotton fields to the finished cloth or calico. The first operation is to open the bales and feed the cotton in large pieces to the bale breaker, in order that it may be loosened before being passed to the blowing machinery. From the hopper of the bale breaker the cotton is carried forward by a horizontal lattice and is pressed against the spikes of the inclined elevating device. Here it is subjected to a combing action, and is then carried upward to the spiked roller, which further combs the cotton and throws back into the hopper any large or unopened pieces. The cotton deposited in the hopper is carried forward by horizontal and inclined lattices up to the combing cylinder, which gives a combing action and allows only small pieces of cotton to pass forward. After passing through the hopper feeder the cotton is delivered in an even and open state on to the feed lattice connected with the Crighton cylinder, where it is further loosened and cleaned before being drawn through the dust trunks and on to the exhaust opener by the action of the fans in the latter machine, and passing through the trunk it beats against the ribs attached to a lattice cloth which moves in the opposite direction. The impurities falling on to the lattice are discharged at the end of the dust trunk, and the cotton passes on to the exhaust opener.

The next operation is to take four of the laps made by the exhaust opener and place them on the feed lattice of a scutcher. Afterwards the material passes to the beater to be further cleaned, thence through the callender rollers, and again made into a lap, this operation being repeated if necessary. Next comes the carding process, where the final cleansing takes place by the elimination of the impurities that have not been removed by the opening and scutching machinery. The fibres, which are at this stage crossed in every possible direction, require to be placed in parallel order and delivered into a can in the form of a thick rope or "sliver." The cans from the cards are put up behind a drawing frame, which serves further to straighten out the fibres and make the sliver as uniform in thickness as possible. The material is next treated in slubbing, intermediate, or roving frames, which are for the purpose of further mixing the fibres, and with the doubling and drafting of the material at the previous operations, produce a finished rove. From the roving frame the bobbins are taken, in the case of a mule spinning mill to the self-acting mule, and in a ring spinning mill to the ring spinning frame, and the yarn is spun into twist or weft of the desired count, the counts being the number of hanks in one pound avoirdupois, and the hank containing 840 yards. From the spinning-room the weft passes to the weft store-room and the twist yarn to the winding-room, where it is cleaned, if necessary, doubled, and finally made into warps. The warp yarn wound on to beams is placed in the loom, and forms the longitudinal threads. The weft yarn in the form of cops is placed in the shuttles of the loom, and forms the transverse threads, and the warp and weft when woven together form the manufactured material.

The Monton mill contains 91,680 mule spindles, divided into 26,784 twist spindles and 64,896 weft spindles, and preparation machinery for the production of medium counts, average 32's twist and 42's weft. All the textile machinery has been made by Platt Bros. and Co., Limited, Oldham. The power plant comprises four 8ft. 6in. by 30ft. Lancashire boilers by Galloways, designed for a pressure of 160 lb., and inverted vertical cross-compound steam engines of 1500 indicated horse-power, by George Saxon, Limited. The present load for the machinery mentioned is 1400 horse-power, and the consumption, we are informed, 1.9 lb. per indicated horse-power per hour of washed slack. Friction diagrams of engine only show 6 per cent. of full load.

The Eccles Spinning Company's mill, which the members also visited, contains 37,000 ring spindles, divided into 20,000 weft and 17,000 twist, and 1000 "Northrop" looms, with all the necessary preparing machinery. The spinning is especially adapted for the Northrop loom. The peculiar feature of this loom, it may be mentioned, is that it stops automatically when an "end" breaks, and has automatic bobbining arrangement which obviates the need of stopping the loom to replenish the weft in the shuttle. The latter is the chief work done by the weaver on the ordinary Lancashire loom, and by adopting this automatic arrangement one person can attend to from four to six times the number of looms. Another special feature of this loom is the ease and speed with which the completed piece can be removed and the loom started again. The bale breakers, scutchers, &c., have been supplied by Lord Bros., Limited, Todmorden; the carding machinery and ring-spinning frames by Howard and Bullough, Limited, Accrington; the winding and warping machinery by the same firm and Henry Livesey, Limited; and the warp-tying machines are by Barber and Colman. The power plant includes four Lancashire boilers, 30ft. by 8ft., by Heaton and Son, pressure 180 lb., and triple-expansion inverted engines by G. Saxon, Limited. These are capable of giving 1700 indicated horse-power, and the coal consumption is 1.8 lb. of good class slack.

CITY AND GUILDS OF LONDON INSTITUTE.

AT a meeting of the Council of the City and Guilds of London Institute, held on the afternoon of the 20th inst., it was resolved to award the diploma of "Associate of the City and Guilds of London Institute" to the following matriculated third year students of the Central Technical College who have completed a full course of instruction as prescribed by the Council:—

Civil and mechanical engineering.—T. E. Beacham (Bramwell Medal), L. H. Swain, A. Mackinnon, J. L. Tann, B. A. R. Hughes, H. G. G. Clarke, L. B. Gilbert, E. Howe, T. A. Stephens, C. A. Shaw, F. R. Whitten, H. C. Thorpe, W. T. Thomas, A. B. B. Bevan, F. Grundy, M. Rodriguez, A. R. Sturgess, W. G. Quinton, G. Hepburn, H. P. B Jones, W. L. Wright, J. L. E. Manes, L. A. Travers, L. E. Vyall, C. W. Jamieson, L. J. Coutanceau, N. M. Clougher, S. N. Chopra, S. E. FitzSimon, F. S. Vyall, H. M. Thompson, H. K. Korgaokar, G. M. Darwin, G. E. W. Hitchcock, H. T. M. Kent, L. del Cueto, C. T. B. Donkin, G. C. Wells, W. D. Bennett, J. Wadia, L. A. H. Winckler, J. W. Hunter, L. J. A. Vallet, W. Wise, A. Morant, C. G. Graham, G. W. Budden, A. R. Fraser, G. H. Harrington, R. O. Herford, G. B. Wickham, G. F. Hall, G. Osborn, T. R. S Kynnersley, E. D. Pougnet, S. H. G. Osborne, G. L. Holzapfel, C. G. Mitchell, G. C. Laughton, F. J. Cunningham, H. L. Burdett, C. M. Houfton, H. B. Harland, H. F. Cook, J. J. Castelain.

Electrical engineering.—F. H. Bramwell (Siemens Memorial Medal and Premium), A. Hutt, C. Higgins, H. Grinsted, R. A. Mack, A. Schmidt, C. G. Hawes, S. L. Smith, S. N. C. Whitehead, D. H. Hammonds, E. L. Reinert, F. P. Swann, W. C. McCallum, T. A. F. Dixon, J. Hollingworth, H. C. Hannam-Clark, L. G. S. Dodwell, C. D. Stoneham, R. W. Canning, H. G. Biggs, A. J. Anido, A. Weiss, B. A Turkhud, W. B. Burford, J. O. Archer, J. R. A. Willey, E. H. Balcombe, J. H. P. Burchett.

Chemistry.—E. H. Rodd, J. S. Arkinstall, R. T. Colgate, A. V. Campbell, F. W. Tilley.

In addition to the above, certificates have been awarded to twenty matriculated third year students who have completed a full course of instruction at the Central Technical College, and to fifty-nine students who have completed a full course of instruction at the Technical College, Finsbury.

INSTITUTION OF MINING ELECTRICAL ENGINEERS.—Meetings of the Yorkshire and Notts Branches of the newly formed Institution of Mining Electrical Engineers will be held on Saturday next, July 24th, at the Victoria Station Hotel, Sheffield, and the Welbeck Hotel, Nottingham, respectively, both at 5 p.m. The business on the agenda at each meeting will be the appointment of local officers, &c., and all those locally interested in the formation and progress of the Institution are invited to attend.

LETTERS TO THE EDITOR.

(*We do not hold ourselves responsible for the opinions of our correspondents.*)

CONDENSATION IN STEAM TURBINES.

SIR,—Although countless discussions have taken place among engineers as to the extent and influence upon steam consumption of internal steam condensation in reciprocating engines, the effect of internal condensation in steam turbines is still universally ignored. Yet we shall see that internal condensation in steam turbines is an item of importance, and by no means unworthy of consideration.

Discussion as to cylinder condensation in reciprocating engines almost invariably centres round the cyclical fluctuations of steam temperature which necessarily occur in each engine cylinder. In the steam turbine these or corresponding fluctuations in temperature may be absent, and with a throttle governor and a steady load are absent. If, however, a blast governor of the Parsons type is employed there is a periodic fluctuation in the temperature of the steam. Fig. 1 is a diagram taken from a Westinghouse-Parsons turbine of 2000 horse-power, from which it will be seen that at 63 per cent. load there is a temperature fluctuation of about 50 deg. Fah., and at 12 per cent. overload there is a fluctuation of about 28 deg. The above fluctuations refer to the turbine side of the inlet valve. The extent of the fluctuation will decrease as the exhaust is approached. Although even at light loads these temperature fluctuations are not so great as those taking place in reciprocating engines, yet it must be remembered that, as a rule, they are slower, usually about fifty or so per minute, and therefore the fluctuation is more likely to penetrate deeply into the metal in contact with the steam. Even more important is the fact that the conditions in a turbine favour the metal following the temperature fluctuations of the steam. The steam passages through the metal are narrow and curved, whilst the velocity of the steam is high, a fact which Professor Nicolson's experiments and those of Dr. Stanton have proved to be conducive to a rapid transmission of heat from fluid to metal.

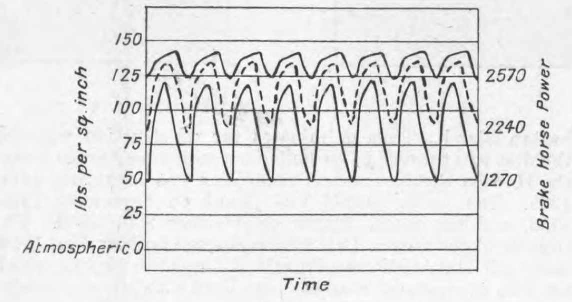


Fig. 1

It may be urged that the cyclical fluctuations of steam temperature, which occur through the use of a blast governor, cannot affect the steam economy, or this governor would have long since given way to the throttle governor. Such an argument would, however, overlook the fact that apart from condensation a throttle governor involves certain thermodynamic losses at all loads less than the maximum, which are partially avoided by the blast governor. We say partially, because at light loads—see Fig. 1—the blast governor produces a certain amount of throttling in the steam, and also utilises the steam after admission partly on a falling pressure. Several makers of Parsons type turbines have, as a matter of fact, adopted throttle governing as their standard, although we are not here concerned with a comparison of methods of governing, but only with the fact that one of the methods in general use involves certain condensation losses in the turbine.

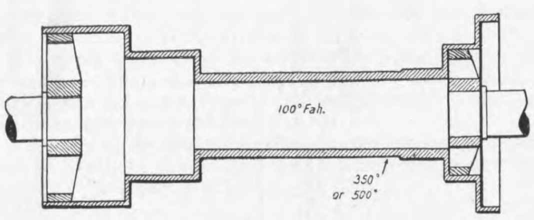


Fig. 2

Apart altogether from the type of governor employed it is still true that, even with a perfectly steady load, there is internal condensation in steam turbines due to differences in temperature between steam and metal.

Consider an impulse turbine of the Rateau or Zoelly type; and, slightly to simplify matters, we will assume that the wheels are all of the same diameter. Then between consecutive chambers there is approximately the same drop in temperature. With twelve stages the temperature difference between the high and low-pressure sides of a diaphragm would be about 20 deg.—rather more with superheated steam. The metal is invariably bare, and the steam, due to the drag of the wheels, sweeps past it at a fair speed. It is impossible to make a close estimate of the condensation, but it is clearly appreciable.

Even more serious is the condensation in a reaction turbine. Fig. 2 illustrates the usual arrangement. It will be seen that the interior of the rotor is at condenser temperature and pressure, whilst the steam on the outside is at a temperature varying from about 350 deg. with saturated steam to 500 deg. with superheated steam at the high-pressure inlet down to condenser temperature at the exhaust end. The working steam is sweeping along the body of the rotor and against the projecting blades fixed to the rotor at very high speeds—up to about 300ft. per second at the high-pressure end and much greater at the low-pressure end, where, however, the temperature difference between the inside and outside of the rotor is not so great. The conditions on the outside of the drum are highly favourable to a rapid transmission of heat from the steam to the metal, or *vice versâ*. The conditions inside the rotor are not quite so favourable, although by no means unfavourable to heat transmission. In fact, the arrangement sketched is equivalent to a surface condenser in the body of the working steam. In marine turbines there are usually two cylinders in series, so that the temperature inside the rotor of the high-pressure cylinder is probably in the neighbourhood of 250 deg., being that of the exhaust from the high-pressure cylinder.

In some of the newer designs special balancing arrangements have led to the use of the interior of the rotor as a special steam pipe. Thus, in the Willans turbine the interior of the rotor is filled with steam at the pressure and temperature of the step between the intermediate and low-pressure sections—usually about atmospheric pressure and a temperature in the neighbourhood of 212. In some designs the interior of the rotor is simply closed in, and the temperature inside then approximates to a mean between those at the inlet and exhaust of the main working steam.

The question arises as to whether this condensation, which undoubtedly occurs through contact between steam and colder metal, is likely seriously to affect the steam consumption of the turbine. The answer is certainly yes. Disc and blade friction increases rapidly with the moisture in the steam. According to Moyer, 20 per cent. of moisture doubles the friction, 10 per cent. increases it by 25 per cent., and 5 per cent. of moisture increases it about 7 per cent. It may be urged that disc and blade friction will reappear as heat, and by drying the steam tend largely to kill the extra friction at its source. That this action takes place is, of course, true, but it is too slight to be effective. Thus, a condensation of 5 per cent. is equal to the abstraction of about 43 B.Th.U. per lb. of steam. The disc and blade friction per lb. of steam would be about 40 or 50 B.Th.U. and the extra friction due to the 5 per cent. condensation, if fully generated, would only amount to 3 or 3.5 B.Th.U., so that its drying power would be small.

In practice, when reducing a test result made with wet steam to the equivalent dry steam consumption, it is usual to reduce the actual consumption by rather more than double the percentage of moisture in the steam. Since the theoretical reduction would be rather less than the percentage of moisture, it is clear that moisture in the steam entails a serious falling off in thermodynamic efficiency. A further, if indirect, proof of the value of really dry steam is to be found in the fact that the gain by using superheated steam is more than that due to the superior thermodynamic conditions, and indicates the detrimental influence of a moist condition in the steam.

A number of methods of more or less completely eliminating this condensation will suggest themselves to designers. One or two may be briefly indicated. As regards the outer shell or casing of a turbine, the present method of lagging is probably sufficiently effective, although steam jacketing could be applied if it were deemed worth the extra cost, which is unlikely. The diaphragms of impulse turbines might be made double-walled, like most steam engine pistons, and, perhaps, the internal space filled with non-conducting composition, but it is very doubtful if the saving would justify the extra cost, except, perhaps, in the case of Curtis or similar turbines with only one or three diaphragms. In these turbines the double-walled diaphragms would be useful, not only because of the large drop in temperature across each, but also because of the greater strength necessitated by the large drop in pressure from front to back.

But it is in reaction turbines that the condensation is most serious and its cure the simplest. The ends of the rotor should be closed in, and hot high-pressure steam admitted to the interior from the main body of the working steam by drilling holes through the shell of the rotor near the high-pressure steam inlet. This would internally jacket the rotor. Now the mistake made with ninety-nine steam jackets out of a hundred, and generally with the hundredth also, is that the steam is not circulated through the jacket. Without circulation a steam jacket is very inefficient as a jacket and fairly effective in increasing radiation losses, with the result that the net gain is small. Circulation is necessary in order to sweep away bubbles of air and gas from the metal surfaces, and in order to secure effective heat transmission between steam and metal. With a jacketed turbine rotor circulation can be produced by drilling small holes in the outer shell of the rotor sufficiently large to discharge the condensed steam and so placed as to discharge it either into the exhaust or the labyrinth packings of the dummy pistons. If the circulation thus obtained is not sufficient it can be increased by drilling holes so as to discharge steam, but not water, into the intermediate or low-pressure sections of the blading. Such a jacketed rotor would cost no mero than the present unjacketed rotors, nor would they add any delicate mechanisms likely to get out of order.

July 13th. FRANK FOSTER.

THE HOME-OFFICE AND POWER GAS ENGINES.

SIR,—In a general way there can be no complaint with the manner in which the factory department of the Home-office exercises the powers which have been given to it under the Factory Act of 1901. The aim of the department and the principal inspectors is to render the condition of employment as safe as possible and to mitigate the hardships under which many men, women, and children in the past have had to exercise their calling. In this they receive no opposition from the better class of factory owner and manager, and, in fact, I find that in the factories which I have had to design since the Act came into operation there is an increasing tendency for employers to go even further than the Act and to provide comforts for their workpeople which were undreamed of even ten years ago. All this is to the good, but in some cases, owing most probably to insufficient or faulty information, regulations are drawn up, and instructions are issued regarding particular apparatus which, while doing no good in themselves, inflict a genuine hardship upon the employers. In the regulations which were recently issued on the employment of electricity in factories the department very properly called in the services of an independent electrical expert as a commissioner, and fairly met the objections of factory owners, with the result that the regulations as they now stand are not open to any reasonable objection. At the end of 1908 a memorandum was issued by the department on the subject of the use of gas containing a large proportion of carbon monoxide (CO), and some of the suggestions made are quite good and reasonable. I should like, however, to point out that one at least of the recommendations is uncalled for. I refer to Section 1 Sub-section (*b*) of preventive measures, relating to gas engines working on suction or other power gas. This reads:—"The air intake for the engine should be from the open air, and not from the engine-house itself. The same observation applies to the silencer or air-box, if any." I am not far out in saying that 99 per cent. of the power-gas engines installed in this country have the air inlet in the engine-room—while the newer engines have the air silencer in the base of the engine itself—where it has been placed for two definite reasons. First, because it is desirable to have as short a length of pipe as possible between the air silencer and the engine; and, secondly, because the fact that the air used in the engine is drawn from the floor of the engine-room provides the most simple and efficient means possible of ventilating that engine-room. It is, in fact, the usual practice to place the silencer on the off or fly-wheel side of the engine, just behind the fly-wheel, where it forms a guard to the wheel, and, being flat topped, a very handy table on which to keep the oil can or any tool which it is desirable to have readily accessible. The objection raised by the factory inspectors is that gas may escape into the room through the air inlet, and apparently they have been led to this conclusion by the phenomena known as "back-firing in the air-box." A moment's consideration, however, will show—first, that gas cannot escape through the air inlet; and secondly, and consequently, that back-fires do not take place in the air-box, for the following reasons:—On all gas engines there is a gas cock on the engine, usually of the plug type, graduated to show the positions of open and shut and the intermediate degrees of opening which will admit the proper proportion of gas for varying loads. This is open when the engine is at work and shut when it is at rest. After passing this cock the gas comes to the gas valve, which is kept closed by a powerful spring, and is positively operated by a lever only on the charge stroke. This valve admits the gas to the cylinder. Once in the cylinder, any gas which may have the evil intention of getting into the air silencer will find its passage barred. (*a*) On the suction stroke by a strong current of air rushing like itself into the cylinder to destroy the vacuum caused by the outward stroke of the piston, or (*b*) on the compression stroke by the air valve, also positively operated by a lever which is kept tightly closed by a powerful spring. It will be obvious, therefore, that (1) When the engine is drawing in its charge and both valves are open at the same time, there can be no escape of gas into the air-box. (2) When the engine is compressing its charge there and both valves are closed at the same time, there can be no escape of gas into the air-box. (3) When the air valve is so poor a fit on its seat as to let gas by on the compression stroke, the engine will not keep its compression and will refuse to work.

The phenomena known as back-firing take place in the engine cylinder, and are due to a pre-ignition, the charge being fired—usually by a piece of incandescent carbon caused by over-lubrication—immediately it enters the cylinder and before the air valve is closed. The force of this explosion—the exhaust valve being, of course, closed—finds a vent through the open gas and air valves, and the noise is heard in the air silencer.

At an interview which I had recently with the factory department on this subject I was told that they attached the greatest possible importance to ventilation, and I pointed out that by placing the air inlet in the engine-room this was secured. If we take the case of a 50 to 60 brake horse-power engine as being a size commonly found, the swept volume of the cylinder will be 234 cubic feet per minute. Allowing the proportion of gas to air as 1 to 1.5, which is a reasonable figure, the result is 8400 cubic feet of air drawn out of the engine-room per hour. This assumes that the engine is firing every cycle. As, however, the majority of engines of this size do not fire every cycle, but, on an average, not more than 60 per cent. of the cycles, and as an engine draws in more air when it is not firing than when it is, the actual quantity of air displaced is considerably greater than the figures given. The capacity of an engine-room for an engine of this size would be about 1500 to 2000 cubic feet, so that, under the worst conditions, the air in the room would be completely changed more than four times every hour.

I have ventured to write on this subject at some length, because a large number of people are being told by the factory inspectors to remove the air silencers from the engine-room to the outer air, a matter which can only be done at a great deal of inconvenience and a quite appreciable cost. At present the option to do this or not rests with the factory owner, but I have reason to know that there is a considerable amount of misapprehension on the subject, and I feel sure that if it is made clear that the presence of the air intake in the engine-room is rather a benefit than otherwise it will allay a good deal of anxiety on the part of gas engine owners, and the factory inspectors, who, as a class, are usually extremely reasonable, will cease to recommend the change.

London, July 16th. HAL WILLIAMS.

MARINE PROPULSION.

SIR,—It seems that in the course of this controversy the very foundations of our faith in dynamics and kinetics are being shaken. Text-books are called in question; even the authority of my old friend the late Sir William Anderson is disputed. Sir George Greenhill has come forward to steady our views, and give a resting place for the soles of our feet. I have worked hard to try and arrive at a conclusion as to what the fight is about. So far as I can see we have an old-fashioned Irish faction fight, the rule being "wherever you see a head hit it." The conditions remind me of a very memorable contention, "The more part knew not wherefore they were come together." Out of all the dust and confusion I think that I have discovered what is the real difficulty, and I will try and state it as simply as possible, and I will ask Sir George Greenhill to give us his explanation of the puzzle. What he has written is, of course, I assume, quite accurate, but it in no way settles the point at issue.

Work is measured by a force multiplied into a distance. Thus, a piston subjected to an average driving pressure of 1000 lb. and moving over 600ft., represents 600,000 foot-pounds. This system of measurement has been adopted all over the world. It is quite well understood, and, so far as I know, it is the only received measure of work. Of course, the units may be changed, as, for example, kilos. per metre, and so on, but the principle is the same. A force moving through a distance represents so many foot-pounds no matter what the velocity. There is at the moment so much confusion of thought among your correspondents that I cannot be too careful in the enunciation of this proposition, which will, no doubt, be accepted by everyone.

Now, let us turn to the 12in. gun. Let us leave out of consideration its weight and the weight of the projectile; we have no need for them; their introduction will complicate matters dreadfully. We must centre our attention on Sir George Greenhill's figures. The burning of the powder sets up a force inside the gun representing an average pressure, he tells us, of 7.25 tons per square inch.

The base of the bore of the gun and of the projectile are the same, 12in. in diameter = 113 square inches area, and 113 × 7.25 = 819.25 tons. I do not know accurately what the recoil of the 50-ton gun is, but I take it at 2ft. The length of the chase, according to Sir George Greenhill, is 50ft.

When the gun is fired it moves 2ft. in one direction, while the projectile moves 50ft. in the opposite direction. The force on the projectile is the same as that on the gun, namely, 819.25 tons. I must here ask your readers to bear carefully in mind what I have said about the measurement of work.

We have now a force of 819 25 tons moving over a distance of 2ft.; and 819.25 tons = 1638.5 foot-tons, expended by the powder in moving the gun 2ft. Sir George gives it as 353 foot-tons; possibly the recoil is less than 2ft.

Turning now to the projectile, we have a force of 819.25 tons moving over a distance of 50ft., and 819.25 × 50 = 40,962 foot-tons. This represents the total work in foot-tons got by multiplying a force into a distance.

But Sir George Greenhill gives the muzzle energy of the projectile as 53,000 foot-tons, or, in round numbers, 12,000 foot-tons in excess.

How was this 12,000 foot-tons produced? Here we have, it seems to me, put into figures the dispute about the power required to produce a given propeller thrust. If I substitute, for the sake of illustration, and with no other motive, horse-power for foot-tons, I may say that according to one set of your correspondents we have 53,000 horse-power expended, and according to another set we have only 41,000 horse-power expended.

Now, so far as I can see, the only way out of the difficulty lies in the repudiation of the dictum that a force moving through a distance will do work which can be measured in foot-pounds. It may be said that it does not apply in gunnery; but if so, why estimate the work stored in the shot in terms of foot-tons?

I honestly believe that I have now put into a definite form the problem, which has more or less vaguely suggested itself to Mr. Preidel and various other correspondents. As to its solution I am quite unable to suggest one. Time does not interfere, because the time is the same for the gun and the projectile. The explosion of the powder has nothing to do with it in the way of establishing an exception; for we measure the work done in a gas engine cylinder by the average pressure on the piston. But furthermore, it may be pointed out that by the aid of crusher gauges it is possible to construct a diagram of pressures inside a gun; and using this like an indicator diagram, the work done during an explosion has been calculated, and that in foot-tons.

If Sir George Greenhill or any other authority will explain how it is that more work is done on the shot than can be accounted for by the force multiplied into the distance, then we shall be in a fair way, I think, to have the present controversy settled.

There is, of course, one explanation of the discrepancy, but I hardly like to suggest it. It is that Sir George Greenhill's figures are all wrong, although his formulæ are all right. I do not know the dimensions of the latest pattern 12in. gun, but I think the chase is 45ft., not 50ft., but this makes the discrepancy still greater. Apparently, the average pressure must be much higher than 7.25 tons on the square inch. But all this is mere unjustifiable guesswork, and I take the figures as they stand.

Finally, let me point out that this method of calculating foot-pounds is simplicity itself. It has nothing to do with acceleration or anything else. Apply this method to the screw propeller; the force thrust exerted by the propeller on the water is precisely equal to the thrust of the water on the propeller. The first is our driving force. Now, if we can measure the distance through which that force operates on the water we can at once tell the foot-pounds expended; just as in the case of the 12in. gun. The projectile represents the ship, the water pushed astern is the gun. I venture to think that, knowing the pitch and the slip, there ought to be very small difficulty in ascertaining the distance passed over by the force acting on the water during a single revolution of the propeller. It seems to me to be the slip. FUSE.

July 20th.

BRITISH LOCOMOTIVE PRACTICE OF TO-DAY.

SIR,—With reference to the letter by Mr. John Reikie which appeared in your columns last issue on "British Locomotives," Mr. Reikie is evidently an enthusiast on compound questions, and I have for some long time since taken great interest in the letters published on this subject.

At the outset, I must state that I think the compound locomotive not necessary or even desirable under present average British conditions, for the following reasons. When one inspects the diagrams taken from an express passenger engine at high speeds, two things stand out most prominently. Firstly, taking the cut-off at not more than 30 per cent.—very often 15 per cent.—we see that the steam is expanded down to quite a low terminal pressure. Secondly, as much steam is locked up in the cylinders as serves to raise the pressure at the end of the stroke to that in the steam chest. Consequently the temperature variation becomes so small as to be for practical purposes quite negligible, especially when one considers the piston speed.

Now, it is these facts that put the case of the compound locomotive for express work into a questionable and doubtful state as regards any superiority and economy over the simple engine. With mineral engines the case is, however, different. The speeds at which these engines work are slower and steadier than those of a passenger engine. So we see that the greatest field for compounding lies with the slow heavy pulling type of engine. I do not say an express compound engine is no good; on the other hand, some have done splendid work, but as regards general all-round considerations, the present simple locomotives, two cylinder and otherwise, are not to be beaten for fast work. And as the compound is generally more expensive in upkeep and first cost, the balance turns in favour of the simple type. Another very great consideration is the latitude with which the simple two inside-cylinder type lends itself to standardisation of working parts; the whole of the motion for all the engines, or at any rate the greater part, can be interchangeable; cylinders can be manufactured irrespective of type of engine, and so on. This cannot very well be done with the compound without a material increase in the cost for each engine, a condition of affairs not much liked by directors. Besides, a multiplicity of types is far from desirable. The aim of every engineer should be to have his engines all alike, when possible. The compound engine has, I admit, been accused of a lot of bad things most undeservedly. This has been due chiefly to ignorance of working conditions. It is useless to expect any economy where the work can be done from 15 per cent. to 30 per cent. cut-off. Strange to say, the compound, when tested occasionally against the simple engine, no effort is made, at least very little, to inquire into the most favourable working conditions, To my mind, the fineness of the problem lies in finding the exact location of the neutral line where simple and compound can be operated equally advantageously. One would be led to think that the service where the compound would be likely to show the advantage would be where inclines were numerous. But here again, while the compound is working to advantage by pulling heavily uphill, the simple engine runs downhill under conditions particularly favourable to itself. The only way then to get at the matter would be to compare the ratio of heavy inclines to the total distance both ways. So whichever way we look at the problem fresh contingencies arise.

To me the whole matter is summed up thus:—That while the indicator shows good expansive lines, low exhaust, and high compression, so as to run the engine smoothly and maintain the cylinder temperature, I think the compound not desirable. When the diagram shows little expansion, high exhaust and low compression, and consequently great variation in temperature in cylinder walls, then compound. I shall be glad to hear Mr. Reikie's criticism. HENRY W. DEARBERG.

West Norwood, July 16th.

SIR,—Mr. Riekie has issued a general challenge for anyone to show cause why locomotive cylinders should not be greatly increased in size, but has it not been found in practice by many railway companies that some of their engines were already over-cylindered? I have always understood that the disadvantage of such engines was found with light loads on the level or down hill when an excessive quantity of steam was required merely to fill the cylinders at atmospheric pressure without exerting any definite forward force. Can Mr. Riekie avoid this in any way?

It is, in fact, the variation in the work required that causes the trouble, and my own feeling is that extra high pressure will be the ultimate solution of the problem, for the following reasons:—

It may reasonably be assumed, I believe, that a locomotive should work with fair economy through a range from full load to quarter load, according to the weights of the different trains and the gradients, "load" in this case meaning tractive force or torque on the driving axle; and, further, that "fair economy" implies that the steam should be expanded about four times, and should never be expanded below the atmospheric pressure, as otherwise there would be a back pressure or retarding effect.

The cylinders then must be of such a size that the steam used at quarter load will just fill them at atmospheric pressure at the end of the expansion, just before exhaust opens. At full load about four times this quantity of steam will be used per stroke, the economy remaining about the same according to the assumption, and therefore the pressure in the cylinders just before exhaust opens will be about 60 lb. per square inch absolute, and if it has been expanded four times the admission pressure must have been 240 lb. per square inch absolute or 225 lb. gauge. To secure this in practice a boiler pressure of about 250 lb. per square inch would be required, or even more, if possible, so as to allow for contingencies. The question is, then, who can design a boiler to stand such pressures without being unduly expensive either in first cost or repairs.

A trial of a Serpollet boiler would be extremely interesting to watch—from a distance!—if only someone would be sufficiently enterprising to make the experiment.

Birmingham, July 20th. EXCELSIOR.

[Plenty of water-tube boilers are working at over 200 lb. per square inch. The Belleville boilers in the Marseillaise and Dupleix have been used at 284 lb.—ED. THE E.]

△ FALLACIES.

SIR,—Please let me wail. I am only a marine engineer trying to learn of the mystic Δ. Now this Δ mystery has ever been preserved by all shipbuilders from Noah to date. No shipbuilder divulges the displacement of any vessel, his or other's production, and when questioned he answers not the truth. But something may be opined from one techincal work, for Sir W. H. White's book introduces "coefficient of fineness," or "block coefficient" sometimes called. Occasionally, by aid of my slide rule, I note very fallacious Δ published, *i.e.*, if Sir William's figures are true. For instance, I feel bound to argue that our Navy List never publishes true figures—always giving too small displacements—*i.e.*, if officially published dimensions including draughts are also true, and block coefficients are true gauges.

To-day you add to perplexity. Page 60 tells of the Bellerophon, says she is Δ 18,600 tons, being 520ft. × 82ft. × 29ft. draught. This gives a block coefficient of 53 per cent., and thus she is almost as fine as a Yarrow vessel with 10 to 1 beam. Therefore I say the figures you give are wrong, and that her displacement at 29ft. draught would be over 22,000 tons. I suggest that at Δ 18,600 tons her draught will be 24½ft., which is not her battle-equipped state, and therefore should not be her trial trip state.

Some thirteen days ago my half-penny "Daily Scarifier" gave, red-hot from Berlin, the new Bluecher class as having a block coefficient of 48 per cent., making them a cross between the Yarrow model and the Shamrock yacht model. There are many similar fallacies in several books giving displacements of the warships of the world.

If only shipbuilders and official publishers would print the truth, many of our mouthy war-scarers and itinerant naval experts—these latter neither naval nor experts—would be less able to preach, their comparison texts would be non-existent. I would even suggest that some of your writers on "Marine Propulsion" might then have correct figures on which to base their appalling algebraisms. But this is beside Δ; only let me hint that as the "steamer-duck" in the Straits of Magellan is the only animal approaching a steamship, propulsively regarded, perhaps a study on the spot might give them all a better conjoint knowledge of "Marine Propulsion" and Δ. W. J. H.

July 16th.

BREAKAGE OF CRANK AXLES.

SIR,—When the crank axle of an engine breaks the cause of the breakage is usually attributed either to a flaw in the material, the design of the axle, or a combination of both. Still crank shafts continue to break. Such being the case it must be obvious that the true cause of the breakage has not been arrived at. That the failure of a crank shaft is becoming less frequent is due, not to any improvement in the design of the inside cylinder engine, but to the fact that the material from which the crank shaft has been manufactured has been improved in quality, and is thus able to withstand the rough usage of a certain type of inside cylinder engine. I refer to that type of engine which, although having coupled wheels, these in no way take their share of the stress on the driving brasses; the result is the whole of the tractive force of the engine is borne by the crank shaft axle alone, the brasses of which soon wear out of shape, setting up a vigorous pounding action quite sufficient to break any axle. If the crank axle is made strong enough to withstand the pounding, excessive and costly wear and tear in the engine is the result. So far as I can judge this is exactly how matters stand with British locomotive practice as regards the design of inside cylinder engines. The obvious remedy to rectify matters is to make use of balanced crank shafts so that the coupling rods can be connected to pins on the same centres as the crank pins, thus allowing the whole of the brasses of the driving wheels to take their equal share of the tractive force. Until this is done crank axles may break any day and may lead to disastrous results.

Argaith, Dumbreck, July 19th. JOHN RIEKIE.

THE INSTITUTE OF MARINE ENGINEERS.—On Saturday, July 24th, a visit will be paid to the Imperial International Exhibition, when Mr. Robert Balfour (member) will read a paper on "Refrigerating Installations, with special reference to the arrangements necessary when Narrow Limits of Temperature are required," in the Congress Hall, near the Cascade, at 4 p.m.

HENRY SAXON SNELL PRIZE COMPETITION.—The Royal Sanitary Institute have appointed Prof. Henry Adams, Dr. Louis C. Parkes, Prof. W. Napier Shaw, and Mr. A. Saxon Snell as the adjudicators for the next "Henry Saxon Snell Prize" Competition, the subject set being "The Principles of Heating and Ventilating Public Buildings." The essays have to be delivered at the Institute, 90, Buckingham Palace-road, by the 31st August.

THE UNITED STATES TARIFF ON STEEL.—The proposed increase in the United States tariff on high-class steel, if it comes into operation, is likely considerably to affect Sheffield, inasmuch as it has been particularly in high-class steels that Sheffield has maintained its connection with that market. Cheap steels have for a long time been practically an unknown quantity in Sheffield exports to the States, and the new duty, if carried, will, it is feared, have results very detrimental to the trade in the higher grades of steel. It is now proposed to impose an *ad valorem* duty of 20 per cent. upon all steel valued at 40 cents per lb. and upward. This increased duty, we are informed, affects not only "high-speed" steel, but also the higher qualities used in the manufacture of superior cutlery, including surgical instruments.

NORTH-EAST ENGLAND MANUFACTURERS AT THE FRANCO-BRITISH EXHIBITION.—This is the title given to a souvenir album containing an illustrated description of the exhibits and works of most of the North-Eastern firms which had stands at the Exhibition at Shepherd's Bush last year. The book is nicely bound in cloth, and the illustrations and letterpress are printed on a high quality of art paper. It is not a publisher's work; the whole of the compilation, we understand, having been arranged by the firms themselves, and the cost divided on a co-operative basis. Of the twenty-nine firms' works which are illustrated, the names of Sir W. G. Armstrong, Whitworth and Co., Limited, Bolckow, Vaughan and Co., Limited, Cochrane and Co., Limited, Jos. T. Eltringham and Co., William Gray and Co., Limited, the Central Marine Engine Works, R. and W. Hawthorn, Leslie and Co., Irvine's Shipbuilding and Dry Docks Company, Limited, North-Eastern Steel Company, Limited, Palmer's Shipbuilding and Iron Company, Limited, C. A. Parsons and Co., the Power Gas Corporation, Limited, the Skinningrove Iron Company, the South Durham Steel and Iron Company, and John Spencer and Sons, Limited, Newburn-on-Tyne, are sufficient to give an idea of the scope of the work. The book has been sent to us by the Chief Goods Manager, Commercial Agency, North-Eastern Railway, York.

THE PERMANENT WAY INSTITUTION.—The twenty-fifth annual Summer Convention of this body commenced in Sheffield last Saturday, and was continued this week. The Institution consists of the various grades of railway men connected with the maintenance of the permanent way, including amongst its 1100 members chief engineers, signal inspectors, and platelayers, and is representative not only of the railways of the United Kingdom, but also of India, Canada, New Zealand, South Africa, and other British Possessions. The summer gathering is held first in one district and then in another, in order to give the members an opportunity of seeing the industries carried on in the particular localities visited. The meeting was held on Saturday in Endcliffe Hall, the chair being occupied by the president, Mr. James R. Robertson, chief engineer of the London, Tilbury, and Southend Railway. The president handed the gold medal of the Institution to Mr. Lionel Hiller, of the North-Eastern Railway, for his paper on "Railway Fog-signalling," and the silver medal to Mr. A. W. Taff, Great Eastern Railway, for his paper on "Signal Interlocking." The bronze medal was won by Mr. W. Butler, Baro-Karno Railway, who is at present in Northern Nigeria. It was decided to hold the next winter general meeting at the Institution of Civil Engineers, Westminster, on the last Saturday in January, and the 1910 Summer Convention in Scotland. At the conclusion of the formal business, Professor McWilliam, of the Sheffield University, delivered a lecture on "Steel," for which he was accorded a vote of thanks, on the motion of the president, seconded by Mr. Willox, chief engineer of the Metropolitan Railway, and ex-president of the Institute. The annual summer dinner followed, the members being the guests of Mr. T. W. Ward, Albion Works, Sheffield. During the evening Mr. William Genders, chief inspector of permanent way for the Great Central Railway, Sheffield district, was presented with a gold watch by his fellow-members of the Sheffield section.

CONDENSING AND WATER-COOLING PLANTS.*

THE condensing plant has always been an important part of a steam-power installation, and since the introduction of the steam turbine the importance of this portion of the equipment has been greatly increased. In the case of steam turbines, condensing plant is essential; and, in the majority of cases, condensing plants can be used with advantage in connection with reciprocating engines, although it is impracticable to utilise a high vacuum to its full value in this class of prime movers. There are, of course, cases where, owing to the small load factor or the small maximum output of the plant, the saving due to condensing would not pay for the additional complication and capital charges on the plant.

The chief points to be taken into account when considering whether it would be advisable to install a condensing plant are the load factor, *i.e.*, $\frac{\text{Number horse-power hours per annum}}{\text{Maximum horse-power}\quad 8760}$, and the cost of obtaining condensing water. The load factor may in some cases be so low, that even with an unlimited supply of cold water conveniently situated, it would not pay to put in condensing plant, while, on the other hand, with a load factor in the neighbourhood of 80 or 90 per cent., the saving in fuel by the use of condensing plant would more than pay for the most expensive kind of water-cooling apparatus. As a general rule, it is not worth while installing condensing plant unless the saving to be effected thereby would amount to more than 10 per cent. on the cost of such plant, as about that amount would be required to cover the cost of interest, depreciation, repairs, and attention.

Assuming a condensing plant would cost £3 per kilowatt, and the cost of fuel and water to be .4d. per unit, and assuming that the plant effects a net saving in fuel and water of 16 per cent.—it is assumed that the steam consumption is reduced by 20 per cent., and that the steam required by the condensing plant amounts to 4 per cent.—then the saving in cost of fuel and water would equal 10 per cent. on the cost of the condensing plant—8 per cent. for interest and depreciation and 2 per cent. for repairs—when the load factor amounted to 13 per cent., *i.e.*, when 1140 units were generated per kilowatt of plant per annum. By installing condensing plant, the maximum output of the engines would be increased by about 20 per cent., and in some cases this might be a valuable consideration; but, neglecting the increased output of the engines, and assuming the above data to be correct, there would be nothing to be gained by the installation of condensing plant unless the load factor exceeded 10 per cent. where cheap condensing water was at hand and 13 per cent. where cooling towers had to be used.

The following types of condensers are in more or less general use:—Surface, evaporative, parallel flow jet, counter-current jet low-level, counter-current jet barometric, ejector.

The ideal condenser, of course, is the one in which the condensing water attains the same temperature as the steam in the condenser, for the amount of condensing water is then reduced to a minimum, and the temperature of the water in the hotwell is the highest obtainable. The efficiency of a surface condenser is governed by the amount of heat transmitted per unit area of surface in a given time from the exhaust steam to the water. The result of the heat having to be transmitted through metal surfaces is that the temperature of the condensing water in an ordinary type surface condenser seldom approaches nearer than 15 deg. Fah. to that of the exhaust steam, approximately three times the difference obtained in a counter-current jet condenser in which no metal intervenes between the steam and water.

When this subject was before the Association some years ago it was stated that the possible theoretical gain from the absence of metal casing between the hot steam and the cold water would not work out at one-tenth of 1 per cent. Where water is plentiful and syphonic action can be obtained, the difference in the power required by a larger or smaller amount of water is practically negligible, but where the expense of obtaining condensing water necessitates the erection of a cooling tower, to the top of which the water will require to be lifted, the difference is appreciable.

Consider the case of a condenser capable of creating a vacuum of 27in. with condensing water at 80 deg. Fah. The temperature of steam at an absolute pressure equal to 27in. vacuum is 114 deg. Fah., and the total heat of dry saturated steam at this temperature is equal to 1116 B.T.U. If the difference between the temperature of the exhaust steam and condensing water is 15 deg. Fah., the discharge temperature will be 99 deg. Fah. (*i.e.*, 114 – 15), and each pound of water in passing through the condenser will receive an amount equal to 99 – 80 = 19 B.T.U., therefore the amount of water necessary to condense 1 lb. of steam equals $\frac{1116-99}{19} = 53.5$ lb.

On the other hand, where a difference of only 5 deg. Fah. exists, which gives a discharge temperature of 109 deg. Fah. (*i.e.*, 114 – 5), the heat received by each pound of water equals 109 – 80 = 29 B.T.U., and the amount required to condense 1 lb. of steam equals $\frac{1116-109}{29} = 34.7$ lb., thus showing the amount of water in the former case to be 54 per cent. more than the amount required in the latter, and this is the ratio of the powers required by the circulating pumps in the two cases. The higher the vacuum and the inlet temperature of condensing water, the more marked does this difference become. In addition to the extra power required in the first case, the increased capacity of the cooling tower, pump, and pipes means a corresponding increase in the capital expenditure.

The effective transmission of heat through the metal surfaces is adversely affected by oil held in suspension by the exhaust steam being deposited on the surface of the tubes during the process of condensation, and by the amount of air in contact with the tubes.

The evaporative condenser is a type of surface condenser, brought into use in central stations some twelve or fifteen years ago to meet the difficulty of limited water supply, as the amount of water required is very small. The actual weight of water required to condense 1 lb. of steam is variously stated at from .75 lb. to 10 lb. Air and circulating pumps are necessary, but as the quantity of condensing water is so small, the total power required is comparatively small. This type of condenser is unsuitable for high vacua, as the position of the condenser outside the engine-room necessitates a long line of exhaust pipe, and the number of joints where a leakage may occur is considerable. Corrosion of the pipes may be prevented to a large extent by periodically passing a small quantity of oil over them.

A parallel-flow jet condenser, with wet air pump, is a most inefficient type of condenser, as the steam comes at once into contact with the coldest water, and the bulk of the condensing takes place immediately, with the result that little further rise of temperature takes place as the water continues its way through the condenser. For a vacuum of 26in., the power required by the pumps when dealing with 12,000 lb. of steam is 50 per cent. more than with any other type, and for higher vacua the increase is considerably more. For small powers and vacua not exceeding 26in., the first cost is less than with any other type of jet condenser.

The disadvantage of the low-level counter-current jet condenser is the remote possibility of flooding the condenser and exhaust pipe, due to the simultaneous failure of the float actuated throttle valve on the injection pipe, and of the emergency vacuum breaking valve. The author has, however, been in constant touch with a condenser working on these lines for the last two years, and has never known the slightest trouble from this cause. The amount of condensing water is less than in the surface type, due to the high temperature of the condensing water discharge, for equal vacua, the relative gain being greater the higher the temperature of the condensing water, and the higher the vacuum required. In discharging the water from a low-level jet condenser the pump has to work against a head measured by the vacuum.

During a three hours full load test on a condenser of this type designed to condense 20,000 lb. of steam per hour and maintain a vacuum of 26in., an average temperature difference of 3.5 deg. Fah. between the exhaust steam and the discharge water was maintained without difficulty. The first cost of a plant of this size is from 70 to 80 per cent. of the cost of a barometric or surface type, the lower percentage where a cooling tower is required, and the higher percentage where water is obtained from a river or canal at a constant level. A barometric counter-current jet condenser requires an expensive steel structure, and strong foundations for its support; the exhaust pipe is long; and the expense of erecting the plant is large. Against these disadvantages, however, must be set the advantage of the barometric action, derived from the elevated position of the condenser. Under no circumstances will the atmospheric pressure cause the water in the discharge pipe to rise so high as to reach the exhaust range, The only way in which water may reach the exhaust range is when more water enters the condenser than the discharge pipe is capable of draining away. This may be brought about by a sudden increase in the speed of the pump when working at a high vacuum.

If the area of the discharge pipe and the height at which the exhaust pipe enters the condenser are correct the possibility of flooding the exhaust range is very remote. The plant is rather simpler in operation than the low-level type, and the power required to drive the pumps is practically the same in each case. The first cost of a plant of this type is practically the same as a surface type in the smaller sizes, but in the larger sizes the cost is considerably less. When comparing the horizontal and vertical types of counter-current jet condensers the extra head of water required in the vertical arrangement must be taken into account.

An ejector condenser gives the best results when provided with an ample supply of cold water with a natural head, as it then becomes an exceedingly simple plant, requiring no moving parts in the form of air or circulating pumps. These conditions are seldom available, and in practically all cases a centrifugal pump must be provided in order to obtain the necessary head of water. The author's experience of ejector condensers is that the injection water must be as free from air as possible, and that the best results obtain where the water is pumped into a tank, providing 15ft. to 20ft. head at the injection inlet. This arrangement ensures a steady flow of water, and also allows any air to escape that may be carried forward by the water from leaky joints or the bearings of the pump. Where a supply of water is obtained direct from a centrifugal pump any air introduced in the above manner tends to break the column of water, and it is essential for the best working that the water be supplied in a constant unbroken column. The temperature of the water for an ejector condenser must be kept below 75 deg. Fah., as at temperatures above this the water and power become disproportionately high. As this type of plant works without an air pump it is not as suitable for high vacua as the surface and counter current jet type, but it may be used with advantage in stations with a low load factor, as the cost is considerably less than any other type.

Wet air pumps.—Formerly the most common type of wet air pump was the vertical single-acting bucket pump, with foot, bucket, and discharge valves. A more recent type is the Edwards pump, its special feature being the elimination of the bucket valves. The pump cylinder is so formed that when the pump bucket or piston reaches the bottom of its stroke, the inlet port of the cylinder is wide open, and the entry of the water and air is assisted by the splash produced by the bucket striking the water, the splash being directed in a proper manner. This splash device is the essence of the Edwards patent. The former type is the most difficult to overhaul, the most costly to maintain, and the most liable to breakdown, all due to the large number of valves the pump contains. A higher vacuum can be obtained with the Edwards pump than with the older type mentioned, as the single-acting bucket pump requires a difference of pressure between the air pump and the condenser, to cause the suction valves to operate. In an Edwards pump of a given piston displacement, the discharge capacity is less than that for a pump with bucket valves, because the inlet ports, being formed in the cylinder barrel, prevent the full length of the stroke being effective.

Dry air pumps.—The two principal types of dry air pumps are the Edwards and the balanced slide valve types. In order to use the Edwards type as a dry air pump, a small supply of cool water is necessary to seal the bucket, but this water has the effect of keeping down the temperature of the air passing through the pump. The balanced slide valve type is one in which the air admission to the cylinder is controlled by means of a slide valve, allowing a momentary connection between the two ends of the pump, as it reaches the end of each stroke. This action of coupling the two ends of the pump has the effect of reducing the pressure of the air in the clearance spaces, and thus increasing the capacity of the pumps. This is shown by the larger area obtained on indicator diagrams. Where it is desirable to have a specially high vacuum, two pump cylinders are sometimes used, arranged in series, as the effect of clearance is then still further reduced. Slide valve friction is the weakness of pumps of this pattern, and the pump cylinder requires water jacketing. It is necessary also to take special precautions against water entering the pump cylinder.

Where a more complete vacuum than about 93 per cent. is desired, this type of plant will give the best results, but for lower vacua the Edwards type is the cheapest, both in first cost and power required. The maximum speed in air pump working is usually fixed at 400ft. per minute, but the author considers this too high in the majority of cases. In an 18 by 18 air pump designed to run at 350ft. per minute, it was found that better results were obtained when this was reduced to 300ft., and still further improvement at 250ft. per minute. The size of an air pump depends upon the conditions of working; for example, with jet condensers the quantity of air is greater than with the surface type, due to the air entering the condenser along with the condensing water. Water taken from a fast running stream or from under a cooling tower contains a larger amount of air in suspension than water from an undisturbed source. This, of course, must be taken into consideration. If the exhaust range is long and the engines scattered, here again must the air pumps be of larger capacity than when the condenser is coupled direct to a single engine or turbine.

The power required to drive an air pump depends upon the degree of vacuum obtained, for the work at the beginning of the evacuation is 0, and at the end, if a perfect vacuum were attained, is 0; in between these extremes there is a certain condenser pressure when the work becomes a maximum, and in the case of a dry air pump this is found to be 0·37 atmosphere, or 18·9in.

Circulating pumps.—Both the reciprocating and centrifugal types are used, but the field of the latter has become more extended of recent years, due to the constant steady flow obtained and to the higher efficiencies now obtainable, together with the lower cost and simpler construction.

Steam and electrically-driven pumps.—In providing motive power for the operation of air and circulating pumps in a central station, it is necessary to consider the question of continuity of operation, in addition to the efficiencies of the two methods of driving, as a failure of the vacuum may have serious consequences. The author contends that the possibilities of a failure occurring in the vacuum are less with steam than with electric driving. With the latter method the number of stages of transition, from the steam to the applied power at the pumps, in each of which an interruption is possible, is greater than with the former method. Steam-driven pumps require from 50 to 100 per cent. more steam than electrically-driven pumps, but this may be counterbalanced to a great extent, by the large percentage of the total heat of the steam it is possible to return to the boiler, by employing a feed-water heater, even after allowing for the reduced efficiency of the economiser.

Steam-driven pumps ought not to exhaust into the main condenser, for while a possible 10 per cent. reduction in the steam consumption of the pumps is effected, the reduction of the available capacity of the condenser caused by this arrangement is a more serious item. A preferable arrangement is to pass the exhaust steam through a feed-water heater, as already explained.

A careful consideration of existing conditions and requirements is necessary before the most advantageous type of condensing plant can be decided upon. It is necessary, for instance, to know whether the initial cost of plant or low running costs is the most important, for a small difference of temperature between the condensing water leaving the condenser, and the exhaust steam entering, means a large condenser and a small quantity of condensing water, and *vice versâ* a large temperature difference gives a small condenser and larger quantity of water. Another point to be borne in mind is that where the load factor is low it is advisable to keep down the capital cost of the plant, even if the power taken by the plant is increased somewhat, and that where the load factor is high the running costs are of the first importance, and more can be expended on the plant in order to reduce the running costs.

The advent of the low-pressure exhaust steam turbine has increased the importance of the condensing plant, for with its aid it is possible in many cases to effect considerable economy, besides increasing the capacity, of practically any steam plant already in operation. There is as much available energy below the atmospheric pressure line as there is above, and the exhaust steam turbine is capable of utilising this lower pressure far more effectively than a reciprocating engine. The increased output obtainable by the installation of a plant of this type, together with condensing plant, where not already installed, is from 25 to 100 per cent. of the present output. A 500-kilowatt exhaust steam turbine with steam pressure of 15 lb. per square inch absolute, and 28in. vacuum at turbine, will require 33 lb. of steam per kilowatt at full load and 40 lb. at half load. In calculating the power available for a plant of this kind an allowance must be made for the loss between engine exhaust and turbine admission.

Water-cooling plants.—Formerly, the usual method of cooling water was by means of a pond, the hot water being delivered by open troughs to the part of the pond most remote from the suction pipe. The actual drop in temperature effected in these troughs is much less than is generally supposed. In an actual case it was found that in a trough 2ft. 6in. wide, 7ft. deep, and falling 1½in. in a length of 80ft., the temperature was only reduced 2 deg. Fah., and this with the temperature of the water at 146 deg. Fah. The duty required of any water-cooling plant, working in conjunction with a condensing plant, is to remove a specified number of units of heat in a given time from the discharged condensing water. Higher efficiency of heat transmission is obtained from the water to the air the nearer the final temperature of the air approaches that of the water. This efficiency is dependent upon the construction, the difference of temperature between air and water, the humidity, and upon the draught.

The three principal types of cooling plants are the natural draught open type, the natural draught chimney type, and the fan draught chimney type. For central station work the second type is the most common, owing to the necessity of economy in ground space, and in order that the vapour issuing from the plant may be carried away at a height at which it will not become a nuisance to any inhabited buildings in the vicinity of the tower. The area of ground required is approximately one square foot for 20 lb. of steam condensed, allowing 30 lb. of water per pound of steam, and the height varies from 40ft. to 80ft. Where these objections do not exist, the open type may be installed at a less cost, the maintenance will be less, and, as the height of the plant is usually about 20ft., the operating costs will be the lowest. An approximate figure for area of ground and steam condensed is one square foot per 12 lb. of steam.

The fan draught tower is only used in special cases, as the upkeep, attendance, and power required by the fan make the operating costs very high. A tower of smaller proportions is required with this arrangement than with the natural draught chimney type, the height varying from 40ft. to 50ft., and one square foot of ground is sufficient for 40 lb. to 50 lb. of steam. Depreciation will vary according to the method of construction and the care taken in erection. It is now possible to obtain water cooling plants in which the wooden laths simply lock each other in position, and the rate of depreciation will be much less with this arrangement than where nails are used. The amount of water lost is usually found to be 75 per cent. of the water required for boiler feed, but owing to varying climatic conditions, this quantity is not constant.

Where it is necessary to install plant of this nature, it is essential that the temperature of the water discharge from the condenser be as high as possible, conducive with economy in the condensing plant, as the conditions are then more favourable for the dispersion of the heat contained in the water. From this it will be plainly evident that surface condensers should only be used for high vacua when other considerations, such as boiler feed water, outweigh the factors of heat dispersion. For a high vacuum of say 28in., and water leaving the condenser about 95 deg. Fah. the quantity of water required at 75 deg. Fah. would be only 75 per cent. of the quantity necessary when cooled to 80 deg. Fah., and as the cost of cooling plant would be practically the same in each case, the lower temperature is the more economical, as the saving in power would be considerable.

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* Abstract of a paper read before the Incorporated Electrical Association by Mr. E. Lunn, Assistant Electrical Engineer, Huddersfield Corporation.

LAUNCHES AND TRIAL TRIPS.

SUN III., tug; built by Messrs. Earle's Shipbuilding and Engineering Company, Limited; to the order of Mr. Alexander; dimensions, length 106ft., beam 25ft. 6in.; engines, triple-expansion, pressure 180 lb.; trial trip, July 3rd.

ATENAS, steel screw steamer; built by Workman, Clark and Co., Limited, Belfast; to the order of the Tropical Fruit Steamship Company, Limited, Glasgow; dimensions, 394ft. long; to carry 5000 tons; engines, triple-expansion; trial trip, July 8th.

MELTONIAN, steel screw steamer; built by Harland and Wolff, Limited; to the order of the Wilsons and Furness-Leyland Line, Limited; engines, quadruple-expansion; launch, July 8th.

BISMARK, trunk deck steamer; built by Messrs. Ropner and Sons, Limited, Stockton-on-Tees; to the order of foreign owners; dimensions, 378ft. 6in.; to carry 7900 tons; engines, triple-expansion; constructed by Messrs. Blair and Co., Limited, Stockton-on-Tees; trial trip, July 10th.

BORBOREMA, steel screw steamer; built by Messrs. Craig, Taylor and Co., Limited, Stockton-on-Tees; to the order of Messrs. Lloyd Brazileiro, Rio de Janeiro and London; dimensions, length 286ft., breadth 44ft. 9in., depth 17ft. 6in.; engines, triple-expansion, 14in., 22in., 37in. by 24in., pressure 185 lb.; constructed by Messrs. Blair and Co., Limited, Stockton-on-Tees; trial trip, July 10th.

ITAPEMA, twin-screw passenger steamer; built by the Ailsa Shipbuilding Company, Limited, Troon; to the order of Messrs. Cia Nacional de Nav Costeira, Rio de Janeiro; dimensions, length 270ft., beam 42ft., depth 18ft. 6in.; engines, triple-expansion; constructed by the builders; launch, July 15th.

RETRIEVER, cable repairing and laying ship; built by the Goole Shipbuilding and Repairing Company, Limited; to the order of the West Coast of America Telegraph Company, Limited; dimensions, 185ft. on load line, beam 28ft., depth 16ft. 6in.; engines constructed by Messrs. Richardsons, Westgarth and Co., Limited, Middlesbrough; trial trip, July 10th.

THE IRON, COAL, AND GENERAL TRADES OF BIRMINGHAM, WOLVERHAMPTON, AND OTHER DISTRICTS.

(*From our own Correspondent.*)

The Collapse in Galvanised Iron.

NOTHING so sensational as the collapse that has occurred in galvanised iron has been witnessed on the Birmingham Iron Exchange for many a long day. At one moment commanding £12 10s. per ton f.o.b., and in the next reduced in price to £10 10s., and in some cases it is even said to £10 per ton—such a market history for galvanised sheets of 24 wire gauge it is impossible to describe by any lesser word than "bewildering." Yet the figures just named are sober fact. At the close of last week it leaked out that at their meeting in London the Galvanised Iron Association had determined upon dissolution, but the information was too late to be included in this trade letter. Immediately upon the resolution becoming known, or, at any rate, the next day, competition amongst makers who were left with an entirely free hand was rampant, and prices fell £1 10s. to £2 per ton, and, as already indicated, in some cases even £2 10s. per ton.

Cause of the Reduction.

The cause of the reduction—in other words, the cause of the dissolution of the makers' combination, which had existed successfully for an unbroken period of four years and three months—was the gradual entry into the trade of new firms in the West of Scotland, South Wales, and Lancashire, which refused to agree to the Association's minimum or to be controlled by the Association. The situation had recently become acute by the rapid increase either in number or in the size of the producing plant of such firms, and at their late meeting the Association had no alternative but to unconditionally withdraw the price minimum, and declare a go-as-you-please policy. The effect upon the buying market for galvanised iron has, of course, been utterly disorganising. To-day (Thursday) in Birmingham the excitement associated with the event was almost as marked as a week ago, while the condition of ruinous competition to which the market has been reduced was pathetic.

Output of the Associated Works.

How great is the importance of the interests affected by what has occurred in the Midlands in the last few days will be readily recognised when it is recalled that the annual capacity of output of galvanised iron of the late associated works ranged between 450,000 and 500,000 tons. Appended are the values of the exports in recent years:—1905, £4,825,211; 1906, £5,896,866; 1907, £6,882,603. That was an exceptional year of prosperity in that branch, and last year (1908) the exports receded to £5,428,406. So far this year, however, the export trade has been very good again, the exports for the first half having been £3,204,013. If this rate is kept up during the autumn and winter, 1909 should prove almost as good a complete year as 1907 was.

Pig Iron Prices.

Pig iron prices are unimproved; indeed, the tendency on the week is rather in an opposite direction. Open market quotations were named to-day (Thursday) as:—Forge pig iron: Staffordshire common, 46s; part-mine, 48s. to 49s. 6d.; best all-mine, 80s. to 81s.; cold blast, 110s.; Northamptonshire, 46s. to 47s.; Derbyshire, 47s. 6d. to 48s. 6d.; North Staffordshire, 49s. to 50s.

Advance in Coal Prices.

Staffordshire colliery owners, who in the Cannock Chase district possess what are admitted as some of the finest seams of house coal in the whole world, have not yet made any advance in the price of fuel, arising out of the increased working expenses at the mines entailed by the carrying out of the latest parliamentary legislation. But they note with a good deal of remark, not unmixed with some degree of interested anticipation, that true to their trading instincts, the merchants on the London market have been prompt to take advantage of the new situation, and have this week put up all classes of house coals 1s. per ton, Staffordshire sorts included.

NOTES FROM LANCASHIRE.

(*From our own Correspondent.*)

MANCHESTER, Thursday.

A Sagging Market.

WHEN relief will come in pig iron, especially for the merchant, is very problematical. If the large attendance on the Iron Exchange might be taken as an example, it should have arrived ere this, but inquiry showed an exceedingly quiet state of things, taken all round. There were individual instances where one or two comparatively good orders were booked, but they were for prompt delivery. The position of the fuel question precludes any engagement far forward. The Glasgow market reopened on Tuesday after the holidays, and it was noteworthy that there was a stronger feeling in Middlesbrough brands, but it was obvious that this was of a speculative character, and on spot there was no quotable change. Derbyshire remains steady, but other sorts are exceedingly dull, especially Scotch foundry iron. Only small quantities are reaching this port from the Clyde. Business in forge iron is of small dimensions.

Finished Iron and Steel.

There was no change to note. Billets were steady.

Copper, Sheet Lead, and Tin.

Manufactured is slow. There was no change in tubes or tough ingots, but sheets were advanced late in the day £1 per ton. Sheet lead steady. Tin ingots, following the course of bars, ruled higher.

Quotations.

Lincolnshire No. 3 foundry, 52s. to 52s. 6d.; Staffordshire, 51s. to 51s. 6d.; Derbyshire, 52s. 6d. to 53s.; Middlesbrough, open brands, 56s. 9d. to 57s. Scotch: Gartsherrie, 58s.; Glengarnock, 57s. 6d.; Eglinton, 56s. 9d. to 57s.; Dalmellington, 56s. 9d. to 57s., delivered Manchester; West Coast hematite, 58s.; East Coast ditto, 55s. 6d., both f.o.t. Delivered Heysham: Gartsherrie, 56s.; Glengarnock, 55s. 6d.; Eglinton, 54s. 9d. to 55s.; Dalmellington, 54s. 9d. to 55s. Delivered Preston: Gartsherrie, 57s.; Glengarnock, 56s. 6d.; Eglinton, 55s. 9d. to 56s.; Dalmellington, 55s. 9d. to 56s. Finished iron: Bars, £6 10s.; hoops, £7 12s. 6d.; sheets, £7 15s. to £8. Steel: Bars, £6 5s.; Lancashire hoops, £7 5s.; Staffordshire ditto, £6 17s. 6d. to £7; sheets, £7 17s. 6d. to £8; boiler plates, £7 2s. 6d.; plates for tank, girder, and bridge work, £6 to £6 5s.; English billets, £4 10s. to £4 12s. 6d.; foreign ditto, £4 7s. 6d. to £4 10s.; cold-drawn steel, £9 5s. to £9 10s. Copper: Sheets, £70; tough ingot, £61 to £61 10s.; best selected, £61 to £61 10s. per ton; copper tubes, 8⅜d.; brass tubes, 6¾d.; condenser, 7¾d.; rolled brass, 6d.; brass wire, 6¼d.; brass turning rods, 6½d.; yellow metal, 6d. per lb. Sheet lead, £17 10s. per ton. English tin ingots, £130 10s. per ton.

The Lancashire Coal Trade.

The principal topic of discussion on the Coal Exchange on Tuesday was again the general position—strike or no strike. Since our last, the condition of affairs in Lancashire is not so satisfactory as could be desired. In some cases men have refused to follow their leaders' advice at certain collieries in the Manchester district pending a settlement of the points in dispute, and in the Wigan district there are signs of unrest amongst the boys. The general feeling on the Exchange amongst salesmen appeared to be that there would be no national strike. In Lancashire, in any case, notice would have been given by the men, and this would take some time, but as full time is not being worked, this course is scarcely likely to be followed. In the coal trade generally there is a steady feeling, and supplies are good. If any change in quotations does come, however, it is now admitted on all hands that it will be of an upward character.

BARROW-IN-FURNESS, Thursday.

Hematites.

The market for hematite iron is still depressed, and the business reported during the week shows a sluggish market. Purchases are being made on a more modest scale, and the wants of consumers are evidently much less than they have been, with the consequence that stocks have begun to accumulate both in makers' yards and in warrant stores; but these increases are not large, and they do not indicate the necessity of putting some of the furnaces out of work. On the contrary, the indications are such as seem to justify the continuance of the present rate of output. The belief is rightly or wrongly entertained that the early future has in store for the trade of this district a more active condition of things than has been experienced for some time past. Of course, there will be no great improvement until the steel trade shows more activity; but there are evidences that this will soon be the fact. In the meantime makers are not badly placed for orders, and especially those who have laid themselves out for the manufacture of special hematite iron, as the latter trade has become an important factor in the economy of iron manufacture in this district. It is selling at 60s. 3d. to 61s. 6d., according to specification, and in some cases the specification is so rigid that higher prices are readily paid. Ordinary hematite iron is still quoted at 58s. net f.o.b., and warrant iron 57s. net cash sellers. Settlement prices are at 56s 7½d. Stocks in warrant stores are now at 13,377 tons, and represent an increase of 500 tons during the last three or four weeks. Very little iron is held in stock in the Cumberland district, and the heaviest weight of metal is in the Furness railway stores at Barrow and Millom. The trade in iron ore is quiet, and prices show no change. Good average ordinary classes are at 11s. net at mines, medium at 13s. 6d., and best sorts at 17s. There is not much foreign ore coming into West Coast ports at present, although cargoes are expected later on. Several of the large smelting establishments in the district possess iron mines in Spain and Algeria, and they are using some of this raw material to mix with the local product.

Steel.

There is no change to report in the steel trade. The demand for rails is not strong, and the works of Cammell, Laird and Co. are at a standstill, while the mills at Barrow and Moss Bay are working. Merchant steel is in poor demand. The plate mills at Barrow are still standing, and it is not likely they will be re-started until shipbuilding is brisk and the demand for material active.

Shipbuilding and Engineering.

Apart from the order to build a floating dock for Aberdeen, there is no new business to report in the shipbuilding trade. Engineers are likely soon to be very busy in the gun-mounting department, and with that view works are being extended, but there is no immediate chance of orders in the marine engineering branch.

Shipping and Coal.

Shipments from West Coast ports last week included 3155 tons of iron and 11,290 tons of steel—a total of 14,445 tons, compared with 15,760 tons in the corresponding week of last year—a decrease of 1325 tons. The aggregate shipments this year to date have reached 336,377 tons, against 281,481 tons in the corresponding period of last year—an increase of 54,896 tons. Coal and coke quiet.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

The Pit Lads Returning to Work.

THE pit lads, for the most part, have re-started work at the different collieries. Various understandings have been arrived at, including references to the Miners' Association. The situation as to "snap time," which the lads put forward as their prominent point, has been already outlined by us, and there is no doubt that within a short time reasonable arrangements to meet that and other matters will be completed. The various "feasts," when "play" is very general in the Yorkshire coalfield, are now beginning, and these will tend to restrict output in some directions, but as this is a general thing, the dislocation of trade will not be great. Fortunately, these village "feasts" come in rotation. As one locality sets down, another is working.

House Coal Firm.

A very steady demand is maintained for domestic fuel, in spite of the more summer-like weather now being experienced. A considerable tonnage is being forwarded to London, and, in view of the time of the year, the call from country stations is good. The principal inquiry is for the better qualities, secondary descriptions being less in request, and stocks reported to be increasing in some quarters. Quotations remain as before, best Barnsley fetching from 11s. 6d. to 13s. per ton at pit; secondary sorts, from 10s. to 11s. per ton at pit. There is an opinion expressed that prices will advance earlier than usual this year.

Steam Coal Dearer.

Steam coal at the present time is fetching better prices in the open market, owing to the dislocation caused by the recent stoppage, 10s. per ton at the pits being freely offered. This, however, is not expected to last long now that the boys are getting back to work. At the time of writing there is marked activity at the various pits, as, owing to the recent setting down, orders are somewhat in arrears, which at this season of the year is rather a serious matter, through the pressure of shipping requirements. We are now at about the height of the shipping season, which begins in April, reaches its maximum in July, and tapers off towards September and October.

Small Coal and Coke.

A ready market is found for all the output in small coal, and prices are firmly maintained. For the Lancashire cotton and Yorkshire woollen districts there is good inquiry, rates continuing at 4s. 6d. to 5s. 6d. per ton. Coking smalls are still scarce, and in some instances temporarily dearer, in consequence, no doubt, of the reduced outputs. Prices from 3s. 6d. to 4s. 6d. per ton. Coke, best washed, 10s. 6d. to 11s. per ton; unwashed, 10s. to 10s. 6d. per ton.

Iron.

The position remains as stated last week. Trade very quiet, and official quotations unaltered. Hematites, West Coast, 68s. to 69s. per ton; East Coast, 64s. to 65s. per ton, both less 2½ per cent., delivered in Sheffield and Rotherham; Lincolnshire No. 3 foundry, 50s. per ton; No. 4 foundry, 49s. per ton; No. 4 forge, 49s. per ton; No. 5 forge, mottled and white, 49s. per ton; basic, 50s. 6d. per ton; Derbyshire, No. 3 foundry, 50s. per ton; No. 4 forge, 49s. per ton. Both Lincolnshire and Derbyshire irons net, delivered in Sheffield and Rotherham. Business is reported to be steadier and rather better in the Derbyshire iron market.

Bars, Hoops, and Sheets.

Finished iron makers are stated to be very indifferently employed, demand for bar iron and hoops having declined considerably of late. Bars, £6 10s. per ton; hoops, £7 10s. per ton; sheets, £8 10s. per ton.

The Heavy Trades.

The condition of the heavy industries still remains languid, there being no change for the better in the demand for railway, marine, or engineering requirements. It is hoped that the statement made this week that the Government have now agreed to carry out their contingent programme of four additional Dreadnoughts is well founded, as this will mean considerable work for the naval and military departments of the large establishments, where the orders in hand will soon be completed, and therefore any new work will be very welcome.

Yorkshire Miners' Association and the Scottish Coal Trouble.

A special meeting of the Yorkshire Miners' Association was held at Barnsley on Tuesday, to make arrangements for taking the ballot throughout Yorkshire on the question of setting down the whole of the pits in the country in support of the Scottish miners' resistance to the proposed wages reduction. All the officials were present, together with a representative body of delegates from various parts of the country. The resolution passed by the Miners' Federation of Great Britain, at the meeting held in London last week, was approved, and the Council decided that the ballot should be taken on or before Friday, the 23rd inst. The result is to be forwarded to Mr. J. Wadsworth, the general secretary, on or before Saturday, July 24th. The figures are to be reported to the adjourned conference of the Miners' Federation in London.

NORTH OF ENGLAND.

(*From our own Correspondent.*)

Cleveland Pig Iron.

A DECIDEDLY more cheerful report can be given this week about the Cleveland pig iron trade than has been possible for some considerable time, a welcome and, it is believed, genuine change for the better having appeared, which has imparted confidence to some of the consumers, with the result that a fair number of orders both for prompt and forward execution have been distributed, and a steady rise in prices has to be recorded. At the close of last week buyers would pay only 48s 0½d. cash for Cleveland warrants, on Wednesday 48s. 5½d. was readily given. Traders are taking a generally more sanguine view of the prospects of business, and certainly the outlook appears to be more encouraging for Cleveland ironmasters, though stocks are still increasing and exports are not good. The market is being influenced probably by the sanguine tone of the Chancellor of the Exchequer's speech, and certainly by the good reports from the United States, where there can be no doubt about the revival of business that has set in. Then the improvement in the copper and other metal markets is a factor which is to be taken into account. Consumers have bought very little for a long time past, and their stocks have got to a very low ebb. They have done something to replenish them this week, and much of the business has been transacted direct between producers and consumers. No. 3 Cleveland G.M.B. pig iron, which lately could be got at 48s. per ton for early delivery, has risen to 48s. 6d., No. 1 to 51s., No. 4 foundry to 47s. 6d., No. 4 forge to 47s. 3d., and mottled and white to 46s. 9d., and for delivery up to the end of the year at least 6d. per ton more must be paid. Consumers have bought a good tonnage for delivery up to the close of 1909 at this premium over the prompt price.

Hematite Pig Iron.

The improvement noted in the Cleveland pig iron market has not extended to the hematite pig iron business, and those engaged in the latter are having a very bad time—worse, indeed, than for several years, and profits for most of them are reported to be altogether lacking; they have too much to pay for their materials, and the prospects of getting these at more reasonable prices do not seem to be good, more especially in the case of Rubio ore. The Spanish mineowners appear to be at present almost independent of the market; they consider that even the current quotations for ore are too low, and, instead of selling it freely, are putting much of it into stock. Sellers of Rubio ore adhere firmly to 16s. 3d. per ton delivered c.i.f. Middlesbrough or the Tyne, which buyers think is too high, with mixed numbers of East Coast hematite iron at 54s. 9d. per ton for early delivery—the lowest figure that has been reported this year, the best being 56s. It is not surprising that producers of hematite iron in this district are somewhat "down in the dumps." The position is too unsatisfactory to consumers to buy iron except for immediate delivery, and as the make is not reduced stocks are accumulating. Consumers in the United States are importing considerable quantities of spiegeleisen, ferro-manganese, and silico-spiegel from this district, and the production of these special irons is on the increase in the North-East of England, in consequence of which the import of manganese ore from India and South America is increasing. The P. and O. liners, which load considerable quantities of rails at Middlesbrough for India, carry part cargo of manganese ore on the return voyage to the Tees.

Stock of Pig Iron.

It does not speak well for the activity of trade that so much Cleveland pig iron continues to be lodged in Connal's public store, but there is some excuse this week, seeing that the Glasgow Fair Holidays are on, and that reduces the large quantities of Cleveland pig iron ordinarily sent to Grangemouth; as much as 2000 tons per day has been forwarded, but latterly on account of depression of trade and the competition of Lincolnshire the average is not much more than half of that. This week the exports are below that, and Connal's stock in consequence has been augmented more rapidly, the quantity held on Wednesday being 249,870 tons, an increase this month of 11,988 tons. The stock consisted of 245,085 tons of No. 3, 4350 tons of No. 4 foundry, and 435 tons of iron not deliverable as standard, but all the increase is in No. 3—in fact, the stock of the other qualities is decreasing slowly. There has been only a single day this month on which a decrease has been recorded, and the quantity held—within 130 tons of a quarter of a million tons—is five times the tonnage held a twelvemonth ago.

Manufactured Iron and Steel.

Quietness is the order of the day in almost all branches of the finished iron and steel industries, and it is difficult to get specifications for what has been bought. In consequence of this, work is short at almost all the mills except those producing rails and sheets. The Newport Rolling Mills of Messrs. John Hill and Co., Middlesbrough, have been reopened this week after a stoppage of six weeks; they are producing iron plates, but it is intended that the manufacture of sheets shall be commenced very shortly. Over 600 hands were restarted. The Rise Carr Rolling Mills of Sir Theodore Fry and Co., at Darlington, after being laid off for a fortnight, were restarted on Monday by the Receiver appointed by the Court. The collapse of the galvanised sheetmakers' combination, which has regulated the prices for the last four years, has been followed by a heavy slump in quotations, for whereas over a considerable period galvanised and corrugated steel or iron sheets, 24 gauge, in bundles, have been at £12 10s., less 4 per cent., now they can be had at £10 10s., less 4 per cent., and competition has become extremely keen. Manufacturers in this district are well placed for securing trade owing to their proximity to the shipping ports, but it is probable that some of the smaller concerns away from the coast will be compelled to close their establishments. They had difficulty in making a profit when the price was £12 10s., and such a figure as ten guineas must be altogether against their competing successfully. The quotations for steel hoops, strip, and bars are easier than last week, for hoops can be got at £6 5s., strip at £6 2s. 6d., and bars at £6 per ton, all less 2½ per cent. f.o.t. Steel ship plates are at £5 15s., less 2½ per cent. for home consumption, but they can be got at £5 12s. 6d less 2½ per cent. for export, while iron ship plates are at £6.; steel ship angles at £5 7s. 6d.; iron ship angles at £6 15s.; iron bars at £6 15s.; packing iron and steel at £5 5s., all less 2½ per cent. f.o.t. Heavy steel rails are firm, and £5 5s. net f.o.b. continues to be the lowest price asked for them. The rail mills are the most fully occupied of any in the district.

Shipbuilding.

Those engaged in the shipbuilding industry are beginning to speak more hopefully about business, and the number of laid up ships is being reduced in a satisfactory manner. Some of those laid up are being repaired, and will shortly be brought into service. There are still, however, about 50 laid up in the Tyne, and none can now be found in the Tees.

Coal and Coke.

The labour troubles in the Scotch coal trade make things very uncertain in this district, and there is a growing opinion that there will be no strike, especially as the Board of Trade is taking the matter up. Buyers of steam coal have lately confined their purchases to lots for early delivery, but now they are more inclined to buy forward. Best steam coal is strong at 12s. 6d. per ton f.o.b.; seconds at 10s. 6d.; and smalls at 5s. to 6s. Gas coals are in good request, and shipments are brisk. Sellers are, therefore, keeping the price of best qualities up at 11s. per ton, and seconds at 10s. Bunker coals are firm at 9s. 6d. per ton, and coking coal at 9s. 9d. Coke prices are firm, and fully 15s. 6d. per ton must be paid for average furnace coke, delivered equal to Middlesbrough, though producers of pig iron consider that too high with the present prices of pig iron, especially hematite.

NOTES FROM SCOTLAND.

(*From our own Correspondent.*)

The Labour Crisis.

HAD it not been that work is at present suspended for the annual holidays in the principal industrial centres of the West of Scotland, the labour crisis in the mining department would have occasioned much more anxiety than it has really done. When the coalmasters gave notice of a reduction of wages and the miners replied with an intimation to terminate their engagements, there were the prospects of comparatively little coal being required for home manufacturing purposes for at least a couple of weeks and the knowledge that this stoppage might be extended if necessary, and so few contracts of large dimensions existed that there was comparatively little apprehension of embarrassment from the strike. Besides, it was, and is felt that there is always the prospect of a settlement being reached and a prolonged struggle averted. The situation gathers in importance and gravity, however, as the time approaches for the beginning of a strike, which is Monday, the 26th inst. It is not merely a reduction of wages by 6d. a day, from 6s. to 5s. 6d., that the coalmasters are contending for, but a readjustment of the scope of the sliding scale, which, as at present constituted, gives advances of wages at earlier periods than the increase in prices admit. It is felt, therefore, that were the parties to agree upon a modification of the scale in this respect, it might be found possible to come to an arrangement regarding the question of a reduction of wages. At present the outlook is certainly depressing, not merely as it affects the coal industry, but the entire range of business. The depression in our leading trades has been so protracted that much suffering has been experienced from unemployment, and a further continuance of this state of matters cannot be contemplated with anything short of dismay.

The Iron Market.

Very little has been done in the Glasgow pig iron warrant market since last report. Speculative business is reduced to a minimum by the holidays, and the unfavourable statistical position as regards stocks and shipments. The market was closed from Thursday till Tuesday owing to the holidays. A small business has taken place in Cleveland warrants at 48s. to 48s. 3d. cash, there being little or nothing for future delivery.

Scotch Makers' Iron.

The inquiry for Scotch makers' pig iron has been quiet, especially as regards the local consumption, which is necessarily much reduced at the moment. One or two brands of iron are 6d. lower, but the prices otherwise have been steady. Monkland, No. 1, is quoted at Glasgow, 55s.; No. 3, 53s.; Carnbroe, No. 1, 57s.; No. 3, 54s.; Clyde, No. 1, 59s. 6d.; No. 3, 53s. 6d.; Gartsherrie, No. 1, 60s.; No. 3, 54s.; Calder, No. 1, 60s. 6d.; No. 3, 55s.; Summerlee and Langloan, Nos. 1, 61s.; Nos. 3, 56s.; Coltness, No. 1, 88s.; No. 3, 56s.; Glengarnock, at Ardrossan, No. 1, 62s.; No. 3, 57s.; Eglinton, at Ardrossan or Troon, No. 1, 55s.; No. 3, 53s.; Dalmellington, at Ayr, No. 1, 58s.; No. 3, 53s.; Shotts, at Leith, No. 1, 60s; No. 3, 55s.; Carron, at Grangemouth, No. 1, 63s.; No. 3, 56s. per ton. There are 82 furnaces in blast in Scotland, compared with 74 at this time last year.

Pig Iron Shipments.

The shipments of pig iron from Scottish ports in the past week amounted to 4428 tons, being 1043 tons more than in the corresponding week. The arrivals at Grangemouth of pig iron from Cleveland and district reached 7705 tons, showing an increase of 329 tons over the quantity received in the corresponding week of last year.

The Hematite Trade.

The demand for hematite pig iron has been poor, many consumers' works being idle. A quantity of Cumberland warrants was offered in Glasgow market at 56s. 9d. cash, but there were no buyers. Business in Scotch hematite is practically suspended. The nominal price is 57s. for delivery at the West of Scotland steel works.

The Coal Trade.

There has been a falling away of about 11,000 tons in the coal shipments at Glasgow, but the clearances at Ayrshire ports show a considerable increase, and East Coast shipments are generally well maintained. The aggregate clearances in the past week at Scottish ports amounted to 338,560 tons, which was 13,275 tons less than in the preceding week, but 16,091 tons larger than in the corresponding week of 1908. Prices of shipping coal are steady, being little influenced one way or the other pending the issue of the wages dispute. At Glasgow Harbour, household and steam coals for shipment are quoted 10s., and splint 10s. 6d. per ton.

WALES AND ADJOINING COUNTIES.

(*From our own Correspondent.*)

Last Week's Coal Trade.

THE supply of coal coming in has been far below the shipping requirements, so that the middlemen did well with the stores they had contrived to obtain, and in some cases sales were effected at 1s. or even 2s. above the current rate. Then, the future conditions have been, and continue so doubtful, that easier prices are unlikely, and must remain so until the Scottish question is settled. Every week strengthens the complaint against the injurious action of the Eight Hours Act. Much of the shortage is due to this, and coalowners are more perplexed than I have known them in trying to grapple with the evils of intrusive legislation, in addition to the ordinary run of evils in connection with the working of coal.

Colliery Troubles.

A well-informed correspondent points out that the habit is becoming chronic to refer to "dangers ahead," or trouble "looming in the coalfield." Nearly every question of importance for years has had trouble ahead to begin with, and were all followed by alarming incidents. Very anxious times, states the writer, were those of five years ago, when the present arrangement was brought about. The eight hours contest, again, was a time of trial to the Powell Duffryn dispute. The writer might have added that the noisier the outcry the less was there left afterwards as a record. The trouble with pit boys loomed very large, that with the hauliers threatened much mischief, and the troubles with engineers and stokers years ago were full of "total disaster" to the colliery industry.

Present State of Trade: Lower Cardiff Prices.

Best coal at one time seemed to be in a fair way to be on the ascending scale, and prices from 17s. to 17s. 3d. for best steam were common. The latest news is that most of the leading collieries are well stemmed until the middle of August, and for prompt shipment a slightly easier tone was creeping into business. When the week opened the general figure for best was 17s. 3d. This has lessened, and 17s. for best was the top figure. Dry coals 3d. easier, but Monmouthshire firm at last quotations. Latest:—Best large, 16s. 9d. to 17s. 3d.; best seconds, 15s. 9d. to 16s. 3d.; ordinary seconds, 14s. 6d. to 15s.; best drys, 15s. 6d. to 16s.; ordinary drys, 13s. 6d. to 14s. 3d.; best washed nuts, 13s. 9d. to 14s. 9d.; seconds, 12s. 6d. to 13s. 3d.; best washed peas, 12s. 6d. to 12s. 9d.; seconds, 10s. to 11s. 6d.; very best smalls, 9s. 6d. to 10s.; best ordinaries, 8s. 3d. to 8s. 6d.; inferior sorts, 7s. to 8s.; very best Monmouthshire black vein, 15s. 6d. to 15s. 9d.; ordinary Western Valleys, 14s. 9d. to 15s. 3d.; best Eastern Valleys, 13s. 9d. to 14s. 3d.; seconds, 12s. 9d. to 13s. Bituminous coal: Very best households, 16s. 6d. to 17s. 6d.; best households, ordinary, 14s. 6d. to 15s. 6d.; No. 3 Rhondda, 16s. 9d. to 17s.; brush, 13s. 3d. to 13s. 6d.; smalls, 9s. 6d. to 10s.; No. 2 Rhondda, 12s. 9d. to 13s. 3d.; through, 10s. 3d. to 10s. 6d.; smalls, 8s. 9d. to 9s. Patent fuel, 15s. to 15s. 9d. Coke: Furnace, 15s. 6d. to 16s. 6d.; foundry, 17s. 6d. to 20s. 6d.; special foundry, 24s. to 30s. Pitwood, 21s. 6d. to 22s. 6d.

Newport Coal.

Shipments were much affected by the prevailing shortage in supplies, and the total despatch foreign was limited last week to 58,501 tons. A good tone prevails, and buyers for best coals are prominent; prices well sustained; pitwood in demand, and harder with upward tendency. Latest, best black vein, 15s. to 15s. 6d.; ordinary Western Valleys, 14s. 6d. to 14s. 9d.; best Eastern Valley, 13s. 6d. to 14s.; other sorts, 12s. 6d. to 12s. 9d.; best small, 8s. 9d. to 9s.; seconds, 8s. to 8s. 3d.; inferiors, 7s. to 7s. 6d.; bituminous best house coal, 15s. to 15s. 3d; seconds, 14s. to 14s. 3d. Patent fuel, 14s. 9d. to 15s. Coke: Foundry, 18s. to 19s.; furnace, 16s. to 16s. 9d. Pitwood, 21s. to 22s.

Swansea Coal.

Exports of coal exceeded 70,000 tons last week, and there was a good deal of buoyancy in the trade; but no alteration of any account in prices has taken place this week, and, as a buyer expressed it, business was on the "slow side;" prices easier. Latest:—Best malting, hand picked, 23s. to 24s. net; second malting, 21s. to 22s. net; big vein, 18s. to 19s. 6d., less 2½; red vein, 12s. 6d. to 13s., less 2½; machine-made cobbles, 23s. to 23s. 6d. net; Paris nuts, 23s. 6d. to 24s. 6d. net; French same. German nuts, 23s. to 23s. 6d. net; beans, 17s. to 18s. net; machine-made large peas, 11s. 6d. to 12s. 6d. net; fine peas, 10s. to 11s. 6d. net.; rubbly culm, 5s. to 5s. 6d., less 2½; duff, 3s. to 3s. 3d.; steam coal, best, 16s. to 16s. 6d., less 2½; seconds, 13s. 6d. to 14s. 6d., less 2½; bunkers, 10s. 3d. to 11s. less 2½; small, 8s. to 9s., less 2½. Bituminous coal: No. 3 Rhondda, 17s. 6d. to 18s. 6d., less 2½; through, 14s. 6d. to 15s., less 2½; small, 9s. 9d. to 10s., less 2½. Patent fuel, 13s. to 13s. 6d., less 2½.

Iron and Steel.

There was more activity at the Dowlais Works than of late, and the result of greater business at furnaces and mills was a bigger make. In heavy rails 2200 tons were despatched on Indian State Railways account to Kurachee, while consignments went to the London and South Coast Railway. Fish-plates also figured well, with steel sleepers, which continue in demand. Substantial cargoes of crop ends have been received from Middlesbrough, and 400 tons pig iron from Harrington, 650 tons pig from Grimsby, 959 tons steel from Rotterdam. Little movement yet in railway iron; consignments of iron to Bristol from Newport continue. Latest quotations:—Hematite, mixed numbers, 56s. 7½d., cash and month; Middlesbrough, 48s. 4d. cash, 48s. 7d. month; Scotch, 54s. 4½d. cash and month; Welsh hematite, 60s. to 61s. 6d. d/d.; East Coast hematite, 59s. to 60s. 6d. c.i.f.; steel bars, Siemens, £4 8s. 9d. to £4 10s.; Bessemer, £4 8s. 9d. to £4 10s. per ton. Best Rubio ore, 15s. 3d. to 15s. 6d.; seconds, 14s. 3d. to 14s. 6d. Other quotations:—Copper, £58 12s. 6d., £59 7s. 6d. month. Lead, £13 3s. 9d. Spelter, £22 per ton. Silver, 1s. 11⅜d. per oz.

Tin-plate.

By the harbour returns of last week tin-plate showed considerable activity, over 99,000 boxes being shipped and 92,897 received from works. Stocks now consist of 197,616 boxes. All the tin-plate work continues in excellent form, with no abatement of the prospects so prominent of late. This also applies to the intermediate and finishing departments. The latest quotations are:—Block tin, £131 17s. 6d. to £133 7s. 6d. three months; C.A. roofing sheets, £8 to £8 5s.; big sheets for galvanising, £8 5s. to £8 7s. 6d. per ton; finished black plate, £9 5s. per ton; galvanised sheets, 24g., £11 nominal per ton; ordinary sheets, from 11s. 10½d.

AMERICAN NOTES.

(*From our own Correspondent.*)

NEW YORK, July 15th.

THE mid-summer season finds the steel mills throughout the country better supplied with business than for the past two years. Structural material is now the most active on the list. The demand comes from all sections, and the orders are mostly under 1000 tons. A great deal of building work is under way and boat and shipyards are quite active. Two ships will be added to the New York-Savannah Line, four-deckers, as a result of the control obtained by Harriman over the Georgia Central Railroad. A strike of 18,000 miners is on in the Pittsburgh district to aid the tin mill workers now on strike. The Pittsburgh Coal Company has seventy mines, and is under contract to furnish 8,000,000 tons coal a year to the United States Steel Corporation; other mining centres are quiet. Work on the Panama Canal is being vigorously prosecuted, and 45,000,000 dols. will be required for the expense account of the coming year. The purpose of the Cuban Government to purchase 15,000 rifles abroad has been thwarted by a suggestion from this Government. The general trade and business of the country is steadily improving, and in many lines prices show an upward tendency. This is particularly true in iron and steel. Pig iron has at last recovered from its extreme depression. Mineral oil developments of some magnitude are reported from the south-western sections of the United States. The use of oil fuel by the western railroads is doing much to encourage pipe-line construction and oil well boring. The operations of these lines are extensive—one, the Prairie Oil and Gas Company, averages a run of 84,000 barrels a day. The demand for tank iron for tanks is quite an item in the course of a year. Tanks are built to hold from 25,000 barrels to 75,000 barrels. After prolonged experiments oil is now being very largely used on Pacific lines. New fields are being discovered, and oil is found at greater depths. The silver mines of Canada, especially the Cobalt Camp, are attracting unusual attention by reason of the remarkable developments. Prospectors have been encouraged to seek more remote regions in Quebec, Ontario, British Columbia, and Alberta. Apart from the wonderful agricultural resources of the north-west, it is believed that mineral deposits will be revealed in the near future. Population is spreading northwards from the North-Western States of the United States, and new markets are being opened up. This outpouring is largely due to the construction of railroads in hitherto inaccessible regions.

CATALOGUES.

E. G. WRIGLEY AND CO., Limited, Foundry-lane Works, Soho, Birmingham.—A leaflet to hand from this company has reference to the Humpage hob for gear cutting.

WM. GEIPEL AND CO., Vulcan Works, St. Thomas-street, London, S.E.—This is an illustrated price list of "Henrion" arc lamp carbons. It also deals with welding carbons for direct or alternating current.

THE MIDLAND ENGINEERING COMPANY, Limited, 2, Victoria-square, Birmingham.—This is a tasteful little booklet dealing with "Zylba" patented condensing and cooling plants. Illustrations are given showing these plants erected in various parts.

THE BRITISH PROMETHEUS COMPANY, Limited, Salop-street Works, Highgate, Birmingham.—Catalogue No. 137 has reached us, which has reference to this company's new system of electric cooking by "silundum" The catalogue fully describes the system, and there are illustrations, particulars, and prices of the apparatus used.

JOHN SMITH, Limited, Crane Works, Keighley.—This company's illustrated catalogue of cranes and modern stone working machinery has reached us. It is a well got up publication, the illustrations being exceptionally large, and the information which it contains is very concise. Dimensions, weights, and code words are given in tables at the foot of each page.

THE GLOBE PNEUMATIC ENGINEERING COMPANY, Limited, 150, Queen Victoria-street, London, E.C.—From this company we have received a well got up pamphlet having reference to the Globe suction cleaner. The pamphlet describes this cleaner as a highly efficient machine, working on a new and correct principle, for removing dust. Illustrations and full particulars are given.

NORTON AND GREGORY, Limited, 34, Robertson-street, Glasgow.—This is a well-bound catalogue having reference to surveying instruments, drawing instruments, drawing materials, photographic apparatus, photographic processes, office stationery, and office furniture. It contains numerous illustrations, and every article illustrated is priced. The catalogue is probably one of the most complete of its kind.

ALFRED HERBERT, Limited, Coventry.—This is a catalogue dealing with universal cutter grinding machines. The catalogue is got up in the company's usual excellent style, the machines and parts being illustrated on the page opposite the descriptive matter. Directions for use are also given, and these directions are accompanied by illustrations. At the end there are some notes on cutter grinding and the use of the machine generally.

THE HART ACCUMULATOR COMPANY, Limited, Marshgate-lane, Stratford, London.—From this company we have received a tasteful little book dealing with Hart accumulators. The book, which may be conveniently carried in the pocket, contains a considerable amount of useful information relating to the management, &c., of accumulators. Illustrations and full particulars are also given of the various types of cells manufactured by the company.

WE have received from Callender's Cable and Construction Company, Limited, a framed and well executed etching, entitled "A Fleet in Being." The vessels represented, which form part of the British fleet, are the Bellerophon, Indomitable, Inflexible, Superb, Téméraire, Invincible, Vanguard, Defence, Boadicea, and Bellona. On all these ships the electrical distribution has been effected either entirely or in part by means of Callender's cables and special boxes.

RICHARD JOHNSON AND NEPHEW, Limited, Bradford Ironworks, Manchester.—With the title of "Recent Improvements in Engine Packing," the above firm has published a pamphlet written by Mr. P. Redford, Wh. Sc., the inventor of a metallic self-adjusting packing which Messrs. Johnson and Nephew are placing on the market. In this spherical packing the only pressure exerted on the rod is that due to light springs which encircle bronze anti-friction metal pieces, and is claimed to amount to no more than 0·5 lb. to 1 lb. per square inch surface contact. The pressure is the same under all loads and steam pressures.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

MESSRS. JAMES E. SAYERS AND CALDWELL inform us that they have entered into new offices at 190, West George-street, Glasgow.

THE address of the Newcastle office of the Union Electric Company, Limited, will for the future be Collingwood-buildings, Newcastle-on-Tyne.

A. AND T BURT, Limited, of New Zealand, advise us that they have opened an office in London at Eldon-street House, E.C. The office is under the charge of Mr. Jas. A. Burt, the firm's resident director.

CONTRACTS.—The Gilbert Little Company, Limited, has received an order for a "Flying Fox" transporter from the Ashanti Goldfields, Limited, and the contracts for 30in. wide double steel chain push-plate conveyors, 16in. diameter Archimedian screw conveyors, belt conveyors, elevators, perforated pipes, gearing, brass and iron water fittings, and the steelwork required by the Cardiff Washed Coal Company, Limited, for the extensions to its coal washing plant at the Roath Docks, Cardiff.—The India-rubber, Gutta-percha, and Telegraph Works Company, Limited, of Silvertown, has recently shipped to South Africa a large consignment of armoured hose and 5in. suction hose for mining work in South Africa. The same company has also lately sent two 24in. diameter suction hoses to South America.

NOTES FROM GERMANY, FRANCE, BELGIUM, &c.

(*From our own Correspondent.*)

Rheinland-Westphalia.

THE market for iron and steel is without animation, and a weak tone was perceptible in several departments, prices having evidently not touched bottom yet. On foreign account little has been done, and quotations are generally regarded as most unremunerative. Depressing accounts are also received from the Siegerland. Employment is irregular and limited in most branches, and the outlook certainly anything but bright.

The Silesian Iron Industry.

There is still the same condition prevailing, and comparatively little is being done in raw and in finished iron. Still, most trades have been tolerably active this week and the last, chiefly on orders for immediate consumption, forward contracts being scarce. Scrap iron has been raised in price; for some sorts M. 3 and M. 4 p.t. more is being asked now.

List Rates.

The following are the present list rates per ton, free at works:—Raw spathose ore, M. 10.90; roasted ditto, M. 15.50; Nassau red iron ore, M. 11.50 per ton at mines; spiegeleisen, 10 to 12 per cent. M., M. 63 to M. 65; white forge pig, Rhenish-Westphalian and Siegerland quality, M. 56 to M. 58; iron for steel making, M. 56 to M. 59; German Bessemer, M. 56 to M. 58; Luxemburg forge pig, free Luxemburg, M. 44 to M. 46; Luxemburg foundry pig No. 3, M. 46 to M. 48; German foundry pig, No. 1, M. 57 to M. 59; No. 3, M. 56 to M. 58; German hematite, M. 58 to M. 60; common bars in basic, M. 97 to M. 103; iron bars, M. 122.50 to M. 125; hoops in basic, M. 120 to M. 122.50; steel plates, M. 104 to M. 110; boiler plates, M. 114 to M. 120; sheets, M. 117.50 to M. 125; drawn wire in steel, M. 127.50.

Sales of the Steel Convention.

In June 418,626 t. were delivered, as compared with 377,718 t. in May, and against 378,360 t. in June, 1908. Deliveries, accordingly, are 40,908 t. higher than in May of present year, and 40,266 t higher than in June last year. Of the sales in June 114,188 t. were semi-finished steel, as compared with 112,418 t. in May of present year, and as against 38,056 t. in June, 1908; railway material, 146,588 t, as against 116,863 t. in May, and as against 165,196 t. in June, 1908; sectional iron, 157,850 t., as against 148,437 t. in May, and as against 115,109 t. in June, 1908.

German Export in Machines.

In April of present year export in all kinds of machines was only 258,893 q., against 291,456 q. in April, 1908, which is equal to a decrease of 12 per cent. During the first four months of this year 973,497 q. have been exported; in the same period in 1908 export was 1,117,543 q., and in 1907 it was 1,026,578 q. Exports in steam engines, as well as in weaving and sewing machines of all kinds, have decreased, while in locomotives a rise in export is noticeable. Export in pumps has decreased from 16,088 q. in the first four months of 1908 to 12,703 q. in the same period of present year. Mining plant also shows a large decrease in export.

Coal Market in Germany.

Compared with the depressed state of the iron industries, the business done in the coal trade has been quite satisfactory, both in Silesia and in Rheinland-Westphalia; in house fuel especially a fair demand was noticed, while sales in engine coal have been somewhat restricted. Gas coal also was sluggish; a reduction in the prices for blast furnace and coking-coal has been taken into consideration for the beginning of October, but nothing definite has become known yet.

Austria-Hungary.

A languid trade is generally reported; only in some special cases have producers been able to do a satisfactory business. German competition has not been quite so keen as before, principally because Austro-Hungarian works have reduced their quotations. Coal is in pretty steady demand. The result of the large tenderings for coal for the State railways will soon become known; the total requirements in locomotive coal were 1,518,000 t., seventy-two offers having been sent in by inland and foreign firms. England, Belgium, Saxony, Silesia, the Ruhr and Saar district, and even Russia tendered, but only a small part of the requirements will be purchased from abroad, England and the Lower Silesian district being likely to be favoured with orders, the former supplying coal for the Southern State Railways and for Triest. Sales in brown coal have been effected at rates that were higher than those formerly paid; the prices for pit coal, on the other hand, show a decrease.

Good Accounts from France.

At most establishments employment has improved, and higher rates have been carried. At the sales of the third quarter a rise of 5f. p.t. was reported, merchant bars thus standing at 165f. to 170f. p.t.; plates 190f. p.t. Prospects are tolerably good as regards employment in the present quarter. Not merely in the East and Marne district, which had been somewhat favoured as regards better prices, but also in the neglected northern districts has an upward tendency been noticed. Prices for coal are firm. In the Loire district stocks increase, output being greater than demand.

Steady Tone in Belgium.

It is gratifying to note that the downward tendency reported last week has given place to a fairly strong tone in most branches. Quotations are the same as before, but they are likely to be raised before long, if the position of the market continues to improve. Plates and sheets are neglected, only the heavier sorts meet with fair request. Some rail orders of importance have been taken in lately, the mills are working regularly. In pig iron a quiet but fairly remunerative trade is done. House coal is very firm, and the demand in engine fuel, though not extensive, has remained regular, as before.

INSTITUTE OF METALS.—The Institute of Metals has just completed the first year of its existence, and during that period the membership has increased from barely two hundred to well over five hundred. The autumn meeting will take place at Manchester on Thursday and Friday, October 14th and 15th. A series of about half a dozen papers will be read and discussed at the two morning sessions of the Institute. The afternoon of the first day will be devoted to a visit to the University of Manchester. The new engineering laboratories will be open for inspection, and facilities will also be given for inspecting the Municipal School of Technology. In the evening a reception will be held by the Lord Mayor at the Town Hall. During the afternoon of Friday, October 15th, members will have the opportunity of visiting works of metallurgical interest in the neighbourhood of Manchester. The present officers of the Institute are already proving to possess insufficient accommodation, and it is, therefore, the intention of the Institute to remove into a more commodious suite of rooms at the earliest possible moment. The address—the Institute of Metals, Caxton House, Westminster, S.W.—will remain unchanged.

BRITISH PATENT SPECIFICATIONS.

When an invention is communicated from abroad the name and address of the Communicator is printed in italics.

When the abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent-office Sale Branch, 25, Southampton-buildings, Chancery-lane, London, W.C., at 8d. each.

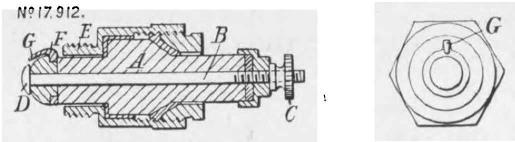
The first date given is the date of application; the second date at the end of the abridgment is the date of the advertisement of the acceptance the complete specification.

Any person may on any of the grounds mentioned in the Acts, within two months of the date given at the end of the abridgment, give notice at the Patent-office of opposition to the grant of a Patent.

INTERNAL COMBUSTION ENGINES.

17,912. August 26th, 1908.—IMPROVEMENTS IN SPARKING PLUGS FOR INTERNAL COMBUSTION ENGINES, Orlebar David Bruce Payne, Walmer, Kent.

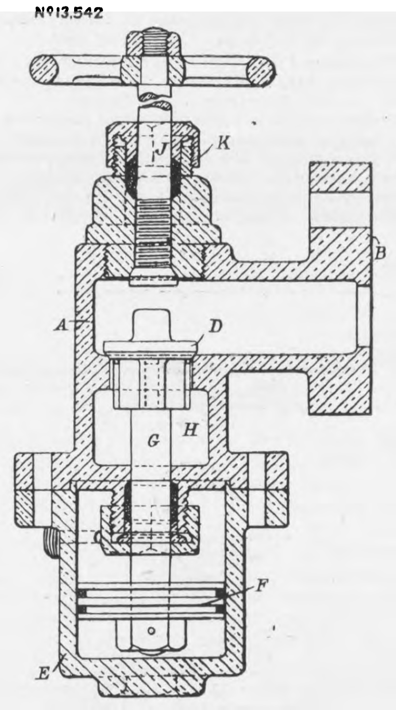
This invention relates to improvements in sparking plugs for internal combustion engines in which two or more spark gaps in series are formed between a central conducting member and an insulated conducting ring or rings arranged between said member and the body of the plug, and has for its object to enable more efficient and reliable sparking to be secured. The central insulating body A surrounds the conductor B for the high tension current, the wire lead being connected by means of the terminal screw C. The exposed point D serves as the electrode. Between D and the part E of the plug an insulated conductor F is disposed, this conductor being made of a metal ring portion formed with a projection G. Thus the insulated metal ring F furnishes a point in the path which is taken by the spark in its passage from the central conductor to the body E.—June 30th, 1909.



LOCOMOTIVES.

13,542. June 25th, 1908.—IMPROVEMENTS IN BLOW-OFF COCKS OR VALVES FOR LOCOMOTIVES, Percy Hulburd, 150, Leadenhall-street, London.

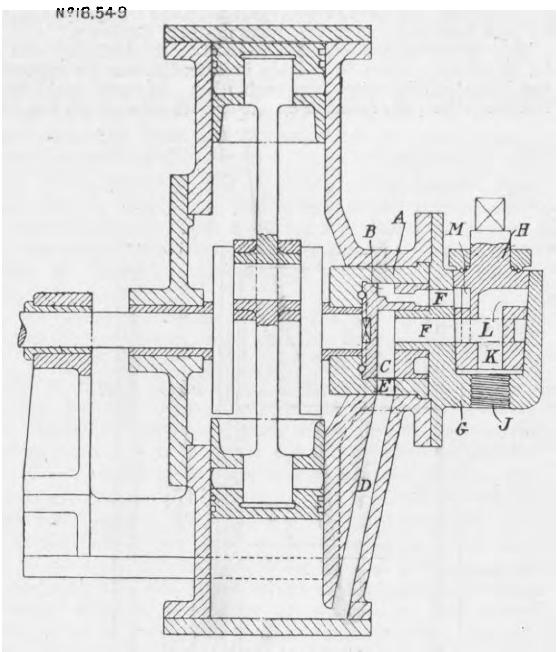
This invention relates to a blow-off cock or valve designed to be operated from the foot-plate of a locomotive when running for the purpose of discharging mud or sediment. The shell A of the cock is provided with a flange B for attachment to the boiler, and with a discharge nozzle formed on the chamber H; D is the discharge valve which normally rests upon its seating; E is a cylinder which contains a piston F, the rod G of which extends through a stuffing-box, this rod being connected to the valve. Nozzles formed on the cylinder E admit the fluid pressure above and below the piston respectively. A screw spindle J is arranged as shown passing through a stuffing-box K, the spindle serving to control the distance which the valve D will be opened. In practice the valve is advantageously connected with the reservoir of the vacuum or air brake, so that the valve will be operated by atmospheric pressure or by compressed air. There are three other figures.—Jnne 30th, 1909.



TRANSMISSION AND POWER.

18,549. September 4th, 1908.—IMPROVEMENTS IN FLUID PRESSURE MOTORS, Alexander Wilson, Ashgrove-road, Aberdeen.

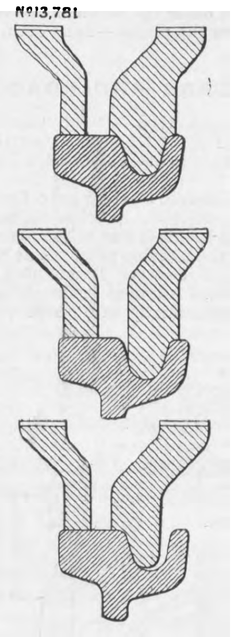
This invention relates to compressed air or other fluid pressure motors comprising three single-acting cylinders arranged radially around a crank shaft, and consists in the particular construction of supply cock and rotary distributing valve here described. Referring to the drawing, the motor comprises three cylinders fitted wtth trunk pistons. At the end of the shaft opposite to that whence power is taken is a rotary valve driven by a square end on the shaft and fitted within a liner A in the side of the cylinder casing. This valve has two passages B C communicating as the valve rotates with ports D E in the cylinders and liner respectively, so that one of the said ports B C serves as the admission while the other serves as the exhaust port. These two valve ports B C also communicate through passages such as F in the end cover G with ports in a cock H to which the compressed air is admitted at J. The cock is a three-way cock having a central admission passage K opening to two lateral ports L, either of which ports may be opened to the admission port of the rotary valve, while the other is closed. The port B or C when closed to the air supply through the cock is open to an exhaust port M, which is of such depth as to serve for exhausting from either valve port B C. The engine is reversed by turning the cock H.—June 30th, 1909.



TRAMWAYS AND RAILWAYS.

13,781. June 29th, 1908.—IMPROVEMENTS RELATING TO MAGNETIC BRAKES FOR RAILWAY AND TRAMWAY VEHICLES, Oscar Howard Baldwin, 2, Norfolk-street, Westminster.

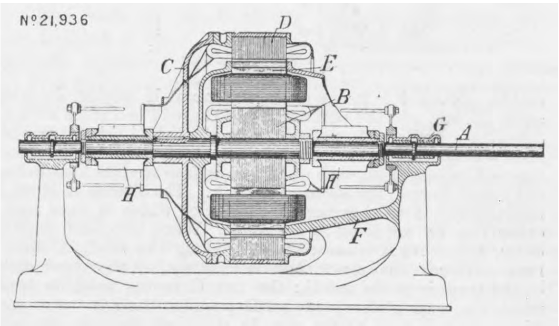
This invention relates to magnetic brakes, and in particular to the brake shoes which make contact with the rail. According to the present invention, in order to reduce the amount of magnetic leakage in brake shoes of the above description without reducing the width of the poles in contact with the rail, one of the poles is formed of such a shape in cross section as will correspond to the profile of a portion of the rail: that is to say, the pole is provided on one edge with a depending portion or flange, which corresponds in size and shape with the groove in the rail. In some instances the depending portion of the pole is arranged so as not to fill the whole of the groove. The engravings show three types of poles.—June 30th, 1909.



DYNAMOS AND MOTORS.

21,936. October 16th, 1908.—IMPROVEMENTS IN DIRECT-CURRENT DYNAMO ELECTRIC MACHINERY, Albert Henry Midgley and Charles Anthony Vandervell, Acton Vale, London.

This invention has for its object the construction and arrangement of parts whereby the weight and cost of the machine in relation to the output can be made much lower than at present obtained in machines of the known type. The drawing shows a sectional view of a machine constructed in accordance with the invention. Upon the shaft A is mounted the armature B of drum type and also the frame C, on which is mounted the second armature D of annular formation, so that a space is left between the two armatures. Within this space are disposed the field magnets E mounted on the frame F formed as part of one of the bearings G. By this arrangement each armature acts as the magnetic yoke to the other. Each armature is provided with a commutator H, or, if desired, only one commutator arranged on the left-hand side can be used for the double purpose of collecting current from both armatures.—June 30th, 1909.

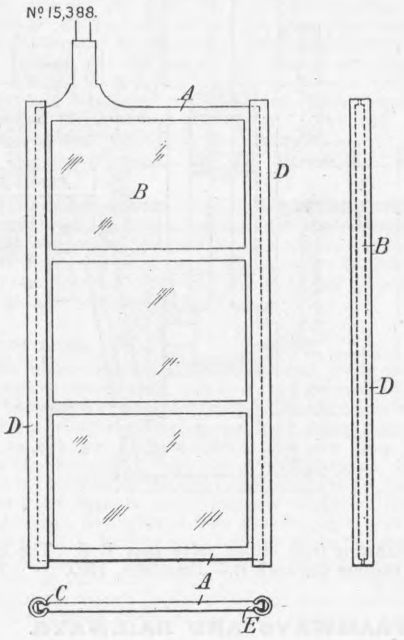


BATTERIES AND ACCUMULATORS.

15,388. July 21st, 1908.—IMPROVEMENTS IN OR RELATING TO ELECTRIC ACCUMULATORS, Van Raden and Company, Limited, and Max Metz, all of 567, Foleshill-road, Coventry.

This invention has reference to electric accumulators, and has for its primary object to provide improved means for separating and insulating the plates from each other. In carrying the invention into effect, the frame A on one or both sides of the plate B is formed with channels C parallel to and near its vertical edges. An insulating and acid-resisting material is applied to the plates in the form of tubes D of vulcanite, or other suitable material. These tubes are split longitudinally at E. By making the width of the splits in the tubes slightly less than that of the grooves, the elasticity of the material of the tubes is found sufficient to retain the latter firmly in position. The diameter of the tubes is greater than the thickness of the plates, so that when two plates are placed against each other the tubes on the edges prevent contact taking place between the plates.—June 30th, 1909.

Nº 15,388.

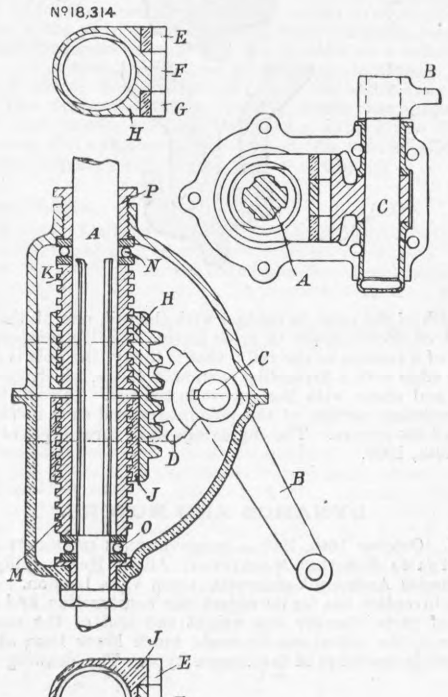


MOTOR CARS AND ROAD TRAFFIC.

18,314. September 1st, 1908.—IMPROVEMENTS IN AND RELATING TO RACK AND PINION GEARING, Oscar Charles Selbach and the Etablissements Selbach Limited, all of 28, Russell-square, London, W.C.

This invention relates to steering gear for motor cars and the like, and has for its object to provide an improved construction thereof whereby the backlash due to the wear of moving parts may be taken up. A is the steering pillar whose motion is transferred to the wheels through the lever B mounted on the shaft C and connected to a toothed segment D meshing with a rack. The rack is divided longitudinally into three portions E F G. The middle portion F is in one piece with a nut H having an internal screw thread, and the portions E and G are in one piece with a nut J having a similar internal screw thread, E F G being arranged to form a single wide rack. H and J are carried by two independent screwed sleeves K M, each of which is free to slide longitudinally but not to turn on the steering shaft A. The sleeves K M are held between two thrust bearings N O, one of which is fixed and the other can be adjusted by a bush P. When this bush is screwed down, the sleeve K is caused to slide along the shaft A until the lower surfaces of its screw threads bear against the upper surfaces of the threads in the nut H; the nut H moves until its teeth F touch the teeth of the quadrant D pushing them in turn against the rack teeth E G of the nut J; thus bringing the threads of the latter into close contact with the threads on the sleeve M and pushing the sleeve against the fixed thrust bearing. Thus, any wear, wherever it may occur, is taken up by a single adjusting screw.—June 30th, 1909.

Nº 18,314



MEASURING AND TESTING INSTRUMENTS.

28,271. December 28th, 1908.—IMPROVEMENTS IN SINGLE-PHASE ALTERNATING ELECTRIC CURRENT METERS, *the firm H. Aron Elektricitätszählerfabrik, G.m.b H.*, 39, *Wilmersdorferstrasse, Charlottenburg.*

It is frequently customary to allow consumers of electric current who have an electro-motor installation to use at the same time a glow lamp at the price charged for motive power, so as to avoid the use of two meters when there are different scales of charges for light and for motive power. When single-phase meters are used where induction motors are installed, and such meters indicate the output of the three-phase current upon the assumption that all phases are equally loaded, it will happen, in the case where the lighting current is passed with the motive power current through the series coil of the meter, that the meter will register, as regards the current used for lighting, three times the amount of current which has been actually consumed. To overcome this disadvantage the series coil of the meter is, in this invention, wound with two divided windings, the one taking the current for motive power, and the other, which has only one-third of the number of windings of the first winding, taking the current for lighting. Under these conditions, as the velocity ratio of the meter counting mechanism is such that it will record triple the amount of energy passing through the meter, the latter will indicate correctly, with one counting mechanism, the amount of current consumed for both motive power and lighting. The specification contains one diagram.—June 30th, 1909.

AERONAUTICS.

20,785. October 2nd, 1908. IMPROVEMENTS IN OR RELATING TO AEROPLANES AND THE LIKE, *Louis Blériot*, 56, *Boulevard Maillot, Neuilly-sur-Seine, France.*

This invention relates to a method of and apparatus for enabling aëroplanes and similar apparatus to rise from a standing position, and consists in applying to such machines propellers with horizontal axles, so arranged that they can drive the air against the inclined wings, and thus submit them to elevating forces similar to those experienced with the ordinary apparatus when running at a high speed. Several ways of carrying out the invention are described. Figs. 1 and 2 show two of these. In the first, propellers B B are mounted on driving shafts which can be rotated through 90 deg., and, as shown, are arranged for ascension. During flight they are turned through a right angle. Z Z are springs, as the ordinary wheels are unnecessary. In the second method the propellers are mounted, as shown, and are kept in the same position during flight, excepting a slight rotation which can be given them for steering purposes. In this case the ascension takes place in an inclined direction, and a claim is lodged for a means of temporarily anchoring the aëroplane, so as to give a vertical ascent. Claims are also made for various means of driving the propellers in the two cases.—June 30th, 1909.

Nº 20,785

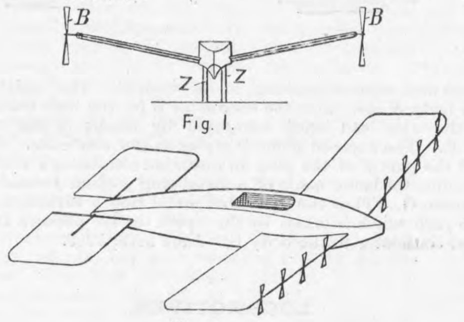


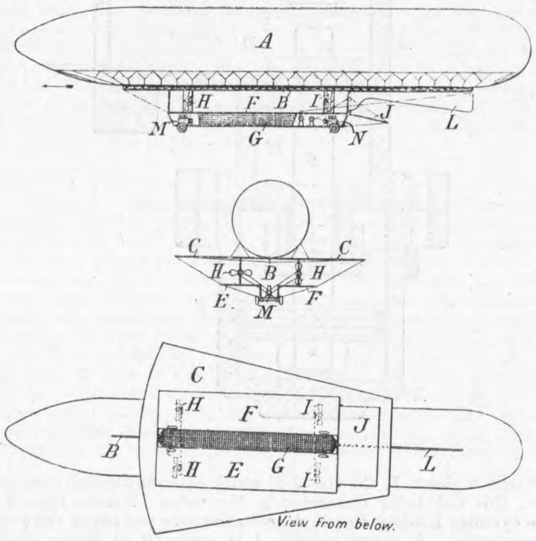
Fig. 1.

Fig. 2.

24,202. November 11th, 1908.—IMPROVEMENTS IN OR RELATING TO DIRIGIBLE AERIAL MACHINES, *Francois André Don Simoni*, 41, *Rue Gaultier, Courbevoie, Seine, France.*

This invention relates to a dirigible aërial machine comprising a combined balloon and aëroplane, the peculiarity of which consists in the weight of the aëroplane apparatus being balanced by a fusiform balloon, to which the said apparatus is rigidly connected, and the propulsion of which is brought about by independent screw propellers driven by means of independent motors, and arranged between superposed planes. The balloon A is of elongated form, and is kept rigid in the greater portion of its length by means of a strong and light truss frame B. The aëroplane comprises a main plane C wider in front than at the back, and strengthened in its longitudinal centre by the frame B. Below are arranged symmetrically two other plane surfaces E F, thus forming two passages along which the air can pass. The car G occupies the space between the two lower planes, and extends along their whole length. A rigid framework connects the different planes and the car together. A horizontal hinged flap J controls the vertical motion of the aërostat. In the front and back portion of the car are arranged two independent motors M and N, acting respectively on two pairs of screw propellers H and J, arranged in the spaces between the planes. The steering of the apparatus is obtained by means of a rudder L, which is hinged vertically as shown.—June 30th, 1909.

Nº 24,202.



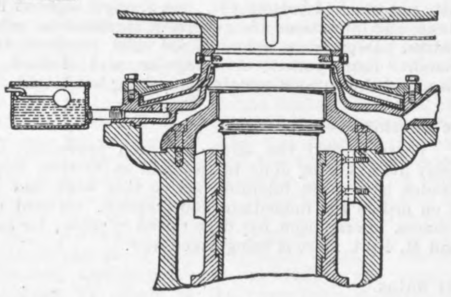
SELECTED AMERICAN PATENTS.

From the United States Patent-office Official Gazette.

924,836. LIQUID SEAL FOR ROTARY APPARATUS, *F. Samuelson, Rugby, England, assignor to General Electric Company, a Corporation of New York.—Filed October 18th*, 1907.

This is a patent for sealing the spindles of vertical turbines. A chambered casing containing liquid has a rotary disc extending into the chamber whose entire periphery is always immersed, vanes on the disc, a source of liquid supply feeding into the chamber, means for maintaining such a level in the source that the liquid in the chamber will not overflow its wall, and a port connecting the source of supply and the chamber which is so disposed that the pressure created by the rotating disc balances the head of liquid so long as it is covered by the moving mass of liquid. There are eight claims.

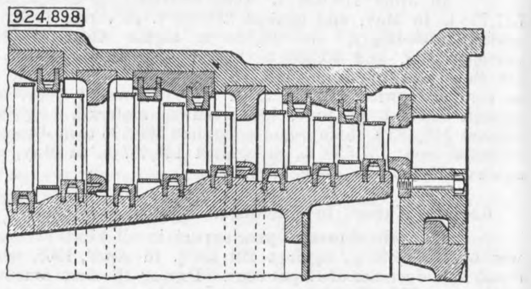
924,836.



924,898. ELASTIC FLUID TURBINE, *W. L. R. Emmet, Schenectady, N.Y., assignor to General Electric Company, a Corporation of New York.—Filed February 24th*, 1909.

There are eight claims. The fifth runs as follows:—In a turbine the combination of a casing, a rotor located therein, rows of buckets mounted on the rotor for driving it, fluid directing devices carried by casing, a structure carried by said devices for reducing leakage and comprising a ring attached to said devices and a second ring supported by the first at one side only and separated at other points to permit of independent expansion and contraction, and means on the second ring that co-operate with the rotor to reduce leakage.

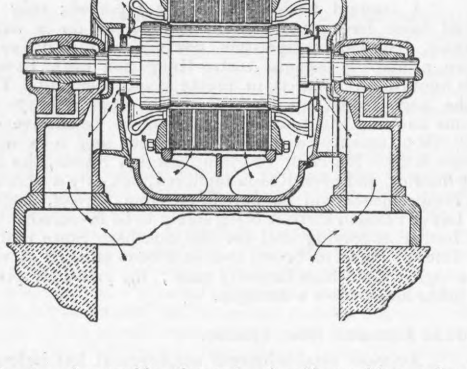
924,898.



925,272. DYNAMO-ELECTRIC MACHINE, *B. A. Behrend, Norwood, Ohio, assignor to Allis-Chalmers Company, a Corporation of New Jersey, and the Bullock Electric Manufacturing Company, a Corporation of Ohio.—Filed May 27th* 1907.

This patent is for the combination in a dynamo-electric machine, of the fixed and movable elements of said machine, a housing therefor which supports one of said elements, and hollow pedestals supporting the other of said elements and serving as conduits through which air is admitted into said housing.

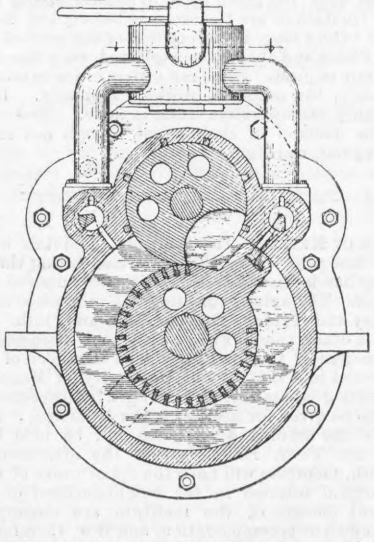
925272.



925,467. COMPOUND ROTARY ENGINE, *J. A. Eaton, Chicago, Ill.—Filed June 15th*, 1908.

There are fifteen claims. The fourth is as follows:—A rotary engine comprising a high-pressure cylinder, a low-pressure cylinder, inlet and outlet valves for said cylinders, a reversible excentric mechanism for operating the valves, a piston in each cylinder and a throttle valve for admitting the motive fluid into the high-pressure cylinder and delivering the exhaust from the high-pressure cylinder to the low-pressure cylinder.

925,467.

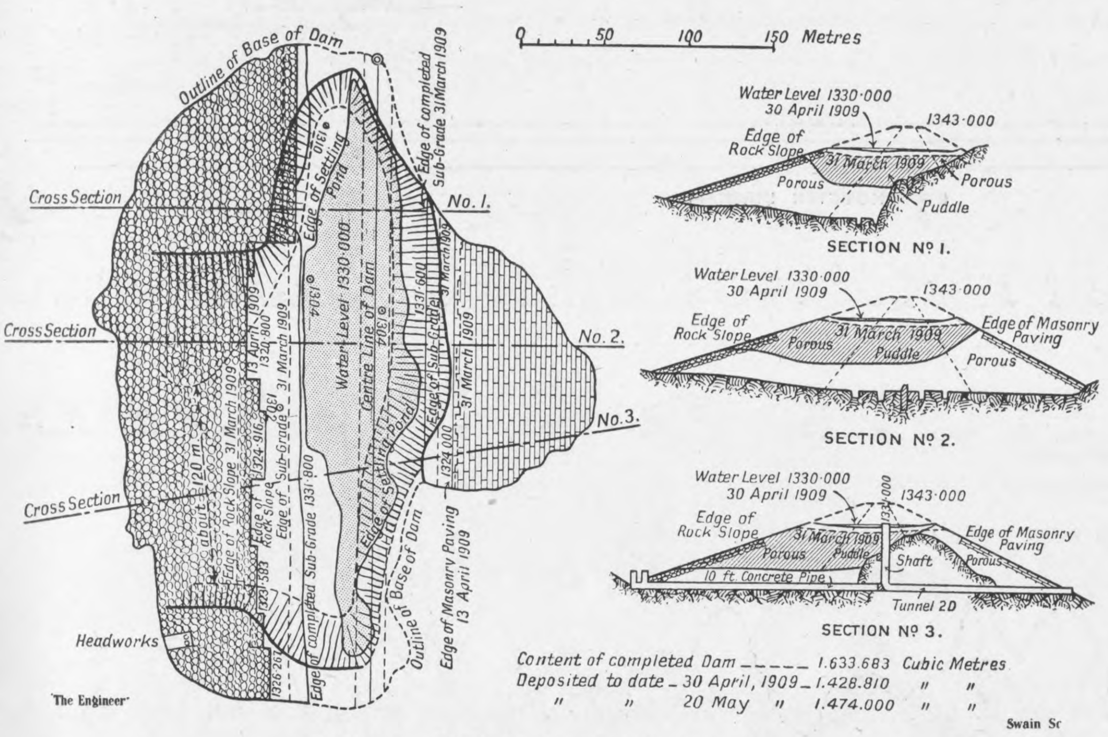


ACCIDENT TO NECAXA DAM NO. 2.

No. I.

We have already drawn attention to the accident which took place at Necaxa, in the State of Puébla, Mexico, towards the end of May last, when a break occurred in one of three large dams under construction, and a huge volume of material, amounting to some 555,000 cubic metres, was displaced and slid into the reservoir. A complete technical description of the Necaxa installation was given in The Engineer of November 8th and 29th, 1907, when it was pointed out that the Mexican Light and Power Company, to which the works belong, could claim to have the largest transmission from its generating station to its customers of any in the world. It will not therefore be necessary to refer to these again, and all that it is proposed to do in the present article is to describe the accident to dam No. 2, showing the various causes which contributed thereto, and the steps which are proposed for reconstruction and restoration.

When the accident occurred, the volume of material in the dam was 1,474,000 cubic metres, and the average elevation of its crest may be put at 1330 m. It was, it will be remembered, being constructed on the hydraulic principle, and the water level in the pond was at 1332, 11 m. below the top of the dam as planned. Side embankments about half a metre higher than the water level in the pond retained the water in the latter. This was from 1 m. to 2 m. deep, from 10 m. to 60 m. wide and 340 m. long, and covered a surface area of about 10,000 square metres. The construction was proceeding both rapidly and normally, the material pumped into the pond having raised its level 2 m. in the previous two weeks, and 9.3 m. in the preceding ten weeks. The level of the water in the reservoir was considerably lower than this, the depth not having exceeded 9.26 m. since October 1st, 1908. At the time of the accident the top level of the water in it stood at 1301.60, so that there was a total difference in level of 31.40 m., or over 100ft. between the pond and the reservoir. The dam lacked only 160,000 cubic yards of completion, and had not the break occurred it would have been finished this July.



PLAN AND SECTIONS OF NECAXA DAM, No. 2

The break happened in the early morning, at 6.5 a.m., when, fortunately, only a few Mexicans and but three Americans, who formed the sluicing crew, were present. The Mexican workmen, and one out of the three Americans, were carried out with the slide some 200 m. or more, before the material came to rest, two of the Mexican peons being drowned. When the material commenced to move, it first pushed out from the upper toe of the dam at about the level of the water in the reservoir, and directly in the line of a 10ft. conduit, which had been built as a temporary passage for flood waters. It was at first supposed that an earthquake had occurred, as the flume vibrated and immediately began to settle. All the material composing the middle or puddle third slid out, to fall with much of the semi-porous and porous parts from the slopes. The break through the up-stream slope, all the way down to about elevation 1303, extended to about 120 m. The lower toe stood all the way across at about elevation 1326, some 2 m. above the paved slope as it had been finished. After the slip the slope of the material from elevation 1326 on the reservoir side varied from almost vertical to about one to one. This was found to be true also with what remained of the shell of the up-stream toe. The whole of the puddled centre of the entire dam from end to end went through the 120 m. break of the upper toe.

Immediately after the break occurred a survey was made by the resident engineer, and the engraving shows the sections and the outlines of the top and bottom of the cavity formed by the slide of earth. The three sections show the depth of this cavity at various points. The complete outline in the drawing shows how the dam stood at the 30th April, about a month before the accident took place, while the shaded part of the section represents the portion which slid out. As already indicated, the volume of material which was displaced and slid into the reservoir was estimated at 555,000 cubic metres. Soundings were made at intervals through mud to hard bottom across the break in the up-stream toe and in the puddle core area. It was found that in the whole width of the break the movement has extended practically to the original hard bottom, averaging about 6 m. deep, and the material thus carried away has been replaced by soft clay, the volume of which was computed at about 34,000 cubic metres. The greater portion of this material will have to be removed in order to get a new toe embankment of rock down to the hard bottom, and the total loss may be fairly estimated at about 600,000 cubic metres, or about 40 per cent of the entire quantity that had been placed. Henceforth the greatest caution will have to be employed and in effecting the repair, and it is estimated that it will take at least six months to refill the dam and bring it up to elevation 1333. At this height it is proposed to suspend construction for a year, so as to give absolutely perfect settlement, or at least to proceed very slowly thenceforward.

Having seen what occurred, it may be interesting to trace its cause, more especially as the accident came as a complete surprise to all the experienced engineers who were connected and familiar with the construction, and who had seen it built up from the bottom with what appeared to be perfect solidity. Everyone who had witnessed the construction and then heard of the accident declare that they would have believed it impossible that such an event could have occurred, more especially as it is quite unprecedented in the building of such dams. Being without precedent, the lesson it conveys is perhaps all the more profound and impressive. The celebrated American consulting hydraulic engineer, Mr. James D. Schuyler, the designer of this dam, is a firm believer in this type of construction, and the accident has in no way shaken his faith. It was Mr. Schuyler who planned its dimensions and method of construction, and he had supervised it from time to time since it began. As far as the type is concerned and the system by which it is built, there seems to be no question in Mr. Schuyler's mind of its superiority over all other methods of construction where the materials available consist of solid rock in place of clay, or a mixture of broken stone and clay. For economy of handling, conveying, separating, depositing, and consolidating such materials no system, he declares, can compare with the hydraulic method, and it is generally admitted that the system was particularly well adapted to the situation at Necaxa. The design of the dam was such as to give two embankments of porous materials resting upon a central embankment of clay, having theoretical side slopes of one to one. The base width of embankments of materials composed of rock, or rock and sand, was about 350ft. on the upper stream side and 250ft. on the down side, while the central core has a base width of about 365ft. The theory upon which this design was based was that as the rock embankments advanced in height, and rested upon the clay, they would aid in forcing the water out of the clay by the superimposed weight, so that the portion of the clay underlying the overhanging part of the rock-fill at least would become particularly hard, while in the centre the water would be forced to rise as the weight of clay increased, and that section would also finally become hard a little later. It was always recognised that there was a considerable excess of thickness of clay in the centre core, but as the materials in the pits where broken stone and clay were mingled were found in about equal proportions, it was not regarded as detrimental to have a layer of clay of extraordinary thickness. It was not desirable to waste the excess clay, and so it was employed, but it was not foreseen that this particular clay was extraordinarily slow in drying or parting with its water when in a mass, remaining semi-liquid far longer than most other clays, such as those, for instance, resulting from decomposition of granite. The curious nature of the clay employed, totally unlike that used by the engineers in any other dams constructed by them, is held to be largely responsible for the lack of stability in the design adopted. It would have required longer time to put in rock in the place of any considerable portion of the clay core, and as the clay would have been wasted the cost would have been much greater. It was therefore with some regard to economy that so much clay was used in the construction of this dam; and that the engineers were justified by previous experience in using clay may be inferred from the following examples of clay used in other dams:—

The Lake Frances dam in California, built wholly by sluicing, was composed almost entirely of clay, and while it hardened quite slowly, it solidified by its own gravity and natural side-drainage, and became hard, solid, and stable. The water in the reservoir was usually kept within 10ft. or 15ft. of the top during construction. The rate at which the pond on the dam was raised was, however, less rapid than the rate of the past eight or nine months at Necaxa, and possibly the clay had rather longer time to settle.

At the Santo Amaro dam, in Brazil, the materials used in sluicing were disintegrated granite containing a reddish clay. This contained also a good deal of mica, which is usually a strong lubricant. The puddle core of this material became firm under water immediately after being deposited, and was really more stable and would stand up more firmly than the sand and gravel separated from it. A washout occurred, which demonstrated the remarkable stability of this clay. In a shallow section of the dam—which is a mile in length altogether—the side levees had been built up by hauling in sand with cars. This material could not be so well settled as the sluiced material, and a break in one side occurred, washing out about 50ft. of the levee, as well as its base down vertically to the original ground surface, the summit pond being quickly emptied the entire length of the dam. Although the water fell vertically over the clay a height of some 8 m., the freshly deposited puddle stood up, resisting erosion almost like stone. This was quite remarkable, as the oldest of the clay had not been deposited more than three months.

The fine surface soils of the plains of Idaho, U.S.A., which geologists say are wind-borne, resemble clay in appearance; but the dams built of this material drained out so quickly that a person could safely walk over the pond of the hydraulic fill a few hours after the water had been drained off the top.

It will be readily seen from the above examples that the respective engineers had abundant justification in employing the clay as a fill at Necaxa. It also seems that they took all the necessary precautions in finding out what the clay in the dam was doing. Soundings were made to ascertain its condition, and upon every occasion it was reported as becoming firm at a depth of below 45 m. from the top. As recently as January of this year a device was introduced for bringing up samples at any depth desired, while tests were frequently made over the puddle core to determine its nature. These samples showed a softer condition than was anticipated, and it was found to be possible to force the 1in. pipe down practically to the bottom with four men. Nevertheless the clay brought up was stiff, and contained very little more moisture than the ordinary clay soils in a bank of that material. To all appearances it seemed firm enough to resist transmission of hydrostatic pressure laterally for at least half its depth from the bottom up.

THE MANAGEMENT AND EQUIPMENT OF AN EXPERIMENTAL TANK.

No. III.*

Filing records.—Not the least important part of tank routine is the systematic filing of all the records in such a way that any required data can be readily obtained. It will be seen that a vast amount of information falls to be dealt with in the course of time, and a regular method must be formulated and adopted. All models, whether of ships or propellers, are numbered, and the particulars of each placed on record in a "history" book. A sample page from such a book is reproduced on page 104. The drawings from which the models are made are similarly numbered and stored in sequence, or by index. The record of weighing, measuring, and ballasting of each ship model is kept in what is called a "trim book." All experiments, of whatever kind, are numbered, and each one as it is taken is entered in a "day book" with all essential notes and particulars of test.

An example reproduced from an actual resistance diagram record is shown in Fig. 1. Results of resistance diagrams analysis are plotted upon section paper, the abscissæ being speed in feet per minute of the model, with a corresponding scale of knots for the ship. The ordinates are resistance in pounds for the model, with a scale of tons for the ship if thought necessary. On each of these sheets are plotted curves of surface friction of the model, and curves of surface friction corrections necessary to be made in passing from the model to a full-sized ship. These latter curves are calculated from the classical experiments made by the late Dr. Froude. It is found convenient to make nearly all ordinary ship models of a constant length, for by this means the correction curves can be systematised and plotted for passing from this constant length to varying lengths of ship, at various speeds, whereas if both lengths were variable the calculations would have to be made in each case *ab initio*. This saves a great deal of work, the correction being proportional to the wetted surfaces of the models. A sample sheet of Curves of Resistance, with surface friction, and surface friction correction, is given in Fig. 4, page 104.

The resistance sheets, when complete, are filed in boxes, where they hang in such a way that any one may be removed without disturbing the others. Each sheet has a numbered tag, and the boxes are all indexed to correspond.

Displacement, skin, and midship area of ship and model; prismatic, block, water line, and midship area coefficients are all calculated, and plotted on sheets in terms of moulded draught. These sheets are filed in indexed boxes also.

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* No. II. appeared July 23rd.

Propeller results are plotted in the way which has been described, on a base of revolution or slip ratio, as the case may be, and similarly filed. In this case the propeller history book forms a convenient index for the sheets, the propellers being arranged numerically, and also indexed in terms of diameter and pitch. An example exactly reproduced from an actual record is shown in Fig. 2.

The next step is to get the resistance into an easily handled form for estimating the power of proposed new vessels. It is convenient to calculate the E.H.P. from all models for ships of constant length, say, 100ft., and the final results may be kept in a constant form, as Dr. Froude did, or simply as E.H.P. for 100ft. ships. If the E.H.P. be divided by a function of the wetted surface, say, in such a form as $\frac{\text{E.H P.} \times 200}{\text{Wetted surface}}$, the curves approach a constant value for all draughts, and may be completely plotted in terms of speed in knots, for a ship 100ft. long. Here, again, the surface friction correction for passing from a constant length of 100ft. to other lengths may be easily systematised, and the correction plotted in the same terms as that adopted for the E.H.P., on a base of speeds for ships 100ft. long. It is then immediately applicable to the "rate" or "constant" curves. A specimen of a rate curve sheet as filed for reference is given in Fig. 3, page 104.

Sheets of these "rate" curves are plotted, having upon them a small scale drawing of the form which enables the estimator to recognise any outstanding feature of the design he is estimating from.

The sheets have numbered tags, and are filed in boxes. The index in this case may be made upon any desired basis, say, breadth, or block coefficient; but in any case, breadth, range of speeds and draught, and block coefficients should appear on the index for facility in selecting suitable forms.

After making the necessary surface friction and other corrections, the E.H.P. from the rate sheet is multiplied by (length of proposed ship $\div$ 100)$^{\frac{7}{2}}$. A table of figures raised to this power is prepared and kept, so that it is readily available for use.

When wave profiles of paddle steamers and transverse sections in the region of the paddle wheels are made, these are drawn to scale, filed, and indexed similarly to the plotted sheets of results.

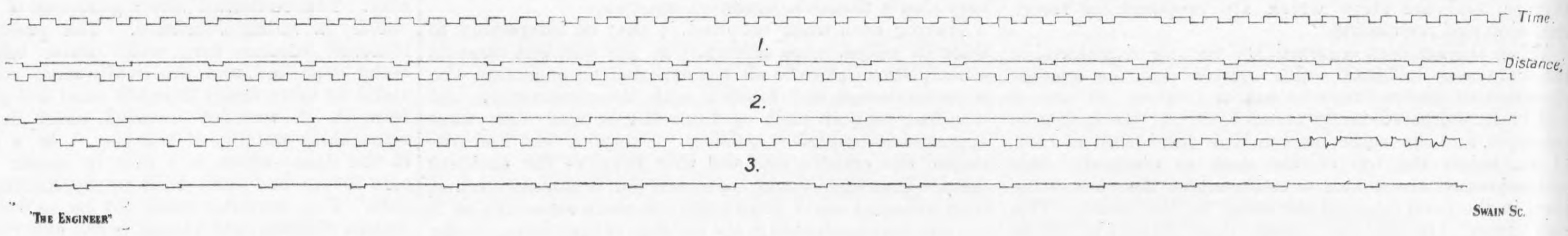
The final form in which the E.H.P. is plotted is as a basis of comparison with the indicated horse-power or shaft horse-power of the actual ships on their measured mile trials. These sheets are termed "efficiency" sheets, and are a complete analysis and comparison of all the data observed and recorded on the trial trip. These sheets are plotted on a base of speed. The E.H.P. with and without excrescences is calculated from the model trials, and these curves plotted first. Indicated horse-power and shaft horse-power spots are then plotted, and from the efficiency curves thus obtained, curves of indicated horse-power and shaft horse-power are passed through their respective spots. All the other usual engine-room information is plotted in the same way, keeping hold of the E.H.P. as a groundwork for building up the rest. The completion of these sheets forms a fitting conclusion to the previous work done during the design and building of the vessel.

Fixing of design and estimating power and speed.—This, the third of the broad groups into which the normal work of a tank may be conveniently divided, is not the least important, because it may be made sufficiently reliable to dispense with the need of actual experiment altogether in many cases. It is the natural fruit of accumulated data and a wide experience of the combined model and ship results under all kinds of conditions.

It is rarely that the problem is an entirely unfettered one. The exigencies of service for which the vessel is intended generally make some of its factors fixed and unalterable—such, perhaps, as draught of water at a harbour wharf, breadth of a dock entrance, maximum length available for canting in a basin, and so on. These fix draught, beam, or length respectively. The problem is then stated in terms of the other variables in order to discover the most suitable combination to attain the highest efficiency of service. Then, again, much depends on what is actually the factor upon which most stress is to be laid. If a vessel for purely high-speed passenger service be under consideration, then endeavour is usually made to attain the highest possible speed with a given expenditure of power. If, however, on the contrary, the problem be that of a slow, or moderate, speed cargo-carrying steamer, then it often happens that speed is of small consequence relatively in comparison with increase of deadweight carrying capacity. The form of the estimate depends upon these things, but the goal aimed at is in every case the same—viz., what is the best form of vessel for the desired conditions?

Now we may consider "form" from two points of view:—(1) The actual mathematical proportions which subsist between the coefficients. These are the relation between block coefficient and prismatic coefficient, and its consequent bearing on midship area coefficient, and the relation between prismatic coefficient and water-line coefficient, which involves the vertical distribution of the displacement and the shape of the cross sections.

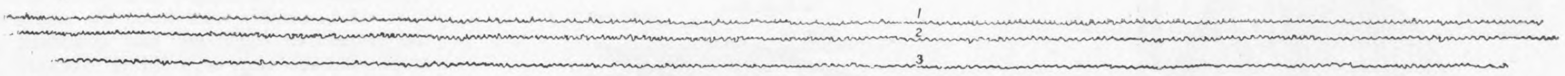
The other aspect of form, namely, the actual contour of the midship section and of the water lines, is not by any means so important, and yet there are conditions where it assumes value which must be seriously reckoned with. We have not yet forgotten the controversy which raged round the question of comparative values of hollow or straight water lines for the 24-knot cruisers. In all these considerations, which are mutually interdependent,



Scale of Spring 13' 498' to 1·5 lbs

	Speed in feet per min.	Resistance in lbs.
1	387·64	3·956
2	374·57	3·645
3	350·03	3·072

Swain Sc.



STROPHOMETER DIAGRAM

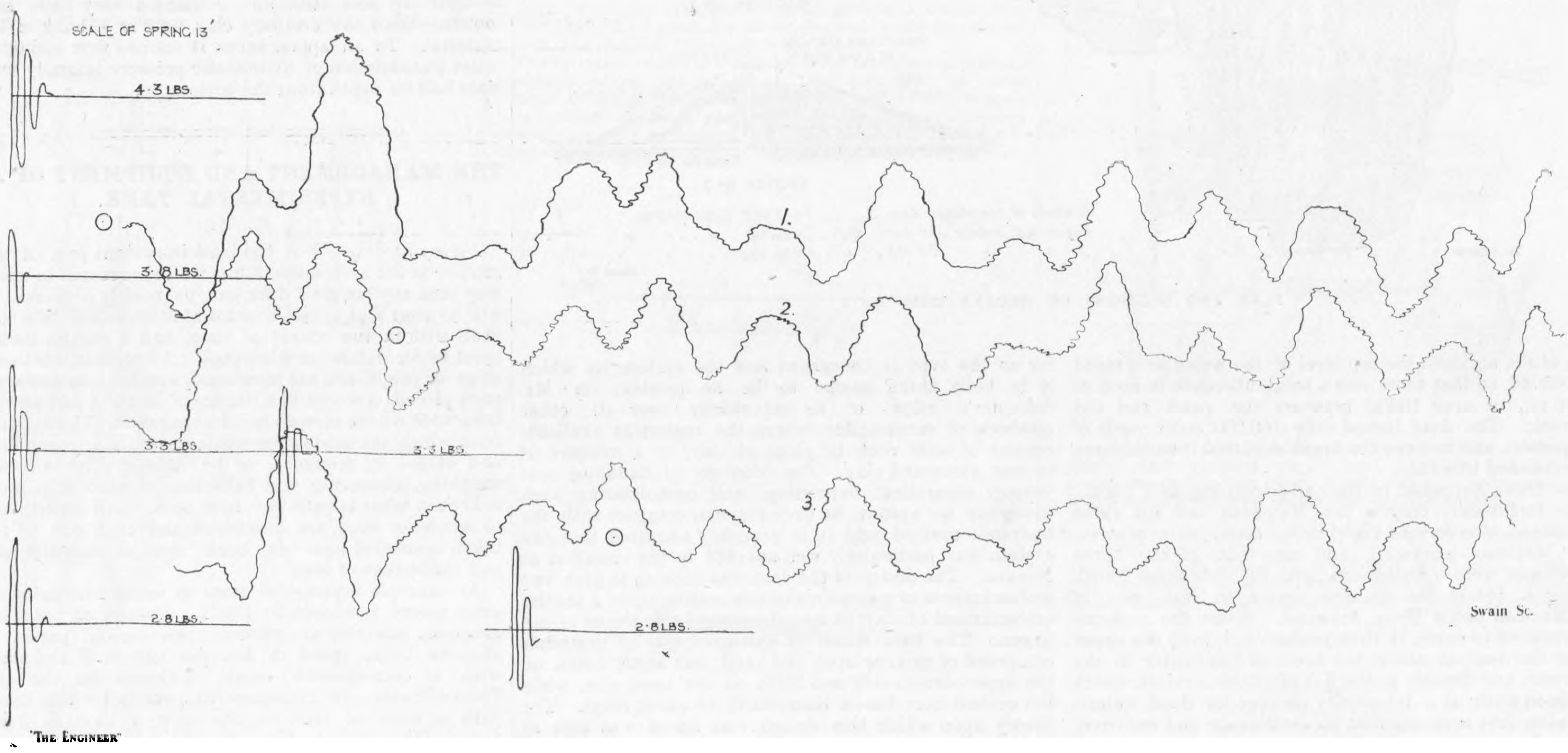
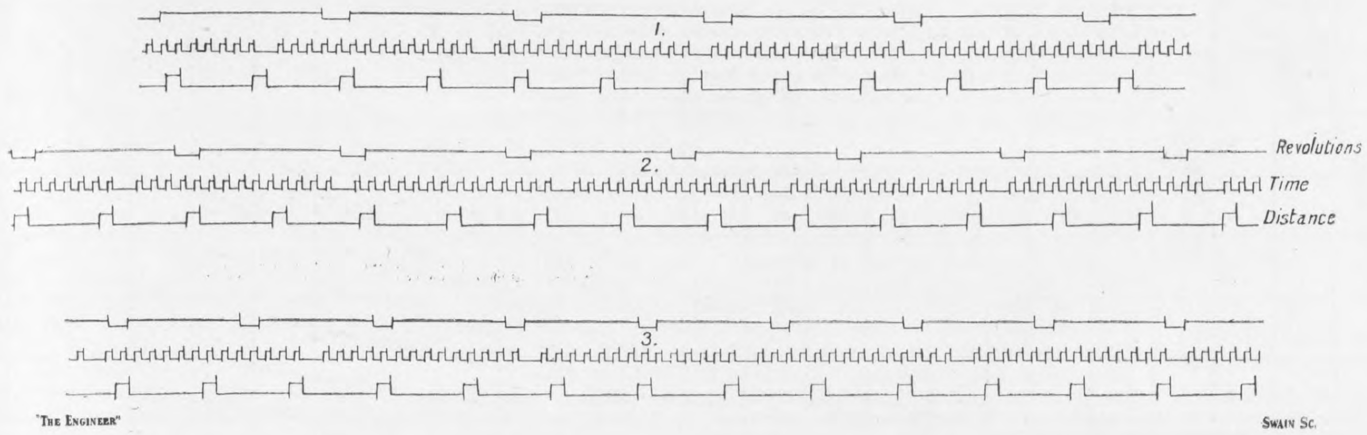


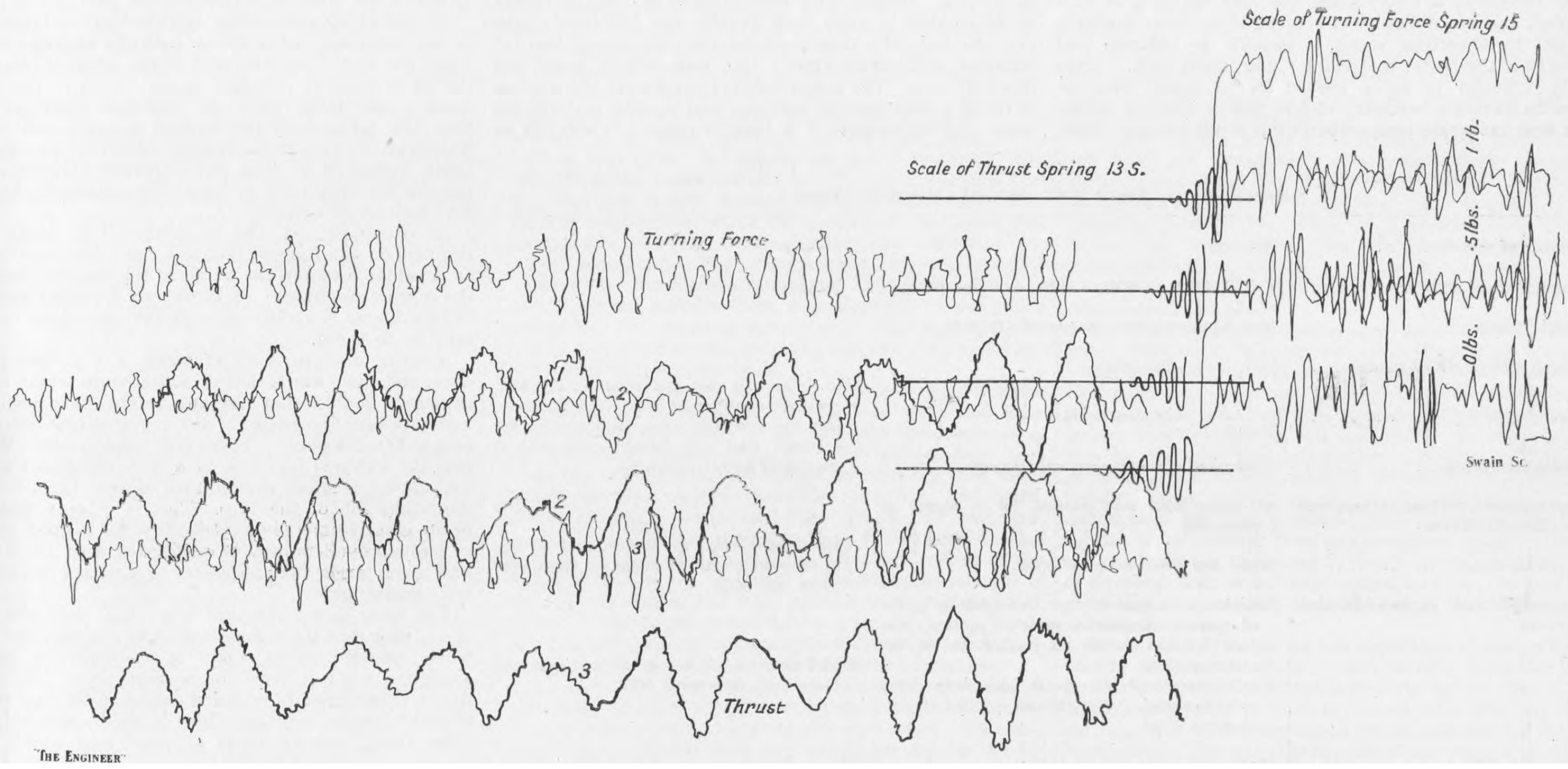
Fig. 1—SPECIMEN OF RESISTANCE DIAGRAM TAKEN ON DYNAMOMETER CARRIAGE

a clear line of argument must be maintained so that confusion of different variables is not allowed to creep in.

The first thing to be done then is to set down the fixed and unalterable factors. To take a simple case of a moderate speed steamer to carry cargo and some passengers:—Suppose length, breadth, and draught are fixed, and a trial speed desired has been also fixed, the problem then is purely to settle what is the best form to carry the maximum displacement. The variables are block and prismatic coefficient, and form of line, to satisfy accommodation requirements, give good stability, and good deep sea efficiency. The dimensions are reduced to a standard of 100ft. length. E.H.P. for many possible forms is calculated from the rate or constant curves above mentioned, and these are all plotted on a basis of block coefficients. A curve of displacement for the various degrees of fullness is plotted on the same base. An inspection of the plotted spots of E.H.P. shows at once the kind of form most suitable for the speed, and a curve of E.H.P. can be put in through those selected as apparently suitable. From this information a curve of weights may be deduced, and plotted on the same base of block coefficients. Obviously the intersection of the curve of weights, and the curve of displacement, determines the maximum fullness which may be used, and the E.H.P. may be read from its curve. Having got this, and made sure that the kind of form selected is suitable from all considerations of service, recourse is had to the efficiency sheets of similar vessels as nearly as may be attained from the records of the trial trips of actual vessels. The relations of E.H.P. to indicated horse-power are carefully considered, and here experience is largely laid under toll, to settle what is a correct probable proportion to assume. This done, the probable indicated horse-power on trial is known.



"The Engineer" Swain Sc.



"The Engineer" Swain Sc.

Fig. 2—SPECIMEN OF DIAGRAMS AS ACTUALLY TAKEN ON PROPELLER CARRIAGE

This last factor is necessarily dependent in a large measure on propeller design. It may be found that on the draught available it will not be possible to carry propellers of adequate size to get maximum efficiency, and we enter on the consideration of one, two, or three propellers, if that is not already fixed by the conditions laid down in the problem. Usually the specification supplied by prospective owners has settled this beforehand. In such a case it is necessary to modify the relation of E.H.P. to indicated horse-power, which is to be assumed accordingly.

The problem may now assume varying degrees of complexity, such as, what will be the value of increasing length? What will be the increase of speed if a certain percentage be added to or taken from the power? What will be the effect of increasing breadth or draught on the same, or a proportionately increased displacement? &c. &c.

Each of these must be stated as a problem by itself.

Suppose, for example, we take the first, what will be the effect of increasing length, keeping power constant? We must make separate calculations for lengths which shall include the proposed alteration and plot the results similarly to the other on a basis of block coefficient. From these curves a cross curve may be constructed and plotted in terms of the new variable, *i.e.*, length, which will give the desired information, and so on for the others.

It is at this point that tank data often save a considerable amount of labour, for if the proposed modifications are moderate in amount, empirical formulæ may be applied with a sufficient degree of accuracy for estimating purposes.

The operations sketched out are of constant occurrence in a tank attached to a shipbuilding establishment. Copies of all estimates sent out are kept and docketed for future reference. The information given is sufficiently accurate in most cases for a tender to be made, and as soon as the variable factors have been tentatively settled upon a model is put in hand and run through in the least possible time. Usually three days serve to confirm the estimate of E.H.P., and a few more, if circumstances demand it, suffice to make and test propellers.

The analytical method of dealing with marine engineering problems, as sketched out, is of great value in differentiating the various factors which go to make up the case under investigation and in putting quantitative values upon them. It also enables an intelligent synthetical treatment of new proposals to be made, and prevents the adoption of schemes which are based on fundamental error. Needless to say, all kinds of inventions and ideas, wise and otherwise, are likely to be submitted for opinion or trial from time to time. It is often possible to point out at once where misconception, or actual want of knowledge, either of fact or of correct proportion, has led to false conclusions, though not always easy to convince the promoter of the inaccuracy.

General maintenance of plant.—There is a daily routine to be followed which, while not absorbing a great amount of time, has to be regularly done in order to maintain the plant in an efficient working condition. The workmen's hours usually begin earlier than those of the staff, and the necessary work can be finished before the experiments for the day are begun.

Each department attends to a particular portion. The mechanics see that the carriages are in good working order, pen batteries charged, propeller frame put into position on the water after having been lifted out, dried, and oiled at the conclusion of the previous day's experimenting, rails cleaned with naphtha or oil, and the mechanical apparatus generally ready for work.

An electrician from the yard staff connects the motor generator with the yard circuit, and charges the main driving batteries, having them at full voltage in time for the operator to start. Every alternate day the ship model under test must be scrubbed or sponged, as the case may demand, to remove a slime which gradually gathers on the surface of the model, and adds considerably to its resistance. The water surface has to be skimmed at intervals to remove floating dirt. This is done by the joiners' labourers. A siphon is fitted at one end of the tank, with a vertical pipe having at the top an open funnel, with a removable plug in its throat. The rim of this funnel is at about the intended normal level of the water surface. When the tank is skimmed, water is run in until the surface is just above the funnel rim. A skimmer is then drawn from the end of the tank furthest from the siphon, towards the funnel outlet, down which all the scum passes to the sewer.

The youngest member of the office staff is responsible for the periodic timing and rating of the clocks and stop watches. The watches are rated once a day, and the clocks on the carriages three times. The level of the water is observed and recorded three times a day, note being taken each time water is either run in or out at the siphon. An abnormal leakage is at once detected, and the cause ascertained.

Storing and classification of models.—Where paraffin is the material adopted for manufacture of ship models, no great accumulation is allowed, those which are tested being broken up and returned to the paraffin store. The exigencies of work generally prevent a straightforward disposal of this kind however, and models lie awaiting completion for a considerable time. In this case they are filled with water and float at the surface of the tank, where they are moored out of the way. They retain their shape under these conditions remarkably well, and can be lifted, scrubbed, polished, or fine scraped if necessary, when occasion allows of completing their tests. After a considerable lapse of time the surface under the slime becomes pitted and the model is apt to become distorted. It is better then to re-cast and re-cut the model, a simple thing to do when drawings and moulding sections are already prepared.

Some operators have preferred to use wood as the normal material of the models. Wood models, when carefully made, are quite suitable for the purpose of experiment, but the time necessary to make them, the cost, which is at least trebled, and the difficulty of keeping them from changing weight by absorbing water, is enough to indicate that paraffin is the better material for a shipyard tank. Some little difficulty is to be looked for in warm weather, paraffin having a tendency to flow and so alter its shape, but with moderate temperatures this is not serious. When wooden models are adopted, provision must be made for storing and classifying the accumulated stock.

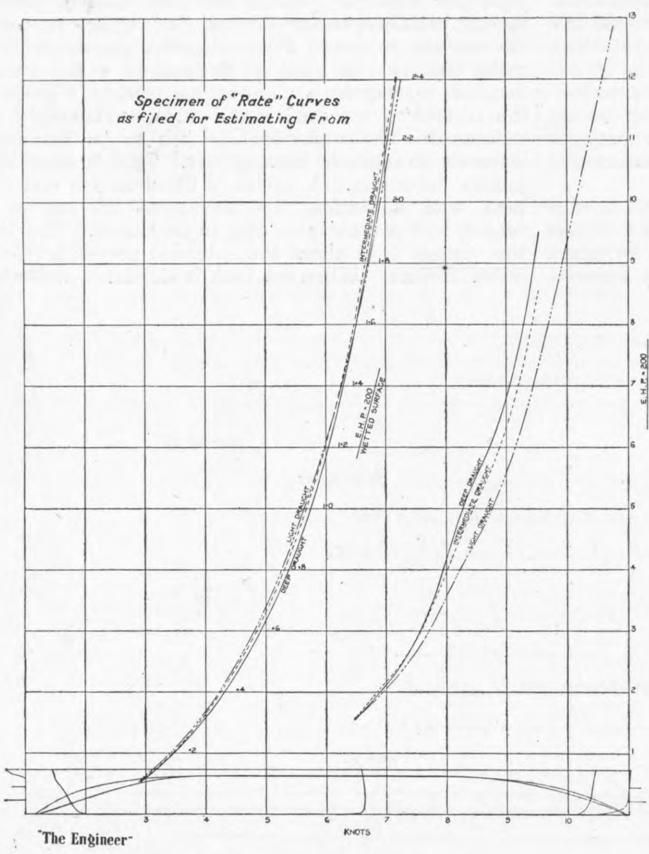


Fig. 3—SPECIMEN OF RATE CURVES

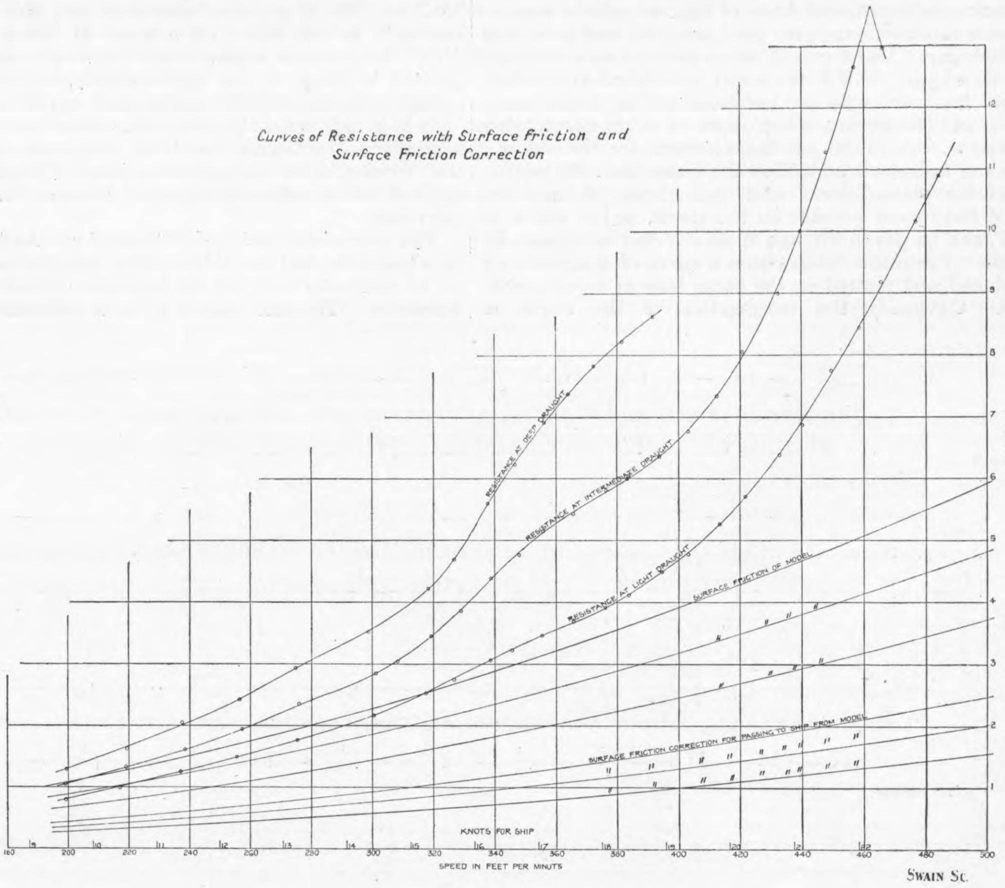


Fig. 4—CURVES OF RESISTANCE AND SURFACE FRICTION CORRECTION

SAMPLE PAGE FROM THE MODEL HISTORY BOOK.

		NOTES.
Number of model	*No.* 500	
Dimensions of ship	*T.S.S.* 440*ft.* × 60*ft.* × 22*ft. moulded draught*	
Model drawing	*New model drawing prepared* 10/12/07	
Length and depth of model ...	12*ft. long,* 15*in. deep*	
Scale of model	$\frac{1}{36.666}$ *of ship dimensions*	*The form was deduced from model* 485, *prismatic coefficient being kept the same, but the midship area coefficient is increased, and the block coefficient is increased correspondingly.*
Needle trimming	*Confirmed displacement calculation*	
Displacement, wetted surface and coefficient curves	*All calculated and plotted for a range of draughts*	
Duplicate ditto	*Made and filed in record-office*	*Shaft bosses fitted at* 30 *deg. and* 40 *deg. to the horizontal, these models numbered* 500A *and* 500B.
Resistance and surface friction curves	*Resistances taken at four draughts in terms of speed. Resistance spots all plotted, surface friction curves all plotted on the resistance sheet.* *Shaft bosses and bilge keels have been fitted to the model. Resistances plotted on resistance sheet*	*Model with shaft bosses at* 40 *deg., and bilge keels numbered* 500C.
Duplicate ditto	*Made and filed in record-office*	*Model* 500D *was a recut of model* 500 *to the actual lines as lifted from the moulding loft floor, being as the ship was built.*
Wave sections and profile	*None done for this model*	
Duplicate ditto	*None*	*A new model drawing was made.*
Rate curves	*All calculated, plotted, and filed*	
Duplicate ditto	*Made and filed in record-office*	*E.H.P. for the efficiency sheet was made at the trial draught from model* 500D.
Duplicates for sending out	*Made and forwarded*	
Efficiency sheets	*Trial results all worked up, and comparison sheet plotted and filed*	*Rolling extinction diagrams were taken with models* 500 *and* 500C.
Duplicate ditto	*All made and forwarded*	
Propeller experiments	*Tests made with two new sets of model propellers made specially, and three sets from stock, Nos.* 250, 251, 86, 192, 210 *respectively. The results all plotted and filed*	*Model broken up* 5/3/08.

With the propeller models the case is different. These are small and permanent, so each propeller or set of propellers as it is made goes into stock. They are all typed with their registered number, and, as has been mentioned, the propeller history book is so indexed that propellers of suitable diameter and pitch may at any time be selected.

Direction of probable improvements.—No one who has studied the work of the late Dr. Froude can fail to be struck with the marvellous insight exhibited in dealing with an entirely new problem, as the experimental tank was when he instituted it. His mechanical methods of dealing with the problem as he found it were entirely admirable. Indeed, were one disposed to criticise recent developments in some tank plants, the criticism might take the form of a statement that the innovations had not followed sufficiently closely the lines which were laid down by him. The much debated question of the wisdom of using a wide span of carriage and thereby introducing large moving weights is a case in point. It will not be surprising to find a reversion to some modifications of Dr. Froude's original narrow carriage in future tanks, and it is curious to note that the old battle of wide and narrow gauge, which Froude's friend Brunel fought unsuccessfully on the railway, is by way of repeating itself on a small scale here, with, we think, the odds in favour of narrow gauge.

An entirely different system of tank work has been proposed and put into material shape by Herr Wellenkamp, at Kiel. The arrangements are ingenious and well worked out. Here, again, Herr Wellenkamp is traversing ground already covered by Dr. Froude at the inception of his idea, and rejected by him as being unreliable, which it certainly is, and by no means so simple to construct as the form in which Froude cast his apparatus.

On the whole, substantial improvements in future tanks, as has been suggested above, seem to be more probable along the line of enlargement of the original plan to suit the more onerous demands made on it. Innovations become inevitable when the demands made are greater than the capacity of the original scheme, and must be welcomed, by whomsover made. Minor details are always being improved as time and experience dictate, but in essence the tank plan, as originally conceived, holds the field against all comers.

In conclusion, it will be conceded by most serious thinkers on the subject, that the tank has justified itself as a valuable tool in the hands of the naval architect and the marine engineer. It is not so apparent that shipowners are as generally alive to the enormous benefit it may be to them.

A saving of 30 per cent. of power is a common experience, and cases are extant of actual ships where a saving of nearly double this amount might have been made had adequate knowledge of the requirements been available to the designer. There is no need to labour the point that the lessened first cost is a trifle compared with the cost of the needless expenditure of coal involved during the whole life of the ship. This is a point which may never clearly emerge on a trial trip, for a good efficiency of screw propellers may be associated with an E.H.P. of hull much larger than necessary to carry the displacement and deadweight.

The tank as a "shipyard tool" has been the burden of the song, but there are sometimes intermittent periods when research work may be indulged in from an academic point of view for a short time. From these much invaluable information can be built up, and empirical formulæ evolved which enable estimating to be done from varying types of ship with much greater accuracy than is ordinarily possible.

The wonder is that more large shipbuilding concerns have not equipped themselves with the plant. Probably the increased, and, as one cannot help thinking, unnecessarily increased, expenditure indulged in by some recent tank designers has a great deal to do with this. Of its usefulness there can be little doubt; of its value to those who have scope and insight to use it to its full capacity there will be less doubt in the minds of those most competent to judge.

SELL'S DICTIONARY OF THE WORLD'S PRESS —The 1909 edition of this useful dictionary contains nearly thirty thousand entries and separate newspaper announcements. There are also interesting articles pertaining to the Imperial Press Conference, flight, anecdotal history of journalism, newspaper happenings, &c. A special feature of the present edition is a novel map of the world which has some noteworthy advantages. An article on page 587 of the book fully describes the map and its special features. Among other things of note, mention should be made of the continuation of the World's Press Survey. It represents more particularly the Anglo-Saxon world which lies beyond the British Isles, and deals with the developments and maintenance of all newspapers printed in our language. It is interesting to note that out of the thirty thousand newspaper entries mentioned above, the number of papers published in the British Isles is approximately 2712, London being responsible for 695 of these. In addition there are some 1400 magazines and miscellaneous publications. The publishers state that all the lists of newspapers and other publications have been carefully checked and brought up to date.

INSTITUTION OF MECHANICAL ENGINEERS.

The summer meeting of this Institution opened on Tuesday last, at the Central Technical School, Byron-street, Liverpool, under the presidency of Mr. J. A. F. Aspinall. There was a very large attendance, the number of members and associate members present at the meeting being the largest for some years past, if indeed it does not constitute a record for the summer meetings of the Institution. This is no doubt partly due to the convenience of Liverpool as a place of meeting, the city being within easy reach of the great centres of mechanical industry. Mr. Aspinall was supported at the opening ceremony by four past-presidents of the Institution in Mr. Edward P. Martin, Mr. William H. Maw, Mr. T. Hurry Riches, and Mr. Hartley Wicksteed, and the vice-presidents were represented by Mr. E. B. Ellington, Mr. H. Graham Harris, and Mr. A. T. Tannett-Walker. The members of Council attending the meeting are Messrs. W. H. Allen, Michael Longridge, Thomas P. Reay, John F. Robinson, Mark H. Robinson, and Mr. Wilson Worsdell. The programme of papers and the comprehensive list of visits arranged has already been published in The Engineer, and it is sufficient to say here that the papers deal with an admirable variety of subjects, including locomotive engineering, marine engineering, reinforced concrete, gas engine problems, and the electrical operation of textile factories.

The proceedings opened with a formal welcome to the Institution on behalf of the city by the Lord Mayor of Liverpool (Councillor H. Chaloner Dowdall, M.A.), who said that were it not for the pleasure it gave him to do so, it would be quite unnecessary to formulate any welcome of the Institution to Liverpool. The city owed so much to the mechanical engineer, that the Institution was inevitably welcome, particularly in view of the President's long and honourable association with Liverpool. Other towns might have much of interest to show, but nowhere would the Institution meet with a more hearty welcome than in Liverpool.

The President briefly thanked the Lord Mayor for his words of welcome, and bore testimony to the part played by various public bodies in Liverpool to make the meeting a success.

The minutes of the last meeting having been confirmed, the reading and discussion of papers was then proceeded with.

The first paper taken was that by Mr. George Hughes dealing with "Locomotives Designed and Built at Horwich, with some Results." We commence reprinting this paper on page 119. A vote of thanks to the author having been passed on the motion of the President, the discussion, which was participated in by many members, and occupied practically the whole of the session on Tuesday, was opened by Mr. Joseph Adamson.

Mr. Adamson said that his interest was in the boiler with the corrugated flue. It would appear that some trouble had been experienced with bulging or collapsing between the bridge and the fire-box, an experience which was not uncommon in marine engineering. The remedy, as far as collapsing and corrosion were concerned, was to take care to get rapid circulation around that part of the boiler. In all types of boilers in which water was allowed to become stagnant, if pains were taken to make the water circulate a much better result would be obtained both in evaporative duty and in general economy of working. Experiments had been carried out at his own works, of which more he hoped would be heard in the future.

Mr. George Cawley said he had been experimenting for some years past with regard to the circulation in locomotive boilers. The experiments were carried out on models, and the results arrived at went to confirm the contention of Mr. Adamson that all boilers would give an improved service if the circulation received more attention. In his experiments it was found possible to get in full operation a circulation of $\frac{1}{2}$ ton of water per minute round the fire-box sides automatically. This suggested what could be done with great advantage to the economy of the boiler and the life of fire-boxes generally. In his experiments there was a special arrangement of the pipes from the smoke-box end of the boiler to the space round the fire-box. He had also made experiments on Lancashire and vertical boilers with satisfactory results in the way of efficient circulation. At the same time the question of water circulation was still open to further consideration.

Mr. T. P. Reay, speaking as a builder and not as a user, said that want of circulation was at the bottom of the boiler difficulty. He would call attention to the fact that the Broton boiler had been introduced into Austria with apparently satisfactory results, and they were giving the boiler a trial in Messrs. Kitson's works. Referring to what the author said on four-cylinder engines, it was clear that they must give better results than any two-cylinder arrangement which could be devised. He would like to know if Mr. Hughes had tried any blast pipe top with an annulus, as they had done so with marked success in some cases. Mr. Hughes appeared to give a fair mileage for his cylinders, the life extending from eight to fourteen years, but he would like to ask if they were not on the soft side.

Mr. T. Hurry Riches said the author had produced a very complete and useful paper which ought to meet with the appreciation of the younger members of the Institution. The paper detailed a large amount of practical experience which it was impossible for the majority of the members to acquire. The information given in the paper was of vital importance to the mechanical engineer. With regard to the corrosion of boilers, he agreed with those who had preceded him in the discussion; but there was one subject which did not appear to have been mentioned, and that was the necessity of taking as far as possible all the impurities out of the water before it went into the boiler. Another important point related to the necessity of having large spaces between the internal and external fire-box, and it was also essential that the tubes should be kept spaced as far apart as possible. He had tried the experiment of using the same number of tubes but of smaller diameter, and spacing them $\frac{1}{4}$in. further apart, and by that device they had overcome a great many of the difficulties to which they had formerly been subjected on the Taff Vale. The trouble in respect to priming disappeared, and corrosion was enormously decreased. He was afraid that locomotive engineers, owing to the pressure of circumstances, often allowed boilers to get into a very dirty state, and he would emphasise the importance of giving the boiler proper rest and cleansing. The blast pipe was a far more important adjunct than most people imagined. The important point was to allow the gases from the smoke-box to escape freely, and he had been very much struck by the difference occasioned by a slight variation in the area of the blast pipe compared with the chimney. The need of ascertaining the correct positions and proportions of blast pipe and chimney was dealt with in the paper, and it was not necessary to go into further detail as to the factors governing that matter. Mr. Hughes had given a good deal of information as to built-up cranks, and much useful knowledge on that subject could be gained from the experience of the marine engineer. In marine work it was the fashion to build up all large cranks, and sound information could be gained from marine experience which would enable the locomotive engineer to do better. The built-up crank lent itself very readily to the balancing of the engine. He hoped that the papers which Mr. Hughes was to read at a later date would lead to a full discussion of the important points involved.

Mr. Henry Fowler said the paper was important partly because the author had done what few people did, and that was, give the Institution the experience of his failures as well as his successes. Mr. Hughes referred to the solid cranks formerly in service having a tensile breaking load of 28 to 32 tons, and he would like to ask if something harder than this had been tried for the journal portion of built-up cranks? They had had no trouble with regard to oval wear on the Midland Railway. He would like to refer to the question of heat treatment in relation to locomotive cranks, and perhaps Mr. Hughes would say if he gave the material of which the cranks were built up any special heat treatment. With straight axles there was always some difficulty in ascertaining the character of the flaw. The flaw tended to creep round the whole circumference of the axle when a flaw occurred, and he would be glad to know what had been the Lancashire and Yorkshire Company's experience. The life of tires was to a large extent bound up with the wear of the flange, and Mr. Hughes had not mentioned if he had experimented with tires of higher tensile strength than that mentioned in the paper, 46 tons with 20 per cent. elongation in 3in. Steel with a tensile strength of 65 tons to the square inch, with an elongation of 8 per cent. in 2in., had been tried by some locomotive engineers. The shrinkage mentioned in the paper, 1 in 750, seemed to be high, the more usual figure being 1 in 1100 or 1 in 1200. An interesting point not dealt with was where the water was put into the boiler, because that was where the largest amount of pitting would take place. He was surprised to see in the diagram in the paper that pitting and grooving occurred round the bottom of the copper tube plate. The information given with regard to priming was of considerable interest. Mr. Hughes showed that when the soluble salts exceeded 230 to 250 grains per gallon bad priming took place. The experience of locomotive superintendents using Belpaire fire-boxes was of interest in this connection.

Mr. E. R. Dolby, referring to the corrosion troubles mentioned in the paper, asked if the feed-water had been artificially softened, and if so, what was the hardness of the artificially softened water. He had recently been installing some stationary boilers, and dealing with water which had an original hardness of 18.5, had artificially softened it down to 3 deg. There had been considerable trouble with corrosion, and it had been decided to make the minimum 4 deg. An examination of the inside of the boiler revealed a considerable amount of rust, and the inside had been painted with graphite paint, which, it was hoped, would prove a remedy. He would like to elicit opinions as to the lowest limit to which feed-water should be artificially softened with advantage.

Mr. J. F. L. Crosland said that reference was made by the author to trials which were being carried out with the Ross-Hotchkiss scum collector and circulator. He could speak of experience with the apparatus as far as the removal of deposit was concerned, and he knew it had some merit as a circulator. He was intensely interested in the trials being carried out on the Lancashire and Yorkshire Railway, and he hoped the results would be communicated at a later date. Mr. Hughes apparently softened his feed-water, the effects upon lead being referred to in the paper, and he also dealt to some extent with the cycle of chemical reactions in connection with pitting. It had always been difficult to understand how it was that plates pitted in parts.

Mr. J. D. Twinberrow discussed the question of water spaced stays. He noted that by increasing the water space Mr. Hughes appeared to have got over the difficulty of stay breakage with the Belpaire fire-box. He knew something of the experience of a foreign railway company in connection with stay breakage. In July, 1907, that company put into service two Pacific type engines, having 48 square feet of grate area and 2800 square feet of heating surface. These engines were supplemented by 68 additional engines of the same type in 1908, and down to the beginning of the present year, when the original engines had a mileage to their credit of 70,000, and the later engines a proportionate mileage, there had been no single case of stay breakage. Objection might be taken to the Belpaire type of fire-box on account of its greater weight and cost and the obstruction which it offered to the look-out from the engine cab. It also suffered from the disadvantage that where the flat plates of the outer shell and the sides merged into the cylindrical shape of the barrel there was necessarily an appreciable amount of flat area which had no counterpart in the shape of the inner box, and consequently the stays at this part exercised a resultant pull upon the flanges of the tube plate. The circular shape was naturally in equilibrium under the internal pressure, which produced a circumferential tension in the plates, and when the load on the box roof was transferred thereto by means of direct stays a load of about 300 tons was imposed over a length of about 8ft. of plates, of about $\frac{5}{8}$in. thickness. This counterbalanced the vertical components of the radial pressures, but the horizontal components had to arrive at equilibrium by exercising bending moments of considerable intensity upon the individual stays. Fig. 1 illustrated a style of construction common in the United States which had given rise to a large amount of stay breakage in modern boilers of large size. Fig. 2 was a half cross section, showing somewhat similar construction, in which the shoulders were entirely unsupported, and therefore exerted their full normal tension in the tangential direction at the landings of the outer rows of roof stays, and the upper rows of water spaced stays; the obvious cure lay in adopting the form of construction used on the Harriman lines in America, or that adopted by the Prussian State and other railways on the Continent, which employed the round top fire-box instead of the Belpaire form.

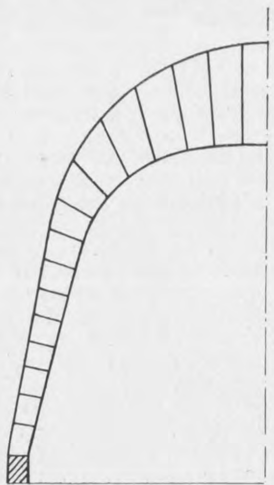


Fig. 1.
Half Cross Sec.
Wide Firebox with
Radial Stays.

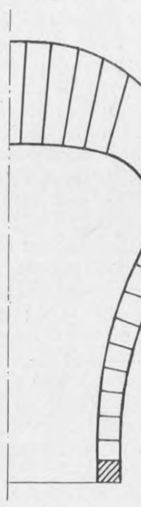


Fig. 2.
Half Cross Sec.
Narrow Firebox with
Direct Stays

On the subject of rapid acceleration, he would point out that the compound accelerated much better at higher speeds than the simple engine. This was borne out by the speed of 96 miles per hour recorded on the Bavarian State Railway, and by a performance on the Baden line of a thirty mile run, start to stop, on a rising gradient averaging 1 in 600, at a speed equal to 75 miles per hour, a performance never equalled by any non-compound engine.

Mr. Graham Harris referred to the statement in the paper that cracks in crank axles developed from a corner, which bore out the contention made by Sir Frederick Bramwell many years ago, that if you had a sharp corner where rapid and varying stresses were experienced failure would commence at that point. In that connection he thought that locomotive engineers might learn something from the automobile industry. In automobile building eight cylinders and eight cranks were not uncommon, and the greatest possible precautions were taken in smoothing over any change of shape. Motor-car engines were subjected to much more rapid changes of direction than a railway engine, and the service was generally more severe than that of a locomotive on a railway track.

Mr. J. W. Smith said he had experience of the problems arising in road locomotion, and having used the locomotive boiler with corrugated fire-box, would like to ask Mr. Hughes whether such fire-boxes with two or three corrugations on the top would not be suitable for the rail locomotive. He was able to quote many years' experience to the effect that there had never been a failure. Tested under hydraulic pressure of 300 lb. to the square inch, the defection measured on the inside of the box was about $\frac{1}{8}$in., and the plate always returned to within a few thousandths of its original form. With regard to cranks, it would be of great assistance if a rule could be formulated of the size of radius to diameter.

Mr. Michael Longridge said it was noteworthy that with the higher steam pressures of recent years feed-water, which formerly produced no corrosion, now had a corrosive action. It was possible, under modern high pressures and temperatures, that there was an interchange between the salt and the carbonate which resulted in the formation of chloride of magnesia, the most corrosive thing which could possibly be put into any boiler. The matter was worth experiment, but there were great difficulties, which hampered research. The blast pipe, although very useful, was a most wasteful contrivance, and he believed that by subdivision much better results could be obtained. He had recently come across a very disquieting fact in relation to forged crank shafts in making tests of a broken shaft. Three pieces had been cut from the crank web parallel to the arm of the crank and three pieces parallel to the axis of the crank pin. These were subjected to tensile and impact tests in the Izod machine, and to fatigue tests in Captain Sankey's machine. The pieces cut parallel to the crank arm broke with a fourth or less of the number of foot-pounds which were required for the pieces cut parallel to the crank pin.

Mr. C. E. Stromeyer said that engineers were more and more coming to the conclusion that boilers might be harmed by using water which had been over-softened, or had been subjected to a particular form of softening. If hard water were taken and soda put in to remove the lime and to get rid of the scale, electrolytic action was set up. Pitting was always due to some extent to galvanic action. What the engineer wanted was a method of getting rid of the scale-forming salts without introducing other salts. It would appear that aluminate of barium was produced sometimes with very unsatisfactory results.

Mr. Aspinall, in winding up the discussion, said he was pleased to notice that the boiler had been the main point discussed, as that was the only thing which caused the locomotive engineer any real trouble. On the tire question members would be interested to hear that over twenty years ago the Lancashire and Yorkshire Company had decided to use rails with the flattest possible top, and to make the curvature at the side of the rail head exactly the same as the tires. When those rails were taken up after ten or twelve years' service, sections were cut and found to exactly fit tires then coming out of the shops. Mr. Aspinall gave the details of an engine built at Wolverton in 1849, to show that even as long since as that date what would now be considered a heavy locomotive had been built.

Mr. Hughes, in replying on the discussion, said that the Joy valve gear was the standard on the Lancashire and Yorkshire, although they had recently built a few engines fitted with Walschaert gear. With regard to the blast pipe problem, they had carried a division up to the orifice of the pipe in the case of four-cylinder engines, but it was found that the plain blast pipe gave the best results. Their experience of water softening was that where good corporation water could be obtained cheaply, at 4d. to 6d., there was not much in water softening. With regard to blast pipes and chimneys, it was all a question of experiment as to the proper position and the proper pipe. Mr. Fowler had asked about heat treatment of steel of which the cranks were built up. Careful attention was paid to annealing at Horwich, the temperature of the furnaces being carefully regulated by pyrometrical methods. With regard to high tensile steel for tires, it was a compromise between the point of view of the locomotive department and the permanent way staff, and a compromise had to be made. It was true that the greatest amount of pitting took place where the water was put in. As to the artificial softening of water, Mr. Riches told him that he never softened below 6 deg. A typical water would contain carbonate of lime, 1.6; carbonate of magnesia, a trace; sulphate of lime, 1.2; sulphate of magnesia, 1.6; sodium chloride, 2.1; maximum scale-forming matter, 4.4; total dissolved solids, 9. With reference to broken stays, as a result of the introduction of wider water spaces and longer stays breakages had been reduced, and the mileage life was increased from 28,000 to 38,000, this longer life being accompanied by a considerable reduction in the wages paid for maintenance of fire-boxes. The four-cylinder compound was only adopted partially by reason of the superior acceleration. With regard to the behaviour of the compound at high speeds, his experience was that at anything over 30 miles per hour the back pressure on the high-pressure piston, by reason of cutting off at such high pressures, was the creation of a negative H.P. in the high-pressure cylinders. He would reply more fully in writing.

Mr. Arthur C. Auden then partly read his paper on "Reinforced Concrete," the discussion on the paper being adjourned until Wednesday.

The members of the Institution were entertained to luncheon on Tuesday at the Exchange Station Hotel, on the invitation of the Tramways and Electricity Power and Lighting Committee.

In view of the more popular excursions which were arranged for the afternoon, and to which we draw attention later on, the number of members who decided on accepting the opportunity of visiting the power stations at Lister Drive was fairly satisfactory. There are two stations, the engine room of each of which is 247ft. long, 52ft. wide by 37ft. high to the eaves of the roof. In No. 1 station the engines are twelve in number. They are of the Willans vertical triple-expansion type, running at 230 revolutions per minute, and giving a continuous output of 1200 horse-power, but are capable of giving 1500 indicated horse-power for short periods. Automatic expansion gear and high speed sensitive governors, with speed regulating adjustment, are provided. The dynamos are Siemens multipolar machines, mounted on a bed-plate rigidly connected to the engine bed-plate, the armature shaft being carried at one end by a flanged connection to the crank shaft, and at the other end revolves in a massive bearing attached to the bed-plate. The machines are shunt wound and self-excited, and give an output of 1420 ampères at 550 volts. On either side of the engine room is a boiler house, the same length as the former, and in the centre of each boiler house is a chimney 220ft. high resting on a bed of concrete 35ft. square and 8ft. thick. These chimneys vary from 13ft. to 15ft. diameter. Each boiler house is divided into two sections by the chimney and pump room, and each contains seven Lancashire boilers and a Green's economiser. The boilers are 30ft. long and 8ft. diameter, and are fitted with Hodgkinson's mechanical stokers. Sidings from the London and North-Western Railway run alongside each boiler house, and the fuel is delivered from the trucks to the storage hoppers. The condensing water is pumped up into cooling towers as it leaves the condensers, and the ashes are raised from the stokeholds by elevators on to a storage platform, from which they are discharged into railway wagons. The switch room extends across the whole width of the building at the front end, and the flat roof of the room affords a space for the main water tanks. The switchboards are fitted with the usual measuring instruments and automatic pressure recorders. The lighting feeding mains are protected by fuses, and the tramway feeding mains by automatic magnetic circuit breakers.

The switchboards are also fitted with the instruments required by the Board of Trade for indicating leakage and the fall of pressure in the tramway rails which form the return conductors. The bus bars for each service are divided into two parts, and connecting plugs for each dynamo and feeder enable the work of the station to be grouped into four divisions. The plant is divided into four independent sections, and each section is connected to a common switchboard. This switchboard is subdivided into two sections, one for the tramways and one for the lighting service, so that it is possible to work any set of plant on either service, and so regulate the work of the station that each unit may be given an equal share of the work.

The No. 2 station has been built to deal with the outlying districts, which cannot be economically served by direct current. It is generally similar in design to No. 1 station, but its output is three-phase current at a pressure of 6000 volts, which is supplied to sub-stations, where it is transformed into low-pressure direct current. The station is not yet complete, three sections only being in working order. The fourth is in course of erection. When complete the generating plant will comprise four 2000-kilowatt Westinghouse horizontal, three 2000-kilowatt and three 2500-kilowatt Curtis British-Thomson Houston vertical turbo alternators. The boiler-house equipment comprises sixteen Babcock boilers, each capable of evaporating 25,000 lb. of water per hour under ordinary conditions, and having each a total heating surface of 6182 square feet. The boiler pressure is 200 lb. per square inch, and the boilers have chain grate stokers and superheaters. Each group of four boilers is connected to a Green's economiser. In connection with the Westinghouse turbines, four Wheeler "Admiralty" pattern surface condensers are used, together with electrically-operated air and circulating pumps and a battery of cooling towers containing ten sections, each fitted with a motor-driven fan. The Curtis machines are mounted on surface condensers, each having a cooling surface of 6600 square feet, and the circulating water is cooled in towers supplied by Richardson, Westgarth and Co., Ltd. Each of these is said to be capable of dealing with 360,000 gallons of water per hour. Each station is provided with a 30-ton overhead electric travelling crane, by J. Booth and Sons, Rodley. Triple concentric distributing mains are run in duplicate to transforming stations. It may be mentioned that the quantity of energy sold last year by all the corporation's stations amounted altogether to 35,387,734 B.T.U.'s.

Three other alternative visits were also arranged. The first was a steamboat excursion on the Mersey; the next a visit to the Cunard Steamship Company's s.s. Carmania; and the third to the Diamond match factory of Bryant and May, Limited. We may say that the Carmania was described in our issue of 24th November, 1905, and that we described and fully illustrated the Diamond match factory in July, 1899.

The Institution dinner was held at the Exchange Station Hotel on Tuesday evening, Mr. Aspinall presiding over a large and distinguished gathering. The toasts, in addition to that of "The Institution," included "The City, Port, and Trade of Liverpool," and "The Engineering Interests of Liverpool."

SUBMARINES AND LIFE-SAVING DEVICES.

THE loss of the Submarine C 11 on the night of Wednesday, July 14th, has served to direct attention to the fact that the boat was unprovided with appliances for saving life in the event of disaster resulting in sinking with members of the crew on board. Replying to a question in the House of Commons immediately after the news of the accident became public, the First Lord of the Admiralty informed Mr. Lee that he "assumed Submarine C 11 was provided with the safety appliances" which have been devised for use in case of disaster; but a few days later Mr. McKenna admitted that neither C 11 nor the sister boat C 17, which was in collision at the time of the disaster, had been fitted with the safety air traps, and supplied with helmets for the use of the crew. The delivery of the helmets ordered will not be completed until November next. Mr. McKenna was unable to state when the order for the helmets was placed, and it is understood that a question to elicit this information will be placed on the paper.

In view of this statement there certainly appears to be some ground for inquiry into the cause of the delay in equipping all British submarines with the simple life-saving appliances which have been available for at least two years. Nearly two years ago we had an opportunity of witnessing tests of the safety helmets at the works of the makers, at which time the appliances had been adopted for use by the Admiralty. The apparatus is so simple, and can be constructed so rapidly, that there does not seem any valid reason why an ample supply could not have been obtained to equip every submarine on commissioning. As regards the air traps, which must be constructed within the hold of the boat for use in conjunction with the safety helmets, the fitment of the screens can be effected without any delay or difficulty in the case of boats under construction, and is only a matter of the detention of the older submarines in dockyard hands for a few days or weeks.

The helmet appliance consists of a short tunic of waterproof material, to which is united a helmet containing cartridges of a certain chemical substance, which, in the presence of water vapour of the breath, gives off pure oxygen, and takes up the carbon dioxide of the expired air. In this respect the apparatus is similar to certain forms of self-contained smoke helmets for use in mines. As adapted for submarines the helmet and jacket complete weighs only 16 lb. For use in conjunction with the helmet a submarine is fitted with a pair of steel curtains or screens, one on either side of the hull, pendant from the shell plating of the main compartment. These screens are closed at either end, and extend to within about 3ft. 6in. of the deck of the boat, thus forming air traps in the event of the hull becoming flooded with water. Within these traps, which are open at the bottom, are suspended helmets for each one of the crew; each helmet is arranged with the dress tucked up inside it, and, if by any mishap the hold is flooded with members of the crew below, or the air becomes charged with chlorine gas, those in danger can quickly get under the steel screens and stand up with their heads and shoulders in the air trap and out of reach of the water. The putting on of the helmet and jacket is a matter of a few moments, the appliance being dropped over the head and the arms inserted. The tap admitting air to the oxygen-producing cartridge is then opened, and a supply of oxygen sufficient for half an hour or more is ensured.

The next step to gain safety no doubt contains some elements of excitement and danger, but any risks are preferable to the almost certainty of a horrible death which awaits those unfortunate enough to be in the hold of a submarine at the time of a serious disaster. If the accident has resulted in the formation of poisonous fumes of chlorine gas, the apparatus enables the wearers to escape through the conning towers with safety, or, perhaps, to rectify defects in the machinery. On the other hand, if, as possibly may have been the case of C 11, a collision results in the sinking of the boat with the conning tower open, the unfortunate man below rushes to the temporary shelter of the trap, and, having donned the helmet, gets under the screen, and finds his way as best he can to the open hatchway, and quickly floats to the surface. In comparatively shallow water, as, for instance, up to 20 fathoms, the ascent to the surface, when once the man is clear of the boat, presents no difficulties, and the dress itself acts as a lifebuoy which will enable the wearer to float without difficulty so long as the supply of oxygen holds out. In deep water the physiological dangers attending a too rapid ascent have to be faced. Even when the conning tower's hatch happens to be closed, it can be opened from within the sunken boat as soon as the hold is flooded to a sufficient degree to equalise the hydrostatic pressure within and without. There is another set of conditions in which the helmet may be used with good prospects of success. In the case of a boat becoming disabled when submerged and refusing to rise to the surface, the crew are able to don their helmets, and then deliberately to flood the compartment, when the hatchway can be opened, and the way of escape to the surface provided.

The trials to which these safety appliances have been subjected have undoubtedly shown that they at least offer a fair chance of safety to the men who risk their lives in the most dangerous form of warship in common use. It is stated that on one occasion when a submarine was accidentally sunk in a basin two men escaped by means of the air trap, without any helmet, but this was in shallow water, and the fore-hatch was open. The conditions which, so far as our knowledge goes, attended the regrettable accident off Haisborough are just those under which the appliances we have described would have had a fair opportunity of being utilised with success, and had the boat been equipped some, if not all, of the lives lost might have been saved.

BOOM-BREAKING EXPERIMENT.

EARLY on Wednesday morning experiments were carried out at Portsmouth with a view to testing the efficacy of the ordinary boom for harbour defence purposes. The destroyer Ferret, one of the older type of vessels, with engines of 4400 indicated horse-power, was dry docked recently and specially prepared for the test. Strengthening plates were fixed to either side of her bows, and these were brought to a sharp edge to facilitate the cutting of the boom. Some alterations and additions to her were also made internally, but great secrecy has been maintained with regard to these.

The boom consisted of heavy logs of timber of about 9ft. in length, the logs being bound together by strong wire rope. On the outer side long steel spikes were fixed, while both above and below the boom were stretched additional wire ropes, intended to foul the funnels, &c., and propellers respectively.

The Ferret, with a volunteer crew on board, approached the boom with a speed of about 15 knots. When quite close steam was shut off. Steering direct for the centre of the boom, she easily cut her way through it, and it is stated that it appeared to offer no resistance to her progress. The vessel herself apparently sustained but little damage. No casualties or injuries of any kind are reported from among her crew.

SPECIFICATION FOR STANDARD CAST IRON PIPES.—The Engineering Standards Committee have just issued the British standard specification for cast iron pipes for hydraulic power. The committee engaged in drafting the specification met for the first time in June, 1904, and information as to current practice was sought from the principal users and manufacturers of hydraulic pipes, resulting in a mass of valuable information being placed at the disposal of the committee. It was found that cast iron pipes for hydraulic power as generally used fell naturally into two divisions, the greater number being for pressures from 700 lb. to 900 lb. per square inch, while in recent years higher pressures from 900 lb. to 1200 lb. per square inch have been extensively used. Two standard series have, therefore, been drawn up to suit these respective ranges of pressure. The committee regard 900 lb. per square inch as the maximum permissible pressure for Class A, and recommend that Class B be used when a working pressure of 900 lb. per square inch and upwards is the normal working pressure. As regards the leading dimensions, the committee have endeavoured, as far as possible, to fall in with the general practice in existing work as indicated by the replies received. In every case except that referred to below, it has been practicable to adopt dimensions which will allow pipes made to the Standard Specification to be connected to existing pipes without alteration. The only exception is in the case of the diameter of the spigot of the 6in. pipe, Class A. Two dimensions, 6⅞in. and 7in., appeared from the replies to be in equally general use, and it was eventually decided to make the diameter of the spigot of the 6in. pipe 7in., as the extra material could readily be turned off if it were required to connect the Standard pipe to one having a socket of 6⅞in. diameter,

TRAIN FERRY SERVICE BETWEEN SASSNITZ AND TRELLEBORG

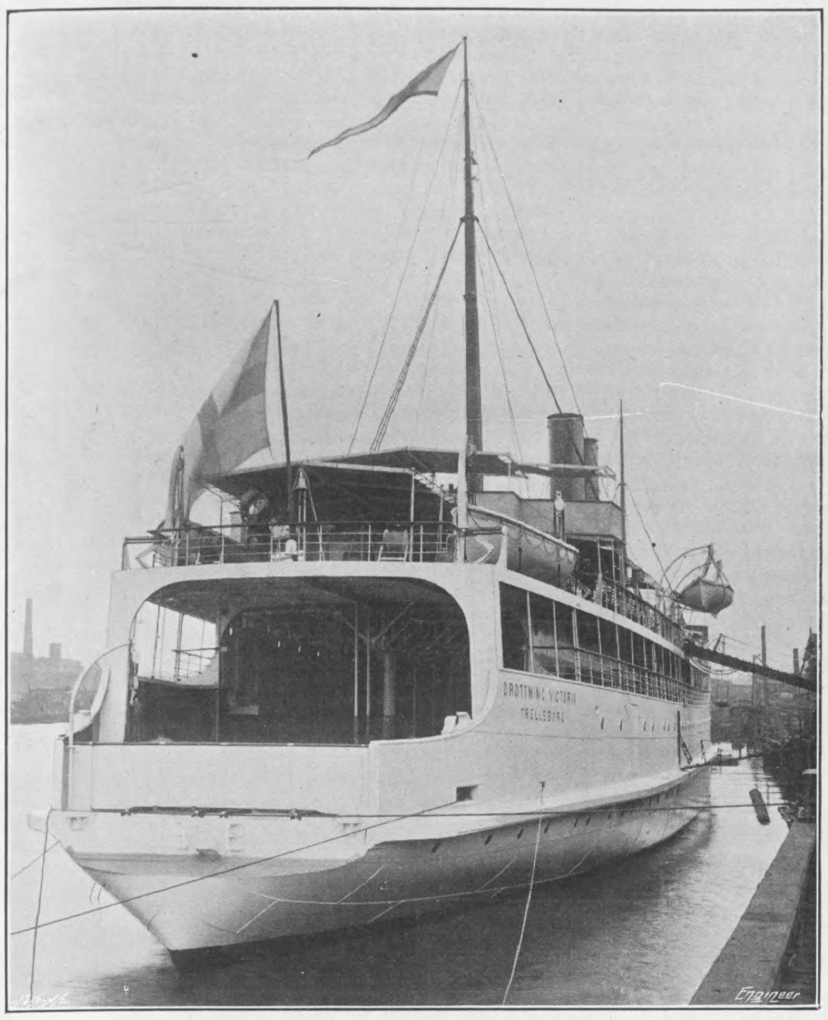


Fig. 4—THE DROTTNING VICTORIA

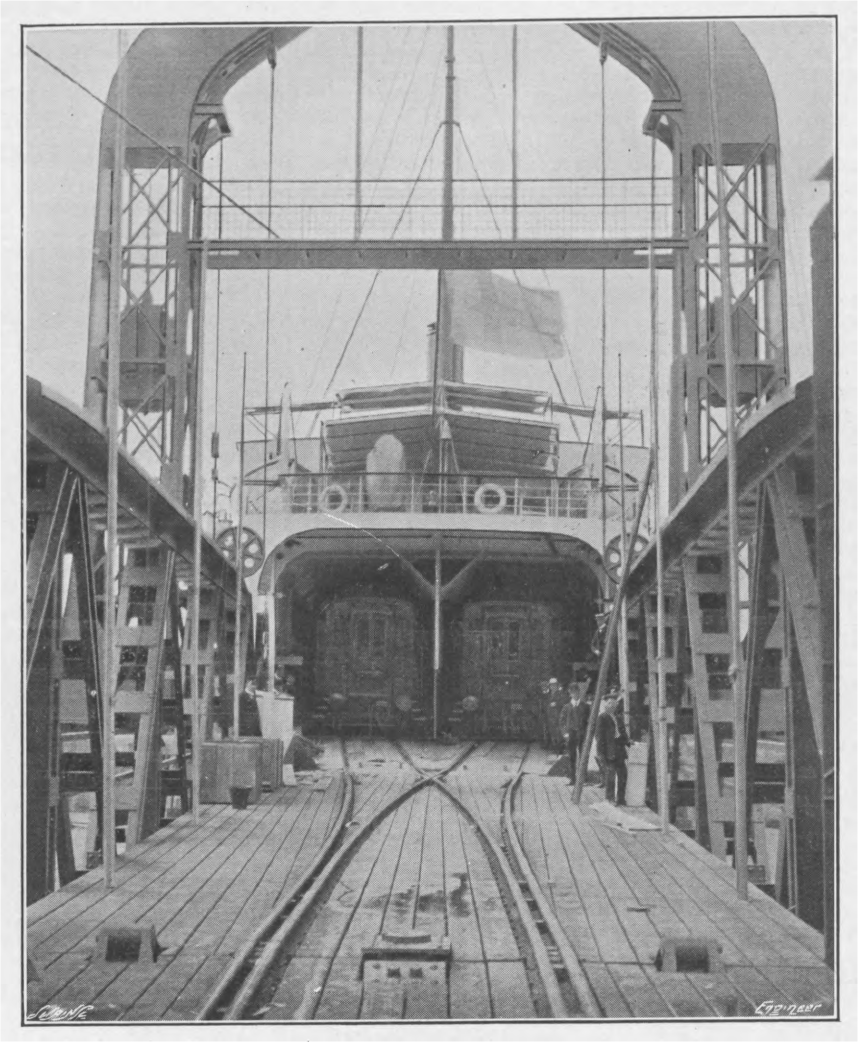


Fig. 5—VIEW OF TRAIN FERRY FROM LANDING BRIDGE

A NEW RAILWAY TRAIN FERRY SERVICE.

No. II.*

THE steamships which have been specially built for the new joint railway train ferry service of the German and Swedish Governments, which was started on July 7th between Sassnitz and Trelleborg, are of outstanding interest, and no other railway car ferries in Europe or America are comparable to them in point of size, speed, accommodation and the provision of safety precautions. The most important American train ferry lines—those of the Père Marquette Steamship Company, the Ann Arbor Railroad Company, and the Grand Trunk Company—are over the waters of Lake Michigan, whilst, with the single exception of the 26 miles journey between Gjedser and Warnemünde, the other seven railway car ferry routes of the Danish Government are chiefly over comparatively short stretches of inland water; but separating Sassnitz and Trelleborg is a distance of no less than 65 miles of Baltic, and where at times heavy seas are to be encountered. Whilst the two train ferries built for the German Government differ in some respects from those of the Swedish Government, yet all four vessels will be of precisely the same overall dimensions and general outline, and, by the courtesy of the builders, we are now enabled to present in a two-page Supplement detailed drawings and a series of engravings reproduced from photographs and other drawings illustrative of the Drottning Victoria, the train ferry steamer which has recently been delivered to the Swedish Government by Swan, Hunter and Wigham Richardson, Limited, of the Neptune Shipyard, Walker-on-Tyne.

The Drottning Victoria is not the first railway train ferry which has been built at the Neptune Shipyard, for it was there that so long ago as 1864 the well-known firm of Wigham Richardson and Co. built a ferry to transport railway vehicles over the Rhine, prior to the erection of a railway bridge. Seven years later the same firm constructed, to the order of the Danish Government, the train ferry Lillebelt. This vessel was the first railway car ferry of a system now so complete, and it continues in regular service on the Sallingsund route. Fig. 6 gives some idea of the design and dimensions of the Lillebelt, the engines of which were supplied by the old Tyneside firm of Thompson, Boyd and Co. The cylinders are 36in. diameter and 45in. stroke. The two boilers work at 25 lb. pressure, and the total heating surface amounts to 1750 square feet. The following table of dimensions will doubtless be perused with interest:—

Lillebelt.		Drottning Victoria.
390	Displacement, tons	4270
85	Nominal horse-power	440
9	Maximum speed in knots	16½ (on service)
140ft.	Length, overall	370ft.
26ft.	Width, overall	53ft. 6in.
7ft.	Draught, loaded	16ft. 6in.
80 tons	Deadweight capacity	600 tons

In the consideration of the dimensions and proportions of the Drottning Victoria the necessity for having a very steady vessel at sea was of prime importance, and a special feature of the form of the ship is the provision of deep bilge keels in order to minimise any rolling tendencies. Briefly described, the Drottning Victoria is 370ft. long and 51ft. in the beam, and she is fitted with triple-expansion engines of sufficient power to enable her to cover the 65 miles between Sassnitz and Trelleborg within four hours. The trains enter the after end of the ship from a specially constructed quay and landing stage made exactly to suit the form of the vessel, and thus ensure perfectly smooth running and safety in embarking and disembarking. A complete train of eight bogie vehicles may be accommodated on board on two parallel lines laid to a gauge of 1.435 metres, and each having an effective length of 295ft. During shipment complete steadiness is secured by a system of trimming tanks. The landing berths consist of stone piers lined with wooden piles and connected thereto by a series of iron spring buffers. Upon reaching the basin the ship strikes against the wooden piles on one side. These yield, owing to the spring buffers, and ricochet her gently to the piles on the other side until the vessel is gradually brought to rest, firmly embedded in the structure of the wooden piles—see the two upper figures on page 108. The connecting link between the land railway and the rails of the ship consists of a bridge of steel construction—see the bottom figure on page 108 and Fig. 5—ordinary open girder work 160ft. in length, and consisting of two portals hinged at one end, with another hinge in the middle, so that the outer hinge only is used under ordinary conditions. At the seaside the bridge is provided with a large steel bolt which fits into a hole in the stern of the ferry boat, and thus rigidly maintains strict alignment between the land rails and ship rails.

Upon arrival on the car deck, the vehicles are secured to the deck by means of specially designed screws, spaced at intervals of 8ft. 8in. on the outside, and at intervals of 4ft. 4in. in the centre of the track. These are attached to gun-metal shackle plates, and then screw jacks are placed under the cars to relieve the car springs. As a special precaution during heavy seas, there is provision made for an additional screw attachment, extending from the top of the cars to the fore and aft girders of the structure of the vessel—Fig. 7. The car deck is built so as to accommodate vehicles having a height of 15ft. 3in., and a width of 11ft. 2in.—the maximum loading limits of the Prussian and Swedish State railways.

The track consists of heavy standard Swedish rails, laid in channels, and secured by cast steel chocks, and not riveted through the deck, so obviating a possibility of any leakage into the cabins below the car deck, and also constituting a portable track, and facilitating the work of renewal and repairs. Heavy girders are placed under the track to take the stresses due to the train load.

The propelling machinery of the Drottning Victoria,

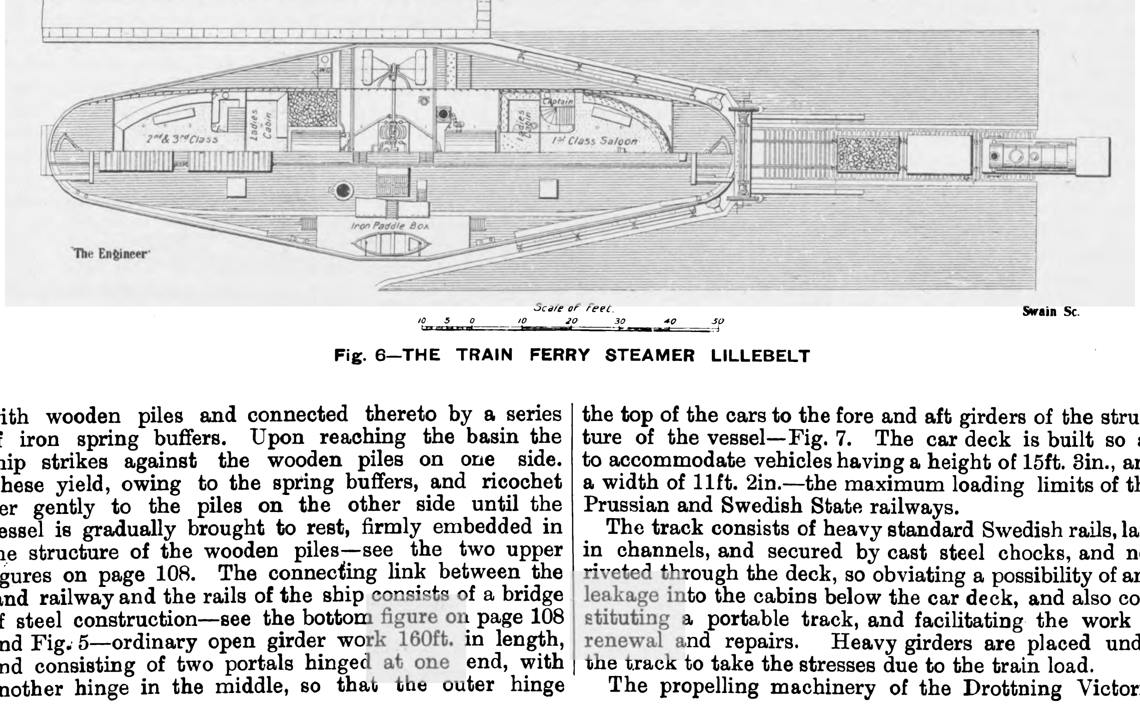


Fig. 6—THE TRAIN FERRY STEAMER LILLEBELT

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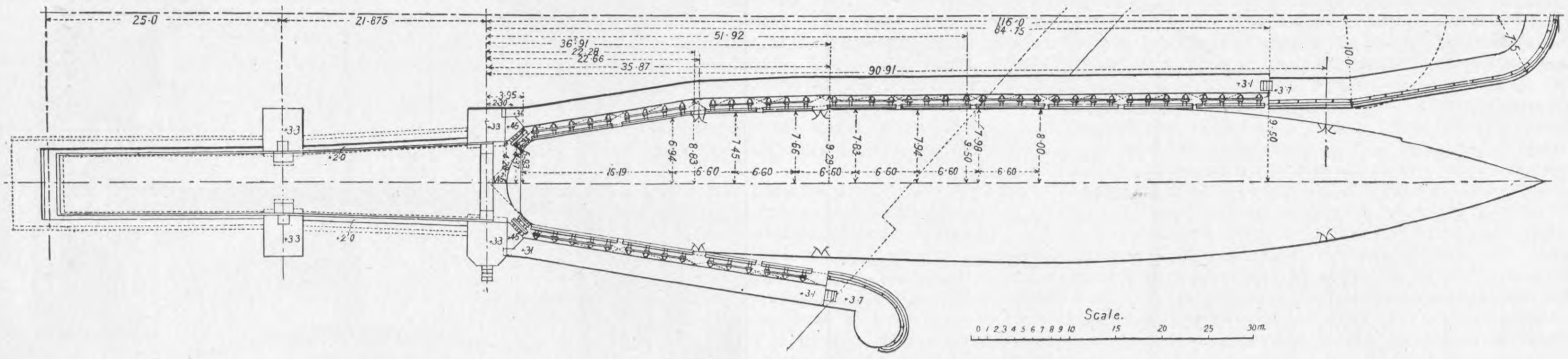
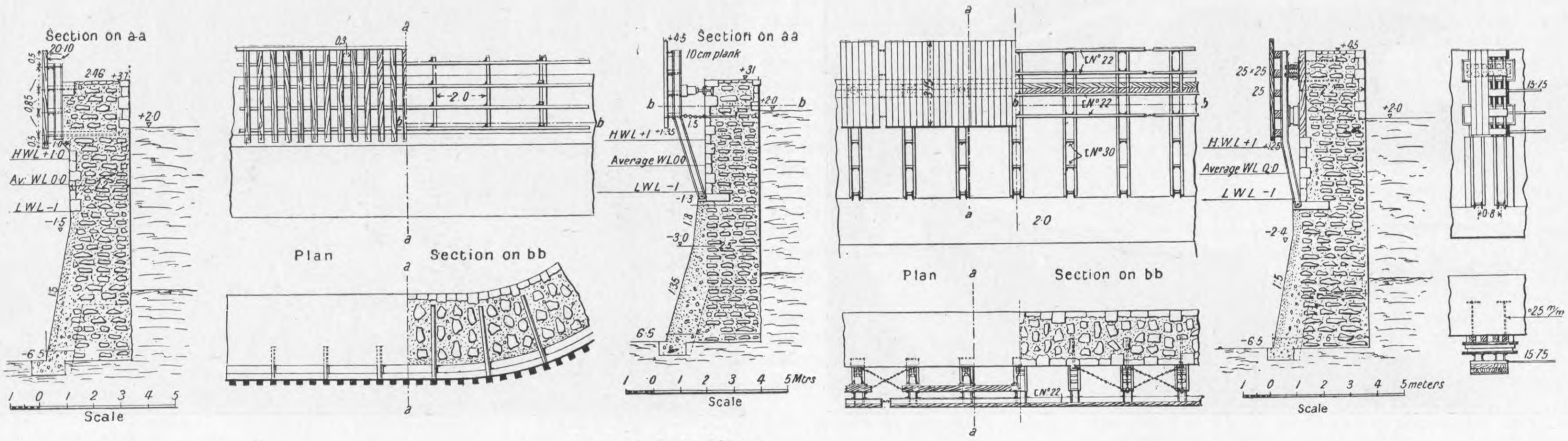
* appeared July 16th.

TRAIN FERRY SERVICE BETWEEN SASSNITZ AND TRELLEBORG

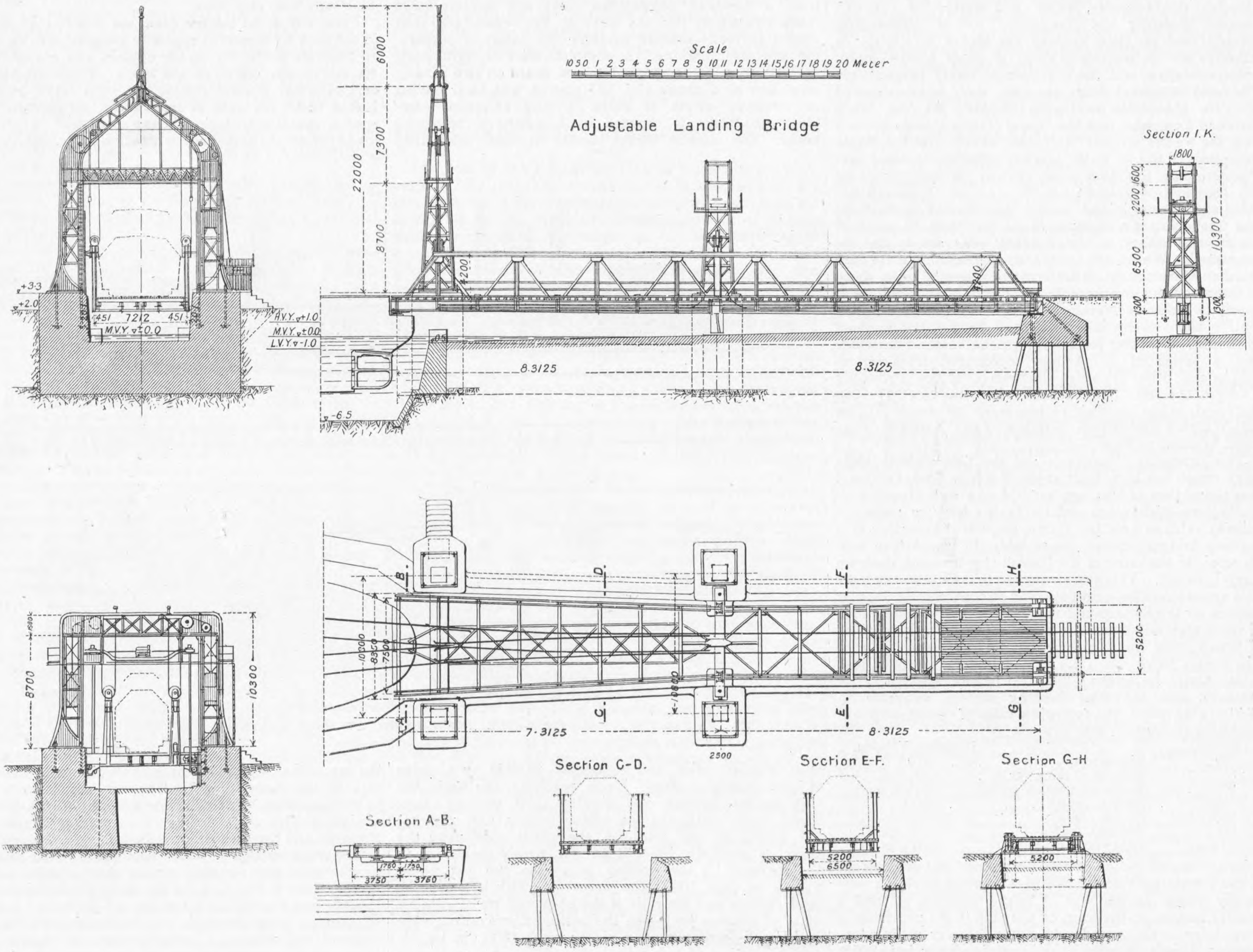
(For description see page 107)


25·0
21·875
116·0
84·75
51·92
36·91
27·28
22·66
35·87
90·91
10·0
+3·3
+2·0
+3·1
+3·7
-3·1
6·94
8·63
7·45
7·66
9·29
7·83
7·96
9·50
10·0
15·19
6·60
Scale.
0 1 2 3 4 5 6 7 8 9 10 15 20 25 30m.

Landing Berth.


Section on a-a
HWL+1·0
Av. WL 0·0
LWL-1
-6·5
+2·0
Plan
Section on bb
Section on aa
10 cm plank
HWL+1
Average WL 0·0
LWL-1
-3·0
6·5
1 0 1 2 3 4 5 Mtrs
Scale
a
b
Nº 22
Nº 30
2·0
Plan
Section on bb
H.W.L+1
Average WL 0·0
LWL-1
-2·4
-6·5
1 0 1 2 3 4 5 meters
Scale
15·15
15·75

Types of Buffers


Scale
10 5 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 Meter
Section I.K.
6000
7300
22000
8700
4200
4400
1800
2200
1600
6500
10300
+3·3
+2·0
451
7212
451
M.V.Y. +0·0
H.V.Y. +1·0
M.V.Y. +0·0
L.V.Y. -1·0
8·3125
8·3125
-6·5
8700
10300
A
B
C
D
E
F
G
H
10000
8500
7500
7·3125
8·3125
2500
5200
Section C-D.
Section E-F.
Section G-H
Section A-B.
3750
3750
1750
1750
5200
6500
5200

Adjustable Landing Bridge

"THE ENGINEER" SWAIN SC.

which was built at the Neptune Works of Swan, Hunter and Wigham Richardson, Limited, consists of twin-screw triple-expansion engines, with four boilers working under Howden's forced draught, 16ft. 4in. diameter and 12ft. long. Air is supplied to the boilers by a fan 102in. in diameter. The steam pipes of the main engines are of steel passing through separators. The main engines are of the following diameters :—23½in., 38½in., 63in. and 36in. stroke, working at a pressure of 185 lb. per square inch. The condensers are independent and are of circular form, carried upon the back column, each being served by a large pump fitted with double engines of Drysdale's manufacture. Worked from the main engines is an Edwards air pump and bilge and sanitary pumps. The feed pumps are independent of the main engine, and are of Clarke, Chapman and Co.'s (Woodeson's) automatic type, discharging through a feed heater made at the Neptune Works. The discharge from each air pump is led into large hotwell tanks, arranged to filter the water previous to reaching the feed pump. A Sees ash ejector is fitted in each stokehold for the discharge of ashes. The engines are fitted with Aspinall's governors, and amongst other auxiliary machinery are two large evaporators and feed and ballast donkeys. The trimming tanks, one being fitted on each side of the vessel abreast of the boilers, have each a maximum capacity of 90 tons, and there is provided in connection with these a 15in. centrifugal pump—Drysdale's manufacture—which quickly empties and fills the tanks, so as to counteract the load on one of the lines of the car deck.

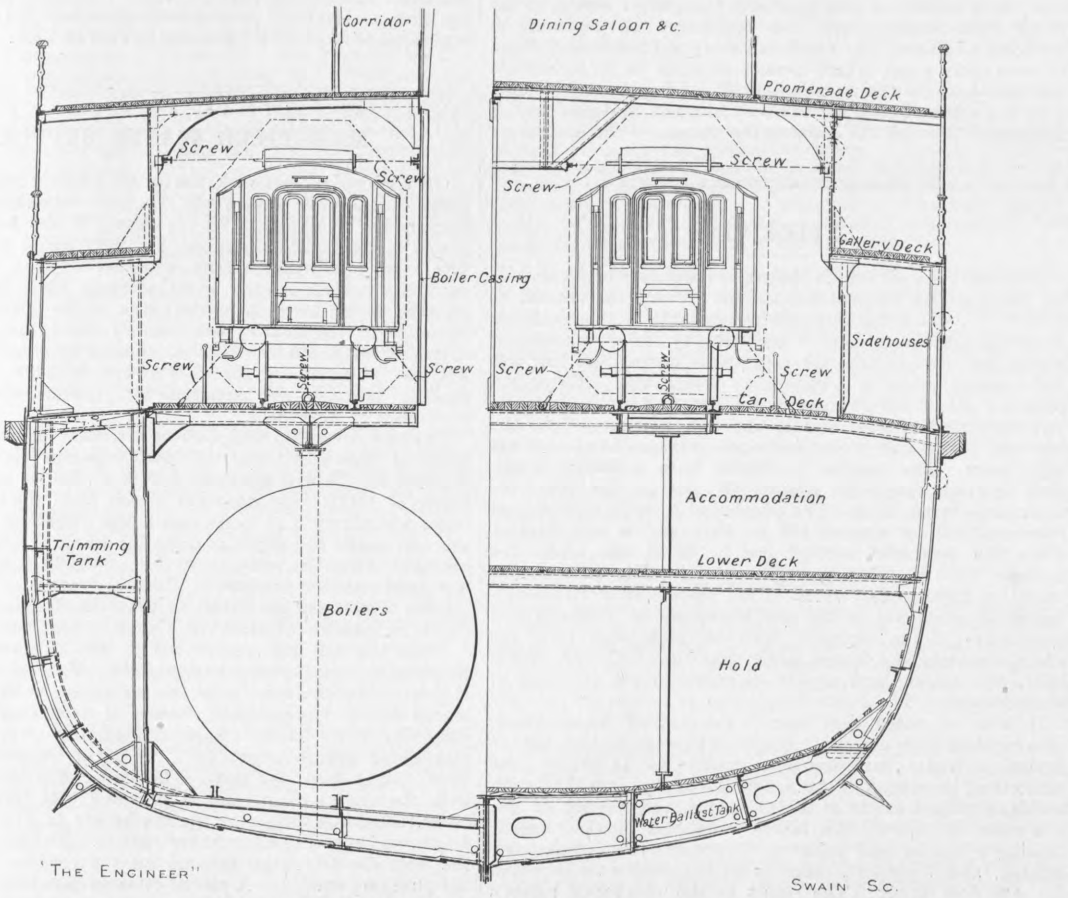


Fig. 7—CROSS SECTIONS OF THE DROTTNING VICTORIA

Apart from the system of shipping the vehicles on a separate deck, the design of the Drottning Victoria is of special interest, inasmuch as besides being a car ferry, she is provided with passenger accommodation but rarely equalled in cross-Channel steamers, and is in every respect a first-class passenger steamship having dining-room, saloon, smoking-room, lounge, ladies' room, and regal apartments, all on the promenade deck, whilst below the car deck there is sleeping accommodation for no fewer than ninety-six first-class and forty-five third-class passengers. In the case of the night services between Berlin and Stockholm, it is probable that the occupants of the sleeping cars will not think it worth while to leave them; but as amongst the travelling public there will, no doubt, be some who prefer to move about, spacious accommodation is provided to meet their various needs. From the car deck, side entrances—one on each side—lead down to the first-class accommodation, which is situated aft of the machinery spaces. There are ten two-berth rooms, and nineteen four-berth rooms. Each room is furnished in pine, panelled and finished, enamelled white, with Molyn's japanlac enriched with gilt mouldings, the ceilings being similarly treated. Each berth has two Hoskins' folding iron beds, and an Orient spring mattress. The two berth cabins are generally of uniform dimensions, 7ft. square, and the four-berth cabins measure 7ft. by 9ft. Folding lavatories and washstands of large size are in each cabin, the floors are covered with linoleum and Brussels carpet, and there are sofa seats. The corridors are of considerable width. From the car deck two side stairways give access to the third-class accommodation, which is situated forward of the boiler spaces. There is a special apartment on the port side, measuring 32ft. 4in. by 14ft., which, by means of fourteen iron beds and eight sofa berths, provides accommodation for twenty-two passengers. This room is panelled in pine, finished enamelled white, and the ceilings are similarly treated. The floors are covered with inlaid linoleum and Brussels runners, and there are green repp sofa seats. On the starboard side is an apartment measuring 32ft. 4in. by 14ft., giving the same accommodation, and between these is the third-class dining saloon, 32ft. 4in. by 16ft. 6in. The framing is in polished ash, with oak panels and oak frieze similarly treated. The ceiling is panelled in pine, finished in enamel white, and there are seats for twenty-two passengers at a centre table. The sofa seats are of green pegamoid, and the floor is covered with green inlaid linoleum and Brussels runners. At the aft end of the dining and sleeping rooms is a large corridor leading to pantry, stewards' stores, and engineers' mess-rooms. The corridor framing is in polished oak, with ash panels and ash frieze, and the ceiling is in pine, painted enamel white. Forward of the dining and sleeping-rooms are lavatories, and the space forward of these is entirely devoted to accommodation for the stewards and crew.

Aft of the first-class sleeping-rooms, and separated therefrom by a bulkhead, is sleeping accommodation for six Customs, ten Post-office, and eight railway officials and servants. These compartments are entered from the car deck by two side stairways aft. From the lower deck a grand staircase, starting from the centre of the first-class accommodation, leads to the promenade deck. The sides of this stairway are handsomely framed and panelled in polished mahogany, and the ceiling is in pine, painted in white enamel. On the car deck there are two tracks, each 295ft. in length, and forward of the spring buffers is mess accommodation for the sailors and firemen. Stairways lead to the stewards' room on the lower deck and to the promenade deck.

The port side of the car deck is devoted to a companion-way to the Customs, Post-office, and railway officials' stores, stairway down to first class sleeping accommodation, and up to the gallery deck. There are mail and sorting rooms, each measuring 23ft. by 4ft. 6in., a third-class galley, and a stairway leading to the third-class accommodation on the lower deck. On the starboard side of the car deck is similar accommodation, with the exception that rooms, measuring 15ft. 2in. by 14ft. 6in., are here provided for the Customs officials. Reached from the car deck by two side stairways is the gallery deck, which has a uniform width of 6ft. 6in., and from which stairways lead to the promenade deck. On the promenade deck there is a verandah at the aft end of the smoke-room. The smoke-room, 21ft. 8in. by 24ft. 6in., is in fumed oak, Old English in style, and in colour harmonises with the covering of the furniture, which is in blue antique morocco leather; a touch of colour is given by the inlaid metal marqueterie in the pilasters and by three beaten copper panels at the fore and aft ends of the room. The ceiling is divided into panels by the oak beams, and the panels are filled with plaster ornament in relief. An octagonal skylight is in the centre of the ceiling, and is filled with antique leaded glass, richly coloured. The fireplace at the fore end of the room has blue antique tiles, and there is a radiator of beaten copper. The floor of the smoke-room is laid with inlaid parquet linoleum, covered with blue Brussels carpet runners, and the windows are finished with festooned hangings of blue art linen.

Leading from the smoke-room is a passage to the lounge, and here are situated gentlemen's lavatory and w.c. accommodation. The lounge, 24ft. 8in. by 24ft. 6in., is treated as a drawing-room, and the woodwork is of grey sycamore, finished with a high polish in a free treatment of German Renaissance. The panels are quartered, and show to advantage the figuring of the wood. A plant stand, with panelled mirror behind, adds to the general effect of the room. The furniture is inlaid mahogany Sheraton, covered with fine French repp in two shades of rose pink, and the curtains are silk tapestry of a similar delicate shade. The carpet is Axminster, and harmonises in colour with the rest of the furniture. In this room also is provided a radiator with coloured tiles behind, and mirror and mantelshelf above. Leading from the lounge is the ladies' ante-room, which is in dark mahogany with grey panels—a contrast to the lounge colours. From the lounge access is had to the first class entrance hall which leads up from the car deck. The grand entrance, 12ft. by 22ft., is Grecian in style, and has been carried out in dark mahogany. Over the main staircase is a plant and flower gallery, in the centre of which is placed a marble bust of Queen Victoria of Sweden. Leading forward from the grand entrance is the Regal room, 10ft. 10in. by 16ft. 6in. This compartment, set aside for the exclusive use of Royalty, is carried out in the Adams style. The wood is sycamore with grey silk panels. The fireplace is richly carved, and the white tiles behind the radiator are decorated with purple Adams ornament. The decoration of the ceiling is enhanced by the provision of four domed lights set in the corners of the ceiling. The furniture is inlaid mahogany, with fine silk tapestry upholstery of delicate purple ground. The floor is entirely covered with a fine Axminster Royal grey carpet.

On the starboard side there is a main corridor in oak and teak, the floor of which is covered with green linoleum and Brussels carpet runners, extending forward to the first-class dining saloon. Leading off from this main corridor is a cosy-corner, which is fitted up with large green curtains and upholstered in green and velvet. On the port side of the main corridor are situated pantry, galley, scullery, and store-rooms. The dining saloon, 39ft. 4in. by 32ft., is treated in Italian Renaissance, and has seating accommodation for eighty persons. The woodwork is oak finished with a dull waxed surface. The panels are inlaid in coloured marqueterie. The ceiling in this, as in all the other first-class social rooms, is covered with Tyne Castle in low relief ornament and picked out in gold. There is a richly carved sideboard with silver case at the fore end of the saloon. The upholstery is in crimson buffalo hide. The floors are covered with inlaid parquet linoleum, and on this are laid crimson Brussels carpet runners. The windows, as in the rest of the first-class social rooms, are large, and of an unusual size for a ship, and give a charming and light appearance. In this room the windows are hung with cream silk tapestry curtains. Forward of the first-class dining saloon is accommodation for the captain and the first and second officers, and at the aft and fore ends are ladders leading to navigating bridges, whilst at the fore end is situated the chart-house. Six lifeboats and two cutters are situated outside the promenade deck.

The electrical equipment of the Drottning Victoria is an exceptionally complete one, and there are no fewer than 800 electric lights fitted throughout the vessel. The fittings in the public rooms are handsome, and were specially designed. Mention should be made of the brackets on the frieze of the Regal room in the Adams style, the double-light wall brackets in the lounge to suit the German Renaissance architecture, and the Old English lanterns fitted on the roof beams in the smoke-room. Each first-class sleeping berth has a lamp having two filaments, one of 16 candle-power, switched from the door, and one of 2 candle-power switched from the bed. On the car deck, besides the lights used for ordinary illumination, a large number is fitted about 2ft. above the deck and also overhead, in order to give light to the men securing the trains. At each stair or entrance for passengers' use a large illuminated sign lantern is fitted, the lettering being in German and also Swedish. In all seventeen of these sign lanterns have been provided. Two large searchlights are fitted, one at the fore end of the ship and one at the aft end. These are operated, and the direction of the beam of light controlled, by electrical means from two control pillars, one on the forward bridge and one on the aft bridge. Fresh air, heated or cooled as required, is forced through galvanised iron trunks into the accommodation by three thermo-tanks, whilst the foul air is exhausted by a number of exhaust fans arranged in connection with exhaust ventilation trunks. The exhaust system is confined to the lavatories, galleys, pantries, and store-rooms. An automatic electric goods elevator, serving four decks, is fitted between stores, pantries, and galleys.

To supply current for this installation, three dynamos are fitted, each having an output of 600 ampères at 65 volts. Each dynamo is direct-coupled to a compound engine of 65 horse-power. The electrical power is controlled by a large switchboard, mounted on marble, and arranged so that the engineer has complete control of the lighting arrangements required at any hour of the day. In order that the engineer and captain may both know the speed of the main engines, a small electric generator is driven by chain gearing from each main engine shaft. Each generator (or transmitter) is connected by electric wires to two receivers, one in the engine-room and one on the bridge, and these indicate not only the speed of rotation, but also the direction in which the propeller is revolving. The vessel is fitted with steering gear forward as well as aft, to enable it to be navigated astern as well as ahead. When steaming ahead only the aft gear is in use, but when steaming astern both the forward and aft gear may be controlled at will from the aft bridge. Each steering engine is fitted with an electric transmitter connected to indicators on the bridges, which show the angle of the rudder; thus on the forward bridge there is an indicator showing the angle of the aft rudder, but not of the forward rudder, while on the aft bridge there are two indicators, one showing the angle of the aft rudder, and the other showing the angle of the forward rudder.

There is also fitted on board the Stone-Lloyd system of water-tight doors with electric indicating lamps in the chart room. Apparatus with two telephone receivers, also placed in chart room, is provided for the detection of submarine signals. The electric bell system is so arranged that the train wiring is connected to that of the ship by a connection at the buffers, so that passengers on the train may be enabled to call the ship's stewards to attend to them. The train accumulators are also similarly replenished from the ship's mains while the train is on board, and there is steam connection at the buffers, by which means steam is transmitted to the railway vehicles whilst on the car deck. The standard compass is fitted on a long pole at the height of about 28ft. above the navigating deck, so that it is out of the range of the effect produced by the cars.

The contractors for the electrical installation were W. C. Martin and Co., Glasgow. The projectors and electric equipment were furnished by Clarke, Chapman and Co., Limited, Gateshead-on-Tyne, which firm also supplied the steam capstans and windlass. The steam steering gears (forward and aft) were supplied by John Hastie and Co.; the telemotor gear by Mactaggart, Scott and Co.; the compasses, &c., by Kelvin and James White, Limited, Glasgow; the stockless anchors by W. L. Byers and Co.; the thermo-tank installation by the Thermo-Tank Ventilation Company; the steel lifeboats by the Seamless Steel-Boat Company, Limited; the boats' davits by the Axel Welin Company, and the cooking ranges and hot press by Thomas Grieve and Co. The design of the furnishing and fittings for the social rooms on the promenade deck was entrusted to Messrs. Matkin and Speight, architects, Sunderland, and the upholstery of these and all the other apartments throughout the vessel was carried out by W. E. Harker, of Newcastle-on-Tyne.

The steaming and other trials of the Drottning Victoria took place on the measured mile at Whitley Bay, off the Northumberland coast, on June 15th, and the contract speed was then not only easily maintained but exceeded. The vessel since she has been in regular service has given further evidence of her sea-going qualities, and there seems no doubt whatever that the enterprise of the Swedish Government and the great skill and experience which has been brought to bear upon the construction of the Drottning Victoria by Swan, Hunter and Wigham Richardson, Limited, will be rewarded with the fullest measure of success.

At the official trials held last month Mr. F. W. S. Pegelow, the director-general of the Swedish State Railways, took the opportunity to express the indebtedness of his department to Swan, Hunter and Wigham Richardson, Limited, for the attention and excellent workmanship bestowed upon the vessel; and upon the occasion of the opening run from Sassnitz to Trelleborg this month the King of Sweden personally conferred upon Mr. J. Denham Christie the Order of the Wasa as a token of his appreciation of the conspicuous part which Mr. Christie, as a director of Swan, Hunter and Wigham Richardson, Limited, had taken in the construction of the train ferry.

The Drottning Victoria is under the charge of Captain C. E. Ljungberg, of Trelleborg. She was built from designs prepared on behalf of the Swedish Government by Mr. William Hok, of Stockholm, a naval architect whose name is equally familiar in this country as on the Continent.

SHIPBUILDING NOTES.

A MEASURE of some importance to shipyard workers has recently been put in operation on the Clyde, and is now proposed to be introduced in the North-East Coast yards. We refer to the "discharge-note" system, under which a workman when he leaves or is discharged from his employment will be supplied with a discharge-note certifying that he has finished his contract and returned his tools to the store. Upon entering new employment he will be required to produce this note, which will be signed by the employer he has left. This, of course, is a common enough business arrangement, not unknown in other industries, and no excuse need be made for reference to it in this place, since, if the system fulfils the expectations of those who have initiated it, there will result a better organisation of shipyard labour. It need hardly be pointed out, too, that the new system is an eminently sensible one in this respect, that it is open and above-board, and is calculated to allay instead of arousing suspicion in the worker's mind.

AT the time of writing, the summer holiday on the lower reaches of the Clyde has ended, and that on the upper reaches is in full swing. Some firms are this year making a special effort to secure a punctual re-start, and to effect this they have intimated that work will be resumed on the Tuesday instead of the Monday, and that failure to start then will be regarded as synonymous with leaving the firm's employment. It is, indeed, regrettable that so much expense should be incurred year after year by shipbuilders in respect of these futile re-starts. In this connection, we have heard of a scheme adopted with success by a large Clydeside engineering firm. The New Year holiday was contracted to a day or two and the summer holiday correspondingly extended. This was found to work well, both from the point of view of employers and employed.

TWO cases of shipping sales have recently created considerable interest, as throwing some light on the depreciation to which ships of a special class are liable. The first of these is the case of the Heliopolis and Cairo vessels built by the Fairfield Company for the Egyptian Mail Steamship Company. They were turbine, shelter-deck passenger steamers of a very high class indeed, designed for Mediterranean service, of dimensions 525ft. by 60ft. by 30ft., and steaming over 20 knots. It will be obvious that vessels such as these are not suited for any and every kind of passenger trade, and therefore no surprise was felt at the difficulty experienced in disposing of them. As stated above, however, they have now been sold. The other case is that of the much-discussed Thames steamers. The figures here are sufficiently significant, the price paid for the remaining fourteen vessels of the fleet being £5500.

ON the North-East Coast there is not much improvement to report in the general shipbuilding outlook. In the Newcastle district, the Walker yard of Messrs. Armstrong, Whitworth and Co. has had its share of the prevailing depression, but the two cargo vessels recently booked by the firm will introduce a welcome change. At Messrs. Palmer's work is proceeding on the new battleship Hercules, which is being built in the berth formerly occupied by the Lord Nelson, the firm's last contribution to the Navy. Mention of Messrs. Palmer's reminds us that the newly appointed manager—Mr. A. B. Gowan—has just been presented with a handsome testimonial from his former colleagues at the London and Glasgow yard.

IN other parts of the district the most considerable orders that have recently been placed are the two cargo steamers secured by Messrs. Craig, Taylor and Co. on the Tees, and the three vessels placed by Sir Alfred Jones with Messrs. Irvine's Shipbuilding and Dry Docks Company. The contracts were intimated by Sir Christopher Furness at the launch of the Shenga, built for Elder, Dempster and Co. by his firm. Sir Christopher took occasion to allude to the serious depression in shipbuilding and shipowning now prevalent, and made a remarkable statement to the effect that fully 50 per cent. of British shipbuilding berths were vacant at the present time.

CONSEQUENT upon the very successful work done at the Sewri-Mazagon Reclamation, Bombay, by the suction cutter dredgers Jinga and Kalu, the builders of these dredgers, Wm. Simons and Co., Limited, Renfrew, have applied for Letters Patent for a suction hopper cutter dredger, fitted with a suction pipe and cutter. This new design of vessel is called the "Simons" dredger, and incorporates a number of special features, all of which have been protected. It is claimed for this vessel with its special fittings, that she will in most cases do the same duty as a dredger fitted with a bucket ladder and chain of buckets. Having neither upper nor lower tumblers, buckets, links, nor pins, the "Simons" dredger has not so many wearing parts as bucket dredgers, and it is therefore confidently anticipated that this new type of dredger will be much less costly in maintenance and repairs. Economy in working is naturally of the greatest moment, not only to contractors carrying out large projects, but also to harbour authorities who have to meet the exigencies for deep water and other requirements in their harbours and channels to suit the dimensions, and especially draught of water, of the many large vessels built and building. In addition to dredging a channel, the vessel can carry the material dredged to some other point where ground requires to be reclaimed, and can then lift the material out of its hopper and deposit it on the shore or over a quay wall; or the material can be discharged through the doors in the bottom of the dredger.

EXPLOSIVES.

THE annual report of his Majesty's Inspectors of Explosives for the year 1908 has just been issued. From the perusal of Part VIII., which has reference to accidents in this country, we notice that the number of accidents by fire or explosion of which the department had cognisance during the year was 392, causing, so far as is known, 44 deaths, and injuring 402 persons. The total number of accidents shows a decrease, viz., 392, against 414, and is above the average 347 for the last ten years, and is also above the average 374 of the last eight years. The number of deaths from accidents is less than in 1907, viz., 44, against 63, and is less than the decennial average 53·3. The number of persons injured last year was 402, as against 422 in 1907, and is considerably above the decennial average 366·4. It is also above the average 395 of the last eight years. The instructions issued in 1900 under which H.M. Inspectors of Mines now report all accidents in the use of explosives, irrespective of the nature of the explosive involved, necessarily have the effect of making the figures larger than they had been before 1901, and make them appear disproportionate to those of former years.

It is to be noted that over 92 per cent. of the accidents, causing death or personal injury, occurred in the use of explosives under miscellaneous conditions to which the controlling provisions of the Act do not apply, and that such accidents caused 39 out of the 44 deaths, and 369 out of the 402 cases of injury; this leaves a balance of 27 accidents causing 5 deaths and injuring 33 persons in manufacture, storage, and transport, these being the conditions to which the Act does apply. The result in the number of persons killed is three less compared with the previous year, viz., 5, and the number of persons injured shows an increase 28 to 33. The number of such accidents is the same as in 1907, viz., 27.

The accidents in factories for explosives numbered 57, which is above the average—53·8—for the last ten years. The number of deaths in manufacture was three. The annual average of deaths for the decade now stands at 7. There were five ignitions of ballisite during the operation of rolling, but in only one case did a work person sustain injury. It is noteworthy that all these ignitions took place in the same factory and within a short time of one another. There were two accidents in connection with the manufacture of cordite, neither of which was attended with personal injury. One was due to the ignition of a shell which was being rolled. The other occurred at Cliffe on April 1st, when a cordite stove built on the cellular system became ignited. The contents of nine compartments were destroyed. The actual cause of the fire could not be conclusively determined, but it appeared probable that it was due to the ignition of a piece of cordite which had fallen on to the gauze over a steam pipe. The steam pressure at the stoves was about 60 lb. per square inch, giving rise to a temperature of about 300 deg. Fah. One accident occurred during the manufacture of dynamite cartridges. While two girls were filling cartridges with "dynamite pumps" an explosion occurred. There is little doubt, the report states, that the kieselguhr in this dynamite contained large pieces of quartz, in some cases one-tenth of an inch across, and the explosion was probably due to one of these pieces being jammed between the plunger and the socket. Another accident, which like that just referred to, forms the subject of a special report, occurred at Roslin during the conveyance within the factory area of a 50 lb. box of gelignite. It was thought to be due to the faulty construction of the 5 lb. inner packages. An experimental nitro-compound was being pressed in a cordite press when an explosion occurred. The ignition, it is stated, was probably due to the use of a washer in the press which was high to gauge. Ten accidents occurred in connection with the manufacture of detonators. Eight of these, all of which occurred in the factory at Polmont, were unattended with personal injury. The excellence of the arrangements at this factory for the protection of the workpeople from injury was again demonstrated.

Of the other accidents one occurred at Faversham during the operation of a hand-sieving, by which two persons were injured, and the other occurred at Chesterfield, by which four persons were injured. In the former case, while a workman was sieving by hand 100 pressed No. 6 detonators in a hair sieve over water in order to remove any loose composition, an explosion occurred, and was communicated to 100 unpressed detonators in a jig on the pressing machine. The second lot was about 5ft. distant from the first lot of detonators and in the same compartment of the hut. No other explosive was present. The foreman had just entered the compartment, and he and the workman were both injured. The cause of the accident, the report states, was probably that a small portion of dry composition adhered to a capsule, or to the hair mesh of the sieve, and was detonated by the friction set up in the sieving. In the case of the other accident one of the workwomen was pulling a jammed fuse out of a detonator when an explosion occurred, and was communicated to 122 detonators on the table in front of her. The report states that the accident was probably due to a streak of composition in the interior of the capsule of the detonator, and the friction caused in pulling out the fuse.

Nine accidents occurred in firework factories, but only one of these calls for special comment. In this instance some packages of self-igniting aluminium torches were lying unloaded from a van when the case ignited spontaneously. The authorised composition of aluminium torches does not admit of the use of an igniting tip. These are some of the most interesting accidents which occurred in factories. The number of accidents which occurred during the year in keeping explosives is given as 5, against 10 in 1907. In one case a youth of sixteen was making chemical experiments in his father's house at Weymouth, when an explosion occurred, blowing off his left hand, and inflicting serious injuries from which he died in a few minutes. There were no accidents during conveyance outside factories throughout the year. The number of accidents grouped under the heading "Uses and Miscellaneous" is less than that for 1907, viz., 330, against 360. By these accidents 39 persons were killed and 369 injured, as compared with 55 killed and 394 injured in 1907.

MANSFIELD WATER SUPPLY.

ON Wednesday, last week, the formal opening ceremony took place of the new waterworks recently constructed by the Corporation of Mansfield for the supply of the borough and the adjoining districts supplied by them under agreements. The town has hitherto been supplied by the Rainworth pumping station, erected about thirteen years ago, but the growth of the town in consequence of the development of collieries in the district has been so rapid that a further supply from another watershed became imperative, and an Act was obtained by the Corporation in 1905, and a well sunk in the new red sandstone at Clipstone, about 5 miles north-east of Mansfield.

The new works are designed for a similar duty to that of those at Rainworth, namely, 750,000 gallons per day. The contract for the well specified that it should be sunk to the depth of 150ft., and headings driven from the bottom, but water was obtained so freely that it was unnecessary to carry the well to the full depth or drive the whole of the headings provided before the test quantity of 1,680,000 gallons per day was continuously pumped. Borings were also put down further to increase the yield, so that the designed quantity might be maintained after many years of continual pumping.

When the well had been proved to the satisfaction of the corporation's consulting engineer, Mr. F. Walter Hodson, M. Inst. C.E., the erection of the permanent works was proceeded with. The pumping station is a compact and substantially built block placed immediately over the well, comprising engine-house, 38ft. by 28ft., boiler-house, coal store, fitting shop, and store. The fitting shop communicates with the engine-room, and is provided with lathe drill and other tools for maintaining the machinery in first-class condition, and effecting all ordinary repairs. The engine driving the tools also drives the dynamo for the electric lighting of the pumping station. A pair of cottages have been erected on the site for the accommodation of the engine-drivers. The pumping main, 15in. diameter and 5 miles long, is connected to the existing gravitation main from the reservoir, so that water is pumped direct from Clipstone to the town, any excess over the consumption for the time being passing direct into the reservoir.

The pumping machinery consists of two duplicate sets of compound surface-condensing steam engines, each driving through gearing a set of treble-barrel deep well pumps of the stand-pipe type, and has been manufactured by Tangyes Limited, of Birmingham. Each set is capable of pumping 40,000 gallons per hour a total height of 468ft. to the reservoir. The steam cylinders are 12in. and 21in. diameter, with the stroke of 24in., the steam pressure being 125 lb. per square inch. A pair of steel Lancashire boilers are installed, and a 4-ton overhead traveller fixed in the engine-house. The pumping station is connected by telephone with the offices at Mansfield, and also with the Rainworth works, and an apparatus is provided for showing a continual record of the water level in the reservoir, and also in the well, and a Venturi meter fixed to check the pumping and assist in prevention of waste. The total cost of the works, including land, will, we understand, be under £30,000.

ENGINEERS AND SMOKE ABATEMENT APPLIANCES.—On Saturday afternoon (17th inst.) about thirty members of the Rochdale and District Motive Power Mutual Improvement Society visited the works of Ed. Bennis and Co., Limited, Little Hulton, Bolton. They were conducted through the shops by Mr. A. W. Bennis, and shown the different branches of coal and labour-saving apparatus in their various stages of manufacture. Amongst the objects of attention were the Bennis machine-stoker, fitted with natural draught furnace, the same apparatus fitted with self-cleaning compressed air furnace, the firm's improved smokeless chain grate stoker, various elevating and conveying plants in course of erection, and the moulding appliances installed by the company for the production of its own castings. Other apparatus inspected were the new balanced shovel arm, and also the improved 1909 model high-duty smokeless and gritless coking stoker fitted with a self-cleaning compressed air furnace.

RAILWAY MATTERS.

From a report of comparative tests made by an American trunk line on the new ferro-titanium steel rails and those of the Bessemer type it is noted that the wear on the former showed 1.45 lb. per yard, as against 4.18 lb. per yard on the latter, which is nearly 300 per cent. in favour of the new alloy steel.

The Earl of Scarborough, presiding at the ordinary meeting of the Niger Company, Limited, said the Baro-Kano Railway had been pushed on with extraordinary rapidity. Over 100 miles of rails had been laid, and it was expected that the remaining 300 miles to Kano would reach completion during 1911.

The electrified portion of the Brighton Railway between Peckham Rye and Victoria Stations will, it is understood, be opened early next month, and it is expected that the full service between Victoria and London Bridge will be in operation by October 1st. Naturally, fares on this section will be revised to take advantage of the new system of working.

Two American railway engineers have just completed a journey from Edmonton to Prince Rupert over the proposed route of the Grand Trunk Pacific. Mr. Parker, the former chief engineer of the Rock Island system, one of the travellers, was greatly pleased with the route selected. He says that easy grades have been secured, so that the company will be able to work the mountain section at a comparatively low cost.

Government surveyors are engaged in carrying out a survey for a tunnel which is to be pierced through the cliffs, giving Dover Naval Harbour access by rail from the eastward, which it does not now possess. This would bring the dockyard centres of Chatham and Sheerness and the Kentish garrison into close touch with the Navy at Dover. The tunnel would be very valuable for sending ammunition and stores direct to the fleet.

An order for two goods locomotives, to be employed on main line work, has been placed by the New York, New Haven, and Hartford Railroad Company. One of these locomotives is to be equipped with side rods, and the other is to be of the geared type. It is understood, states the *Electrical Engineer*, that tests will be made with these locomotives to determine the relative performance of electric and steam locomotives for goods service and the relative advantages of the two types of locomotives which are to be employed.

The Grand Trunk Pacific Railway (Canada) has commenced a novel undertaking whereby a record of the growth of the West so far as the railway is a factor in its growth will be kept. The official photographers of the company have begun to work on the plan of the company, and towns along the line will be photographed, each photograph being duplicated yearly, so that a continuous record may be obtained and kept of each individual town from the time it sprung up throughout the period of its growth. The record kept is expected to be of invaluable importance in years to come.

The North-Eastern Railway, like its other two partners in the East Coast route, still believes in the efficiency of the Atlantic type of express locomotive. Some ten more of these are about to be built to haul the heavy East Coast expresses between York and Edinburgh. They will have coupled wheels of 6ft. 10in. diameter, bogie wheels of 3ft. 7½in., and trailing wheels of 4ft. diameter. The wheel base will be 28ft. in length and the cylinders 20in. by 28in., and piston valves will be used. The boiler will have a total heating surface of 2455 square feet. The weight of the engine in working order will be 72 tons and the tender 43½ tons, with a capacity for 4125 gallons of water and five tons of coal.

The Pennsylvania Railway is planning to set out more than 1,000,000 trees. This will make a total of 3,430,000 trees planted in the last three years to provide for some of the company's future requirements in timber and sleepers. This constitutes the largest forestry plan yet undertaken by any private corporation. Heretofore, the company's forestry operations have been confined to a limited area between Philadelphia and Altoona. This year, however, 65,000 trees are being set out on tracts of land near Metuchen and New Brunswick, N.J. In addition, there are to be planted within the next month 207,000 trees near Conewago, Pa., 186,000 in the vicinity of Van Dyke, 334,000 at Lewistown Junction, 7000 at Pomeroy, and 205,000 at Denholm.

The following information is from the report by H.M. Consul at Helsingfors—Mr. C. J. Cooke—on the trade of Finland in 1908, which will shortly be issued:—"For new railway lines a sum of about £380,000 has been granted. It is proposed to build a line through Vichtis to Högfors, forming a continuation of the projected line from Sockenbacka, near Helsingfors, to Nurmijärvi, north-west of Helsingfors. So far the project has reached the preparatory stage only, there being many difficulties in the way. The Finnish Senate have decided that a railway should be built from Seinäjoki station to Kristinestad and Kaskö, but the course of the line is not fixed yet. The line would begin at Seinäjoki, and run along the Kyrö River to the village of Perälä, where it would fork off into two branches.

The railway from the Piræus to the Turkish frontier (246 miles) may be said to be practically completed, the section from Bralo to Larissa having been opened to traffic since October last, and trains now run in twelve hours from Athens to Larissa. The construction of the final section of 28 miles to the frontier is in an advanced state. There remains, then, in order to release Greece from the isolation which she is the last of European States to suffer, but 70 miles between the frontier and the nearest station on the Ottoman railway system. There appears no indication, however, of any disposition on the part of the Ottoman Government to facilitate the construction of the junction line, and it will be regrettable if the reformed Government of Turkey continues to oppose a project so evidently appertaining to an era of civilisation and progress.

On December 12th, 1908, states a consular report, the new Mexican Central Railway line from Guadalajara to the sea port and harbour of Manzanillo, *viâ* Colima, was formally declared open for traffic by the President of the Republic, General Porfirio Diaz, although trains have been running regularly since November 2nd. The opening of this new line, built at a heavy cost, and the completion of which has been delayed time after time by disastrous floods, marks the commencement of a new era in the history of Mexico. The entire Pacific coast, one of the richest districts of Mexico, has hitherto been neglected, undeveloped, and only partially known to the civilised world owing to its remoteness and difficulty of access. With the new railway, Colima, which is the largest city on the Pacific coast, is brought within 24 hours of the city of Mexico.

Reinforced concrete telegraph poles have now been in use on the Pennsylvania Lines West for two years, and while erected in only a few places, are reported to be giving satisfaction where sufficient time for observation has elapsed. The first poles of this description, erected near Maples, Ind., were built after an elaborate series of experiments on both wooden and reinforced concrete poles, which were described by Mr. Robert A. Cummings at the 1907 meeting of the American Society for Testing Materials. These poles are still in service, and though they were within the belt of influence of the severe sleet storm of February 15th of this year, none of them showed any signs of failure. The latest installations are those near Crestline, O., and through the town of New Brighton, Pa. The poles are 30ft. long, 14in. in diameter at the bottom and 6in. at the top, and at present carry one cross-arm, accommodating eight wires.

NOTES AND MEMORANDA.

In 1907 the United States produced 166,000,000 barrels of oil, and in 1908, according to unofficial estimates, the total was in excess of that amount. The United States produces 63.12 per cent. of the entire oil production of the world.

Aluminium paint is made by blowing air or gas through molten aluminium while it is setting and at the same time stirring violently. This forms a spongy or granulated metal that is easily pulverised. The powdered metal is sized and polished.

There were 32 dredges at work in New South Wales at the close of 1908, in the recovery of tin ore, or stream tin; three being bucket dredges and 29 pump dredges. The quantity of stream tin saved during the year was 1562 tons, of £126,480 estimated value.

A rust-preventing coating for iron, used by a German manufacturing company, consists in coating iron and steelware first with lead, then electrolytically with zinc, and finally heating this coating, so as to obtain an alloy of the two metals which has the same potential as zinc.

A new pyrometer for the measurement of high temperatures, known as the Féry spiral pyrometer, has been brought out recently. The new instrument is simple in principle and construction. Instead of the heat rays being concentrated on a thermo-electric couple, as in earlier instruments, they are focussed on a small bi-metallic strip made of two metals rolled into the form of a spiral, which unrolls when heated, owing to a difference in their coefficients of expansion.

An interesting experiment to determine whether the strength of iron and steel was affected by magnetism was carried out at the Technical Institute of Belfast with the following reported result:—Bars of mild steel and wrought iron 8in. long by ½in. to 1in. in diameter were used, part of which were magnetised by being saturated in a solenoid. When tested, the elongation of the magnetised parts decreased 3 to 16 per cent., and the average breaking load seemed to be increased.

The mica produced in the United States during 1908 amounted to 972,964 lb. of sheet mica and 2417 short tons of scrap mica, with a total value of £53,585. In 1907 the production of sheet mica was 1,060,182 lb., of scrap mica 3025 tons, and the total value was £78,422. The average price of sheet mica in the United States during 1908 was 24.1 cents per lb., as compared with 33 cents in 1907. North Carolina is the largest producer, supplying in 1908 599,234 lb. of sheet mica and 1308 short tons of scrap mica.

There are in the United States over 250 makers of automobiles, and this number does not include makers of commercial motor vehicles and trucks. In short, it refers to makers of cars primarily for pleasure purposes. Upward of 100,000 workpeople are directly engaged in these factories, and not less than 4000 allied industries and works are more or less dependent upon the motor-car industry. Truly this is remarkable growth, and if, by reason of its years, this is still an "infant industry," all must admit that it looks like a thriving infant.

A report on the resistance of rivets is presented by M. Ch. Fremont to the *Bulletin de la Société d'Encouragement* for April. It is pointed out that the resistance of riveted plates to statical forces or shocks should be borne as much as possible by the adhesion of the plates, and as little as possible by shearing of the rivets themselves, and the author emphasises the necessity of standardising the heads of rivets and of regulating the maximum temperature during the process of heating, so as not to destroy the elastic qualities of the rivet. The increased efficiency obtained by the application of continued pressure during the riveting is also mentioned.

A monoplane of a new type, designed by Mr. John Neale and housed in a shed on the Aëronautical Society's ground at Dagenham, has been recently completed. The machine consists of a triangular girder of spruce stayed with steel piano wire. At the front end, in solid wooden supports, is the engine, of 12 horse-power. At the extreme front of the machine is the 6ft. 6in. wooden propeller, geared to the engine to revolve once to every three revolutions of the latter. The main plane is 18ft. across by 5ft. in width. At each end of the plane are vertical wooden fins to "hold" the air, and, slightly to the rear, at each extremity are disposed "flaps" for steering and equilibrating. The tail consists of two superposed planes with a vertical rudder behind.

Considerable finds of asbestos have been made in the Urenberg district, covering large areas and of great body and fine quality. The discovery refers to two places named Peyan-Tchin and Ak-Zigit respectively, the area of the latter asbestiferous ground being estimated at 48 square versts. The deposits are found in the form of large strata of serpentine lying amongst silicious schist and porphyry. The strata are intersected by many veins of serpentine which contains the asbestos. These veins in many cases rise right to the surface, and where the ground is stony and there is no soil on the top they are quite visible. The veins extend to various lengths, varying from 350ft. to 1400ft. and even 2100ft., and it has been found that at that depth the mineral does not change in form and that the quality rather improves. The fibre taken singly seems to be quite white, but in the bulk the colour is olive green. It is beautifully soft and woolly. The land on which the discovery has been made is in the Orsk district.

It may be affirmed, states a consular report, that the State of São Paulo has been the cradle of the utilisation of hydraulic power in Brazil for generating electricity. That at present, however, turned to account is but insignificant in comparison with the immense undeveloped resources which the State possesses in the numerous large waterfalls, mostly State property, and to a large extent still unexplored. The principal hydro-electric installations constructed in the State are that of the São Paulo Tramway, Light, and Power at Parnahyba, with a capacity of 8000 horse-power, and those of various other companies, viz.:—Jundiahy, generating 1000 kilowatts; Sorocaba, 1000 kilowatts; Rio Claro, 580 kilowatts; Mococa, 500 kilowatts; Piracicaba, 450 kilowatts. The important hydro-electric station in course of construction by the Santos Dock Company at the Itatinga Falls, near to Santos, which should be completed in a year's time, will transform and transmit electric energy of 3000 kilowatts, which will be used in the working of the cranes on the quay at Santos and the supply of light and power to that city.

"With the advent of the airship and aëroplane as practical machines," states a contemporary, "there arises the enormous possibility of their being used for illegal purposes, namely, smuggling. Within the next year or two the science of aviation is certain to grow to an extraordinary extent, and then we shall behold a gradual revival of the old smuggling days, only by air instead of by sea. According to reports, a privately owned airship recently started from its hiding place somewhere in the south of England and calmly journeyed to Ireland in one night, encamped during the day within a few miles of a large town, and returned to its home the following night without being discovered. Now, if that is true, continues our contemporary, how simple it would have been for the owner of that airship, had he so desired, to have done a little smuggling of illicitly-distilled whisky. And so airships in their present embryonic state are in reality an unknown danger to the Customs, for who knows that there are not other secret airships in construction in this country and abroad? How the possible evil is to be encountered is a problem which the authorities should consider at once."

MISCELLANEA.

The sixth German Dreadnought, the Ersatz Oldenburg, will be launched at Wilhelmshaven in the middle of September.

The next international congress of mining and metallurgy is to be held in June, 1910, at Düsseldorf. The last Congress was in 1905, and the place of meeting Liège.

A consular report dealing with the trade of Japan states that machinery is one of the very few items which not only shows a substantial increase over the 1907 figures, but which establishes an easy record as regards all previous years.

Elaborate provision has been made at Portishead for the importation and storage of motor spirit. This is a new enterprise developed at Bristol docks, which are to serve as a centre for the distribution of supplies to the West of England, the Midlands, and South Wales.

The difficult navigation in the Sound in the winter season, on account of the ice, not only in the traffic with Copenhagen, but in the passage through, to and from the Baltic, has given rise to the idea of making a deep-water harbour north of Elsinore, at the entrance to the Sound.

The first steel steamship ever built in the maritime provinces of Canada is under construction at Yarmouth, Nova Scotia. A great development is expected in this industry, which, in the days of wooden vessels, was such an important factor in the prosperity of the provinces bordering on the Atlantic Coast.

The new graving dock which the Clyde Trustees propose to construct at Renfrew is, states a contemporary, hardly likely to commend itself favourably to the Admiralty, owing to its situation so far up the river, with its restricted width and depth, which would prove a stumbling-block to its use by such Dreadnoughts as might reach the Clyde in a damaged state under abnormal draught conditions—the very contingency which has to be provided against, and which a floating dock appears to be best suited to cope with.

A matter of great importance for Leipzig, states a consular report, is the building of a canal, which will give the town a direct waterway to the sea, and will thus facilitate commerce with foreign countries, and not least with the United Kingdom. The scheme has developed considerably in the year 1908, after careful preparatory consideration extending over thirty years. Shortly before Christmas a Leipzig company, the Leipzig Canal Company, Limited, was formed to provide capital for the initial and technical expenses of a connection between Leipzig and the river Saale.

The Carnarvonshire County Council have passed the following resolution:—"That the attention of the Chancellor of the Exchequer be called to the unfairness of imposing a tax on petrol when used for commercial purposes, when steam motor lorries are not subject to any tax or duty, and that, whereas soft-tired motor cars have to pay a carriage duty varying at present with the weight, and next year with the horse-power, of the car, and traction engines are subject to an annual licence of £10, heavy motor cars, which do an incalculable amount of damage to the roads, are exempt from all impositions of the kind."

Owing to the extreme lightness of the hull plating of torpedo craft, it has been found necessary strictly to carry out the "drill testing" of the bottom plating of these vessels periodically, in order to check deterioration and ensure their being maintained, as regards the hulls, in a state of efficiency. Postponement of these important tests having recently led to the development of weakness in certain cases, with consequent leakage, thus necessitating special docking, orders have been issued that in future the instructions governing the tests are to be strictly adhered to, advantage being taken to carry out the drill tests while the vessel is in dock for her regular overhaul of the underwater fittings.

As the result of several representative meetings of electrical engineers held recently, it was considered advisable to form a South African Institute of Electrical Engineers, and at a largely attended meeting, held on the 12th inst. at the Grand National Hotel, Johannesburg, the Institute was duly founded, and draft rules approved. A provisional committee was elected to act as the council until the first general meeting of members, when the officers and council will be elected. All those joining the Institute prior to July 7th, 1909, will be considered foundation members. It is hoped that the hearty co-operation of the electrical engineers of South Africa will be given to this new society.

Replying to Mr. Arthur Lee, in Parliament, recently, Mr. McKenna said that neither the submarine C 11 nor C 17 carried the new safety helmets for enabling the crew to escape in the event of the vessel foundering. These life-saving helmets were a new invention, of which it had not been possible to obtain supplies sufficient to equip all submarine vessels. Delivery of the whole quantity ordered would not be completed until November next, but supplies were being distributed to submarines as the deliveries were received. The air traps required to enable the helmets to be used had been fitted to C 17, and were to have been fitted to C 11 at the first opportunity of the boat being in dockyard hands.

The work of building the engines for submarine C 19 in the engineering factory of the dockyard has been completed, and they were recently subjected to a very severe test. No difficulty was experienced in securing the requisite horse-power, and the machinery worked smoothly. The engines will now be placed in position on board the boat which is lying in dock. Considerable progress has also been made with the building of the engines for C 33 and C 34, the last pair of boats to be ordered. It is expected that orders will be received next month for a commencement to be made with the construction of two boats of a larger and improved type. The new submarines are to be fitted for burning oil fuel.

The destroyers Bonetta and Albacore, which were directly purchased, have during the recent operations been subjected to a thorough test of their steaming and sea-going qualities, with satisfactory results. These destroyers differ considerably in design from previous vessels of the type, and may be considered as a compromise between the 30-knot and River class, possessing the curved deck of the former and the high bow of the latter class. They differ, however, from both classes in having the upper strake of plating hollowed out to form a "flam" bow, which gives them a very striking appearance, and steadies the vessel when pitching. The stern section of the Bonetta and Albacore is almost identical with that of the Scout class. They are now being prepared for receiving their gun and torpedo armament.

In the House of Commons recently, Captain Craig asked the First Lord of the Admiralty whether the Great Central Railway Company had at any time offered to construct a dry dock on the East Coast at Immingham, capable of accommodating a battleship of the Dreadnought class, for a yearly subsidy or for the difference in price between such a dock and one satisfying commercial requirements; if so, when was such an offer made; and had it been accepted by the Admiralty? Mr. McKenna said that an offer had been received from a company in close connection with the Great Central Company to construct a dry dock for a yearly subsidy. It was made last month, and was declined, as the subsidy was so high as to be prohibitive. Mr. Renwick (U., Newcastle-on-Tyne) asked if negotiations were still going on. Mr. McKenna said that he could not answer that question.

THE TRAIN FERRY STEAMER DROTTNING VICTORIA

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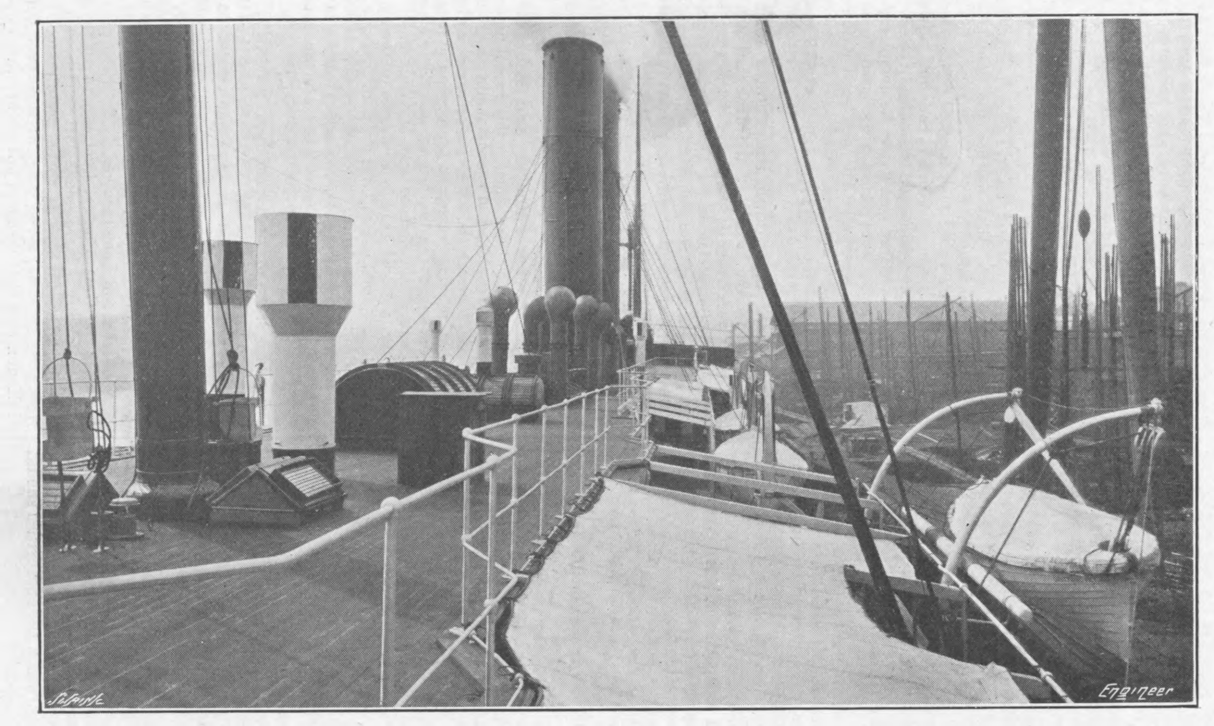
(For description see page 107)



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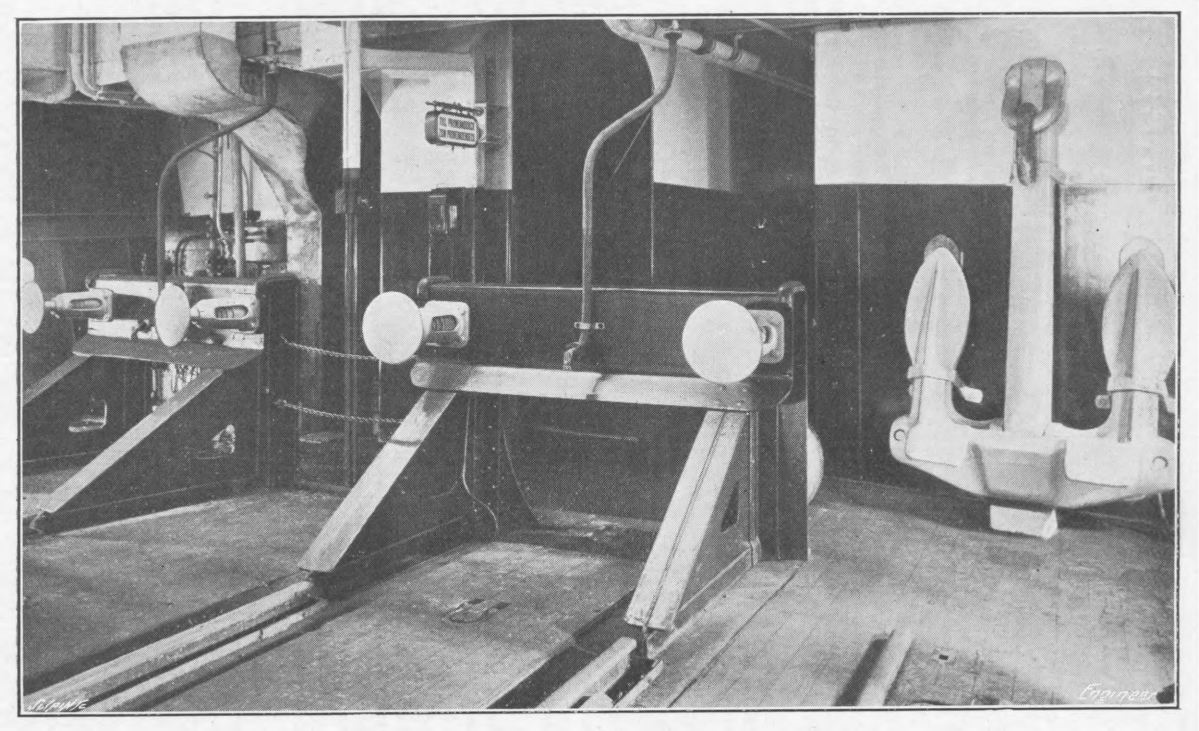

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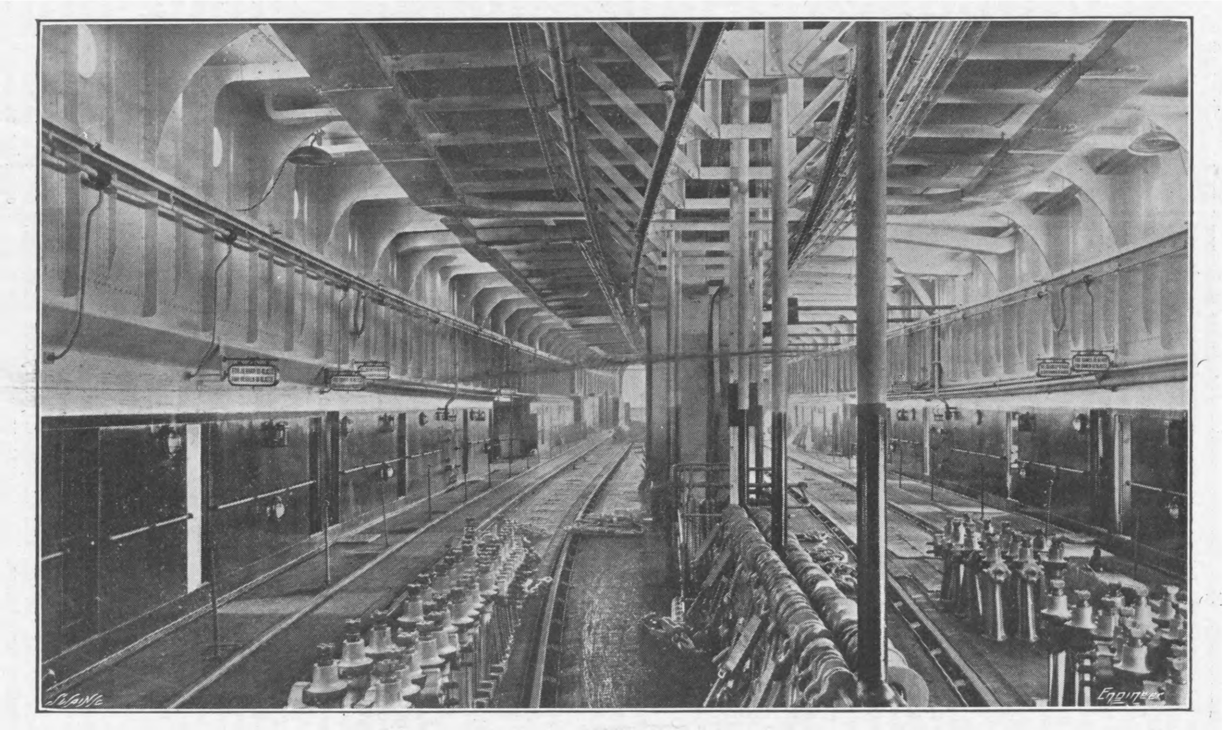

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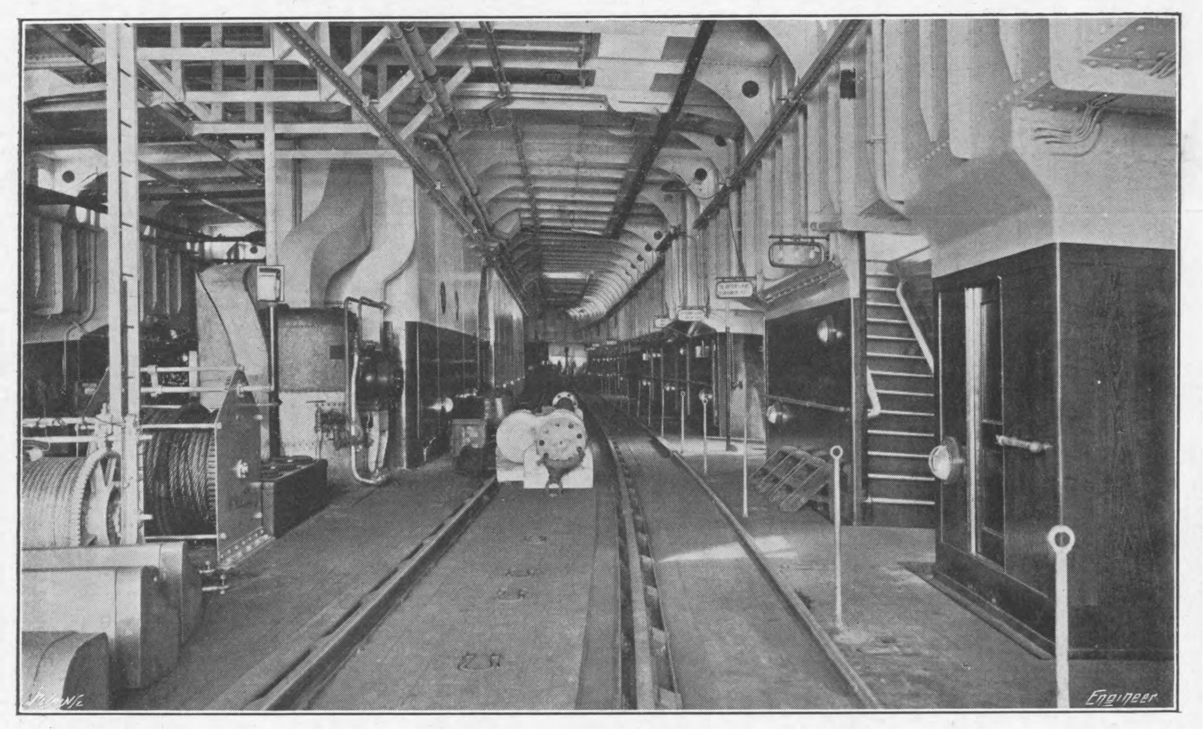

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Letters relating to Advertisements and the Publishing Department of the Paper are to be addressed to the Publisher, Mr. Sydney White; all other Letters to be addressed to the Editor of The Engineer.

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*** *With this week's number is issued, as a Supplement, a Two-page Drawing of the Train Ferry Steamer Drottning Victoria. Every copy as issued by the Publisher includes a copy of this Supplement, and subscribers are requested to notify the fact should they not receive it.*

H.M.S. BELLEROPHON.

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TO CORRESPONDENTS.

☛ *In order to avoid trouble and confusion we find it necessary to inform correspondents that letters of inquiry addressed to the public, and intended for insertion in this column, must in all cases be accompanied by a large envelope legibly directed by the writer to himself, and stamped, in order that answers received by us may be forwarded to their destination. No notice can be taken of communications which do not comply with these instructions.*

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INQUIRIES.

COATING COPPER WITH LEAD.

Sir,—I shall be much obliged to any reader who can tell me how to coat plates of thin copper, about 8in. square, with lead on one side. I can tin these plates easily enough, but I cannot lead them. I have tried resin, killed spirit, sal-ammoniac, without success.

Cuprum.

July 28th.

THE ENGINEER.

JULY 30, 1909.

The Coal Trade Situation.

THE best that can be said about the Scottish coal trade dispute at the moment of writing is that negotiations between the Miners' Union and the coalowners, under the auspices of the Board of Trade, have not been broken off. But the prospects of a peaceful settlement are less bright than they were a week ago. As a result of last Thursday's conference the Scottish coalowners agreed to suspend the notice of a 12½ per cent. reduction of wages, which was to become operative on 26th inst., for a week, and, in the meantime, negotiation was to proceed upon a reference as to the "conditions" which "ought fairly to be attached to the recognition of a new minimum, both as regards the limits and the rates of variation of wages above the minimum, and the procedure by which changes of wages should be regulated." On Friday, in London, and again on Tuesday, in Glasgow, the terms of this reference were discussed. No settlement was arrived at, and another joint conference is to be held in London to-day, Thursday. Possibly the threatened conflict may even yet be avoided, but the attitude—we may almost say the temper—displayed by the miners' leaders on Tuesday, both in conference and in conversation after the conference, renders the hope of avoiding rupture somewhat meagre. We may still hope that a strike, and all that that implies in financial loss and human suffering, will be averted; but frankly, we view the prospect with grave misgiving. Even if the Scottish dispute—the merits of which we discussed on 16th and 23rd inst.—is settled peacefully, the question of a 5 per cent. reduction in the wages of English miners will have to be faced a fortnight hence. Besides this, the difficulties connected with the operation of the new Eight Hours Law are not being smoothed out very well, and are of such a character that in some districts both miners and managers are having their tempers sorely tried. We hear many mutterings, and we know that in some quarters there is a disposition to welcome the prospect of a great national strike merely to "clear the air." With the question of a new minimum wage and sliding-scale for Scotland; the demand of the coalowners in the Federated districts of England and Wales for a five per cent. reduction of wages; with a serious diminution of output in Wales and some other districts consequent upon the reduced working day; and various other inconveniences which are being suffered by miners as well as owners—notably the interference with mealtimes and Saturday half-holidays—it is not too much to say that the mining industry was never in a more widespread state of unrest than at the present moment. Anything may happen. The whole situation is being aggravated by the Eight Hours Act, by the vapourings of untruthful Socialists, and by the existence of the infamous Rule 20 of the Miners' Federation.

Rule 20 stipulates "That whenever any county, federation or district is attacked on the wages question, the members connected with the Society shall tender notices to terminate their contracts, if approved of by the conference called to consider the advisability of such joint action being taken." It is the knowledge that the great majority of the miners in England and Wales are prepared to enforce this rule that is encouraging the leaders of the Scottish Miners' Union not only to resist the demand of the owners for a reduction of wages, but in refusing to submit the matter to arbitration. What justification is there for Rule 20? And what justification is there for its enforcement, in case the Scottish coalowners persist in their demand for a reduction? Why should there be a national strike, or the threat of such a strike, over a local wage dispute? It is a physical impossibility to work all our mines on one hard and inflexible principle. Not only have we widely varying qualities and prices of coal, but we have widely varying *per capita* outputs of coal, in the various districts. In one part of the country the output of coal, per worker employed, exceeds 373 tons a year; in another district the *per capita* production is less than 260 tons. As with the natural conditions of mining, so with the market value of the mineral. Roughly, the pit mouth price of coal in Scotland is, on the average, from 1s. 3d. to 1s. 6d. per ton less than in England, and from 3s. to 4s. per ton less than in Wales. In face of such facts as these we can do nothing but condemn the Miners' Union for seeking to set local conditions at defiance. Surely the wages of Scottish miners might be ruled by the circumstances of Scottish industry, and fixed by mutual bargaining and independent judgment on the spot by responsible persons, rather than by the strength of organised labour in England, manipulated by irresponsible agitators. The real object of this Rule 20 is the ultimate establishment of one uniform wage for all the miners in the country, regardless not merely of the abilities of the men, but of the natural conditions of the mines. Obviously, the ultimate end is as impossible as the immediate means are unwise. Besides, granting for a moment that Rule 20 was drafted with a practical, or legitimate, object in view—that the miners in one district are entitled to support, even to the extent of a sympathetic strike, their comrades in another district, in accordance with the terms of the rule—what cause, we may ask, is there for the application of this rule on the present occasion? Where is there in the demand of the Scottish coalowners any "attack" on the wage question? In 1904 the Scottish Miners' Union was a consenting party to an agreement under which wages might, by sliding scale, drop to a minimum of 5s. 6d. per day. All that the owners have asked is that this agreement be adhered to. Failing this, they have offered to submit the point to arbitration, or to the judgment of the independent Chairman of the Coal Trade Conciliation Board. They have offered to support their case by documentary proof of market conditions, and then to abide by the result. Where, then, we repeat, is the "attack" upon wages which justifies the enforcement of Rule 20? The machinery of the sliding scale was quite good enough for the Miners' Union when trade was "booming" and prices rising; but now, in a moment of deep depression and acute unemployment, and when cheap coal is the cardinal essential of industrial recuperation, the sliding scale agreement which has served so well in the past is to be abrogated, and either the price of coal is to be put up permanently, or its supply is to be cut off temporarily. For, indeed, if the coalowners consent so to revise the "basis price" of coal, or the sliding scale, so as to permit of the establishment of the 6s. minimum for which the miners are contending, it will be the public, and not the coalowners, who will inevitably be called upon to pay the difference between the new "basis" and the old one. Strike or no strike, we are about to pay dearly for having elevated coal-mining to the rank of a petted industry, and for giving a too attentive ear to the gospel of Socialism.

Ever since 1842 the State has been interfering with working conditions in the interests of the miners. Much has been done—and rightly so—to promote safety. But in enacting the Eight Hours Law the State has gone too far. The granting of this unjustifiable concession, coupled with the dissemination of Socialist doctrines, is working mischief among the miners. That the wiser heads of the Miners' Federation recognise the nature of the mischief may be gathered from some significant remarks made at Durham last Saturday. Speaking at a mass meeting of miners, Mr. Charles Fenwick said: "It grieved him more than he could tell when they had men coming amongst them free from responsibility counselling extreme measures amongst men whose passions were easily inflamed, but not easily allayed. These men occupied a position wholly detached from the association, and if industrial war should take place, would not be there to share with the leaders of their association the responsibility of guiding it to a correct issue. He regretted more deeply still that these men should be listened to." And there is ample cause for regret. These Socialists come into the big cities and tell the public that the miners raise coal for a mere fraction of its selling price, and then they go among the miners and inform them that no matter what course they—the miners—adopt, both public and Parliament will support them.

Locomotive Fire-boxes.

WE all know that the weakest part of a locomotive engine is the internal fire-box, in the sense that it wears out quickly and costs much money for renewals and repairs. It is therefore not a little remarkable that no complete study of fire-boxes has ever been made. Much has been written about them, no doubt, but the literature of the fire-box is desultory and unsatisfactory. No principles of dimensions or form have been settled. As to material, there is a wide diversity of opinion, resulting in an equal diversity of practice. Theory has been invoked, limited practice has been cited, and so at this moment the duration of the fire-boxes in any particular group of engines seems to be more a matter of luck than guidance.

The internal fire-box presents itself for consideration in two aspects—first, as a chamber in which to burn fuel to the best advantage; secondly, as a chamber whose external superficies constitute heating surface. In so far as combustion is concerned, the proportions of the fire-box are largely determined by the quality and formation of the fuel burned. Thus, to cite extreme cases, we have the anthracite pea coal, which must be burned on a close barred grate, in a thin stratum, with a gentle draught; a sharp draught would lift it off the bars and send it flying unburned up the chimney. Thus, grates as much as 8ft. wide and 9ft. long have been used. Again, in Belgium, fine bituminous slack coal is well watered until it resembles mud, and this is burned on grates of about the same dimensions. For good bituminous coal a grate 3ft. 5in. wide and 9ft. long is freely used in this and other countries. To get a still larger grate, the fire-box has been made to overhang the side frames, and we have in this way grates 5ft. wide and 6ft. long. The distance from the crown sheet to the grate bars is an important point, varying with different kinds of coal. Some coals must be fired "thin," some "thick." A thick fire in a shallow box will usually make a great deal of smoke; a thin fire in a deep box will not keep steam. But the locomotive boiler is very accommodating, and unless there are outrageous defects in proportion, a skilful fireman will usually surmount difficulties. Theoretically the level of the fire bars ought to admit of adjustment with the character of the coal and the load behind the tender. In practice this idea could not be carried out, save, indeed, to the extent that grates may be altered both in level and width of opening to suit the coal of particular districts on which the engines are working for the time being. The difficulties met with in securing complete smokeless combustion are fairly well understood. We have no intention of discussing them here. It is enough to say that none of the refinements dictated by theory can be applied in practice. The regulation of the air supply can only be done roughly; everything depends after all on the coal and the fireman. The first consideration with him is to keep the safety valves very nearly lifting. After that he will take account for economy and smokelessness.

The way in which coal is burned seems to have little effect on the life of a fire-box. That depends in the main on the performance of the outside of the box as heating surface. We have shown not long since that if the surfaces are clean, and kept really wet, the presence of the plate may be disregarded, the temperature of the plate at the fire side not being much greater than that of the water in the boiler. But the "if" involves a great deal, and some facts learned in practice are rather curious. Thus it seems to be proved that fire-boxes with narrow grates will last much longer than those with wide grates. There are so few locomotives with wide grates running in Great Britain, that experience had with them is far too limited to count for much. In the United States it is not so. We find much information in a paper by Mr. Seley, read before the Western Railway Club not long ago. Mr. Seley is mechanical engineer of the Chicago, Rock Island and Pacific Railway. He finds that one of the special troubles with the wide fire-boxes on several roads has been the short life of the side sheets as compared with those of narrower boxes, involving a large increase in the maintenance and repair expenses. Discussing this paper, Mr. J. F. De-Voy, assistant superintendent of motive power of the Chicago, Milwaukee and St. Paul Railway, was very emphatic. Of 18 passenger locomotives of the 4 : 4 : 2 class with narrow (42in.) fire-boxes, only 4 have had new door, tube, crown or side sheets in ten years. Of 28 engines of the same class with wide (66in.) fire-boxes, each had had at least one new sheet in seven years, and some had had as many as three sets of side sheets in that time. In one year, 140 stay bolts were applied to the narrow boxes as against 585 in the wide boxes. Of 16 freight locomotives of the 4 : 6 : 0 class built in 1900, and having narrow fire-boxes, all retained their original boxes in 1906. Of 66 locomotives of the same type, but with wide fire-boxes, built during 1901 to 1903, 14 had had new door, tube, crown, and side sheets in 1906. Tubes lasted nearly twice as long in the narrow boxes. During 1½ years there were 152 new stay bolts applied to the narrow boxes, as against 1127 for the wide boxes.

At first sight it is very difficult to account for these rapid failures. Generally speaking, the water spaces in the fire-box legs are wider with the large than the small box. The water is the same for all the engines. It is reasonable to suppose that the combustion is less fierce in the wide than in the narrow box; indeed, to secure slower combustion is one of the objects had in view. So far as we can learn, there is small difference in the explanation given by various engineers. It has been argued that to slope the sides of a fire-box inwards over the fire must be a good thing, as it favours the absorption of heat by the water, and facilitates the rise of steam bubbles, instead of permitting them to cling to the metal. But in practice it is found that somehow this theory does not work, and it is best to make the side sheet either stand up straight, or, still better, incline outwards. There is reason to believe that although water cannot, if left to itself, be heated from above downward, save with extreme slowness, yet that a rapidly flowing current will freely take heat from a plate above it. It is known that the currents in water legs are very rapid. The explanation given of the injurious effect of sloping the plates inwards is that the rising current is so rapid that it interferes with the descending current, the result being that the leg is filled with foam instead of solid water, and the plate is overheated; whereas, when the plate inclines outward, the action is not so violent, and clashing of currents does not in effect take place. It may be added, we think, that deposit is far more likely to cling on a sheet inclined inward than under a sheet inclined outward. However, be the explanation what it may, it seems to be clear that the wide fire-box will not stand as well as the narrow box.

Mr. Hughes, chief mechanical engineer of the Lancashire and Yorkshire Railway, read this week, during the Liverpool meeting of the Institution of Mechanical Engineers, a paper on the locomotives built at Horwich which contains a great deal of useful information. Nothing is said, however, concerning fire-boxes which throws any light on the questions we have raised. We find, however, that the water spaces have been made wider, as constantly advocated in our pages, with the best results. Mr. Hughes has not found the Hoy corrugated circular fire-box a success. No fewer than 108 large eight-coupled coal engines were built in 1900 with Belpaire boxes, and a further twenty-one with the corrugated fire-box. Particulars will be found in the paper itself. The point which claims particular attention here is that these furnaces became distorted, coming in, not at the top, but at the sides. They were set out again with a 200-ton hydraulic jack in the usual way. Up to the present it appears that fifteen of the boxes have been twice jacked, with an average mileage of 61,700. It is obvious that there is something exceptionally wrong here. We can cite the case of a large steamer, with six double-ended boilers, and thirty-six furnaces carrying 160lb.; only two furnaces have needed jacking in eighteen years. Mr. Hughes says that the circulation in the Hoy boiler is bad; but he does not say why, nor can we see any reason why the furnace plates should become short of solid water. It is, of course, true that the combustion is much more rapid and the heat intense than it is in a marine boiler. It is suggestive that the sides come in, tending to raise the crown, instead of the crown coming down. This seems to support the contention that the sides of a box should not turn in over the fire.

Of course there are a great many factors to be considered, as, for example, the material of the box, and the treatment which it receives. Information is too small to permit of any dogmatic assertion of opinion. Facts, however, whether they can or cannot be explained, must not be ignored. Those we have given are too consistent and too serious not to possess a great deal of value if they are properly used. In this country extraordinary and indeed unaccountable differences are met with in the duration of fire-boxes. No satisfactory conclusions can be drawn until facts are collected and compiled—a work well worth doing.

The Treatment of Rail Steel.

IN our last impression we dealt with the information supplied and the opinion expressed during the recent meeting of the American society for testing materials. We confined our attention, it will be remembered, to the breakage of steel rails; and we expressed the opinion that for the breakages it was not so much the chemical character of the metal or the method of its production that was responsible as the treatment which the steel received during the process of its conversion from the ingot into the rail. Papers were read, and much discussion took place, particularly on the treatment of the ingot. Much ground with which the steel manufacturer and the rail maker ought to be quite familiar was traversed over again once more. The apparent ignorance of men who are esteemed skilful and competent concerning what has been done years ago at this side of the Atlantic is at once curious and interesting. For example, let us take the consolidation of ingots.

Last week we mentioned a rail which had a fissure in it extending from end to end, the result of a blow-hole in the ingot. This was but one of many cases cited. The question turned not on the prevention of the formation of these blow-holes in the ingot, but on the possibility of welding them up subsequently. In this country a certain proportion of every ingot has to be cut off because it is "piped" or otherwise unsound. In the whole report of the paper and discussion which lie before us we can find no reference whatever to the cutting off of the tops of the ingots. We, of course, do not say that it is not done. Indeed, we know that it is done frequently. But we gather that the cutting is not popular; and all the speakers dealt, not with the removal of blow-holes, but the possibility of welding them up. That they could be welded efficiently was contended by many speakers. Indeed, the point was brought out on behalf of the steel manufacturers that the closing of blow-holes is the very purpose of certain methods of working, such as the raising of the steel to a very high temperature, and then cogging it with a heavy draught. It is contended that fissures in an ingot treated in this way will all be welded up, the occluded gas being squeezed out. On the other hand, it is argued with perfect soundness that if any scale or oxide is in the original fissure, as it cannot escape no welding can take place. It is not easy to see how oxidation can occur inside an ingot, and it appears to be indisputable that soundness can be imparted by proper treatment. One speaker attributed all the defects of modern rails to the cogging mill. Thus, forty years ago, ingots instead of being cogged were treated by the hydraulic squeezer, which was, if not introduced, much used by the late John Haswell when locomotive superintendent of the Austrian State Railway. At Pencoyd works a 20-ton steam hammer was used to reduce ingots for the rolling mill, with, it is said, the result that broken rails were unknown. But it must not be forgotten that more time was available. The enormous output of rails in the States is inimical to leisurely processes and methods of manufacture; and the problem is complicated by the necessity for speed. If, that is to say, more time is required to hammer an ingot than to cog it, it will be cogged, not forged.

The question next comes up, can soundness in the ingot be obtained by fluid compression? This is a very, very old story with English steel manufacturers. Much water has run under the bridges since Whitworth patented fluid compression. The contention was then, and is now, that no amount of compression will get rid of occluded gas, simply because it cannot get out. Among the papers read was one by Mr. Bradley Stoughton, of New York, "On the Physical Quality of Steel which has been subjected to Compression during Solidification." The conclusions at which he arrived may be thus stated:—"Compression during solidification lessens the liability of steel to contain the remnants of pipes, blowholes, segregation and external cracks, and partially prevents the development of a weak structure during crystallisation. So far as is shown by the tests we have been able to find, it also slightly increases the strength of finished steel and increases its toughness under impact, besides making the different parts of ingots more uniform in quality both before and after rolling. There are at least eighteen plants in England and Europe equipped with a total of three to forty presses, and at least three or four plants, so far as we are informed, with about an equal number of presses in America."

Professor Howe, who opened the discussion, confined his remarks almost entirely to the Harmet process, which consists, as is pretty well known, in the forcing up through a tapered ingot mould of the molten metal. This he terms a forging operation taking place at an unusually high temperature. But as to what really goes on he did not pretend to know any more than other people—that is to say, next to nothing. About all that could be said was derived from Harmet's own reports, which showed that finished steel rolled or forged from compressed ingots showed an enormously high elastic ratio, suggesting that the steel may have been finished at lower temperatures than material from ordinary ingots with which comparisons were made. Similarly the impact tests give evidences of colder finishing of the steel from compressed ingots than of that from ordinary ingots. The question is thus raised whether the superiority indicated for the fluid compressed steel is not due to treatment subsequent to the compression.

Steel makers will see that all this leaves matters very much where they were. It must be remembered that all compressing plant intended to deal with a very large output is enormously expensive, occupies much ground, and may cause serious delay. This question of cost was not forgotten, and Professor Dudley asked the meeting whether it was worth while to make better steel. It is proper to add that he meant that the true remedy lay not in making better rails, but in supporting incompetent rails better. In other words, by making permanent way better as a whole. He went on to make the extraordinary statement that while the question of rails is a balance between the cost of the rail and the cost of supporting the rail, "No data as to methods or cost of better track construction and maintenance are now available. Engineers of maintenance-of-way must obtain them, and so lay a foundation for answering the question. The problem will come up prominently during the next five years; and if it turns out that it will cost more to give the rail better support than to get better rails, we must get better rails." This is to attribute an ignorance to the railway engineers of the United States, an ignorance which they will no doubt hasten to repudiate. So far as our own experience goes, the men who design the permanent way of the better class of railways in the United States and are responsible for its efficient maintenance know quite well what it costs, and can supply Professor Dudley with the information for which he asks—if they think it desirable. It may be added that one speaker said that he did not see what was to be got by putting ties—sleepers—closer together, as he had broken rails on bridges where the ties were only 4in. apart. Professor Dudley forgets that there is a limit to the closeness of sleepers beyond which they cannot be packed up.

It is a pity that none of the great rail makers were present, or, if present, took no part in the discussion. There are so many things to be considered in the production of really good rails that little is to be expected from discussions carried on by men who only possess a half knowledge of the subject. The proceedings as a whole added nothing to the existing store of information in so far as it might lead to the production of better rails. The American question is really, it seems to us, not, how shall we make a better rail? but, why do we not make a better rail? The reply to the first question can be obtained by studying the practice of this country, France, Germany or Italy. The answer to the second question will only be obtained when the people of the United States insist that it shall be given.

LITERATURE.

Cane Sugar and its Manufacture. By H. C. Prinsen Geerligs. Amsterdam. 1909.

AT the first glance one may be disposed to consider this book, if not fitful, at least somewhat fragmentary, but judging it purely as a compilation its encyclopædic nature will make it a valuable addition to the literature of sugar, and as a work used in conjunction with other works on this subject, as also for purposes of rapid reference, the clear definitions and concise paragraphic style will make it exceedingly helpful.

Touching now upon one or two details, we must first commend the use of Fischer's nomenclature for the purpose of differentiating between the varieties of sugars, and we are in entire agreement with the author that confusion is frequently caused by the usual want of clear definitions of such important terms as invert and reducing sugar, sucrose, fructose, &c., which should, and in this case has been made to, constitute actually the very alphabet of sugar chemistry.

The first portion of this work is devoted to dealing with the raw material, and is really an index of chemical conditions; being explanatory of the principal phenomena occurring in sugar chemistry, it thus serves as a useful preface to the all-important subject dealt with in the second part, viz., the manufacture of sugar.

In Chapter I. of Part I., dealing with the constituents of the sugar cane, very complete tabulation has been resorted to for illustration of such matters as the solubility of sucrose at different temperatures, and its contraction on being dissolved in water; also Scheibler's interpolation formulæ from computation of Gerlach's formula for the specific gravity of x per cent. of sucrose dissolved at 17.5 deg. Cent., is a useful adjunct to the Brix. spec. grav. tables of sucrose solutions at a temperature of 15 deg. Cent. The author has given a very full determination of the refractive index of pure sucrose solutions at a standard tropical temperature, and this, followed up with a table of corrections for temperature, makes it universally useful.

The second chapter, on the proportions and distribution of the constituents of sugar cane, contains much useful information; but perhaps the most noticeable feature here is the manner in which the separate joints of the cane stalk has been treated with a view to their analysis and for the accurate determination of the places of maximum sucrose content at variable periods of growth and season.

In Chapter I. of Part II., dealing with mills, the subject of maceration takes a prominent part, and receives careful analysis; also the recorded results of tests on 12-roller mills will not fail to interest those whose plans for central factories are in the initial stages of formulation.

The stress laid on the regulation of crushing and maceration by striking a judicious compromise between these two important factors, shows the very comprehensive view the author takes of this subject.

From the chapter on diffusion and those immediately preceding it, one is able to draw a very fair comparison between the advantages and disadvantages of milling and diffusion, a most important consideration, before committing oneself to either process.

Clarification and carbonatation methods, together with the chemistry of lime kilns, crystallisation-in-motion process, and the problems of megass as fuel, &c., occupy most of the last portion of the work. We feel that the author was right in restricting his work to a purely chemical treatise, as in many cases where elaborate analysis of constructive engineering details is intermixed, the very multiplicity of information is liable to defeat its own ends.

SHORT NOTICES.

A Practical Treatise on Bridge Construction. By T. Clax, ton Fidler. London: C. Griffin and Co., Limited, 12-Exeter-street, Strand. Price 30s.—Since the previous edition of this book was published in 1901, the author has naturally acquired more up-to-date knowledge, and he has taken the opportunity of embodying it in this fourth edition. The problem of finding a rational determination for the safe working stress is again taken up at the end of Chapter XIII., and the new information given is based on the author's observations and laboratory experiments. In Chapter X. the table giving the calculated breaking weight of columns is now given in more extended and convenient form. The figures have been obtained as before, but they are worked out for closer intervals in the ratio of length to radius of gyration. In Chapter XI. the deductions of Art. 144 regarding the calculable stresses in the various members of a brand strut are compared with the evidences afforded by Professor Burr's recent experiment, as quoted in the report of the Royal Commission of Inquiry upon the fall of the Quebec Bridge. Some of the results of Dr. Stanton's wind experiments are also dealt with. The author points out that the design of the Quebec Bridge was in many respects different from those which he illustrates on the plate of cantilever bridges, and he briefly mentions the general effects that have to be considered in connection with such special features.

Theory of the Recoil of Guns. By F. Rausenberger. Translated by Alfred Slater. London: Crosby Lockwood and Son, 7, Stationers' Hall-court, E.C. Price 10s. 6d. net.—This book is the outcome of some lectures on the theory and calculation of recoiling-gun mountings, which were delivered by the author in 1905, at the Military Technical Academy in Berlin. The book is divided into six sections, and each section is again sub-divided. In the first section the author gives a short general explanation of the subject. He then considers the external forces on a recoiling-gun mounting which come into action on firing. The determination of the brake pressure and the length of recoil is next considered, and following this the running-forward device is dealt with. The fifth section has reference to recoil brakes, and the last section is devoted to the running-forward brake. In the translator's preface it is pointed out that, owing to the extreme secrecy with which the science of gunnery is regarded in this country, there is very little important English literature dealing with guns and gun mountings available; but on the Continent such literature is far more plentiful. The book is one which enters into a good many calculations, and should therefore prove useful to the designer; but at the same time the user of artillery should find the work interesting.

Azimuth. By G. L. Hosmer. London: Chapman and Hall, Limited, Henrietta-street, Strand. Price 4s. 6d. net.—The object of this book, the author states, is to present in compact form certain approximate methods of determining the true bearing of a line, together with the necessary rules and tables arranged in a simple manner, so that they will be useful to the surveyor. It is a handbook rather than a text-book. In all the methods dealt with the author's aim has been to secure sufficient accuracy for the purpose of checking the measured angles of a survey with the least expenditure of time. The author points out in his preface that the necessity for making astronomical observations from azimuth is confined chiefly to geodetic work, and arises so seldom in general engineering practice that many persons engaged in surveying are not familiar with astronomical methods, and therefore are likely to avoid making use of such observations. In this book an endeavour has been made to present the subject so that any one unfamiliar with astronomy will be able to apply these methods, and obtain satisfactory results, without taking the time completely to master the theory underlying the method used.

The Building Foreman's Pocket Book and Ready Reference. By H. G. Richey. London: Chapman and Hall, Limited, Henrietta-street, Strand, W.C. Price 21s. net.—As the title implies, this book is intended for the use of building foremen and for others associated with the various trades which enter into building operations. It is an American publication, and therefore deals with American practice, but at the same time a considerable portion of the information which it contains is equally as useful in this country as it is in America. In the first part of the book the author deals with duties, &c., of foremen, excavating and stone work, brick and terra-cotta work, lime and cements, mortar and concrete, miscellaneous cement and concrete work. Then he goes on to consider carpentry and woodwork, heating and plumbing, miscellaneous trades, drawing and laying out work and the strength of materials. The last three sections of the book are devoted to the weight, size, &c., of various materials; mensuration and time-saving tables, useful receipts, &c. A large amount of information is given in tabular form, and the work throughout is arranged for ready reference.

Automatic Screw Machines and their Tools. By C. L. Goodrich and F. A. Stanley. London: Hill Publishing Company, Limited, 6, Bouverie-street, E.C. Price 8s. 6d. net.—This is an American publication, which is intended for the use of tool designers, tool makers, and machine operators. One section of the book is devoted to various types of machines and their construction, general tool equipments and methods of camming, &c. The other section deals with tools in detail, and it contains specific information, and making and using these tools, the speeds and feeds at which they should be operated, and other particulars are given which should be of service to mechanics connected with screw machine work. The chapters on camming, and on different types of cutting tools, originally appeared in the *American Machinist*. In Section I. some of the machines dealt with are, strictly speaking, of the chucking-machine type, and semi-automatic in their operation. The book is well illustrated, and is probably one of the most exhaustive of the kind.

Slide Valve Motion for Marine Engineers. By Peter Youngson. Glasgow: James Munro and Co., Limited. Price 5s. net.—The slide valve with its gear, the author of this book states, is the pulse of the engine, and is of paramount importance in providing economy in full combined with sweetness in running. The book has been specially written for marine engineers, but at the same time it is not without value to others who are interested in reciprocating engines. It is intended to illustrate the working and management of marine valve gear in a simple and complete manner. The drawings and diagrams which the book contains are well done, and they are very clear. A noteworthy feature about the book is that the last chapter contains one hundred verbal questions and answers on slide valve motion, which makes the book of particular value to marine engineers who are desirous of gaining Board of Trade certificates. The book, which is divided into eight chapters, constitutes a useful addition to the literature on the subject.

The Instanter Decimal Tables of Weights, Measures, and Monies. By O. G. Winzar. London: Simpkin, Marshall and Co., Stationers' Hall-court, E.C. Price 1s. 6d. net.—Although this is a small book, it is nevertheless a useful one. It gives at a glance the decimal equivalents of the monies, weights, measures, angles, fractions, &c., in general use in the British Empire and the United States. For convenience of comparing our weights and measures with those of other countries, or *vice versâ*, tables of metric and other equivalents are given at the end of the book. The author points out that hitherto slide rules and other calculating machines which are so universally used in every class of commercial work on the Continent, have been of comparatively little value to us, as they only work in decimals; but with the aid of this book it should be possible to take more advantage of these time-saving instruments. A noteworthy feature about the book is that it is provided with a thumb index.

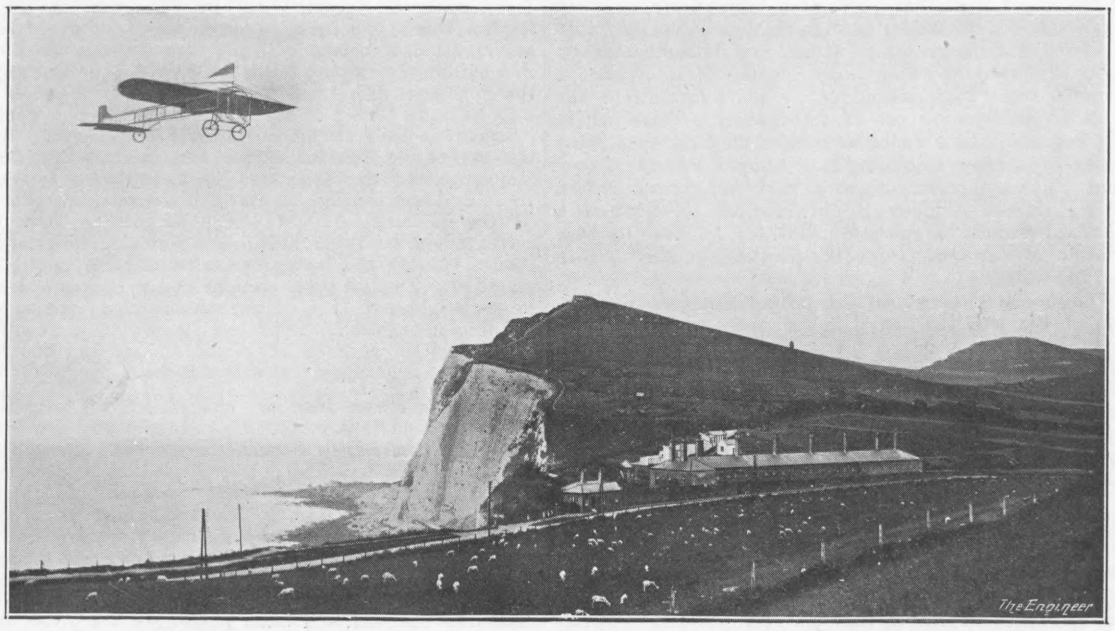
Steam Turbines. By Hubert E. Collins. London: Hill Publishing Company, Limited, 6, Bouverie-street, E.C. Price 4s. 6d. net.—The object of this little book, which is the ninth of the series of "Power Handbooks," is to provide instruction for the adjustment and operation of the principal types of American steam turbines. As in the case of the other books in this series, the majority of the information originally appeared in our contemporary *Power*. The book deals with the Curtis turbine, the Allis-Chalmers turbine, and the Westinghouse-Parsons turbine; and there are chapters on testing a steam turbine, auxiliaries for steam turbines, trouble with steam turbine auxiliaries, and getting the values of a Curtis turbine. The book, which is the first of its kind we have seen, gives a very good insight into the operation and adjustment of steam turbines; but it is by no means exhaustive, and, as already stated, it deals only with turbines of the American types.

Practical Testing of Gas and Gas Meters. By C. H. Stone, B.Sc., M.S. London: Chapman and Hall, Limited, Henrietta-street, Strand. Price 15s. net.—It is doubtful whether this book will prove of much value to English readers, for it deals with American methods of gas manufacture and testing, and as the author points out in his preface, there are many points of difference between the procedure in this country and America. Those, however, who are desirous of gaining knowledge of American methods will find the book useful. The book is divided into four parts, which deal with photometry, chemical tests, calorimetry, specific gravity and pressure, and the testing of meters respectively.

The Ore Deposits of South Africa J. P. Johnson. London: Crosby Lockwood and Sons, 7, Stationers' Hall-court, E.C. Price 5s. net.—This book is intended to meet the demand among those technically connected with the mining industry for a co-ordinated and condensed account of the ore deposits at present known in South Africa. It is also intended as a guide to the prospector. There are chapters on titaniferous and chromiferous iron oxides, nickel, copper, cobalt, tin, molybdenum, tungsten, lead, mercury, antimony, iron, and hints to prospectors. The book is one which can be understood by anyone possessing an elementary knowledge of geology, and who has had some mining experience.

THE CROSS-CHANNEL FLIGHT.

IMMEDIATELY following the attempt made last week by Mr. Latham, M. Blériot, a French engineer, has succeeded in crossing the English Channel on an aëroplane. Starting from Baraques, a village on the French coast, two miles west of Calais, M. Blériot landed at Dover on Sunday morning after safely accomplishing the cross-Channel passage.



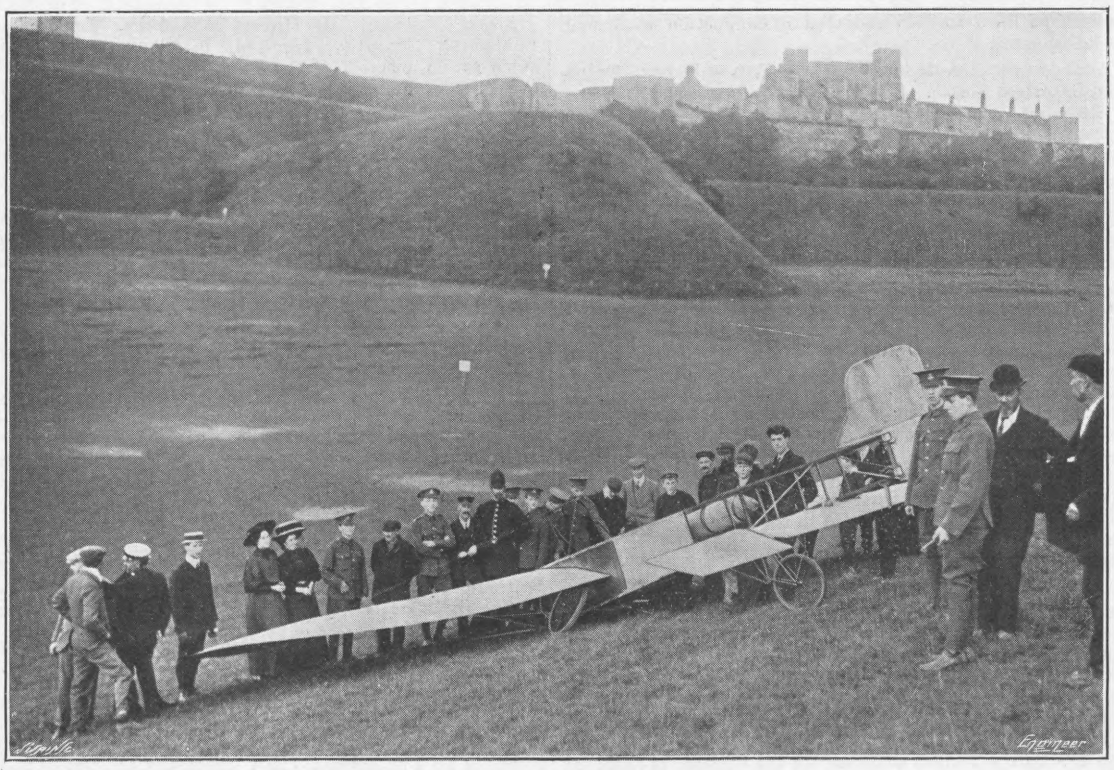
THE BLERIOT AEROPLANE JUST BEFORE ALIGHTING AT DOVER

The journey across was not made without difficulty and danger, although the aëroplanist appears to have had complete confidence in the construction of his machine and in the trustworthiness of his motor. That such confidence is absolutely necessary is obvious, and we are inclined to believe that M. Blériot owes his success largely to this reason.

Favoured by a light south-westerly wind, the aëronaut, after making a trial flight of about 3½ miles, left the French coast at 4.35 a.m., and headed his machine for Dover by the shortest route, being guided at first by the direction in which the destroyer Escopette, which was acting as escort, was steering. The destroyer, however, although steaming at full speed, was soon left behind, and M. Blériot found himself for about ten minutes unable to determine the direction in which he was flying. Proceeding on his journey, he, however, shortly afterwards sighted the English coast, but saw that, owing to the wind, he had been carried to the eastward of his predetermined landing place, and hence, keeping a little over a mile from the coast, he steered his machine in a westerly direction.

On reaching Dover he turned and flew over the cliffs until he arrived above the spot chosen as suitable for the descent. Circling round twice he alighted safely, although some slight damage was done to the aëroplane.

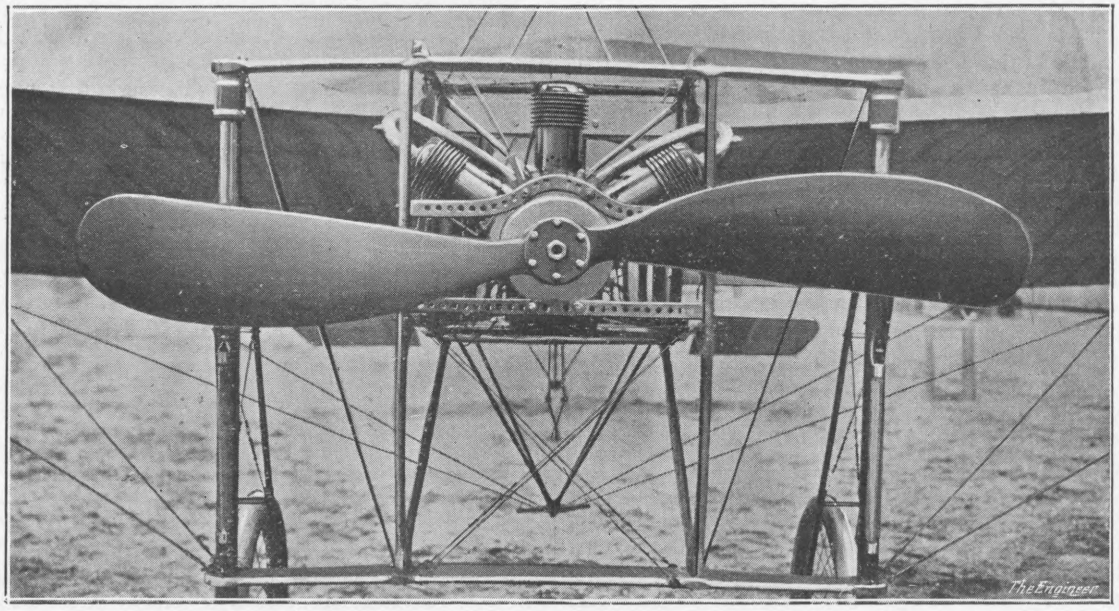
The distance traversed has been estimated at 26 miles and the time taken was 35 minutes. Supposing the estimate of distance to be correct, the average speed works out to about 45 miles per hour. M. Blériot states that he had no difficulty in regulating the height at which he wished to fly, and gives this at about 250ft. above the sea, although he says that he could with ease have doubled this figure.



THE BLERIOT AEROPLANE AFTER ALIGHTING AT DOVER

The aëroplane used on this occasion by M. Blériot is of his own design and construction, and is of the monoplane type, as is that of Mr. Latham.

It consists of a light framework formed of ash and poplar, piano wire being employed for bracing. Attached to the forward end are two curved and inclined planes having a total sustaining area of 17 square yards, the spread of these being 25½ft., while the breadth is about 6ft. A vertical rudder and a horizontal elevating plane are hinged at the after end of the framework, the motions of these being easily controlled from the driver's seat. Suitable means are also provided for changing the inclination of the wings whereby the stability of the machine may be controlled. Immediately in front of the operator's seat is placed the motor, which is directly connected to the propeller. The motor is a three-cylinder Anzani machine, the bore of the cylinders being 4.13in. It is rated at 22 25 horse power, and during the flight on Sunday M. Blériot estimated its rotations at 1200 to 1400 per minute. As regards the weight of the machine, the following have been given as some of the items:—Motor, 132 lb.; framework, 45 lb.; landing chassis, 66 lb. Its total weight, including operator and a supply of petrol, is about 600 lb.



FRONT VIEW OF THE BLERIOT AEROPLANE, SHOWING ENGINE AND PROPELLER

The machine, which is the eleventh made by its inventor, was exhibited at the Salon du Grand Palais, and since its construction in December, 1908, it has been continuously tested and its design improved in the directions indicated by experience gained as to its powers. On July 3rd M. Blériot flew in this machine from Etampes to Chevilly, a distance of twenty-six miles.

Whether or not M. Blériot's performance constitutes a real advance in the science of aëronautics, one perhaps would hesitate to say. There is no doubt, however, that he has greatly increased the interest taken by the outside public in the doings of his fellow-experimenters. In the meanwhile, it is interesting to note that he is reported as having stated that he is prepared to construct a machine capable of carrying six people across the Channel.

We are enabled to reproduce in the accompanying engravings several photographs taken of this aëroplane. One of these shows the machine just completing the passage of the Channel. Another shows it as it lay on the Downs above Dover after the descent, and the third is a front view showing the motor and propeller.

A second attempt made by Mr. Latham on Tuesday to cross the Channel in his aëroplane has, like the first, ended by the aëronaut's falling into the sea. Starting as before from Sangatte, he followed the line of the French coast for a few hundred yards, then turning, proceeded seawards. A flotilla of destroyers was detached to form a convoy, and profiting by M. Blériot's experience, these vessels were spread out at distances of about five miles, so that Mr. Latham had little chance of losing his direction, although rain was falling at the time. He expressed his intention before leaving of flying to Dover, and then continuing, to land somewhere in the neighbourhood of London.

It would appear that everything went well in connection with the machine until the aëronaut had reached a distance of about one and a-half miles from the English coast. At this point, Mr. Latham afterwards stated, the motor, from some cause unexplained at present, suddenly stopped, and the aëroplane dived rapidly from a height of about 200ft. to the surface of the sea. The shock in this case was somewhat more severe than previously, and the operator received some minor injuries. He was quickly rescued and conveyed to land. An estimate puts the distance traversed by Mr. Latham before his mishap at 21 miles, and the time of flight at 20 minutes.

Accepting these figures as correct, it will be seen that he was travelling at a rate greater than sixty miles an hour, a figure which may be compared with the average of 45 miles an hour attained by M. Blériot on Sunday. It is to be noted, however, that Mr. Latham, in his second attempt had substituted a 100 horse-power motor for the 50 horse-power motor which he used in the first instance. The new motor seemed, however, to give some trouble in the earlier part of the day while trial flights were being conducted.

It is reported that a third aëronaut, Count de Lambert, is preparing to cross the Channel. Should this take place, the results will be observed with added interest, since in this case the machine is of the biplane type.

SIX new electric motor coaches have recently been put to work on the North-Eastern Railway. Each coach is equipped with two motors with commutating poles, both carried on the leading bogie, the controllers and other gear being provided at each end of the cars. A feature of the design of the motors is the way in which it is possible for the armatures to be removed from the shafts in case of damage. Each coach accommodates 64 passengers and weighs 33¾ tons.

THE TRAIN FERRY STEAMER DROTTNING VICTORIA

SWAN, HUNTER, AND WIGHAM RICHA ON, LIMITED, WALKER-ON-TYNE, BUILDERS

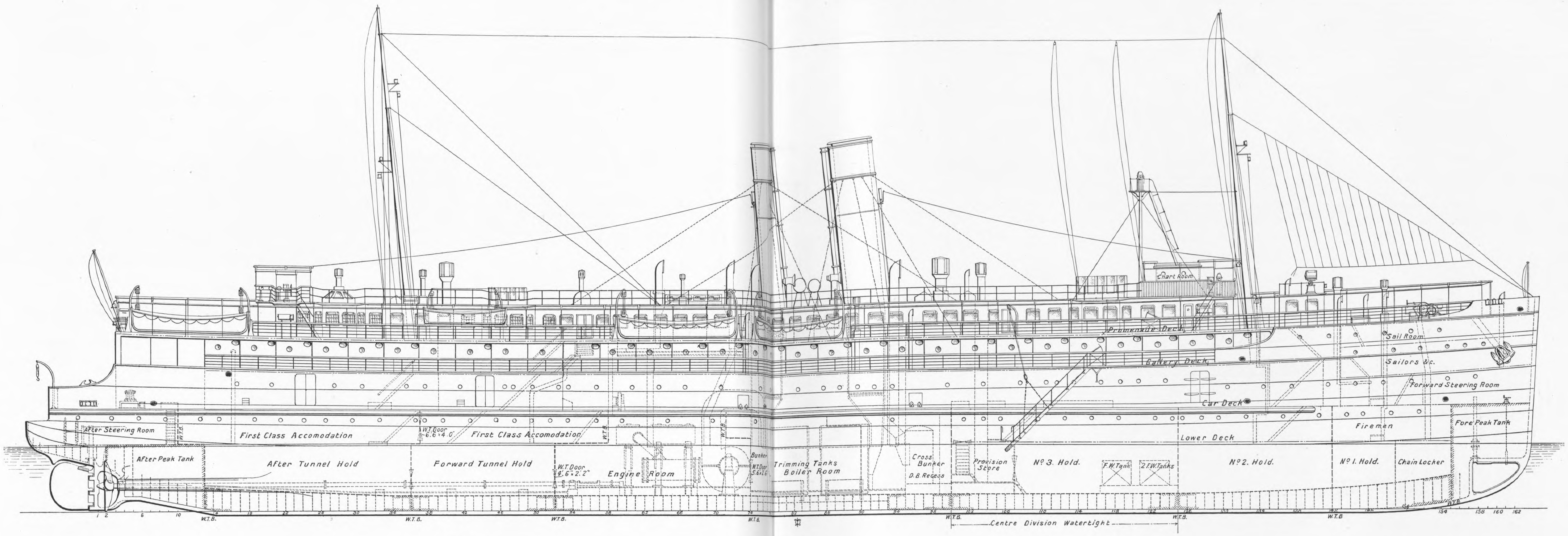


Chart Room
Promenade Deck
Gallery Deck
Sail Room
Sailors &c.
Forward Steering Room
Car Deck
After Steering Room
W.T.B.
First Class Accomodation
W.T. Door 6.6 × 4.0"
First Class Accomodation
Fire men
Fore Peak Tank
Lower Deck
After Peak Tank
After Tunnel Hold
Forward Tunnel Hold
W.T. Door 4.6" × 2.2"
Engine Room
Bunker
W.T. Door 5.6 × 2.6
Trimming Tanks Boiler Room
Cross Bunker
D.B. Recess
Provision Store
Nº 3. Hold.
F.W. Tank
2 F.W. Tanks
Nº 2. Hold.
Nº 1. Hold.
Chain Locker
Centre Division Watertight
1
2
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14
18
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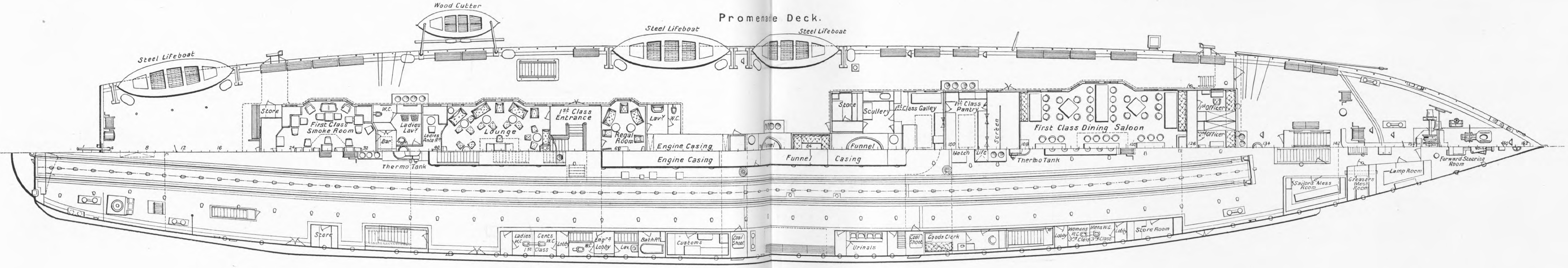
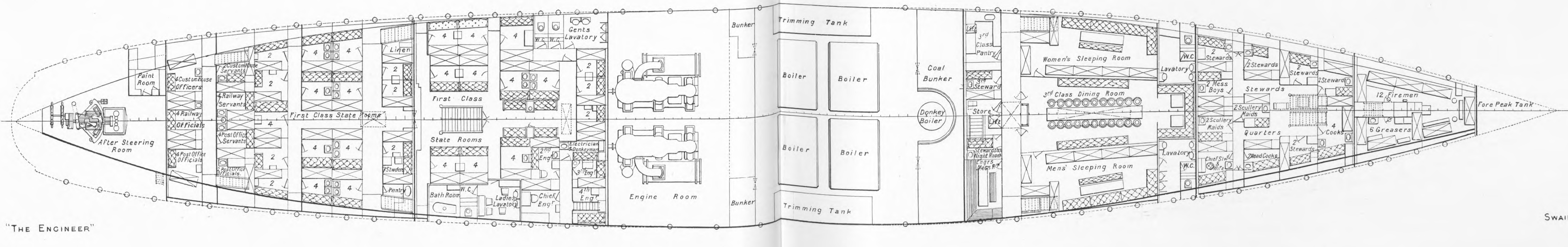

Promenade Deck.
Wood Cutter
Steel Lifeboat
Steel Lifeboat
Steel Lifeboat
Store
First Class Smoke Room
W.C.
Ladies Lavy
Bar
Ladies Ante Rm
Lounge
1st Class Entrance
Regal Room
Lavy
W.C.
Engine Casing
Engine Casing
Thermo Tank
Funnel
Funnel
Funnel Casing
Store
Scullery
1st Class Galley
1st Class Pantry
Screen
Hatch
Lift
Thermo Tank
First Class Dining Saloon
1st Officer
2nd Officer
Forward Steering Room
Lamp Room
Greasers Mess Room
Sailors Mess Room
Store
Ladies W.C.
Gents W.C.
1st Class
Lobby
W.C.
Engrs Lobby
Lav.
Bath Rm
Customs
Coal Shoot
Coal Shoot
Urinals
Goods Clerk
Lobby
Womens W.C. 3rd Class
Mens W.C. 3rd Class
Lobby
Store Room
16
24
32
40
60
76
84
100
108
120
126
134
142
150
160
162

Car Deck

Lower Deck.


Paint Room
After Steering Room
4 Custom House Officers
4 Railway Officials
4 Post Office Officials
2 Custom House Servants
4 Railway Servants
4 Post Office Servants
2 Post Office Officials.
First Class State Rooms
Linen
Stwdess
Pantry
First Class
State Rooms
Bath Room
W.C.
Ladies Lavatory
W.C.
W.C.
Gents Lavatory
2nd Engr
Electrician & Donkeyman
3rd Engr
4th Engr
Chief Engr
Engine Room
Bunker
Bunker
Trimming Tank
Trimming Tank
Boiler
Boiler
Boiler
Boiler
Coal Bunker
Donkey Boiler
Lift
3rd Class Pantry
3rd Steward
Store
Lift
Stewardess Night Room
Engrs Mess Rm
Women's Sleeping Room
3rd Class Dining Room
Mens' Sleeping Room
Lavatory
Lavatory
W.C.
W.C.
2 Stewards
2 Mess Boys
2 Scullery Maids
Chief Stwd & Wife
2 Stewards
Stewards
2 Scullery Maids
Quarters
2 Head Cooks
2 Stewards
2 Stewards
2 Stewards
4 Cooks
12 Firemen
6 Greasers
Fore Peak Tank

"The Engineer"

Swain Sc

THE PORHYDROMETER.

AN opportunity was recently afforded us of inspecting the instrument known as the Porhydrometer. This apparatus has for its main object the estimating of the weight of cargo loaded into or taken out of ships, barges, &c., and it is claimed that, owing to its simple construction, it can be readily applied to vessels either at the time of building or later. The engraving—Fig. 1—which shows the apparatus in diagrammatic form, will help to make clear the following description of its construction and mode of working.

Erected vertically over the longitudinal and transverse centre of the vessel, a pipe A is in communication with the water in which the vessel floats by means of a smaller pipe B. Thus the water in the pipe A rises to the same height as that outside. Inside this pipe a float C is suspended from a horizontal lever D, which has its fulcrum at E. The other end of the lever D is connected to a steelyard weighing machine situated at F, and shown diagrammatically in Fig. 2. All parts of the apparatus are standardised with the exception of the float C, which requires to be specially constructed for each vessel. This float extends downwards, far enough to bring its lower end below the plane of flotation for light loading, and far enough upwards to bring its upper end above that for maximum draught. Its profile is such that the area of the float at any cross section bears a constant ratio to the area of the ship at the same level. Thus, if a weight w be placed on board the vessel, the latter will be depressed in the water to an extent h, say, and Z being the area of the plane of flotation at this particular draught, and w the weight of unit volume of the water, the following relation holds:—$W = w Z h$. At the same time, the lever D must experience an additional upward force, due to the further immersion of the float C, this force being of amount $w z h$, where z represents the cross-sectional area of the float at this particular draught. This force is measured on the weighing apparatus, and is found to be of amount f, say. Then $f = w z h$.

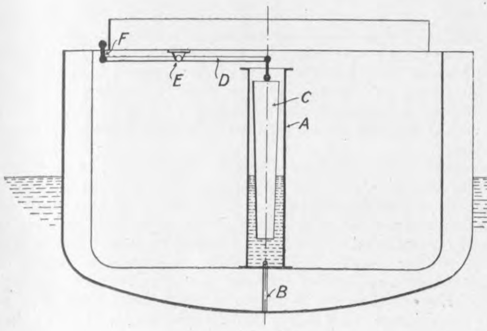


Fig. 1.

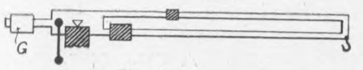


Fig. 2.

THE PORHYDROMETER

Therefore, $W = \frac{Z}{z}, f = k f$, where k is a constant. Hence the reading on the steelyard can be arranged to read directly the weight placed on board.

In the actual example inspected, where it was applied to a barge of 200 tons carrying capacity, the weight of the float itself was counterbalanced by a weight attached permanently to the extremity of the other arm of the lever D. All the bearings are carried on knife edges, and the makers claim to be able to read to within $\frac{1}{100}$ per cent. The machine was demonstrated to be capable of giving the weight of a man stepping on board.

When commencing to read the weighing apparatus is first set to zero by means of a movable weight G attached as shown. When a balance has been obtained the reading of the weight of cargo added to or extracted from the vessel is proceeded with, two scales being provided for this purpose. The upper scale in the example inspected was graduated so as to read hundredweights, the lower scale being divided into 100 equal divisions, each one corresponding to a load of one ton. A small weight equivalent to 100 tons can be attached at the extremity of the arm; thus the total measurable load in this case was 201 tons.

The instrument can be adopted to vessels of any size, and the makers are, we understand, in negotiation regarding its application to a vessel of 10,000 tons burden. In this case the diameter of the float will be about 9in.; for the barge inspected this was $3\frac{1}{4}$in. at the top and $2\frac{7}{8}$in. at the lower end.

At first sight it might be thought that a variation in the density of the water would introduce discrepancies into the weight of a cargo as estimated by the porhydrometer, but it will be seen by an inspection of the principle on which the apparatus depends that this is not so. Again, by placing the float in the position described the makers hold that the weight of the cargo is given independently of the trim of the vessel; that is to say, that a load placed forward or aft will be weighed exactly the same as if placed near the centre of the vessel, since the draught directly under the instrument is the mean of that forward and aft.

In addition to its primary use, the porhydrometer can be conveniently used for checking the amount of water in the ballast tanks, and for indicating any leakage. For the latter purpose the instrument can be fitted with an electric alarm bell, which will give warning of any leakage taking place.

The Italian Government has, we hear, tested the invention, and has authorised its Customs officials to accept as correct the weighings given by it.

SECRECY IN NAVAL CONSTRUCTION.

AT the present time four Professors of the Maritime Architectural Department of the Technical College of Charlottenburg, Germany, accompanied by twenty students of the College, are in this country on a tour of inspection of some of the important British shipbuilding establishments. Before the party left home attempts were made with the help of the British Ambassador in Berlin to obtain permission from the British Admiralty for the party to inspect those shipbuilding yards in England in which warships of various types are now being constructed, but the British Admiralty refused to grant this request. That the British Admiralty in their policy of observing secrecy in affairs connected with naval construction are being strongly seconded by British builders themselves, would appear from what has just been made public in connection with the forthcoming joint meeting to be held in Glasgow, between the North-East Coast Institution of Engineers and Shipbuilders and the Institution of Engineers and Shipbuilders in Scotland. Besides the reading of papers on professional subjects, the members of the two societies will pay visits, on the invitation of the respective firms, to a large number of important shipbuilding, engineering, and steel manufacturing establishments on the Clyde and around Glasgow. In the list of these, however, there are notable omissions, such as the works of Fairfield, Clydebank, Beardmore's, Scott's, and Denny's, although in most cases members of these firms have a close connection with the Scottish Institution. The reason for these omissions is that, after fully considering the question of inviting the members of the joint meeting, all the firms in whose works British naval contracts are on hand decided to respect the wish of the Admiralty that as much secrecy as possible shall be observed regarding the structural character and progress of contracts. The only establishment to be visited where naval work is proceeding is that of Yarrow and Co., Limited, at Scotstoun, where almost all the work on hand is of a naval character, but is all for foreign countries.

A NEW STARTING SWITCH.

FOR use with electrically-operated printing machines, the Adams Manufacturing Company, of Bedford, and of 106, New Bond-street, London, has introduced a new type of starting switch which is illustrated in the accompanying illustrations, Figs. 1 and 2. It is well known by those associated with printing machine work that the starting of presses is very hard on the switch gear on account of the constant "inching," which is necessary when preparing the press. By "inching" is meant that the minder keeps starting up the motor, and immediately stopping it again, the object being to move the press forward a very small distance. This process constantly repeated may cause injurious arcing on the contacts of the starting switch, with the result that ordinary types are liable to be soon destroyed, and even though renewable contacts may be used, the renewals may be so frequently required as to become a nuisance, as well as an appreciable expense.

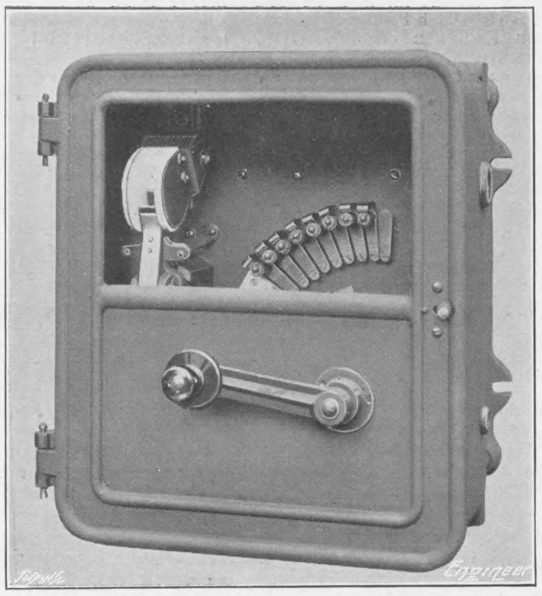


Fig. 1—STARTING SWITCH

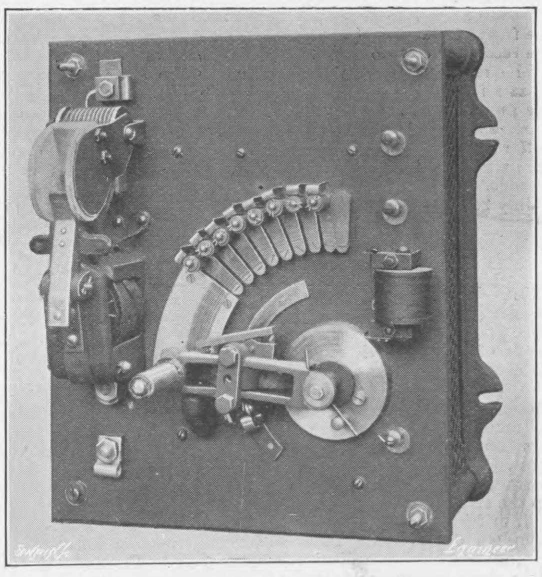


Fig. 2—STARTING SWITCH

To prevent this arcing various devices have been introduced, but in the starter illustrated a new method has been adopted which it is claimed is far more satisfactory than anything which has hitherto been placed upon the market. The manufacturers of this new starter maintain that other devices have failed because they have only protected the first step, whereas the minder, whose eyes must be on the machine and not on the starter, pushes the handle when "inching" over to the third or fourth contact, or perhaps further, and in moving it back draws a destructive arc across the contacts.

As will be gathered from the illustrations, this new switch is provided with an interlocked magnetic circuit maker and breaker. The special feature of this arrangement is that no matter how far the operator pushes the handle over in a forward direction, the slightest backward movement instantly opens the circuit breaker. Consequently no arcing can occur on the starter contacts, because they are made dead by the opening of the breaker. The circuit breaker has carbon contacts and magnetic blow-out, and will consequently open the circuit an infinite number of times without injury. It is claimed that with this starter "inching" may be practised to any extent. We are told that a recent extended trial in a large printing works, under ordinary working conditions, left the contacts as good as new. In addition the interlocking of the circuit breaker with the starter makes it impossible to close the motor circuit unless all the starting resistance is in circuit, thus the motor receives proper usage, for the starting switch is practically fool-proof.

THE "TIME-SAVER" AUTOMATIC INJECTOR.

THE injector illustrated in Figs. 1 and 2 herewith differs from others at present before the public in that the body which contains the nozzles can be dismounted by removing four T bolts, and without disconnecting any pipe joints. The instrument consists of three main parts, a branch piece, body, and cap. The bottom section has four branches—for the steam A, water B, delivery C, and overflow D. Attached to it is the overflow valve, consisting of a small bend with inclined seat, on which an automatic hinged valve seats. After the body has been removed, this valve and seat can be easily withdrawn for examination. In the body are arranged the steam, water, mixing, and pressure nozzles, which can be removed with ease. The working of the injector is not interfered with by the joints, as the nozzles are fitted in such a manner that the thickness of the jointing material does not affect the distance between the nozzles and their proper setting. It will be seen from the sectional views that there are no moving cones. The steam valve is contained in the cap. The injector is made according to Dikker's patent by W. H. Bailey and Co., Limited, Manchester.

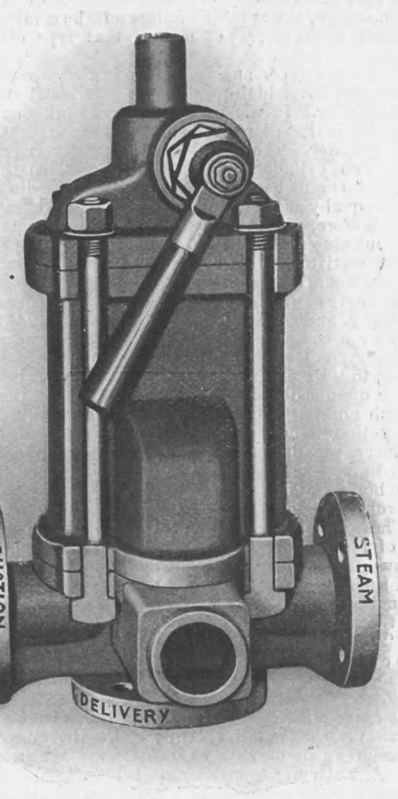


Fig. 1—THE "TIME-SAVER" INJECTOR

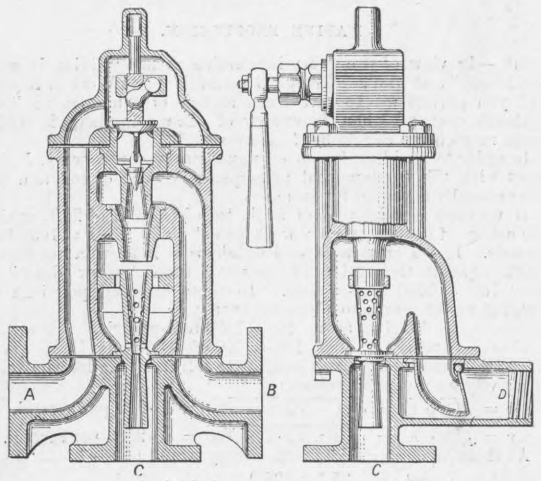


Fig. 2—DETAILS OF INJECTOR

EXPERIMENTS are being conducted under the supervision of the Ordnance Department of the United States Army with a light-running motor designed to carry small rapid-firing guns, ammunition or rations. The idea is to devise a high-speed light-running car that may be applied to the numerous uses necessary in a flying campaign.

LETTERS TO THE EDITOR.

(We do not hold ourselves responsible for the opinions of our correspondents.)

BRITISH LOCOMOTIVE PRACTICE OF TO-DAY.

SIR,—I have read Mr. Henry W. Dearberg's letter, as also the one signed "Excelsior," which appeared in your issue of July 23rd, with great interest. In reply to Mr. Dearberg, I should like to point out that although the diagram of the express simple engine may appear to leave nothing to be desired as regards expanding the steam down to a low terminal pressure, we know that the Worsdell type of compound engine also did excellent work when expanding the steam in two cylinders, and that it was also able to maintain a high rate of speed when so doing. As the power developed and economy attained by both simple and compound engines is practically the same, it may be assumed that each use an equal weight of steam; there are, therefore, two methods of using up steam expansively in the cylinders of a locomotive; the question is which method is the better when seeking to increase the power of the engine?

In face of the good work which is being done by the De Glehn type of compound, I cannot agree that the greatest field for compounding lies with the slow heavy pulling type of engine. The whole question is one of enhanced power. The engine which has the power to pull the heaviest load will also have the power to climb gradients at a high speed. Let us assume, for instance, that the power of the locomotive requires to be enhanced by as much as 50 per cent. It must be obvious that the cylinders would require to be of large capacity to meet this demand, probably with the assistance of high steam pressure. When we consider that an engine on the compound system can be designed to meet this demand from the use of a combination of high and low-pressure cylinders, and that the simple engine could only be designed to meet the demand by enlarging the high-pressure cylinders up to the capacity of the low-pressure cylinders of the compound engine, the apparent failure of the compound can only be attributed to engineers not making that type of engine more powerful.

Let us, for instance, analyse the Worsdell compound engine, which has one 20in. high-pressure cylinder, and one 28in. low-pressure cylinder. In the first place, the work done by a compound engine is that of referring the steam to that of the low-pressure cylinder. The area of this cylinder is practically the same as two cylinders 19¾in. in diameter, so that had the "Worsdell" engine been fitted with two such cylinders it would have done equally as well as the compound. Compounding an engine, therefore, without increasing the total cylinder capacity brings about absolutely no gain. This, however, is practically how British locomotive practice stands to-day; at the same time continental engineers are making progress but slowly.

I quite agree with Mr. Dearberg as to the necessity for standardising, and consider that there is not the slightest difficulty in designing a compound engine which will answer all purposes having one type of engine only.

In reply to "Excelsior." He begins his letter by referring to that much discussed question of over-cylindering the locomotive, than which nothing has done more to delay its improvement. In this connection we have surely been taught a lesson by the motor car engineer, who designs engines to develop as much as 250 horse-power and places them on frames, to which they also fit engines of only 40 horse-power, the adhesive weight on the wheels of the latter probably being the greater. It is, however, due to this over-cylindering that the high-powered motor car is able to get up a speed of 125 miles an hour, or twice that possible with the 40 horse-power car. If our locomotives were similarly over-cylindered, I think we could safely rely on the drivers making use of the steam in a similar manner to that of the chauffeur when controlling the carburettor.

If, as "Excelsior" states, there is a disadvantage from the use of large cylinders—I found none from the use of a 31½in. cylinder—it can only be due to faulty design, and can therefore easily be remedied.

I quite agree with "Excelsior" that the introduction of very high steam pressure would speedily settle the question, for very high pressures can only be used to advantage in a compound engine. Any attempt to make use of high steam pressure in a simple engine would necessitate a reduction in the cylinder area, which would merely be a distinction without a difference, nor would the use of multiple high-pressure cylinders be of much avail.

"Excelsior" states that the trial of a Serpollet boiler would be interesting to watch—at a distance. Why at a distance? He must surely be aware that there can be no disastrous explosion from such a boiler. Personally I sit within a couple of feet of a Serpollet boiler when the pressure gauge records a pressure of 1000 lb. Nor is there the slightest danger in working the boiler at this pressure. I can see no difficulty in designing a boiler of this type which would be suitable for a high-powered engine.

JOHN RIEKIE.

Argaith, Dumbreck, July 26th.

MARINE PROPULSION.

SIR,—In view of your very interesting article "Going Down to the Roots," and also Sir George Greenhill's "The Work of Recoil," will you permit me to give some aspects of "momentum" and "kinetic energy" when the energy of one moving body is used to cause momentum on another?

In order to avoid confusion or unnecessary controversy, I shall start with the fundamental principle of "work done," and only use generally accepted formulæ.

If we raise a weight W of 50 lb. to a height H of 20ft. against the action of gravity, then "work done" = 50 × 20 = 1000 foot-pounds. If we raise a second weight w of 10 lb. to a height h of 100ft. against the action of gravity, then "work done" = 10 × 100 = 1000 foot-pounds. In these elevated positions the weights would represent potential energy =

$$\mathrm{W\,H} = 50 \times 20 = 1000 \text{ foot-pounds,}$$

$$\text{and } w\,h = 10 \times 100 = 1000 \text{ foot-pounds.}$$

To allow these respective weights to fall freely under the action of gravity we obtain velocities:—

$$\mathrm{V} = \sqrt{2\,g\,\mathrm{H}} = \sqrt{2 \times 32{\cdot}2 \times 20} = 35{\cdot}9\text{ft. per second.}$$

$$v = \sqrt{2\,g\,h} = \sqrt{2 \times 32{\cdot}2 \times 100} = 80{\cdot}25\text{ft. per second.}$$

At these velocities the kinetic energy would be:—

$$\mathrm{W}\frac{\mathrm{V}^2}{2g} = 50\,\frac{35.9 \times 35.9}{64.4} = 1000 \text{ foot-pounds,}$$

$$w\,\frac{v^2}{2\,g} = 10\,\frac{80.25 \times 80.25}{64.4} = 1000 \text{ foot-pounds.}$$

We have now two certain masses with two certain velocities possessing equal kinetic energy.

To use the same figures for weight and mass will here make no difference in the results. If, now, the two masses were to impinge on one another in a straight opposite direction, taking the masses to be abstract, perfect solids, then, according to the conservation of momentum, we obtain:—

$$\mathrm{V}_1 = \frac{\mathrm{M\,V} - m\,v}{\mathrm{M} + m} = \frac{(50 \times 35\ 9) - (10 \times 80\ 25)}{50 + 10}$$

$$= \mathrm{V}_1 = 16.54\text{ft. per second.}$$

So that after the impact both masses would move with velocity V_1 of 16.54ft. per second in the direction of motion of the greater mass before the impact.

Accordingly the energy (1000 foot-pounds) of M or W has not only overcome the equal energy (1000 foot-pounds) of m or w, but retained itself:—

$$\mathrm{W}\frac{\mathrm{V}^2{}_1}{2\,g} = 50\frac{16.54 \times 16\ 54}{64.4} = 212 \text{ foot-pounds,}$$

and given to m

$$w\frac{\mathrm{V}^2{}_1}{2\,g} = 10\,\frac{16.54 \times 16.54}{64\ 4} = 42.4 \text{ foot-pounds.}$$

If only the greater mass were moving and the smaller one were stationary, then we obtain

$$\mathrm{V}_2 = \frac{\mathrm{M\,V} + m}{\mathrm{M} + m} = \frac{50 \times 35.9 + 10}{50 + 10} = 30\text{ft. per second.}$$

$$\text{Energy left} = \mathrm{W}\,\frac{\mathrm{V}^2{}_2}{2\,g} = 50\,\frac{30 \times 30}{64.4} = 697.5 \text{ foot-pounds,}$$

$$\text{and in} \quad = w\,\frac{\mathrm{V}^2{}_2}{2\,g} = 10\,\frac{30 \times 30}{64.4} = 139.5 \text{ foot-pounds.}$$

Energy apparently disappeared = 1000 – 837 = 163 foot-pounds.

If, however, the smaller mass only is moving, and it impinges on the greater mass, we find that much more energy seems to disappear, and if this is done with the shot cited by Sir George Greenhill, and allowed to impinge on the mass of the gun and carriage, then we find that the energy of the shot is just about sufficient to produce the same velocity in the gun which the recoil did originally. In figures:—

$$\mathrm{V} = \frac{w\,v + \mathrm{W}}{w + \mathrm{W}} = \frac{850 \times 3000 + 112{,}000}{850 + 112{,}000} = 23{\cdot}5\text{ft. per second,}$$

which is very near the recoil velocity given by Sir George Greenhill, namely, 20 f/s about. This seems to justify my logical deduction that as the shot cannot produce more velocity on the gun than the original recoil, the energy expended in producing the original recoil must be equal to the energy expended on the shot. It is this that I have maintained throughout this discussion, namely, that the magnitude, or amount of work done by action and reaction, in foot-pounds, foot-tons, or metre kilogrammes, is equal and opposite, whilst, of course, it is evident that the kind of work may differ to any extent, like moving large masses slowly or small masses quickly. It does not seem logical to me that when estimating any "total work done," it is only necessary to ascertain the "available kinetic energy."

Regarding marine propulsion, kinetic energy need really not at all be brought in, and the whole matter could be settled by pressure, which I endeavoured to do in my letters published in THE ENGINEER on June 11th, May 21st, April 23rd and March 19th.

It must be evident that not only 5 per cent. or 10 per cent. or 50 per cent. of the engine energy is transmitted on to the water, but the whole 100 per cent. which reaches the propeller, and it is on the reaction of the water on which the speed of the vessel depends. It must also be evident that a column of water of a certain cross section moved twice as fast as originally also means twice as much water, and the resistance or reaction must be in proportion to the energy absorbed by the water.

July 26th. W. PREIDEL.

MOMENTUM, ENERGY, AND WORK.

SIR,—If, as "Fuse" assumes, the gun recoils freely 2ft. while the shot advances 48ft. along a chase 50ft. long, he implies that the gun is only twenty-four times the weight of the shot, while the energy is as 1 to 24; so that, taking the figures given in Lieut. Dawson's lecture, the energy of the shot being 53,000 foot-tons, the energy of the gun is 53,000 ÷ 24 = 2208 foot-tons—much too great to be manageable.

Lieut. Dawson tells us that 53,000 foot-tons is the energy of the shot at a velocity of 3000 f./s., and this implies that, if the shot weighs w lb.,

$$\frac{w}{2240}\ \frac{v^2}{2g} = 53{,}000,$$

when $v = 3000$; or, with $g = 32$, $w = 2240 \times 64 \times 53{,}000 \div (3000)^2 = 844.23$ lb., and this becomes 850 lb., the official figure, on raising g to 32.2.

We should have been spared the trouble of this calculation if the weight of the shot had been stated in the lecture; but, now, a gun twenty-four times heavier than this shot will weigh 24 × 850 = 20,400 lb. = 9.1 tons, and the energy of 2208 foot-tons of recoil would be enough to lift the gun vertically 2208 ÷ 9.1 = 242.6ft., which will show the liveliness of the recoil of so light a gun.

But the real gun weighs more like 50 tons = 112,000 lb., or 132 fold; and then the length of recoil during the passage of the shot up a chase 50ft. long is only 50 × 850 ÷ 112,850 = 0.376ft., say four inches and a-half.

If F is the average thrust in tons of the powder on the base of the shot, F = 53,000 ÷ (50 – 0.376) = 1068 tons, equivalent in a 12in. gun to a pressure 1068 ÷ (0.7854 × 144) = 9.44 tons/inch², instead of the 7.25 given previously; the discrepancy was due to the fault of taking round numbers with the small figures, cutting the recoil velocity down to 20 f./s., and g down to 32.

The recoiling velocity of the gun as the shot is leaving the muzzle is 3000 × 850 ÷ 112,000 = 22.8 f./s., and the energy of the gun is then 53,000 × 850 ÷ 112,000 = 402 ft./tons—enough to raise its weight of 50 tons vertically about 8ft.; or an average buffer resistance of 100 tons would check the recoil in 4ft.; and at an average velocity of 11.4 f./s. this takes 4 ÷ 11.4 = 0 35 seconds.

July 26th. G. GREENHILL.

COLOMBIAN MINING.

SIR,—Your article in THE ENGINEER of 23rd inst. was very interesting to me as an engineer who has been there, and having some knowledge of interior conditions—no doubt there are hundreds of persons with more—I think I can give some useful information amplifying your article.

(*a*) Communications:—It may be said that—roughly—communication with the interior is wholly dependent on the rivers and on mules. The navigation of the Magdalena is impeded by numerous shoals and by baffling and perplexing cross currents and limited by low water in the dry season. Thus goods landed at Barranquilla may have to lie there for weeks before they can be sent up the river, and *en route* the steamer may swing suddenly round, and, drifting into the bank, wreck her stern wheel and come to complete destruction. Such an accident may seriously spoil a mining company's prospects for half a year. This is on the main river where steamers drawing 4ft. 6in. can pass. On the smaller rivers—*e.g.*, the Nechi—navigation is still more difficult, and impossible to the larger steamers. Thus it is out of the question to do work quickly, and the best laid plans are often defeated by causes beyond the control of anyone.

The railways, such as there are, only serve as feeders to and from the river Magdalena, and to pass absolute bars to navigation of any sort, *e.g.*, the railway from Savanilla to Barranquilla. Thus the river governs everything.

Mules:—A fair average load may be taken at 250 lb. Some exceptional animals will carry 300 lb., and some poor beasts will die under less than 200 lb. A great deal depends on the route and season. It is obvious that a beast can carry much more weight, and with less distress on a good, hard trail than it can on a road formed on a tough sticky clay, into which it sinks to the girths at frequent intervals. This latter may be taken as the common condition of the roads at the close of the wet season.

The practicable load also depends on the class of load and its packing. The essential point is to get as evenly balanced a load as possible each side of the fore-and-aft line, and so arranged that it is as little topheavy as possible. Thus we have a load of 125 lb. slung each side of the animal by the lashings—raw hide, dried—passing over the pack saddle. It is possible to carry a heavy load, such as a casting, on the back of the animal, provided that its shape is such that it naturally fits, or can be made to fit the saddle, and also can be effectively lashed. It must not be of any great height, for in the—inevitable—event of the beast leaning to one side, the weight tends to pull him over, and on rough ground he may either roll down a hill and destroy himself or the load, or fall into a mud hole and stick there. Note: In both cases the load will quite likely lie where it has fallen for months. There must be hundreds of tons of machinery lying on the banks of the river which is abandoned, owing to the impossibility of transporting it farther.

(*b*) Engineering:—What precisely is meant by "First-class Engineers?" Book knowledge is at a heavy discount, for the reason that it is useless designing elaborate and delicate machinery to be run by more or less careless native labour, perhaps entirely without supervision whilst the English boss is in bed with fever. What is wanted is ability to scheme ways out of difficulties caused by breakdown and losses in transport, fair health, and—for this country—muscular strength. Muscular strength will largely fail when an Englishman tries to make long continued exertion of any kind, even in the higher country of Antioquia. The real cause of so many failures is the total inability of men at home to realise the difficulties and needs of their concerns. Thus, machinery is designed and sent out, which may be reckoned extra first-class in this or any civilised country, but which proves a miserable failure from the simple cause of insufficient consideration of climate and labour.

For example, a plant is designed and sent out, I have no doubt admirable for better conditions, but quite unreliable in the circumstances and requiring an electrician's skilled supervision. The generators built for 3000 volts after repeated breakdown, due to insulation failures caused by the mouldy tropical dampness of the air, have necessitated the lowering of the pressure to 1700 volts. What was really required was a special design to meet the conditions.

Departures from standard designs cost money, it is true, but reasonable capital cost is less important than having a rich level drowned for months together by a short failure of pumping power. To unwater a drowned shaft takes vastly more time than it takes to keep it unwatered. Thus, if a pumping plant has a reserve capacity 10 per cent. beyond ordinary needs, a single day's stoppage causes a collection of water that will require ten days to get out. Electrical power is put to a vastly more vital duty when applied to drainage than in any other department. Such points as this are liable to be overlooked.

Angmering, July 24th. GEO. T. PARDOE.

Δ FALLACIES.

SIR,—Your correspondent "W. J. H." is distressed that he is unable to find out the correct displacement of our ships, and finds a general unwillingness on the part of owners and naval architects to disclose the Δ of their productions. But surely he must know that this is because they do not know what Δ is themselves.

You will remember, Sir, doubtless if you have studied your "Alice," that the White Knight sang a song, and he was careful to explain what it was before he began. First of all, there was the name of the song, then there was what the song was called, and, lastly, there was what the song really was, and these were all different.

A similar state of affairs rules with Δ, especially in the case of warships. First of all, there is the name of it, which, being interpreted, is the displacement at the designed draught. A warship passes through this stage once during completion. When the designed draught has been reached within ¼in., an urgent telegram is sent to the Admiralty. The next day a constructor arrives, and, having walked round the ship, and noticed that everything—or nearly everything—is on board, he proceeds to row round the vessel in a boat, and notes the draught. In the meantime, a few hundred more men have been sent on board, and, hey presto! the vessel is exactly down to the designed draught. Much cheering, and a special meeting of the Admiralty Mutual Admiration Society, at which pats on the back are administered all round. Some months elapse before we come to the second stage—what the displacement is called. It is called "deep draught." By this time the vessel has undergone trials, several junior officers have joined, with their sea chests and bicycles, the ward-room piano is on board, and the washing has all come back from the laundry. These items, and possibly some others, account for the deep draught. The last stage—what the displacement really is—does not arrive until the vessel is in regular commission, and, presumably, ready for battle. At this time a few unconsidered trifles of weight, such as coal in reserve bunkers and ammunition, have been added. But when we arrive at this stage, the upper edge of the armour belt is getting perilously near the water-line, and it is discreet to say as little about this stage as possible. Hence the mystery of Δ.

July 28th. WETTED SURFACE.

LAUNCHES AND TRIAL TRIPS.

WOODMERE, steel screw steamer; built by the Blyth Shipbuilding and Dry Docks Company, Limited; to the order of Messrs. Falconer, Ross and Co., Newcastle-on-Tyne; dimensions, length, 193ft. 8in., beam 26ft. 6in.; engines, triple-expansion; constructed by Mr. G. T. Grey, South Shields; launch, July 15th.

SHONGA, steel screw steamer; built by Irvine's Shipbuilding and Dry Docks Company, Limited; to the order of Elder, Dempster and Co., Liverpool; dimensions, 355ft. by 46ft. by 25ft. 3in.; engines, triple-expansion, 25in., 40in., 67in. by 45in. stroke, pressure 180 lb.; constructed by Richardsons, Westgarth and Co., Limited, Hartlepool; launch, July 19th.

APPENINE, steel screw steamer; built by Irvine's Shipbuilding and Dry Docks Company, Limited; to the order of the Gulf Line, Limited; dimensions, 360ft. by 51ft. by 25ft. 6in.; to carry 6300 tons; engines, triple-expansion, 25in., 40in., 67in. by 45in. stroke, pressure 180 lb.; constructed by Richardsons, Westgarth and Co.; launch, July 20th.

ROSENDAL, steel screw steamer for passenger and cargo trade; built by the Laxevaags Engineering and Shipbuilding Company, Bergen; to the order of "Hardanger Sondhordlandske Selskab," Bergen; dimensions, 151ft. by 23ft. by 11ft. 3in.; launch, July 20th.

ARMSTOR, steel screw steamer; built by Irvine's Shipbuilding and Dry Docks Company, Limited; to the order of Furness, Withy and Co, Limited; dimensions, 336ft. by 47ft. by 24ft. 10in.; engines, triple-expansion, 32½in., 36in., 64in. by 42in. stroke, pressure 180 lb.; constructed by Richardsons, Westgarth and Co.; trial trip, July 24th.

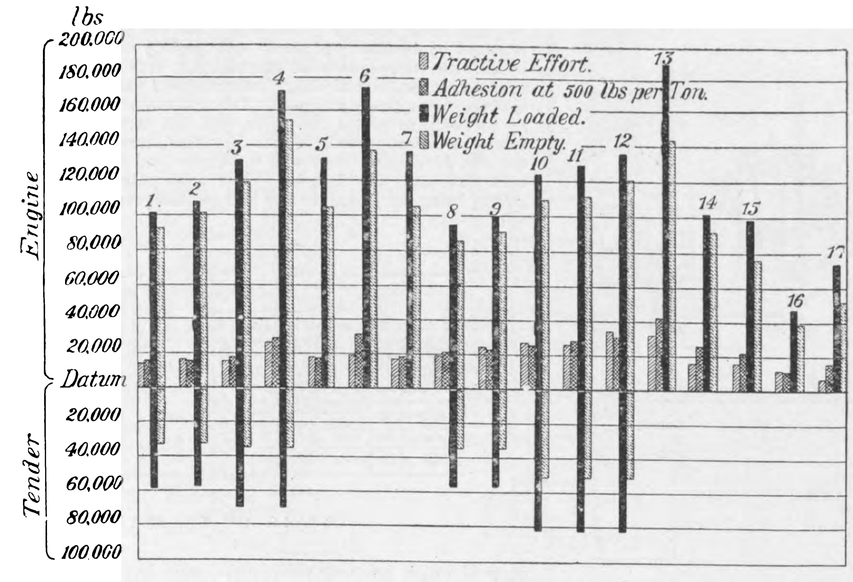
NYLAND, turret deck steamer; built by William Doxford and Son, Limited; to the order of Axel Broström and Son, Gothenburg; trial trip, July 27th.

TYNEMOUTH, steel screw steamer; built by Wood, Skinner and Co., Limited; to the order of the Burnett Steamship Company, Limited; engines, triple-expansion, 21in., 34in., 56in. by 36in. stroke, pressure 180lb.; constructed by the North-Eastern Marine Engineering Company, Limited; trial trip recently.

LOCOMOTIVES DESIGNED AND BUILT AT HORWICH, WITH SOME RESULTS.[*]

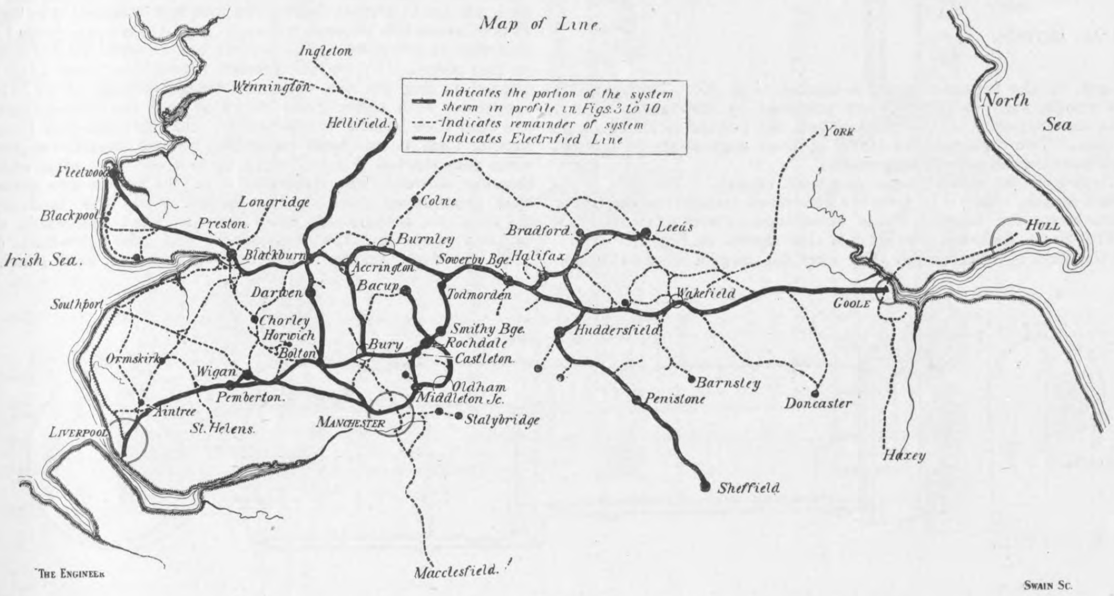
By Mr. GEORGE HUGHES, Member, Chief Mechanical Engineer, Lancashire and Yorkshire Railway, Horwich.

BEFORE discussing the design and performance of locomotives the critic must have some knowledge of the railway upon which they run and the nature of the work they perform. Particulars will be found by referring to the appendices and the subjoined diagram—Fig. 1—and statement, which give the power and weight of the various locomotives operating this traffic—see also Figs. 2 to 10.

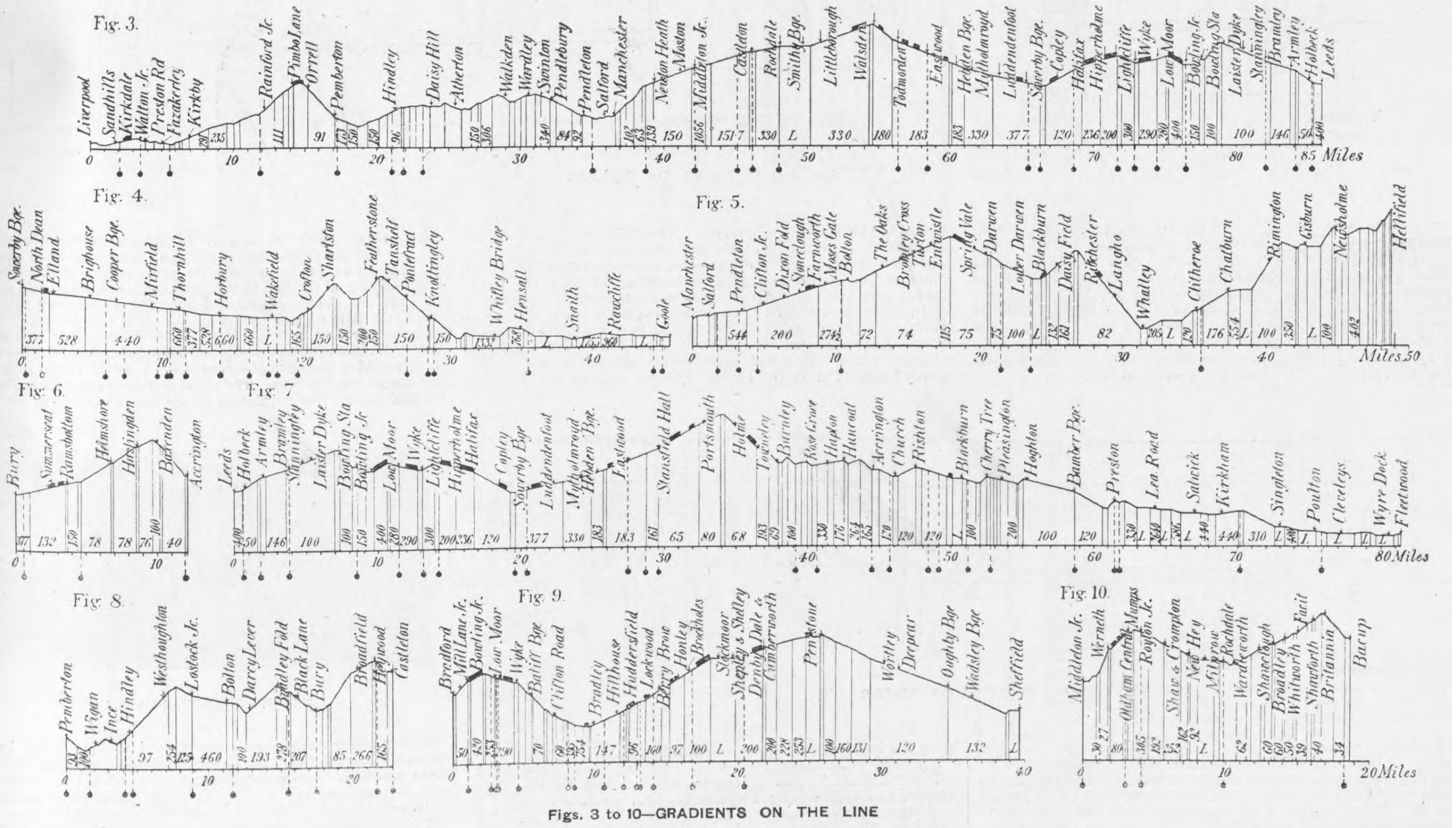


	Class.	Tractive Effort 80% of Boiler Pressure	Adhesion at 500lbs per Ton.	Weight of Engine Loaded.	Weight of Engine Empty.	Ratio of Weight on Drivers to Tractive Effort.	Ratio of Weight on Drivers to Total Weight.	Ratio of Weight Loaded to Weight Empty.
		LBS.	LBS.	LBS.	LBS.			
1	Aspinalls Eight Wheeled Passenger.	13943	15500	100352	92512	4.97	.69	1.08
2	Eight Wheeled Passenger with Superheater.	17214	16175	107604	101248	4.21	.67	1.06
3	Aspinall's Ten Wheeled Passenger.	15535	17500	131600	118300	5.04	.50	1.11
4	Hughes' Four Cylinder Passenger.	25559	29500	172648	158704	5.17	.76	1.09
5	Aspinall's Eight Wheeled Radial Tanks.	17839	17375	132244	103096	4.36	.59	1.28
6	Hoy's Ten Wheeled Radial Tanks.	19876	26175	173628	136668	5.9	.68	1.27
7	Eight Wheeled Radial Tanks with Thermal Storage	17839	18425	135184	104524	4.63	.61	1.20
8	Aspinall's Six Wheeled Goods.	19886	21075	94164	85120	4.74	1.00	1.10
9	Six Wheeled Goods with Superheater.	24551	22125	99120	91728	4.03	1.00	1.08
10	Aspinall's Eight Wheeled Goods.	27733	26875	120372	109732	4.34	1.00	1.09
11	Eight Wheeled Goods with Corrugated Boiler.	27733	28975	129680	112672	4.68	1.00	1.15
12	Hughes' Four Cylinder Compound Goods.	33555	30400	136220	121716	4.06	1.00	1.12
13	Hughes' Banking Engine.	32049	42000	188160	146468	5.87	1.00	1.28
14	Aspinall's Six Wheeled Shunting Tanks.	16441	25000	112000	91924	6.8	1.00	1.21
15	Converted Saddle Tanks.	16515	21925	98224	76160	5.94	1.00	1.29
16	Pug Engines.	10704	10625	47600	39088	4.44	1.00	1.21
17	Rail Motors.	7605	16350	78248	51656	9.63	1.00	1.18

Fig. 1—POWER AND WEIGHT OF LOCOMOTIVES



The Lancashire and Yorkshire Railway Company possess 1517 locomotives, 1052 of which have been constructed at Horwich, and there are about 1100 engines in steam daily, varying, of course, according to the demands of the traffic.



Figs. 3 to 10—GRADIENTS ON THE LINE

When the works at Horwich were opened the company had 1000 engines, namely, 353 passenger, and 647 goods. There were twenty-nine different types of passenger engines, and twenty-six types of goods engines. Realising the great importance of having as few classes as possible, Mr. Aspinall, then chief mechanical engineer, resolved to reduce the number, and to introduce standardisation, and, wherever possible, interchangeability. This policy, no doubt, from a commercial point of view, is correct, but requires to be judiciously handled, and at the right moment, otherwise it may have a tendency to impede progress. After due consideration and from the running experience of a number of engines, some fitted with Joy gear, and others with the Stephenson link motion, but otherwise of the same design, Mr. Aspinall decided to adopt the Joy gear, as it was found that the mileage between repairs was greater, and also that there was a slight economy of coal per engine mile. Consequently, the Joy motion was adopted for all future new engines—Fig. 11. At the time this gear was designed, the cylinders were 17½in. by 26in. stroke, with a working pressure of 160 lb. per square inch, but bearing the fact in mind that the size of trains was increasing rapidly, and having decided upon interchangeability, the motion was designed on such liberal lines that it has stood the test of over twenty years, and has actually been used for engines with 21½in. diameter cylinders, and a working pressure of 180 lb. per square inch. Until the advent of the fast heavy passenger and goods trains, this gave every satisfaction. However, the increasing size of cylinders, demanded by heavier trains and accelerated speeds, has now rendered it necessary to strengthen this motion.

As regards interchangeability of boilers, the flanged plates were common to each class for a number of years, with only a slight difference in the lengths of the barrels, but this uniformity was disturbed by the introduction of the larger types, and Figs. 12 to 16 illustrate the different boilers, and Fig. 17 gives specimens of the flanged plates now in use. Interchangeability was also extended to cylinders, valves, axles, axle-boxes, springs, wheels, and boiler mountings.

Aspinall's standard radial passenger tank engine. (Built February, 1889.)—The first type of engine built was the eight-wheeled tank engine, four wheels coupled, with a radial box at each end—Fig. 18—an arrangement possessing many advantages for engines which have to work equally well in either direction. The number of engines built of this class is 270, and their usefulness is shown by the fact that they run 56 per cent. of the total passenger engine miles. The cylinders are inside, with valves on the top, thus giving ample steam-chest room and easy access to valve faces. The earlier engines of this class were fitted with unbalanced D valves, but a number are now running with the Richardson balanced form of valve, and some also with a circular balanced back-to-back valve of Mr. Aspinall's design. Water is carried in side and back tanks, fitted with a scoop to pick up when running in either direction. The lowering and raising of the scoop is accomplished by means of Aspinall's well-known vacuum arrangement, which has been used on all subsequent engines. These engines haul trains of 270 tons behind the draw-bar, at an average speed of 36.5 miles per hour, over grades shown on Fig. 6.

Aspinall's six-wheeled goods engine. (Built September, 1889.)—The next class of engine was the six-wheeled coupled goods—Fig. 25. There are 440 of this class, twenty-two of which are, or will be, fitted with the Schmidt system of superheating. The cylinders, with the exception of those fitted with superheaters, are similar to those on the radial tank engines, having either unbalanced D valves or the Richardson balanced type. These engines are employed in hauling goods loads up to 760 tons, and, possessing a moderately-sized wheel, are very useful for passenger traffic during the excursion season. Being simple in design, and the parts accessible, they are light on maintenance, and easy to repair. Several are fitted for steam heating of carriages. The six-wheeled tenders, which carry 1800 gallons of water and 3 tons of coal, have the water pick-up arrangement.

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[*] The Institution of Mechanical Engineers.

Aspinall's eight-wheeled bogie passenger engine. (Built March, 1891.)—These engines—Fig. 27—followed the goods engines. They were designed to work the fast passenger traffic between Manchester and Southport, Manchester and Liverpool, Manchester and Blackpool, and Manchester and Leeds, and have similar cylinders to the goods engines, and unbalanced valves. When designed, they had the largest coupled driving wheels in this country—namely, 7ft. 3in. diameter. The tenders are interchangeable with those of the goods engines. The maximum loads hauled are 220 tons over routes shown on Fig. 3, at an average speed of 42.8 miles per hour. Forty of these engines have been constructed.

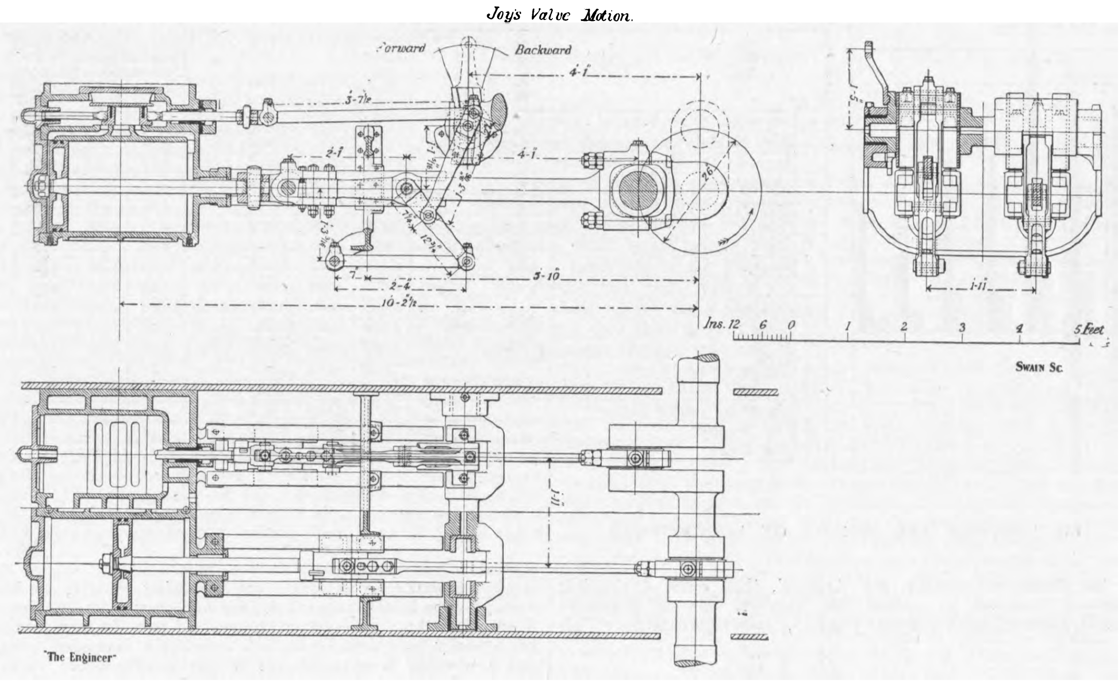
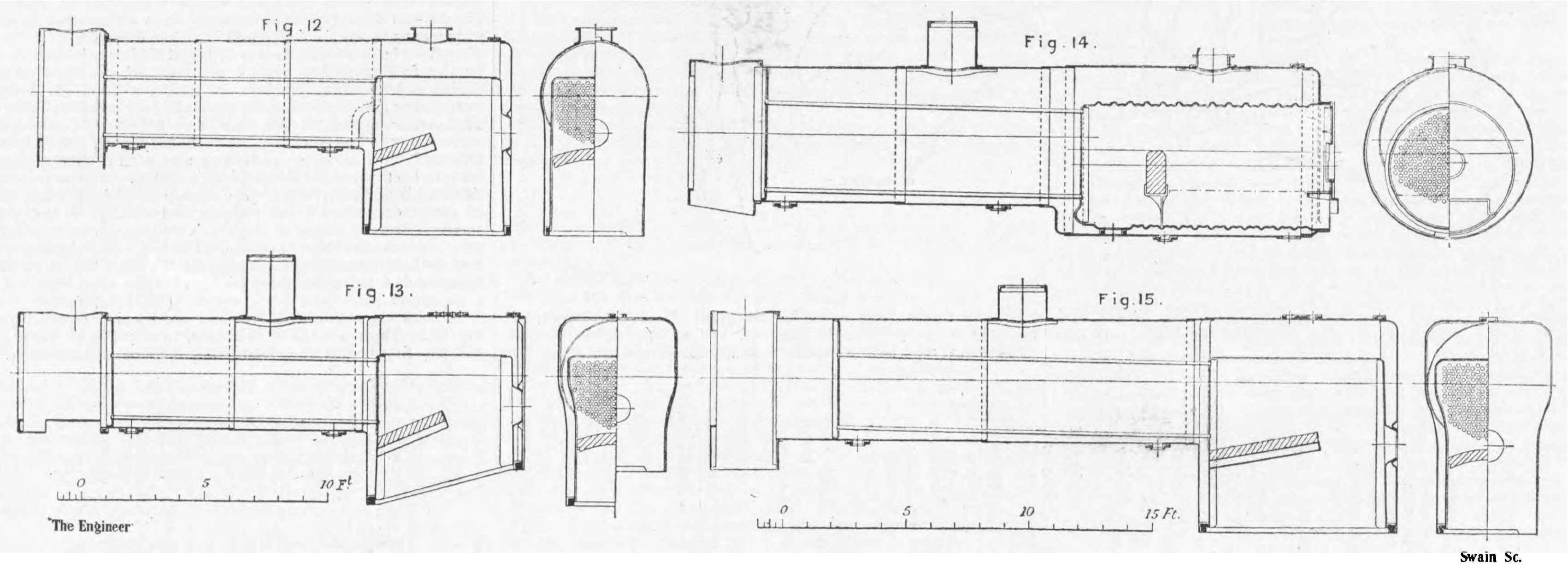


Fig. 11—JOY'S VALVE MOTION

Aspinall's small four-wheeled shunting tank engine. (Built November, 1891.)—The next engine constructed was the small shunting tank, or "Pug" engine—Fig. 24. The aim in this design was to attain lightness and power. They have outside cylinders, with valves placed inside the frames, Stephenson motion, and are employed to work the traffic on the dock sides at Liverpool, Fleetwood, and Goole. Possessing good hauling power for their weight, and having a short wheel base, they are useful for handling the traffic round the sharp curves with which these dock sides abound. There are thirty-seven of this type.



Figs. 12 to 15—TYPES OF BOILERS

Aspinall's six-wheeled coupled outside-cylinder shunting tank engines. (Built October, 1891.)—These engines are employed for shunting purposes in the various goods yards, and for hauling the traffic up the stiff incline from the Manchester Ship Canal Dock—Fig. 23. They are fitted with outside cylinders, and Richardson's balanced valves placed on the top. The motion is a combination of the "Allan" type, with a rocking shaft. In order to negotiate sharp curves, the weight is concentrated on a short wheel base. Twenty of this type have been built, and haul loads of 1000 tons on the level.

Aspinall's converted tank engines for shunting. (May, 1893.)—Prior to the construction of locomotives at Horwich, the stock for goods service comprised a large number of 4ft. 6in. tender engines and a variety of designs of out-of-date tank engines. To bring the shunting stock up to date, and meet the heavy demand for this class of work, Mr. Aspinall decided gradually to convert the 4ft. 6in. tender engines into saddle tanks, cutting up the obsolete types, and using the tenders for new stock. The conversion consisted of placing a saddle tank on the boiler, and adding a short length to the frames to carry a bunker—Fig. 35. The cylinders are inside, with valves between, actuated by Stephenson's gear. The tank capacity is 1000 gallons, and the bunker holds two tons of coal. Two hundred and thirty of these engines are in service, and have proved exceedingly useful.

Aspinall's ten-wheeled bogie passenger engine, "Atlantic" type. (Built March, 1899.)—To meet the persistent demands of the traffic department for heavier trains, these engines were next designed—Fig. 29; a sectional elevation is also shown on Fig. 35A (post). At the time of construction they were the largest inside-cylinder engines of this type in the country. The cylinders were of similar design to those of the eight-wheeled passenger, radial tanks, and goods, but were of larger dimensions, steam-jacketed,* and had valves of the Richardson type, exhausting through the back. Twenty were first built, one of which was fitted with a superheater of Mr. Aspinall's design. The tenders, which are larger than those previously constructed, carry five tons of coal and 2290 gallons of water. A further twenty followed, not fitted with jacketed cylinders, five of which had superheaters, similar to the one previously built. The trains hauled by these engines are 375 tons, being the heaviest and fastest on the line.

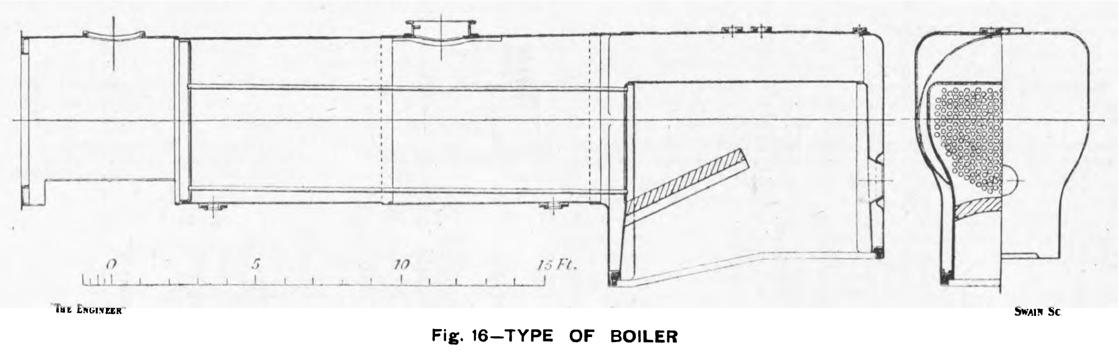


Fig. 16—TYPE OF BOILER

Aspinall's eight-wheeled coupled coal engines. (Built April, 1900.)—The "Atlantic" type of engine was followed by the eight-wheeled coal engine, with Belpaire fire-box, specially designed to haul the heaviest mineral and goods train—Fig. 31. The cylinders, 20in. diameter, placed inside the frames, were the largest yet employed by this company. The valves were of the Richardson type, placed on the top, and exhausted through the back. The employment of large cylinders and small driving wheels renders these engines extremely powerful for heavy haulage. They are fitted with large tenders carried on four pairs of fixed wheels, with a capacity of 3600 gallons of water and five tons of coal. One hundred and eight of this type are in use, and a further twenty-one have been constructed, but with corrugated flue boilers, March, 1903—Figs. 32 and 14. Originally the tube plate of the corrugated steel flue was ⅞in. thick, and steel tubes were employed, but this combination was unsuccessful, owing to frequent tube leakage. The tube plate was then taken out, and replaced by another ⅝in. thick, with slightly better results. Steel tubes with copper ends in combination with the ⅝in. plate were next employed, and although improvement was effected, the leakage was not entirely stopped. The thin plates were then replaced by copper tube plates 1in. thick, and the trouble through leaky tubes has disappeared. After 5½ years' service, however, many are now developing cracks in the upper and side portions of the tube plate near the flange. It was anticipated that the fire-box crown, being subjected to the highest temperature, would be the point at which drooping would first occur, but in some cases, contrary to expectations, there was no droop; but the crown actually moved upwards and flat places also appeared in other parts, notably in positions from 12in. to 18in. on either side of the centre line. Later measurements showed that there was a tendency for the box to assume a more or less oval form. It was calculated that a deviation of 1½in. from the circle could be allowed as a safe maximum; the defective part is forced back to its original form by a 200-ton hydraulic jack. The first box attained a mileage of 43,000 before this became requisite, and it was again jacked after a further 19,500 miles. The second box covered 29,000 miles in its first period. Up to the present fifteen fire-boxes have been treated in this manner, with an average mileage of 61,700, and experience with these boxes indicates that the mileage becomes less each time jacking is resorted to. In this deflection from the circular form it has been repeatedly noticed that the movement when once started is fairly rapid up to about 1in., after which it becomes slower. The depressions in the crown are generally most pronounced over the fire-bridge, while the tendency of the box to assume an oval form is most noticeable about half-way between the fire-bridge and the fire-hole door. After the first jacking it was noticed that the weld which was placed at an angle of 45 deg. on bottom of right-hand side, had just become visible, but subsequent service did not affect it. An experiment has been made to prevent this deformation by direct staying of the flue to the outer shell, but with little success. The most recent examinations of this type of flue show that comparatively little wasting occurs on the sides and crown, but it is pronounced round the ash-hopper. This wasting has reduced the plate thickness in some cases $\frac{3}{16}$in., the original thickness being ¾in. Some grooving has been observed at the junction of the tube-plate and flue on the fire side. The usual pitting is encountered on the box and shell. The circulation in this type of boiler is poor, and compares unfavourably with the stayed fire-box boiler in this respect. Trouble has been experienced with priming, especially when shunting. Several appliances have been tried to obviate this, such as increasing the size of the dome, baffle-plates across the boiler near the base of the dome, perforated plates in the dome, &c., but none of these removed the evil. Satisfactory results, however, have been obtained by connecting the safety-valve manhole to the dome with an anti-priming pipe placed outside the boiler. An arrangement is also under trial known as the Ross-Hotchkiss scum collector and circulator. Both the Belpaire and corrugated types are hauling trains up to 1000 tons.

Figures.	Boiler.			Firebox Shell.		Copperbox.		Tubes.		Heating Surface.		Firegrate.
	Diam.	Length.	Pressure.	Long.	Wide.	Long.	High.	Number.	Out. Dia.	Tubes.	Firebox.	
	ft. ins.	ft. ins.	lbs.	ft. ins.	ft. ins.	ft. ins.	ft. ins.	–	ins.	super.	feet.	feet.
12	4 - 2	10-7⅜	180	6 - 0	4 - 1	5 - 4⅝	5 - 10	220	1¾	1108·73	107·68	18¾
13	4 - 6	10-9⅜	180	6 - 4	4 - 1	5 6⅛	F 5-11¾ B 4-8¾	220	1¾	1086	107	18¾
14	5 - 5¼	12 - 9	180	Shell 6-8½ dia. Flue 9-6 long. dia. over corrugations 5-1½.				280	2	1775	125	26
15	4-10	15 - 0	180	8 - 1	4 - 1	7 - 5⅝	6 -11¼	225	2	1767	161	23
16	5 - 8¼	15 - 0	180	9 - 6	4 - 1	8 - 7 7/16	F 7-0 B 6-1	295	2	2317	190	27

DETAILS OF BOILERS

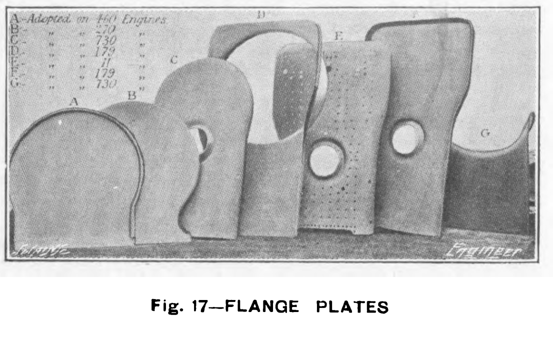


Fig. 17—FLANGE PLATES

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* "Proceedings," Inst. Mech. E., 1896, Part 4, page 466.

LOCOMOTIVES OF THE LANCASHIRE AND YORKSHIRE RAILWAY

(For description see page 119)

Fig. 18. Eight Wheeled Radial Tank Engine.

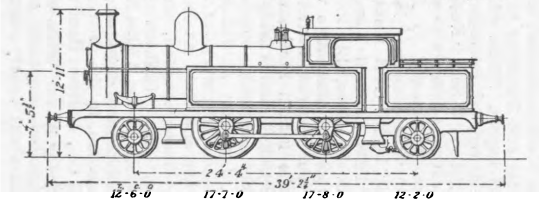

24-4
39-2½
12-6-0
17-7-0
17-8-0
12-2-0

Fig. 22. Ten Wheeled Banking Engine.

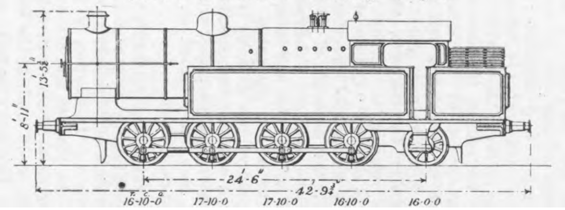

24-6
42-9¼
16-10-0
17-10-0
17-10-0
10-10-0
16-0-0

Fig. 27. Eight Wheeled Passenger Engine.

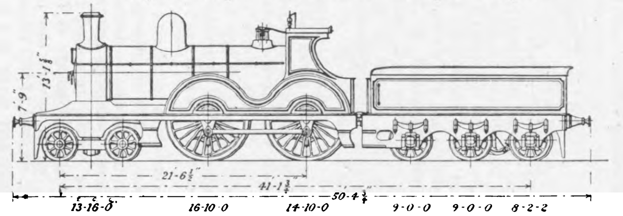

21-6½
41-1½
50-4¾
15-16-0
16-10-0
14-10-0
9-0-0
9-0-0
8-2-2

Fig. 31. Eight Wheeled Coal Engine

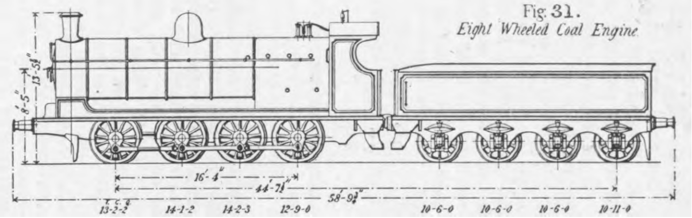

16-4
44-7½
58-9¾
14-1-2
14-2-3
12-9-0
10-6-0
10-6-0
10-6-4
10-11-0

Fig. 19 Eight Wheeled Radial Tank Engine with "Belpaire" Firebox.

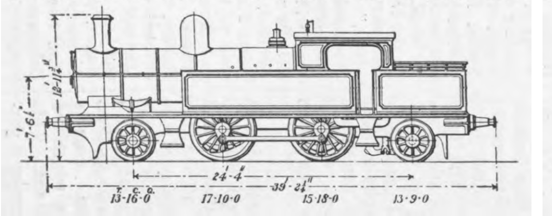

24-4
39-2½
13-16-0
17-10-0
15-18-0
13-9-0

Fig. 23. Shunting Tank Engines.

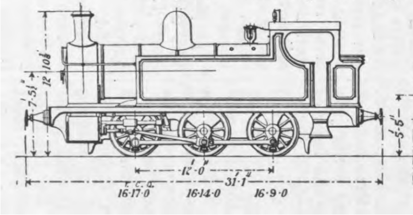

12-0
31-7
16-17-0
16-14-0
16-9-0

Fig. 24

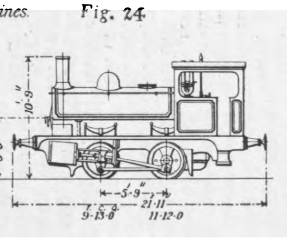

5-9
21-11
9-13-0
11-12-0

Fig. 28. Eight Wheeled Passenger Engine with Superheater.

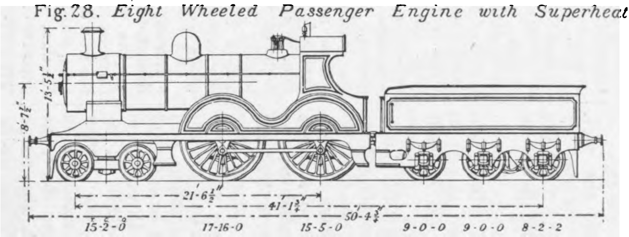

21-6½
41-1½
50-4¾
15-2-0
17-16-0
15-5-0
9-0-0
9-0-0
8-2-2

Fig. 32. Eight Wheeled Coal Engine with Corrugated Steel Firebox

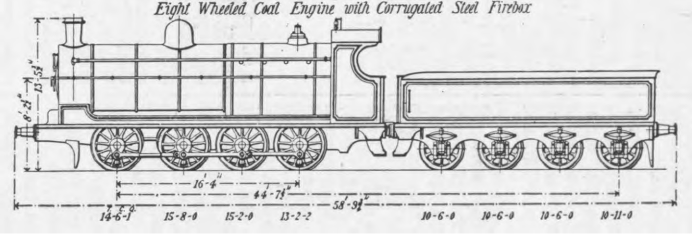

16-4
44-7½
58-9¾
14-6-1
15-8-0
15-2-0
13-2-2
10-6-0
10-6-0
10-6-0
10-11-0

Fig. 20 Eight Wheeled Radial Tank Engine with Thermal Storage System.

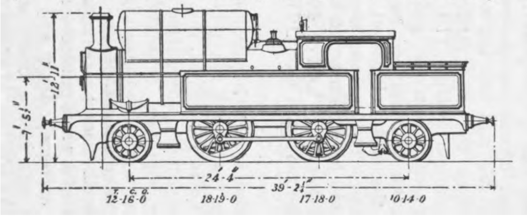

24-4
39-2½
12-16-0
18-15-0
17-18-0
10-14-0

Fig. 25 Six Wheeled Goods Engine.

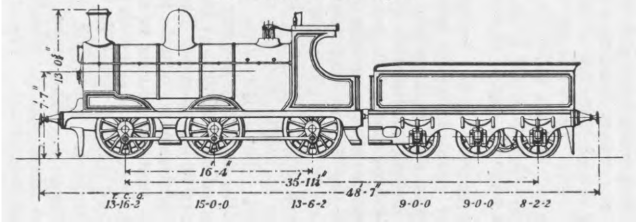

16-4
35-11¼
48-7
15-16-3
15-0-0
13-6-2
9-0-0
9-0-0
8-2-2

Fig. 29. Ten Wheeled Passenger Engine

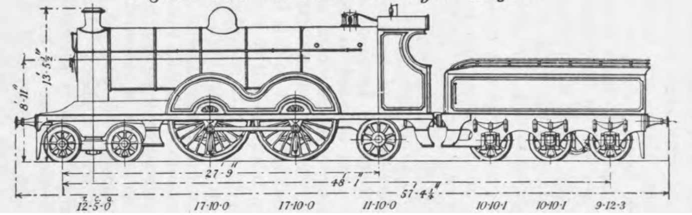

27-9
48-1
57-4¾
12-5-0
17-10-0
17-10-0
11-10-0
10-10-1
10-10-1
9-12-3

Fig. 33 Eight Wheeled Compound Coal Engine.

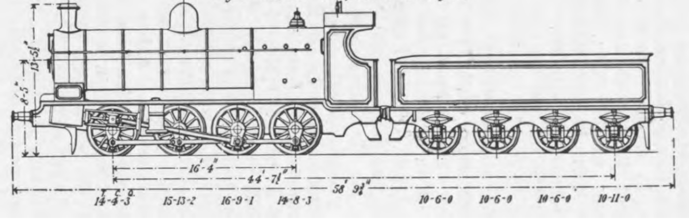

16-4
44-7½
58-9¾
16-4-3
15-13-2
16-9-1
14-8-3
10-6-0
10-6-0
10-6-0
10-11-0

Fig. 21. Ten Wheeled Radial Tank Engine

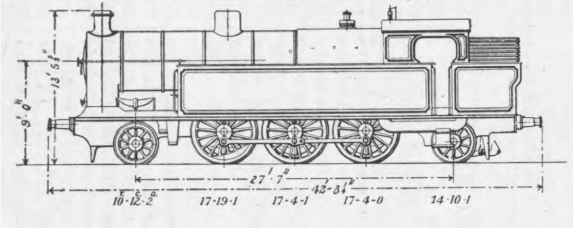

27-7
42-3¼
10-12-2
17-19-1
17-4-1
17-4-0
14-10-1

Fig. 26 Six Wheeled Goods Engine with Superheater.

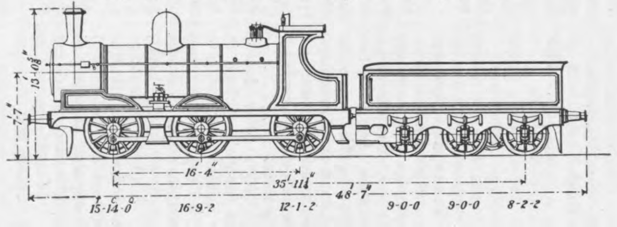

16-4
35-11¼
48-7
15-14-0
16-9-2
12-1-2
9-0-0
9-0-0
8-2-2

Fig. 30 Four Cylinder, Ten Wheeled Passenger and Fast Goods Engine.

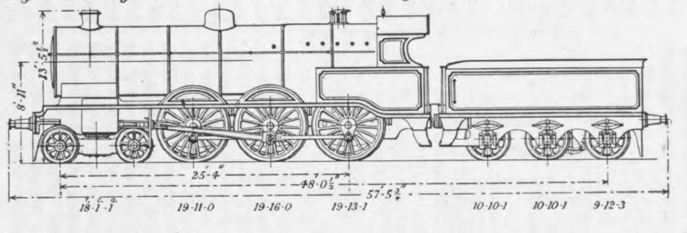
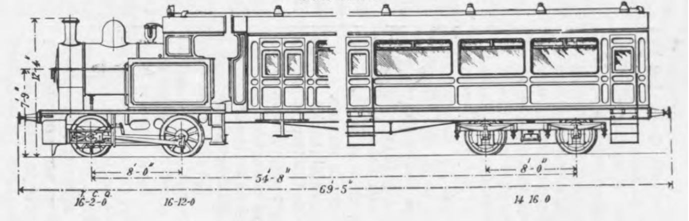

25-4
48-0½
57-5¾
18-1-1
19-11-0
19-16-0
19-13-1
10-10-1
10-10-1
9-12-3

Fig. 34. Rail Motor.


8-0
54-8
69-5
8-0
16-2-0
16-12-0
14 16 0

Figures	Cyl'rs. Diam.	Cyl'rs. Stroke.	Wheels. Radial	Wheels. Coupled.	Boiler. Diam	Boiler. Length.	Firebox Shell Long.	Firebox Shell Wide.	Copperbox. Long.	Copperbox. High.	Tubes. Number	Tubes. Out.Dia.	Heating Surface. Tubes.	Heating Surface. Firebox.	Firegrate.	Tank.
	inches.		ft. ins.	ft. ins.	ft. ins.	ft. ins.	ft. ins.	ft. in.	ft. ins.	ft. ins.	-	ins.	super	feet.	feet.	gal's.
18	18	26	3 7¾	5 8	4-2	10-7⅜	6-0	4 1	5-4⅝	5-10	220	1¾	1108·73	107·68	18¾	1540
19	18	26	3-7¼	5-8	4-6	10-9⅜	6-4	4-1	5-6⅜	F 5-11¾ B 4-8¾	220	1¾	1086	107	18¾	1540
20	18	26	3-7¾	5-8	4-2	10-7⅜	6-0	4-1	5-4⅝	5-10	220	1¾	1108·73	107·68	18¾	1540
21	19	26	3-7¾	5-8	4-10	15-0	8-1	4-7	7 5⅜	6-3¼	239	2	1877	161·64	26·05	2000

Figures.	Cyl'rs. Diam.	Cyl'rs. Stroke.	Wheels. Coupled.	Wheels. Radial.	Boiler. Diam.	Boiler. Length.	Firebox Shell. Long.	Firebox Shell. Wide.	Copperbox. Long.	Copperbox. High.	Tubes. Number.	Tubes. Out.Dia.	Heating Surface. Tubes.	Heating Surface. Firebox.	Firegrate.	Tank.
	inches.		ft. ins.	ft. ins.	ft. ins.	ft. ins.	ft. ins.	ft. in.	ft. ins.	ft. ins.	-	ins.	super.	feet.	feet.	gal's.
22	21½	26	4-6	3-7⅝	5-8¼	13-0	8-10	4-1	7-11 7/16	7-0	295	2	2008	190	25·6	2000
23	17	24	4-6	-	4-2	10-4¾	5-6	4-1	4-6¾	4-10¾	220	1¾	1081·5	85·9	17	980
24	13	18	3-0⅜	-	3-0	8-10	2-10	3-9	2-3⅛	4-3¾	104	1¾	432·75	43	7·2	450
25	18	26	5-1	-	4-2	10-4¾	6-0	4-1	5-4⅝	5-10	220	1¾	1102·26	107·68	18¾	1800
26	20	26	5-1	-	4-2	10-4¾	6-0	4-1	5-4⅝	5-10	see description.					1800

Figures.	Cyl'rs. Diam.	Cyl'rs. Stroke.	Wheels. Bogie.	Wheels. Coupled.	Wheels. Trailing.	Boiler. Diam.	Boiler. Length.	Firebox Shell. Long.	Firebox Shell. Wide.	Copperbox. Long.	Copperbox. High.	Tubes. Number.	Tubes. Out.Dia.	Heating Surface. Tubes.	Heating Surface. Firebox.	Firegrate.	Tank.
	inches.		ft. ins.	ft. ins.	ft. ins.	ft. ins.	ft. ins.	ft. ins.	ft. in.	ft. ins.	ft. ins.	--	ins.	super.	feet.	feet.	gal's.
27	18	26	3-0½	7-3	-	4-2	10-7⅜	6-0	4-1	5-4⅝	5-10	220	1¾	1108·73	107·68	18¾	1800
28	20	26	3-0½	7-3	-	4-2	10-7⅜	6-0	4-1	5-4⅝	5-10	see description.					1800
29	19	26	3-0½	7-3	3-7¾	4-10	15-0	8-1	4-1	7-5⅝	6-11½	225	2	1767	161	23	2290
30	16	26	3-0½	6-3	-	5-8¼	15-0	9-6	4-1	8-7 7/16	F 7-0 B 6-1	295	2	2317·0	190	27	2480

Figures.	Cylinders. Diam.	Cylinders. Stroke.	Wheels.	Boiler. Diam	Boiler. Length.	Firebox Shell. Long.	Firebox Shell. Wide.	Copperbox. Long.	Copperbox. High.	Tubes. Number.	Tubes. Out.Dia.	Heating Surface. Tubes.	Heating Surface. Firebox.	Firegrate.	Tank.
	inches.		ft. ins.	ft. ins.	ft. ins.	ft. ins.	ft. ins.	ft. in.	ft. ins.	-	ins.	super.	feet.	feet.	gal's.
31	20	26	4-6	4-10	15-0	8-1	4-1	7-2¼	6-3⅜	225	2	1767	147	23·05	3600
32	20	26	4-6	5-5¼	12-9	Shell 6′-8¼″ dia. Flue 9′-6″ long. dia. over corrugations 5′-1½″				280	2	1775	125	26	3600
33	15½ & 22	26	4-6	4-10	15-0	8-1	4-1	7-2¼	6-3⅜	225	2	1767	147	23·05	3600
34	12	16	3-7⅝	4-3	5-0	3-4	4-1	2-5⅝	4-3¼	199	1¾	455	54	9·4	550
35	17½	26	4-6	4-2	10-3	6-0	4-1	5-4½	F 4-11¼ R 3-5	194	1¾	945	97	19¼	932

"THE ENGINEER"

SWAIN Sc

Hoy's ten-wheeled radial tank engines. (Built October, 1903.)—The next design was a ten-wheeled radial tank engine, built for the Manchester and Oldham branch service—Fig. 21. The gradients on this section are as severe as 1 in 41, eight stations occurring in 7½ miles. Loads of 200 tons have to be hauled at an average speed of 26 miles per hour, including stops, and with a restricted time allowance an engine possessing rapid acceleration was necessary. To obtain sufficient adhesion six wheels coupled were employed, with a radial box at each end. The cylinders, which are 19in. diameter, are similar to those of the goods and passenger engines previously described. Water is carried in side and back tanks of 2000 gallons capacity, and the double scoop apparatus, similar to the eight-wheeled tanks, is used. The coal capacity is 3¾ tons.

Hughes' eight-wheeled radial tank engines with Belpaire fire-boxes. (Built April, 1905).—These engines are similar to the previous eight-wheeled tanks, except that the fire-box is of the Belpaire pattern, and the boiler has 20 per cent. more water and 40 per cent. more steam space than the ordinary round top type—Fig. 19—this addition being obtained without altering any other portion of the original design. These engines are employed on the same work as the other eight-wheeled tanks, and twenty are in service.

Thermal storage tanks. (June, 1902).—Six radial tanks of the round top fire-box type have been equipped with the Druitt-Halpin thermal storage tank—Fig. 20. This arrangement consists of a cylindrical tank mounted above the boiler, and connected thereto by a saddle-plate—Fig. 37 (post)—and is so well known that a further description is unnecessary. Where stopping places are frequent on rising gradients there is distinct economy. Certain tests were carried out between Salford and Accrington, resulting in an actual saving of one ton of water, and under similar conditions elsewhere the saving was 12 per cent. When, however, these engines have to take their turn on other sections of the line which are not so favourable the all round economy is brought down to 4 per cent.

Hughes' steam rail motor cars. (Built May, 1906).—Thirteen steam rail motor cars have been built—Fig. 34. The engines have outside cylinders, 12in. by 16in. stroke, and the valves are operated by the Walschaert gear. A locomotive type boiler is fitted, similar in design to Fig. 18, which allows the employment of standard flanged plates and fittings, thereby reducing the cost of manufacture. The adoption of a comparatively large boiler gives additional heating surface, and provides a good margin for starting purposes. The car body is 47ft. long, and divided into three sections, namely, a luggage compartment with a capacity of 340 cubic feet, third-class accommodation for 56 passengers, and a driver's compartment. The car is steam heated, and lighted by incandescent oil-gas lamps. A feature in the design is the collapsible steps at each doorway, which can be raised or lowered from the trailing end so as to form a staircase from the car floor to the rail level, to enable passengers to board or leave at the "halts." The ease of attaching or detaching the engine from the car is another feature, thirty minutes being ample time for this work. The car can be operated from either end, and electric bell communication is also provided for signalling purposes between the driver and fireman when propelling. These cars run on gradients of 1 in 40 and 1 in 50, and attain an average speed of 35 miles per hour, with an annual average mileage of 34,000.

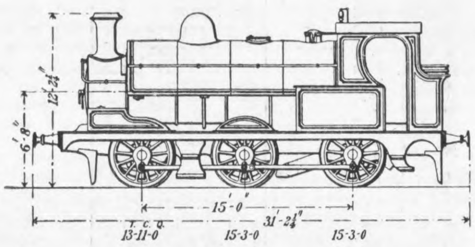


Fig. 35—CONVERTED TANK ENGINE

Hughes' compound coal engine. (Built April, 1907).—Following the rail motors, ten compound coal engines were constructed—Fig. 33. This step was taken after some exhaustive tests with an engine which the author had converted into a compound. This subject will be dealt with in a future paper at an early date.

Schmidt's superheater.—In November, 1906, two standard goods engines were fitted with Schmidt's superheating arrangement—Fig. 26. Schmidt's experience showed the possibility of increased piston area, and so the 18in. cylinders were replaced by cylinders 20in. diameter; the maximum steam cut-off at the same time was reduced to 70 per cent. With superheating, a higher initial pressure is maintained in the cylinder, and therefore a greater range of expansion is possible, whilst condensation is less. The additional weight, by reason of fitting this appliance, is about two tons, but the tractive force is increased in a greater ratio than the adhesion. Five passenger engines and twenty new standard goods engines, with this arrangement, have been built, or are under construction, and the actual number in service up to date is sixteen. The subject will be dealt with in a future paper at an early date.

Hughes' banking engines. (Built March, 1908).—For heavy banking service and coal-shunting in the neighbourhood of Fazakerley, Liverpool, and Accrington, the author has put into service five very powerful engines—Fig. 22. They are equipped with the largest diameter of cylinders yet employed in a simple engine in this country, and, with their comparatively small wheels, possess a high tractive effort—an essential quality for shunting. In this design, owing to permanent-way considerations, it was necessary slightly to increase the fixed wheel base beyond that of the six-wheeled goods and eight-wheeled coal engines. For ease in passing round curves the flanges of the two middle pairs of driving wheels are omitted and the tires made wider. Water is carried in side and back tanks of 2000 gallons capacity. Steam and vacuum brakes are provided.

(*To be continued*).

AMERICAN ENGINEERING NEWS.

Waterworks and fire protection.—At the annual meeting of the American Waterworks Association, Mr. H. M. Wilson presented a paper on "Fire Wastes," in which he showed that the total cost of or loss in fires in the United States during the year 1907 amounted to £91,300,000, while the actual fire loss due to the buildings and their contents being destroyed was £43,000,000, or a per capita loss of 10s. for the entire country. He pointed out the significance of these figures in view of the fact that the average for the six leading countries of Europe was a loss of only 1s. 4d. per capita. The insurance loss for the year amounted to £29,000,000. The cost of fire department maintenance—including interest on capital—amounted to £8,800 000, while that of private fire protection was £3,600,000. Of the £43,000,000 due to the burning of buildings and their contents, £13,700,000 was chargeable to brick and stone buildings, and £29,300,000 to wooden buildings. The total cost of the waterworks systems of the United States amounts to some £225,849,500. Of this total, £176,715,000 is chargeable to domestic service and £49,134,500 is chargeable to fire service. Thus, only 22 per cent. of the total cost of waterworks systems is due to the additional supplies necessary for protection against fires. In individual cities, this proportion of fire protection cost to total cost of waterworks ranges from zero up to 60 per cent. Of the total amount given above, £49,134,500, the water supply cost represents £13,300,000; the distributing system, £25,450,000; hydrants, £6,000,000; and separate high-pressure fire service, £4,440,000. The cost of waterworks ranges from £4 15s. 6d. per capita in towns of 5000 to 30,000 inhabitants, to £5 16s. 10d. in those of 30,000 to 100,000, and £6 11s. 4d. per capita in cities of over 100,000.

Factory stock room methods.—To reduce the work of handling stock when taking an inventory, the Ryerson Company has an extra vertical row of empty bins at the end of each stack of bins. Thus, if there are fifteen bins in each horizontal row, the first one will be empty and the others numbered 1 to 14. In taking stock the contents of No. 1 are counted and placed directly in the adjacent empty bin, which is then marked No. 1. In the same way the contents of No. 2 are transferred to form No. 1, which is re-numbered as No. 2, and so on until No. 13 becomes No. 14, and the end—or fifteenth—bin is empty. At the next stock-taking, No. 14 is taken first, and the contents placed in the adjacent empty bin, which is then numbered No. 14, and so on down the line. The Pierce Automobile Company uses rows of sheet steel boxes or drawers in horizontal and vertical rows for storing small articles. A boy makes a daily round of the stacks, and wherever he finds the supply low he turns on end the stock card, which is set in a frame on the box and indicates the contents. These upright cards attract the attention of the stock clerk, who makes out the necessary order for replenishing the supply; he then replaces the card, but with its reverse side outward, indicating that the supply has been ordered. For emery wheels and polishing wheels, which are of odd sizes, and for other odd shaped articles, the United Shoe Machinery Company uses long pegs of iron rods, each having an iron lug cast on one end. A rack of horizontal angle irons is placed against the wall, and the rods are set in any desired part of the rack by means of the lugs, which form attachment lugs. Thus the spacing or position of the rods is varied to suit the size or shape of the articles strung upon them.

Machines for loading railway wagons with coal.—In certain parts of the United States coal is shipped very largely in covered wagons or "box cars," partly to reduce loss by theft and partly to utilise the ordinary goods wagons. As these wagons are of 30 to 40 tons capacity and about 30ft. long, with a door in the middle of each side, special means are required to give them full loads promptly. Special portable conveyors have been adapted to this work. Some of these have fast-running belts, the belt being carried on a frame which is inserted in the wagon and turned parallel with its length. The coal delivered to this frame or belt, or inclined shoot, is thrown from the belt to the end of the wagon. This method is liable to result in considerable breakage with certain kinds of coal. Another form of machine has a trough-shaped hopper, which travels to and fro inside the wagon, and has a rocking motion which tilts the contents out at each end of the travel, assisted by a scraper which passes through the hopper before the motion is reversed. At the middle of its travel, when opposite the door of the wagon, the hopper receives its load from a shoot. The hopper is mounted on the end of an arm which is inserted through the door, the hopper being pivoted so as to be parallel with the frame during the placing or removal of the frame. When inside the wagon the hopper or trough is placed parallel with the rails. The frame is pivoted to a steel truck or lorry, which carries the driving machinery and travels on a line of rails parallel with the wagon loading siding. A 75 horse-power electric motor is used, running at 450 revolutions, and using current at 220 volts. Two wires and a double trolley are used, one for the supply and the other for the return current. The last few tons are shot in direct from the shoot. The machine can load from 40 to 50 wagons in ten hours.

A steel bowstring arch bridge.—At Philadelphia, a steel bridge of novel design is being built to carry a street across a railway at a point where there are some sixteen lines of rail, and no intermediate piers or columns could be used. The rails are about 20ft. below the level of the street. The bridge has two steel arch ribs of box section, 15in. wide, 16in. deep at the crown, and 10½ft. deep at the inclined springing lines on the abutments, the springing being just below the street level. The clear span between the faces of the springings is 250ft., and the rise of the arch is 54½ft. above this level. The height from the roadway to the top of the arch is 46ft., and the roadway has a camber of 3ft. in 125ft., with a radius of 2000ft. at the middle of the span and gradients of 1 in 33 at the ends. The arches are 37½ft. apart, and the floor girders carry outside footpaths, the total width being 57ft. A peculiar feature is that the hollow arch ribs are filled with concrete, made with ⅞in. stone, and very wet. This is deposited through holes in the top cover plate and thoroughly rammed. The filling is carried on from both sides simultaneously. The arches were erected on staging and bolted at three splices, which were not riveted until the centers had been struck. The cross girders for the floor are suspended from the arch by hangers made of 15in. steel joists, the upper end of the joist lying inside the arch rib, with its flanges riveted to the web plates. The bottom cover plates of the ribs are cut to fit snugly between the hangers. Between the cross girders are 15in. rolled joists forming longitudinal bearers 17ft. 4in. long. The cross girders are encased in concrete, and concrete jack arches are built between the longitudinals, being so placed as to completely encase the steel and protect it from smoke and gases from the engines. The roadway is paved with asphalt. The bridge is designed for a distributed load of 100 lb. per square foot, with a concentrated load of 40 tons on a four-wheeled tram car on the roadway, and 110 lb. per square foot on the footpath.

Road improvement experiments.—Much experimental work is being done in the United States to improve the public roads of two different classes:—First, the roads of moderate and heavy traffic, especially near cities and towns; second, the roads in thinly populated country districts. Many of the experiments are in relation to utilising local materials, where ordinary road-making materials are not easily available. In the neighbourhood of some large sugar refineries a by-product—which is almost a waste product—is "blackstrap," a heavy treacle. It is extremely dense and sticky, and when mixed with quicklime sets into a heavy and sticky cement. This being soluble, the addition of heavy oil serves to make it permanent and waterproof. About 300 lb. of lime are slaked with 100 gallons of water and 90 gallons of treacle residuum added and well mixed; to this are added 50 gallons of asphaltic oil. While the mixture is hot, road metal in graded sizes is added and thoroughly mixed. When rolled upon the road surface it produces a firm and resilient paving. Another experiment consists in mixing oil or asphalt compositions with the natural earth, whether sandy or clayey. The road surface is alternately ploughed—or harrowed—and sprinkled, and finally rolled. With sandy soil the rolling is best done by a roller having its face formed by a series of mushroom-shaped lugs or projections, which thus pack the material by ramming instead of by dead pressure. In still another case, in sandy districts, where the sandy road material is blown away by constant winds, a bed of heavy clay is laid upon the sandy road and well packed. This is watered, harrowed, covered with sand, and rolled until a thick and dense road covering is formed.

MIDLAND INSTITUTE OF ENGINEERS.—The annual meeting of the Midland Institute of Mining, Civil, and Mechanical Engineers was held at Sheffield on the 22nd inst., Mr. M. H. Habershon presiding. The annual report notified a membership of 365, as compared with 363 last year. The report dealt with various aspects of the work of the Institute during the year, and, referring to the appointment of Professor C. T. O'Shea as hon. secretary of the Institution of Mining Engineers, in succession to the late Mr. Walton Brown, said that Mr. O'Shea had asked to be allowed to resign the secretaryship of the Midland Institute in consequence of the extra work his new appointment entailed. The Council had accepted his resignation, having taken the view that what was undoubtedly an immediate loss to that Institute was for the ultimate benefit of the Institution of Mining Engineers. Officers for the ensuing year were elected, and subsequently Mr. James Elce Silverwood, read a paper on "Some Notes on the Working and Testing of Locked-coil Winding Ropes." An interesting discussion followed.

THE THWAITE FUND.—The B. H. Thwaite fund has received from Mr. Carnegie a cheque for £500. The conditions which were attached to Mr. Carnegie's offer—namely, that a further £500 should be forthcoming from subscriptions from those who recognised the value of the services rendered to certain departments of science and industry by the late Mr. Thwaite—were not exactly complied with, as the subscriptions did not reach a quite equal sum; but Mr. Carnegie has not allowed this to stand in the way. He was doubtless influenced in his decision by the successful efforts of the committee with regard to Mr. Thwaite's son, aged nine, who has been elected to the Yorkshire Society School. We understand that arrangements are also in progress for placing Mr. Thwaite's daughter in a school. The Committee are desirous of expressing, through our pages, their gratitude to Mr. Carnegie for his generosity and kind consideration, to all who by their subscriptions have helped to make up the required sum, and to those who have so substantially assisted by placing Mr. Thwaite's son in the above school. In the last-named connection, special thanks are due to Mr. George Mellor, the secretary of the Association of Yorkshiremen in London, of which association the late Mr. Thwaite was a founder.

REPORT ON THE IRON ORES OF NOVA SCOTIA.—The Mines Branch of the Department of Mines, Ottawa, which was organised for the purpose of devoting special attention to the economic features of Canada's mineral resources, has just issued a report on the iron deposits of Nova Scotia, prepared by Dr. J. E. Woodman, until recently Professor of Geology at Dalhousie University, Halifax. This report, which covers the more important iron deposits of the province, consists of 222 pages of text, 63 illustrative photographs, diagrams and maps, and an index. The scope and economic importance of the work may be judged from the instructions given to the author, who was requested to give special attention to:—(1) Localities of iron ore deposits so far discovered, and names and addresses of owners; (2) history of development of mines and companies (if any); (3) geological description; (4) analyses of ores; (5) in cases of mines which have been worked, output and statistics; (6) transportation facilities; (7) limestone in neighbourhood of deposits; (8) the general character of the forest in the neighbourhood, *i.e.*, whether the supply is sufficient for mining purposes and for the production of charcoal in the event of the introduction of electric smelting; and (9) maps of mines (and drill holes, if any). The report itself is divided into two main parts:—Part I. deals with the geographic relations of the deposits, their mineralogy and geology, and questions relating to mining policy, bounties and mining laws. Part II. is entitled "Details of Iron Districts," and covers more particularly the ores of the Clementsport basin, the Nictaux-Torbrook field, the deposits of Hants and Colchester counties, the ores of the Western Cobequid mountains and of Arisaig, and the ores of Cape Breton, and is replete with analyses of ores, records of bore-holes and geological sections, and other statistical data. A second volume covering iron ore deposits, not referred to in Volume I., and devoting special attention to limestones of value for metallurgical purposes, will shortly be issued. Copies of the report may be obtained on application to Dr. Haanel, Director of Mines, Ottawa.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND.—The detailed official programme of the summer meeting of the North-East Coast Institution of Engineers and Shipbuilders, to be held jointly with the Scottish Institution of Engineers and Shipbuilders in Glasgow on the 4th, 5th and 6th August, has now been issued. The representatives from both bodies will meet on Wednesday, August 4th, at 10 a.m., at the fine new home of the Scottish Institution in Elmbank-crescent, when an address of welcome will be given by Mr. John Ward, the President of the Scottish Institution, which will be responded to by Mr. Summers Hunter, President of the North-East Coast Institution. The forenoons of both Wednesday and Thursday will be devoted to the reading and discussion of papers. These will be as follows:—"A Slight Sketch on the History of Propellants," by Sir Andrew Noble, Bart., K.C.B., F.R.S., D.Sc.; "Notes on the Trials and Performances of the s.s. Otaki, fitted with a Combination of Reciprocating and Turbine Machinery," by Engineer-Commander W. McK. Wisnom, R.N.; "Sixty Years of Merchant Shipbuilding on the North-East Coast," by Dr. G. B. Hunter and by Mr. E. W. DeRusett, M.I.N.A.; "Fifty Years of Warship Building on the Clyde," by Professor J. H. Biles, LL.D. The afternoon of Wednesday will be devoted to alternative visits to works in the Motherwell, Johnstone, and Renfrew districts. At Motherwell a visit will be paid to the Dalzell Steel and Ironworks (David Colville and Co., Limited), the Brandon Bridge Building Company, Limited, and the steel roof and bridge-building works of Messrs. Alex. Findlay and Co., Limited. At Johnstone a visit will be paid to the machine tool-making works of John Lang and Sons and Messrs. Thos. Shanks and Co. At Renfrew the works of Messrs. Babcock and Wilcox, Limited, engineers and boiler-makers, will be visited. The afternoon of Thursday will be devoted to alternative visits to the Albion Motor Car Company, Limited, and the shipbuilding and engineering works of Yarrow and Co., Limited, at Scotstoun, to the dredger-building works of Messrs. Wm. Simons and Co., Limited, Renfrew, or to the Steel Company of Scotland's works at Blochairn, and the works of Sir Wm. Arrol and Co., Limited, engineers and bridge builders, Dalmarnock. In addition about twenty other works will be open to visitors.

THE IRON, COAL, AND GENERAL TRADES OF BIRMINGHAM, WOLVERHAMPTON, AND OTHER DISTRICTS.

(*From our own Correspondent.*)

War in Galvanised Sheet Trade.

THE war in the galvanised sheet trade was confirmed in every detail to-day. It is stated that the members of the late organisation have in set purpose declared war to the knife against the newer firms, which, by refusing to join the late Association, brought about the downfall of that body, and that they have determined to try either to drive these newer firms out of the trade, or force them to reconsider their decision to remain outside any association. With this express object, selling prices, it was declared this afternoon, are to be sacrificed in an utterly reckless manner, and the conduct of business below cost is to be the rule of the trade. The ruin which this reckless state of things must of necessity bring about is almost shameful to contemplate, and the money which must be lost in the course of the fight is certain to be very large. Names were freely canvassed to-day respecting which makers in the galvanised sheet trade are supposed to be in the best—*i.e.*, the strongest—position to emerge sound out of the fierce racket, and which must succumb, but beyond the general fact that makers situated near the ports will, owing to their situation, stand a much better chance of surviving than those inland, such as the Staffordshire and Midland makers in particular, nothing definite could be declared. The position which has been sprung upon the industry is certainly one for extreme regret, and of grave trade moment. Selling prices to-day for 24 w.g. f.o.b. Liverpool or equal were £10 to £10 10s. and £10 15s. per ton, compared with £12 10s., which was the ruling quotation before the break up of the Association. The spelter market partakes of the disorganisation of the sheet branch, and virgin spelter is quoted £12 15s. at Birmingham, and hard at £18 10s.

Closing Ironworks.

The immediate result upon the black iron trade of the war which has been declared in galvanised sheets is disastrous. One large firm in the Wolverhampton district owning four sheet mills has given notice to its men of its intention immediately to close down the works until such time as better trade arrives, and more remunerative prices can be got. This is a very serious state of things, and it is feared that some other ironworks may follow the example. Owing to the unsatisfactory state of trade and the exceedingly low prices prevailing, certain of the common bar ironworks have been closing down some of their mills for some time past, and now it seems the black sheet makers are to do the same. Black sheets have fallen 2s. 6d. to 5s. per ton the last fortnight, and prices are now:—20 w.g. sheets, £7 to £7 2s. 6d., 24 w.g., £7 2s. 6d., and 27 and 28 w.g., £7 15s. to £7 17s. 6d. per ton. Common bars for nut and bolt and fencing purposes are down to £5 12s. 6d. per ton, and merchant bars are as low as £5 17s. 6d. North Staffordshire "crown" bars are £6 10s. at the ports.

Raw Iron Trade.

The price of pig iron is said to be out of proportion to the selling values of finished material, but makers will not listen to consumers' demands for any sensible reduction in prices. The improvement on the Cleveland market, with an advance in the value of No. 3 iron of 1s. 1d. on the week, adds to the strength of the local makers' position. Prices are quoted:—Forge pig iron: Staffordshire common, 46s.; part-mine, 48s. to 49s. 6d.; best all-mine, 80s. to 81s.; cold blast, 110s.; Northamptonshire, 46s. to 47s.; Derbyshire, 47s. 6d. to 48s. 6d.; North Staffordshire, 49s. to 50s.

NOTES FROM LANCASHIRE.

(*From our own Correspondent.*)

MANCHESTER, Thursday.

Better Undercurrent in Pig Iron.

IT is pleasing to note that there are now improved prospects in pig iron. Merchants are sending out a fair number of inquiries for decent quantities, and, notwithstanding bad trade, consumers are at last compelled to cover their requirements. There is also some anxiety to buy for forward delivery, but this makers in most cases will not hear of. Indeed, one well-known Scotch firm has withdrawn quotations for a time owing to the critical position in the coal trade, while others will not quote for delivery within the next three months. No doubt much of this is caused by buying on speculative account, coupled with strong American advices. English brands are firmly held for full rates, and Middlesbrough and Scotch are 6d. to 1s. better on the week, according to circumstances. On the month, Staffordshire and Derbyshire are practically unchanged, and Lincolnshire 6d. better. Gartsherrie has shown the highest figure, 1s. to 1s. 3d.; Eglinton and Dalmellington, 9d. to 1s.; and Glengarnock, 6d. per ton. Hematite is about 6d. per ton better, but the close is dull. Forge iron was in better inquiry, but remains weak on spot.

Finished Iron and Steel.

Shows little change. There is still a scarcity of foreign billets, which now pretty well approximate to English in price.

Copper.

Manufactured rallied somewhat in the concluding week of this month, but while tubes were $\frac{1}{8}$d. per lb. higher, sheets were £2 per ton lower. Tough ingot was rather easier.

Lead.

Values gradually dropped, and sheets are 10s. per ton lower, and the feeling easier.

Tin.

English ingots have been variable, but close about 20s. per ton better on the month.

Quotations.

Pig iron: Lincolnshire No. 3 foundry, 52s. to 52s. 6d.; Staffordshire, 51s. to 51s. 6d.; Derbyshire, 52s. 6d. to 53s.; Middlesbrough, open brands, 57s. 10d. to 58s. 1d. Scotch: Gartsherrie, 59s. 3d.; Glengarnock, 58s.; Eglinton, 57s. 6d.; Dalmellington, 57s. 6d., delivered Manchester; West Coast hematite, 58s. 6d.; East Coast ditto, 56s., both f.o.t. Delivered Heysham: Gartsherrie, 57s. 3d.; Glengarnock, 56s.; Eglinton, 55s. 6d.; Dalmellington, 55s. 6d. Delivered Preston: Gartsherrie, 58s. 3d.; Glengarnock, 57s.; Eglinton, 56s. 6d.; Dalmellington, 56s. 6d. Finished iron: Bars, £6 10s.; hoops, £7 12s. 6d.; sheets, £7 15s. to £8. Steel: Bars, £6 5s.; Lancashire hoops, £7 5s.; Staffordshire ditto, £6 17s. 6d. to £7; sheets, £7 17s. 6d. to £8; boiler plates, £7 2s. 6d.; plates for tank, girder, and bridge work, £6 to £6 5s.; English billets, £4 10s. to £4 12s. 6d.; foreign ditto, £4 7s. 6d. to £4 10s.; cold-drawn steel, £9 5s. to £9 10s. Copper: Sheets, £71; tough ingot, £62 to £62 10s.; best selected, £62 to £62 10s. per ton; copper tubes, 8$\frac{1}{2}$d.; brass tubes, 6$\frac{7}{8}$d.; condenser, 7$\frac{7}{8}$d.; rolled brass, 6$\frac{1}{4}$d.; brass wire, 6$\frac{1}{2}$d.; brass turning rods, 6$\frac{1}{2}$d.; yellow metal, 6$\frac{1}{8}$d. per lb. Sheet lead, £17 5s. per ton. English tin ingots, £131 10s. per ton.

The Lancashire Coal Trade.

The attendance on the Coal Exchange was rather under the average, but there was more business being done. The Eight Hours Act, with one or two slight exceptions, does not appear to have caused much trouble. Still, there was a marked disposition on the part of buyers to cover forward, especially in house coal. In shipping and bunkering coal the tone was also decidedly better. The market closed with an upward tendency, although no change was made in official quotations.

BARROW-IN-FURNESS, Thursday.

Hematites.

The tone of the hematite iron trade has not improved. The demand is confined to a much smaller business than has been the fact of late, and makers, generally speaking, are not holding as many orders as for some time past. Consequently there is an increase of stocks in makers' yards, and the prospect of a further increase in warrant stores. The iron held in the latter is the same as last week, 13,377 tons, which is, of course, only looked upon as a comparatively small bulk of metal. There are still 26 furnaces in blast, and it is not proposed at the moment to put any of these out of blast, as the general feeling is that the present period of depression will only be of brief duration. Prices are still easy at 58s. net f.o.b. for mixed Bessemer numbers, and 56s. 6d. for warrant iron net cash sellers, 56s. buyers, special hematites are at 60s. to 61s. 6d., and are in fairly good demand; indeed, although the general trade is quiet, the special trade is reasonably supplied with orders. There are good prospects for this particular business, as by the means of specifying exactly the analysis of metal a consumer wants half his battle is fought in the special manufactures which require this high grade metal as the basis of their operations. The sale of spiegeleisen is not large, and most of it is used in the district, but a portion of it is being utilised on foreign account. Ferro-manganese is making a market for itself, and there is no question that this material will be in very strong demand when there is a general improvement in trade. Charcoal iron is selling fairly well, and there is much activity in the district in the manufacture of charcoal required in the smelting operations. Scrap iron is in good demand, and some large parcels have recently been sold. Iron ore is in small request, and the mines are being but indifferently worked, except those at Hodbarrow and Ronhead, where there is a good output of iron ore, which, of course, is of the best quality, and realises 17s. per ton net at mines, while medium sorts are at 13s. 6d. and ordinary at 11s. per ton. Cargoes of foreign ores have not been largely imported of late.

Steel.

There is no improvement to report in the steel trade. The mills are not fully employed, even in the Bessemer department. The demand for rails is not large enough to keep all the mills in the district employed, and considerable foreign competition has now to be faced. Merchant steel is in quiet demand. Shipbuilding classes of steel are in poor request, although some good local orders are expected.

Shipbuilding and Engineering.

The only news in the shipbuilding trade this week is the receipt of an order by Vickers, Sons and Maxim for the construction of a floating dock to raise one of the Dreadnoughts. No information is to hand as to the size of this dock, but as it has to lift about 23,000 tons, it may be judged to be of considerable dimensions. Other docks of this class have to be built for the Admiralty. Orders have been received for a large number of gun mountings, and this department of local industry will soon be very briskly employed.

Shipping and Coal.

The shipping figures this week are not to hand, but it is known that the exports of iron and steel are low. Coal and coke quiet, but prices, in view of the crisis, are high.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

Steam Coal Active.

STEAM coal is at present much in demand for shipment, at prices reaching up to 9s. 6d. per ton. Heavy tonnages are leaving the South Yorkshire districts for the East Coast more especially, and also for the West. All kinds of steam fuel are selling freely, steam nuts and seconds hards being inclined to move with almost equal freedom to best hards, at corresponding rates. The latest available official return of exports of coal from Hull—that for the week ending 20th July—shows the total to have been 106,241 tons, as compared with 84,979 tons for the corresponding period of last year. Cronstadt was the principal market, taking 19,690 tons, Alexandria second with 9831 tons, and Rotterdam third with 9271 tons.

House, Gas, and Small Coal.

House coal keeps in fair demand, owing largely to householders putting in their winter supplies. London merchants maintain their requirements, which are stated to be rather larger than usual at this period of the year. Country merchants are also reported to be ordering somewhat more freely, especially from the Eastern Counties. Secondary qualities do not sell so actively as the superior grades. Best Barnsley continues at 11s. 6d. to 13s. per ton at pit; secondary descriptions, from 10s. to 11s. per ton at pit. Gas coal is in moderate demand, a considerable tonnage being despatched on account of contracts. Slacks are in good request, extra supplies being taken in several instances for stock at works and mills. For qualities used in Lancashire cotton and Yorkshire woollen districts the prices are maintained at 4s. 6d. to 5s. 6d. per ton.

Coke.

A fair demand continues in the coke market at recent prices, and is showing no tendency to decline. Best washed coke, 10s. 6d. to 11s. per ton; unwashed, 10s. to 10s. 6d. per ton. Coking smalls are in good request, and somewhat scarce, the firmer tone noted last week being still evident.

The Iron Market.

Official prices of hematites still continue as during the past few weeks. A brisk demand arose for East Coast iron a few days ago for shipment, but not sufficient to affect prices permanently. Generally the demand for East or West Coast is much below the output, and iron is being daily put into stock. Hopes are still entertained of better times, and this, with the low Bank rate, keeps up the make and price. The Lincolnshire Ironmasters' Association met last Friday, but made no alteration in prices—neither buyers nor sellers seem to be pushing business. Most of the pig iron producers are fairly well sold until after the holiday season, when they expect trade will improve. Quotations:—Hematites: West Coast, 68s. to 69s. per ton; East Coast, 64s. to 65s. per ton; both less 2$\frac{1}{2}$ per cent. delivered in Sheffield and Rotherham; Lincolnshire, No. 3 foundry, 50s. per ton; No. 4 foundry, 49s. per ton; No. 4 forge, 49s. per ton; No. 5 forge, mottled and white, 49s. per ton; basic, 50s. 6d. per ton; Derbyshire, No. 3 foundry, 49s. 6d. to 50s. per ton; No. 4 forge, 48s. 6d. to 49s. per ton. Both Lincolnshire and Derbyshire irons net delivered in Sheffield and Rotherham.

Bars, Hoops, and Sheets.

The finished iron trade of the district is very much in want of work, the employment afforded being little more than half time in several directions. Quotations unaltered, viz.:—Bars, £6 10s. per ton; hoops, £7 10s. per ton; sheets, £8 10s. per ton.

The Heavy Trades—Armour Orders.

The statement that the Government had decided to carry out their contingent programme of four additional Dreadnoughts was most acceptable. The Government have given out the orders for armour for two ships, and distributed them fairly equally amongst the five armour-making firms of the country. The total weight is from 6000 to 7000 tons. This will follow on very conveniently the work just being completed, and is very welcome all round. In other departments of the heavy industries we do not hear of much change. Orders for railway material are very small and engineering requirements languid. No firms are fully employed, the majority probably only about half on these classes of work. In marine work there is nothing new except for special lines, and limited to few firms.

Tne Lighter Trades.

Several of the lighter departments are moderately employed on foreign account, more especially in tool steel, circular saws, and various kinds of tools. Russia and Italy are reported to be ordering pretty freely in several lines. There is said to be rather less being done in high-speed steel.

NORTH OF ENGLAND.

(*From our own Correspondent.*)

Cleveland Pig Iron.

SELLERS of Cleveland iron have not done so well this week as they did last, though on Monday they booked very good orders, and this has placed them in a rather satisfactory position, so that for the present they have no need to press iron upon the market. On Tuesday, however, the active buying ceased, and prices have since fallen away a few pence. The upward movement resulted in the price of Cleveland pig iron being raised 1s. 3d. per ton, 49s. 3d. per ton for No. 3 being touched on Monday, but since then 3d. of this has been lost, while the Cleveland warrant price has dropped 4d. Consumers bought rather freely last week, and there was considerable animation in the warrant market, the stocks of users having been allowed to get small, and the need to have them replenished became rather pressing. This week since Monday a quieter state of things has been reported, and one reason for the reaction is said to be the more rapid increase in the stock of Cleveland pig iron in Connal's store, and another reason was that speculators in warrants were endeavouring to take profits, and thus were offering them more freely. Then tin and copper prices are somewhat easier. No. 3 Cleveland G.M.B. pig iron on Wednesday was quoted at 49s.; No. 1 at 51s. 6d.; No. 4 foundry at 48s.; No. 4 forge at 47s. 9d.; and mottled and white at 47s. 3d., all for early f.o.b. delivery. The prices for forward delivery were practically nominal, buyers holding back.

Hematite Pig Iron.

Makers of East Coast hematite pig iron at last are able to give somewhat more cheerful reports about their business, and it is now hoped by them that the worst of the depression is over, so far as they are concerned, for there appears some improvement in the shipbuilding industry, on which local hematite pig iron producers largely depend. Consumers have been buying more freely during the last few days, and sellers have seen their way to advance quotations for mixed numbers to 55s. per ton for early delivery, which is a rise of 3d. per ton this week, and the higher price can be more readily realised now than was the 54s. 9d. asked last week. Makers of East Coast hematite pig iron have had a very unsatisfactory experience during the last two years, and the directors of the Normanby Ironworks Company, Limited, Middlesbrough, in their annual report, state that at no time during the past twelve months has it been possible to sell hematite iron and purchase the ironmaking materials so as to leave a reasonable margin of profit. They have only kept two furnaces in operation out of their four built, and nevertheless it has, at times, been difficult to dispose of even the reduced make and keep down the stocks of pig iron. This company makes exclusively hematite pig iron. This experience is more or less general among those who produce this class of pig iron for the market. Cheaper ore cannot be reported, for 16s. 3d. per ton c.i.f. Tees is firmly adhered to, nor is any relief obtainable in the price to be paid for coke, the figure for furnace coke being maintained at 15s. 6d. per ton delivered equal to Middlesbrough, and some sellers hold out for 15s. 9d.

Stock and Shipments of Pig Iron.

It must be conceded that the figures with respect to the stock and shipments of pig iron are most disappointing. They were bad enough in June, but are much worse this month, more especially the stock returns. Last week alone nearly 8000 tons were added to Connal's stock of Cleveland pig iron, and for the first time since July, 1907, that stock, which was under 48,000 tons a year ago, has overtopped a quarter of a million tons. It has a weakening effect to find that iron is going into the public store from furnaces which have not heretofore had any of their iron lodged with Connal's. The quantity of Cleveland pig iron in Connal's store on the 28th was 258,353 tons—an increase of 20,471 tons for the month—a more rapid increase than has been known since 1905. The stock consisted of 252,718 tons of No. 3, 4734 tons of No. 4 foundry, and 901 tons of other iron undeliverable as standard. Shipments are poor this month; they were not good in June, but are much worse this month, only 83,946 tons having been despatched up to the 28th, as compared with 96,546 tons last month; 97,881 tons in July, 1908; and 129,268 tons in July, 1907, all to 28th.

Realised Prices of Manufactured Iron.

It has been this week notified to the Board of Conciliation and Arbitration for the Manufactured Iron Trade of the North of England that the average net price realised by the manufacturers of the district for the finished iron despatched from their works during May and June was £6 6s. 7.16d. per ton, which was 1s. 2.26d. per ton below the average for March and April, and in accordance with the sliding scale arrangement, the rate for puddling in the North-East of England will be reduced 3d. per ton, viz., to 8s. 3d. per ton, while other forge and mill wages will be reduced 2$\frac{1}{2}$ per cent. from Monday next. The following were the average prices realised for the different descriptions of finished iron, and the increase or decrease on the figures for the March-April rates:—Rails, £5 12s. 2.65d. per ton, decrease 16s. 2.47d.; plates, £5 18s. 6.35d., decrease 2s. 9.06d.; bars, £6 7s. 7.8d., increase 2.25d.; and angles, £6 14s. 8.45d., decrease 3s. 7.66d. The fall in realised prices during the first half of the year was 6s. 10$\frac{1}{2}$d. per ton, and over the last twelve months 7s. 3.45d.; while from the highest average of the late "boom" the decrease has been 20s. 1.94d. The rate for puddling has fallen 1s. per ton, and other mill and forge wages 10 per cent. The price now reported for all kinds—£6 6s. 7.16d.—is the worst that has been announced since November-December, 1905. The deliveries of the last two months were the smallest ever reported—they were at the rate of only 30,000 tons per annum, whereas as much as 657,000 tons were turned out at one time in a year.

Manufactured Iron and Steel.

On the whole more sanguine reports are given with respect to business in the finished iron and steel trades, and increased business is being done in several branches, more particularly in rails, sheets, and plates, the better demand for the last being due to the improvement which is at last being experienced in shipbuilding. Messrs. Bolckow, Vaughan and Co. have secured the order for 25,000 tons of steel rails for the Transvaal Government Railways, also one for 12,000 tons for the Australian Railways. On the other hand, one of the other railmaking concerns, owing to shortness of specifications, cannot keep its works fully going. At Messrs. Bolckow, Vaughan and Co.'s Eston

Steelworks the wages of the men, which are regulated by a sliding scale based upon the prices which the firm realises for steel rails, have been raised 4 per cent. for the next two months. No changes have been made in the quotations for manufactured iron and steel during this week. The Darlington Forge Company has this week sent to Belfast two of the largest boss brackets ever forged. They weigh nearly 40 tons each, and are for the new White Star liners now being built there.

Shipbuilding and Engineering.

Some improvement in shipbuilding in this district can now fairly be reported, a number of orders for new vessels having been secured, and the outlook is certainly more favourable. The list of "laid up" vessels is being shortened, and on the Tyne the number is under fifty, or nearly a third of what it was at the commencement of the year, while rates of freight are showing a slight improvement. The directors of the West Hartlepool Steam Navigation Company say that they believe the worst of the depression has been experienced, and the current voyages of their steamers are more satisfactory. Profitable business is likely to be done in the autumn.

Cleveland Ironstone Miners' Wages.

A fortnight ago the Cleveland Mineowners' Association claimed a reduction of 2½ per cent. in miners' wages. This they regarded as due owing to the fall in the price of pig iron shown by the last ascertainment. A deputation of the men on Wednesday asked the owners if they could not forego a reduction on this occasion. The owners were unable to acquiesce in the suggestion, but expressed a willingness to settle at 1½ per cent. reduction. This proposal will be placed before the district.

Coal and Coke.

The coal trade in Northumberland and Durham continues to show much activity; indeed, the collieries experience some difficulty in satisfying the demand for coal for early delivery. The rates for forward execution are not so brisk as they were, because the consumers expect prices will ease if there is an amicable settlement of the dispute in the Scotch coal trade. Quotations are now comparatively high, best steams at 12s. 6d. to 13s.; steam, smalls, 5s. 6d. to 6s. 6d.; best gas coals at 11s.; gas, seconds, 10s.; and bunkers and coking coal 9s. 6d. to 10s. 3d. Coke is very firm in price, and in good request; furnace coke is realising 15s. 6d. to 15s. 9d. per ton delivered at Middlesbrough.

NOTES FROM SCOTLAND.

(*From our own Correspondent.*)

The Crisis in the Coal Trade.

THERE was a general impression in trade circles early in the week that a settlement might be reached by the conference that took place in Glasgow on Tuesday between representatives of coalmasters and miners to deal with the wages dispute. It was understood that the employers were not unwilling that the 6s. minimum wage should be obtained by the miners, provided that they—the employers—could be saved from loss by a readjustment of the sliding scale. The conference lasted over three hours, and failed to arrive at an arrangement, it being understood that its proceedings would be reported to an adjourned meeting to be held at the Board of Trade offices in London on Thursday. Hardly any information regarding what occurred at Tuesday's meeting was allowed to leak out, but it became known that the representatives of the men took up an uncompromising position, fortified as they were by the very large majority by which the Scottish miners have voted in favour of a general strike. Of the 80,000 miners, no less than 68,275 took part in the vote, and 63,083 voted in favour of a strike, and 5192 against. This result, together with reports as to the balloting in England, seems to have encouraged the miners' leaders to assume very high ground, and the outlook at the moment is not reassuring.

The Pig Iron Market.

At the end of last and beginning of the present week there was a more hopeful feeling in the warrant market, and a fair business took place, with a gradual improvement in prices. This feeling has not been maintained, the result of the conference on the mining dispute having had an unfavourable effect on the market. Business has been done in Cleveland warrants from 48s. 5½d. to 49s. 2d. cash, 48s. 9½d. to 49s. 5d. one month, and 49s. 2½d. to [illegible] 10d. three months. Transactions were also noted at 49s. and [illegible] 1½d. for delivery in seven days, 49s. 2d. seventeen days, and [illegible] 1d. for September 2nd.

Scotch Makers' Iron.

Deliveries and shipments of pig iron in the last few weeks showed a tendency to increase, this being due not so much to any real improvement in trade as to a desire on the part of consumers to be supplied with raw iron in case of a rise in price. There was, of course, the probability of a proportion of the furnaces being put out of blast in the event of a general strike of colliers, and a scarcity of fuel might reduce the output of iron. The demand for pig iron fell away considerably, however, in the course of the past week, so that the market was flat; but it is quite likely that a strike of miners might help somewhat to raise prices by reducing output and stocks. Ten furnaces have been stopped, but it has been quite usual to reduce the production during the summer trade holidays. There are now 72 furnaces in blast in Scotland, compared with 82 in the preceding week, and 69 at this time last year. Should the mining trouble be prolonged, it is not unlikely that the pig iron output may be further curtailed. Some brands of pig iron are lower this week. Monkland, No. 1, is quoted f.o.s. at Glasgow, 55s.; No. 3, 53s.; Carnbroe, No. 1, 58s. 6d.; No. 3, 53s. 6d.; Clyde, No. 1, 59s. 6d.; No. 3, 53s. 6d.; Gartsherrie, No. 1, 60s.; No. 3, 54s.; Calder, No. 1, 60s.; No. 3, 55s.; Summerlee, No. 1, 60s. 6d.; No. 3, 55s. 6d.; Langloan, No. 1, 61s.; No. 3, 56s.; Coltness, No. 1, 88s.; No. 3, 56s.; Glengarnock, at Ardrossan No. 1, 62s.; No. 3, 57s.; Eglinton, at Ardrossan or Troon, No. 1, 55s.; No. 3, 53s.; Dalmellington, at Ayr, No. 1, 58s.; No. 3, 53s.; Shotts, at Leith, No. 1, 60s.; No. 3, 55s.; Carron, at Grangemouth, No. 1, 63s.; No. 3, 56s. per ton.

The Hematite Trade.

The market for hematite has this week been very dull. Consumption in the West of Scotland has been at a standstill, with some doubt as to when it might be fully resumed. Cleveland warrants have been on offer at 56s. 6d. without purchasers, and Scotch hematite is also comparatively neglected, the nominal price being 57s. for delivery at the West of Scotland steelworks.

Shipments of Pig Iron.

The shipments of pig iron from Scottish ports in the past week amounted to 5968 tons, against 3846 in the corresponding week of 1908. Of the total, there was despatched to Italy 2052 tons, Belgium 120, Canada 400, India 60, France 25, Germany 41, Holland 60, China and Japan 110, other countries 225, the coastwise shipments being 2875 tons, compared with 2113 in the corresponding week. The arrivals at Grangemouth of pig iron from Cleveland and district were 7090 tons, showing an increase of 3137 tons over the corresponding week's imports last year.

Finished Iron and Steel.

Only a partial start was made this week after the holidays at the finished iron and steel works. The orders coming to hand have been unsatisfactory, both as regards malleable iron and steel. For shipbuilding material the new orders are small, but if a strike of miners were averted, it is believed they would soon become more important, as it is understood the prices are now low enough to induce business.

The Coal Trade.

Business is disorganised in the Scottish coal markets by the labour dispute, and the tension pending the final result of the conferences between representatives of employers and workmen has been so great that scarcely any business could be attempted, except for prompt delivery. The demand for manufacturing purposes has been reduced by the holidays, and from the same cause shipments have decreased to little over one-half what they were in the preceding week. Prices cannot be given at the moment with anything like accuracy.

WALES AND ADJOINING COUNTIES.

(*From our own Correspondent.*)

Last Week's Coal Trade.

IN some respects business last week was of a disappointing character. Usually before holiday there is a more vigorous tone, with a tendency to stronger prices, but last week, what with absenteeism on the part of colliers, many of whom are engaged in harvest work, supplies were scanty, and yet quite sufficient to meet the demand, so that prices remained but slightly affected. Newport totals were good, considering, the total being 90,525 tons, of which nearly 77,000 tons went to foreign destinations. Swansea total was only 62,000 tons, and in all there was a decrease in the export and import trade of the port of 6000 tons. Port Talbot showed an improved total. Occasionally during the week Cardiff showed an improvement, and the foreign shipments were large, but on the whole there was a falling off. Among the larger shipments, Port Said, Cronstadt, Montevideo, and Alexandria figured well. Steam coal was brisk; dry coals in demand. Supplies of steam and semi-bituminous remain in the ascendant. No. 3 Rhondda continues with an upward tendency. Best bunker prices firm; other kinds unsteady. No improvement in house coal, which remains, both in volume and in price, below the expectation of coalowners—in fact, the season so far has failed to bring this class of coal up to summer bulk and values.

Present State of Coal Trade.

The severe weather has told seriously against the coal trade, and even best and seconds steam coal have been in poor demand. Drys and Monmouthshire are in a similar position. The outlook is bad. The situation, authorities say, can only be saved by the successful issue of Mr. Churchill's intervention. At Cardiff, mid-week, prospects were stated to be gloomy, even by authorities who have hitherto been hopeful. Latest prices:—Best large steam, 16s. 9d. to 17s; best seconds, 15s. 9d. to 16s.; ordinary seconds, 14s. 6d. to 15s.; best drys, 15s. 6d. to 16s.; ordinary drys, 13s. 6d. to 14s. 3d.; best washed nuts, 13s. 9d. to 14s. 9d.; seconds, 12s. 9d. to 13s. 3d.; best washed peas, 12s. 6d. to 12s. 9d.; seconds, 10s. 9d. to 11s. 9d.; very best smalls, 9s. 3d. to 9s. 9d.; best ordinaries, 7s. 3d. to 7s. 9d.; inferior sorts, 6s. 6d. to 7s.; best Monmouthshire black vein, 15s. 6d. to 15s. 9d.; ordinary Western Valleys, 14s. 6d. to 14s. 9d.; best Eastern Valleys, 13s. 9d. to 14s. 3d.; seconds, 12s. 9d. to 13s. Bituminous coal: Very best households, 15s. 6d. to 15s. 9d.; best ordinaries, 14s. 6d. to 15s. 6d.; No. 3 Rhondda, large 17s. to 17s. 6d.; brush, 13s. 6d. to 13s. 9d.; smalls, 10s. to 10s. 3d.; No. 2 Rhondda, 12s. 9d. to 13s.; through, 10s. to 10s. 6d.; smalls, 8s. 9d. to 9s. Patent fuel, 15s. to 15s. 6d. Coke: Furnace, 17s. to 17s. 9d.; foundry, 18s. 6d. to 21s. 6d.; special foundry, 24s. 6d. to 27s. 6d. Pitwood, ex-ship, 21s. to 22s.

Newport Coal.

This district continues to enjoy a greater degree of favour than has been obtained by Cardiff of late. There was a difficulty in getting supplies for this side of the holidays, and sellers were firmer in their quotations. Best black vein in good demand. Best black vein, 15s. 3d. to 15s. 6d.; ordinary Western Valleys, 14s. 3d. to 14s. 6d.; best Eastern Valleys, 13s. 6d. to 14s.; other sorts, 12s. 6d. to 12s. 9d.; best smalls, 8s. to 8s. 6d.; seconds, 7s. 3d. to 7s. 9d.; inferiors, 6s. 9d. to 7s. Bituminous coal: Best house coal, 15s. to 15s. 3d; seconds, 14s. to 14s. 3d. Patent fuel, 14s. 6d. to 15s. Coke: Foundry, 18s. to 19s.; furnace, 16s. to 16s. 6d. Pitwood, 21s. 6d. to 22s.

Swansea Coal.

Trade showing a slight improvement and demand improving, but, as at all parts, the weather has been and continues very adverse, and strike foreshadowings are prominent. Latest prices:—Best malting, hand picked, 23s. to 24s. net; second malting, 21s. to 22s. net; big vein, 18s. to 19s. 6d., less 2½; red vein, 12s. to 12s. 6d., less 2½; machine-made cobbles, 23s. to 23s. 6d. net; Paris nuts, 23s. 6d. to 24s. 6d. net; French nuts, 23s. 6d. to 24s. 6d. net; German nuts, 23s. to 23s. 6d. net; beans, 17s. to 17s. 6d. net; machine-made large peas, 10s. 6d. to 11s. 6d. net; fine peas, 10s. to 11s. 6d. net.; rubbly culm, 5s. to 5s. 3d., less 2½; duff, 3s. to 3s. 3d. Other coal: Steam, best large, 15s. 6d. to 16s., less 2½; seconds, 13s. 6d. to 14s. 6d., less 2½; bunkers, 10s. to 10s. 9d., less 2½; small, 8s. to 9s., less 2½. Bituminous coal: No. 3 Rhondda, 17s. 6d. to 18s. 6d., less 2½; through, 14s. 6d. to 15s., less 2½; small, 9s. 9d. to 10s., less 2½. Patent fuel, 13s. to 13s. 6d., less 2½.

Amalgamated Society of Engineers.

Mr. C. A. Adams has been selected for the vacant position of Organising Secretary for the West of England and South Wales.

Miners' Refusal to Work Extra Hours.

The refusal of miners to work the extra hours authorised by the Coal Mines Regulation Act is to be associated with police proceedings. Early in August a summons is returnable in connection with the Porth case at Ystrad, Insoles Company claiming for damages. This is to be a test case.

Mabon and the Coal Trade Crisis.

Mabon's opinion is that the Scotch coalowners will not persist in forcing a reduction. In closing my despatch the question is left in great uncertainty. The outside opinion is that to strike will be suicidal, but, unfortunately, the colliers appear to be banded together to bring about a crisis. North and South Wales colliers support the Scotch in advocating a strike.

Iron and Steel.

There was only half a week's work last week. The Big Mill at Dowlais was busy up to Thursday, but in the finished steel departments very little was done, and the situation generally may be regarded as unimproved. In the Llanelly and Swansea districts the condition of things is better. The local market in Llanelly is doing well with steel bars. At Swansea all the steel smelting works are brisk. Cargoes of steel have been coming in freely; 1720 tons from Bruges, 1112 from Antwerp, old rails and scrap iron from Southampton. Swansea imported 3540 tons pig iron, 1290 tons scrap steel, 4087 tons iron ore. The iron cargoes have been large and varied, including a quantity from Belfast. Quotations remain much about the same:—Steel bars: Siemens £4 8s. 9d. to £4 10s.; Bessemer the same. Hematite pig: Mixed numbers, 50s. 3d. cash and month; Middlesbrough, 49s. cash; 49s. 3d. month. Scotch, 55s. cash and month. Welsh hematite, 60s. to 61s. East Coast hematite, 59s. 6d. c.i.f. Rubio, 15s. 6d. to 15s. 9d.-16s.

Tin-plate.

The harbour returns for last week were as follows:—Received from works, 101,241 boxes; shipped during the week, 81,129 boxes; stocks remaining at docks, 219,728 boxes. Latest prices:—Siemens and Bessemer, 11s. 10½d.; C.A. roofing sheets, £8 5s. to £8 7s. 6d.; big sheets for galvanising, £8 7s. 6d. to £8 10s. per ton; finished black plates, £9 5s.; galvanised sheets, 24 g., £10 10s. to £11 nominal per ton; ternes, 21s. 6d. Norway is importing largely of terne plates.

Other Quotations.

Block tin, £132 12s. 6d. cash, £134 three months; copper, £58 13s. 9d., three months £59 8s. 9d.; lead, £13; spelter, £22; silver, 1s. 11½d. Tin-plate works all fully occupied; spelter refineries busy, and produce of copper works a good average. Foundries and engineering works busy, and ample orders in hand generally that will necessitate full time for some time to come. At Llanelly extensions are well in hand. The break up of the galvanising combination is noted with interest, and its effect on local works is being noted carefully.

CATALOGUES.

GILBERT LITTLE AND CO., Limited, Horton Works, Bradford.—This company has forwarded us a concise little pamphlet having reference to belt conveyors for various classes of service.

THE TUDOR ACCUMULATOR COMPANY, 119, Victoria-street, Westminster, S.W.—This is a list giving prices of battery installations working at 25 and 50 volts, and suitable for metallic filament lamps.

ROPEWAYS, Limited, Eldon-street, South-place, E.C.—This is an excellently got up catalogue dealing with ropeways. It contains many illustrations, showing the company's ropeways in various kinds of industrial service.

THE GLOBE PNEUMATIC ENGINEERING COMPANY, Limited, 150, Queen Victoria-street, London.—A well got up illustrated catalogue of pneumatic tools and appliances has reached us. Also an interesting and useful little booklet dealing with the care of pneumatic tools.

THE LONDON ELECTRIC FIRM, George-street, Croydon.—Catalogue No. 125 has reached us. It deals with arc lamp lowering gear and self-sustaining winches, and many other fittings and accessories connected with arc lamps, such as guide pulleys, flexible wire rope, span wire lowering gear, contact devices, and so forth.

WILLANS AND ROBINSON, Limited, Victoria Works, Rugby.—From this company we have received an excellently got up pamphlet dealing with steam turbines. It contains a considerable amount of descriptive matter, also illustrations showing turbines erected in various power stations, parts of steam turbines, the company's system of blading, &c.

J. DAMPNEY AND CO, Limited, Bute Docks, Cardiff.—This is a little booklet dealing with Dampney's "Apexior" compound for coating the internal surfaces of steam boilers to prevent the deposit of hard scale and pitting, also for coating the external surface of steam boilers and steam pipes before clothing, as a protection from corrosion, and for various other purposes.

NEWALL'S INSULATION COMPANY, Limited, Scottish Provident-buildings, Mosley-street, Newcastle-on-Tyne.—A well got up pamphlet has reached us which has reference to Newall's magnesia covering for steam pipes, boilers, &c. Among the illustrations which the pamphlet contains there is one showing a large turbine lagged with the company's magnesia slabs.

CALLENDER'S CABLE AND CONSTRUCTION COMPANY, Limited, Hamilton House, Victoria Embankment, London, E.C.—The 1909 edition of this company's catalogue has reached us. It has been got up in the usual excellent style and the cable code at the end obviates the possibility of telegraph errors when ordering rubber insulated wires, and the heavier mains of the vulcanised bitumen, paper insulated, lead sheathed, and steel tape armoured types.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

AT a meeting of the directors of Vickers, Sons, and Maxim, Limited, held on the 20th inst., Mr. Frank Barker, director of Parsons Foreign Patent Company, Limited, was elected a director of the company.

MESSRS. J. BEARDSHAW AND SON, Limited, of the Baltic Steel Works, Sheffield, have just appointed Messrs. W. A. Walber and Co., 38, Victoria-street, Westminster, their agents for London and the South of England.

THE sole control of sales in the Eastern Hemisphere of the "Schureman" switch gear, has now passed into the hands of the Adams Manufacturing Company, Limited, of Bedford, and 106, New Bond-street, London.

MR. JENS ORTEN-BOVING, M.I.M.E., informs us that he has taken into partnership Mr. Douglas Spencer, and Mr. P. R. Cobb. The style of the firm will henceforth be Jens Orten-Böving and Co., and on and after Monday, 26th inst., the address of the firm will be 9½, Union-court, Old Broad-street, London, E.C. Telegrams: "Jenorten, London." Telephone: London Wall 6480.

JOHN I. THORNYCROFT AND CO., Limited, ask us to state that, having disposed of their Chiswick works, they have made the following alterations in their addresses:—The head office has been transferred from Church Wharf, Chiswick, to Caxton House, Westminster, S.W. The marine motor, stationary motor, and motor launch sales department is also situated at Caxton House. For the car and vehicle repairs department they have acquired a large and well-equipped garage and repairing works, the Vauxhall Bridge Garage, 5-11, Vauxhall Bridge-road, S.W.

CONTRACTS.—Ed. Bennis and Co., Limited, have recently received orders for over thirty stoking plants of various types, many of which are, we understand, repeat orders.—Willans and Robinson, Limited, have just received an order from the Lambton Collieries for a pump on the Orten-Böving principle, to deliver 2500 gallons per minute against a head of 315ft. at 1170 revolutions per minute. This firm is also employed on an order for two similar pumps for Messrs. Isaac Holden and Sons, of Reims. Each of these pumps will deliver 400 gallons per minute against a head of 170ft. at 950 revolutions per minute.—In addition to the 100-ton electric Giant crane which Applebys Limited have supplied to Earle's Shipbuilding and Engineering Company, the former firm is erecting a similar 100-ton crane at the works of George Clark, Limited, at Sunderland, and has just shipped to Japan a Giant crane of 150 tons power, and has recently completed a 75-ton floating crane.—On July 21st the opening ceremony of the new refuse destructor installed by the Gainsborough Urban District Council took place. The plant is a two-cell "Meldrum" destructor of the back-feed type, capable of efficiently destroying 1½ tons of general house refuse per hour, the heat being utilised for steam raising in a Lancashire boiler 30ft. by 7ft., working at 150 lb. per square inch pressure.—The contracts for seven Warner trucks—non-parallel axle—10ft. wheel base, for the Llandudno Tramways Company, has been awarded to Mountain and Gibson, Limited, of Bury, Lancashire.—We understand that Sir Raylton Dixon and Co., Limited, have secured a further order from the Rea Shipping Company, Limited, for a duplicate of the steamer they are now building for that company's general trade.

NOTES FROM GERMANY, FRANCE, BELGIUM, &c.

(*From our own Correspondent.*)

Rhenish-Westphalian Iron Trade.

SALES have been restricted to the utmost during the past week. The steel works of the district are reported to intend stopping the production of rails and sectional iron for a while owing to a want of orders. Quotations for pig iron again met with a reduction of M. 1 p.t. on the 16th inst., chiefly in consequence of the exceedingly keen competition for next year's purchases.

Iron and Steel in Silesia.

Though activity is moderate and output has been restricted in many departments, stocks have increased and very low rates are complained of. The business in merchant iron, as well as in plates, is getting more languid every week, and prices leave next to no profit.

The Coal Trade.

Concerning coal, the reports of previous weeks can only be repeated; there is very little activity shown, and purchases are not extensive. Silesian coalowners are doing a fair trade with Russia; gas coal is in improving request; engine coal remains in moderate demand. A steady trade is done on the Rhenish-Westphalian coal market. Owing to the favourable state of the Rhine, shipments to South Germany have been lively. Deliveries in steam coal are reported to be much higher than in last month. In coke likewise an improvement against previous weeks can be noticed.

Austria-Hungary.

Considering the general depression in the iron industry, sales of the United Austrian Ironworks for June of the present year have been fairly satisfactory, as may be seen from the following:—

	1909.	1908.
	q.	q.
Bars	267,189	310,377
Girders	141,859	121,165
Heavy plates	40,579	42,684
Rails	73,620	85,209
Production since the 1st of January.		
Bars	1,549,459	1,891 168
Girders	630,721	625,213
Heavy plates	282, 47	277,825
Rails	565,040	541,813

The building department is likely to be better employed during the next few weeks, owing to the commencement of some large public buildings. Both pit coal and brown coal have shown a good deal of firmness. In the Ostrau-Karwin district output goes into immediate consumption, and orders for forward delivery are numerous.

Good Accounts from France.

Pig iron has been in increasing demand during this and last week, and activity in the semi-finished steel trade and at the construction shops has been more lively than before. Additional blast furnaces have been blown in at various establishments in the Meurthe-et-Moselle district. Girders show increasing animation, and the business in machines has developed satisfactorily. Stocks in coal show a decrease, in consequence of more demand for most sorts. Rates are firm.

Steady Business in Belgium.

In finished iron a slight upward movement is noticeable, while pig iron shows a weakening tendency in consequence of strong foreign competition. Basic, however, remains firm at 66 to 67f. p.t. Of 44 existing blast furnaces 37 are in blow at present. Rails and also merchant iron show increasing strength. Foreign business in bars is rather better than previously, but in girders little has been done for abroad. Plates, both light and heavy sorts, sell freely at fair rates, although German competition is very active and successful in sheets. An abatement in deliveries of dry coal is noticeable, owing to a very moderate demand from the brick kilns. The prolonged rainy period has been most unfavourable for the brick industry, and this is naturally influencing the demand for coal. An official change in prices for coal and coke has not taken place.

AMERICAN NOTES.

(*From our own Correspondent.*)

NEW YORK, July 19th.

THE pipe line builders are entering upon constructions of lines which will create a heavy demand upon mills furnishing pipe and upon furnaces making pipe iron. Among recent orders are one for 12 miles of 20in. pipe, another for 30 miles of 6in. and 8in. pipe. Inquiries are in the market for 400 miles of 8in. pipe to be laid in the State of Illinois, to be constructed by the Pure Oil Company. The Hope Natural Gas Company will construct a line between 400 and 500 miles long, from the oil field in West Virginia to the city of Baltimore. The Union Petroleum Company, of Buffalo, will construct a line 60 miles long with 8in. to 10in. pipe. Under this heavy present and prospective demand prices have been advanced 2 dols. to 4 dols. per ton.

The tin-plate manufacturers are making a stubborn fight against the Union, and are endeavouring, without present pronounced success, to operate their mills. The amalgamated membership ceased work July 15th. Some tin-plate mills are working, especially the independent mills. The demand for plates is good, and prices have hardened. The last Panama Canal steel order is for 1600 tons shapes for lock gates. The Jones and Laughlins Company will soon make 6000 tons of shapes for its new open-hearth plant at Alliquippa, and 4000 tons for its new tin-plate plant under erection. There are even now probabilities of speculative advances in steel, but manufacturers are lending no countenance to those who would buy for speculative purposes. The Carnegie Steel Company will name its price this week on enough steel plate to construct 34,000 freight cars which have been contracted for.

Large blocks of pig iron are now under negotiation for delivery during the rest of the year. An upward tendency has developed in pig, and a number of makers are declining to quote prices for late delivery until after mid-August. Industrial activities are bringing out a good many orders for light rails ranging from 16 lb. to 45 lb. sections. The locomotive works are steadily filling up, and full time will be the rule within a few weeks. Nearly all railway systems are increasing their motive power, and, as a rule, engines of a larger driving capacity than formerly are being built. There are not a few evidences to lead to the probability of excessive activity in the steel industry. Congress will soon adjourn, and with that body not sitting people will begin to get busy.

Copper interests anticipate an active buying movement will set in about August 1st. There is no threatening accumulation to deal with, and the consuming industries are becoming more and more active. Electrolytic is selling at 13.

THE Highways Committee of the London County Council estimates that the tramcars on the northern and southern tramway systems will number 1425 at the end of the financial year.

BRITISH PATENT SPECIFICATIONS.

When an invention is communicated from abroad the name and address of the Communicator is printed in italics.

When the abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent-office Sale Branch, 25, *Southampton-buildings, Chancery-lane, London, W.C., at* 8*d. each.*

The first date given is the date of application; the second date at the end of the abridgment is the date of the advertisement of the acceptance the complete specification.

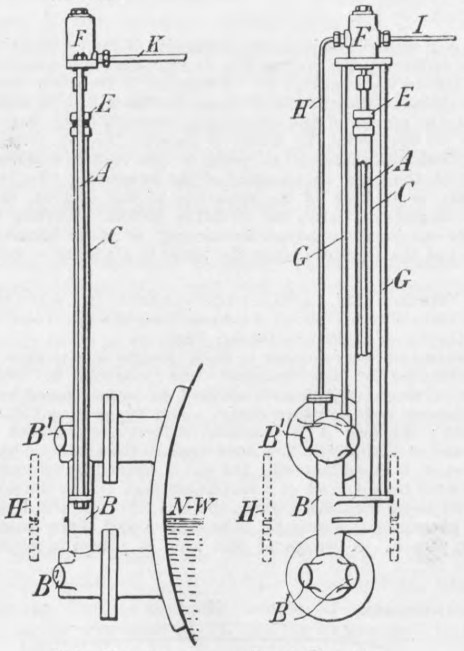
Any person may on any of the grounds mentioned in the Acts, within two months of the date given at the end of the abridgment, give notice at the Patent-office of opposition to the grant of a Patent.

STEAM GENERATORS.

14,162. July 3rd, 1908.—A COMBINED WATER GAUGE AND FEED-WATER REGULATOR, by *Herman Garbe, of* 17, *Sybelstrasse, Charlottenburg, Berlin, Germany.*

This feed-water regulator presents the special arrangement that the expanding body A is fixed in a lateral widening of the water-gauge casing B and enclosed in a narrow cooling tube C, so that only a small quantity of steam is able to enter the cylindrical space between the expansion body and the cooling tube. The casing B has sockets B^1 formed thereon, which serve for securing the water-gauge cock and the gauge glass H (shown in dotted lines). If the water level in the boiler falls below the normal water line N—W, the lateral widening of the water-gauge casing becomes filled with boiler steam, and, consequently, the cooling tube is filled also; by raising the temperature this steam causes the expansion body A to expand. This causes feed-water to be supplied to the boiler, the water in the gauge again rises, and access of steam to the expansion bar is prevented. The steam contained in the cooling tube speedily condenses as the water drawn in becomes cooled by yielding up its heat to the exterior, and thereby causes the expansion bar to contract and, consequently, cuts off the supply of feed-water. The arrangement is such that the apparatus operates very sensitively. The free end of the bar A passes through a stuffing-box E to the outside of the cooling tube and comes directly into contact with the guide pin of a valve mounted in the upper valve casing F, and held against its seat by means of a spiral spring. The valve and its spiral spring are not, however, illustrated. The valve casing F is rigidly connected with the gauge tube by the rods G, G. When the valve is closed the conduits H and I are subjected to the pressure of the boiler steam. The tube I transmits this pressure to the cut-off valves of the feed pump, which are thus maintained closed in the known manner. An exhaust conduit K is also fitted to the valve casing F. If now the valve be opened by the expansion of the bar A, the steam flows out of the two tubes H and I through the valve and the exhaust pipe K into the atmosphere, the cut-off valves of the feed pump being thereby relieved and opened, so that the feed-water can be supplied to the boiler until the valve is again closed by the cooling, that is to say, the contraction of the bar A, thereby preventing the escape of the steam from the valve casing F.—*July 7th*, 1909.

Nº 14,162.

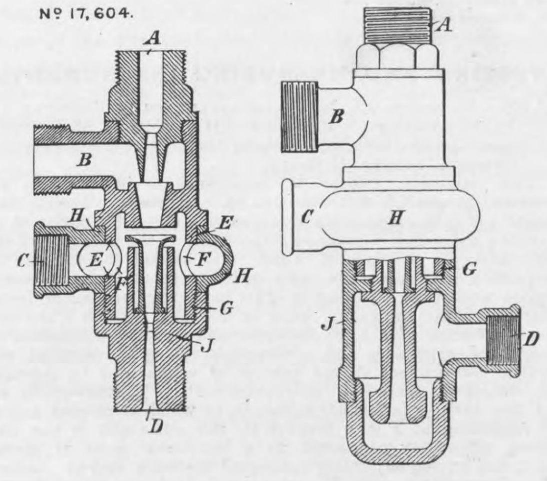


Side Elevation. Front Elevation.

17,604. August 21st, 1908.—IMPROVEMENTS IN INJECTORS, Robert Grundy Brooke, Upton Grange, Macclesfield, Chester.

The object of this invention is to provide improved constructions whereby the adjustment, setting and removal of the overflow chamber and branch can be effected upon the manipulation of a portion of the body of the injector to which the lower cones are attached, the case A is the steam inlet, B the water inlet, C the overflow branch and D the delivery. In the arrangement shown on the left the upper portion of the injector from which the water branch B extends is formed with an extension that is externally cylindrical at E and is formed with ports F and a threaded portion G. The overflow branch C projects from a channel or trough section ring H which forms a passage through which the overflow escaping through the ports F passes to the branch C. The ring H fits the cylindrical portion E and is faced at its ends so that when the lower portion J of the injector is screwed up tight on the threaded part G of the upper portion, the ring H is held tight in its adjusted position. By slightly screwing back the lower portion J, the ring H can be turned on the cylindrical extension of the upper portion so as to bring the branch C into the required position. The right-hand engraving illustrates a modification, in which the delivery D is at the side.—*July 7th*, 1909.

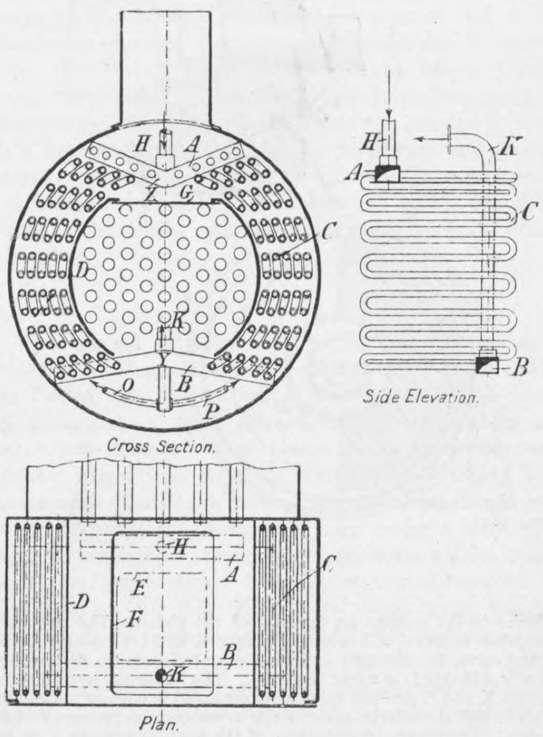
Nº 17,604.



27,761. December 21st, 1908.—IMPROVEMENTS IN SMOKE-BOX SUPERHEATERS FOR USE WITH BOILERS OF THE LOCOMOTIVE TYPE, *T. Heinrich Lanz, of Mannheim, Germany.*

The object of the present invention is to produce a simple and effective smoke-box superheater arranged in an annular space. According to the form shown two headers A and B are arranged in the smoke-box of the boiler. These headers are connected by zigzag tubes C which are arranged in concentric cylindrical planes. The header A receives steam from the boiler through a pipe H, while the superheated steam passes from the header B by the pipe K. The tubes passing from the header A to the header B are arranged in two groups lying on opposite sides of the central axis of the boiler. To facilitate this grouping, the headers A and B are preferably bent at X and Y inwardly towards the axis of the boiler. The annular space occupied by the zigzag tubes C is on its inner part closed off by a wall D which shows the openings E and F at the top and bottom. In the form of the invention shown the opening E is provided with a damper plate G. A tube having branches O and P is preferably provided for the purpose of cleaning the tubes of the superheater.—*July 7th*, 1909.

Nº 27,761.



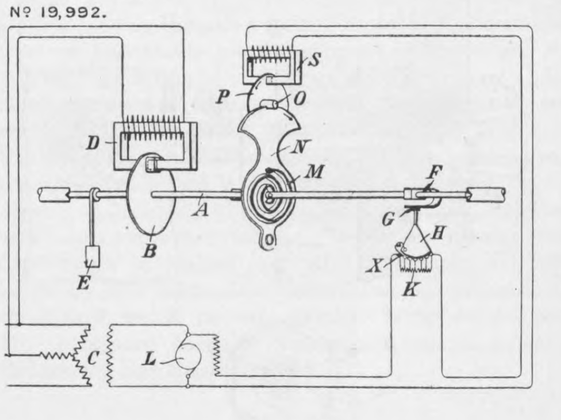
Cross Section. Side Elevation. Plan.

DYNAMOS AND MOTORS.

19,992. September 23rd, 1908.—IMPROVEMENTS RELATING TO AUTOMATICALLY REGULATING DIRECT-CURRENT AND ALTERNATING-CURRENT MACHINES, *the Aktiengesellschaft Brown, Boveri et Cie, of Baden, Switzerland.*

A metal disc B is mounted on the spindle or shaft A, on which disc an electro-magnet D, fed by the current, in this case a shunt current of the generator C to be regulated, exerts a torque which is normally counterbalanced by a weight E. Further, a plate spring F, having a point bearing G, is mounted on this spindle A. This spring presses a sector H resting with its point in the bearing G, against stationary resistance contacts X which are arranged along an arc and provided with resistances K, connected in the shunt circuit of the exciting dynamo L, the arrangement also being such that the sector H can roll along the contacts in order to vary the effective field resistance. A spiral spring M is connected at its inner end with the spindle A, and at its outer end with a disc N loosely mounted on this shaft or spindle. This disc has a serrated or toothed portion engaging with a small wheel O, of a damping device consisting of a disc P, mounted together with the small wheel O on a shaft, and of a direct-current electro-magnet S, which on movement of the disc exerts a torque on the same. If the pressure of the generator C varies, then the torque exerted on the disc B also varies, that is to say, the disc will rotate with the spindle A, and consequently roll along the arc of the sector H on the contacts X in such a manner that according to the variation and pressure more or less resistances are inserted.—*July 7th*, 1909.

Nº 19,992.

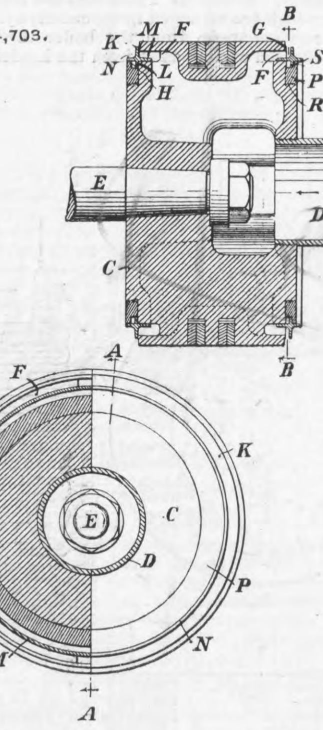


PUMPING AND BLOWING MACHINERY.

24,703. November 17th, 1908.—IMPROVEMENTS IN VALVED PISTON AIR OR GAS COMPRESSORS, *Ingersoll-Rand Company, of* 11, *Broadway, Manhattan, New York, U.S.A.*

The upper engraving is a longitudinal central section through the piston taken in the plane of the line A A of the lower engraving, looking in the direction of the arrows. The lower engraving is a face view of the piston, one-half of the view being taken in section in the plane of the line B B of the upper engraving, looking in the direction of the arrows. C designates the hollow piston of a double-acting air compressor. The central pipe D is connected to the piston and constitutes the inlet for the fluid to be compressed. In the example represented the piston is furnished on the side opposite to the central pipe D with a rod E for the purpose of making connection between the piston and the motor for driving it. The piston is provided in one or both of its faces, in the present instance both of its faces, with annular passages F, arranged near the periphery of the piston. Ring valves are arranged to open and close the passages F. An annular seat G is provided exterior to each passage F, and an annular seat H is provided interior to the passage on the face of the piston. The ring valve comprises external and internal flanges K and L forming the face of the valve, an inwardly extended annular stem M, and an outwardly extended annular stem N. The external and internal flanges K and L provide valve faces arranged to engage the annular seats G and H, exterior and interior to the annular passage F in the piston. The inner circumference of the annular passage F in the piston is turned truly to form a cylindrical guide for the inwardly extended annular valve stem M, the stem being turned to fit the so formed cylindrical guide with an easy sliding movement. A plate P is screwed on to the piston face, as shown at R, which plate is provided with a circumferential flange S, which is arranged to overlap the internal flange L of the ring valve so as to limit the outward movement of the valve. The periphery of the flange S is turned truly to form a cylindrical guide for the outwardly extended annular valve stem N, the inner wall of which is turned to fit the said cylindrical guide with an easy sliding movement. The valve in this instance is thus guided inside and outside of its external and internal flanges K and L which form the face of the valve.—*July 7th*, 1909.

Nº 24,703.

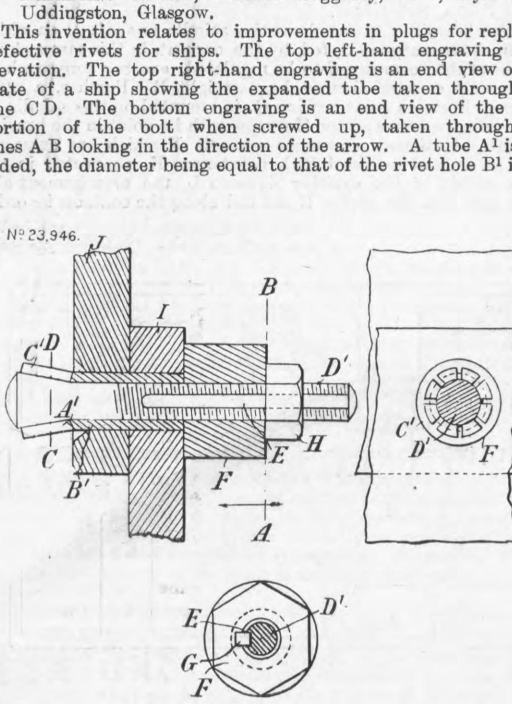


SHIPS AND BOATS.

23,946. November 9th, 1908.—IMPROVEMENTS IN PLUGS FOR REPLACING RIVETS, William Bagguley, of 3, Kyle Park, Uddingston, Glasgow.

This invention relates to improvements in plugs for replacing defective rivets for ships. The top left-hand engraving is an elevation. The top right-hand engraving is an end view of the plate of a ship showing the expanded tube taken through the line C D. The bottom engraving is an end view of the inner portion of the bolt when screwed up, taken through the lines A B looking in the direction of the arrow. A tube A^1 is provided, the diameter being equal to that of the rivet hole B^1 in the plate. This tube is slotted at its outer end C^1, so that when driven into position it will expand by the aid of a cone-shaped bolt D^1, which bolt is provided with a keyway E towards its inner end. Carried on the bolt there is a washer F, having a key G which engages with the keyway E. When the bolt D^1 is driven into position, the washer F is held by a wrench and prevented from turning, and a nut H on the bolt D causes the cone-shaped piece of the bolt D to be drawn into the slotted part of the tube, thus expanding it beyond the diameter of the rivet hole, as shown, so making it water and air-tight, and at the same time drawing the two plates I, J, into their normal position.—*July 7th*, 1909.

Nº 23,946.

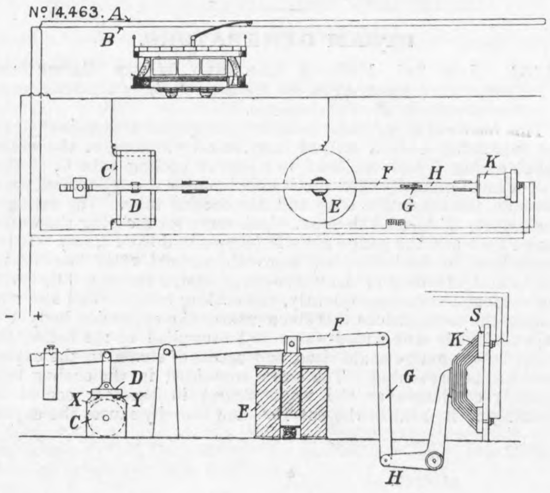


TRAMWAYS AND RAILWAYS.

14,463. July 8th, 1908.—NEW OR IMPROVED AUTOMATIC ELECTRO-MAGNETIC SWITCH OR CUT-OUT FOR DISCONNECTING CHARGED CONDUCTORS IN OVERHEAD SYSTEMS OF ELECTRIC TRACTION OR THE LIKE, Willie Barraclough, of Bankfield, Rayner-road, Brighouse, York.

This invention relates to overhead electric wires or conductors, particularly the overhead trolley wires in electric traction systems, and comprises a new or improved automatic electro-magnetic switch for disconnecting or cutting off the current to the wires in the event of a breakage or other disturbance in the continuity of the system, the object of the improvements being to provide simple and effective means for this purpose which can be applied to existing traction systems at comparatively little cost. If one of the conductors A B should break, or the continuity of the current through them be disturbed, the magnet C is de-energised and consequently fails to attract the armature D. The latter is therefore released, and the action of the solenoid E causes the lever F to be rocked on its pivot, the motion of the lever being transmitted by link G and lever H to the switch K, which is thereby opened, cutting off current from the section. A spring or like buffer cushions the descent of the core or plunger of the solenoid. To prevent adherence or sticking of the armature to the magnet, through residual magnetism, when the circuit is broken, adjusting screws X Y are employed to adjust the air gap or space between the magnet and the armature when the latter is attracted.—*July 7th*, 1909.

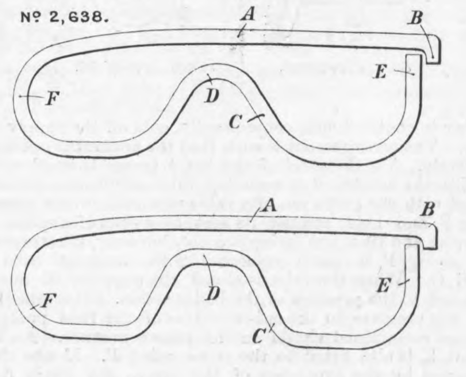
Nº 14,463.



2638. February 3rd, 1909.—IMPROVEMENTS IN WEDGES FOR RAILWAY TRACKS, *Société Anonyme Etablissements Arbel, Forges de Couzon, of* 25, *Rue de Rocher, Paris.*

This invention has reference to metal wedges of that kind which are constituted by two branches, one parabolic in form and another of sinuous form, and adapted to be interposed between double-headed rails and their chairs. This wedge is constituted by two arms; the arm A is parabolic in form and provided with a nose B and is intended to be placed against the chair. The other arm C which is in contact with the rail is formed by two arcs of a curve united by a curved or a rectilinear part D, the concavity of these arcs being directed towards the arm A. The arm B ends at its free extremity in a nose E. The arms A and B are united by a circular part F. A wedge of this kind is placed in position by engaging the extremity F between the chair and the rail and in striking the nose B in order to drive the wedge in. The wedge arranged between the bearing and the rail forms a resilient joint. If a sudden shock results say from the rocking movement of a train the parabolic arm A comes into contact with the nose E, which gives rise to a fresh resistance and, owing to the movement continuing the arm A encounters the shoulder D. This shoulder is capable of great deformation while at the same time remaining perfectly resilient owing to its form. It enables the wedge to remain always in contact with the rail, and this at a considerable pressure; finally it imparts smoothness to the running whilst not interfering with the necessary rigidity of the track. The parts D and E of the arm thus constitute two resilient bearings. The shoulder D may present various forms. The engravings illustrate two examples.—*July 7th*, 1909.

Nº 2,638.

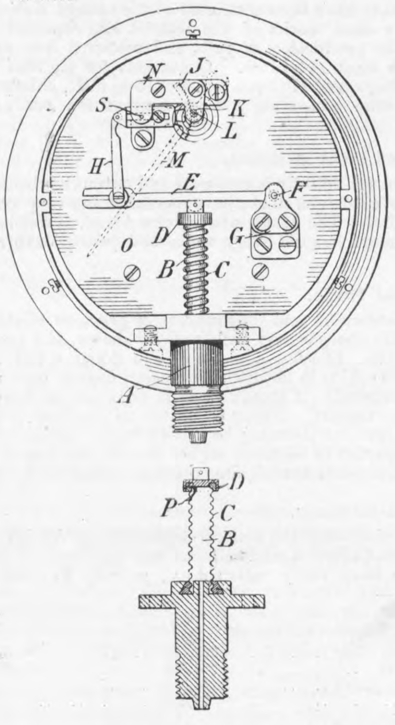


TESTING AND MEASURING INSTRUMENTS.

18,952. September 9th, 1908.—IMPROVEMENTS IN PRESSURE AND VACUUM GAUGES, Walter Charles Hill, of 28 29, St. Swithin's-lane, London, E C., and Richard Matthes, of Goethe Platz 10, Chemnitz, Saxony, Germany.

This invention relates to improvements in pressure and vacuum gauges of that class which comprises a flexible tube capable of axial expansion and contraction under the action of the positive and negative pressure respectively of the gaseous or liquid substance the pressure of which it is desired to indicate, the expansion and contraction being used to operate through appropriate mechanism a pointer or other indicating member or device. Extending into the gauge casing in the usual manner is the pressure or vacuum pipe A, to the upper end of which is attached the length of expansible and contractible tubing B provided with helical corrugations C, the number of which may be increased or decreased according to requirements. To the upper end of the tube is attached a cap D, to which is pivoted a lever E fulcrumed at F in a bracket G, the other end of the lever being adjustably connected to a bell-crank lever H pivoted at S, and having adjustably connected thereto a racked quadrant J meshing with a pinion K on the spindle L of the pointer M. The lever H and spindle L are carried in a bracket N, which, together with the bracket G, may be mounted within the casing on a removable plate O. As a means of connecting the tubing B to the pipe A and cap D respectively in such a manner as to make a fluid-tight joint, the upper end of the pipe and the lower surface of the cap are each provided with a groove P, into which the ends of the tube B are inserted, the connection being effected by means of a soldered or brazed joint. The sensitiveness of the tubing to changes of pressure for a given diameter is dependent on the thickness of the tubing and on the number of corrugations or equivalents within a given length thereof.—*July 7th*, 1909.

Nº 18,952.



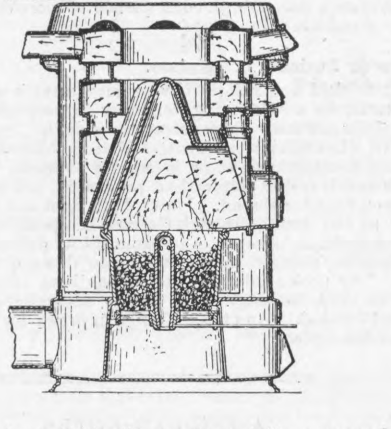
SELECTED AMERICAN PATENTS.

From the United States Patent-office Official Gazette.

925,486. FURNACE, *F. S. Lang, Seattle, Wash.—Filed June 5th*, 1908.

There is only one claim, which is as follows:—In a furnace, a grate member having a depending hub, a tubular member fixed in said hub and provided with openings at its upper and lower ends, and a second grate member having a hub portion in which the hub of the first said grate member is journalled.

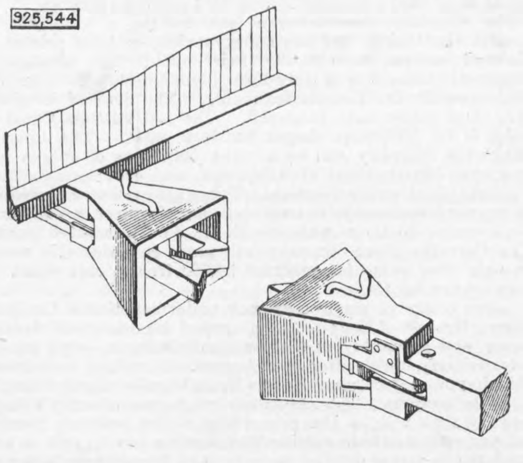
925,486



925,544. CAR-COUPLING, *M. Westra, Orange City, Iowa.—Filed May 12th*, 1908.

The only claim for this invention is the following:—In a car coupler, the combination of a pair of draw-bars having the extremities thereof slotted, hollow draw-heads at the ends of the draw-bars, the said draw-heads being provided with side openings at the rear ends thereof, a pair of oppositely-facing hook members arranged within each of the draw-heads and superposed one above the other, the rear ends of the hook members being pivoted within the slotted extremity of the draw-bar, while the outer ends project beyond the draw-head and terminate in bevelled noses, spring strips bearing against the hook members and normally tending to force the same inwardly, the said spring strips extending through the side openings of the draw-heads and being secured to the exterior of the draw-heads; means for moving the hook members outwardly against the action of the springs, and a laterally extending pin upon one of the hook members of each draw-head for engagement with the opposite hook member when the two hook members have been swung inwardly into operative position.

925,544



JULY.

The opening of two more "tube" tunnels under the Hudson River at New York makes an important change in the railway geography of that city by connecting the city with some of the great passenger terminal stations on the opposite side of the river. In 1908 a local underground railway company completed a pair of "tubes" under the river, serving one of the railway termini, and on July 19th last it opened to traffic another pair of "tubes" about two miles further down the river, with a connecting underground line following the west bank of the river. Thus the completed line forms a U, with two termini in New York city, and passing under three main line termini on the opposite side of the river. These main line railways will still maintain their fleets of steam ferry boats, but passengers will have the option of crossing the river by boat or "tube." As this is a local line only, passengers will of course change at the termini, which are connected with the "tube" line by lifts. The Pennsylvania Railroad, however, will in a short time operate trains through its own tunnels under the river to its immense underground terminus in New York city. The "tube" lines just opened are 15¼ft. inside diameter, and connect with the Pennsylvania Railroad station in Jersey city by six hydraulic lifts, the cars of which hold fifty people each. The terminus of the tube line in New York is beneath a 22-storey building, 400ft. by 175ft., owned by the railway company. It has four passenger lines with platforms 375ft. long, the lines connecting at each end with a single line into a "tube," so that the trains move in one direction through the station without reversing. A fifth line is provided for trains handling luggage and bringing in coal for—or removing ashes from—the power station of the building. There is an enormous traffic to be handled. The various ferries carry about 128 million passengers annually, and it is expected that the tunnels will carry from 50 to 60 per cent. of this traffic. The normal service will be trains at 3 minute intervals, with from five to eight carriages. The maximum capacity will be 220 million passengers annually, with trains of eight carriages at 1½-minute intervals.

An interesting test of the boom defence, such as in time of war would be placed across the narrow harbour entrances, was carried out on Thursday, July 29th, at Portsmouth. This test demonstrated that it is possible for a destroyer, with bows stiffened by steel plates, to cut through it, and so to effect an entrance. Early morning was fixed for the trial, so as to ensure privacy and not to cause too much inconvenience to the ordinary harbour traffic. At about 5 a.m. the Ferret was seen steaming up the harbour at some 15 knots. She struck the boom a direct blow, and forced her way clean through the obstruction, the steel hawsers and timbers parting before her as if they had been small cord. Large waves were forced up under her bows, but she did not show the slightest inclination to "hang up." With the exception of a dent on her bows, the vessel sustained very little damage, and no water was taken in. The Ferret is one of the older types of destroyers, having a speed of 25 knots. She had been specially strengthened for the experiment, steel plates having been riveted on either side of the bows so as to stiffen the fore part, and in other ways the bows were prepared for enabling them to cut through the obstacle. The boom, which is similar to those at the other naval ports, consists of massive baulks of timber about 10ft. long, held together by stout wire ropes. On each timber are steel spikes, which it was expected would penetrate the thin plates of any torpedo craft that struck them. An additional obstacle, consisting of a 3in. wire hawser, was stretched some 3ft. above the timbers, the idea being that, should any destroyer charge the boom, this hawser would throw down the funnels and sweep the deck of everything upon it. Below the surface of the water was another hawser so fixed as to offer considerable impediment to the hull, and possibly foul the propellers. Notwithstanding all this, however, the Ferret easily entered the harbour.

At the opening of the new engineering laboratories of the Manchester University last month, Mr. J. A. F. Aspinall, the general manager of the Lancashire and Yorkshire Railway Company, made an eminently sensible suggestion which it would be well if large teaching bodies such as Universities would adopt, namely, specialisation in some particular subject. There seems to be a growing tendency to make the engineering course too wide in some institutions, with the result that it does not attract the endowments which might otherwise flow in, and be concentrated on subjects of special interest to the general body of engineers in the particular district. The chief danger regarding the adoption of such a suggestion as that made by Mr. Aspinall seems to be that students who may not have already made up their minds which branch of engineering fits in with their ideas may be led from want of choice to adopt a side to which they have the least inclination. On the other hand, the proposal would seem to afford a method of preventing unnecessary competition between rival universities.

Another submarine, with eleven of her crew, has been lost under circumstances which can only be described as absolutely accidental. There is no question this time of open hatches, mistaken orders, bad rivets, petrol explosion, or any other defects of the kind that have been the alleged or proved causes of other accidents. The submarine—C 11—in company with several others, and escorted by the mother ship Bonaventure, was making her way from Grimsby, where she was stationed, to Lowestoft, when the tramp steamer Eddystone ran in amongst the fleet, sinking the ill-fated vessel and causing two others to collide with such force as so seriously to damage one that she had to be taken in tow. How the Eddystone failed to see the lights of the submarines will no doubt be settled at the inquiry, but it is at the moment a mystery. Some reports say that there was a fog or mist at the time, whilst others assert that the night was clear and the lights of the little vessel shone out clearly. The C 11, after the collision, sank immediately in 15 fathoms, and was found easily by the vessels which arrived quickly at the scene of the accident.

A deputation representing the whole body of men of science in this country waited upon Mr. Runciman on July 13th to urge the importance of proper housing for the valuable science collections at South Kensington. The memorial, which was presented by Sir Henry Roscoe, set forth in detail the demand for a science museum representative of all branches of physical science, both pure and applied, so housed that its treasures might be easily accessible for the purpose of scientific education and research. At present these treasures are huddled together in makeshift buildings quite unsuitable for the purpose of a museum, and with an area altogether inadequate. In consequence, it is impossible to show them properly even as exhibits, and it is still more impossible to obtain the benefit from them that should be derived for educational purposes. Mr. Runciman agreed with all that was said, and confessed that he was ashamed that things were in their present condition. But there was the difficulty of money and land. On this point he had little to say, except that he would press the necessities of the case upon his colleagues, and that he would use all the personal influence he possessed. Many years ago the Duke of Devonshire's Commission urged the necessity for a properly equipped science museum. Afterwards the commissioners of the 1851 Exhibition offered the Government £100,000 and a site for such a museum, on condition that the Government would undertake its maintenance. The offer, which was repeated in 1897, was declined on both occasions. Sir Henry Roscoe hinted that the twice-rejected offer might be repeated if the Government showed a disposition to do its part.

On Wednesday, July 7th, his Majesty tke King, accompanied by Queen Alexandra, opened the new buildings of the Birmingham University at Bournbrook. During the nine years which have elapsed since the foundation of this university the progress has more than fulfilled the expectations of its founders. The nucleus of its teaching staff, taken over from Mason's College, and including the Queen's Faculty of Medicine, numbered 28 professors, with their complement of lecturers and demonstrators. Now there are 39 professors, with a full staff of assistants. There were 678 students enrolled during the first session of the university, 1900-1901, and with the exception of one year, in which there was a fall in the number of students, there has been a substantial annual increase. The year in which the number of students went down was the second in the record, when there were twelve students less on the roll than in the previous year. This is attributed to the fact that the first examinations, especially the matriculation, were unusually difficult, the authorities having been influenced by a desire to uphold a high educational standard. Since that year the number of students has shown a steady increase. Seven years have elapsed since the work of erecting the new buildings was commenced, and about two-thirds of the buildings shown in the architects' designs have been erected and equipped, the work done and the liabilities incurred in respect of site, building and equipment accounting for an expenditure of over £500,000. On an average about 200 men have been constantly employed on the site during the past six years, and it is worthy of note that the undertaking has been carried out without a fatal or even a serious accident occurring.

On the evening of Monday, July 19th, a Technical Committee of the Royal Automobile Club began, at the Crystal Palace, a series of trials of headlights for motor cars and motor cycles. It is believed that one of the causes which contribute to the unpopularity of motor cars among a certain section of the public is the use of headlights which are a source of annoyance owing to their dazzling effect. The Technical Committee of the Royal Automobile Club considers that this effect can be greatly reduced by the use of different lanterns, which, while affording sufficient light for driving purposes, have their beams so controlled that the eyes of approaching pedestrians and others are not dazzled. The tests were, therefore, carried out for ascertaining the power and range of illumination and the dazzling effect of the lamps entered for the trials. A measured scale, 100 yards long, and divided into yards and feet, was laid down. A photometer, having its screen illuminated by an electric lamp of known candle-power and placed at a measured distance from it, provided a standard, and it was moved backwards and forwards until a balance was established with the lamp under test for the purpose of measuring the illuminating power. Next the photometer was moved half-way towards the lamp, and at that point the divergence of the beam of light was observed. In order to arrive at the dazzling effect, the judges approached the lamp from a point on which the light had been centred and moved diagonally through the beam to a point 6ft. to its rear side. The distance at which the eye, at a level of 4ft. 6in. from the ground, was not prevented from discerning an illuminated object two yards behind the lamp, was taken as a figure of merit. Acetylene, petroleum, and electric lamps were tested. The Club will issue a certificate of performance in relation to each lamp, but the numerical value of the marks awarded under each head will not be published.

The annual summer meeting of the Institution of Mechanical Engineers, which was brought to a conclusion on Friday last proved, under Mr. Aspinall's presidency, at Liverpool, a great attraction to the members and their lady friends. Few places in this country offer greater attractions to those bent on sight-seeing than Liverpool. But if the membership roll continues to grow at the present rate there will soon come a time when suitable centres for these annual reunions will be limited to about half a dozen large cities. At Liverpool, for instance, on one day there were about seven hundred persons to be entertained at luncheon under one roof. This necessitated the appropriation of all manner of rooms, including bedrooms, for the purpose. Only two morning sessions were devoted to the reading and discussion of papers on engineering subjects. Such a short time is altogether inadequate for the purpose. Authors had to skip very briefly through the principal points in their papers, and those who came to discuss had to limit their efforts to the shortest possible time. Mr. Hughes' excellent paper, which, as one of the speakers remarked, was "bristling with debatable points," suffered greatly on this account, while the "closuring" of the debate must have prevented many members from taking part. It would be more in keeping with the otherwise excellent organisation of this annual gathering if either more time were devoted to the serious part of the business, or the number of papers more strictly limited. In the opinion of some it would apparently be a more popular course to do away with this portion of the proceedings altogether!

A Swedish tunnel project is at present the subject of much discussion in Denmark and the South of Sweden. Mr. Quistgaard, a Swedish engineer, has published in Swedish and Danish engineering journals a plan in which all technical details are fully taken into account for connecting the towns of Copenhagen and Malmö by an electric railway through a tunnel beneath the Oeresund. One of Denmark's most distinguished engineers, Mr. Winkel, has reviewed Quistgaard's project in one of the latest numbers of a Danish journal, *Der Ingenieur*, and comes to the conclusion that the plan has been well thought out and could be executed in the manner proposed by Quistgaard. The whole line between Copenhagen and Malmö is 36 kiloms. long; the tunnel, however, would only measure 16 kiloms. Whilst the journey from Copenhagen to Malmö now takes 2 h. 17 min., the time taken by the submarine electric railway proposed by Quistgaard would be only 41 min. It is reported that Mr. Quistgaard has also projected a tunnel between Helsingfors and Helsingör.

Since the review of the Fleet held in June for the benefit of the representatives of the colonial Press other similar opportunities of inspecting the naval strength of the country have been afforded the general public. These were taken full advantage of. Never before had Londoners had such an opportunity of seeing so many ships of war so close at hand, and it is doubtful if so many fighting ships were ever in the river at one time before. On Saturday last the Fleet was reviewed by the King off

Spithead, and still another review was held off Cowes on Monday, the occasion this time being the visit to this country of the Tsar of Russia. That such occasions mean a vast amount of additional work to the crews of the various ships engaged—work, too, which does not appeal to the sailor instinct nor add anything to the efficiency of the Fleet as a fighting unit—is obvious to anyone who inspected, however cursorily, the ships in the Thames. Torpedo attacks carried out under impossible conditions and rendered realistic by means of hydrogen phosphide can only be regarded as of spectacular value, and as this form of mimic warfare has already been witnessed several times by most of those who saw it last Saturday, we would surmise that all that could be learned from it has already been acquired. A regrettable accident is reported from H.M.S. Temeraire as having occurred during the firing of the Royal salute on Saturday, whereby one seaman lost his life and three were injured. With four reviews in a little over a month's time and the annual manœuvres interposed between two of these, the Home and Atlantic Fleets have been busily employed recently.

Tunnel engineers are aware that all men's constitutions are not such as will permit of their sojourn in an atmosphere under abnormal pressure. This fact was emphasised during the month by the fatal effects of the pressure of six atmospheres on an engineer who was working in a tunnel beneath the river Elbe. When the works were commenced several workmen were taken ill, but they soon recovered, and were able to resume their work. A fortnight ago the engineer mentioned above fell ill also, but with his doctor's permission he resumed work some days later. On re-entering the tunnel and subjecting himself to the same atmospheric pressure he again collapsed, and died soon after being carried out and brought to the works office.

The completion of the last section of the Trauen Railway, the new Alpine railway which leads from Schwarzach to Spittal, *viâ* Gastein, and which shortens the journey from Germany to the Adriatic by several hours, was celebrated with great ceremony in the presence of the Emperor Franz Josef of Austria on the 5th of the month. This railway, the purpose of which is to provide direct communication between the Austrian crown lands of Salzburg and Kärnten, forms an important new railway connection with the South of Europe, as it shortens the distance over the Alps to Triest by about 175 kiloms. The construction of the Trauen railway was commenced in 1902, and the section of the same extending from Schwarzach to Gastein was put into commission in September, 1905. It was then that the most difficult part of the line was begun, viz., the 8½-kilom. tunnel through the lofty Trauen mountains, which was finished in July, 1907. A prominent feature of the railway is its large variety of constructive works. These comprise, among other things, about fifty-five tunnels, and over fifty viaducts. The length of the three longest tunnels together is 23 kiloms., which exceeds the length of the Simplon tunnel.

The German International Aëronautical Exhibition—Internationale Luftschiffahrts - Ausstellung, I.L.A.—generally spoken of in Germany as the "Ila," was opened at Frankfort-on-Main, in the presence of numerous aëronauts, on the 10th of the month, and will last till the 10th of October. Practically all known kinds and forms of ordinary balloons, dirigible balloons, kites, gliders, aëroplanes, guns for combating against aërial war vessels, &c., are on view. So rapid are the changes wrought in the domain of aëronautic construction by the unceasing activity of inventors and constructors, that the probability is that the exhibition will wear a very different aspect at its close from what it did at the beginning. The historical department, which comprises a most complete collection of everything bearing in any way on the existence and development of aëronautics, will alone be unaffected by such changes. Its completeness may be judged by the fact that it includes pictures, old copper plates, drawings, letters, brochures, pamphlets, advertisements, placards, flags, &c., and it has been said that it is a wonder that the indefatigable collector, Dr. Liebmann, has not procured the petticoat of Madame Montgolfier, which was caught up by warm air whilst she was drying it before the fire, and thus caused her husband to construct the first hot-air balloon. The public interest at the exhibition will be enhanced by various flying competitions and practical experiments on the exhibition grounds. At the latter end of the month Professor Erdmann gave an interesting lecture at the "Ila" on "Liquid Hydrogen." He said that there were now good prospects of the manufacture of the hydrogen liquefier, designed by Kammerlinggh Omnes, being taken up by large engineering concerns. This would be a very great help to practical aëronautics. Liquid hydrogen takes up only $\frac{1}{800}$th of the space required by gaseous hydrogen. One cubic metre, which weighs 60 kilos., is sufficient to fill a moderate-sized balloon, which operation can be performed by simply warming up the vessel used for transporting the liquid and causing it to gasify. Refills during journeys, especially in the case of dirigible balloons, can be carried out without difficulty or danger.

The recent flights, successful and otherwise, which have been made by Mr. Latham and M. Blériot in their respective aëroplanes have aroused considerable interest and enthusiasm on the part of the general public, but already, like other outstanding innovations, they are being forgotten in the progress of other events. That these aëronauts deserved much of the praise which was accorded them no one will deny, but we are inclined to believe that the public has over-estimated the importance of their attempts and accomplishments. As a test of the capabilities of the means for transportation and travel afforded by aëroplanes, the successful cross-Channel flight gives us practically no results which were not previously known. Longer flights both in time and distance have recently taken place. Taking account of everything which has yet been achieved, it is still evident that much must yet be done before we can seriously think of aërial travel or fear an invasion facilitated by aërial flight. The organisation of a transport service on a commercial basis or for military purposes is brought no farther within the region of possibilities by the recent events except in so far as they may indirectly bring about an added interest in these affairs on the part of the public. So rapid, however, has been the advance in the practice of flight, particularly within the last year, that it is dangerous to predict an estimate of the time required for the progress which has yet to be made before the experimental stage of flying has been passed. Recognising this, the Government intend spending a considerable sum of money during the forthcoming year on investigations and experiments relating to the subject, and from these, it is to be hoped, this country will be enabled to show an advance in this direction equal or exceeding that which has recently been made by other countries.

One of the first successes achieved by the promoters of street tramways in this country was the establishment of a line from the Elephant and Castle to Brixton. Steam was tried on this line, but failed, as the rails were quite unable to carry the locomotives. After a chequered career as a horse-worked line, rope traction was used on a portion of this line. After much opposition from the inhabitants of Streatham the rope-worked tramways were extended to Streatham, and ruined it as a beautiful village with two splendid commons. The population of the district was about 17,000. The rope system remained for some time, and five or six years ago the L.C.C. took the trams over, and converted them to the electric conduit system. In the meantime, Croydon had extended the overhead system northwards to Norbury, about two miles from Streatham on the one hand, and southwards to Purley on the other. It was proposed from the first to carry the L.C.C. lines through Streatham. Much negotiation took place with the Wandsworth Borough Council, under whose control is Streatham, which is now a place of 100,000 inhabitants. Considerable difficulties had to be overcome because of the narrowness and steepness of the main road. Operations were begun early in the present year. Gas and water mains had to be shifted, and much time was lost. but the line was opened for traffic on the last day of July and is now in successful operation. The conduit system ends at Streatham railway station. Thence to Norbury the overhead system is used, the cars being fitted both with ploughs for the conduits and poles for the overhead wires. With this connecting link it is possible to travel by tram from Purley northwards through London to Barnet in Hertfordshire—a distance of some 21½ miles—passing through Croydon, Thornton Heath, Norbury, Streatham, Brixton, Kennington, the Embankment, Holborn, Islington, and Highgate. The journey takes about two hours—an average of eleven miles per hour.

The discussion in Committee of the House of Commons on the Naval Works Vote is of particular interest in view of the attention which has been devoted to the question of docking accommodation for warships of the Dreadnought and Invincible classes on the East Coast. Mr. Lambert, the Civil Lord of the Admiralty, admitted that we possess only one up-to-date Government docking establishment, that at Devonport, notwithstanding the huge loan expenditure incurred. The Admiralty hoped to complete the new Rosyth establishment and the new lock at Portsmouth earlier than the contract time, and had offered to the contractors bonuses for early completion of £800 and £400 per week respectively. The Civil Lord announced that the Government had definitely decided to construct two large floating docks which would each be capable of accommodating a Dreadnought, and could be constructed in eighteen months. He intimated that the negotiations for the construction of a large subsidised graving dock at Immingham, on the Humber, had fallen through owing to financial disagreement, and that the Admiralty were still open to consider similar proposals from the Tyne. Since the date of the discussion it has been stated that contracts have been placed with Swan, Hunter and Wigham Richardson, Limited, of Wallsend-on-Tyne, and Vickers, Son and Maxim, Limited, of Barrow, for the construction of the two floating docks, each of which will have a lifting capacity of about 35,000 tons. It is reported that one of the docks will be stationed at Jarrow Slake, on the Tyne, and Portsmouth is mentioned as the position of the other, but neither of these statements has been officially confirmed.

The terrible disaster which occurred on the 2nd July on the South Dock Extension Works at Newport is one of the most serious in the annals of public works construction in this country. The timbering of a deep trench, which had been excavated for the foundations of the external north-west wing wall of the new entrance lock and for a portion of the lock wall itself, suddenly collapsed, the majority of the men engaged in the excavation at the time being buried under the *débris* of the timbering and hundreds of tons of soil. It is believed that thirty-eight men lost their lives, but the exact number cannot be known until the trench has been re-excavated. The cause of the failure is at present in some doubt; a good deal of expert evidence has been tendered at the inquest, which stands adjourned, but all that is definitely known goes to show that the central line of "King" piles which ran down the middle of the trench and to which the sheeting piles were strutted suddenly lifted, and the side walls caved in. It appears that some indication of the rising of the piles was observed several hours before the disaster occurred, and additional rakers were being put in to resist the upward thrust. Failures of trench timbering are by no means uncommon occurrences, and most contractors and engineers who have carried out such works on a large scale have had experience of such troubles, but, fortunately, in most cases, the actual collapse is preceded by unmistakable signs of the approaching failure, which give sufficient warning to enable the workers to leave the trench in time to escape injury. The peculiar features of the Newport accident appear to be the suddenness of the collapse, the admittedly treacherous nature of the ground in which the trench was being sunk, and the exceptional strength of the timbering employed.

The dispute in the coal trade which at one time threatened to assume proportions of national gravity has now been satisfactorily terminated, and for the present the danger of an entire cessation of work at the mines is averted. The Scottish coalowners, some time ago, determined to enforce a reduction of 12½ per cent. in the wages of their workpeople, the alteration to take effect on the 26th of last month. The question of a minimum wage was also in dispute. Before the trouble arose this was fixed at 5s. 6d. per day, but the unions had for more than a year been agitating for a 6s. minimum. This the owners refused to concede, and further expressed a desire that, as trade was so dull, the minimum wage should be reduced to 5s. 3d. a day. Meanwhile the English miners, while still in dispute with their own masters regarding a 5 per cent. reduction in their wages and the operation of the new Act, decided by ballot, and with an eight-to-one majority, to support their Scottish fellow-workers by declaring a general stoppage of work throughout the country, provided no compromise were arrived at. The gravity of the situation called for prompt action, and, at the instigation of the President of the Board of Trade, a joint conference was held there on the 29th and 30th of last month between the representatives of the owners and the miners, the date of the alteration in the wages having been meanwhile deferred. As a result of this, the parties have been reconciled, and the miners express themselves as satisfied with the terms accorded them, which are much more favourable than were to be expected. The agreement arrived at provides that the minimum wage be 6s. per day. The basis price of coal at which this minimum is to take effect and the subsequent steps of the sliding scale are to be referred to an arbitrator, but it has been decided that the new basis price shall not be below the recent basis price, namely, 7s. 5.45d. It has been further agreed that if at any time between the date of the conference and March 31st, 1910, the prices prevailing do not justify the 6s. minimum wage, then for an equal period of time any increase in wages accruing under the agreement shall be reduced by 6¼ per cent.

EXPERIENCE WITH SUCTION GAS PRODUCERS.

No. II.*

GENERATORS.

There are numerous types of generators working successfully, for each of which certain advantages are claimed, but the principal difference will be found in the methods of vaporising the water and heating the air supply which carries this steam into the furnace, and in the size of the furnace for a given horse-power. The methods of vaporising the water by means of the heat from the gases leaving the generator may be roughly divided into three groups.

(1) With self-contained water boiler at the top of the generator, heated by the hot gases rising from the furnace, and having more or less water storage.

(2) A similar arrangement to the above, but of what is generally known as the "flash" type, in which there is no water storage, the water being delivered in small quantities on to the hot metal casing and at once vaporised.

(3) With a boiler or vaporiser placed on the gas piping between the generator and the scrubber, in which the water is heated by the hot gases passing to the scrubber.

Good examples of the first type are the generators made by Messrs. Crossley, Tangye, Campbell, Otto Deutz, Fetu Defize, &c., and while they are said to be somewhat slow in providing steam when the plant is started, owing to the volume of cold water in the boiler to be heated, this does not cause any real difficulty, especially as too much steam is not advisable until the generator fire has reached the high temperature necessary completely to decompose it.

The second type is represented by the plants made by Messrs. Dowson, Lane, the National Gas Engine Company, Winterthur, and others. These vaporisers respond very quickly to any changes of load, and can be easily regulated to give the exact amount of steam required for the best working of the plant; care must be taken to ensure a constant supply of water, as this type is more liable than the first type to suffer should the water supply fail for a few minutes, particularly if the vaporiser is of cast iron, which may crack when overheated. To avoid this risk most makers of such plants advise the use of a small feed tank, fitted with a ball cock, which enables a small reserve to be kept, and ensures a constant and even rate of supply.

The third type is much used on the continent of Europe and also in the United States. It is made by Messrs. Kynoch, Dudbridge Ironworks, Pintsch, Kiderlen, Bollinckx, Taylor, &c.

This arrangement simplifies the form of the generator, but renders it difficult to obtain ample vaporising surface to utilise the waste heat in the gas without making elaborate tubular boilers.

The success of suction gas plants depends to a great extent upon the working of the vaporiser. When supplied with dry air only, they should give a gas containing about 34.7 per cent. of (CO) carbon monoxide and 65.3 per cent. of (N) nitrogen, having a calorific value of 118.8 B.Th.U. per cubic foot and providing about 85.8 cubic feet of this gas per lb. of carbon. The actual value of the gas would be less than the theoretical figures given above, and too low for working successfully with gas engines. The excessive heat generated would also cause the fuel to "clinker" badly, would necessitate the use of an excessive quantity of water in the scrubber to cool the hot gases, and generally spoil the working of the plant. To prevent this excessive amount of heat being generated it is necessary to saturate the air with water vapour, which is dissociated in the combustion zone into hydrogen and oxygen, absorbing in the process the surplus heat from the incandescent fuel and increasing and enriching the gas supplied. The chemical reactions involved are rather complicated, but anyone interested will find them fully set forth in Messrs. Dowson and Larter's valuable book on producer gas.

It will be seen that in designing a suction plant it is necessary to keep a sufficiently high temperature in the combustion zone to ensure the necessary reactions between the hot fuel, the air and vapour, but the temperature must also be kept as low as possible to avoid "clinker," so that the range between the two conditions is very small.

Amount of water to generator.—Theoretically the richest gas will be obtained when using .064 lb. of water per pound of carbon, which would give a gas containing

About 39·9	per cent.	by volume of	carbon monoxide (CO)
,, 17·1	,,	,,	hydrogen (H)
,, 43·0	,,	,,	nitrogen (N)

having a calorific value of 186.7 B.Th.U. per cubic foot, and producing about 74.6 cubic feet of gas per pound of carbon.

It must be understood that the above assumes perfect working, but in practice some heat is lost by radiation from the producer, and some carried away by the gases, nor do the chemical changes take place to the extent necessary to secure the results shown above.

A good average result from a producer supplying an engine of 220 brake horse-power gave gas containing by volume CO_2, 6.83 per cent.; CO, 22.64; CH_4, 1.65; H, 16.37; N, 52.51; with a net heat value of 141.26 B.Th.U. per cubic foot.

To carry the water into the furnace it is vaporised in the boiler or vaporiser before mentioned by the heat of the gases leaving the generator, and allowed to saturate the air which is being drawn into the generator by the suction of the engine. As this is the only method used for supplying water to the generator, and the amount that saturated air will carry varies to a great extent with its temperature, it will be seen that the adjustment of this air temperature provides a ready means of varying the water supply. However much water may be fed to the vaporiser, and however much steam may be generated, only the amount carried by fully saturated air at a given temperature can be delivered into the fire, and the remainder cannot be taken up by the air, but will be carried away by the overflow pipe.

The diagram—Fig. 1—shows the temperature in deg. Fah. of the air for carrying a given amount of water per pound of carbon. Also the B.Th.U. obtained from each cubic foot of gas when securing the maximum theoretical efficiency, and the B.Th.U. obtained from each pound of carbon under similar conditions. The actual results would be 10 to 20 per cent. less than shown according to the conditions of the fuel, plant, &c. It has been stated by a well-known authority on suction plants that air of a temperature of 85 deg. Fah., when saturated, will carry the necessary amount of vapour, but it will be seen from the above table that a temperature of about 145 deg. Fah. is required for this purpose when the saturated vapour is being delivered at the fire bars of the generator.

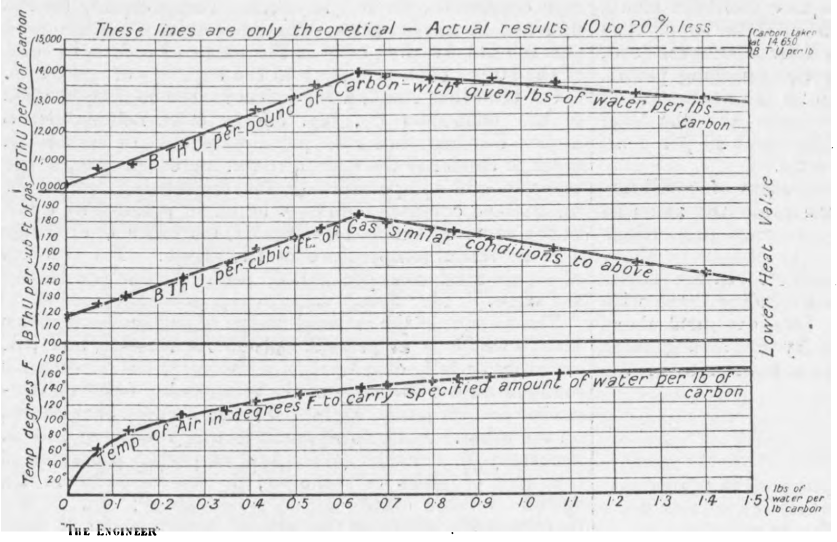


Fig. 1

The above temperature of fully saturated air will give the richest gas, but the air may be made hotter by superheating only—after leaving the vaporiser to avoid carrying any more vapour—which will be of assistance in keeping the fire hot, especially on light loads. When fully saturated air above 145 deg. Fah. is used, the excess of vapour will lower the temperature of the generator, and cause the production of carbon dioxide (CO_2), instead of carbon monoxide (CO), thus reducing the heat value of the gas. The low temperature of the fire will also prevent the producer responding quickly to the demands of the engine under varying loads.

In no case should the temperature of the air when fully saturated exceed 165 deg. to 170 deg. Fah., owing to the large amount of vapour it will carry into the fire. This amount increases very rapidly with the increase of temperature, changing from about .17 lb. at 145 deg. Fah. to about .36 lb. at 165 deg. Fah. per lb. of air.

The experience with Mond producers—see Messrs. Bone and Wheeler's experiments (The Engineer of May 24th, 1907)—show that this excess of vapour is not usually decomposed in the fire, but will absorb heat from the fuel in the generator, lowering its temperature, which heat must afterwards be removed in the scrubber by an extra amount of cooling water.

The above shows that to be thoroughly efficient the vaporiser and air heater should be sensitive to changes in fire temperature, so that the air temperature and vapour supply will quickly diminish when the engine is running on a light load, thus supplying drier air to the fire to keep up its temperature as far as possible, and only providing the full supply of vapour when the fire has become hotter and able to decompose the air and vapour.

Diameter and depth of the furnace.—There seems a considerable difference of opinion as to the inside diameter of the generator for a given horse-power necessary for dealing with the main conditions, which require—

(1) Hot fire at the combustion zone to ensure decomposition of the air and vapour; this should have a temperature of about 1800 deg. Fah., and will give gases containing CO_2, H, and N in various proportions.

(2) Hot fuel above combustion zone to enable CO_2 to take up more carbon, thus converting CO_2 into a combustible gas CO.

(3) Fire should not be much over 1800 deg. Fah. to avoid formation of clinker, and must not get too low on light loads to prevent engine slowing down or even stopping if the full load should come on again suddenly.

The suction of the engine under ordinary conditions will control the air and vapour supply sufficiently to ensure good working, the only difficulty with a well-designed plant being a sudden change from a long continued light load to full load; such a change rarely happens, and can often be avoided by extending the time for putting on maximum load over five or six minutes, thus allowing the fire to be gradually increased and raised to a suitable temperature for decomposing the air and vapour.

Diameter of furnace.—Some makers allow only a small area per brake horse-power; others consider much larger areas necessary, and the following examples show the wide variation between different makers and writers on this subject.

Area of furnace—square inches per B.H.P.

		Small sizes.		Large sizes.
A.	In ordinary work	5		3
B.	In ordinary work	4	to	4
	For maximum duty on for several hours	7	to	5
C.	The plants of about 20 B.H.P. tested at the R.A.S. Show at Derby in 1906 averaged about	8¼		—
D.	Another maker uses	9	to	5

An American writer recently stated that suction gas plants in America were not generally found successful until the makers had considerably increased the areas above the size—based on European practice—with which they originally commenced to make experiments, and another writer gave his experience—based on inquiry as to the size of numerous plants then working, that about 14½ square inches per brake horse-power would be found to give the best results. This seems excessive as compared with English plants, but may be due to the difference in coal used. In an American plant recently tested the engine was about 150 brake horse-power, and used about 1 lb. of fuel per brake horse-power per hour. This coal was said to be an ordinary grade of buckwheat Pennsylvania anthracite containing by analysis:

Fixed carbon	78.9	per cent.
Volatile	5.3	do.
Ash	13.0	do.
Moisture	2.7	do.
Sulphur	0.77	do.

and having a heating value of 13,590 B.Th.U. per pound fired.

In contrast to the large area specified for American practice, it may be noted that a well-known continental writer on gas engines and producer-gas plants says:—"The essential portion of the generator, which contributes to the production of a proper gas, is that which corresponds with the combustion zone. To this portion a cross section is given, varying in size between one-half and one-quarter of the surface of the engine piston, sometimes between one-half and nine-tenths of this surface, according to the nature and the size of the fuel that is used. It is to be noted that most modern generators are rather too large than otherwise."

Taking two well-known makes of gas engines, this would give producers of the following sizes:—

For an engine with an 11in. diameter cylinder running at 180 revolutions per minute, which gave 29 brake horse-power on suction gas:

11in. diameter cylinder = 95 square inches area.

	Size of furnace. Area.	Diameter.
At $\frac{1}{4}$ of cylinder area	= 23.75 sq. in.	= 5.5 in.
,, $\frac{1}{2}$ do.	= 47.50 do.	= 7.8 in.
,, $\frac{9}{10}$ do.	= 85.50 do.	= 10.4 in.

For an engine, with a cylinder 24in. diameter, and running at 160 revolutions per minute, which gave 200 brake horse-power on suction gas:

24in. diameter cylinder = 452 square inches area.

	Size of furnace. Area.	Diameter.
At $\frac{1}{4}$ of cylinder area	= 113 sq. in.	= 12 in.
,, $\frac{1}{2}$ do.	= 226 do.	= 17 in.
,, $\frac{9}{10}$ do.	= 407 do.	= 22.75 in.

These sizes seem much too small compared with the usual practice here, even the maximum proportions only giving areas of 3 and 2 square inches respectively per brake horse-power; but possibly the above extract has not been clearly expressed in the translation, and is meant to apply only to a type of generator sometimes used on the Continent, as shown in Fig. 2, where the small end or combustion zone is the size really referred to. A small size of generator is used in some cases to ensure quick combustion at the fire zone, but the makers are careful to provide an ample steam supply from the vaporiser, which is usually placed over the fire in such plants. This vapour supply enables the heat in the generator to be kept within reasonable limits, and thus avoid "clinker," while the small size of the fire enables such a plant to be quickly drawn up to full load, and generally makes it very sensitive to varying demands from the engine.

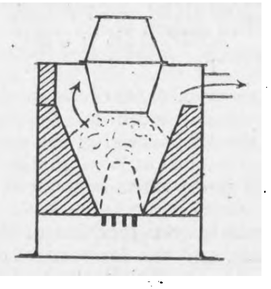


Fig. 2

Though these plants—with small area per brake horse-power—work well with Welsh anthracite or similar fuel, which is almost pure carbon, and contains very little ash or dirt, they are at a disadvantage in using fuel containing a large percentage of ash, &c., which will form a certain amount of clinker, however well supplied with vapour, causing the small generator to become choked up, and necessitating stoppages at intervals to get rid of clinkers and ash.

With a steady load of 10 brake horse-power a plant having 15 square inches per brake horse-power worked well and economically, but was too large for a fluctuating load between 0 and 10 brake horse-power. On a steady load of 32 brake horse-power a similar plant having 4.7 square inches per brake horse-power worked well and gave good results on loads fluctuating from 0 to 32 brake horse-power, but was not quite so economical at full load as a similar plant with rather more area per brake horse-power. On larger size plants—about 220 brake horse-power—3.9 square inches per brake-horse-power gave good results, but an area of about

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* No. I. appeared July 23rd.

5 square inches was found to be rather more economical.

The above figures show that generators can be used with wide ranges of furnace area, provided a good clean anthracite fuel is used and the vapour supply suitably arranged; for poorer fuel generators of larger area have an advantage, as they allow more room to deal with ash and clinker, and also permit the air and vapour passing through the generator to be a longer time in contact with the hot fuel, which assists the chemical reactions. When running on varying loads, such as are usual when driving workshops, &c., the areas recommended are for small sizes, say, 15 brake horse-power, about 7 to 8 square inches per brake horse-power, gradually reducing the area per brake horse-power to about 4 square inches in plants of 200 brake horse-power. When used to supply gas engines working constantly against their maximum load, such as would be found in waterworks pumping plants, the area should be increased 15 to 20 per cent. When using coke or fuel containing more ash and dirt than usual, the area of generator should be about 20 per cent. larger than that specified for anthracite.

Grate area.—It is usual with generators of small furnace areas to make the area of the grate the same as the furnace, but in those of more generous proportions this is not advisable, and the grate area should be about 50 to 70 per cent. of that of the furnace. In the plants tested at the Derby trials in 1906—excluding those with special forms of grates—the grate area averaged about 70 per cent. of the furnace area. By this arrangement the air and vapour supply to the fire is kept more in the centre, and passing through a smaller fuel area, ensures the combustion zone being kept at a suitable heat for decomposing the air and vapour when working on moderate or light loads; it also blows up the fire quicker when changing from light to heavy loads. This arrangement of smaller grate than furnace is shown by Fig. 3, and will be seen to have the same advantages as the small furnace, whilst leaving a large area between the grate and the inner side of the lining for the disposal of such clinker as cannot be taken out while the plant is working. The grate area can thus be kept free for the passage of the hot air and vapour, ensuring a hot zone in the centre for combustion.

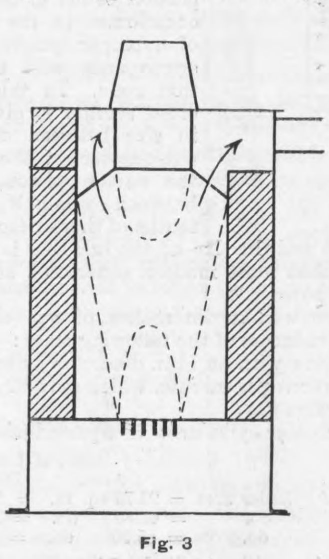

Fig. 3

THE RELATIONSHIP BETWEEN CONDENSER AND AIR PUMP.

By R. M. NEILSON.

In nearly all practical cases of steam condensation, air is present in the steam; and in the working of condensing steam engines the withdrawal of the air has always been recognised as an important item in the operation of the plant, and an air pump or its equivalent provided for this purpose.

Speaking generally, the function of the air pump is to withdraw the air, and the function of the condenser to condense the steam. This is known to every tyro in steam engineering; but the precise scientific relationship between condenser and air pump does not seem to have received the attention which it deserves. The condenser has to deal with air as well as steam, and the air pump discharges steam as well as air. Air most adversely affects the condensation of steam in a surface condenser, and the steam mixed with the air entering an air pump has the greatest influence on the capacity of the latter necessary to enable it to perform its work.

The aforesaid definitions of the functions of the condenser and air pump are, therefore, only good when considered in a general way. To be strictly correct and explicit, the respective functions must be expressed as follows:—

The function of the condenser is to reduce the ratio of steam to air by the condensation of the greater part of the steam, so as to diminish the volume of the mixture of air and steam which has to be discharged by the air pump.

The function of the air pump is to keep down the ratio of air to steam in the condenser, so as to allow the cooling surface of the latter to act effectively.

In the case of a well designed surface-condensing plant correctly proportioned for its work, which is capable of maintaining a given vacuum under given conditions, a reduction in the cooling surface of the condenser or in the displacement per minute of the air pump bucket will produce a fall in the vacuum; but the cooling surface of the condenser is not the minimum necessary to condense the steam, nor is the capacity of the air pump the minimum required to discharge the air.

A reduction in the capacity of the air pump by, say, 50 per cent., will, however, reduce the amount of steam which can be discharged with the air, and so will necessitate an alteration in the conditions existing in the condenser, so that in the latter, or at least at its air outlet end, the ratio of steam to air will be less. This greater air richness—or weight of air per unit weight of steam—in the condenser will in its turn tend to reduce the condensation rate, which can only be maintained by some other alteration, namely, the fall in vacuum, which assists condensation by augmenting the density of the steam, and also by raising the temperature of the latter, and thus increasing the difference in temperature between the entering steam and the condensing water. Equilibrium is thus re-established under new conditions, the fall in vacuum compensating for the increase in air richness. The amount of air discharged per minute by the pump is the same as before, in spite of the 50 per cent. reduction in the capacity of the pump.

On the other hand, a reduction in the cooling surface of the condenser by, say, 50 per cent. necessitates a higher condensation rate per square foot of surface in order to condense the steam, which increased rate, if the velocity and temperature of the condensing water are maintained constant, can only be made possible by a fall in the vacuum, which, as aforesaid, increases the density and the initial temperature of the steam. The amount of steam condensed per unit of time remains practically the same.

The science of the rational design of surface condensing plant—which is at present only in its infancy, but will probably be fully developed in a few years—is necessarily founded on a knowledge of the relationship between condenser and air pump, and the influence which each exerts on the other. Fully to appreciate this relationship it is necessary to consider (1) the law of partial pressures of mixtures of gases or vapours; (2) the variation in the specific volume of the air in a condenser; and (3) the factors which influence the rate of transmission of heat from the steam to the condensing water.

PARTIAL PRESSURES.

In a mixture of two or more gases each exerts a pressure as if the other were not present, and the total pressure exerted on the sides of a containing vessel or on a pressure gauge is the sum of the individual pressures—called the "partial pressures"—of the several gases. A cubic foot of atmospheric air is commonly said to contain 0.21 cubic foot of oxygen and 0.79 cubic foot of nitrogen; but the true situation is expressed better by saying that the cubic foot of air at atmospheric pressure contains a cubic foot of oxygen at a pressure of 0.21 of an atmosphere and a cubic foot of nitrogen at a pressure of 0.79 of an atmosphere.

If one cubic foot of oxygen at a pressure of 0.21 of an atmosphere is forced into a vessel of one cubic foot capacity containing nitrogen at a pressure of 0.79 of an atmosphere, each will continue to exert its original pressure, and the pressure of the mixture recorded by a gauge will be the sum of the partial pressures, namely, one atmosphere; and we will have produced—except for the omission of small proportions of other elements—atmospheric air the same as could be obtained by opening the vessel to the atmosphere. Moreover, if the oxygen is withdrawn from atmospheric air in a closed vessel, the nitrogen will continue to exert its partial pressure of 0.79 of an atmosphere, which can then be measured by a gauge—the pressures of the other elements being nearly negligible.

In steam condensing plant we have to deal with mixtures of steam or water vapour with air, or with a mixture of atmospheric gases in other proportions than found in the atmosphere, but usually—and without much objection—spoken of as air. Water in the liquid state being also present, the steam is necessarily saturated, except on certain occasions which can be ignored at present; there is therefore a definite relation between the temperature and the pressure of the steam, as is well known. This pressure of the steam, on which the temperature depends, is, when air is present, the partial pressure of the steam, and not the total pressure of air and steam as recorded by a gauge.

Steam entering a surface condenser contains air; but, unless in very exceptional cases, the ratio of air to steam is so small that the partial pressure of the air is negligible. The partial pressure of the steam is consequently practically equivalent to the total pressure of the mixture; and the temperature and total pressure of the mixture bear practically the same relation to each other as is the case with pure saturated steam. As the fluid passes through the condenser and the steam gets condensed while the air remains in full strength, it follows that the air richness increases. It must not be inferred that the flow of steam through a condenser is slow. Except with low vacua or under abnormal conditions the first portion of the passage of the steam between the tubes of a condenser is usually performed at a velocity of over 100ft., and sometimes over 300ft., per second. The velocity then slackens as the steam gets condensed, but the whole time taken by the fluid which is not condensed to pass through the condenser into the air pump suction pipe is usually only a fraction of a second; and 90 per cent. of the steam which enters a condenser is commonly condensed in the first tenth of a second or less. It is advantageous to consider a condenser of a type in which the path of the steam is clearly defined, as, for example, in condensers of the counter current or contraflo types, as usually made; but the action is substantially the same in all surface condensers, although in many the flow must be somewhat irregular. The total pressure—as recorded by a vacuum gauge—is nearly the same in all parts of the condenser, differing only by the small amount necessary to produce the flow; and hence, as the air richness increases, the partial pressure of the steam must diminish; and, as the steam is necessarily in the saturated state, its temperature must fall and the temperature of the air fall with it. The gaseous fluid passing through a condenser has therefore a varying temperature in its passage, this being highest at the steam inlet end of the condenser and lowest at the air pump suction.

An example will be useful to illustrate this point. Suppose the vacuum at the inlet end of a condenser to be equal to 28in. of mercury with the barometer at 30in.* and suppose for simplicity that the vacuum at the other end is exactly, as it will be approximately, the same. The air mixed with the steam at entry to the condenser being in such a small proportion that its partial pressure is negligible, the partial pressure of the steam corresponds to 30 − 28 = 2in. of mercury, or 0.982 of a pound per square inch. Referring to a table of the properties of saturated steam it will be seen that the temperature corresponding to this pressure is about 101.5 deg. Fah.

All except a small proportion of the steam is condensed before the exit end of the condenser is reached, so that, when the last of the cooling surface is being passed, the air forms a very appreciable proportion of the mixture. Suppose that the ratio of air to steam by weight is now 3/10; the weight of air and the weight of steam in a cubic foot of the mixture can be calculated, and likewise the partial pressure of each. The partial pressures work out as 0.15 lb. per square inch for the air and 0.83 lb. per square inch for the steam. The steam being in intimate association with water, and consequently in the saturated state, its temperature can be found from a table of the properties of saturated steam to be about 96 deg. Fah. The air is necessarily at the same temperature, and consequently the temperature in the condenser varies from 101.5 deg. Fah. at the steam inlet end to 96 deg. Fah. at the air exit end. The metallic casing of the condenser is, however, not necessarily at these temperatures, because of the conduction and radiation of heat.

THE SPECIFIC VOLUME OF THE AIR IN A CONDENSER.

The weight of air per cubic foot of air-steam mixture in any part of a condenser—which, of course, is the reciprocal of the volume of air-steam mixture per pound of air—varies with the temperature and the total pressure. It can be obtained as follows:—

At any temperature saturated steam has a definite pressure which, if the steam is alone, constitutes the total pressure, but which, if the steam is mixed with air, constitutes the partial pressure of the steam. Therefore, in an air-steam mixture in a condenser, and at a given temperature and total pressure, if the partial pressure of the steam which corresponds to the given temperature is subtracted from the total pressure, the difference will be the partial pressure of the air; and, as we know the laws connecting the pressure and temperature of air with its specific volume, we can find the weight of air per cubic foot of air, which is also per cubic foot of the mixture.

A numerical example will make this clearer. We have, let us say, a mixture of air and steam at a temperature of 100 deg. Fah., and a pressure of 3in. of mercury. The pressure of saturated steam at 100 deg. Fah. is 0.94 lb. per square inch absolute, which is, therefore, the partial pressure of the steam in the mixture. As the sum of the partial pressures of the steam and air is equal to 3in. of mercury, that is, 1.47 lb. per square inch, the partial pressure of the air must be 1·47 − 0.94 = 0.53 lb. per square inch. That is, each cubic foot of the mixture contains a cubic foot of air at a pressure of 0.53 lb. per square inch, and a cubic foot of steam at 0.94 lb. pressure. Now we know from the laws connecting the pressure, temperature and specific volume of air, that a cubic foot of air at 0.53 lb. per square inch and 100 deg. Fah. weighs $\frac{1}{390}$ of a pound, from which it follows that for every pound of air we have 390 cubic feet of air—*i.e.*, 390 cubic feet of the mixture.

If, with the same temperature as before, and therefore with the same partial pressure for the steam, the total pressure of the mixture had been equal to 4in. of mercury—*i.e.*, 1.965 lb. per square inch—the partial pressure of the air would have been 1.96 − 0.94 = 1.02 lb. per square inch, at which pressure and at a temperature of 100 deg. Fah., air occupies 203 cubic feet per pound; hence there would be 203 cubic feet of the mixture per pound of air.

Moreover, if the total pressure had been equal to 3in. of mercury, but the temperature only 90 deg. Fah., the partial pressure of the steam would have been 0.69 lb. per square inch, which would have made the partial pressure of the air 0.78, at which pressure and at 90 deg. Fah., 260 cubic feet of air weigh a pound; and hence this number would have represented the volume of the mixture per pound of air.

It is instructive to note that, as the partial pressure of the steam approaches the total pressure of the mixture, the volume per pound of air increases at a very rapid rate, till in the limit when the partial pressure of the steam equals the total pressure, there is no air present, or the volume of mixture per pound of air is infinitely great. This occurs when the temperature of the mixture is the boiling point of water at the total pressure.

When, on the other hand, the temperature is very far from the boiling point at the total pressure, the partial pressure of the steam is only a small percentage of the total pressure, and the steam forms only a small percentage of the mixture, which, as regards volume, is not far different from dry air. The mixture in such a case has, in fact, the properties of atmospheric air on a damp day, which, although consisting mainly of air, contains a relatively small but very appreciable amount of steam—usually in this connection spoken of as water vapour—which it is ready to deposit in the liquid form on any small fall in temperature.

On such a day the atmospheric temperature may be, say, 50 deg. Fah.; the partial pressure of water vapour at this temperature is 0.173 lb. per square inch, and hence, if the barometer is at 29in., which is equivalent to a pressure of 14.245 lb. per square inch, the partial pressure of the air must be 14.245 − 0.173 = 14.072 lb. per square inch. Knowing the specific volumes of air and steam at the above pressures and temperature, we can calculate the relative weights, and it will be found that the steam is less than 1 per cent. by weight of the mixture. In steam condensers under vacuum it is not usual in practice to have conditions in which the proportion of steam to air in any part of the condenser is as small as 1 per cent., but at the steam inlet end of the condenser we have the other extreme, in which the ratio of air to steam is extremely small.

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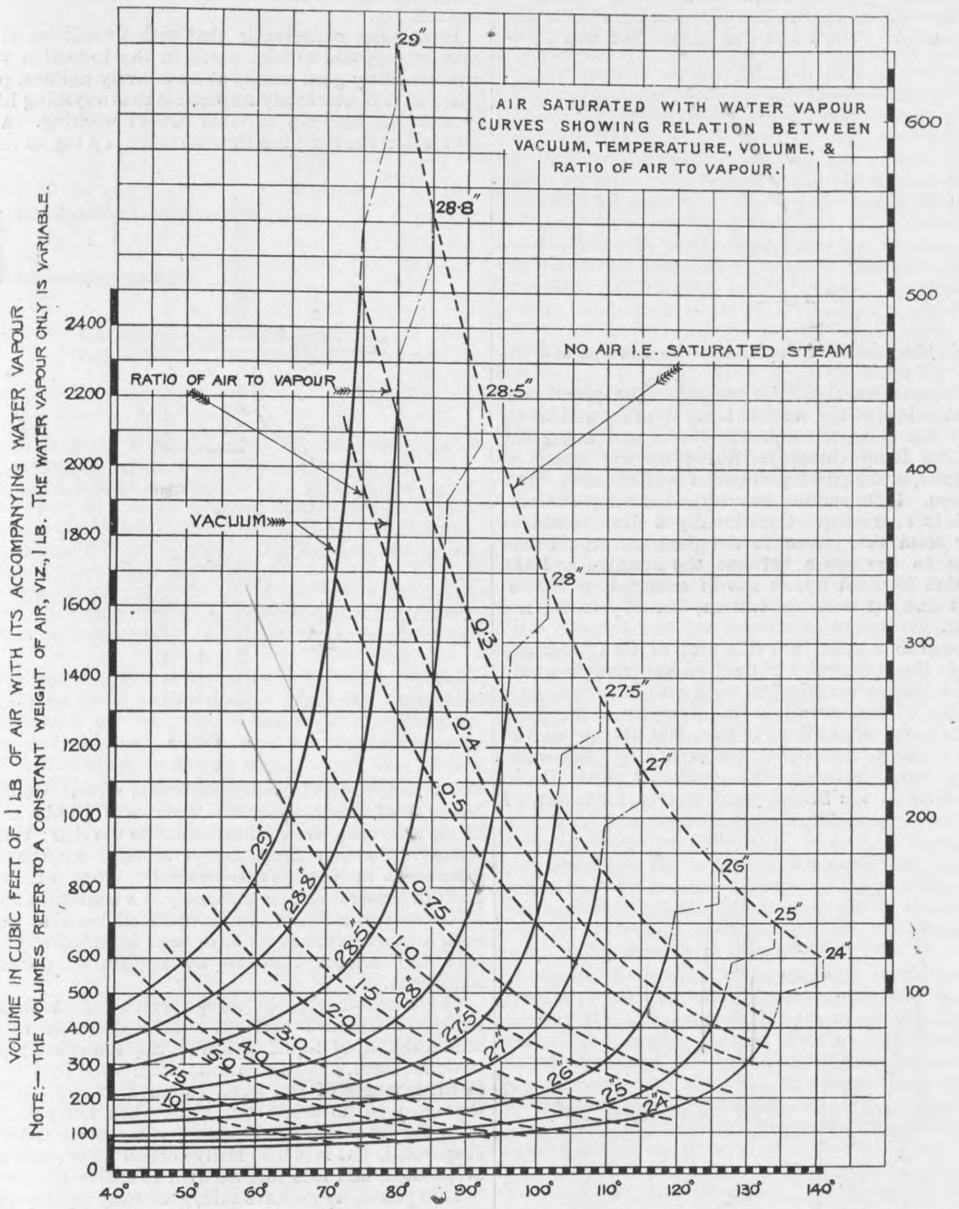
* Henceforth in this article, when a vacuum is expressed in inches of mercury, it should be understood to mean the corrected height of the mercury column for a 30in. barometer. For example, 27.5in. of vacuum with barometer at 29.5 would simply be expressed as 28in. of vacuum. This mode of expression, which is in accordance with general practice, is purely arbitrary but in general quite satisfactory.

The volumes of air-steam mixtures have been calculated by the writer for various temperatures and vacua, and he has likewise calculated the ratio of air to steam by weight; these volumes and ratios are given in Fig. 1.* In this figure the abscissæ represent temperature, while the ordinates represent volume; the volume of the air-steam mixture is according to the left-hand scale. The full line curves represent the vacuum and the dotted curves the ratio of air to vapour. The zero ratio curve—that is, pure steam—would, of course, be at an infinite height on the diagram; in order to show it for the sake of the volumes, the diagram has been broken and this curve inserted immediately above that representing a ratio of 0.3. The volumes for this pure steam curve are given by the scale at the right-hand side of the diagram.



The Engineer SWAIN Sc.

Fig. 1

If vertical lines were drawn at the boiling point of water at the various vacua represented by the full line curves, these lines would be asymptotic to the curves, each to each; and the meeting points of the lines and curves would be on the pure steam curve. The coinciding ends of these lines and curves are shown by the short vertical dotted lines cutting the pure steam line and connected by broken lines with the vacuum curves.

Referring to the diagram it will be seen, for example, that the volume of air-steam mixture containing 1 lb. of air is, at 90 deg. Fah. and 27in. of vacuum, 260 cubic feet, and at 100 deg. Fah., and the same vacuum, 390 cubic feet. The ratio of air to steam by weight is, in the former case, 1.8 and in the latter case 0.84. At 85 deg. Fah. the volume of a mixture containing four parts of air by weight to one part of steam is 130 cubic feet. At the same temperature, and when the proportions are two of air and one of steam, the volume is 270 cubic feet, while pure steam at the same temperature has a volume of 546 cubic feet. This diagram shows well how greatly the volume is affected by the temperature when the latter approaches the boiling point of water corresponding to the total pressure, and how little it is affected by temperature when remote from the boiling point.

It must be noted that this diagram refers only to air-steam mixtures, in which the air is saturated with steam; this is the normal condition in steam condensers. With air containing steam, but not saturated with it, there is, of course, no relation between temperature and pressure; this condition is, however, of no interest in the present discussion.

THE FACTORS WHICH INFLUENCE THE TRANSMISSION OF HEAT FROM THE STEAM TO THE CONDENSING WATER.

Let F denote the transmission of heat through the metal of the condenser tubes from the steam side to the water side per square foot of surface per hour. Then F depends on (1) the material and thickness of the tubes, (2) the cleanness of these, (3) the density of the gaseous fluid, (4) the air richness, (5) the velocity of the steam, (6) the velocity of the circulating water, (7) the diameter, and to a certain extent the length, of the tubes, and (8) the difference in temperature between the steam-air mixture and the circulating water, which will be denoted by θ. The first, second, fifth, sixth, and seventh factors may be constant, and the third nearly constant, for the whole condenser; the eighth usually and the fourth always varies. Hence F varies throughout the condenser.

In Fig. 2 are given four typical curves of variation of F in a condenser of the counter-current type, that is a condenser in which the entering, and therefore coldest, condensing water is at the air exit end of the condenser and the warmest water at the steam inlet end. The result of this arrangement of flow is, as a rule, to cause θ to be greater at the exit than at the inlet end of the condenser, because the difference between the inlet and exit temperatures of the condensing water is usually much greater than the difference between the temperatures of steam-air mixture at the two ends of the condenser; a great variation in θ is usual in practice. The air richness, of course, increases from the steam inlet to the air exit end.

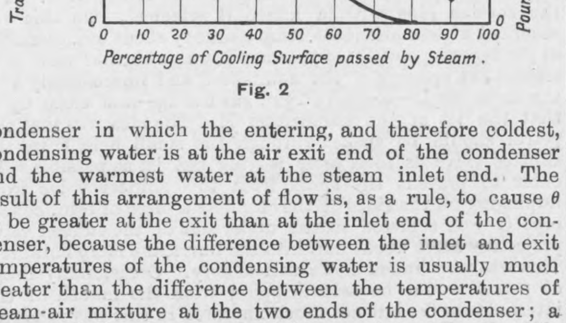


Fig. 2

It should be noted that F in B.Th.U.'s divided by 1000 is for steam vacuum condensers approximately equal to the condensation rate per square foot of surface per hour.

It will be seen in Fig. 2 that the condensation rate at first increases owing to increase in the value of θ, the air richness being still too small to produce much effect. Thereafter the condensation rate either diminishes or increases less rapidly, in spite of the decrease in the temperature of the circulating water, owing to the great effect of the increasing air richness which not only directly influences F, but lowers the temperature of the steam-air mixture, and consequently makes the increase in θ less than it otherwise would be.

THE AIR PUMP INFLUENCE ON THE CONDENSER.

Now let us consider how air pump capacity affects F.

The greater the air pump capacity, the greater will be the volume of air-steam mixture which can be withdrawn per minute from the condenser. Therefore, with a constant weight of air to be discharged per minute, increase in pump capacity allows of an increase in the volume of the air-gas mixture per pound of air. Now from what has already been said, and from Fig. 1, it will be evident that this volume per pound of air depends on the temperature and the pressure, there being a definite volume per pound of air for every temperature and pressure within the possible limits, and hence air pump capacity controls the necessary temperature of the air-steam mixture at the air exit end of a condenser for any given vacuum to be obtained with a given amount of air admitted per minute into the condenser. The nearer this temperature approaches to that of the condensing water, the lower (as before mentioned) is the rate of transmission of heat. It is further evident from what has already been said, and from Fig. 1, that there is at any vacuum a definite ratio of air to steam for any volume of air-steam mixture per pound of air; and hence, for any given air pump capacity, any required vacuum, and any given admission of air to the condenser, there must be a definite ratio of air to vapour—or definite air richness at the air exit end of the condenser. This also, as before mentioned, affects the rate of transmission of heat from the steam and air to the condensing water. Air pump capacity, therefore, affects the condensation rate in the condenser in a two-fold manner.

With varying air pump capacity the condensation rate for the whole condensing surface really remains practically constant, but some other condition must alter to allow of this. For example, with diminution of air pump capacity, either the inlet temperature of the condensing water must be lowered, or the velocity of the water increased, or the tubes—if dirty or covered with scale—cleaned, or else the vacuum will fall. Increase of air pump capacity, on the other hand, allows of increase in inlet temperature of the condensing water, or reduction of velocity, or allows of the tubes being dirtier, or else permits of increase of vacuum.

THE CONDENSER INFLUENCE ON THE AIR PUMP.

Now let us consider how the extent of cooling surface in the condenser, or the efficiency of this surface, affects the air pump.

F, as before mentioned, is influenced by a number of factors, one of which is the air richness, and another is θ, *i.e.*, the difference in temperature between the steam and steam-air mixture and the condensing water. Therefore an increase in cooling surface, by reducing F (the rate of heat transmission per square foot) allows of (1) an increase in air richness at the air exit end of the condenser, and (2) a fall in the temperature of the air-steam mixture at the same place. By reference to Fig. 1 it will be seen that this modification in the air richness and the temperature allows of the same vacuum existing at the air exit end of the condenser with a less volume per pound of air. Therefore, with the same admission of air per minute to the condenser, the latter can maintain the same vacuum with a less volume of air-steam mixture discharged per minute to the air pump, *i.e.*, a less air pump capacity will suffice.

If, however, the air pump capacity is maintained, the conditions at the air exit end of the condenser will remain on the same horizontal line on the diagram, and the increase in surface will allow—along with the increase in air richness and fall in temperature—of an increase in vacuum.

It will thus be seen that increase in the air pump capacity can compensate for reduction in the condenser cooling surface, and increase in cooling surface compensate for reduction in pump capacity. The practical limits within which this compensating action can be effected are not, however, wide. By reference to Fig. 1 it will be seen that towards one end of each vacuum curve a small increase in temperature and decrease in air richness is accompanied by a very large increase in volume. It would, therefore, be very uneconomical to compensate in such a case for reduced condenser cooling surface by increasing the air pump capacity, for the increase in the cost of the pump and in the power to drive it would be quite out of proportion to the small reduction possible in the cost of the condenser.

Moreover, towards the other end of each vacuum curve the decrease in volume is very small for a great fall in temperature and great increase in air richness. Here, therefore, it would not pay to increase the condenser cooling surface in order to reduce the capacity of the pump.

Therefore, although condenser cooling surface and pump capacity can compensate for each other to a certain extent, the sphere in which this can be practically adopted is limited, and in all cases there is a given relation which is best between the extent of cooling surface of the condenser and the capacity of the air pump.

This best paying ratio between the condenser cooling surface and the air pump capacity has been roughly ascertained by experience for average conditions; but, as the air admission to one condenser may be several times greater than that to another receiving the same amount of steam, and even when the two are supposed to be working under the same conditions, the proportions of condenser and air pump found in practice are often far from the best. It frequently happens, for example, that with a twin-cylinder air pump either cylinder will give nearly the same result as both, thus showing that the conditions at the air exit end of the condenser correspond to a position on the diagram—Fig. 1—at which large variation in the volume is accompanied by small variation in the temperature. On the other hand, it often happens that decrease in pump capacity greatly affects the maximum amount of steam which can be condensed with the maintaining of a given vacuum, thus showing that the air steam mixture is being withdrawn from the condenser at a point on the vacuum curve in the diagram at which moderate variation in volume is accompanied by great variation in temperature and air richness.

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* This diagram, which was prepared by the writer when at Hartlepool Engine Works, was first published in the paper read by Mr. D. B. Morison before the Institution of Naval Architects in April, 1908, on "The Influence of Air on Vacuum in Surface Condensers."

The best paying ratio between condenser cooling surface and pump capacity depends to a certain extent on the cost of power and on the price of condensing water—or the cost of cooling it for repeated use—and the height, if any, to which the water has to be pumped. On board ship the question of weight and bulk has also to be considered, especially on warships. The most important influencing factor is, however, the amount of air which gains admission to the condenser, and which varies greatly in different cases. Condensing plant cannot be economically proportioned to maintain a given vacuum with a given exhaust steam supply without a knowledge of the amount of air to be dealt with. It is difficult to foretell, even with only approximate exactness, the amount of air which will gain admission to the condenser in a prospective case; but air measurements made on existing plant, where care has been taken to reduce the air leakage to reasonable amount, will be of great use. The Weighton air gauge offers a convenient means of measuring the air discharged by the pump.

If air pump capacity is expressed in cubic feet of working stroke piston displacement per hour and condenser cooling surface is expressed in square feet, experience has shown that, in steam engine condensing plant intended to be run under conditions not departing far from the average and involving the use of condensers of the tubular surface type, it is best to design the plant for a ratio of pump capacity to condenser cooling surface of between 4 and 7½, there being a tendency for this ratio to fall beneath the lower figure with large steam turbines. More research is required—especially with regard to the effect of air richness on F—before the best ratio can be expressed much more definitely with reference to the influencing factors; such research is greatly to be desired.

EXPERIMENTS WITH A GLASS CARBURETTER.

By J. S. V. BICKFORD.

WITH a view to obtaining information about carburation—information which it is difficult, if not impossible, to get from the usual sources of information—I decided to construct an experimental glass carburetter.

There happened to be in the shop one of those blowers having two cylinders arranged excentrically with sliding vanes in the inner one (Beale's exhauster). This machine was capable of delivering about 60 cubic feet of air per minute, and it struck me that if it was run backwards it would probably suck all right. It did; so I connected to its erstwhile delivery pipe a length of 1½in. gas pipe, and led it to a bench, and to that I connected four lamp chimneys, also about 1½in. diameter at the smallest part, each provided with a bulb. The arrangement is illustrated in Fig. 1. The joints were made with short sleeves of rubber cycle tube, and a nick was filed in the edge of the lamp chimneys at one point A to admit the nozzle of the carburetter. This was an ordinary float chamber and spraying nozzle borrowed from a 6 horse-power car. Over the end of the last lamp chimney B a brass annulus was fitted, the hole being so arranged that the proportions of petrol and air were approximately those necessary for perfect combustion. The apparatus was started up, and a more unpromising thing with which to work an engine I have never seen. Spraying, as it is commonly understood in the sense of atomising into a sort of dust, there was none whatever. The petrol left the end of the jet in a solid stream, and was blown down the chimneys by the incoming air. The jet was certainly broken up into drops when the suction at the jet was above about 3in. water gauge, and these drops were whirled down the pipe. Most of them struck the sides of the lamp chimneys, and were then blown along the glass in ripples, the appearance being just that produced by blowing tangentially on the surface of a piece of wet glass. There were three bulbs in the lamp chimneys between the jet and the suction pipe. Each one of these was full of petrol, and petrol was running down the suction pipe, and, as far as I know to the contrary, was running into the blower itself. No liquid petrol could be seen discharging from the blower, so it is to be supposed that vaporisation took place eventually.

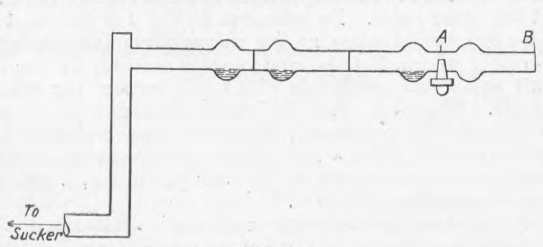


Fig. 1

It may be objected that this arrangement was crude. Certainly it was, but it did not differ in any respect in principle from the 1904 Mercédès carburetter. Here the jet entered the side of a pipe about 1in. diameter, and this pipe communicated direct with the suction valves of the engine; the end of the tube was surrounded by a metal box in order to increase the vacuum. Now this arrangement is very like my lamp chimneys, and the car works well with it, and though it weighs over a ton, it travels 20 miles per gallon with a four-cylinder engine 4in. by 5in.

Again, the old Wolseley was a fairly economical car of its date, and, though heavy and fast, ran 17 miles per gallon. Its carburetter was a perfectly plain round pipe, with the jet sticking up in the middle, and no warm air was used. It is doubtful whether much more spraying takes place in either of these cars than in the glass carburetter I have described. My own opinion is that the evaporation takes place on the top of the hot inlet valves, and in the cylinder, and that next to none takes place in the carburetter itself; but this is merely opinion.

Another arrangement was then tried. One of the cars which I have often driven has a carburetter consisting of a vertical plain round tube with the petrol jet projecting up the middle of it. The vertical pipe is partly choked at the bottom to produce the necessary vacuum.

I therefore fitted a brass annulus to a vertical lamp chimney at the bottom end, and connected the upper end by an elbow of copper pipe to three further lamp chimneys, arranged horizontally as in Fig. 2. These in turn were connected to the sucker. The jet of the carburetter was introduced through the middle of the hole in the annulus and the apparatus started up.

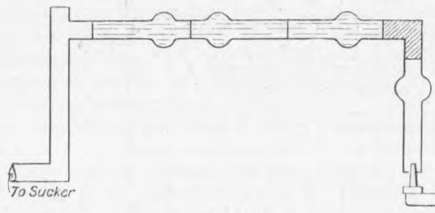


Fig. 2

Again there was no sign of spraying. The petrol was blown on to the sides of the vertical lamp chimney and blown in ripples up the glass, through the elbow, and along the three horizontal lamp chimneys, filling up the globes of these with petrol, and again liquid petrol was running down the suction pipe. If the suction was reduced to a mere breath, there was still less spraying. Occasionally a drop would be blown bodily from the jet on to the glass, and would then run down on to the space between the annulus and the chimney, which it filled up, as shown enlarged in Fig. 3. Petrol did not leak out from the bottom, but why it did not I do not know.

I see no reason to suppose that this sort of thing was not going on inside the carburetter of my own car, and the only mystery is how the car managed to work with it.

I should like to try several other experiments on these lines. For instance, what effect, if any, has hot air on the action; what effect would be produced by hot-water jacketing the tube between the points A and B in Fig. 3, as is done in the Siddeley carburetter, for instance?

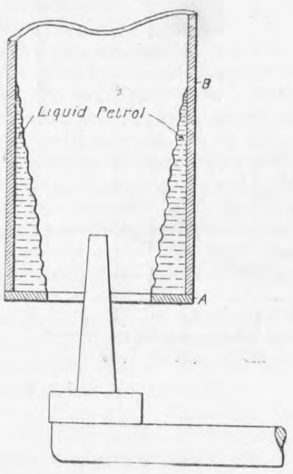


Fig. 3

I tried hot petrol, by passing the petrol through a coil of copper pipe in boiling water, but the result was nil. The petrol was so hot that the float of the float-chamber was dancing up and down, but I could notice no difference in the action of the petrol. I took the temperature in the first experiment just beyond the jet and found it to be about one degree below freezing point. I should like to know by what amount this would vary with a hot-air supply. It would also be very interesting to see what would happen if one were to connect up one or two well-known good carburetters to the suction pipe by glass pipe and supply them with air at the usual temperature. All these are subjects for future inquiry.

The old 6 horse-power Rover carburetter worked remarkably well. It consisted, speaking from memory, of an ordinary tumbler cock in the suction pipe just in front of the jet, so that the petrol, on leaving the jet, was sucked through a small hole when the throttle was partly shut. Now, it is obvious that, when the throttle is nearly closed, the blast through the remainder of the opening will be very great, certainly much greater than that past the jet, and it seemed that it was at least possible that a little real atomising might take place in this way. To throw some light on the point, the apparatus shown in Fig. 4 was constructed. A is the suction pipe with a flange B attached. On this was mounted a glass hurricane lamp chimney about 5in. diameter at the largest point. On that again was a shutter valve C to restrict the opening of the admission, and immediately over this an elbow D—ordinary 1½in. gas fitting—and close up to that the jet of the carburetter E. The idea was that the petrol should be sucked through the small hole F in the shutter valve as soon after leaving the jet as possible. In order to prevent the spray from this shutter valve from impinging on the sides of the chimney a piece of 1½in. copper pipe G was soldered to the under side of the shutter valve projecting down about 6in. into the hurricane lamp chimney. This was very much more satisfactory. Occasionally drops of petrol would be seen dripping from the mouth of the internal tube G; but not much appeared in this way, the rest of the time, when the shutter valve was partly closed, the lamp chimney was clear and transparent, though occasionally little cloudlets of vapour would whirl through it and down the suction pipe. To some extent this principle is used in the White and Poppe carburetter, and it would be interesting to test one of these with a glass suction pipe.

The data of these experiments are, of course, insufficient to dogmatise on in any way, but nevertheless they give much food for thought, if only because they in some ways account for one or two peculiarities of the petrol engine. Every driver knows what it is to feel the car check a bit on opening the throttle. The car is running along with the throttle wide open; as we have seen, there is good reason to believe that the whole of the induction ports and pipes are covered internally with liquid petrol. By the adjustment of the carburetter on the test stand things have been so arranged that the evaporation from these wet pipes just keeps the mixture right. Now the throttle is closed and this petrol evaporates and the pipes become dry. A few moments later the throttle is opened again, and until the pipes are again wetted with petrol the mixture is too weak and there is a consequent lag.

It is quite conceivable that such a condition of affairs as may be supposed to take place in the induction pipe might produce fairly good results at an entirely uniform power output, but it is absolutely impossible that anything like the best results can follow a variable rate of working. As we have seen, after shutting the throttle there is a lag on reopening it owing to the mixture being too weak, and it would seem to follow that every time the throttle is partly closed after being wide open the mixture must be too rich; thus petrol is wasted. Possibly these things account for the surprising differences in various carburetters. What is really required to work a petrol engine efficiently is a constant supply of gas at the correct richness, and it seems difficult to believe that such arrangements as we have been considering can possibly give the correct richness at all times under varying conditions.

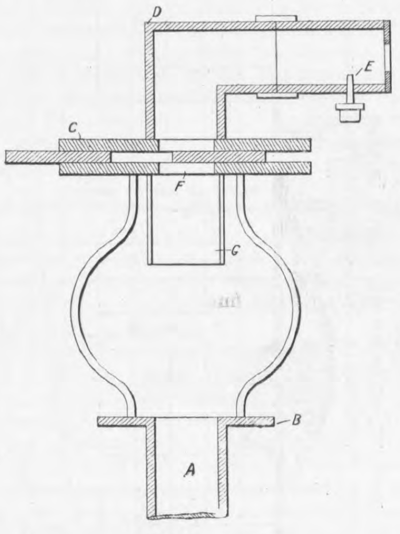


Fig. 4

There are one or two things which suggest themselves as likely to improve matters. It is desirable to avoid the accumulation of liquid petrol in the induction pipes, for, as it would seem, such an accumulation must lead to variations in the richness of the gases supplied to the engine. Now, there can be no doubt but that, when the petrol is blown from the jet in drops and spray, some of it is immediately evaporated, but it is also fairly certain that some of it is not evaporated, and it is this we wish to deal with.

This petrol, as we have said, goes away in drops, and sooner or later impinges on the walls of the induction pipe. Now, if it could be arranged so that this fuel would strike a hot surface immediately, it is possible that the desired result might be obtained. In the 14 horse-power Siddeley the induction pipe is jacketed, but the distance through which the pipe is so jacketed is only about 3in., and as this pipe and the induction pipe for some distance beyond it is perfectly straight, it is almost certain that much of the petrol strikes the unjacketed part of the pipe. If this is to be prevented it would probably be necessary to arrange a bend or elbow in the jacketed part of the pipe, so that any drops carried centrally through the induction pipe would here strike the sides of the pipe and be evaporated.

What amount of information is in the possession of manufacturers I do not, of course, know, but the published information is of the meagerest description, and there is room for a series of experiments on these lines which would be of great value.

Proportional fuel and air supply in carburetters.—After completing the experiments just described, I thought it would be of interest to obtain some figures as to the relative fuel and air supply in the ordinary plain carburetter. For instance, suppose the supply of fuel and air is in the proportions of one to six at a suction of 1in. water gauge, what will be the relative deliveries at 6in. water gauge? As every one knows, the supply is richer; that is to say, a greater proportion of petrol is delivered at higher pressures than of air, and for this reason most modern carburetters are provided with some means of diluting the mixture when the speed of the engine reaches a certain point, or when the throttle is opened a definite amount. Furthermore, many people must have been struck with the great range of appliances which seem to give substantially the same results. I believe that the data which the following experiments give will be found to explain how it is that these different arrangements do perform as well as they undoubtedly do. For instance, we have the old Wolseley with a plain carburetter, with no adjustment whatever, running with a one-ton load about 17 miles per gallon and averaging 24 miles per hour. Then we have a car like the 24 Austin provided with a scientifically arranged Krebs carburetter running about 26 miles per hour with substantially the same load at 20 miles per gallon.

In order to conduct these experiments, it was necessary to provide means of knowing the amount of air passing through the carburetter, and I wished if possible to have means of reading this off from some form of gauge, and it occurred to me that if the various arrangements tried were connected up to suck from a box or chamber having a given size of inlet hole, then if the air delivery were found for all variations of suction in this box, there could be no reason to suppose that these values would vary afterwards. The apparatus used is shown in Fig. 5.

A is the air suction pipe from the blower, as before, and to this was connected the carburetter to be tried, B. Immediately above the jet of the carburetter a small hole was drilled in the pipe, through which a fine glass tube C was introduced in order to measure the suction at the jet. This was connected to a water gauge D. Beyond the carburetter the pipe was connected to the pipe E, and this entered the suction-box F, provided with a small tube communicating with a second water gauge G. This is the air-box mentioned above for measuring the rate of flow. This air-box was connected by a pipe passing through the side of a 36-gallon barrel to a vertical pipe, which terminated flush with the top of the barrel, which had no head. Suspended over the barrel was a tin-plate drum H, open at the bottom, and balanced by a weight. This made up a gasometer.

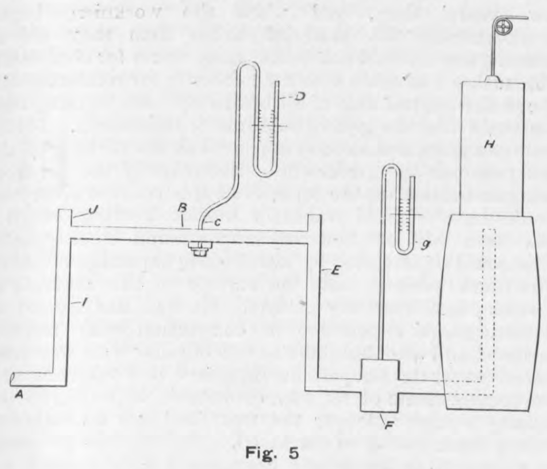


Fig. 5

The pipes I and E both finished off in a T-piece, the upper branch being open, so that by covering these open ends with pieces of plate or uncovering them, the action of the instrument could be modified or stopped. The suction was varied by partly opening the top of the T-piece J.

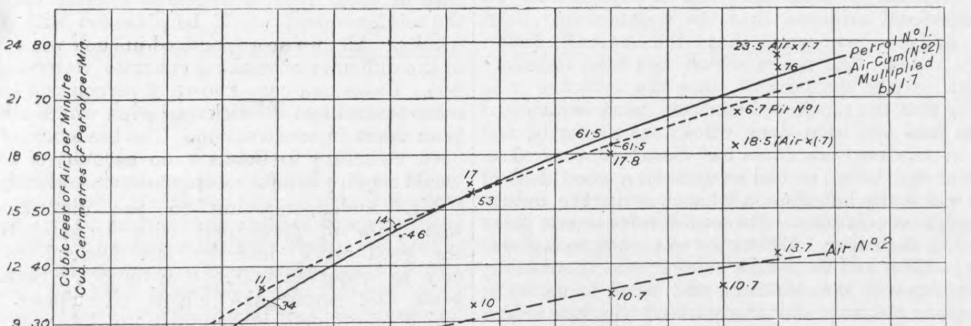
The time was then noted in which the bell was sucked empty for various indications of the gauge, and these results were repeated and tabulated, and used for subsequent reference.

The petrol was supplied from a graduated tube, so that accurate readings could be obtained. After the apparatus had been set and got running, a series of simultaneous observations was obtained, which have been plotted in the curve Fig. 6. The curve for the air supply is not that which was actually obtained, as it was found by calculation that too much air was passing at all pressures, and the air curve has therefore been corrected till it is right for the lowest rate of flow. That is to say, the curve represents the proportions of air and petrol in a carburetter which delivers a correct mixture at the minimum air flow of 3 cubic feet per minute, which will be approximately the minimum demand of a four-cylinder engine 4in. by 4½in.

The curve No. 3 is obtained by multiplying the air curve No. 2 by 1·7. It therefore represents the air flow obtained by opening an additional air valve equal to about ·7 of the main suction pipe, other things being equal, such as the suction at the additional air valve, and in the induction pipe. This will be referred to presently.

There are a few notable points about this set of curves which seem to explain one or two obscure things.

It has been mentioned that the old 12 horse-power Wolseley worked well with a plain carburetter. Now, it will be noted that the curve No. 3 is practically coincident with the petrol curve for some distance from the right—that is to say, from rates of petrol flow from 30 to 70 c.c. per minute. Now, these old two-cylinder cars were not worked much with the throttle closed; in practice they were usually either pulling at different engine speed with the throttle open or they were running idle. Further, the top speed of the car was about 32 miles per hour, and its lowest speed without clutch manipulation was about 12 miles per hour on top speed. Now, with wide open throttle the variation of the quantity of mixture taken in varies only with the engine speed, and will therefore not exceed a variation of about 3 to 1. A glance at the curves shows that if the calibration of the carburetter is right for the highest rates of flow it will, within these limits, remain correct down to the minimum required of one-third this maximum rate, or nearly so. From this it appears that for all conditions of wide open throttle a plain carburetter does all that is required and no additional air valve is required. That this was the method of calibrating employed is shown by the fact that these engines were very inclined to "pop" in the carburetter when running idle and throttled down, thus indicating too weak a mixture.



'The Engineer'

Fig. 6

We now come to the effect of throttling. As has been said, about 3 to 1 is all the variation which takes place in practice with the throttle open. An 18 Siddeley, for instance, which is as flexible a car as I have driven, will run about 45 miles per hour with the throttle open, and as low as about 11 miles per hour under similar conditions, that is to say, when climbing a hill, with the throttle open wide. At the former speed the engines will be running about 1200 revolutions, and at the latter about 300 revolutions, which gives a maximum variation of 1 to 4. Within these limits the carburetter can be left to take care of itself, for it is probable that proportions remain about right at pressures above those I tried, and, as a matter of fact, the additional air valve will be found open whenever the throttle is wide open no matter how low the engine speed. When the throttle is partly closed the conditions change. We may now get a much wider range of variation. This engine—the 18 Siddeley—will run down to about 350 revolutions running idle with partly closed throttle. To be on the safe side, let us say that it runs 400 revolutions. It is running idle, and it may therefore be assumed to require, say, one-seventh of the gas that it would to run it at full power at the same revolutions. Further, it is running one-third of the maximum speed; so that, running idle at 400 revolutions, it is probably getting only one-twentieth of the gas required at maximum speed and power. If, then, the engine requires 60 cubic feet of gas per minute at 1200 revolutions at full power, it will require about 20 cubic feet at 400 revolutions at full power, and only 6 cubic feet at the same speed, with partly closed throttle, running light. It is this reduction from 20 to 6 cubic feet per minute which presents the difficulty. It will, however, be obvious that this portion of the scale of power, or at least a considerable proportion of it, will not be so very much used, and, consequently, if the apparatus be designed to give an approximately correct mixture from 10 to 20 cubic feet per minute, then the rest of the scale from 6 to 10 cubic feet per minute may be considerably wrong without greatly affecting matters. What is more, it is obvious that it is not difficult to arrange the carburetter so that it shall get a correct mixture at the lowest rate of supply when the additional air valve is closed, and it is equally easy to ensure a correct delivery at 20 cubic feet per minute, above which point the additional air valve is wide open, by merely opening an additional air port having .7 the area of the main supply; and it is not very difficult to suppose that the more or less gradual opening of this additional air port will proportion the air supply between 6 and 20 cubic feet per minute to something like the right amount.

This explains the action of the ordinary spring-loaded additional air valve first introduced in 1903 by the Mors Company, and now very largely used. The Krebs explains itself. The only thing remaining to be discussed is the additional air valve, opened by the throttle, and having nothing automatic about it. The action of this is in principle only to open a tap for pure air into the induction pipe as the throttle opens. From what has been said, if the carburetter with additional air valve closed give the correct mixture at the lowest rate of flow, and with the additional air valve wide open gives the correct mixture for the slowest running of the engine with open throttle, then this carburetter will do all that is wanted, both for wide open throttle and for idle running. What does it do between these points?

Suppose the engine is running 400 revolutions, with the throttle so set that the cylinders are getting half a charge, and that the additional air valve is so set that the mixture is correct, the engine load is reduced, and the speed rises without a change of throttle to 1200 revolutions. Now, we have already seen that if the flow were three times as great, the proportions would automatically remain constant through this range; but the flow is probably not increased three-fold, because the charge is being wire-drawn. Exactly how much it is increased it is impossible to say, but it is safe to say that it is less than three-fold; consequently, the disturbing effect is less than it is with wide open throttle, and as the proportions will remain about right with wide open throttle, they may be expected to remain more correct with the throttle partly shut, provided the proportions are arranged to give the correct mixture at some one rate of flow, say at 700 revolutions.

This explains how such carburetters as the Mercédès, Rolls-Royce Tourist Trophy, and White and Poppe act so well. In the White and Poppe, of course, the closing of the throttle partly closes the jet at the same time, which has the effect of permitting a higher rate of air flow, and consequently better spraying, than otherwise would be the case, but this is incidental.

It will be understood from this that it is by no means difficult to design a carburetter which shall give the correct proportions of air and petrol so long as the flow is for the moment constant; the difficulty probably lies in all cases in giving a correct mixture at the moment of change, as when the throttle is opened, and I have reason to believe that carburetter design is still very much like the design of screw propellers—a matter of luck and trial and error.

INSTITUTION OF MECHANICAL ENGINEERS.

No. II.*

There was an excellent attendance of members when Mr. Aspinall took the chair at the Central Technical School, Byrom-street, Liverpool, on Wednesday morning, July 28th, at the adjourned meeting. The paper by Mr. Arthur C. Auden on "Reinforced Concrete," partly read at the previous day's meeting, was first on the agenda.

Mr. Auden commenced his paper by saying that it was customary to talk of reinforced concrete as comparatively new. This was erroneous. It was not so new as it was made out to be, and he quoted instances in which structures made on this principle up to twenty years ago were still in good condition. He then went on to discuss the question of materials, and first of all dealt with flint and showed that, though this made good, tough concrete, it was unreliable for fire-resisting purposes owing to its tendency to crack and "fly" under heat. The same remark applied, he said, to limestone, but this substance did not resist fire after it was broken up into small pieces, whereas the tendency of flint to "fly" was much reduced when that stone was broken up small. Sandstone was abundant throughout the country, but as a rule it was too soft, too porous, and too absorbent for use in reinforced concrete work. Reference was also made to quartzite, granite basalt, millstone grit, breccia, diorite, trap, &c., and to artificially produced aggregates such as broken earthenware, stoneware from potteries, burnt clay and gault for use in concrete. Speaking generally, broken bricks did not form a good aggregate. Coke breeze made an excellent class of concrete. Ashes, clinkers, and slag came in for mention, and the maximum content of sulphur in these discussed. It was pointed out that if the sulphur was in the form of sulphate it was practically harmless, but in the form of sulphide it was very deleterious, and anything more than a very small amount indeed should not be allowed. The presence of free lime should also be guarded against. The qualities of sand were next reviewed, and it was pointed out that in some parts of the country sand was more difficult to obtain than any other constituent of concrete. A certain amount was always necessary, and nothing had yet been found which would take its place. Sand for concrete must not "bind"; it must be incapable of being smoothed with a trowel to a bright surface or of "standing up" by itself when cut with a shovel. Dirt in the form of slime, mud, or vegetable refuse is distinctly bad, but a little loam, enough to soil the fingers when lightly rubbing the sand between them, but not enough to make the sand itself adhere to them, is no detriment. Cement was dismissed by the statement that any user is safe if he insists that his cement should pass the British standard specification in every detail, and provided that it is purchased from a reliable manufacturer. The author then dealt with reinforcement. Practically every one of the many systems at present in use had its good points, in which it was superior to the others, but it was certain that no one system had the monopoly of being the best in every instance and every form of construction. It was frequently cheaper to sacrifice a little of the theoretical efficiency of any method for the sake of ease of handling upon the actual work in progress. All reinforcement should be designed to possess a considerable amount of initial rigidity, so that it does not "sag" nor "warp" nor "twist" when placed in position in the moulding-boxes. Punching or slitting solid plates into strips or bars was an efficient form of reinforcement for flat surfaces. Attention was then devoted to the placing of auxiliary tension members in beams and slabs, to the reinforcement of struts and columns, and to centering, and the author completed his remarks under these heads by saying that "a contractor with considerable resources in the way of plant and materials is also very advisable. It is not long ago since a somewhat serious collapse occurred in a job where concrete was put in on a Friday, and the centering struck on a Monday, as the contractor had not, and could not get, any more timber!" Paragraphs were next devoted to calculations, standardisation, methods of using, buildings in general, boats and barges, chimneys, drain and sewer pipes, and dock, retaining, and reservoir walls. In an illustration which we reproduce in Fig. 1 the author showed the saving in space which might be effected by the use of reinforced concrete. The right-hand figure shows the space taken up by non-reinforced and the left-hand figure that occupied by reinforced concrete. Both cases are drawn to the same scale, and calculated for the same strength, with the same factor of safety. The concluding portions of the paper dealt with engine and dynamo beds, fence posts, magazines for explosives, safes and strong rooms, piles, piers, and jetties, pithead gears and pit props, railway sleepers, telegraph and tramway poles, and painting.

Comparison between amount of material required and useful space occupied in mass concrete and reinforced concrete Dock or Retaining Walls

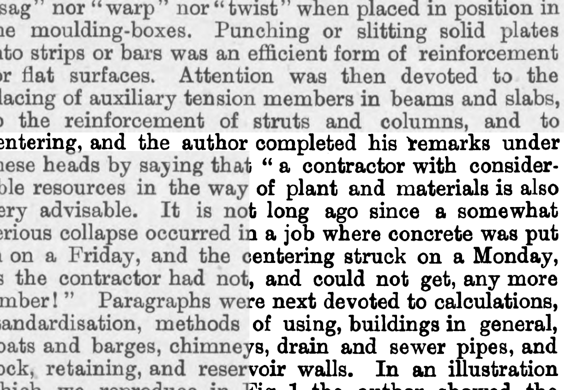


Fig. 1

Mr. Aspinall, in moving a vote of thanks to the author for his paper, said the subject was one which was attracting great attention at the present time, and reinforced concrete was being used to a large extent in Liverpool for a number of works. The material was being employed for piles with wonderfully good results, and he would have liked the members to have paid a visit to Fleetwood Dock in order to view the work now proceeding there in the way of reinforced concrete piling. Abroad the material had been employed to a great extent for work of an ornamental character, but in England reinforced concrete had been used mainly upon work of a practical character. When visiting Belgium recently he had had an opportunity of inspecting some bridges and other works in which reinforced concrete was the material used. The vote of thanks to the author was carried with acclamation.

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* No. I. appeared July 30th.

Dr. H. S. Hele-Shaw said he would like at the outset to pay a tribute to the late Mr. George F. Deacon, formerly water engineer of Liverpool, who was one of the first to demonstrate what could be done by the scientific treatment of this material. At the time Mr. Deacon began his experiments with the Vyrnwy dam, engineers were generally content to accept the guarantee of concrete manufacturers, and were quite satisfied with the strength of the ordinary briquette dried in air, which was considered to have a high value if it withstood 450 lb. Mr. Deacon insisted upon something like 50 per cent. in advance of that, and he was able to obtain it for the work at Vyrnwy. The result was that when a scare took place some time afterwards, and two eminent engineers were appointed to test the dam they found great difficulty in making any impression on the cement at all, which was as hard as the stone itself, and by this time was probably harder. The officials of Liverpool had been experimenting and dealing with problems arising in connection with reinforced concrete on scientific lines, and he might refer to the work of Mr. Brodie, the city engineer, and his staff. He hoped that the results of Mr. Brodie's work, particularly in the use of destructor clinker as an aggregate, would be put on record.

Mr. E. Spencer Bourne said the paper was an eminently practical one, but there were one or two points upon which further information might be given. The author pointed out that the action of sulphur on concrete in the form of sulphide was very deleterious, and he would like to ask if the deleterious action of sulphur would take place to any extent in connection with the iron, seeing that the iron was almost hermetically sealed in the concrete. Would there be anything but local action? The author asked that the cement should pass the British standard specification in every detail, and he would like to add that it was very necessary that the cement should be properly stored, a point to which insufficient attention was frequently paid. Cement must be stored where it would be kept perfectly dry. Mr. Auden pointed out that it was often necessary to sacrifice some of the theoretical efficiency for the sake of convenience. That was very true of most departments of engineering, and was particularly true of reinforced concrete, which was not merely a framing together of manufactured materials, but a complete process of manufacture on the spot from the raw material. He did not quite understand the reference made by the author to wire meshing for flats being cheaper owing to the cross span wires taking the load. There would be the same weight of metal in the longitudinal direction as in the cross direction, and he did not see why the wire meshing should be cheaper. Reference might be made to the effect of temperature stresses on concrete and steel. In columns and girders of long span which were subjected to considerable variations of temperature there might be set up alternating stresses which were very difficult to calculate and which in present practice were compensated for by extra reinforcement.

Mr. Priest said an interesting part of the paper was that giving the qualities of sand, and he noted that Mr. Auden indicated that in his view the sand should be sharp. He was bound to say that although he had been using that expression in specifications for a quarter of a century he had come to the conclusion that he did not know what it meant. He used to think it meant such sand as viewed through a powerful microscope looked like stone broken from macadam, but there was probably no such thing as sand of that quality. All sand consisted of rounded grains, and the angular form did not present any advantage. When cement and sand were brought together it was not a mixture but a combination which was formed, and he was glad to notice that Mr. Auden referred to the remarkable fact that it was not necessary that the sand should be clean. That was quite true from his experience, clean sand being no more necessary than sharp sand. The result with what might be called dirty sand was quite as satisfactory as when clean sand was used. He would go further, and say that it was almost safe to assume that the strength of the combination increased with the amount of dirt in the sand. Standard sand from the Leighton Buzzard district gave a tensile strength higher than most other sands, but after six months there was very little improvement, whilst other sands showed a considerable improvement between one and six months. Sand containing 15 per cent. of loam gave a result 20 per cent. better than one which had been washed free from loam, and this held good up to as high as 22 per cent. of loam, after which the effect of the adulterant was revealed. It was remarkable to notice also that the new red sandstone, which gave results infinitely better than the standard sand, and much better than any pit sand, exhibited such a marked improvement between one and six months. These facts seemed to point to something which had not yet been taken into account in making combinations of cement and some other material. Pure silica was clearly not required. A mixture called sand should be the complement of the cement, but the exact character of the mixture necessary had not yet been accurately determined, and he suggested to chemists interested in the matter that the problem should have their consideration. The cement being sold at the present time was an excellent material, but it was something which was capable of achieving more satisfactory results than were yet got out of it. It appeared to him that it was a virtual waste of money to obtain expensive sand from a distance, when some common material close at hand would produce better results. It almost seemed as if the composition of the cement would have to be made according to some formula to suit particular sands. Dealing with the general principles of reinforced concrete, it seemed to him that the adoption of a skeleton in steel around which the material was built was a very correct copy of animal life. Another important matter which was not mentioned in the paper was that the metallic portions of the material must not be placed too near the surface if the best results were to be obtained. There had been many instances where, owing to the reinforcement being too near the surface, the concrete had become absorbent, and the material had become partially disintegrated, in which case oxidation was set up and the efficiency of the material reduced. The modern tendency was to keep the reinforcement away from the surface, and eventually they would probably be placed no closer than 2in. Any less distance than that introduced the risk of deterioration.

Mr. E. B. Ellington said that for some time past he had been employing reinforced concrete for the construction of reservoirs and floors and roadways, and the conclusion at which he had arrived was that it was most necessary, if success was to attend the use of the material, that, quite apart from the design adopted, there must be adequate and competent supervision. It also seemed to him that without much greater experience of the material than was available at the present time there must be a very large margin allowed in calculations. It would seem that the structures in which reinforced concrete was the governing material might be regarded as a compound of steel and concrete, or the structure might be regarded as a steel structure in which the steel took the stresses and in place of rivets concrete was employed. The steel itself should do the work.

Professor W. C. Unwin said the paper was valuable because it was obviously based upon a considerable amount of experience. He had, however, looked at the drawings in the paper, and it appeared to him that the designer was absolutely dependent upon the workmen for the proper placing of the tension and compression members. For that reason engineers had been rather shy in the past of using this method of construction, and he had no doubt there would be some very serious accidents with reinforced concrete unless in the execution of the work on the ground a great deal of skill and experience were brought to bear to see that the arrangements indicated by the engineer were carried out. In the case of this material the designer was almost wholly dependent upon the adhesion of the concrete to the steel rods for what corresponded to the rivets in a steel girder. The importance of the subject had been recognised by the appointment by the Institution of Civil Engineers of a strong committee to collect evidence and particulars from abroad as to the methods adopted, and the limitations imposed in the use of this material. The author had expressed the opinion that the material must be handled by the use of very simple formulæ, and while he was not really opposed to that, it was necessary that there should be a clear understanding of what was being done. The formulæ Mr. Auden had placed upon the board, $b\,d^2 = \frac{w\,1}{8 \times k}$, assumed conditions which were not satisfied. He was not opposed to the use of empirical formulæ, but it should be borne in mind that in the use of such formulæ everything depended on the range of experimental work on which the constant had been based, and in using so simple a formula as that there was no objection if you had experimental evidence that the constant had been properly arrived at, and that the actual design did not go outside the range which had been tested by experiment. Up to the present time the evidence was very strong that the reinforced concrete work which had been done had not been done wholly satisfactorily, and although in only very few cases had disasters occurred as the result of bad design or bad execution, a good deal of the work was really based upon what was in the nature of guess work calculations. He would refer to one point mentioned in the paper. Reference was made to a girder supporting a floor and the whole being made monolithic, and Mr. Auden said that the floor and beam being all in one solid piece not only did the part of the floor immediately over the beam contribute to the desired area, but portions of the floor on each side were also available, and except under special conditions of loading, the breadth of floor to be considered for the purposes of the calculation should not exceed four to six times the breadth of the beam itself. In his opinion these figures were guess work, and more experimental investigation was called for, and until that was done there would be the greatest uncertainty as to the actual factor of safety which was being obtained. It was curious there was no reference in the paper to the hundreds of patented arrangements of notched bars and twisted bars which were sometimes used in reinforced concrete work.

Dr. W. H. Maw referred to a diagram in the paper showing the arrangement of reinforcing rods and shear members to resist reverse flexure in the end of a beam. The point to which he desired to call attention was the difficulty of obtaining anchorage in the wall for the end beam, so that it would be regarded as a continuous girder. It seemed to him that there were reasons why the last portion of the girder next to the wall could not be regarded as continuous.

Mr. Graham Harris referred to work in reinforced concrete at Southampton Docks ten or twelve years ago, and said that from a considerable experience in the use of the material he would like to endorse what had been said by Professor Unwin and other speakers as to the necessity for continuous supervision of the work. It should be recognised that there was a vast difference between the ordinary method of using concrete and the delicate manner in which it had to be employed for reinforced concrete work. Constant supervision was necessary to see that the material was properly used. The object of employing standard sand was not merely to obtain the best possible result, but to employ a material which the engineer understood. At the Southampton Dock work it was necessary to use piles 65ft. long, which in those days was a somewhat novel proposition, but the London and South-Western Railway Company, which was largely interested in the work, decided that as the reinforced concrete piles formed the cheapest method of construction they should be used. After considerable experimenting means were evolved of driving these piles which proved quite satisfactory.

Mr. F. E. G. Badger said that reference had been made to the present want of skilled supervision, but in a few years' time, and when the workmen began to understand the material better than they did at present, there would not be the same cause for complaint. The author had dealt with the necessity for reinforcement above the neutral axis of all beams or floors running continuously over the tops of columns or stanchions. If this were not done cracks soon appeared at the surface of the concrete over the girders in consequence of the concrete being in tension on the top side at this point. Everyone would have noticed cracks in mosaic flooring where it had been laid on concrete surrounding steel girders. This could be obviated by introducing expanded metal or wire mesh work as near the surface of the concrete as possible, and over the girders. He had had fifteen or sixteen years' experience in connection with railway sleepers, and although he was not familiar with the reinforced concrete sleeper, he imagined it would not suit the requirements of railway companies, as owing to the rigidity of such a sleeper the wear and tear on rails and rolling stock would be increased. He believed it would be a long time before the creosoted timber sleeper was displaced. The steel sleeper was not a success, there being a difficulty in packing to obtain a good top on the road, while that type of sleeper was unreliable owing to breakages. The question of reducing the annual cost of painting structures was a most important one to a railway engineer, when one recalled the enormous sums involved in preserving the life of girder bridges. He was looking forward to the time when reinforced concrete girders made in the divisional engineers' yards would replace the riveted plate girders now employed. He saw no reason whatever why this change should not come about immediately, as the main girders, cross girders, and flooring could be built and seasoned in very little more time than was needed under present conditions. The maintenance charges on the reinforced concrete superstructure would be practically nil. Another useful application for reinforced concrete would be for platform copings. It would be quite possible to make the platforms in reinforced concrete and the edge in white cement. He was gratified, as an official of the Liverpool Corporation, to hear the remarks of the author relative to the Act of Parliament obtained last year to enable the Health Committee to consider these more modern forms of construction. The Committee felt that frame buildings had come to stay, and that it was necessary to put the regulations in order without delay. He understood that other cities were following the lead which has just been set.

Mr. H. A. Lewis-Dale asked if the author had any experience in the construction of dock walls similar to that shown on page 22 of the paper. If so, he would like to inquire how long such walls had been standing? Few engineers would now be found to question the advantages of ferro-concrete for the many purposes referred to in the paper, but where there were structures somewhat exposed to the action of sea water under pressure, as in the case of dock walls, it appeared to him very likely that the reinforcement would be attacked with very serious results. All engineers engaged in such work were aware of the difficulty of making concrete water-tight in practice. Cases had been known of percolation through concrete several feet in thickness, even where every care had been taken in construction. The tendency of the whole dock structure to flotation on account of its lightness would require careful consideration in waterlogged ground.

Mr. Auden, replying to the discussion, said he was quite in agreement with Dr. Hele-Shaw as to the good work done by Mr. Deacon in his capacity as water engineer of Liverpool. Something had been said about the effects of sulphur. Materials which contained it required to be very judiciously employed, and he personally would like to do without them altogether if it were possible. With regard to the storage of cement that was a very important point, and it often happened that cement for which a large sum had been paid was stored quite carelessly and allowed to deteriorate. With reference to cross wires, if you had a long narrow span 100ft. long by 6ft. wide with cross wires to take the strain, all you wanted was a No. 10 mesh wire between the heavier bars across to keep them in pitch. With a long narrow span one might just as well use bars as punched plates, but they should be tied together with thin mesh. Reference had been made to the temperature coefficients for steel and concrete, and no doubt there was a possibility in long girders under certain conditions of temperature being experienced which would have to be very carefully allowed for. He would like to have heard something from other speakers as to the best method of dealing with temperature stresses, as all that was done in present practice was to increase the reinforcement. That was theoretically quite wrong. Mr. Priest's remarks as to sand were most interesting indeed. One or two people with whom he had tested sand had held up their hands in pious horror at 2 per cent. of dirt, but he had tested it up to 10 or 12 per cent., and had obtained excellent results from it at three months. Mr. Priest confirmed his opinion that it gave better results up to as high a proportion of loam as 22 per cent. He could not say that his experience of the New Red Sandstone showed it to be so very much better than the average sand. With regard to the comparison between riveting and concrete, concrete was not so effective as riveting. On the subject of deterioration, he would refer to the case of the Old Chain Pier at Brighton, where steel used in the foundations had after 115 years been found to be quite bright and clean, and in another case some old hammer heads, pick heads, and wedges had been discovered in the Lias formation quite clean after being embedded for 2300 years. These things went to show that if you could keep the water away from iron it would not deteriorate. Professor Unwin had referred to the employment of empirical formulæ, and while admitting that they were used, he would remind members that they were carrying out experiments in their test department practically every day in order to ascertain the behaviour of the material. In large and important work the greatest care must be used in design, and with regard to the formula which he had put on the board, he would only say that the ordinary engineer need not be tied down to that simple formula unless he wished, although he would be quite safe in using it. He agreed that the formula must be based on experiment, and that the design should not go beyond the scope of experiments which had been carried out. Dr. Maw had raised an interesting question, which he would answer in writing. With regard to the observations of Mr. Badger on the railway sleeper, it had to be borne in mind that when the reinforced concrete sleeper was once down its life was almost indefinite. Standardisation in manufacture was an important subject, and the manufacture of integral parts of reinforced concrete and carrying them to their sites was coming into use. It was a method of construction which would never supersede the far finer effects of monolithic construction, but the plan indicated by Mr. Badger would be very useful where it was not worth while to install a plant to work on the site. He would answer Mr. Dale's remarks about dock walls in writing.

The next paper read was that by Mr. Arthur J. Maginnis on "Advances of Marine Engineering in the Early Twentieth Century." Mr. Maginnis first of all drew attention to the Turbinia, which was the first turbine-driven craft, and which created such marked attention in 1896. It was not till 1901 that a real test of this form of propulsion for a commercial venture was entered upon. In that year the King Edward commenced plying on the river Clyde, and was so successful that this vessel was soon afterwards followed by the Queen Alexandra in 1902. Since then a rapid adoption of the system had taken place, and turbine steamers had practically superseded all others for rapid Channel services and also for ocean-going passenger vessels of considerable speed. Up to the present time but little progress had, however, been made in the adoption of turbines for slow-going merchant vessels, and the nature of the problem awaiting solution in this direction was next considered. Amongst other things it was pointed out that the speed of revolutions of the propeller was not great enough to allow the shaft being driven direct from the turbine rotor, so that—notwithstanding the increased first cost—it would seem as if even for this class of vessels it would be necessary to adopt twin or even triple screws. The advantages of turbine machinery were then enumerated, these including absence of reciprocating parts; absence of piston-rods, glands, slide valves, guides, crossheads, connecting-rods, link motion and crank shafts; steady turning effort; avoidance of risk of serious breakdowns owing to racing; marked economy in stores, such as oil, packing, &c.; saving of time in opening up, adjusting and general overhauling, and avoidance of an excessive outfit of tools and gear for these purposes; reduction in first cost of spare parts; lowering of boiler pressure, and hence a saving in weight; and freedom from breakdowns and stoppages. On the other hand, beyond the difficulty of keeping down the speed of the propeller revolutions to suit the turbine, the objections to the adoption of this system of propulsion were not serious. Some cargo space would be absorbed by having two or three tunnels aft, but this could be partly compensated for by a considerable reduction of engine-room, opening through the decks upward. Tables were given showing the rapid advance of turbine machinery both for merchant vessels and for warships of all kinds during the last nine years. Combined piston and turbine machinery then came in for attention, and an outline arrangement of the combined system of piston and turbine engines on the steamship Otaki was given. This is reproduced in Fig. 2. It was pointed out that so far as combined piston and turbine-engined vessels had been at work satisfactory results had been obtained, but it was stated that it was evident that an extensive adoption of this system would not be made, as the days of the steam piston engine for marine propulsion were numbered. The author then considered in order the questions of condensers, propellers, boilers, mechanical stoking, and fuel, and concluded with references to the employment of internal combustion engines in vessels and the direct electric drive for propellers.

Outline Arrangement of the Combined System of Piston and Turbine Engines on T.S.S "Otaki," 1908.

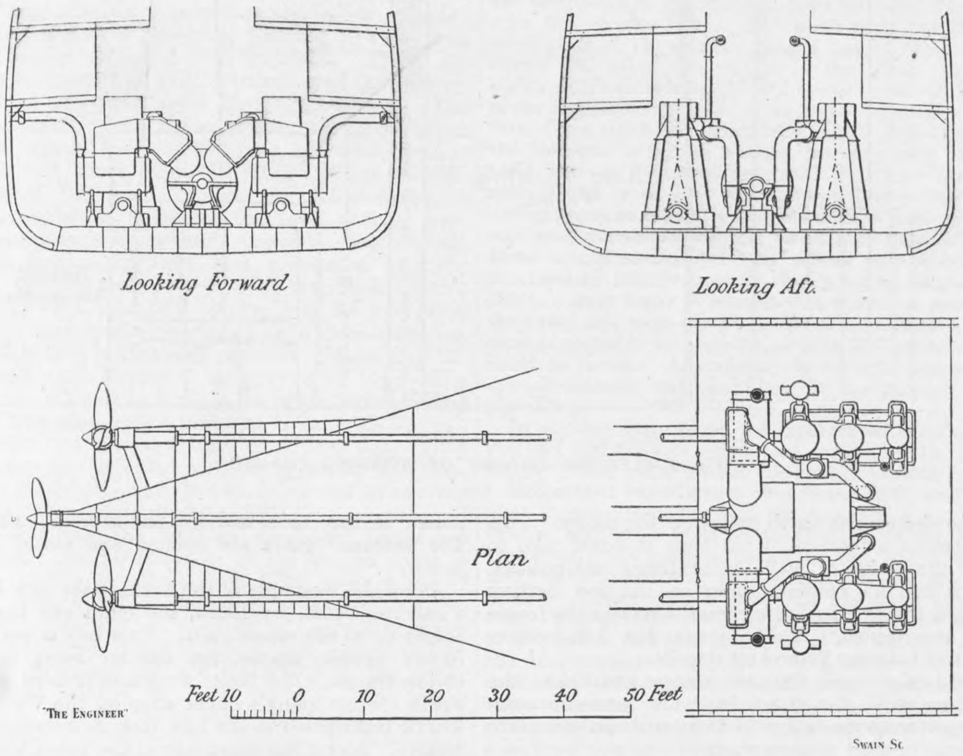


Fig. 2–OUTLINE ARRANGEMENTS OF THE ENGINES OF THE OTAKI

Mr. Aspinall having moved a vote of thanks to the author for his paper, which was unanimously carried, Mr. Edward B. Ellington took the chair for the remainder of the meeting.

Mr. A. K. Bruce, in opening the discussion, said that the paper differed from previous contributions on the same subject, inasmuch as the earlier papers were only reviews of progress, while the present paper to some extent indulged in prophecy. He had been looking through the bibliography, and he noted an important omission. He referred to the paper contributed to the Glasgow meeting in 1856, in which Mr. William Thomson—subsequently Lord Kelvin—made an important series of observations on questions relating to the surface condenser. If that paper were referred to by those interested in the subject, they would agree that engineers all over the world owed a great deal to Lord Kelvin for his researches in that direction. His experience did not confirm what the author said about low boiler pressures with turbine installations. He could instance the case of a mail steamer, with quadruple-expansion engines, where the boiler pressure was 215 lb., and that in the high-pressure cylinder 204 lb. In the case of a turbine steamer of which he had the figures the boiler pressure was 225 lb., and the pressure between the turbine stop valves and the first row of blades only 140 lb. It would seem that the boiler did not get the benefit of low-pressure steam. The steam space in boilers was a matter which did not receive the attention it deserved, and which in connection with turbine-propelled vessels was bound to receive more and more study. Even with a big steam space great care had to be exercised that the water level in the boilers was not carried unduly high. Cases had come under his notice in turbine steamers where considerable trouble had been experienced with wet steam, and the keeping of a lower water level brought about a decided improvement.

Mr. William Sisson said he was a crank-handle engineer, but he would like to point out one or two directions in which the advantages of the turbine could be added to. Reference might be made to the importance of the regularity of turning. The high speed of revolution of the turbine handicapped propeller design very materially, but there was the advantage of this regularity of turning with the turbine. He had always considered one great element in the success of the triple-expansion engine that the three-crank engine gave a regularity of turning greatly in excess of the two-crank engine. That was the reason why the efficiency of the turbine propeller installation was not worse than it was. With regard to water-tube boilers, it was perfectly plain that for ordinary commercial use the express type of water-tube boiler was entirely ruled out, but the semi-express type was not quite in that position. He had just had a report from abroad as to the behaviour of some semi-express boilers which were working on the Congo. They were of the Yarrow type, with large water drum, and they had been reported on most favourably. He would point out that the success of the internal combustion engine was really bound up with the success of the gas producer. It was necessary that a producer should be evolved which could deal with almost any class of coal, and not be confined to anthracite coal. He was not intimately acquainted with the various methods of electric drive on shipboard, but the Durtnall system seemed to be very promising, and more would doubtless be heard of it.

Mr. J. F. L. Crosland referred to the mechanical stoker, and asked if any explanation could be given as to why it had not been more generally adopted. By the adoption of mechanical stokers a large reduction in the number of firemen could be accomplished, and in his view it would be an enormous improvement all round if mechanical stoking could be installed on shipboard.

Mr. David Gibson said that the problem now awaiting solution was the adaptation of the turbine to slow full-lined cargo steamers of the tramp type, and so far very little progress had been made. That class of vessel did the greater part of the carrying trade of the world, and the simplicity and reliability of the steam turbine and the small amount of repairs and adjustment it required made it a most desirable form of motor in such ships. The difficulty, as the author had pointed out, was that the economical speed of revolution of the turbine was about five or six times too fast for the economical speed of the propeller. For slow ships a large diametered propeller running at fifty to eighty revolutions per minute had proved by fifty years of experience to be the most effective for the varying conditions of loading and the weather resistances met with. Mr. Maginnis suggested that the problem would be eventually dealt with by adopting two or more propellers, but he did not believe that that would overcome the trouble, as there would still remain the inefficiencies that were associated with fast running propellers of small pitch, and there would still be curious and anomalous results arising when running the ship at different degrees of loading. Many engineers were looking for the solution of the problem by retaining the larger slow running propeller and connecting its shaft in the engine-room to the turbine by means of speed reducing gear. It was true that a good reducing gear capable of dealing with the large powers transmitted in marine work had not yet been devised, but there were many people working at the problem, and another few years should witness the introduction of such an appliance. The powers required were really not so considerable. It was only a very few tramp steamers which required more than 3000 indicated horse-power, and most of them required about 2000 indicated horse-power, or even less. Taking 2000 indicated horse-power as an average, and assuming that two turbines were fitted to drive a single propeller, the power transmitted at the point of contact with the speed reducer would be 1000 horse-power. Regarded in that light the problem appeared more hopeful of solution, as even if epicyclic gears or other mechanical combinations failed to solve it, it was not outside the bounds of practical application to fit a large wheel on the propeller shaft with a turbine engaging each side of it, this wheel having strong shallow teeth or serrations stepped at several points, and fitted with the necessary refinements preventing noise and vibration. Very great improvements had been made in cut gears of late years, and whilst the proposal put forward might be considered ridiculous if 5000 or 6000 horse-power were involved, he submitted that for 1000 horse-power it was capable of realisation. An arrangement of a single propeller worked by twin turbines running at about 600 revolutions per minute, with a boiler pressure of 160 lb., and using superheated steam, would give a high efficiency, and would mean a great simplification of machinery. It would not entail any alteration in the usual design of vessels, nor would it encroach on the cargo space. That seemed to be the line of least resistance and the line of probable development.

Dr. W. H. Maw said it would interest members to know that an arrangement of gearing for use with turbine-driven steamers was now actually being made, if, indeed, it was being run at the present moment in America. A large firm had taken up the matter, and had constructed a set of gearing for transmitting 6000 horse-power, so that it was not on a small scale. It was intended, he believed, to run the gearing for two months on land, and then put it on a tramp steamer to do the worst it could with it. Among those who were dealing with the problem in America was Admiral Melville, the late chief engineer of the United States navy.

Mr. Kinghorn, speaking with considerable sea-going experience, said as a passenger he should always choose a turbine engine ship. If the speaker who suggested the employment of gearing had any knowledge of the trouble associated with gearing in the marine engine, he would never wish to revive such a method.

Mr. Wilson took up the subject of the electric drive for vessels of moderate power. He said that Messrs. Siemens, Schuckert had installed a 2000 horse-power electric plant on a vessel of 1800 tons in order to ascertain what result could be obtained. There could be no question that, in order to utilise the slow speed of the propeller in combination with the high-speed turbine, the electric drive offered advantages superior to those of any form of cut gearing. Experience indicated that any arrangement of cut gearing would give a somewhat low efficiency, and a case had come under his notice where, after the first month or two of service, a guaranteed efficiency of 97 per cent. fell to 80 per cent. There were, of course, difficulties in marine work in using electric motors for the propellers. The controlling of the motors to obtain reversibility and speed variation presented difficulties which were hardly realised by those not familiar with the requirements of marine work.

Mr. Maginnis replied briefly on the discussion, and promised to deal more fully with the points raised in writing. He was much obliged to Mr. Bruce for calling his attention to the paper omitted in the bibliography.

It was interesting to notice that Mr. Sisson, who came before them as a crank engineer, gave evidence in favour of the turbine. He had raised the question as to the merits of the semi-express type of boiler, but he would have great difficulty in convincing marine engineers on that point. Mr. Sisson had met with considerable success with that type of boiler in smooth and fresh water, but that differed widely from ordinary sea-going practice. Mr. Gibson had put forward an excellent idea, and one which appeared to be very feasible, but he had his doubts as to the possibility of using gearing for marine work. He was glad to hear Mr. Wilson's observations on the electric drive, which he believed had a future before it.

Mr. Herbert W. Wilson then read his paper in abstract on "The Electrical Operation of a Textile Factory." Mr. Wilson began by stating that in considering the advantages of this style of operation it was obvious, since the primary conditions presented differed so widely in each case, that one could not lay down a list of advantages which would apply to all cases. Stated briefly, however, these might be summed up as yielding an improvement in both quality and quantity of the output of almost all textile machines. This improvement was mainly due to the greater steadiness of drive which could be obtained, and the consequent higher average speed and increased output. Except in cases where variable speed was required to suit special conditions, an absolutely constant speed was, the author pointed out, most desirable. The tension in the yarn being spun was, he said, mainly dependent on the spindle speed, hence any variations in this would cause the yarn to break. Therefore, if constant speed could not be relied on, it was necessary to allow a margin of safety and to run at a speed materially below that corresponding to breaking point. With even the best of rope drives it had been found in a number of cases that the output of machines closest to the driving point was greater than that of those placed elsewhere, and this was due to the steadier running at this point. In a well-known case in Lancashire the results obtained from two mills under the same management and working under the same general conditions showed that the quality of the yarn obtained from an electrically-operated mill was distinctly superior to that from a mechanically-operated mill. This was so to an extent, it was stated, of a 2½ per cent. increase in the selling price of the yarn from the former. It was difficult to obtain reliable statistics concerning the increase in quantity produced in the case of electrically-driven factories, but this might be taken on the average as 5 per cent. Neglecting the increase in selling price, and taking into account the reputed heavier charges for power, which the author did not admit as having any foundation, he showed that the above 5 per cent. increase in quantity meant a margin of 0.35 per cent. extra profit on the whole turnover. The objection to the increased capital cost caused by the installation of electrical transmission was admitted in the case of mills with 80,000 spindles or less. In cases where the number of spindles varied from 80,000 to 100,000 the costs were about equal, while for more than 100,000 spindles it was claimed that the electrical system was cheaper. Where an old factory required re-equipment the inconvenient arrangement of the existing buildings frequently rendered the adoption of the electric system distinctly advantageous. In the case of a fairly modern factory with a good mechanical transmission system, and requiring extensions above the capacity of the engine, it was stated that the use of the exhaust steam turbine with whole or partial electric driving of the factory possessed many advantages. In a case mentioned a factory was mechanically driven by a 1000 indicated horse-power engine with a steam consumption of about 13 lb. per indicated horse-power per hour. By slightly altering the valve setting it was found possible to obtain about 850 indicated horse-power from the main engine running it non-condensingly, and 500 indicated horse-power from an exhaust steam turbine utilising the steam from the engine. In this way it was possible to obtain some 1350 indicated horse-power for a steam consumption of about 10.5 lb. per indicated horse-power hour. The main differences of opinion among engineers designing the lay-out of electrically-equipped mills related to the questions of group or individual driving.

The larger and fewer the motors in a mill the smaller was the capital outlay, but the less were the special advantages of electrical driving felt. A motor to each machine was the ideal case, but as a compromise the author was in favour of the individual driving of ring spinning-frames and the group driving of all other machines, the groups, however, being kept fairly small.

The table showed the horse-power required by several kinds of machine installed in a small mule-spinning mill. Three other tables were also embodied in the paper, giving further particulars regarding the horse-power and size of motors required for the various types of machine.

Machines.	Horse-power.
1 Bale breaker and lattice mixing arrangement	3
3 Horizontal exhaust openers	18
10 Single scutchers	35
84 Carding engines	84
11 Draw frames...	20
9 Slubbers, total spindles 882	17
16 Intermediates, total spindles 2212	36
40 Rovers, total spindles 6880	100
28 Mules, 1⅛in. gauge, total spindles 36,063 ...	314
40 Mules, 1⅜in. " " " 42,320 ...	242
Total	869

Mr. E. B. Ellington moved a vote of thanks to the author, which was unanimously adopted.

Mr. Mark Sutton said the firm with which he was associated had put two electrical installations into textile mills. Personally, he believed in the individual drive for machines, which called for something like 5 horse-power, but the difficulty up to the present time was to employ a 5 horse-power motor to do the work of a 5 horse-power machine. Makers in the majority of cases preferred to put in 8 horse-power motors to drive spinning frames which only require from 4 to 5 horse-power. The first mill his firm had installed had group driving, because they were not satisfied to put in machines which would not work at their most efficient rate; but after giving the matter a good deal of consideration he had devised the arrangement shown in Fig. 3. The motors employed in this case for individual driving were 5 horse-power each, and manufactured by Messrs. Bruce Peebles and Co. They ran on ball bearings at 1500 revolutions per minute, and the following were a few of the advantages claimed for this particular drive. In the first place, a motor could be employed which would be working practically all the time at its most economical load. It started up on the loose pulley, thus avoiding a margin of about 50 to 60 per cent., which was necessary on similar motors for similar service for starting. The motors did not occupy any floor space, were out of reach, and could not be tampered with, while they worked under cooler conditions in the elevated position. The overload release could be set so finely that if a bearing got hot or any improper resistance occurred the motor would stop. When the counts of yarn required changing to such an extent as to necessitate the changing of the speed of the machine, which, in the majority of cases, was done by changing the pulleys on the machines, all that had to be done was to change the small pulley on the motor. This could be done in a fraction of the time it would take to change in the ordinary way by changing the pulleys. Each motor had an ampère meter on the top starting panel, so that the exact working conditions of each frame could be ascertained. The average per horse-power worked out at between 70 and 80 spindles.

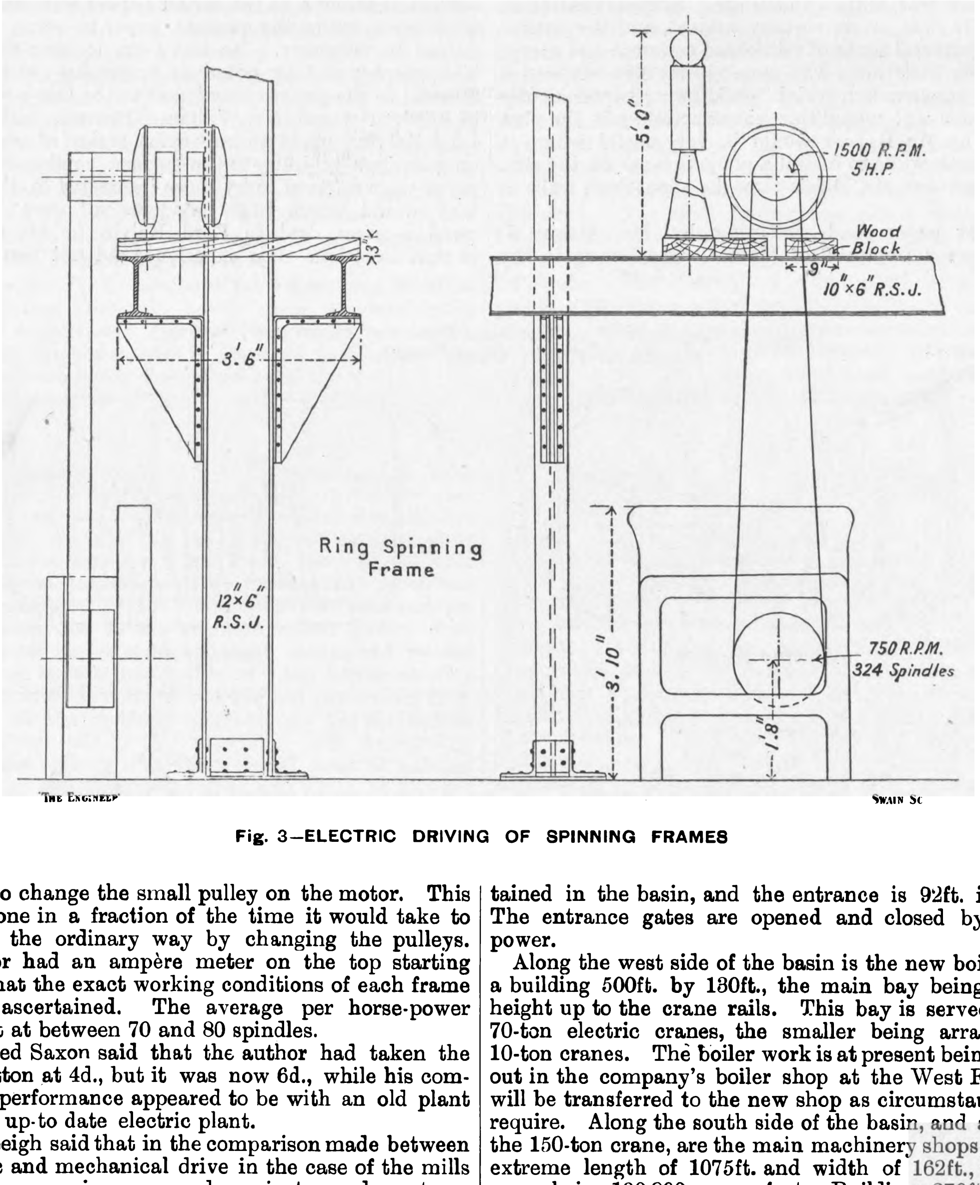


Fig. 3—ELECTRIC DRIVING OF SPINNING FRAMES

Mr. Alfred Saxon said that the author had taken the price of cotton at 4d., but it was now 6d., while his comparison of performance appeared to be with an old plant against an up-to date electric plant.

Mr. C. Leigh said that in the comparison made between the electric and mechanical drive in the case of the mills referred to, comparison was made against a modern steam plant, and that the result came out decidedly in favour of electrical driving as being cheaper and more reliable.

The author, in reply on the discussion, said he had taken 4d. as the price of cotton, and if the price had risen to 6d. since that time, that was in favour of his case rather than against it.

The paper by Professor F. W. Burstall, on the "Indicating of Gas Engines," was taken as read. On the motion of the President, votes of thanks were passed to the Lord Mayor of Liverpool, the Reception Committee, and the various public bodies and firms which had placed facilities at the disposal of the members of the Institution, and had offered hospitality.

On the invitation of the Lancashire and Yorkshire Railway, the members were entertained to luncheon at the Exchange Station Hotel.

For the afternoon alternative visits had been arranged (1) to Birkenhead, where the shipyards and engineering works of Cammell, Laird and Co. might be inspected; (2) to the Mersey Railway and the Woodside Lairage and Refrigerating Plant; and (3) to the soap works of Lever Brothers at Port Sunlight.

CAMMELL, LAIRD'S WORKS.

The works of Cammell, Laird and Co., Limited, Birkenhead, comprise the yard formerly worked by Messrs. Laird Brothers, and the large extensions at Tranmere made during the past few years. The works cover an area of about 100 acres, with a river frontage of over 3000ft.

The whole of the site of the Tranmere extension has been reclaimed from the foreshore of the river, the excavation from the docks having been utilised to fill up the rest of the land to the required levels. Passing first through the old works, where vessels of up to 450ft. in length can be built, there may be seen three destroyers now being built for the British Admiralty. The platers' sheds, smithy and engine-shops are conveniently arranged for dealing with the type of work turned out.

In the old yard there are five graving docks, and in the extension there are two others. This series of graving docks, which is claimed to be the most complete of any in private hands, together with the disposition of the workshops, offers excellent facilities for executing repairs.

The leading particulars of the docks are as follows:—

	No. 1. ft. in.	No. 2. ft. in.	No. 3. ft. in.	No. 4. ft. in.	No. 5. ft. in.	No. 6. ft. in.	No. 7. ft. in.
Length ...	310 0	360 0	448 6	440 0	423 0	708 0	860 0
Width at entrance ...	38 0	43 0	75 0	83 3	80 0	80 0	92 0
Draught of water ...	13 6	13 6	21 6	21 9	17 6	31 0	34 0

Most of the docks are closed by floating caissons, and all except the two largest empty by tidal action. These latter are pumped out by two 36in. centrifugal pumps drawing from a common sump between the docks. The larger of the two can be dried in about three hours. Next to the two large graving docks is the fitting-out basin, 13½ acres in area and with about 3500ft. of quay space. It is served by 150-ton and 40-ton cranes, the latter of which travels along the quay and also serves the larger of the two graving docks. Both cranes are worked electrically. A depth of water of over 30ft. can be maintained in the basin, and the entrance is 92ft. in width. The entrance gates are opened and closed by electric power.

Along the west side of the basin is the new boiler shop, a building 500ft. by 130ft., the main bay being 50ft. in height up to the crane rails. This bay is served by two 70-ton electric cranes, the smaller being arranged for 10-ton cranes. The boiler work is at present being carried out in the company's boiler shop at the West Float, but will be transferred to the new shop as circumstances may require. Along the south side of the basin, and adjoining the 150-ton crane, are the main machinery shops, with an extreme length of 1075ft. and width of 162ft., the floor space being 130,800 square feet. Buildings 270ft. by 43ft. and 315ft. by 43ft. adjoining are intended for smithy and coppersmiths' shops respectively. The main bay is served by two 70-ton electric cranes, and the side bays by smaller travellers. The large machines in the centre bay are mostly direct motor-driven and the smaller machines are chiefly driven in groups by line shafting.

Passing on to the shipbuilding department, it will be seen that there are six slips capable of building vessels from 700ft. in length and upwards. In fact, the extreme south slip can accommodate vessels of over 1000ft. in length.

The shipbuilders' machine shop is immediately at the head of the slips, and consists of three bays, each of 120ft. span, with a total covered area of 145,000 square feet. The machinery is of the latest and most powerful description. Behind the machine shops is a yard for storing plates, which is served by an overhead travelling crane, and is in direct communication with the railway systems in the yard. There is also a spacious mould loft, 280ft. by 70ft, with stores underneath, and a ship fitters' shop and smithy, each 210ft. by 70ft. The wood-working department, consisting of saw mills and joiners' shops, 200ft. by 110ft., and 300ft. by 100ft. respectively, is in a convenient position for vessels on the slips or in the docks.

The power for the whole works is obtained from the power station close to the joiners' shop, the source of power being three Mond gas producers of a capacity equivalent to 2000 horse-power each, which supply gas to engines for driving electric generators and hydraulic and pneumatic pumps. Gas is also supplied from these producers to the plate and angle furnaces in the shipbuilding department. The electric generators are driven by Premier gas engines, the largest unit in use being 450 indicated horse-power, the current produced being continuous at 440 volts. The hydraulic pumps are driven by Premier gas engines, and the pneumatic plant by

Westinghouse vertical gas engines. The yard is in direct communication with the main railway systems of the country, and has the additional advantage of being in communication by water with the chief coal and steel-producing districts.

THE MERSEY RAILWAY.

This railway, which was formerly worked by steam traction, connects Liverpool with Birkenhead by a tunnel under the Mersey, which is here 1320 yards in width. It is almost entirely in tunnel, lined throughout with brick in cement, and is laid with a double line of steel rails 86 lb. to the yard. Under the river the tunnel is in sandstone rock, with a cover of 30ft. to 35ft. between river bed and the top of the tunnel. The lowest level is 145ft. below mean high-water mark, and the gradient on the Liverpool side is 1 in 27 for a short distance. The tunnel is kept drained by powerful pumping machinery. Hydraulic lifts are provided for raising and lowering the passengers at each end of the line. The traffic is worked electrically, the power house being situated in Birkenhead. There are three double-current generators of 1250 kilowatts capacity, which can deliver either direct current at 650 volts, or three-phase current at 25 periods. The rolling stock consists of 24 motor cars and 37 trailers.

THE WOODSIDE LAIRAGE.

This is situated on the Cheshire side of the river adjoining the Woodside Ferry of the Birkenhead Corporation. Its combined capacity is 6172 cattle and 16,000 sheep. There are spacious slaughter-houses, meat stores, and chill rooms. There is also a large market. At Woodside 2100 and at Wallasey 1200 beasts can be slaughtered in the twenty-four hours. The chill rooms and meat stores can accommodate 2250 and 1300 carcases respectively. The refrigerating plant is on the ammonia absorption principle in three units of 50 tons ice-making capacity each. That at Wallasey is on the Linde ammonia compression system.

LEVER BROTHERS' SOAP WORKS AT PORT SUNLIGHT.

A very large number of members and ladies accepted the invitation of Lever Brothers, Limited, to visit their works and model village at Port Sunlight. These are situated on Bromborough Pool, a tributary of the Mersey, between three and four miles from Birkenhead. The buildings constituting the works cover a total floor space of 1,920,000 square feet, and the land and water area of the works is 216 acres, while the village covers an additional area of 132 acres. There are 720 cottages, a church, day schools, technical institute, cottage hospital, restaurants, library and museum, concert hall, gymnasium, swimming bath, and recreation grounds. The works produce over 3000 tons of soap and kindred materials per week, and find employment for over 4000 people. The soap making is carried on in three soaperies, and a fourth is now in course of erection. More than 100 pans are used, each having a capacity of 60 tons. The members were allowed to witness the operation of boiling and noted how the boiled material is run off through wooden spouts into cooling frames on a lower floor. They afterwards saw the solidified soap being cut up into bars, stamped by machinery, and afterwards carried by moving conveyors to the packing tables, where they are wrapped up and packed into the familiar cardboard boxes and wooden cases. The manufacture of the wooden cases is carried out entirely by machinery. The present power station is capable of developing over 2000 horse-power, and comprises a number of separate units. There is also under construction a new power station which when completed will add materially to the available electrical energy in the works. The power plant consists of a side-by-side compound horizontal condensing Corliss engine capable of developing 1200 horse-power per hour, with a direct-driven generator. The fly-wheel weighs 35 tons. In addition there are a side-by-side compound horizontal condensing engine with belt-driven generator, a three-throw tandem compound vertical engine with direct-driven generator, and two compound condensing vertical engines with direct-driven generators. The lighting plant includes three side-by-side vertical compound direct-driven generators and a large storage battery. The steam generating plant includes sixty double-flued Lancashire boilers, most of them 30ft. by 8ft., arranged in batteries in different parts of the works. Most of these are fitted with mechanical stokers, which are fed by conveyors from bunkers overhead.

The subsidiary industries carried on include glycerine recovery and refining works and printing. The new printing works, through which the members were conducted, cover about four acres, and include the most modern printing appliances. The works has its own dock and wharf, with electric transporters and locomotives. There are also an oil mill and refining and chemical laboratories. The comfort and well-being of the workers, a very large percentage of whom are females, have received the utmost consideration. In the various parts of the establishment rest-rooms, surgeries, bath-rooms and chambers for drying garments, &c., are provided. There is an ambulance corps ready at all times to render first aid in case of accidents until the surgeons arrive. All cases of accident are subject to inquiry by personal accident inquiry committees, and suggestions for their prevention are encouraged. For this purpose boxes are placed throughout the works in convenient places, and prizes are awarded for meritorious ideas. The firm even goes further than this, and pays the expenses of patenting any device which it considers worthy, in the name of the worker, who receives the royalties from the patent from all users except Lever Brothers.

After the somewhat hurried survey of the works and village, all the visitors were hospitably entertained at tea in the Auditorium by the firm.

The whole of the Thursday and Friday, the 29th and 30th ult., was devoted to various visits. We shall defer mention of these until our next issue.

In the evening of Wednesday there was a reception in the Town Hall at the invitation of the Lord Mayor and Lady Mayoress.

SHORT-DISTANCE WIRELESS TELEGRAPHY.

THE enormous strides which have been made during recent years in the development of wireless telegraphy cannot fail to have attracted the attention of even the most uninterested in electrical science. So rapid have these developments been that it is only those very closely associated with the work who have been able to follow all that has been done, and to distinguish that which is useful and clever from the unnecessary complications which have from time to time been introduced. Thus busy men engaged in other work have, no doubt, been bewildered by the mass of literature on the subject which has poured in upon them, and have given up all hopes of understanding the apparent mysteries which surround this wonderful work of mankind. Yet it is surprising how simple it is to carry out experiments on a small scale, and to transmit messages over short distances. An interesting example of what can be done at comparatively small expense has recently been brought to light in an article by Mr. C. A. Booth on radio-telegraphic apparatus for short-distance transmission, published in the *Post Office Electrical Engineers' Journal* for July.

In conjunction with Mr. J. E. Taylor, the author carried out some experiments between the Post-office radio-telegraph station at Skegness and Hunstanton, with a view to obtaining a simple and cheap yet satisfactory means of transmission for short distances, such as is required between the mainland and small islands around the British coast. In such cases there is not much telegraphic traffic, and the provision of a submarine cable is prohibited on account of the costly and frequent repairs rendered necessary by the action of tide races in chafing away the protective sheathing against the rocks. In the experiments it was arranged that the height of the aërial wire should not exceed 80ft. Two $\frac{3}{18}$ stranded copper wires were joined together at the base, but separated by about 4ft. with wooden spreaders till they reached the required height of 80ft.; they were then extended outwardly and downward in opposite directions for 70ft. The insulators were 6in. ebonite links. The earth plate was the ordinary earth plate of the station, being a fan of 6in. copper strips buried 2ft. below the surface of the earth. An ordinary high-speed trembler ignition coil—as used on present-day motor cars and costing about 25s.—was supplied with current from three small secondary cells. The high-tension side of the coil was joined to a spark gap consisting of two brass balls 1in. in diameter, separated $\frac{1}{32}$ of an inch. Each side of the spark gap was connected to a Leyden jar of .003 microfarad capacity, and the outside coatings of the two jars were connected together through an inductance of four turns of stranded copper wire wound on a wooden box approximately 12in. square, giving a wave length of about 800ft. Four turns of similar wire wound on another box of the same size were placed in the aërial circuit. The boxes were arranged to be movable, so that the degree of coupling could be varied. An ordinary Morse telegraph key without special contacts was connected in the primary circuit for signalling.

In another experiment the separate aërial inductance was omitted, and a direct connection made from the two ends of the jar circuit inductance to the aërial and earth respectively.

Subsequent experiments were made with enclosed glass-plate condensers in place of the jars, which are liable to be broken, with the result that three plates of 6in. square gave very closely the same value as the two jars in series—viz., .0015 microfarad, and the inductance was made by four turns of $\frac{7}{22}$ electric-light wire, with the turns wound side by side. The current through the primary of the coil was 1.5 to 2 ampères, and that in the aërial—as shown by a Duddell thermo-ammeter—was from 1.7 to 2 ampères.

Good reliable signals, the author states, of almost a musical note were received across the 16 miles separating the two stations by means of a De Forest electrolytic receiver and by a Marconi magnetic detector.

THE POSTMASTER-GENERAL AND THE CITY OF DUBLIN STEAM PACKET COMPANY.

IN our monthly summary for June, 1908, we referred to the judgment of the Court of Appeal in the case of the City of Dublin Steam Packet Company *v.* The King, by which it was held that the contract between the Postmaster-General and the Steam Packet Company covering the carrying of the mails between Holyhead and Kingstown implied the continuous use of certain berths alongside the Carlisle Pier at Kingstown by the Steamship Company. The question is of some importance as affecting the cross-Channel traffic between Holyhead and Kingstown, which is now carried on not only by the City of Dublin Company, but by the London and North-Western Railway Company. The present mail contract expires in 1917. The Crown appealed from the decision of the Court of Appeal, and the case was argued in the House of Lords on three days in May last. The judgment of the House of Lords has now been given, and reverses the previous decision in important respects. The Lord Chancellor in his judgment held that there was an implied contract to give the company reasonable use of the pier, but not the exclusive use of the whole or any part of it. His Lordship held that no action of the Postmaster-General or the Harbour authority as representing the Crown had impeded the use of the pier by the company, or constituted a breach of the contract. Lord Gorrel and Lord Shaw delivered judgments in concurrence with that of the Lord Chancellor, and the petitions of right presented by the company were dismissed with costs against the company both in House of Lords and below. Lord Ashbourne, in a lengthy judgment, dissented from the majority, and agreed with the judgment in the Court of Appeal. Incidentally he pointed out that matters were working quite smoothly in Kingstown Harbour under the arrangement come to as a result of the decision of the Court of Appeal.

LETTERS TO THE EDITOR.

(*We do not hold ourselves responsible for the opinions of our correspondents.*)

BRITISH LOCOMOTIVE PRACTICE OF TO-DAY.

SIR,—Attention has already been drawn by THE ENGINEER to the extraordinary difference in cost for renewals and repairs of the locomotives on the chief lines of the kingdom. The discrepancy is so great that the question has become one of general interest to engineers. When a great railway spends nearly twice as much per locomotive as another first-class line doing equal or heavier work, the matter becomes of importance, not only to the shareholders directly involved who may have little opportunity of reviewing the actual figures, but to engineers in general who are all concerned that the locomotive superintendent should do as much with one dollar as anyone can do with two.

The latest cost figures for the principal English railways, those for the second half-year of 1908, published in THE ENGINEER, are as follows:—

TABLE I.—*Cost of Renewals and Repairs per Locomotive, Second Half-year*, 1908.

Railway.	Number of new engines.	£
Lancashire and Yorkshire Railway	—	100.0
Great Central Railway	3	104.8
Great Northern Railway	20	107.3
Midland Railway	0	116.8
London and North-Western Railway	35	124.3
South-Eastern and Chatham Railway	2	125.0
London and South-Western Railway	—	135.5
London, Brighton, and South Coast	8	140.1
North-Eastern Railway	14	156.6
Great Eastern Railway	20	157.0
Great Western Railway	11	174.9

These figures are sufficiently striking. A column has been inserted giving the total number of new engines built during the period, which, it will be seen, is insufficient greatly to affect the question, for, in the cases of the Great Northern and Great Western Railways for instance, the locomotives of the former, including nearly double the number of new engines, cost £107.3 each for the half year, and those for the latter £174.9, a difference of £67.6 per locomotive. Since the number of the Great Western locomotives exceeds 2200, this difference is at the rate of nearly £300,000 per annum.

It is to this figure I wish to draw attention. That the figures for the last half year are unfortunately not exceptional is clear from the continuous increase in locomotive expenditure of late years. The figures for the last two years are as follows:—

TABLE II.—*Increase in Locomotive Expenditure, Great Western Railway.*

1907.		1908.		Total increase in two years.
1st half.	2nd half.	1st half.	2nd half.	
£	£	£	£	£
84,742	144,000	89,320	36,598	354,660

The figures refer, of course, to revenue expenditure only, in addition to which this railway has incurred heavy capital expenditure on locomotives.

As regards the work done by the locomotives of the two lines taken for the purpose of comparison, the Great Western main track is well known to have the easiest gradients of any line in England, whilst in the outlying districts light trains and slow speeds prevail and double heading is frequent. On the Great Northern with steeper gradients, the average weight is considerably heavier, and the average speed no less. On the Great Western therefore lighter work costs half as much again for repairs. Clearly therefore the cause of the excessive expenditure lies in the company's locomotive practice. Without discussing the details of design, not uninteresting in this connection, the broad facts of this practice during the last few years have been the number and variety of types built and employed on similar work, the frequent alteration and rebuilding, and the return to features universally discarded by the principal lines both of England and America.

Taking first ten-wheeled express engines, those built in 1901-03 comprised Nos. 100, 98, and 171 of the 4-6-0 type, three different engines, one of each class. In 1904 No. 100 was rebuilt with a different boiler. No. 171, a simple engine with 225 lb. pressure, built, it was stated, to compete with the De Glehn compound Atlantic, an entirely different type, was after a few months' running rebuilt with the Atlantic wheel arrangement. The result was, of course, somewhat of a patchwork which failed to take advantage of some of the chief possibilities of the Atlantic type, such as the wide fire-box, universal in America and very numerous here.

Extraordinary as it seems, a number of 4-6-0 engines like the original No. 171, and Atlantic engines like the rebuilt No. 171 then appeared together. Two years later No. 171 was again rebuilt to the 4-6-0 type, and it is stated that the Atlantics were being similarly treated.

In 1906-7 thirty more engines of the 4-6-0 type were built. In 1907, during which twenty of these thirty engines appeared, the type was finally abandoned and four-cylinder engines produced. In addition No. 40, a four-cylinder Atlantic, the only one of its type, was built in 1906 and three De Glehns, differing slightly, produced in 1903-05. Thus eight distinct types of ten-wheeled express engines were produced in nine years.

Similarly in eight-wheeled passenger engines there were at least five distinctly different types in the same period.

Again, in goods engines there were in the same time four distinct types, and many engines were rebuilt to different types, some of them twice over.

Lastly, in tank engines six types were also brought out in the nine years.

Thus, in all, the Great Western in nine years produced no less than twenty-three different types. Many of these were abandoned after a few months' trial when a considerable number of engines had been built.

On the other hand, the Great Northern, to continue the same comparison as before, produced in the same nine years but nine separate types, of which four were isolated engines and five have remained standard to the present time.

Rebuilding with regard to ten-wheeled express engines has already been briefly referred to, but the practice has been equally prevalent with other types. Thus, for instance, some 2-6-2 tank engines were produced in 1907, which, it was stated, had been converted from 0-6-0 goods class. These latter were of comparatively modern construction, whilst a year or two previously an equal number of 2-2-2 passenger singles had been converted to the 0-6-0 goods type.

In general, engines but a few years old have been fitted with a new type of boiler, sometimes with a succession of new types. The difference in these, at least as regards the earning value of the locomotive, has been quite trivial, whilst the cost of fitting new boilers is, of course, very heavy.

Many of the twenty-three new types of engine above enumerated have had outside cylinders with 30in. stroke, which has the great disadvantage of very high piston speed—1260ft. per minute at sixty miles per hour—and very serious want of balance. The 30in. stroke was tried and abandoned many years ago by the North-Eastern, and has not been adopted by any other English line since.

Other types have outside frames, a practice finally discarded by the principal English railways at least twenty years ago.

Engineers do not cavil at the cost of scientific experiment, and the experiments of the Great Western, if their full significance when cost is included is understood, will not be without their usefulness, particularly to other railways; but if, as is to be feared,

these experiments which are so prominently before the public are regarded by many at home and abroad as representative of British progress in locomotive development, the results will be wholly deplorable.
L. A. F.

July 16th.

Sir,—Mr. Riekie is evidently under the impression that the cylinder power of the modern British locomotive is not sufficient for the work to be performed. From his letter he advocates over-cylindering an engine with complete disregard to the adhesive power, and then relying upon the judgment of the driver for the successful running of the engine. Unless the adhesive power exceeds the cylinder effort, the engine can never develop its maximum tractive effort, so what is the use of providing power which cannot be utilised? I am of the opinion that for most of the work on British railways, express and otherwise, 18in. cylinders will do all that is required. I do not mean to infer that larger ones are not sometimes required, for in a few cases they certainly are, but I do say that larger cylinders than 21in. by 26in. are not required, and such are capable of performing any work that at present can be found in this country. 20in. cylinders were probably, for a simple engine, first tried in this country by the late Mr. Dean on the Great Western Railway in a series of convertible broad-gauge engines. This diameter was speedily found detrimental to successful running, and the cylinders were consequently lined up. Mr. Johnson on the Midland, in 1884, tried 19in. cylinders. These engines, too, were noted for their "breathlessness." There are other instances where the cylinder capacity has been largely increased, with total disregard for the other proportions of the engine, and in nearly every case the cylinder diameter has had to be reduced. The notable exceptions to this statement were Mr. P. Stirling's 8ft. single wheelers. The success of these engines was, no doubt, entirely due to the great size of the driving wheels.

Mr. Riekie, in the face of this, says that "the whole question is one of enhanced power." And further on he talks about increasing the power by 50 per cent. Is an engine with 50 per cent. more power than the Great Western Railway's new 4-6-2 required in England? Does Mr. Riekie imagine our locomotives are not sufficiently powerful? Or does he think that by adopting the compound system our engines would be better and more efficient than at present? The only answer I can give is, that the gentlemen who so ably control our locomotives are, without the slightest doubt, men of very great experience and capabilities, and any course taken by these gentlemen must be taken as authoritative.

My own experience has certainly been conclusive in pointing out to me that larger cylinders than 18in. or 19in. diameter are not necessary for average work. In fact, the cause of most failures of my experience with regard to inefficient performances has been lack of boiler-power and adhesive weight. With the large-boiler policy of recent years this is happily disappearing.

When greatly augmented power is required, the four-cylinder simple engine will rise to the occasion. For with four high-pressure cylinders just as good expansion can be got as with a four-cylinder compound if the cylinders are of the right proportions and a boiler sufficiently large provided to supply them. At any rate, I ask any correspondent to show me better work than is being daily performed by the present four-cylinder 4-6-0's on the Great Western Railway.

I wish to make no odious comparisons, but I state this to bring out facts. Three De Glehn compounds have been tried on this line, and after a series of most exhaustive tests, the result has not been the introduction of compounds, but the building of a large batch of four-cylinder simple engines. The work being done by these engines is even better than the splendid performances given by the imported engines. Again, I do not state this with any disrespect to those fine French locomotives which were and are undoubtedly excellent examples of engineering skill, but I give the facts as they are. The compounds have in every way given satisfaction, but the four-cylinder simples are doing better, and are relatively cheaper and less expensive in many ways.

Now, with respect to higher boiler pressures. The London and North-Western Railway has recently reduced the working pressure of a number of converted compounds, so have many American lines, with beneficial results. The London, Brighton and South Coast Railway has adopted 150 lb. per square inch on its new 4-4-2 express engines. It has been found on many lines that the gain in enhanced power and steam economy has had to be dearly paid for in fire-box repairs due to the consequent high temperatures. With regard to "Excelsior," it might interest him to know that in New Zealand a banking engine is at work with 250 lb. per square inch of steam pressure.

It is very doubtful indeed whether a greater pressure than 175 lb. is in reality necessary; at any rate, some of the heaviest and fastest work in this country is being performed with engines working at that pressure. Draw-bar tests taken from engines under the above conditions have shown that sufficient power is available without need of augmented pressures.

I did not say in my last letter that there was any difficulty in designing cylinders for a compound to suit all classes of engine. I said it could not be done without increasing the first cost of the engine, as compared with a two-cylinder simple engine. I still believe it cannot be done. I must call Mr. Riekie's attention to the fact that better work is being done with 19in. cylinders on the North-Eastern Railway than was ever possible with Mr. T. W. Worsdell's compounds with their equivalent 19$\frac{3}{4}$in. diameter cylinders. The Midland Railway is, however, employing compounds on a large scale, but is at the same time building simple 4-4-0's of the same power. What the results will be I cannot foretell, as it takes years with experiments of this kind to come to a satisfactory conclusion. The late Mr. Webb spent the best part of his life in experimenting with the compound question, and so long as the weights and speeds remained within their power they did very well; but, unfortunately, no margin of power was allowed them so as to be able to cope with increased duties; for present requirements these were far too small.

In conclusion, I must state I do not quite see what the gist of Mr. Riekie's argument is, and until he can show me that our engines are very much wanting in power, &c., I think this discussion must wane in interest.

West Norwood, July 30th.
Henry W. Dearberg.

PROPELLERS IN TUBES.

Sir,—With all deference to the reputation of Mr. S. W. Barnaby as an accomplished engineer and naval architect, I am called upon to take an exception to what he has got to say in his letter appearing in your issue of June 11th with reference to the proposed system of running the high-speed turbine propeller in the throat of a Venturi tube, as a mistaken notion on the part of such authority as he is in matters connected with screw propulsion may have a wrong general impression brought upon the subject. It is hardly necessary for me to dwell upon the absurdity of making the diameter of the discharge end of the tube any larger than the diameter of the inlet. In my paper, read at Newcastle, it has expressly been stated that the area of cross-section at the outlet end is to be made slightly less than that at the inlet end; so that the velocity of water at the outlet end would be slightly higher than that at the inlet end.

In the opinion of Mr. Barnaby, a fatal defect inherent to this system of propulsion is "cavitation." But it is not very clear what he means to say as to the consequences of so-called "cavitation" in this particular instance. It cannot be supposed for one moment that the supply of water to the propeller is deficient. As a matter of fact, the screw, when running in the throat of a Venturi tube, could be made to receive a much larger quantity of water per unit of time than when it is employed in the usual way in the open current under the same speed condition of the ship. The final velocity of water at the discharge end of the tube can be controlled to some reasonable extent by keeping a proper ratio between the inlet and outlet areas, so that there should be no cause to fear from an excessive slip. The reduction of hydrostatic head within the tube is certainly one cause of inefficiency, so far as the screw itself is concerned; but then we have a large increase of indirect thrust exerted upon the propeller casing, as shown in the annexed sketches, in which Fig. 1 represents a general shape of the Venturi tube, at the throat of which a screw propeller is made to rotate, and Fig. 2 a distribution of hydrostatic pressure within and without the tube, this being drawn to no particular scale.

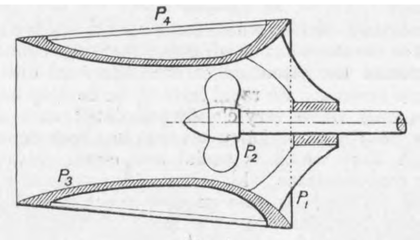


Fig. 1

When the matter stands as illustrated in the sketches it will readily be seen that any reduction of hydrostatic pressure within the tube is always attended with an increase of indirect force pushing the propeller casing forwards. This indirect thrust amounts in most cases to over 30 per cent. of the total thrust, and would be more than sufficient to make up the reduction of direct thrust upon the propeller shafting. Thus we have what is called "cavitation," and known as a serious cause of lost work with the common type of screw propellers turned into a veritable boon in this particular method of propulsion. Mr. Barnaby tells us only about half the aspect of whole truth when he says that the limiting thrust per unit of area necessary to avoid "cavitation" would still be measured on the area of the propeller itself, and not on the area of the discharge end of the tube.

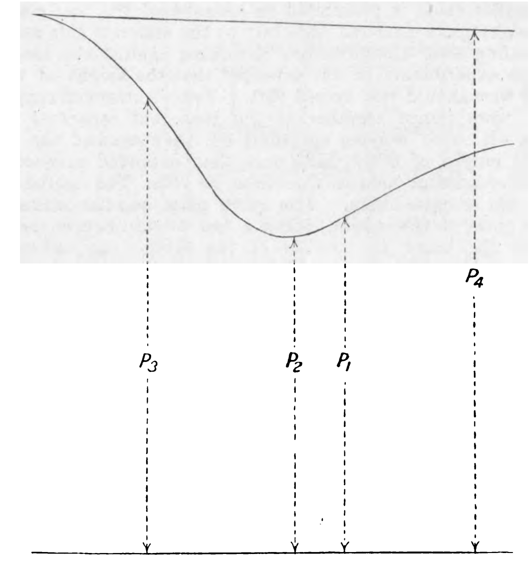
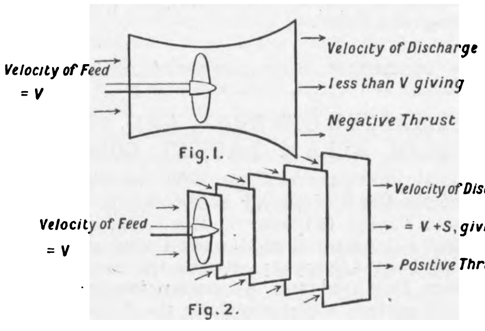


Fig. 2

Let me remind him that the thrust on the propeller itself is not the total thrust in this particular system of propulsion, but only about two-thirds of it, and that, therefore, he is not justified in measuring its intensity by the area of the propeller alone.

The correctness of Mr. Barnaby's formula for the theoretical efficiency of screw propellers will be unquestioned when its application is confined to standard designs. Its usefulness would cease, however, where the value of S in his formula fails to take a precise account of the final condition of discharge velocity.

With the complicated arrangement of several cones—as shown in Fig. 2* of Mr. Barnaby's letter—there must necessarily be a large amount of power lost on account of the edgewise resistance and skin friction of numerous cones past which currents of water at different velocities are compelled to unite under the action of mutual impact. The resistance to the flow of water through a properly shaped Venturi tube need not be so high, and it would be hardly fair to judge the merit of the one by the result of the other.



ILLUSTRATIONS WHICH ACCOMPANIED MR. BARNABY'S LETTER

Azabu, Tokio, Japan,
July 15th.
Yasuzo Wadagaki.

G.N.R. LOCOMOTIVES AT THE WHITE CITY.

Sir,—In a short paragraph in your issue of July 23rd it is stated that "No. 1," the first of Mr. Patrick Stirling's 8ft. singles, now being exhibited at Shepherd's Bush, has been restored "as it was in 1870 when it was built." The first part of this statement is not strictly accurate. Thanks to Mr. Ivatt, everything has been done that could reasonably be expected towards restoring the engine to its original condition. But nothing short of rebuilding "No. 1" would have enabled it to be shown as it was when new. Externally, there is a marked difference between the original and present appearance of the engine. As exhibited, "No. 1" has a higher-pitched and somewhat larger boiler, and a cast iron instead of a wrought iron built-up chimney, as compared with the boiler and chimney fitted to it in 1870. In other words, the public see the engine very much in the same condition in which it was reconstructed—"modernised," one might say—by Mr. Stirling in the early eighties. Those of your readers who remember the original eight-footers will agree with me that while the design remains substantially as before, there is a great contrast between the non-rebuilt and the rebuilt engines, the latter being necessarily more up to date in appearance. Moreover, "No. 1," as turned out in 1870, had spring-balance safety valves, and—what is of less importance, perhaps, since it could not easily be seen—a mid-feather in the fire-box, in place of the now customary brick arch.

Your paragraph incorrectly states that the engine weighed 70 tons, with the tender, and that it had a total heating surface of 968 square feet. These details should be 64 tons 19 cwt. (engine 38 tons 9 cwt., tender 26½ tons) and 1165 square feet (tubes 1043 square feet, fire-box 122 square feet) respectively. The grate area was 17.6 square feet, and the steam pressure 140 lb., as against 30.9 square feet and 200 lb. for the large Atlantic No. 1442. It should be noted, however, that the later boiler fitted to "No. 1" had 1045 square feet of heating surface, 17$\frac{3}{4}$ square feet of grate area, and a steam pressure of 160 lb. The weight of the engine was increased to approximately 45 tons when rebuilt.

Everybody who is interested in the development of the locomotive will appreciate Mr. Ivatt's action in sending the Stirling single to the International Exhibition at Shepherd's Bush, where, standing side by side with his own large Atlantic, No. 1442, it will enable the public to see the differences in its size and type as compared with the present-day standard express engine on the Great Northern Railway.

London, N., August 2nd.
F. W. Brewer.

MARINE PROPULSION.

Sir,—Sir George Greenhill's frank admission that his powder pressures were much too low settles one question; but it inadvertently casts some light on the rapid destruction of gun chases, seeing that the initial pressures may reach as much as 18 or 19 tons on the square inch, or about that to which a rail table is subjected by the tread of the driving wheel of a heavy locomotive. One thing, however, comes out quite clearly and satisfactorily, namely, that foot-pounds can be calculated only in terms of a force moving over a distance. This being conceded without dispute by Sir George Greenhill and your correspondents, let me proceed to apply it to marine propulsion. The principle is just the same whether we deal with a paddle wheel or a screw. But it is more simple to deal with the paddle wheel in the first instance.

A feathering float goes into the water nearly vertical and comes out nearly vertical. During the time it is in the water it pushes a mass varying in weight astern at varying speeds, which admit of being averaged. As the floats succeed one another in rapid succession, the distance over which water is moved may be averaged. Let us, for the sake of argument, suppose that the velocity of the ship is 20 miles an hour and that the slip is two miles an hour, then the forward thrust on the ship may be, say, 15 tons moved over 20 miles = to 300 mile-tons, and the backward movement of the water represents (slip) = 30 mile-tons. The power wasted is 10 per cent. We have nothing whatever to do with acceleration, or the smaller quantity driven astern at the higher speed, or loss of power in the ratio of the square of the velocity imparted to the water, or the weight of water moved, or any other condition whatever, except the two stated. The forces concerned are equal and opposite in direction, just as they are in the gun. The distance passed over by the paddle wheel centre of effort is greater than the distance passed over by the centre of effort of the crank shaft. If the distances were the same there would be no power wasted. They are not the same, and power is wasted.

We know that the thrust on the engine frames driving the ship forward is precisely equal to the thrust of the paddles on the water. Call the first force a, and the second b; a passes over, under this condition, 1760ft. per minute—the thrust is 23,800 lb., and 23,800 × 1760 = 41,888,000 foot-pounds, or 1269 indicated horse-power. But the distance passed over by the paddle-wheel thrust b is 10 per cent. greater, representing 126.9 indicated horse-power. If the slip were doubled it would represent 253.8 indicated horse-power, and so on. Precisely the same reasoning applies to the screw.

It now rests with your readers to show in what way my reasoning is wrong. We have nothing to do with the square of the velocity of the water driven astern or the work done on the water. We have two efforts—that of the paddle shaft pushing the ship ahead and that of the floats pushing water astern. The efforts are in amount precisely equal, and the work done by them is proportionate to the distances passed over. The force acting on the water moves over a greater distance in a given time than the force acting on the ship; the excess represents loss, from which it follows that slip is the direct and absolute measure of the power unavoidably wasted.

Of course there are friction and eddies to be taken into account, but these things have nothing to do with the principles involved.

August 4th.
Fuse.

Δ FALLACIES.

Sir,—"Owners and naval architects do not know what Δ is themselves." Thus says "Wetted Surface." Even though he augments my perplexity I thank him for his letter. But surely the Lords of the Admiralty must know all about Δ. Surely this must have been part of the "Britannia" training wherein they learned that (the) Britannia rules the Navy and owns it. As surely naval architects, the world over, must know their Δ. But these never divulge; following Noah, who seems to have learned a few wrinkles from the Chaldeans.

But perhaps the simile of "Wetted Surface" may apply. He compares Δ to a song without words, or maybe he means the earlier song "Alice, where art Thou?" I gather from him that navy list Δ are Fancy—, and not Fighting—, displacements. I have also gathered that there is a fourth factor in Δ additions not mentioned by "W. S." For after completion, and being duly lauded as another Britannia-brain-produced-world-wonder and Final Word, the war vessel is placed in charge of a captain who has been garnering war-fitness at the golf links while on half-pay, and who immediately asks his chief engineer to prepare a long list of defects, alterations, and improvements of the machinery. The gunnery lieutenant—wishing also to shine—volunteers a longer list, asking that all the guns shall be fitted with a pilot vent and carbonic acid flush, so as to discern, and obviate back-fire. The emulating torpedo lieutenant gives his list, proposing fitting three or four propellers abreast of each other, to the Whiteheads, instead of the present race-choppers, whereby 120 knots will result, also a few items in the E.L. system, to run into tons and thousands sterling. The navigating officer wants his standard compass fitted on the seismographic principle. The marine officer wants receptacles for the ward-room servants' gloves. All these are incorporated with a list of alterations and additions to the captain's quarters, and he—late of the golf links—persuades the Navy rulers that this additional Δ and its cost are absolutely necessary for war-worthiness. His adamantine heart heeds not the taxpayer. But suppose a captain of a Mauretania acted similarly!

I chide "Wetted Surface." He need not have invented that A.M.A.S. There is none. Doubtless the legends of the "loppy" Sidon, the Captain, and other vessels of the submerged-armour type are well known. Hence, I think, their commendable rejoicing when a warship draws no more than she should at her legend—which is the fancy—Δ. It shows that irresponsible Δ-loaders have been kept outside the compound. These are the terrors of which much might be written. They often cost their country their weight in gold yearly. And but for the Official Secrets Act——

August 2nd.
W. J. H.

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* Both the figures which accompanied Mr. Barnaby's letter are reproduced herewith for the convenience of our readers.—Ed. The E.

RAILWAY MATTERS.

In consequence of the part played by the gas-lighting equipments of the trains involved in some recent accidents, states a contemporary, the Prussian railway authorities have decided to convert all their sleeping-cars now fitted for gas lighting (some 170 cars) for electric lighting.

On the 1st of the month the electric railway from Pontresina to Bernina-Hospiz was put into commission. It is expected that in another twelve months the last section, Poschiavo-Bernina-Hospiz, of the Bernina railway, will be completed, and the service then established on the whole railway—Tirano-Veltin-Bernina-Hospiz-Samaden-St. Moritz.

The East London Railway directors' report for the half-year to April 30th last touches on the question of electrical working, as usual. It is pointed out that, as the Brighton Company's Victoria-London Bridge line is not yet working, no data as to the comparative cost of working the overhead and third-rail systems are yet available, and therefore the directors are unable to make any suggestion as to electrification at present.

It is announced in the *Railway Gazette* that, having found great advantages to accrue from the adoption of automatic signalling on the Inner Circle, the Metropolitan Railway now has it in contemplation to use this system of signalling also on the extension line from Baker-street as far as Neasden, as the train service on that section is now so heavy as to necessitate a quicker method of signalling than the existing manual system.

The result of the tenders for eight locomotives for which the Tientsin-Pukow Railway Company called in May last has just been made known by mail from China. It appears that seventy-three different tenders were submitted, and we understand that the contracts have been placed with English and American builders, in spite of the fact that the lowest tender sent in was that of the Société Anonyme des Ateliers du Thirian of Belgium, which it is stated tendered in exact accordance with the railway company's requirements and tests.

The receipts for private railways in Sweden in 1908 amount to 63,244,235 kr. (£3,513,568). This is about 500,000 kr. less than in 1907, whereas those of 1907 were about 4,000,000 kr. more than 1906, and those of 1906 were about 5,000,000 kr. more than 1905. Of these receipts about 50,000,000 kr. belong to the standard-gauge lines, the total length of which is 5944 kiloms. (3691 miles), while 13,300.000 kr. belong to the narrow-gauged railways, 3084 kiloms. (1915 miles) in length. These figures are considered to prove that narrow-gauge railways do not pay per mile compared with standard-gauge lines, although there is admittedly considerable variation in the income per day per mile on both kinds.

Construction on the Chinese section of the Canton-Kowloon Railway, which is in British hands, was begun in July, 1908, and the engineer-in-chief hopes to be able to open a section of 30 miles to traffic by April, 1910, and to run trains through to the British section by July, 1911. The foundation stone of the railway terminus buildings at Tai Sha Tau, on the river bank two miles below Canton, was laid by the Viceroy of Canton, in the presence of the Governor of Hong-Kong and a distinguished gathering of Chinese and foreign officials on April 7th, 1909. From a place called Tongshan, 1 mile down the line, where quarters for the foreign railway staff have been recently erected, a loop line will be carried round the north side of the city to connect with the Hankow main line terminus at Wangsha.

A committee of investigation has been appointed by the American Railway Association to report upon the railways which have adopted electrification. This committee is composed of officers of roads which have electrified portions of their lines or contemplate doing so. The railways represented on the committee are the Illinois Central, Union Pacific, Southern Pacific, Erie, Delaware and Hudson, and New York, New Haven and Hartford. A proposal is now before the New York Central Lines to lay out considerably over £4,000,000 during the current year, largely for the continuation of the electrification work at the New York terminal. Another section of the West Shore road between Syracuse and Utica will be electrified, and some double tracking, elimination of level crossings, and gradient revision will be carried out around Rochester and Buffalo. A considerable amount of new equipment will be purchased.

The locomotive superintendent to the Midland Railway, Mr. Deeley, has published some test data regarding the Heysham electrification. He estimates the greater weight of the single-phase over the continuous-current equipment at about 33 per cent., or about $7\frac{1}{2}$ per cent. of the total weight of the train. It is to be noted, however, that the single-phase equipment is artificially cooled, although this does not appreciably affect the energy consumption. The test data obtained over artificial runs of one mile between stops showed 100 watt-hours per ton-mile, although Mr. Deeley believed that by changing the gears and wheels to suit suburban service this figure could be reduced to 84. Unfortunately, these are not regular working results, and we have nothing quite comparable with them obtained with continuous current. On the Lancashire and Yorkshire Railway Mr. Aspinall stated the energy consumptions at the power station to be 49 watt-hours for express trains and 112 watt-hours for all classes of traffic, including stopping trains and shunting work.

The operation of the 1200-volt direct-current system of inter-urban railway control is dealt with by Mr. C. D. Eveleth in a paper read before the Street Railway Association of the State of New York. Four lines have adopted the system in America. The obvious advantages, assuming that there are no drawbacks, which Mr. Eveleth sets out to demonstrate, are that the first cost is low, maintenance is not more expensive, and extensions to existing lines can be entered upon with much more ease and confidence. There are now in operation or under contract eleven systems of 1200-volt direct-current railways, employing motors of 50, 75, and 150 horse-power, and Mr. Eveleth predicts that in a few years the 1200 voltage will be as common as 600. The cars can be easily operated on 600-volt sections where necessary. Those electrical engineers in this country who still hope that the authorities will some day "encourage" the construction of rural and inter-urban light railways will welcome these American experiences as suggesting further sources of economy in rendering their schemes commercially attractive.

We hear that the Paris-Lyon-Méditerrannée Railway Company intends, in conjunction with the Elektrizitätsgesellschaft Alioth of Basle, to convert the main line section between Cannes and Ventimiglia to electric traction. A short section from Grasse to Mouans-Sartoux will be equipped at once for experimental purposes; this section is especially suitable on account of the heavy gradients and sharp curves, and the fact that there is not much traffic on this part of the line. The overhead equipment for 12,500-volt single-phase will be carried out on a new multiple-catenary system. Wooden poles are to be used on the experimental section, but eventually steel girder supports will be adopted. The first locomotive will have four driving axles and a bogie truck at either end. It will be about 65ft. long and will weigh about 140 tons. A drawbar pull of some 16,000 lb. at 38 miles per hour, and 10,600 lb. at 62 miles per hour. The alternating current is to be converted to continuous-current on the locomotive at any pressure between 0 and 600 volts. Each driving axle will be geared to a 450 horse-power continuous-current motor.

NOTES AND MEMORANDA.

In sinking a reinforced concrete caisson for a railway bridge near Gouda, Holland, the difficulties of sinking vertically were overcome by the use of scaffolding from which the caisson was suspended from pulley blocks and steel ropes, each sustaining 100 tons. Dynamometers indicated the pull on each rope, thus showing irregularities in the soil.

According to the latest statistics, the total peat bogs of Sweden would be capable of producing 10,000 millions of tons of air-dried peat, suitable for fuel. This quantity, as compared with the present import of coal, would be sufficient for a period of 1500 years. More exact examinations of the geological character of the peat bogs will soon be started by the Swedish Geological Society.

According to statistics published in 1908 the State of São Paulo holds the second place, the Federal district coming first, as regards manufacturing industries in Brazil, the number of establishments amounting to 323, that of operatives employed to 23.007, the capital invested being estimated at 114,822,000 milreis (£7,176,375) and the value of annual production at 117,377,000 milreis (£7,336,062).

The Charts supplied to the Conservancy of the river Mersey by the Upper Mersey Commissioners show that opposite Widnes Marsh the navigable channel remains very liable to change its position. Between Widnes and the Northern Hale Beacon the fairly stable channel that has maintained itself since March, 1891, skirting the northern shore, remains. Between Hale and Dungeon Point there have been many changes, but between Speke Hall and Garston the channel remained fairly stable throughout the year, at a distance of about 2000 yards off shore.

The consumption of pulp wood during 1908 by 251 pulp mills in the United States amounted, according to a preliminary report of the Bureau of the Census, to 3,346,106 cords of wood, which furnished 2,118,947 tons of pulp. Nearly $1\frac{1}{2}$ million cords of domestic and over 670,000 cords of imported spruce were consumed. Next in order is domestic hemlock, of which 569,173 cords were converted into pulp. More than 300,000 cords of poplar were cut last year, mostly from domestic timber. The remainder of the timber, about 10 per cent. was chiefly supplied by pine, cottonwood, and balsam.

In the *Revue de la Soudure Autogène*, Bournonville describes a method of repairing cracked iron pulleys by local heating. The crack in the rim is opened by means of an expansion screw acting on the two adjoining spokes, so as to make a gap about $\frac{1}{16}$in. to $\frac{1}{24}$in. in width. Welding metal being then melted in the crack by means of the oxy-acetylene flame, the expansion screw is withdrawn quickly, whilst the metal is still red hot, and the elastic pressure of the rim counteracts the contraction of the joint in cooling. No special care is needed in cooling, and the metal can be tempered without risk of cracking.

Timber is scarce at Tucson, Ariz., and fence posts are expensive. Recently, states the *Industrial World*, the manager of the Tucson Rapid Transit Company found it necessary to string some wire fencing, and in lieu of fence posts he cut up a lot of old boiler tubes into suitable lengths and made holes in them to attach the wire fencing. He made some convenient gates by sliding 4in. tubes inside of $4\frac{1}{2}$in. tubes, the collapsible tubes serving the purpose of cross bars. Recently, in sinking a well for power-station circulating water, he utilised the shells of two water-tube boilers, sinking them one above the other to a depth of 36ft.

For eight nights during the Hudson-Fulton celebration New York will be the most brilliantly lighted city in the world, according to the plans of the Hudson-Fulton Celebration Commission. The illumination will begin at 6 30 nightly, and continue until 12.30 a.m. Estimates place the number of lights to be used, in addition to the regular lighting, at between 1,000,000 and 1,500,000 incandescent, 7000 arc lights, 3000 flare arcs, one battery of four searchlights of 100,000 candle-power each, and one battery of twelve searchlights, aggregating 1,700,000 candle-power. It is calculated that the total candle-power of lights will reach 26,260,000.

The cause of the disappearance of rust from iron bars, &c., used in the erection of reinforced concrete structures, has been traced by Rohland, in *Stahl und Eisen*, March 17th, 1909, to the presence of acid carbonates and sulphates in the cement, these salts dissolving the iron oxide and leaving the metal bright. The cement in setting absorbs carbonic acid from the air, thus forming the necessary acid carbonates; and experience has shown that the de-rusting process is effected while the concrete is setting and commencing to harden. This discovery affords an additional guarantee for the safety of reinforced concrete structures, inasmuch as the metal is protected from rusting by the alkaline reaction of the cement during the mixing process, and any rust on the bars is removed by the acid carbonates at an early stage in the erection of the structures.

At the Health Congress in Leeds, a paper was recently read by Dr. H. Scurfield, of Sheffield, on "Lung Diseases amongst Sheffield Grinders." He stated that the general death rate of all males over 20 years old in Sheffield in 1905, 1906 and 1907, was 16.2 per 1000, whilst the rate in the grinding trade was 30 per 1000. The general phthisis mortality was 2.6 per 1000, but the rate amongst grinders was 14.8 per 1000, and amongst the cutlery trade generally 6 per 1000. He accounted for this by the predisposing effect of the dust from the grinding stones on the lung. This theory was confirmed by the fact that tuberculosis was not unduly prevalent amongst the women of Sheffield, and tuberculous grinders did not appear to infect their wives and families. He emphasised the importance of cleanliness, lighting and ventilation, and the encouragement of a greater interest in personal hygiene.

A great many of the steel balls made for bearings are discarded because of imperfections. Some are not round, some unevenly hardened, and some have flat spots or other surface defects. The best of these are assorted into one or more inferior grades for use in the cheaper bicycles, clothes wringers, carpet sweepers, and the like. Many, however, are unfit for service as bearing balls, and such have become quite popular for polishing small metal objects. A typical mode of using them for this purpose is to employ a small tumbling barrel made for the purpose. The objects to be polished are placed in this barrel, together with a supply of balls, and a quantity of a soap solution. According to the *Brass World*, this solution is made of a special material. Some ammonia may be added, depending on the class of work. The barrel is then operated and, after a time, the objects become highly polished, the effect being almost equal to burnishing.

The old method of determining the temperature of a coal pile by driving pipes and hanging thermometers in them, has, states the *Scientific American*, been greatly improved by means of a special coal auger, similar in form to that used in the mines, but provided with a means of inserting a small maximum thermometer near the point. Extensions 4ft. in length—for convenience in carrying—may be attached to the auger, so that the thermometer can be readily inserted into any depth in a pile. The point of the auger can be driven 20ft. in three to five minutes. About ten minutes is required for the thermometer to attain the temperature of the surrounding coal. Temperatures taken in this manner are much more accurate than those obtained by hanging a thermometer down a pipe, where there is more or less circulation of air, making it impossible to locate the hottest spot. Temperatures obtained by means of the auger have been found to be 40 deg. Fah. higher than by the pipe method.

MISCELLANEA.

The French destroyer Chasseur, built at the shipyard of Monsieur Augustin Normand, made her full-speed trial on the 31st ult., and reached a speed of 30.4 knots, 28 knots being the guaranteed speed.

The Admiralty have directed that stoker petty officers, second class, not in possession of the educational certificate may be advanced to the rating of stoker petty officer, provided they can read and write fairly well, and are considered otherwise fit for advancement.

Wireless telegraph stations in China, according to the *Far Eastern Review*, are to be erected in the interior for the purpose of establishing communication between Pekin and the north-western portion of the empire across the Gobi Desert. Preliminary investigations of wireless installations are now being made by the Board of Posts and Communications.

Towards the end of 1908 a company was formed in São Paulo, Brazil, and a factory put up for the manufacture of a new explosive, "Steelite," the secret of which product was acquired from the inventor, a professor of chemistry in Germany. The company in question, states a consular report, supplied in the month of November alone about 2800 kilos. of their product to the Sorocabana Railway Company for blasting in the construction works which that railway is carrying out.

The winter of 1908-9 was very long and continuous in the Odessa district. There were about 100 days of frost. Great quantities of ice were formed and many casualties resulted. Fields of ice were encountered as far south as Fidonisi Island. But, though of course impeded, the entrance to the port was never sealed. Indeed, since ice-breakers were brought to Odessa in the year 1899 the traffic has never been quite stopped. In former years the port used to be stopped almost every year for a fortnight or three weeks.

Early in 1908 considerable friction existed between the Russian black plate manufacturers in the Odessa district and the local tin platers, who usually imported their black plates from Wales. The feud came to an end during the second half of 1908. An understanding was arrived at by which the local tin platers agreed to take a certain portion of the Russian black plate manufactures. The quantity that is thus to be supplied to this market not being a very considerable one, it is scarcely likely that it will have any great effect upon the usual demand for British-made black plates. This trade bids fair, therefore, to remain in British hands for some time to come.

Referring to the decision of the Government that it was desirable that, at any rate, the principal wireless stations for communication with ships should be not in private hands, but in the hands of the Government, Mr Buxton recently remarked that no licences for such stations had been given or promised for more than three years from the present time, and therefore in any case the Government would be able to take the service into its own hands. "But I think it would be desirable," he added, "to anticipate that date and take over the stations at once if it is found possible, as I hope it may be, to make an arrangement for that purpose which will be acceptable to those concerned."

Particulars were recently published of a remarkable gun-laying test of the King Alfred, flagship of Admiral Sir Hedworth Lambton, on the China station, by which a new world's record is believed to have been established. The figures regarding the test, which were transmitted by cablegram from Wei-hai-Wei, read as follows:—King Alfred's gunlayer test is found to be a world's record: Two 9.2 guns, 19 rounds, 14 hits; sixteen 6in. guns, $15\frac{1}{2}$ rounds, 10.95 hits per gun per minute; best guns, 6in., Gunner Scutchings, 12 rounds 11 hits; 12-pounder guns, Able Seaman Salwey, 17 rounds, 14 hits. The King Alfred has been a splendid gunnery ship during her term of service as flagship on the China station.

The deepening of the Kertch-Yenikale channel, states a consular report dealing with the trade of Odessa, has now been achieved, and last October the entire channel, from the Black Sea to the Sea of Azov, was surveyed by a commission appointed by the Imperial Russian Government, and the minimum depth of water was then officially announced to be 24ft.; sufficient for the steamers usually engaged in the Sea of Azov trade to cross the Kertch bar and proceed direct to the Black Sea with a full cargo without lightening. This channel is said to have been dredged to a depth of 26ft., but there is no guarantee that such depth is either uniform or permanent, and it would appear highly imprudent to reckon on there being more water than the depth officially announced.

The intention of the City Corporation further to improve the lighting of the streets under its control and to adopt gas as preferable to electricity does not please the electric lighting companies. The latter deny that gas is cheaper than electricity, as stated in the report of the Streets Committee, and they have offered to do the whole of the street lighting in the City at £17 10s. per lamp, as against £26 now being paid. The inverted gas burner which is proposed to be used by the Corporation has a candle-power of 1500, and costs £16 10s. per lamp per annum, while the electric flame arc lamp which the Electric Light Company offers at £17 10s. has a candle-power of 2000. Fleet-street is at present lighted by gas burners at £16 10s. per lamp, and the Electric Company offers to give more illumination with eleven lamps centrally hung, each to cost £17 10s.

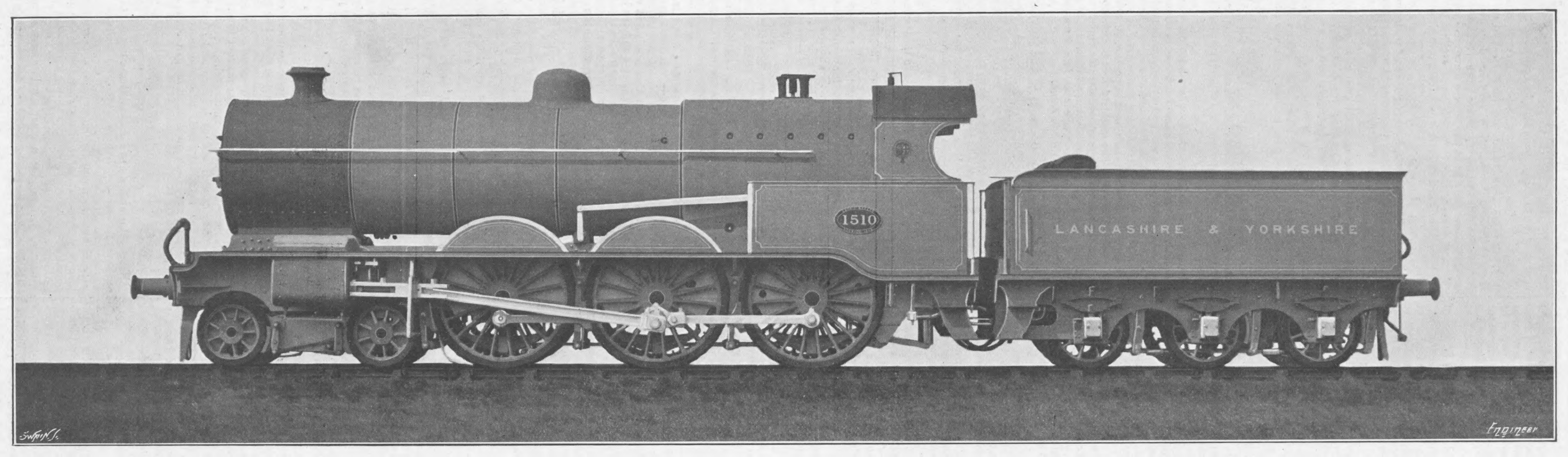
The Manchester Paving and Highways Committee, in their annual report, refer to an experiment they are making in some of the streets of the more thickly populated parts of the city. In certain streets in Ancoats, for example, the sett paving has been removed, and the carriage-ways reformed and paved with granited rock asphalt laid on a concrete foundation. This gives a smooth and unbroken surface, from which liquids fall away at once to the gullies, and enable the pavements to be more easily swept, and kept clean and sanitary. It is hoped that this type of carriage-way pavement will be successful and suitable for the class of street in which it has been laid, and, if found so, further streets will probably be dealt with in a similar manner in the future. Then, with the increased use of motor vehicles, and the consequent heavier loads carried and at higher speeds, stronger pavements have become necessary, and, in consequence, during the year granite setts have been substituted for grit setts, &c., in fourteen streets.

A paper was recently read before the American Institute of Electrical Engineers by Mr. J. B. Taylor which dealt with "Even Harmonics in Alternating-current Circuits." It is customary to assume that the electromotive force wave shapes of commercial generators do not contain even harmonics. If both the winding and the north and south poles are asymmetrical, even harmonics appear. In three-phase transmission also, when the neutral points of the transformers at both the generating and distributing stations are earthed, leakage direct-current may flow through the windings, and so, the magnetic field being asymmetrical, even harmonics are produced. The author's oscillograph records of the magnetising currents in transformers when affected by direct current show that a pronounced second harmonic is often produced. When a rotary converter is connected with a direct-current three-wire system of supply, the magnetic field is asymmetrical, and even harmonics appear in the wave shapes of currents and electromotive forces. The author has previously suggested the use of counter-electromotive force cells—similar to storage batteries with plates unformed—in order to check leakage direct currents.

LOCOMOTIVES BUILT AT HORWICH

MR. GEORGE HUGHES, M. INST. C.E., M.I. MECH. E., HORWICH, ENGINEER

(For descriptions see pages 122 [ante] and 147)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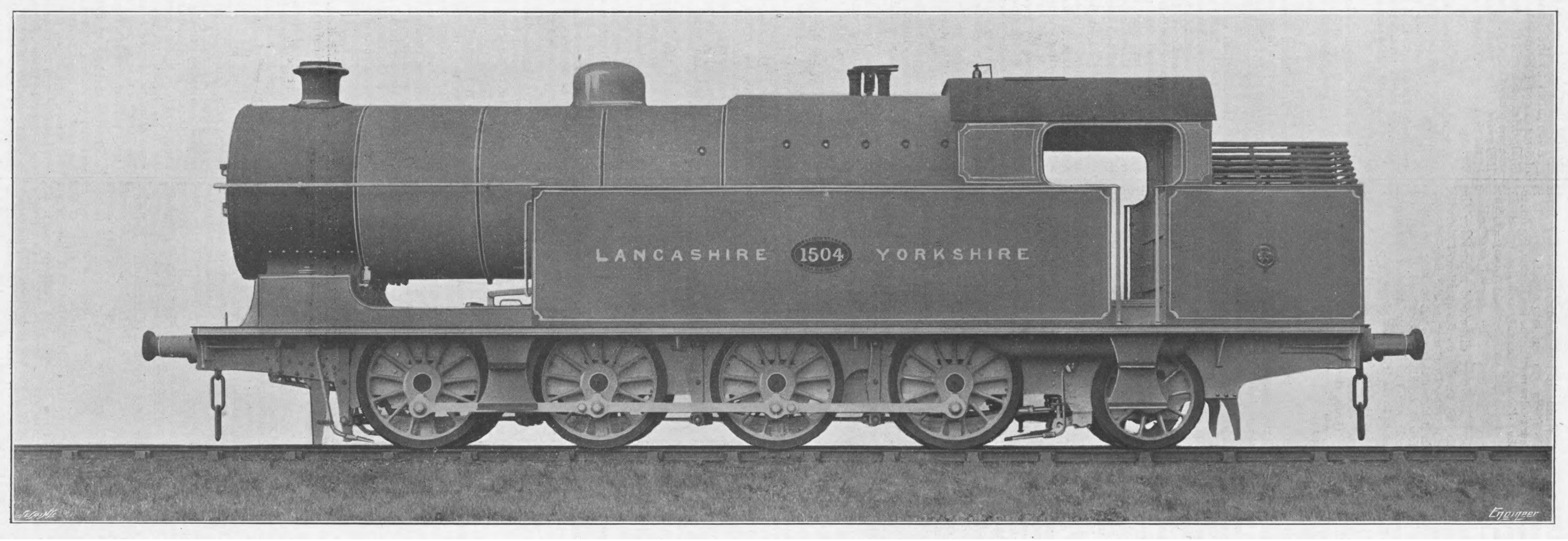
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TO CORRESPONDENTS.

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REPLIES.

W. B. (Barnstable).—The matter is entirely a question of the power applied to the pump. To lift water 12ft. requires three times as much power as is necessary to lift the same volume 4ft. For a given power therefore you will only get a third as much water from a depth of 12ft. as you will from a depth of 4ft., providing the delivery is at the pump and not above it. If the lift above the pump is heavy the disparity is, of course, not so great.

MEETINGS NEXT WEEK.

The Railway Club.—Thursday, August 12th. Visit Croft Granite Quarry and Works. Leave Leicester, Midland station, by 2.10 p.m. train for Croft.

THE ENGINEER.

AUGUST 6, 1909.

The Scottish Coal Dispute.

It is with gratification that we chronicle the settlement of the Scottish coal dispute on one of the lines we ventured to suggest a fortnight ago—namely, the concession by the coalowners of the 6s. a day minimum on condition that they were to retain a larger share of the advances in price beyond the "basis" than hitherto. The miners are to have higher wages during times of depression, and the owners higher profits in time of prosperity. The Scottish Coal Trade Conciliation Board is renewed for three years, the minimum wage is raised from 5s. 6d. per day to 6s., and the sliding scale is to be recast so that the miners will have a lesser, and the owners a greater, share in the price advances above 7s. 5.45d. per ton than has been the case under the old agreement. The readjustment of the sliding scale may possibly provide matter for difficult and delicate negotiation, for it is laid down in the terms of settlement that in the fixing of the new "basis price" and "steps," or compartments, by which rises and falls of wages are to be measured, "consideration is to be given to the effect which the granting of an increased minimum wage would have on the relation between prices and wages, and also any other new circumstances bearing on increased or decreased costs since the agreement of 1904 was entered into, which the arbiter considers relevant." With the dispute verging upon open conflict, a looseness in the drafting of agreement is not to be wondered at. We merely point to the fact in order to indicate the possibilities of debate, if not dispute, over the readjustment of the sliding scale. It is also provided that the neutral chairman, in giving his decision as to alterations in the rate of wages, "shall take into account the state and prospects of trade." In view of what the Eight Hours Act may mean in shape of "new circumstances bearing on . . . costs . . . since . . . 1904," and the difficulty of accurately gauging trade "prospects," coupled with the firm resolution of the miners that neither the laws of trade nor the laws of the State shall impose any loss or disadvantage upon them, it is quite conceivable that we have not yet heard the last of the Scottish coal dispute.

For the moment, however, a great national strike has been averted, and for this happy issue the nation's thanks are due to the coalowners, who have displayed not merely a conciliatory but a positively generous spirit. The Scottish coalowners have granted concession where no concession was due. They have saved our industries from dislocation at their own immediate expense at a point where they would have been absolutely justified in yielding nothing, and their action is in marked contrast to the utter disregard of the commonweal evidenced by the Miners' Union. On every point of fact connected with this dispute the masters were entitled to refuse concession; therefore, while we rejoice in the settlement, it is with small satisfaction that we view the spectacle of a labour union dishonouring its pledge, entering a dispute in which its case is so poor that it would not stand the test of arbitration, and then under threat of inflicting intense suffering upon the nation, winning its demand. This is the triumph of might over right, and it is time we pondered seriously the issues involved. We have been brought to the verge of a large industrial war over a small local matter. We have had glaringly displayed the power and the readiness of an organised faction to put the whole community to unlimited loss and annoyance. The situation is intolerable, and the community must take measures to diminish, if not banish, the dangers of the position. We have already travelled a long way on the road of State interference and control, and it is worth considering whether we should not go a step further and make industrial arbitration compulsory. At any rate, we might follow the Canadian example in requiring employers and workmen to confer together and publish the particulars of their disputes before any strike or lock-out can be proclaimed. In our present complex commercial system the employers and workmen immediately concerned in a labour dispute are not the only persons who have a stake in the matter. It is time the public interest was considered. As the State is making itself more and more responsible for the welfare of labour—free education in youth, restricted hours in manhood, and pensions in old age—then the State must attend to the duties of labour.

The Steam Consumption of Turbines.

The veil of mystery which has surrounded the design of steam turbines is gradually being lifted. At intervals papers are read before the various learned societies which throw more light upon this subject. One of the most recent of these contributions is entitled "A Method of Determining Pressures for Steam Turbines," and was read before the Society of Naval Architects and Marine Engineers in America by Professor C. H. Peabody. In this paper the author describes a method of equalising the adiabatic heat fall in different stages of a turbine. He applies this method in the first instance to a two-stage and then to a six-stage Curtis turbine. The object in view is to have the same velocity in the nozzles of all the stages. Merely dividing the adiabatic heat fall between admission and exhaust into equal parts does not give true results, for the simple reason that some of the heat not converted into work in one stage is utilised in subsequent stages. The error, however, is only in the neighbourhood of 3 per cent. There is no great difficulty in correcting this error by a method of trial and error, but Professor Peabody has devised an ingenious albeit rather cumbersome scientific method of arriving at the desired result. His method is apparently more direct than the method usually employed, but it involves much recourse to steam tables, not to mention the interpolation of numerous entropies. We think the designer will prefer the simpler and in reality more expeditious method of trial and error.

There is, however, an extremely simple graphic method of arriving at the desired result by using Mollier's well-known Heat Entropy chart. It so happens that on this chart the condition line of the steam as it passes through the turbine from stage to stage is represented by a curve so flat that for all practical purposes it may be taken as a straight line, and this curve can be laid down as soon as the stage efficiency ratio has been determined. The points of equal adiabatic heat fall for each stage are almost equidistant on this condition line, and the small correction necessary can be effected by inspection. We have calculated Professor Peabody's six-stage example by this method, and have arrived at a somewhat more accurate distribution of the heat fall than he has. The operation took something under fifteen minutes, whereas the Professor's method could hardly be computed under an hour. Further, the Mollier chart method can be applied with equal ease when the admission steam is superheated, whereas Professor Peabody only shows how his method can be applied with saturated steam, and it is difficult to see how it would would work with superheated steam. It is to be noted that Professor Peabody, in working out his numerical example, assumes an efficiency ratio of 65 per cent., which, incidentally, he terms the "overall internal heat factor." He also discriminates between the efficiency ratio of each stage and the overall efficiency ratio of the turbine, and seems to think that this distinction is new. In this, however, he is in error, as the distinction is well known, at any rate on this side of the Atlantic. It is further to be observed that the 65 per cent. efficiency ratio which he takes is determined by comparing the assumed economy of a turbine with the corresponding Rankine engine.

This leads us to point out the considerable difference which lies between the predetermination of the steam consumption of a reciprocating engine and that of a turbine. In the case of the former the losses are deemed to consist principally of leakages and condensation, which is partially recovered by re-evaporation; but, unfortunately, these losses are so intermixed that it has so far been impossible to disentangle them. We need not elaborate this point, as it is well known to engineers, and has been referred to on many occasions in these columns. In the case of the steam turbine, however, the various losses, which are principally leakage and steam friction, can be measured separately by suitably devised experiments. This has already been done to a certain extent, and formulæ by which these losses may be estimated have been established by Stodola and others. Undoubtedly, also, the various turbine manufacturers have data of their own which they do not make public. It is therefore possible in the case of a steam turbine to estimate the losses with considerable accuracy, and then by comparison with the corresponding Rankine engine the steam economy can be readily obtained. The experiments to determine the losses in a steam turbine are still, however, somewhat meagre, and it would be of great advantage if an exhaustive series of such experiments could be made. Would it not be possible for our technical colleges to collaborate in this matter, each undertaking a definite portion of a well-considered scheme of investigation?

Flexible Crank Axles.

THE crank axle is the weakest member of the machinery of a locomotive, in the sense that it is that part most liable to fracture. It has been said that if only the fire-box would last as long as the engines the life of a locomotive would be wearisomely prolonged. The crank shaft is the exception to the general rule, and this is one reason why the outside cylinder is popular. The crank axle usually breaks somewhere about the webs. The pins separate from them, or they break away from the body of the axle, or the webs will break straight across. To guard against this it is a usual practice to shrink steel hoops round them. There is a very old fable about the oak and the reed. In a storm the oak was torn up by the roots, and, dying, it asked the reed how it had escaped. "By bending to the storm," was the answer. This principle has been invoked over and over again in the case of crank axles, and various methods of imparting elasticity have been tried, always with a certain amount of success. The simplest plan is to make the crank webs thin. But if they are thinned sufficiently they are apt to give way in the plane of rotation instead of transversely. Mr. Thomas Worsdell, of the North-Eastern, therefore patented a crank axle with circular disc webs, which can be made quite thin, and have nevertheless enough metal in them for strength. The well-known oval crank cheek effects the same purpose, but not so efficiently.

Recently in France a new flexible crank axle has been tried apparently with great success, and has been made the subject of a report prepared by M. Ed. Sauvage for the Comite des Arts Mécaniques. The report is based on the proposals of M. Charles Fremont, who has submitted to La Société d'Encouragement particulars and specimens of his invention. Several crank shafts were sent for examination, both of the ordinary four-web and the French two-web or "Z" type. They had cracks occurring for the most part at the junction of the crank pin with the web, or the junction of the last with the main body of the axle. M. Sauvage explains that failure is almost invariably gradual; a minute crack starts, and extends by degrees under the influence of the longitudinal shocks to which the axle is exposed by the impact of the flange against the inside of the rail, and particularly by the striking of the inside of the tire against guard rails at crossings. The cracks manifest themselves after variable terms of service. They are always small at first, and go on spreading. Superficial at the onset, they gradually become deeper; but how deep there is no means of knowing until the axle breaks. After a time the axles have to be withdrawn from service. M. Sauvage is positive that the failures are always due to end-long shocks or stresses acting "perpendicularly to the line of road." M. Fremont argues that when a portion of a machine receives a shock the work corresponding should be absorbed by the elastic deformations of the piece, otherwise permanent set will be imparted. But the longitudinal stresses to which a crank axle body is exposed cannot produce elastic or any other deformation. The crank cheeks again are very stiff; and the result is that the mischief is concentrated about the angles where the cylindrical portions are united to the web. To get over this M. Fremont uses broad webs thinned away in the middle of their length. Furthermore, a large aperture is made in the centre of the web, which, while retaining to the full its power to resist the torsional effort of the piston, becomes so far weakened as regards transverse shocks that it can freely respond to them. With the Worsdell circular web he attains the result by making a large aperture, resembling in form a dumb bell in section in the web, which otherwise remains unaltered, being fitted with a hoop shrunk on in the normal way.

The position of M. Sauvage as assistant mechanical engineer-in-chief of the Western Railway of France imparts weight to his utterances. He is altogether in favour of combating, by imparting elasticity, the stresses which break crank axles, holding that to attempt to fight them by brute strength must lead to disaster in the long run. Also he holds that M. Fremont appears to have hit on a very satisfactory solution of this difficulty, even going so far as to say that axles which are already slightly cracked, may be continued in use if the crank webs are bored and slotted out as proposed. It is unnecessary to remove the wheels, and the cost, everything included, is given by M. Sauvage as only 87f., or say, £3 10s.; quite insignificant when compared with the value of the further service which can be had from the axle. It seems that on the Southern Railway of France five cracked axles have been thus kept in service. These engines had run distances varying from 106,000 to 212,600 miles from the time they were put to work until the cracks were discovered. Subsequently they ran further distances varying from about 32,000 to 81,000 miles. The webs were then "modified," and since they have run from 90,000 to 114,000 miles up to the 31st of March last. An interesting fact about the first of these axles is that it showed when the web was bored out the existence of an old crack. Careful examination has proved that since the operation there has been no extension of this fissure. Four new crank axles made on this system have already run large mileages—125,400 in one case—the most careful examination failing to discover any symptoms of cracking. M. Sauvage's final conclusion is that M. Fremont's system is logical. It augments the life of crank axles, and improves all the conditions of their service.

There is, we think, very little to criticise in this report. No one, so far as we are aware, disputes the vital importance of imparting elasticity to a crank axle. The question for solution is the best method of doing it. In effect the removal of a large part of each web seems to be much the same thing as boring out crank pins and crank shafts in marine work. We are not aware of any instance in which the crank pin of locomotives have been bored out. The stresses are quite different in many respects from that to which a marine crank shaft may be subjected. Many locomotive engineers hold that if only the steel is really good, nothing more is needed than the normal hooped web. This is, we think, a mistake. In large modern engines it has been found almost indispensable to fit a central bearing to take fore-and-aft stresses. But this can only partially deal with the shocks, which M. Fremont eludes. Mr. Ivatt, of the Great Northern, is now exhibiting at the "White City" a very novel crank axle, which we illustrate on another page.

M. Sauvage does not say whether the engines running with cracked axles are goods or passenger locomotives. In either case a notable divergence from English practice is manifest. We do not think it would be easy to find a locomotive superintendent in this country who would take the responsibility of keeping in service a cracked crank axle. He would get little mercy from a Board of Trade Inspector if an accident took place. We may, however, profit by amiable indiscretions of our neighbours, and gather increased confidence in the Fremont system from the fact that it will keep even cracked axles going for an apparently indefinite period.

LITERATURE.

The Adventures of a Civil Engineer: Fifty Years on Five Continents. By C. O. Burge, M. Inst. C.E. London: Alston Rivers, Limited. 1909.

THIS is the holiday season. Engineers are like other men. They usually read at least a little while they are resting, and this is just the book for them. We have the interesting reminiscences of a professional man, told in a most delightful way. Mr. Burge is an Irishman, full of humour, abounding in good stories. Even when these are old his method of telling them gives them a new charm. The book is full of suggestions. To the young engineer of the moment it should be full of interest, if he cares, as he ought to care, to hear something of the things men of the last generation did, and how they did them.

Mr. Burge begins by pointing out that the life of a railway engineer, most of whose career has been spent in the wilds, naturally presents a series of incidents largely of an adventurous character. "The big-game slayer generally confines himself to his one exciting subject, but the railway engineer has to make the best of an ordinary life in the wild jungle, veldt, or lonely bush, making things comfortable by the construction of railways for the people who follow him, which done, duty calls him still further into earth's wildernesses to repeat the process." He sketches life in Dublin in the middle of the last century. His innate spirit of fun crops up in every page. Speaking of the early railway days, when all trains stopped at every station, he goes on to write about the first expresses. "When the more modern system was introduced, and an express train at Broadstone Terminus, Dublin, was about to be started, a porter came along the platform shouting in stentorian accents, 'This train stops nowhere.'" And again, speaking of the extreme slowness of trains, "A friend of a director, remarking that a line was the first one built, the latter replied, 'Well, no, it was one of the early ones, but not the first.' 'But I can prove it; your trains are mentioned in the first chapter of Genesis, where it is stated that God made everything that creepeth upon the earth." We must content ourselves with one more of Mr. Burge's railway annecdotes. An Irishman who was hurt in a collision "claimed and got compensation not only for himself but his wife, who had not been injured by the accident. 'An' how did ye manage it? said a friend. 'Shure an' hadn't I the prisence of mind to fetch her one in the head before they dhragged us out.'"

Up to 1866 Mr. Burge was employed on railway work in the Isle of Man and various other places at home. Then he went to Madras, and the story he has to tell of an engineer's life in India in these days is well worth reading. We commend in particular, however, the account of the way in which he got the best of several opportunities going. There were several berths to be filled up on the Madras Railway. He asked at the London office by what mail steamer he ought to start, and was told that either the next or the one after would do. So he secured a passage in the first boat, arrived at Madras a fortnight before the other engineers, and was at once appointed to the entire charge of the only railway construction division then vacant, the filling of which was a matter of urgency. "The rest, most of them just as experienced and well qualified as I, but coming later on the scene, became only assistants to others in my position, and in consequence they were left years behind me in subsequent promotion, owing not so much to absence of qualifications as to want of opportunities of showing them." Mr. Burge does not mention what ought indeed to be an obvious deduction. A young man, prompt and zealous enough to lose not a day in going to India, possessed qualifications of a very valuable kind. Indeed, we find cropping out continuously evidence that our author was peculiarly fitted to make himself useful in the fullest degree to all whom he served. He seems to have been blest with an indomitable tendency to make the best of everything, to take life by the smooth handle, and to get his work done under all manner of difficulties. He never seems to have missed the humorous side of life. This, for example, is what he says about English navvies in India.

> "When railways were first introduced into India the English contractor thought that English navvies were essential to construction, and they were accordingly imported, but it was soon found that the climate was unsuitable for European manual work, and though the native could not rival the white man in the amount of work done, his wages were small enough to overbalance this, and so white labour ceased. The English railway navvy of the mid-Victorian period belongs to an extinct species. He was very different from the labourers of the present day, when railway construction has practically ceased at home, and machinery has so largely supplanted manual effort. He had the thews and sinews of a prize-fighter, and an enormous capacity for work, and, unfortunately, at times for drink. I suppose it was the latter propensity which led to an order by the Madras Government censuring some of the navvies for seizing and carrying off some native policemen whose sense of duty led them to interfere in a drunken row. It was before my time, and it was said that each navvy took two constables, one under each arm, and chucked them outside the railway fence."

Leaving India, Mr. Burge obtained work in South Africa. It is impossible to begin this section and put down the book before it is finished. He must be a dull dog indeed who will not find his reward. He used his eyes to some purpose, and we commend his views as to the characteristics of various native people to the consideration of those who form opinions at home based on them. "The Kaffir has a splendid physique; but he is not only born but lives and dies tired." On the whole, however, he has a fairly high opinion of foreign labour. But we must hasten on.

Possibly no chapter in the book will interest engineers more than the story of the construction of the great Hawkesbury Bridge, New South Wales, in which Mr. Burge took an active part as resident engineer in charge. The work was carried out by American contractors, and involved a great number of exciting incidents. He speaks in high terms of American engineers. "I have had many dealings with English, Indian, French, Spanish and American civil engineers, and for infinite resource in emergencies, for boldness of conception, for grasping successfully the skirts of happy chance, the latter seem to me to stand unrivalled."

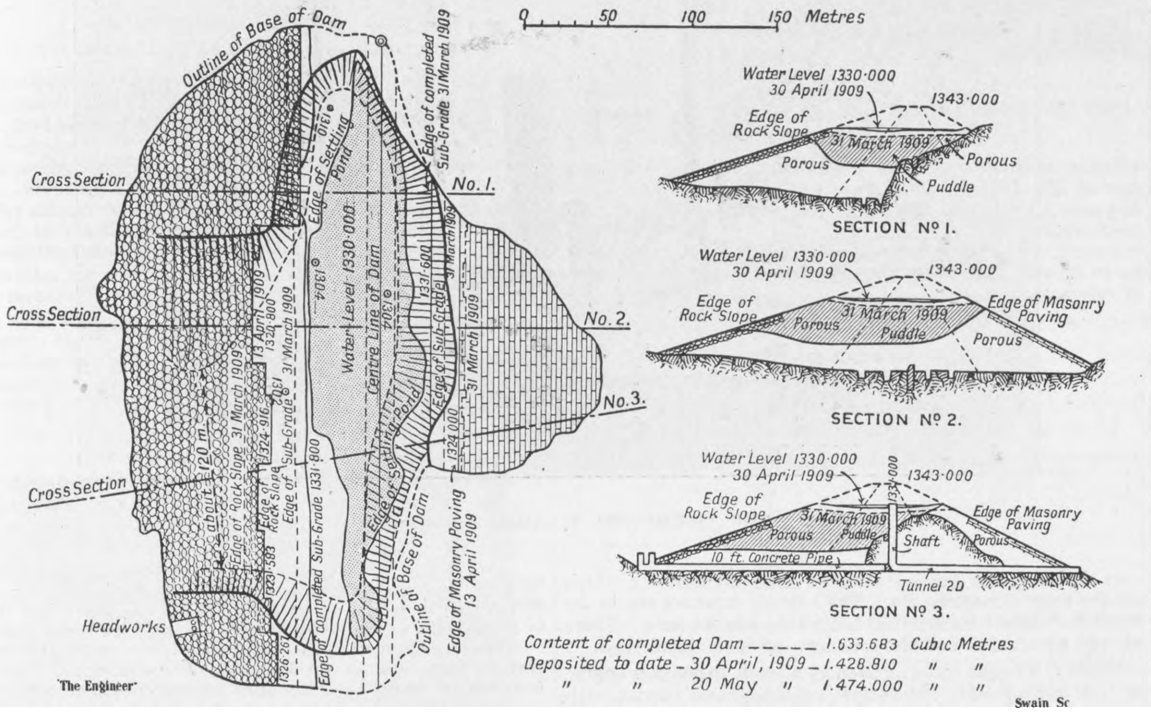
The latter pages of the book are as interesting as shrewd, as full of humour as the first. The last paragraph must be our last quotation. Speaking of the numerous colleagues with whom he has worked, our author says:—"Many have I found highly capable, many hard workers, some of them mathematical geniuses, several of infinite courage and resource, some ignorant, some lazy, a few drunkards, others crotchety and difficult to deal with, but not one have I met with who was dishonourable or corrupt."

The volume is illustrated by eight extremely good reproductions of excellent photographs. The printing and paper leave nothing to be desired.

ACCIDENT TO NECAXA DAM NO. 2.

No. II.[*]

After the break, it was found, by examining the sides of the emptied clay puddle core, that there remained clinging to these sides a very considerable thickness of between 2 m. to 5 m. of clay, which had parted from its surplus water by drainage into the adjacent rocky embankment, or into the tepetate of the hill-sides, and had become solid, stable, and firm, just as it was expected it would have become. On the 1st June a test pit was sunk in the lower toe embankment with a bight, where the 1310 contour was furthest from the centre line, the idea being to find out what the material was like in that position. This pit went down to 2.40 m., through stiff yellow clay in very firm condition, containing particles of gravel in places. From the bottom of this pit a sounding rod was churned down to a further depth of 2.30 m. by eight men, passing through practically the same class of material. At elevation 1305.30 they stopped, as they could get no further. It was considered that nothing could be more satisfactory than this test; in fact the entire down-stream toe was built up at all times under more favourable conditions, with a broader crest and greater super-elevation above the pond than the up-stream toe dyke. This was due to the dam being so placed that it lapped over the face of the hills on each side, in order that the latter could be covered with a blanket of clay to prevent leakage from the reservoir through the tepetate. This made the up-stream toe much longer than the down-stream toe, and consequently it required much longer flumes to carry materials. In order to make the progress of the up-stream toe keep pace with the other, the crest was always made narrower than the broad top of the down-stream toe, although, theoretically, it should have been wider. To increase the pace on this slower side of the dam it was finally resolved to go to the south side and begin sluicing from the clay and tepetate on that side. Mr. Schuyler declares that he assented to this with reluctance, as he had always endeavoured to avoid the use of tepetate or the reddish clay which goes with it, and in his original report he recommended that the dam should be built exclusively of limestone and the yellow clay which accompanies it. In all probability the down-stream toe owes its greater stability to the fact that limestone has been used in its construction exclusively to about elevation 1325. Having a slope of two to one, it was theoretically less stable than the up-stream slope built three to one; but the limestone weighs practically twice as much as the tepetate, and as the part of the up-stream slope where the break occurred was entirely composed of tepetate, except possibly for 3 m. or 4 m. in the bottom, it was less stable than the down-stream toe, although of a greater bulk as planned. Actually, there were narrow places in the crest of the up-stream toe, very frequently due to the fact that the flumes did not always quite meet from each side.



PLAN AND SECTIONS OF NECAXA DAM No. 2

A photograph was taken in March of last year, which shows one of these narrow spots directly in the line of the 10ft. pipe, where the slide started. In such a bay left by a narrow crest clay would be deposited outside the theoretical section. It was at this spot that a break occurred on the 2nd March, 1908, when the summit pond was emptied, and some 10,000 cubic metres of clay were washed into the reservoir. It is considered beyond question that this old break, combined with the fact that the crest of the up-stream toe was not immediately refilled to the full width, such as the north end possessed, contributed to the accident. Another contributory cause may possibly have been the heavy blasting which had been proceeding for many months past. The explosions, which were very violent on occasions, might have shaken open a way for water to percolate from the summit pond out underneath sufficiently to lubricate the mass. Mr. Schuyler himself does not believe in the last possibility, but attributes the causes of the accident to a combination of four principal conditions or facts, which he summarises as follows:—

(1) The scarcity of water, due to the long drought and the consequent emptying of the reservoir, for had the reservoir been half full, as it would have been under normal conditions, the pressure on the up-stream slope, in combination with the weight of the stone itself in that slope, would have counteracted the hydrostatic pressure of the summit pond, and the equilibrium of the mass would not have been disturbed. Once the pond on top was replaced with earth or rock, the drainage of the core would have proceeded more rapidly, and the mass have become solidified within a few months thereafter.

(2) The peculiar quality of the clay, which did not harden in the centre, although making both side embankments impervious to water. In this respect it differed from other clays that have been used for this type of dam elsewhere.

(3) The narrow crest width of the up-stream rock-filling, due to the greater length of that side, and the constant difficulty of keeping the flumes built sufficiently in advance of the work.

(4) The use of tepetate having a specific gravity of 1.75 to 1.80, for the up-stream rock-fill in place of limestone with a specific gravity of 3.0 to 3.4. This combined with the particularly narrow crest width which existed at the time of the break of March 2nd, 1908, where much clay must have been deposited dangerously near the edge, and directly in line of the final break, might have been the most important of all the contributory causes.

Having shown the result of the accident, it will be of interest to point out the remedy suggested, which was arrived at after a long conference between all the engineers employed upon the Necaxa dam:—

(1) That the up-stream toe wall should be replaced where broken by an embankment of limestone sluiced in place, using materials of all sizes, but devoid of clay, and that the embankment should be given an inner slope of one to one instead of resting upon the clay as heretofore.

(2) That the down-stream toe sluiced wall should be reinforced on the inner side by limestone in place on a slope of one to one.

(3) That underneath the base of the down-stream toe in the break all soft clay overlying the hard rocky bottom should be removed by sluicing with a hydraulic jet, which was to be kept boring out the mud to the bottom in advance of the stone filling, so as to ensure the new embankment resting on solid bottom. In the south pit some basalt can be obtained, and is to be used for the south end of the up-stream dyke, but tepetate is to be kept out of the first construction entirely.

(4) That the centre core between the dykes thus formed should be filled with a mixture of clay and limestone and tepetate, having just enough clay completely to fill voids in the stone and to become stable and solid at once.

It is believed that, constructed in this manner, the dam must be safe at every stage of its progress, no matter what may happen. If floods fill the reservoir to the top of the 10ft. tower, they would not materially interfere with the work or endanger it in any way.

So far as the working condition of the dam is concerned, the down-stream toe is said to be in such a satisfactory state of solidity and imperviousness as to be perfectly safe against water pressure to an elevation of at least 1315. If, as is expected, the clay under the up-stream dyke can be removed and replaced with stone within two months, it would probably no longer interfere materially with construction to allow the reservoir to fill to 1310 level.

With regard to the reconstruction which is proceeding, the work on the flumes required to begin depositing rock shows much progress. The down-stream toe flume is almost ready. According to the estimates made, there will be required 100,000 c.m. to build the up-stream toe to the 1320 elevation, and 44,000 c.m. to fill out the down-stream toe to the elevation of 1333. To reach this level there will be required, according to the agreed plan, a deposit of this 144,000 c.m. without holding the contained clay. The remaining 433,000 c.m. will be chiefly the clay concrete, although to build the up-stream dyke above the 1320 contour will require a considerable quantity of clean rock. Thus probably half of the 577,000 cubic metres needed to finish to the 1333 level will consist of rock with its accompanying clay wasted. This portion of the work will, as above indicated, occupy at least six months.

The plan of building the up-stream dyke is to carry rock from the north pit in a flume of such height as will reach the south side of the break at about elevation 1315. As the rock drops from the flume the mud which has to be removed will be stirred up by a monitor directly in front of the dump. In this way it is expected to sluice away the mud, displacing it with the stone.

The central clay core is said to be drying out rapidly on top where exposed, and the engineers are now sinking 4in. pipes every 20 m. to the 10ft. concrete pipe, in the expectation that they can drill holes through the top of the concrete, and thus provide drainage for the clay core into the large pipe. The water would then be drained off through the bulkhead at the shaft by opening the 4in. valve or removing it. Inasmuch as these holes would determine whether the pipe is filled with clay or water, they should prove of great benefit. Should the drainage not be accomplished in this way, the holes could still be used to let down dynamite to the concrete pipe and blow it up, thus ensuring its being filled.

As already indicated, the accident to the Necaxa dam No. 2 is absolutely unparalleled and unprecedented in the construction of earth dams; but serious and costly as the occurrence has proved, it is not altogether impossible to take a favourable view of the occurrence, since it has proved a valuable experience to the engineering world. In fact, Mr. Schuyler in discussing the matter declares that the break is really "a blessing in disguise," coming as it did at a time when several other important dams were being constructed, and when the lesson of this experience was likely to prove most valuable. A great deal of exaggeration has been indulged in with regard to the amount of pecuniary loss incurred by the Mexican Light and Power Company, and it may be worth while, therefore, to state exactly what this will be. From a careful estimate it may be said that the money lost will not exceed 1 per cent. or 2 per cent. of the total capital expenditure, and, therefore, must be regarded as of comparatively small importance. Considering the stupendous character of the whole undertaking, and recollecting that this is the first really serious accident which has occurred since construction commenced, an unnecessarily gloomy view of the matter need not, it is thought, be taken. Apart from the financial loss which may, we understand, be regarded as not exceeding £40,000, the result of the accident has been that the power plant was shut down entirely from the 21st May until 3 a.m. on the 26th, when it again resumed operations, and has so continued. The full power at the El Oro Mines was not resumed, however, until the 10th July, but is now in full force. Since May 26th the head works at Necaxa have been entirely cleared, and there has since been no interruption whatever to the service.

THE FORERUNNERS OF THE METALLIC FILAMENT INCANDESCENT LAMP.

By Dr. C. RICHARD BÖHM, Berlin.

The power of the alkaline earths and of magnesia to emit an intense light when heated was already well known when the electric arc light came into use, and therefore it was only natural that attempts should have been made to use those substances in the electric lighting industry. Early trials made with them proved temporarily successful, but they were superseded by the rapid development of the electric arc and the electric incandescent lamps. Then came the incandescent gas mantle, and the desire to compete with it, caused further experiments to be made with a view to utilise these rare earths which had proved so successful with gas.

At first the oxides or salts were mixed with powdered carbon and ground to a paste with an organic binding material, viz., gum, coal-tar, molasses, &c. Out of this paste filaments were formed by pressing, and these, after being coated with carbon powder, were subjected to red heat. Further on, organic fibres or collodion threads were impregnated with solutions of suitable salts, or carbon filaments were used, and these were coated with light-emitting earths or oxides, which may be termed conductors of second class order, or with metals, which are conductors of first class order. Then a filament of metal was given a trial, and for this purpose the metals of the platinum group, which have such a high fusing point, naturally received the first consideration. The manufacture of a filament of osmium, which is so brittle, but has such a high fusing point, offered considerable difficulties. These were, however, overcome by Auer, who with his Osmium or Osram lamp, put a weapon into the hands of the electric lighting industry which first made it possible to compete on more equal terms with the incandescent gaslight.

All the proposals for manufacturing filaments for electric incandescent lamps out of a compound of conductors of first and second class order have hitherto led to no practical result. The reason for this is to be found in the effect of the high temperature in the glowing filament and the subsequent chemical reaction. It is now considered beyond doubt that the formation of carbides plays an important part in the destruction of the filaments of this sort. In this respect the German patent No. 128,925 of 1902 of Just and Falk does not help to overcome the difficulty, because experience has so far taught that filaments cannot be made from zirconium or its oxide without organic binding material. The same may be said of the German patent of Kellner (No. 138,468), according to which the mantles are to consist of thorium or titanium, intermixed with their oxides.

In choosing a filament of carbon or metal in combination with conductors of first and second class order, it must be remembered that the outside coating of oxide will have a section five or six times as large as that of the core. In order to create the heat for making the filament glow, a current of such strength has to be carried by the core that it would also be volatilised. The alternative way is to coat a core composed of conductors of second class order with a conductor of first class order. Such a proposal is to be found in the classical patent of Jablochkoff and in an English patent.

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[*] No. I appeared July 30th

By using mixtures of two or three oxides instead of magnesia or zirconia (with yttrium oxide for instance), Nernst filaments were obtained; these require heating mechanisms. Scharf wanted to avoid this drawback by a combination of oxides and metals, an idea which is again met with in the German patent 128,925. According to this patent the filament is composed of a metal (Zr) and an oxide ($Zr\,O_2$). If we consider all oxides as conductors of second class order, then Bolton's idea is more to the point, as he proposes in the German patent No. 161,081 that the lower oxide of tantalum, which is to carry the electric current, shall be mixed with the non-conducting oxide of zirconium ($Zr\,O_2$), then turned into a thread, which is to be heated by the electric current in the usual way. By this process the oxide of tantalum is reduced to the metallic state, whereas the zirconium oxide is left unaltered, but in a very fine state of sub-division. This circumstance should prove a matter of great importance in the manufacture of filaments from conductors of the first and second class order, as it has been ascertained that the original materials must be in a state of the finest possible division, and this condition can ordinarily only be attained with the greatest difficulty. It is a well-known fact that it is almost impossible to mix the more or less ductile metals intimately with oxides. Although the idea of Bolton was perfectly correct, he was foiled through the great affinity of tantalum metal for hydrogen, and therefore it was impossible to manufacture useful filaments according to his German patent No. 161,081. The metal wolfram or tungsten does not offer the same drawback, because a compound of tungstic acid with conductors of the second class can be heated in a current of hydrogen to the point of the reduction to the metal, and thus the desired fine division of conductors of first and second class order may be obtained. According to a later patent, specified quantities of $Th\,O_2$ and $Zr\,O_2$ mixed with tungstic acid are fused together in an iridium crucible by means of an oxyhydrogen blow-pipe, and the highly refractory tungsten compounds are then pulverised. If this product is then heated in a current of hydrogen, a combination of conductors of first and second class order in the finest division will be the result. If anyone did succeed in manufacturing filaments composed of metals and oxides of metals in a fine state of division, it could be said that the heater and filament of the Nernst lamp had been united in one single thread. It can be gathered from the German patent 187,083 that the latest endeavours are being directed towards this end, as according to this patent the conductor of first class order consists of metallic tungsten, or a tungsten alloy, whereas the rare earths ($Zr\,O_2$) and ytterit earths are selected for conductors of the second order.

At present no satisfactory way of doing away with the organic binding material appears to have been discovered, and as the rare earths easily unite with carbon, the resulting filaments must contain carbide. It may be mentioned that Léon de Somzée of Brussels, protected in 1899 a filament made of silicon to which he added some rare earths (oxides) for the purpose of increasing the emission of light.

Tungsten carbide, which is formed intermittently, is decomposed at the temperature of the glowing filament, so that metallic tungsten is left, and the carbon is, as we may say, distilled out of it. This peculiarity and the slight affinity of tungsten for hydrogen have led to the important position which tungsten now holds in the metallic filament lamp industry. Molybdenum, which is closely related to tungsten, cannot by itself be made to yield threads, but it has a favourable influence if it is added in small proportions to tungsten. Titanium, which has often been recommended for such purposes, is sure to become of importance in the industry, but the same cannot be said of silicon, which, of late, American inventors have recommended.

JOINT ENGINEERING MEETING IN GLASGOW.

A JOINT meeting of the Institution of Engineers and Shipbuilders in Scotland and the North-East Coast Institution of Engineers and Shipbuilders was held in Glasgow during this week on the 4th, 5th, and 6th inst. The mornings of the 4th and 5th inst. were devoted to the reading and discussion of papers and the afternoons to visits, the whole of the Friday being taken up with a pleasure excursion on the Firth of Clyde.

The papers read were as follows:—"A Slight Sketch on the History of Propellants," by Sir Andrew Noble, K.C.B., F.R.S.; "Notes on the Trials and Performances of the ss. Otaki, Fitted with a Combination of Reciprocating and Turbine Machinery," by Engineer-Commander W. McK. Wisnom, R.N.; "Sixty Years of Merchant Shipbuilding on the North-East Coast," by Dr. G. B. Hunter and Mr. E. W. De Rusett; and "Fifty Years of Warship Building on the Clyde," by Professor J. H. Biles. We defer our account of the meeting until our next issue.

THE LIFE-SAVING STEAMSHIP SNOHOMISH.

THE North Pacific Coast of the United States is a dangerous neighbourhood for shipping, owing to the rocky character of the coast line, the absence of harbours or places of refuge, the heavy storms, and the frequent fogs, especially during the winter. As a result of numerous accidents to vessels in the coasting and Alaska service, and especially the wreck of the steamship Valencia on Vancouver Island—with the loss of over one hundred lives—in 1906, the United States Government have had a steamer built specially to patrol these dangerous waters, to help ships in distress, and to rescue persons shipwrecked or castaway.

The life-saving steamer Snohomish was built on the Atlantic Coast by the Pusey and Jones Company, of Wilmington, and after a voyage round the Horn arrived at its station in April. From the view in the accompanying illustration it will be seen that it resembles a large sea-going tugboat, but it is exceptionally strongly built, and has special equipment for its peculiar service. Those experienced in the navigation of the North Pacific have some criticisms of the design which will be mentioned later. The vessel is 152ft. long overall; 140ft. long between perpendiculars, 29ft. moulded beam, 17ft. deep from base line amidships. The displacement is 795 tons on a mean draught of 12ft. 4½in., with 125 tons of coal and 11,000 gallons of water on board. At the designed speed of 12 knots she can steam 25 knots per ton of coal, giving a steaming capacity of 3000 knots with her bunker capacity. This might be necessary when cruising in search of any missing vessel. The maximum speed is between 14 and 15 knots.

The hull is built of open-hearth mild steel, and has an inner bottom at the boiler space. The double bottom forms a water tank, and provides safety in case of grounding. The hull is well divided into water-tight compartments. The deck is of teak, instead of pine, as the climate is very wet during the winter. The upper deck extends from bow to stern, and is entirely enclosed by steel bulwarks. Above this rises the steel deck-house—narrower than the hull—in which are the crew's quarters, &c. The officers' quarters are in an upper deck-house immediately behind the wheel-house. There are two pole masts, and the foremast carries a signal yard.

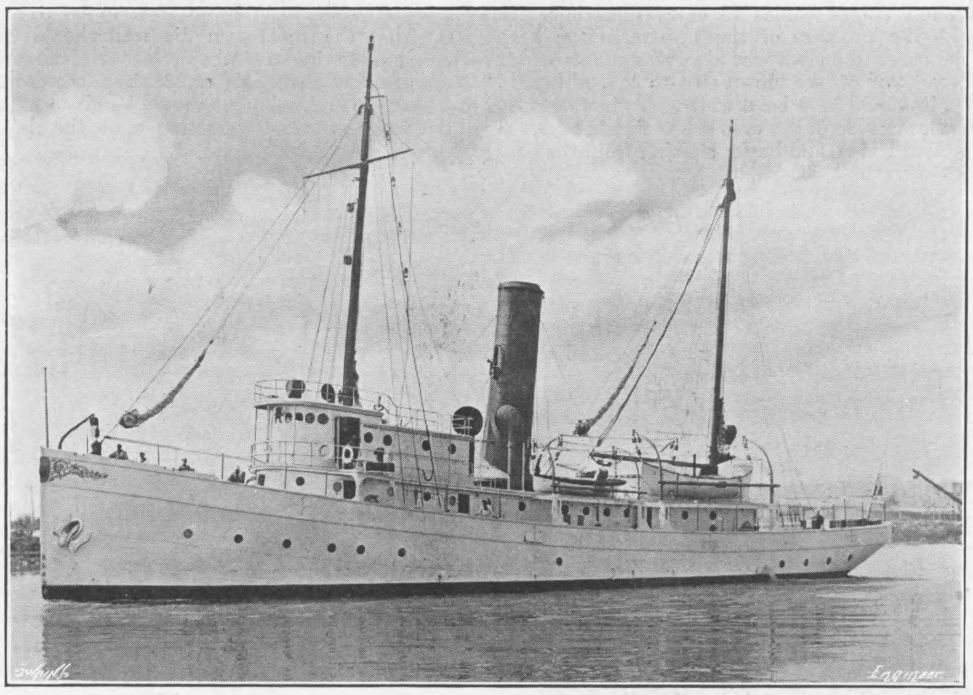
There is a single screw, driven by a triple-expansion engine of 1200 horse-power. The screw is of manganese bronze, with adjustable pitch; it has a diameter of 11ft. and a mean pitch of 11½ft. The cylinders are 18in., 29in., and 47in. diameter, with a stroke of 30in. Steam is supplied by one Scotch marine boiler and one Babcock and Wilcox water-tube boiler. The vessel will spend much of its time at anchor, but the water-tube boiler will be kept primed and ready for firing at any time, while the Scotch boiler will be kept under a banked fire. It is a troublesome matter to keep banked fires under water-tube boilers, and a slow matter to raise steam in a Scotch boiler. But with this arrangement, the Scotch boiler will always be in service, while the water-tube boiler can be fired up and set its full steam pressure in about half an hour, while the vessel is under way.

The Scotch boiler is 13ft. 6in. diameter, 10ft. 3in. long, with three 40in. furnaces. It has 60 square feet of grate and 1803 square feet of heating surface, and carries 180 lb. pressure. The water-tube boiler is 10ft. 4in. long, 12ft. 9in. wide, and 15ft. high, with tubes 9ft. long. It has 78½ square feet of grate, 2565 square feet of heating surface, and carries 180 lb. pressure. The main condenser has 1650 square feet of cooling surface, the feed-water heater has 120 square feet, and there is a distilling apparatus with a capacity of 1700 gallons in twenty-four hours. There is the usual arrangement of air pumps, circulating pumps, feed, fire, wrecking, and bilge pumps. There is a steam windlass, steam steering gear, a steam towing machine, and a direct-connected electric generator of 15 kilowatts, 110 volts.

The boats include two metal lifeboats 24ft. long, a 20ft. whaleboat, a 16ft. dingey, a 17ft. metallic life raft, and a petrol launch.

The special equipment includes the following:—Two self-righting and self-bailing lifeboats, a life raft, a line-throwing gun, a Miller breeches-buoy apparatus, wireless telegraph system, Ardois electric system of night signalling, two powerful searchlights, fire-extinguishing apparatus, and apparatus for pumping out wrecked vessels. The breeches-buoy gear is rigged to a cable attached to the mainmast, and the arrangement is similar to that employed in coaling warships at sea.

The main criticism against the design of this steamer are as regards the open upper deck. For the rough weather in which the vessel will be employed, and in working head to sea, it is considered that a high forecastle should have been built, extending back to the wheel-house, and that the after deck should have been fitted with railings, instead of solid bulwarks. For launching boats, the suggestion has been made to use a steel military mast carrying a steel arm or boom pivoted to swing from a horizontal to an inclined position, the arm revolving so as to lower a boat clear of the steamer on either side.



THE LIFE-SAVING STEAMSHIP SNOHOMISH

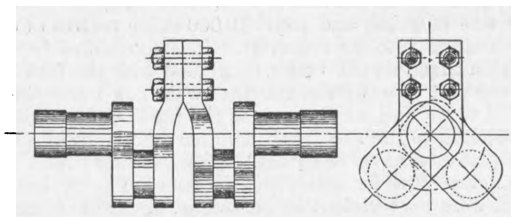
The anchors and ground tackle of a steamer of this class are of vital importance, and Mr. Moran, a shipbuilder of experience on the Pacific Coast, recommended that this equipment should be such as to hold in the roughest weather. For this purpose he proposed to use steel wire cables instead of chain cables. When the anchors were housed home the cables would be detached and stored in a tank surrounding the winding drum, submerged in lime water to prevent corrosion. This, of course, would require windlass gear of a special kind. The anchors would be so arranged that they could be let go or housed home in hawse pipes, so as not to require the crew to go to an exposed part of the forward deck.

NEW DEEP WATER QUAY AT HAVRE.

THE President of the French Republic formally opened the new deep water quay at Havre on July 17th, when the ceremonies were attended by several members of the late French Government and French and British naval officers. We described this work in our issues of May 29th and June 5th, 1908, at which time it was anticipated that the quay would be opened for traffic at the end of last year. Unforeseen difficulties, however, delayed the completion of the works, and although the deep water quay itself was finished some months ago, the clearing of the old harbour structures, which occupied a part of the approach, was not effected until shortly before the President's visit. A portion of the dredging of the berths fronting the quay has yet to be completed, when a depth of 33ft. at low-water of ordinary spring tides will be available. The quay wall, which is founded on concrete and masonry caissons, is 500 m. in length, and upon it will be erected a huge harbour railway station for passenger traffic, which will be over 260 m. in length. The Florida lock, which we also described last year, was not completed in time to be opened by the President. This lock will form the principal entrance to the Bassin de l'Eure and the other docks in communication with it. The total cost of the harbour improvements included in the scheme of 1895, which is now nearing completion, will exceed £2,500,000. The project for further extension on a large scale, which was drawn up in 1907, and described by us in our issue of October 11th of that year, has now been finally adopted by the Senate, after having passed the Chamber of Deputies last year. The scheme is estimated to cost £3,464,000, nearly half of which will be covered by a State subsidy, the balance being met by the Chambers of Commerce of Havre and Rouen.

A NEW FLEXIBLE CRANK AXLE.

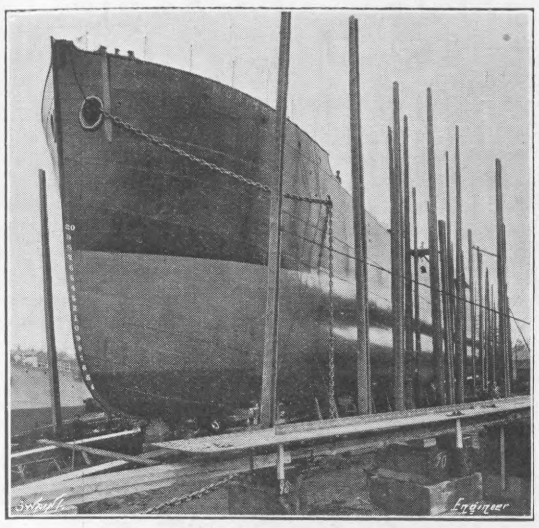
THE accompanying illustration shows a new crank axle which has been patented by Mr. H. Ivatt, chief mechanical engineer, Great Northern Railway. The object is to get flexibility to deal with end thrusts. The axle is made in two solid forged pieces, which are bolted together as shown, being grooved and tongued for greater security. The bolted portion acts efficiently as a balance weight. Several of these axles have been fitted to goods engines experimentally, and the results obtained have been quite satisfactory. The invention is so simple that it will be at once understood without description from the engraving. The valve gear is Joy's, but, of course, Walschaerts' is equally applicable.



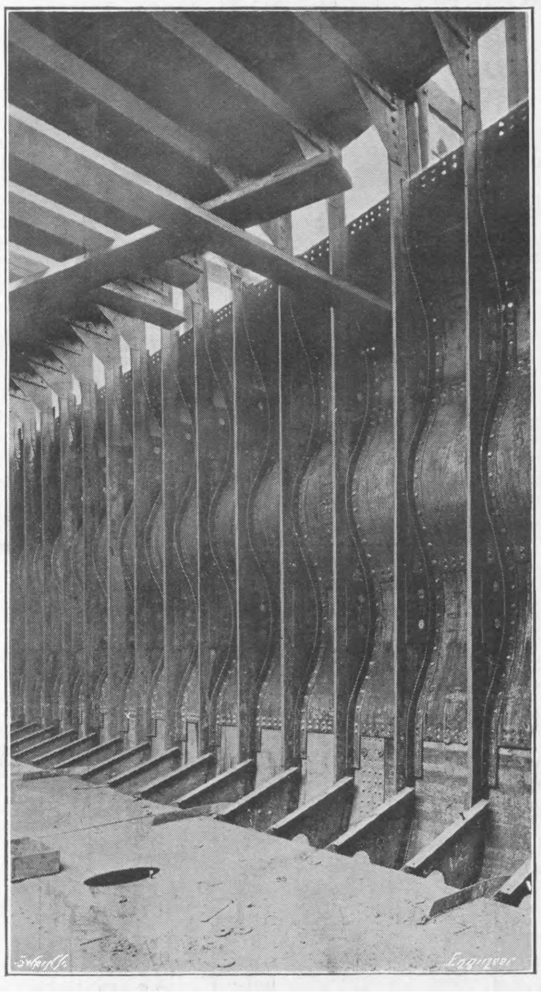
FLEXIBLE CRANK AXLE

CORRUGATED SYSTEM OF SHIP CONSTRUCTION.

As we have already announced, there has recently been launched at the shipyard of Osbourne, Graham and Co., at Hylton, Sunderland, the steamship Monitoria, which is being built to the order of the Ericsson Shipping Company, Limited, of Newcastle-on-Tyne. This vessel is the first to be built from the designs of the Monitor Shipping Corporation, of Newcastle-on-Tyne, and her construction represents an interesting departure from ordinary practice. The Monitoria measures 279ft. by 40ft. 1½in. normal extreme breadth, increased to 42ft. by the application of the Monitor projection, and has a depth, moulded, of 20ft. 7½in. The vessel is of the single-deck type, with poop, bridge, and forecastle, and her deadweight capacity is about 3300 tons. She will have large hatchways, five winches, steam windlass, steam steering gear, and large water ballast capacity, and will be fitted with triple-expansion engines built by the North-Eastern Marine Engineering Co., Limited, Sunderland, with cylinders 21in., 36in., and 56in. diameter, and 36in. stroke.

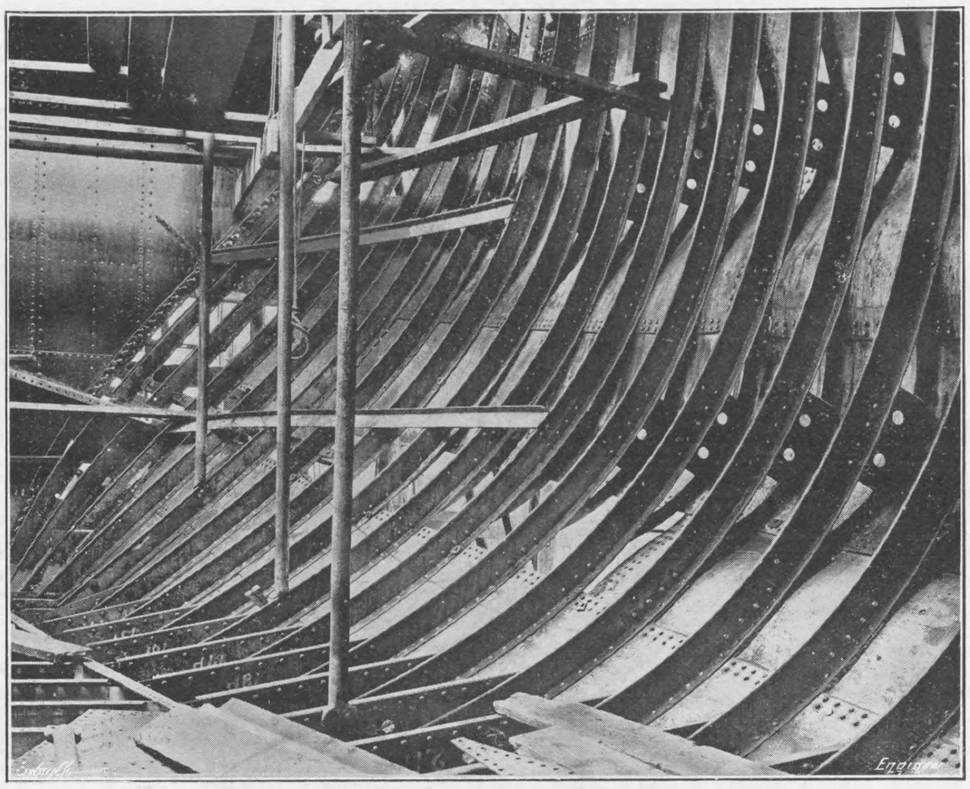

THE MONITORIA ON THE STOCKS

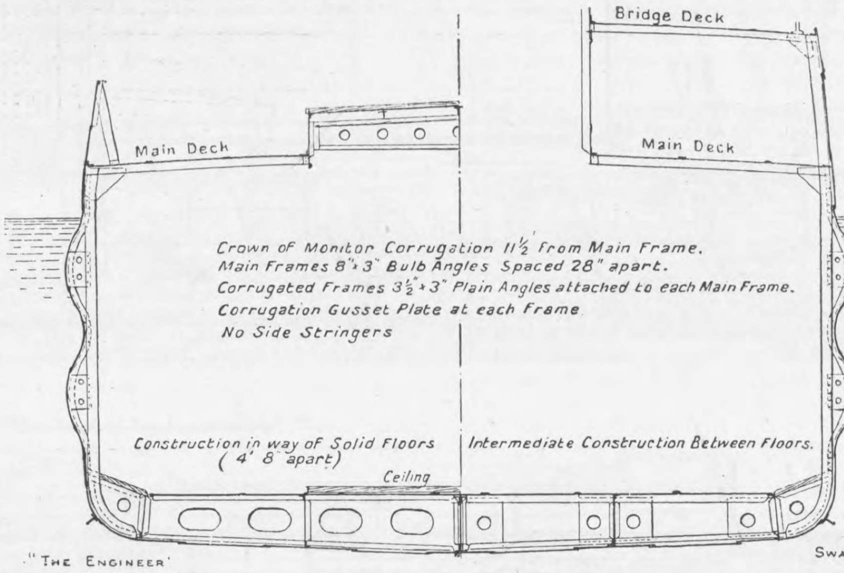
The salient features of the Monitor system are well illustrated in the accompanying engravings, from which it will be seen that the shell plating is swelled out in two places at each side, between the light and the load lines, in the form of a somewhat flat arc, which is gradually curved into the flat side of the normal vessel above and below and also between these arcs. As a result of experimental work extending over some few years, it is claimed that with the Monitor system it will be possible to reduce the vertical amplitude of the waves, and to utilise the power thus saved.


INTERIOR VIEW SHOWING PLATING

The crown of the Monitor corrugation is 11½in. from the main frame, which latter is 8in. by 3in. The bulb angles are spaced 2ft. 4in. apart, and the corrugated frames are 3½in. by 3in. Plain angles are attached to each main frame and the corrugation gusset plate at each frame. There are no side stringers. It is affirmed that the projections will give additional buoyancy, and a considerable increase in the hogging and sagging strength, so that the stress on the material is reduced both at the keel and the gunwale.

As this application is in the nature of an addition to the ship rather than a drastic alteration to the main structural system, it will be applicable to all classes of steamships. As a matter of importance to owners who have vessels coming on to their No. 3 Surveys, it is stated that the alteration may be effected at very slight additional cost, and that it will increase the deadweight by 3 to 4 per cent., whilst the coal bill will be reduced by 12 to 15 per cent. for the same speed as previously, or, if the coal consumption remains unaltered, the vessel with her extra deadweight will have a speed increase of about ¼ to ½ knot, according to her size and class. It is claimed that this system of ship construction will bring about a reduction in the weight of machinery necessary for a given speed, and will, therefore, permit of an increase of the deadweight amounting to (approximately) 3½ to 4½ per cent., and, with more economical engines, there will be a reduction in coal consumption for the same speed as obtained with a vessel of the ordinary form.


INTERIOR VIEW SHOWING PLATING


Bridge Deck
Main Deck
Main Deck
Crown of Monitor Corrugation 11½' from Main Frame.
Main Frames 8"×3" Bulb Angles Spaced 28" apart.
Corrugated Frames 3½"×3" Plain Angles attached to each Main Frame.
Corrugation Gusset Plate at each Frame
No Side Stringers
Construction in way of Solid Floors (4' 8" apart)
Intermediate Construction Between Floors.
Ceiling
"The Engineer"
Swain Sc.
SECTIONS OF THE MONITORIA

THE RIVER MERSEY.

The annual report on the state of the navigation of the river Mersey has just been issued. The information which it contains as to the condition of the bar and the navigable channels in the Mersey estuary in the neighbourhood of Liverpool during the year ended December 31st, 1908, has been prepared from particulars supplied to the Conservancy by the Mersey Docks and Harbour Board. Surveys have been made of the Queen's and Crosby channels, parts of the Rock channel, the Great Burbo Bank, Spencer's Spit, and other places in the bay. Monthly surveys, with few exceptions, were made of the dredged cut, Crosby Shoal, Askew Spit, and of the western and south-eastern ends of Taylor's Bank. Monthly surveys were also made when the weather permitted off the Canada, Sandon, Herculaneum, Alfred, and Morpet dock entrances. To the end of September fortnightly surveys were made off the Brunswick dock entrances, but since then the surveys have been made daily, weather permitting. Soundings were taken monthly off the Liverpool landing stage, and the depths off the Woodside and Wallasey landing stages were examined. The part of the river between Walton Bridge and Runcorn Bridge was surveyed. Half-yearly surveys were made of the Eastham channel and Pluckington bank. Under the heading of the bar, the report states that the dredged cut has been maintained so that in mid-channel there has always been a depth of at least 27ft. below low water level of spring tides, and in April, May, and June the least depth was 28ft. Outside the dredged cut the least depth on the bar within the buoyed area was 10ft., compared with 9ft. in 1907 on the south side. The five-fathom contour to the westward of the buoyed channel had slightly receded, the greatest difference being between the two and three-fathom contours which had extended to the westward 350 and 400 yards respectively.

The contours of the Queen's channel were much the same as in 1907. From the westward to beyond Q 6 red conical buoy the part of the channel with less than 30ft. of water had increased in area, and there is now a distance of about 1450 yards between the five-fathom contours in this vicinity, as compared with a distance of about 650 yards in 1907. Towards the Askew spit, close to C 1 red gas bell beacon, the two-fathom contour has extended to the south-eastward. The run between the two and three-fathom contours which first showed itself in the year 1903 has since then been steadily increasing, until it has now removed the point of Askew spit from about 350 yards west of C 1 red gas bell beacon to within half-way between that buoy and C 2 conical buoy. The maximum extension of the Askew spit is about 100 yards in a northerly direction, and the concave side of the Taylor's bank has receded 106 yards.

The Crosby channel has considerably improved, the five-fathom contour extending through the channel. In the mid-channel the minimum depths fluctuated from 25ft. in May to 23ft. in November, the average minimum depth throughout the year being 27½ft. To the east and west of the Crosby shoal the average minimum depth was 23ft. 9in. on the east, and 23ft. 4in. on the west side. The inlet near the north mile marks has increased in depth, the sand spit south of it now dries 4ft. against 6ft. last year. The seaward entrance to Rock channel is very similar to last year, but the East Hoyle bank from R 1 to R 2 red conical buoys has extended about 100 yards, thus narrowing the channel at the turning point between R 1 and R 2 black can buoys. Beyond this the area of the two-fathom contour has considerably increased, and now extends to R 3 black can buoy. The least water in the Rock cut, the river entrance to the Rock channel, was 2ft.; the same depth as last year. Pluckington bank continued to alter throughout the year. In the channel between the Pluckington bank and Devil's bank there was a depth of 21ft. in November and 23ft. in March last, as compared with 25¼ft. in October, 1907. Under the heading of Eastham channel, the report states that in November last the depth at the bar buoys was 10¼ft., which was exactly the same depth as in the previous March.

LOCOMOTIVES BUILT AT HORWICH

(For description see pages 120 (ante) and 147)

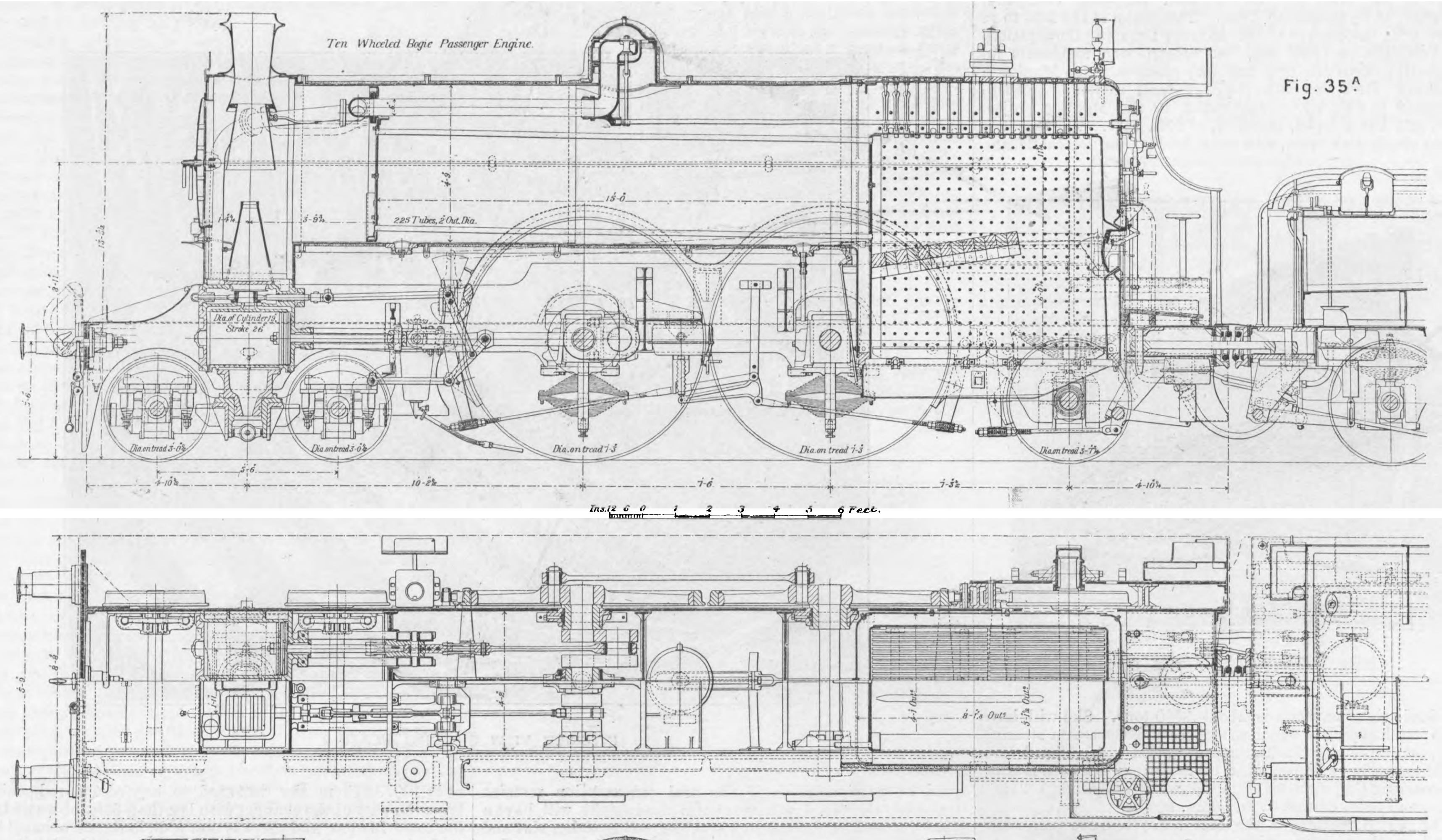

Ten Wheeled Bogie Passenger Engine.
225 Tubes, 2" Out. Dia.
15-6
Dia. of Cylinders 19, Stroke 26
Dia. on tread 3'-6½
Dia. on tread 7'-3
Dia. on tread 3'-7½
5-6
10-2½
7-6
7-3½
4-10½
Ins. 12 6 0 1 2 3 4 5 6 Feet.
4-7½ Out.

Fig. 35A

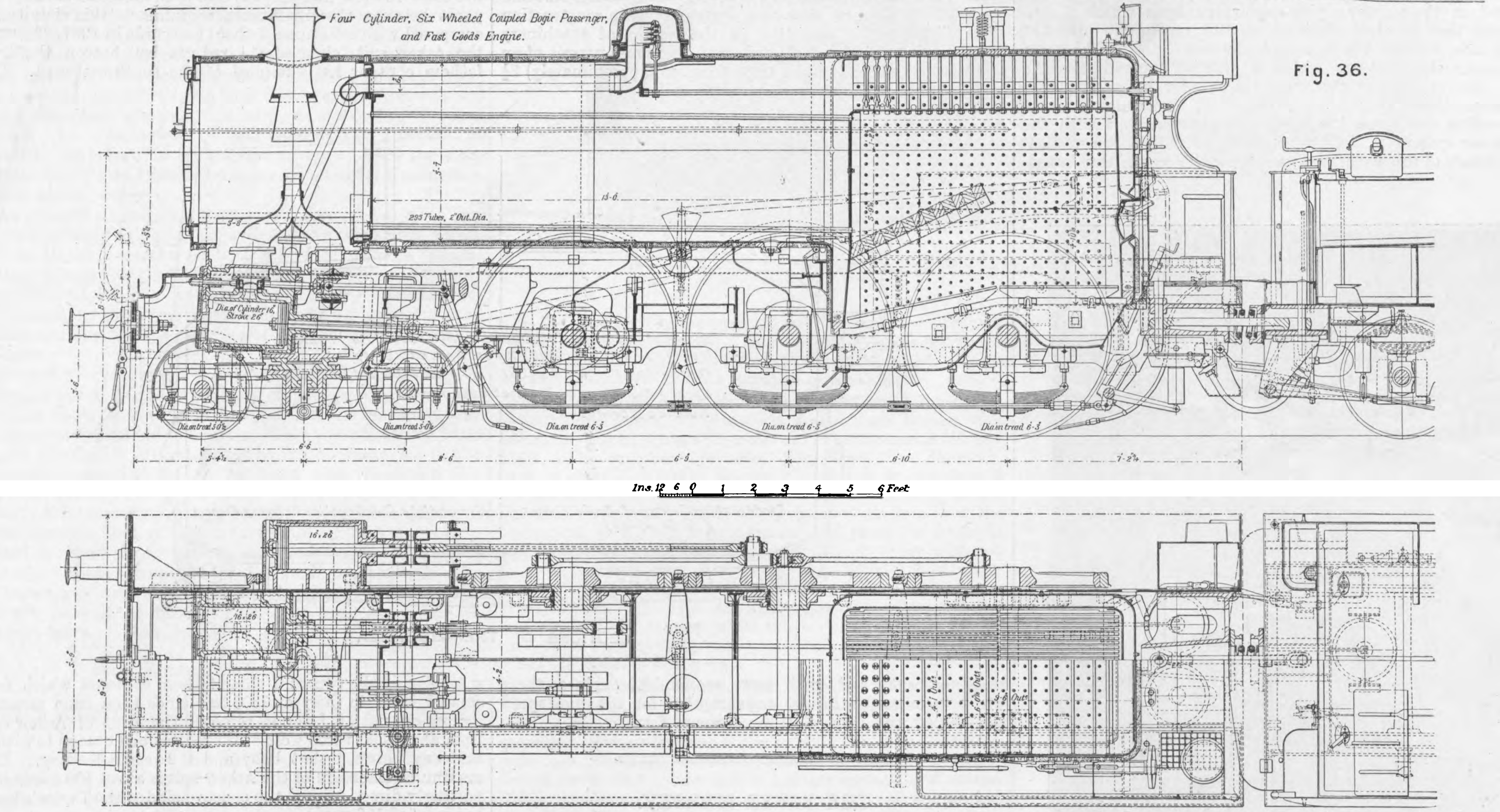

Four Cylinder, Six Wheeled Coupled Bogie Passenger, and Fast Goods Engine.
223 Tubes, 2" Out. Dia.
15-0
Dia. of Cylinders 16, Stroke 26
Dia. on tread 3'-0½
Dia. on tread 6'-3
6-6
9-6
6-3
8-10
7-2½
Ins. 12 6 0 1 2 3 4 5 6 Feet
16 x 26

Fig. 36.

Fig. 36A.

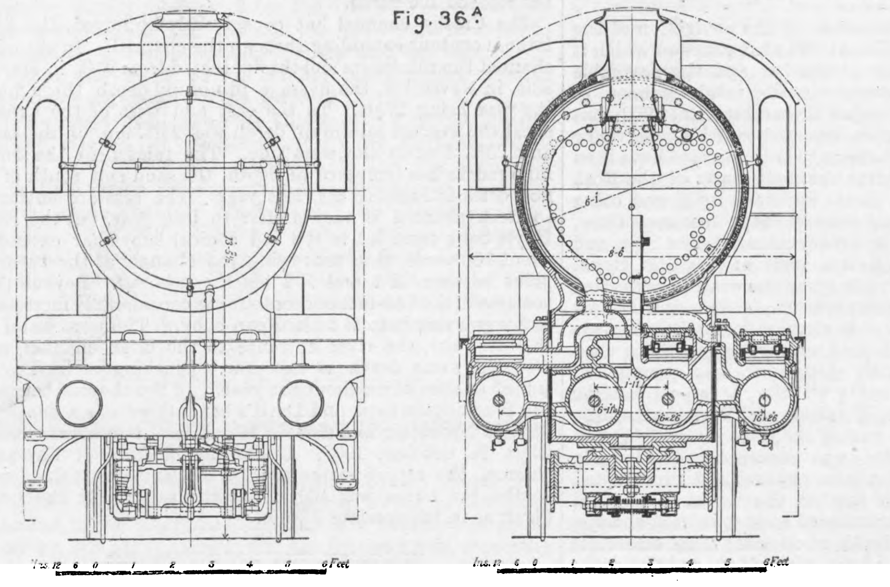
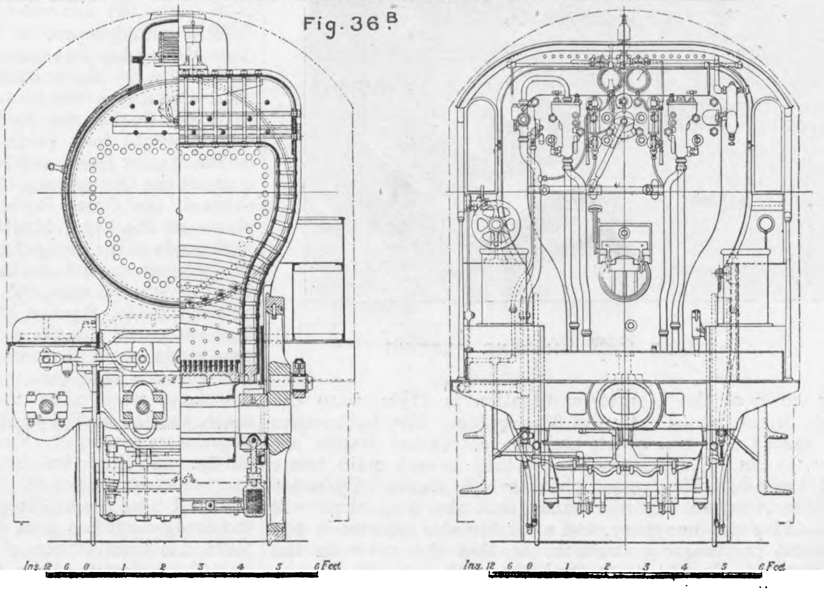

Ins. 12 6 0 1 2 3 4 5 6 Feet
Ins. 12 6 0 1 2 3 4 5 6 Feet
16 x 26

Fig. 36B


Ins. 12 6 0 1 2 3 4 5 6 Feet
Ins. 12 6 0 1 2 3 4 5 6 Feet

"The Engineer"

Swain Sc.

LOCOMOTIVES DESIGNED AND BUILT AT HORWICH, WITH SOME RESULTS.*

By Mr. GEORGE HUGHES, Member, Chief Mechanical Engineer, Lancashire and Yorkshire Railway, Horwich.

(*Continued from page* 122.)

Hughes' four-cylinder passenger and express goods engine. (Built June, 1908.)—Fig. 30, page 121 (*ante*). This design was brought about by the further increased weight of trains and the necessity for accurate timekeeping with the accelerated train schedule of the Liverpool, Manchester, and Hull expresses, the Leeds, Bradford, and Fleetwood boat trains, and to cope with gradients on the Bradford, Huddersfield, and Sheffield sections. The author also had in mind certain very important heavy express goods trains. An engine embodying rapid acceleration, great hauling power, with a suitable wheel base for the easy negotiation of curves, was essential, and as the four-cylinder arrangement possesses many advantages from a mechanical standpoint, such as division of stresses and superior balancing, this type was decided upon. The author also preferred a simple to a compound engine, owing to the greater range of expansion obtainable with express trains. To obtain rapid acceleration and great adhesive power the wheels were made of moderate size, and three pairs coupled. The wheel base was kept as short as possible by placing the inside cylinders well in advance of the bogie centre—Fig. 36, page 146. Flexibility was attained by giving $\frac{3}{16}$in. lateral play to the trailing coupled wheels, and the coupling-rods are provided with ball-and-socket joints which give vertical as well as lateral movement. The outside cylinder crank pin and coupling-rod pin are in one, the former having 13in. throw and the latter 11in. This diminishes the centrifugal force of the coupling-rod at sixty miles per hour by 15.3 per cent. To allow for the 2in. excentricity the coupling-rod portion has to be of large dimensions. The inside cylinders drive on the first axle, and a reasonable length of connecting-rod results. The outside cylinders are fixed behind the inside, and about midway between the bogie wheels; these drive on to the second axle. By this disposition the steam and exhaust pipes can be kept within the smoke-box, thus minimising the additional condensation brought about by exposed steam pipes, and also obviating the increased back pressure which necessarily follows when the exhaust has to be led through long and tortuous passages. Four cylinders, of a necessity, bring about steam and exhaust pipe complications, but the author has been able to dispose of this difficulty in an original way. The exhaust from the inside cylinders is carried away between the cylinders to the front leg of a breeches pipe, and the exhaust from the outside cylinders passes through a duct cast in the smoke-box saddle plate to the back leg of this breeches pipe, this pipe being placed longitudinally in the smoke-box, instead of crosswise, as is usually the case with two-cylinder engines. This arrangement allows a ready access to the tubes for the purpose of cleaning. The joint between the outside cylinder exhaust and the saddle plate is also of a novel character, being formed by a "making up" piece slightly taper, pressed and held in position by two set screws and a retaining plate. This will be better understood by referring to Fig. 38.

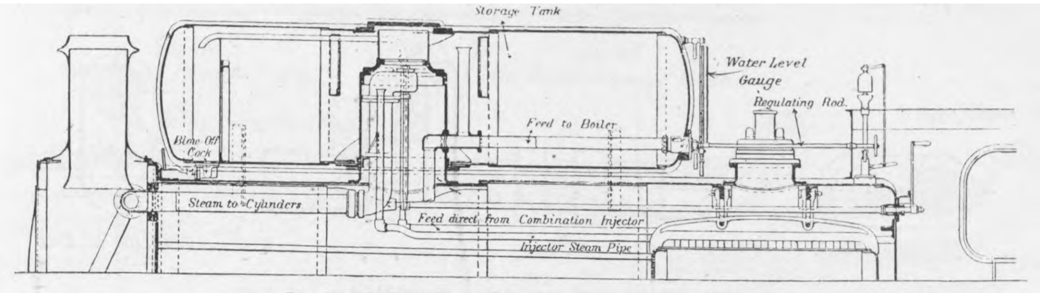


Fig. 37—HALPIN'S THERMAL STORAGE HEATER

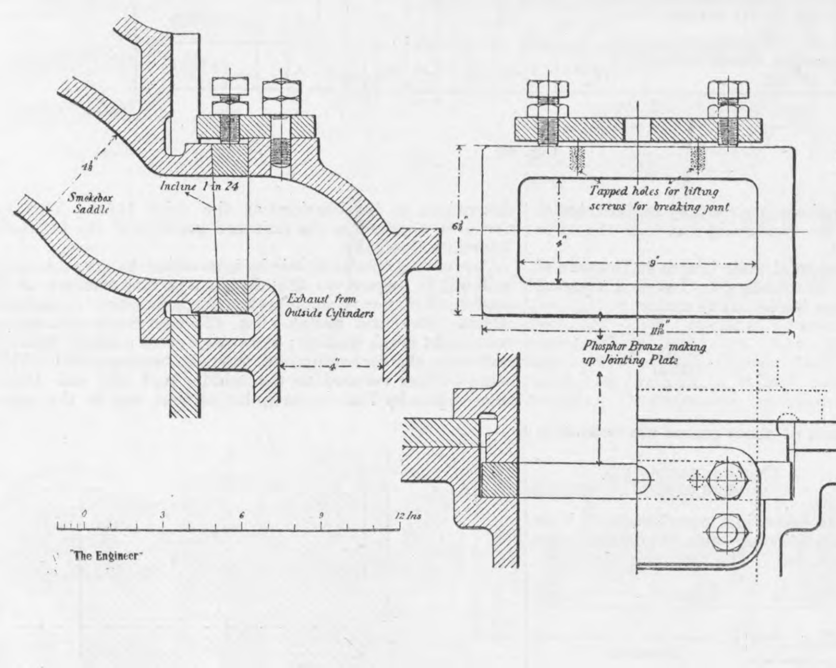

Smokebox Saddle
Incline 1 in 24
Exhaust from Outside Cylinders
Tapped holes for lifting screws for breaking joint
Phosphor Bronze making up Jointing Plate
0 3 6 9 12 Ins
The Engineer

Fig. 38—METHOD OF MAKING JOINT FOR OUTSIDE CYLINDER EXHAUST

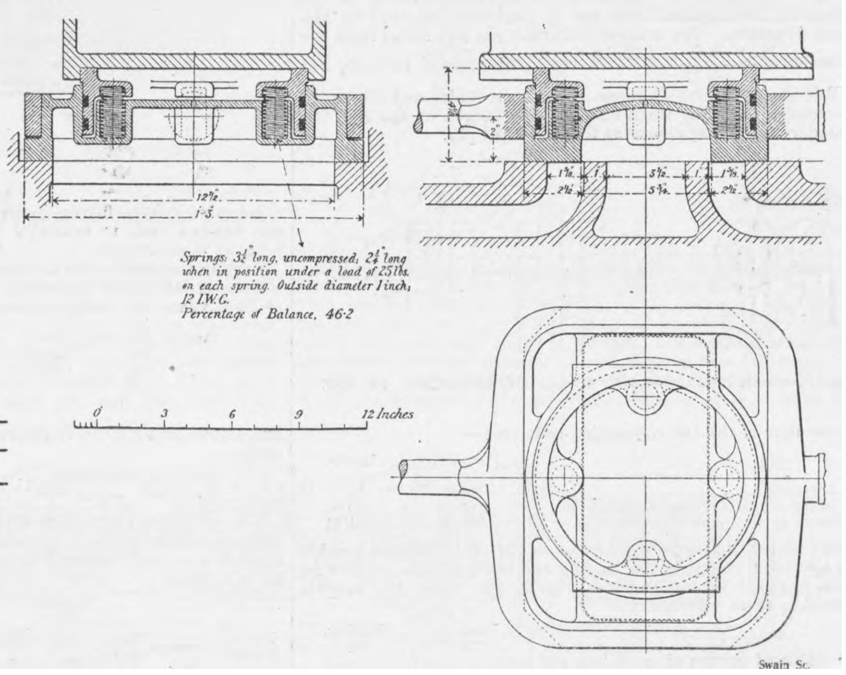
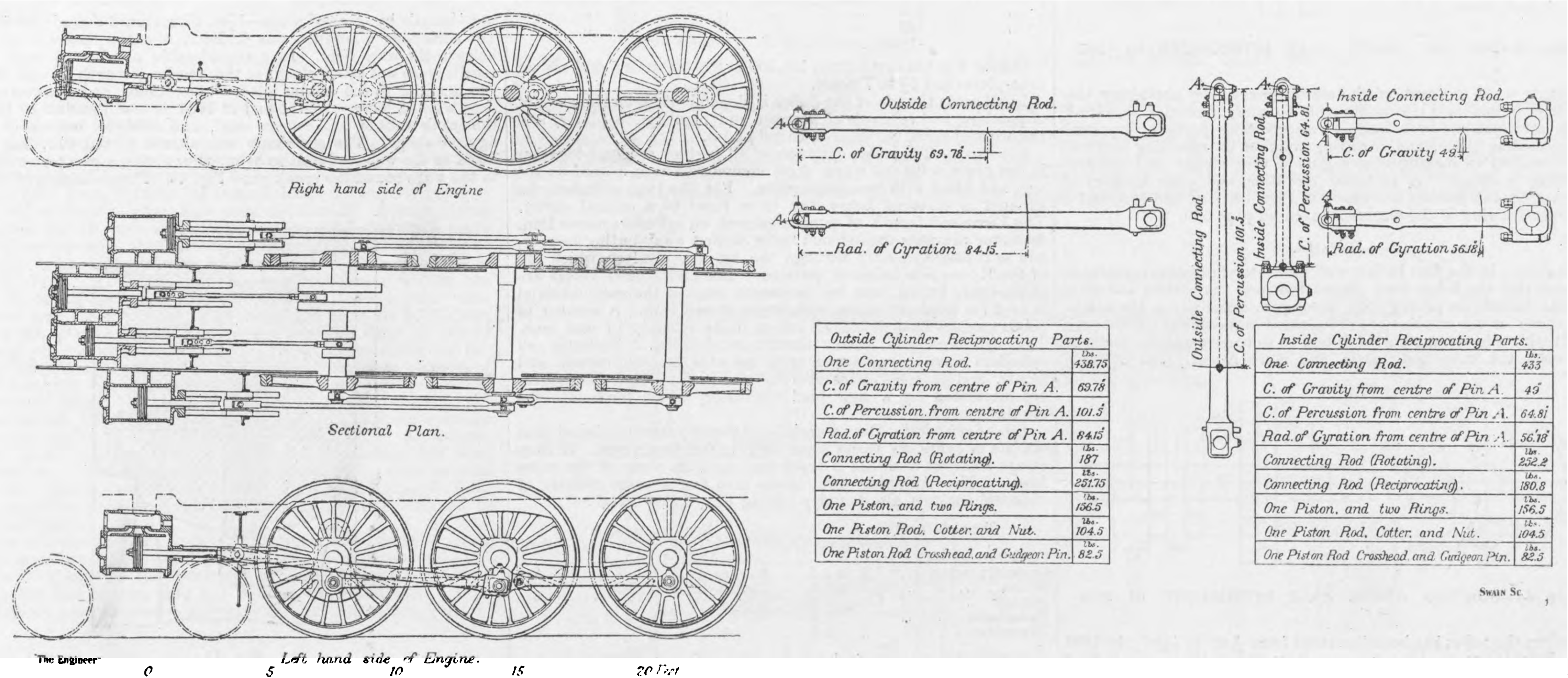

Springs 3½ long, uncompressed, 2¼ long when in position under a load of 25lbs on each spring. Outside diameter 1 inch, 12 I.W.G.
Percentage of Balance. 46·2
0 3 6 9 12 Inches
Swain Sc.

Fig. 39—BALANCED CIRCULAR VALVE



Outside Cylinder Reciprocating Parts.	
One Connecting Rod.	lbs. 438.75
C. of Gravity from centre of Pin A.	69.78"
C. of Percussion from centre of Pin A.	101.5"
Rad. of Gyration from centre of Pin A.	84.15"
Connecting Rod (Rotating).	lbs. 187
Connecting Rod (Reciprocating).	lbs. 251.75
One Piston, and two Rings.	lbs. 156.5
One Piston Rod, Cotter, and Nut.	lbs. 104.5
One Piston Rod Crosshead, and Gudgeon Pin.	82.5

Inside Cylinder Reciprocating Parts.	
One Connecting Rod.	lbs. 433
C. of Gravity from centre of Pin A.	49"
C. of Percussion from centre of Pin A.	64.81"
Rad. of Gyration from centre of Pin A.	56.18"
Connecting Rod (Rotating).	lbs. 252.2
Connecting Rod (Reciprocating).	lbs. 180.8
One Piston, and two Rings.	lbs. 156.5
One Piston Rod, Cotter, and Nut.	lbs. 104.5
One Piston Rod Crosshead, and Gudgeon Pin.	lbs. 82.5

Fig. 40—FOUR-CYLINDER, SIX-WHEELS COUPLED PASSENGER AND FAST GOODS ENGINE—ARRANGEMENT OF BALANCING

The pistons, piston-rods, crossheads, slide blocks, slide bars, and slide valves are all interchangeable. The last named are a new departure in circular balanced valves—see Fig. 39.

The balanced ring is fitted with two piston rings and terminates with a small flange pressing against a rubbing plate, provided with lugs at the sides to prevent any rocking action of the valve. Four spiral springs are used for keeping up the balanced ring to the face of the rubbing plate when the engine is coasting. These valves up to the present have given excellent results; they have been examined periodically, and have shown no signs of leakage. Any slight wear on faces has been uniform. The standard Joy motion is used.

The crosshead between the valve spindle and valve rod is guided between two bars with ample bearing surfaces. This crosshead is provided with a lug for attachment to the rocking lever for driving the outside valves. The boiler has been made of large proportions to meet the demand of the four cylinders, and has been so disposed that there is approximately the same weight upon each driving axle—the weights are thus obtained naturally and not by adjustment of springs. Perfection in the design of this engine has been sacrificed in order to obtain simplicity and to avoid interference with existing workshop methods. Absolutely perfect balancing could have been achieved without the aid of balance weights if the angles of the cranks, the disposition of the cylinders, and the weights of the reciprocating parts had been arranged to neutralise amongst themselves the reciprocating disturbing forces; and then by balancing the revolving masses, the variations of rail load, and horizontal swaying couple would have disappeared. The engine would have then been perfectly balanced, except for a slight vertical component produced by the obliquity of the connecting-rod. This arrangement, known as the Yarrow-Schlick-Tweedy system, introduces complications from the fact that the disposition of the cranks involves the use of an independent set of valve-gear for each cylinder. All these refinements are extremely costly, and the author came to the conclusion that the compromise arrived at was not only sound commercially, but as near scientific perfection as common sense dictated. At the period when the author was considering this question of balancing, his knowledge of marine practice caused him to give the Yarrow-Schlick-Tweedy system some consideration. No four-crank locomotive engines have been built on this system in this country, the usual arrangement being to place the cranks at right angles. The reciprocating parts on the inside of the frames, moving in an opposite direction to the outside, counteract each other, and the engine is balanced so far as reciprocating parts are concerned, except for a horizontal swaying couple, which is inconsiderable. The crank pins of this engine are arranged in pairs at about 180 deg. apart respectively—Fig. 40. A slight departure from this angle is caused by the inside and outside cylinders having a slight inclination with each other for clearance purposes; the valve spindle attachment to the crosshead, however, is provided with a fine adjustment to allow for correct valve setting. With the cranks set at 90 deg. apart round the circle, the reciprocating masses, if equal, balance each other.

The weights of these reciprocating and revolving parts are as follows:—

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* The Institution of Mechanical Engineers.

TABLE I.

Reciprocating parts.	Outside. lb.	Inside. lb.
Connecting-rod, reciprocating portion	251.75	180.8
Piston and rings	156.5	156.5
Piston-rod cotter and nut	104.5	104.5
Piston-rod, crosshead, and pin	82.5	82.5
Revolving parts.	**Outside. lb.**	**Inside. lb.**
Connecting-rod, revolving portion	187.0	252.2
Total weight of connecting-rod	438.8	433.0
Unbalanced portion of crank sweeps, or crank bosses	109.0	513.0
Part of crank pin	115.3	57.0
Part of coupling-rod	258.0	—

It will be observed that, with the exception of the connecting-rods, the above reciprocating parts are equal, so that for all practical purposes the reciprocating masses are balanced.

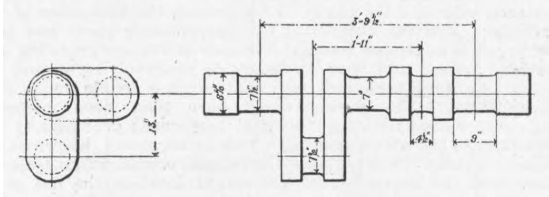


Fig. 41—SOLID CRANK AXLE USED TILL 1901

The revolving masses are balanced in the following manner:—The inside revolving parts are balanced by prolonging the crank arms to the opposite side of the axle to form a balance weight—Fig. 40 and Fig. 44—thus avoiding loading of the axle with centrifugal force between the wheels, which sets up a bending moment on the axle. The connecting-rod, which partly revolves and partly reciprocates, cannot be perfectly balanced by a rotating weight, but by dividing the masses of the rod between the crank pin and crosshead, as suggested by Professor Dalby in his "Balancing of Engines," the rod is perfectly balanced in the vertical direction. The mass at the crank pin was found from the expression $\frac{M \times BC \times BH}{KB^2}$, M being the mass of the rod, B C and B H the respective distances of the mass centre and the centre of percussion from the small end, K B the length of the rod, the remainder of M being placed at the crosshead pin.

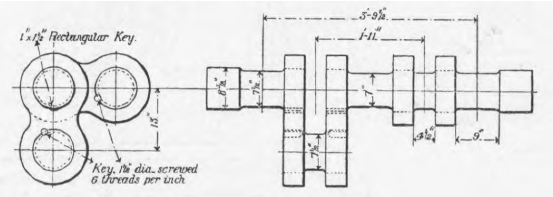


Fig. 42—BUILT-UP CRANK AXLE INTRODUCED IN 1901

Particulars of the two connecting-rods are:—

	Outside. in.	Inside. in.
Centres	129	74
Centre of gravity from crosshead pin	69.78	49
Centre of percussion from ditto	101.5	64.81

These connecting-rods are shown on Fig. 40. Balance weights have also been placed in the leading and trailing pairs of driving wheels, opposite the crank boss; Fig. 40 also shows the weights balanced in these wheels are:—

	Leading. lb.	Trailing. lb.
Unbalanced portion of crank boss and part of crank pin	124	124
Portion of coupling rod and crank pin	144.9	137.4

The question of perfect balancing is extremely important. In two-cylinder engines the hammer blow upon the rails sometimes amounts to 25 per cent. of the static weight. By abolishing this hammer-blow action it is permissible to carry a heavier axle load. This arrangement of balancing reciprocating parts by opposite reciprocating parts, and revolving weights by revolving weights, has resulted in making this engine a very steady and smooth-running machine. A sectional elevation and cross sections of smoke-box and fire-box are shown in Figs. 36, 36A, and 36B, and a perspective view of the engine is given on page 140.

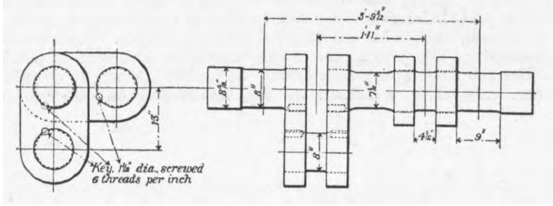


Fig. 43—BUILT-UP CRANK AXLE INTRODUCED IN 1903

DETAILS.

Boilers.—In the first boilers with round-top fire-boxes experience proved that the tubes were placed too near the bottom and sides of the barrels, as pitting soon developed, especially in the neighbourhood of the smoke-box tube plate. Subsequent boilers were built with a fewer number of tubes, so as to give greater distance between the tube and barrel, and more recently the distance between the tubes has been increased from $\frac{9}{16}$in. to $\frac{11}{16}$in. In 1896 the Belpaire type of fire-box was introduced into a number of shunting tank engines. This type of box had advantages in the way of increased steam and water space, additional surface on the back plate for mountings, and direct staying of the crown. A similar design, of suitable proportions, was adopted for the large engines. With these boilers it was impossible to introduce the inside box from the bottom, and Mr. Aspinall decided to pass it in from the back, and flange the back plate outward, for convenience of riveting up by machine. This method of flanging cured more than one evil, but resulted in setting up severe stresses in the crown shell along the line of rivet holes which join the back plate to the wrapper. There has also been much grooving down each side of the plate along the waist. To relieve the crown plate of these stresses, some engines have been fitted with a row of flexible stays at the back end. The later boilers are now being made with the back plate flanged inwards, the final operation of riveting up this plate to the wrapper being done by hand. All new fire-boxes of the larger classes since January, 1904, have had wider water spaces, which have resulted in increased mileage and fewer repairs, particularly in the renewal of stays. The reduction of grate surface, caused by increasing the spaces, has not interfered with the steaming qualities of the engines.

In the ten-wheeled passenger and coal engines the original boilers had 239 tubes, 2in. diameter, and the more recent boilers, with wide water spaces, have only 225 tubes. In each top corner a group of tubes—fifteen in number—are reduced in diameter at the fire-box end, to minimise the fracturing between the tube holes at these corners.

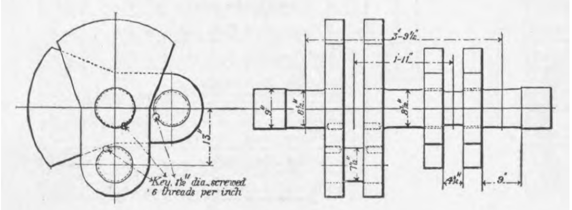


Fig. 44—BUILT-UP CRANK AXLE INTRODUCED IN 1904

Copper and steel tubes are used, and their life, as in the case of boilers, is influenced by several circumstances; but over a period of eight years the average mileage works out as under:—

Copper, 1st period	(new)	110,000	miles.
,, 2nd ,,	(stretched)	80,000	,,
,, 3rd ,,	(pieced)	50,000	,,
Total		240,000	,,

and subsequently 30 to 40 per cent. of those pieced are treated so again.

Steel, 1st period	(new)	70,000 to 80,000	miles.
,, 2nd ,,	(pieced)	30,000 to 40,000	,,

Life of boilers.—It is difficult to make just comparisons. This factor is influenced by many contingencies, such as pressure, constant employment, severity of use, &c. The following table may be of interest:—

No. of boilers cut up.	Average age.	Maximum age.	Miles.		Remarks.
			Average.	Maximum.	
336	18	38	485,480	1,207,191	For $10\frac{1}{2}$ years ending December, 1897.
181	$11\frac{3}{4}$	$30\frac{1}{4}$	326,187	739,798	27 months ending May, 1902, and personally examined by the author.
206	$14\frac{3}{8}$	$29\frac{3}{4}$	356,268	959,944	For 3 years ending December, 1908.

Boiler Pressure.

Previous to year	1888	the boiler pressures did not exceed	140 lb. per sq. in.
,, ,,	1899	,, ,, ,, ,,	160 ,, ,,
,, ,,	1901	,, ,, ,, ,,	175 ,, ,,

Present practice, 180 lb. per square inch.

Copper fire-boxes run from 150,000 to 275,000 miles, and copper tube-plates last $3\frac{3}{4}$ to 7 years.

In all cases the life of the boiler is dependent upon the amount of patching and renewals of wrapper and mouthpiece plates, and restoring of tube, throat, and barrel plates.

Cylinders.—The inside cylinders of all engines are cast together in one piece, with one steam chest common to both, placed on the top, and fitted with two steam pipes. For the 18in. cylinders the exhaust is directed below the valve faces to a central cavity. The increased length of port employed on cylinders above 18in. diameter prevents the exhaust being carried away in this manner, and so it passes directly through the top of the valves, which are of the Richardson balanced pattern. The unbalanced valves are of phosphor bronze, and for passenger engines the same material is used for balanced valves with strips of cast iron. A number of goods engines have balanced valves made entirely of cast iron. The cylinders and steam chests are drained. Recently all cylinders have been lagged with asbestos on the barrels and fronts, and in some cases also on the backs. The slide valves are lubricated by a sight-feed lubricator, which feeds into the regulator head.

Life of cylinders.—Over a period of twenty years it is found that the life of cylinders varies from eight to fourteen years. If they escape accident their life is dependent upon the wear of the valve faces. The following two tables give the average results of chemical analysis, also foundry mixing of cylinder metal:—

Chemical analysis

	Per cent.
Combined carbon	0.3
Graphitic carbon	3.0 to 3.5
Silicon	1.25 to 1.6
Sulphur	Under 0.10
Phosphorus	,, 1.0
Manganese	,, 0.8

Foundry mixing.

	Cwt.
Goldendale	7
Warner, No. 5	7
Clean cylinder Scrap	6

In regard to the tensile tests, sometimes these reach 14 tons per square inch, but, generally, good cylinder metal would be about 12 tons per square inch. Transverse tests are taken on bars 3ft. between centres, 2in. deep and 1in. wide, and give 28 cwt. before fracture.

Crank axles.—The crank axles used on all engines built by this company up to 1901 were of the solid type without hoops—Fig. 41. The material was Siemens-Martin open-hearth steel, having an ultimate tensile breaking load of 28 to 32 tons, with an elongation of 25 per cent. on 3in., and the usual bend test. Nearly all the flaws on these axles occurred on the inside of the connecting-rod journal at the bottom of the radius, where it joins the crank web, due to the constant opening and closing of the throws. The following diagram—Fig. 45—and table below give the position and percentage of flaws:—

These axles did very good service, averaging 250,000 miles before being condemned. Having passed this mileage, axles frequently attain a life of 600,000 to 700,000 miles. Standardisation and interchangeability caused the same type to be introduced in the design of the ten-wheeled bogie passenger engines, the ten-wheeled radial tank engines, and the eight-wheeled coal engines, but the larger diameter cylinders, increased boiler pressures, demand for higher speeds and heavier hauling capacity, soon proved that this axle was inadequate to meet the stress; the built-up pattern therefore was introduced in 1901, having the same dimensions in the bearings as the solid type. This type has now been adopted as the standard practice of the Lancashire and Yorkshire Company.

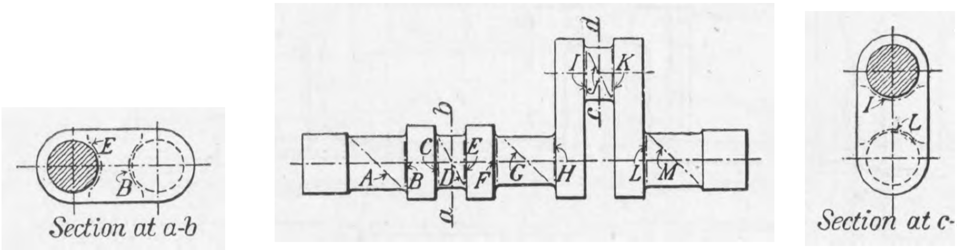


Diagram of Position of Flaws and Table of Percentage of Failures of Solid Crank Axles, from 1892 to 1909.

Class of Engine	A	B	C	D	E	F	G	H	I	J	K	L	M	Average Mileage
Standard Goods, Wheels 5'-1" dia., Cylinders 17½" × 26".		6	6		27	12	3	6	21		3	15		249,932
Standard Goods, Wheels 5'-1" dia., Cylinders 18" × 26".		9	9		14	15	2	11	31		3	3		232,932
Radial Tanks, Wheels 5'-8" dia., Cylinders 17½" × 26".	2	5	9		18	20	3	13	15	2	5	4	2	285,674
Radial Tanks, Wheels 5'-8" dia., Cylinders 18" × 26".		11	5		33	17	3	5	17			5		276,932
Bogie Passengers, Wheels 7'-3" dia., Cylinders 18" × 26".		15	16		20	16	3	10	10		3	4		247,031

"The Engineer" Swain Sc.

Fig. 45

The author thinks it will be interesting to give his experience in detail in regard to the design and manufacture of built-up cranks; it may save some useless experimenting by members and others. The first design—Fig. 42—was made entirely of mild steel, solid crank quality; the sweeps were made of figure 8 shape shrunk on the connecting-rod journals, bearings, and middle part, being further secured to the middle part and end portions by keys—$1\frac{1}{2}$in. by 1in.—rectangular section, and to the connecting-rod journals by screwed plugs—$1\frac{1}{2}$in. diameter, 6 threads per inch. The shrinkage allowance was 0.009in., and the diameter of the holes in the webs $8\frac{5}{8}$in. In a considerable number of cases the results were not satisfactory, as the tensile strength of the webs was unequal to the strains placed upon them, and consequently they worked loose. At the end of 1903 it was decided to make the crank webs of 0.35 carbon steel, and straight, instead of the figure 8 shape. The shrinkage was altered to 0.014in., and the holes in the webs reduced to $8\frac{1}{4}$in., thus giving a greater strength to the webs round the crank pin—Fig. 43. These changes effected a decided improvement in one respect, as there was a considerable reduction in the number of cranks working loose at the webs. But a new difficulty developed; fractures were found commencing at the keyways, and in several cases they had extended a considerable length before being noticed. The first attempt to prevent these fractures, towards the end of 1904, was to increase the radius at the centre of the axle from $\frac{5}{8}$in. to $4\frac{1}{2}$in., and also to put a small radius at the bottom of the key bed, the result being that there were no more fractures in the centre; but as it was not thought advisable to reduce the surface of the centre bearing by extending the radius, the trouble was still likely to occur at that

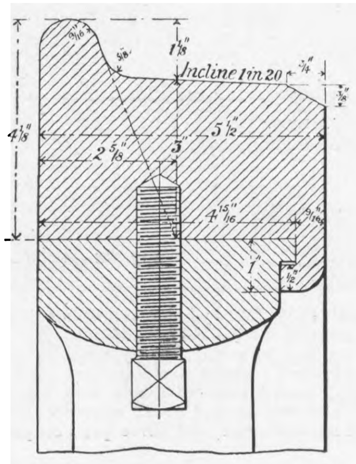


Fig. 46

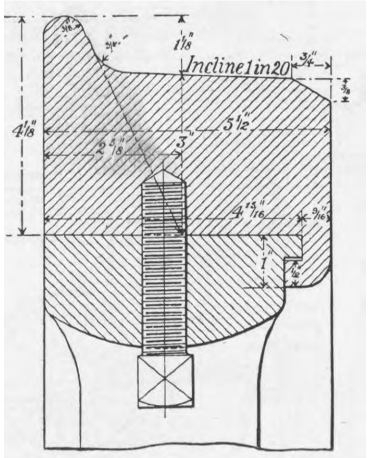


Fig. 47

particular part. The only solution appeared to be the total elimination of the rectangular section keys. The first built-up crank axle secured entirely with screwed plugs was made in March, 1905, and at the same time the shrinkage was increased to 0.018in. A short time previous to this change taking place, a series of tests, to determine the tensile limits of the crank webs, was commenced; several webs were prepared with special pieces having a shrinkage allowance of from 0.010in. to 0.016in. They were afterwards removed and records taken, which demonstrated that the shop practice of allowing 0.016in. was well within the tensile limits of the webs. The next test, taken in October, 1905, was an attempt to fracture the webs by an absurdly high shrinkage allowance. The webs prepared had a shrinkage of 0.030in. and 0.040in., and after being shrunk together, the one with 0.040in. was drilled and tapped at the usual position. A special plug was driven in with extreme pressure and the web struck with a large hammer. As no fracture occurred, the plug was withdrawn, and the pieces pressed out. The records taken proved that the elastic limit of the webs had now been exceeded, as the webs with 0.030in. allowance required 318 tons each to move the pieces, and those with 0.040in. allowance took 298 tons; 230 cranks have been built by the present method, and sent into service, and of these only two have been condemned. Briefly, it may be stated that the mild steel cranks were succeeded by those made of 0.35 carbon steel, the shape being altered from figure 8 shape to straight webs. Cranks with screwed plugs were introduced in March, 1905. The shrinkage has increased from 0.009in. to 0.018in., and the diameter of the hole in the standard crank webs reduced from 8⅝in. to 8¼in. This shrinkage amounts to $\frac{1}{458}$ part of the diameter. The author does not propose to give the life of condemned built-up cranks during the experimental stage, but the subjoined Table II. shows the average and maximum mileage of these cranks in use on the heavier and more powerful engines at the present time.

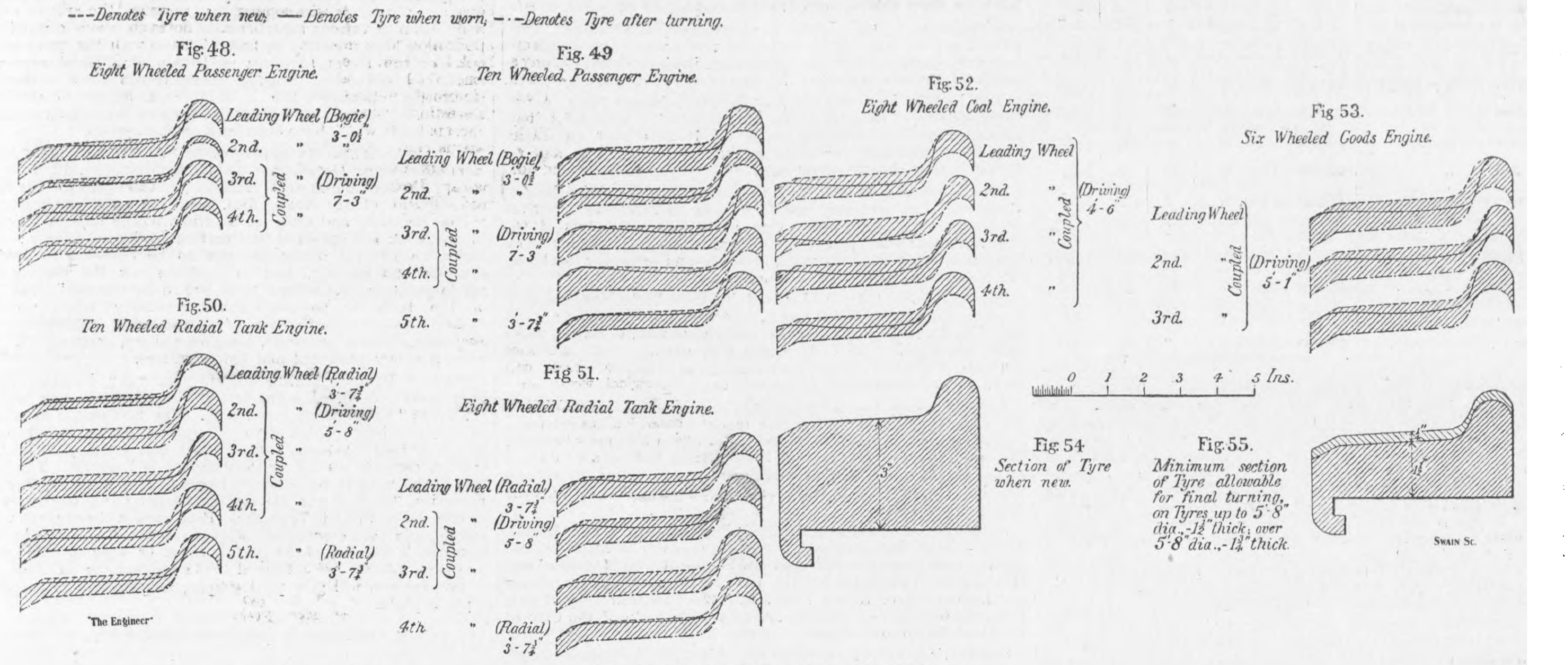


Fig. 48. Eight Wheeled Passenger Engine.

Fig. 49 Ten Wheeled Passenger Engine.

Fig. 50. Ten Wheeled Radial Tank Engine.

Fig 51. Eight Wheeled Radial Tank Engine.

Fig. 52. Eight Wheeled Coal Engine.

Fig 53. Six Wheeled Goods Engine.

Fig 54 Section of Tyre when new.

Fig 55. Minimum section of Tyre allowable for final turning, on Tyres up to 5'8" dia.,-1½" thick; over 5'8" dia.,-1¾" thick.

DIAGRAMS SHOWING WEAR OF TYRES

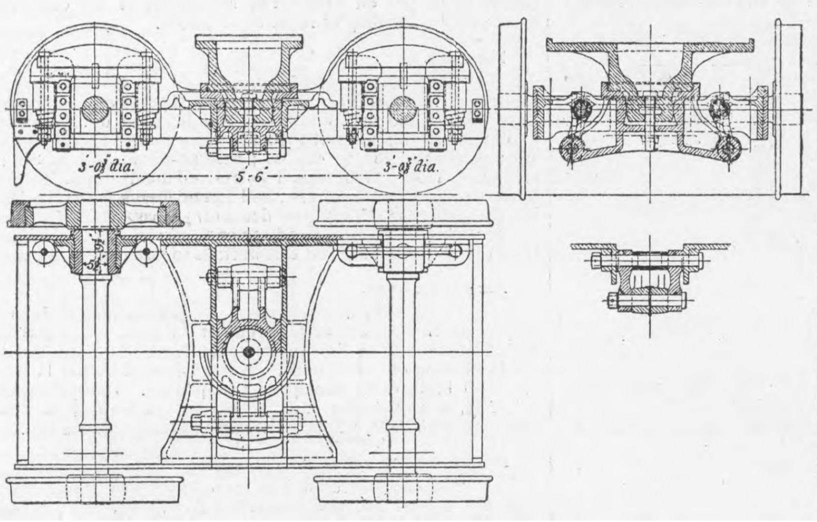


Fig. 56—ENGINE BOGIE. CRADLE PATTERN

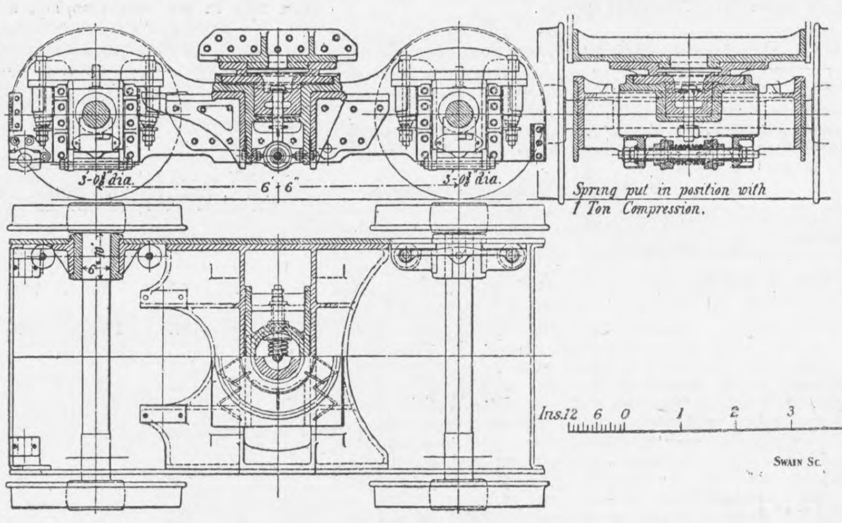


Fig. 57—ENGINE BOGIE, SLIDE PATTERN

The heavier loads upon the axle-box journals of the four-cylinder passenger engine have necessitated the adoption of a stronger crank axle, but the same method of manufacture has been adhered to. The webs—Fig. 44—are extended to form balance weights. Particulars of this balancing are given on pages 18-23. Heating of journals or crank pins must be specially avoided in built-up cranks.

Wear of cranks.—The axle-box journals wear oval at right angles to the near web. This wear has never been found to exceed $\frac{1}{32}$in., and is not always on the same side. They also sometimes wear taper, but this is rare, and not allowed to exceed $\frac{1}{16}$in. Connecting-rod journals also wear oval, but never more than $\frac{1}{64}$in.

Table II.

Class of engine.	Dia. of cylinders.	Dia. of wheels.	Boiler pressure.	7½in. dia. journal.		8in. dia. journal.	
				Average.	Maximum.	Average.	Maximum.
	in.	ft. in.	lb.				
10-wheeled bogie ..	19	7 3	180	—	—	96,400	142,947
10-wheeled radial tank	19	5 8	180	106,568	117,736	—	—
4ft. 6in. coal engine	20	4 6	180	86,780	98,753	—	—

Straight axles.—The straight axles manufactured at Horwich are of Siemens-Martin open-hearth steel, having an ultimate tensile strength of 28 to 32 tons, with an elongation of 25 per cent. in 3in., and to stand the usual percussion test. The life of straight axles in the different classes of engines varies from sixteen to twenty years, or from 250,000 to 500,000 miles.

Iron straight axles manufactured by the Lancashire and Yorkshire Railway Company—previous to the manufacture of axles at Horwich—Low Moor Iron Company, Monk Bridge Company, Taylor's, Brown, Bailey and Dixon, had a life of from eighteen to twenty-five years. Steel straight axles of Horwich make, Bolton Iron and Steel Company, Cammell's, Vickers, the age was from fourteen to twenty years. The life of tender axles ranged from twenty-five to twenty-seven years; steel bogie and steel radial axles from fourteen to twenty years. Straight axles do not give trouble. They are not condemned on any age limit, but only when bent, or worn below standard dimensions and for flaws. Straight engine axles are allowed to wear down ½in.; tender, ⅜in. for light and ¼in. for heavy goods. Bogie axles of all classes are allowed to wear ¼in., and radial axles ½in. Straight engine axles wear slightly oval, never more than $\frac{1}{64}$in. After eight or nine years they are usually found to be wearing taper, but this is not allowed to exceed $\frac{1}{16}$in. The journals of radial and bogie axles wear oval and occasionally taper; the journals of the radial boxes wear outwards, and the bogie journals inwards; all are turned up when $\frac{1}{16}$in. taper has developed.

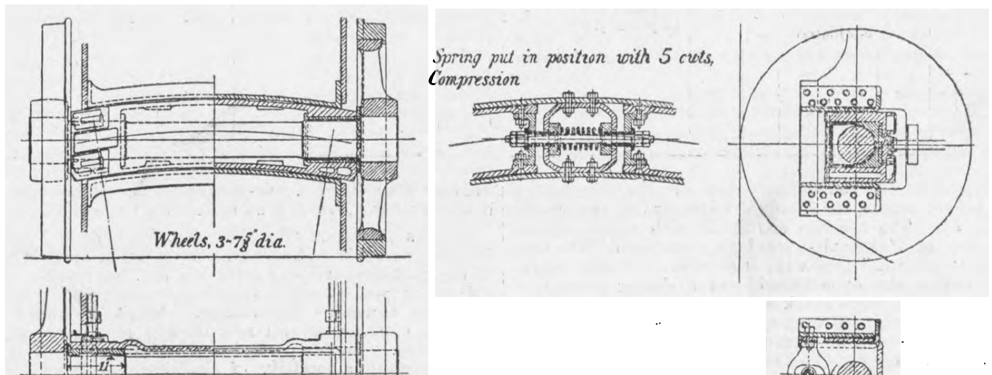


Fig. 58—RADIAL AXLE BOX FOR TANK ENGINES

Wheels and tyres.—The wheels of all engines are of cast steel. Tyres rolled at Horwich are manufactured of Siemens-Martin open-hearth steel. For locomotive and tender tyres this material must stand an ultimate breaking load of not less than 46 tons with a minimum of 20 per cent. elongation in 3in. The ultimate breaking load of carriage and wagon tyres is 35 tons, with 25 per cent. elongation in 3in.

Figs. 46 and 47 show the profile and fastening of locomotive tyres.

Renewal of tyres.—In the case of wheels up to 5ft. 8in. diameter, providing the tyres will turn up to 1½in. thickness and are in sound condition, they are retained. For wheels over this diameter the limit is 1¾in. For the half-year ending the 31st of December, 1908, out of 917 scrapped tyres, 674, or 73½ per cent., were worn to the limit; 123, or 13 per cent., scrapped on account of slackness; and 8 or 9 per cent. for thin flanges; the remainder for flaws, blow-holes, or wheel defects. Some three or four years ago, with wheels of a larger diameter, the minimum tyre thickness allowed had to be increased, because a considerable number of large tyres showed signs of slackness, thereby increasing liability to fracture, hence the 1¾in. minimum. At that time tyre material was generally 38 to 42 tons tensile, which has gradually been raised from 42 to 48. This hardening of the material, and in some cases strengthening of the rims, where new centres have been supplied, has been the chief step taken to prevent tyres becoming slack. In the ten-wheeled bogie passenger class, which has the largest proportion of slack tyres, the main cause of this tendency must be attributed to the comparatively weak wheel centre.

Practice re shrinking.—Previous to November, 1908, the practice with regard to shrinkage was not quite proportionate to the diameter. Too much shrinkage was allowed in the case of small tyres, and probably not enough with large tyres. After some consideration the shrinkage was revised, and now stands at $\frac{1}{750}$th of the wheel centre diameter for all sizes.

Wear of tyres—Table III. represents the life and reasons for scrapping a certain number of tyres.

TABLE III.

Class.	Average mileage.	Total No. condemned in 4 yrs.	Percentage of worn down.	Per cent. loose.	Per cent. of thin flanges.	Average thickness.
10 wheeled bogie passenger..	140,000	249	67	23	10	1.984
8-wheeled ,, ...	227,500	144	70	56	14	1.953
10-wheeled radial tank	148,650	24	80	—	20	1.875
8-wheeled ,, ...	195,000	1174	80	14	6	1.86
6-wheeled tender goods.. ..	170,000	1700	87	5	8	1.547
Coal engines	140,000	367	$87\frac{3}{4}$	$1\frac{1}{4}$	3	1.5
Pug engines	56,000	126	99.2	—	0.8	1.3125
Radial tyres	127,500	1202	76	10	14	1.734
Bogie ,, ...	280,000	491	$82\frac{3}{4}$	$2\frac{1}{4}$	15	1.687
Tender ,, ...	298,000	2378	83	7	10	1.571

Tank engines of the shunting type, which work continually in goods yards, wear their tires faster than any other class. The practice with coupled wheels is to note that tyre which shows most wear on tread or flange, and based upon that, turn up if possible, or else renew the whole of the tyres. Sometimes a special tyre of full or half section is substituted for the worn tyre. It seems almost impossible to arrive at any definite statement as to which particular portion of the line most affects the wear of individual tyres. There is, however, a good deal of evidence that engines running in a particular district wear one radial tyre more than the other, and the leading tyres occasionally become sharper than those on the coupled wheels. In turning up tyres it is important to leave a witness mark. Figs. 48 to 55 show the wear of tyres.

Axle-boxes.—The driving and bogie axle-boxes are of phosphor bronze, cast with chambers on the top for oil and tallow. No underfeed is employed, but recently, on the bogie boxes, the top feed has been dispensed with, and the bottom sponge box packed with white waste soaked with oil. This method allows the bogies to run for a considerable time without attention, but provision is made for additional lubrication when necessary.

Springs.—All bearing springs for driving wheels are under-hung. On the 8-wheeled radial tanks, 8-wheeled bogie passenger, and 10-wheeled bogie passenger engines, the springs, for ease in changing, are of the elliptical pattern introduced by Mr. Aspinall. For the four-cylinder passenger engine and the 10-wheeled radial tanks, also tender, goods, and coal engines, laminated springs are used. The bogie springs are of the volute pattern, and radial springs are laminated and placed on the top of the axle-boxes. Elliptical springs have also been introduced in a number of tenders—see Table IV. for particulars of repaired springs.

TABLE IV.—*Statement Showing Number of Springs Repaired and Average Mileage from July*, 1906, *to December*, 1908.

Class of engine.	No. of engines.	Type of spring.	Width of plates.	No. of plates.	Thickness of plates.	Span.	Load on spring.	Total number of springs.	No. of springs repaired per year.			Average mileage of springs.	Position of springs.	No. of springs per engine.
			in.			ft. in.	t. c.		July, '06 to July, '07.	July, '07 to July, '08.	July, '08 to Dec., '08.			
8-wheeled radial tanks ..	270	laminated	4	14	1 plate $\frac{5}{8}$in. 13 plates $\frac{1}{2}$in.	3 3	4 10	540	488	436	202	32,370	leading radial	2
,, ..	270	,,	4	14	,,	3 3	,,	540	488	436	202	32,370	trailing radial	2
,, ..	270	elliptical	$3\frac{1}{2}$	6	1 plate $\frac{1}{2}$in. 5 plates $\frac{5}{8}$in.	2 6	6 18	1080	1446	1394	640	20,739	driving and trailing	4
8-wheeled radial tanks (extended smoke-box) ..	20	laminated	4	14	1 plate $\frac{5}{8}$in. 13 plates $\frac{1}{2}$in.	3 3	5 0	40	43	27	17	31,548	leading radial	2
,, ..	20	,,	4	14	,,	3 3	,,	40	43	27	17	31,548	trailing radial	2
,, ..	20	,,	$4\frac{1}{2}$	12	2 plates $\frac{5}{8}$in. 10 plates $\frac{1}{2}$ F.	3 1	6 3	80	132	112	43	19,107	driving and trailing	4
10-wheeled radial tanks ..	20	,,	4	14	1 plate $\frac{5}{8}$in. 13 plates $\frac{1}{2}$in.	3 3	3 10	40	35	30	9	33,814	leading radial	2
,, ..	20	,,	4	14	,,	3 3	5 10	40	43	35	9	31,123	trailing radial	2
,, ..	20	,,	$4\frac{1}{2}$	12	2 plates $\frac{5}{8}$in. 10 plates $\frac{1}{2}$ F.	3 1	7 2	120	182	149	68	17,005	driving and trailing	6
8-wheeled bogie passenger ..	40	elliptical	$3\frac{1}{2}$	14	$\frac{7}{16}$in.	2 6	6 1	160	261	256	117	21,676	driving and trailing	4
10-wheeled bogie passenger ..	40	,,	$3\frac{1}{2}$	14	$\frac{7}{16}$in.	2 6	6 6	160	261	255	117	20,202	driving and trailing	4
6-wheeled coupled goods ..	440	laminated	$4\frac{1}{2}$	12	2 plates $\frac{5}{8}$in. 10 plates $\frac{1}{2}$in.	3 1	5 12	2520	2360	2360	1090	23,972	leading driving and trailing	6
8-wheeled coupled goods ..	138	,,	$4\frac{1}{2}$	12	,,	3 1	5 6	1104	730	921	275	25,341	leading, driving, intermediate and trailing	8

Bogies.—Previous to the introduction of the 10-wheeled "Atlantic" type of engine, the standard bogie was of the cradle pattern—Fig. 56. The bearings are inside with volute springs connected to the top of the axle-boxes by a cross-beam. The first engines of the "Atlantic" type were also fitted with this bogie. Considerable rolling was experienced, and a sliding pattern of bogie was tried with a single check spring. This bogie resulted in steadier riding engines, and is now adopted as standard. With the advent of the four-cylinder engine the wheelbase was increased from 5ft. 6in. to 6ft. 6in.—Fig. 57—The standard design of bogie was adhered to, but all the parts were strengthened, including the axles, on account of the greater load.

Radial axle-boxes.—The standard radial axle-box used on tank engines—Fig. 58—is of the design introduced by the late Mr. Webb, and the side movement is controlled by a single check spring of the Timmis section.

A supplementary paper is in preparation by the author for an early date, on Compounding and Superheating in Lancashire and Yorkshire Railway locomotives.

(*To be continued*).

IN spite of the Government approval to the scheme for electrification of the Odessa tramways, the tramway company has not, we hear, yet been able to begin work owing to fresh preliminary difficulties.

CATALOGUES.

DONOVAN AND CO., 12, Barwick-street, Birmingham.—This firm has recently issued circulars devoted to the "Danco" single-enclosure arc lamps, Barwick motor starters, metal and carbon filament lamps, and china replacement fuses.

T. MILLER AND CO, 66, Victoria-street, Westminster, S.W.—A leaflet sent to us by this company deals with oil accessories for engineers. Illustrations and prices are given of the company's barrel or drum pumps, petrol funnels and injectors, oils cans, &c.

WELDLESS CHAINS, Limited, Gartsherrie, Coatbridge.—Pamphlet No. 5 has reached us, which has reference to this company's universal chain adjuster for shortening, joining, or adjusting the length of chains and slings. Prices and full particulars are given.

THE DUNLOP RUBBER COMPANY, Limited, Manor Mills, Aston, Birmingham.—"Rain to Order" is the title of a tasteful little pamphlet received from this company. It deals with an ingenious little contrivance for attaching to the garden hose and for giving an imitation of actual rain.

THE HORSFALL DESTRUCTOR COMPANY, Limited, Atlas Works, Pershore.—This company has forwarded us three sections from its general catalogue which give up-to-date particulars of the Horsfall destructor plant, agricultural machinery, and general machinery, such as mortarmills, crushing and screening machines, mortar and concrete-mixing machines, &c.

W. T. GLOVER AND CO., Limited, Trafford Park, Manchester.—Glover's almanac is always useful, interesting, and amusing. The new copy for 1909-1910, which has just reached us, is well up to the usual standard. The daily sheets give extracts from technical journals, humorous pictures pertaining to electrical work, and much general information of interest to engineers.

CROMPTON AND CO., Limited, Salisbury House, London Wall.—An interesting little circular has reached us which has reference to the Hounsfield patented excess-speed alarm for motor vehicles. We are informed that one of these alarms has been fitted to a motor cab and submitted for approval to the police authorities, who have expressed themselves as being satisfied that it fulfils the required conditions.

JAMES LUMB AND SONS, Limited, Perseverance Works, Elland, Yorks.—From this company we have received a little booklet dealing with a lecture delivered before the Bolton Managers' and Overlookers' Association by Mr. Levi Lumb on "The Governing and Regulating of Steam Engines." We have also a report on a governor test carried out by Professor Charnock, of the City of Bradford Technical College.

SCHMIDT'S SUPERHEATER COMPANY, Limited, 28, Victoria-street, Westminster, London.—An interesting and well got up pamphlet on the generation and use of superheated steam in marine practice has reached us. Also a list of vessels which have been fitted with the Schmidt superheater. From the latter we note that 142 vessels are using superheated steam on the Schmidt system, and 40 vessels in the course of construction are to be fitted with it.

THE CONSOLIDATED PNEUMATIC TOOL COMPANY, Limited, Palace Chambers, 9, Bridge-street, Westminster, S.W.—A new edition of Catalogue No. 1 E has reached us which has reference to electric tools of various descriptions. Among the newer types of tools which the company now supplies are its three-speed pillar drill, dealt with in the catalogue, and a coal and ore-boring machine. This and a new type of side-spindle corner drill are also dealt with in the catalogue, which is an interesting little publication.

COWANS, SHELDON AND COMPANY, Limited, 3, Victoria-street, Westminster, S.W.—A new edition of this company's catalogue of lifting machinery, railway materials, &c., has reached us. It is a well bound and extensive volume containing 160 large pages, and there are numerous illustrations. While somewhat similar to previous editions, several new designs and improvements have been added. From a perusal of this catalogue we notice that the company makes a speciality of electrically-operated cranes of all types, in addition to those operated by hand, steam, hydraulic power, and air.

APPLEBYS LIMITED, 58, Victoria-street, Westminster, S.W.—"Steel Work Plant" is the title of a well got up pamphlet which has been sent to us by this company. It deals with blast furnace charging machines, a special five-motor electric ingot crane, a magnetic lifting overhead travelling crane, a 100-ton electric ladle crane, an 80-ton electric ladle crane, an electric foundry or forge crane, a three-motor overhead travelling crane, open-hearth electric charging machines, a 3-ton steam cantilever tower crane, electric ingot rotating gear for forge cranes, &c. The catalogue is well illustrated, and each illustration is accompanied by a concise description.

R. WAYGOOD AND CO, Limited, Falmouth-road, London, S.E.—A new catalogue on electric lifts has reached us. It is a well got up publication, giving particulars and illustrations of electric lifts for passengers and goods, motor car lifts, public lifts, cliff lifts, lifts on liners, &c. The company's methods of driving and methods of control are also dealt with, and there are illustrations of the gear which is employed. A point worthy of mention is that the catalogue states that the difficulty of working lifts from a single-phase supply has been entirely overcome, and the company has constructed a large number of passenger and goods lifts working in this way.

JAMES H. TOZER AND SON, Limited, York Mansion, York-street, Westminster, S.W.—This is a handbook on the lock-woven mesh system of concrete reinforcement, but at the same time it has been compiled to serve as the company's catalogue. The book contains formulæ and tables with explanatory notes on the system and its application to various structures. The calculations given in the book have been prepared on lines identical with the recommendations of the Royal Institute of British Architects' report on reinforced concrete. Among other things of a useful and interesting character, the book gives a history of reinforced concrete. There are also many illustrations showing structures of various kinds which have been built on this system.

BERLIN-ANHALTISCHE MASCHINENBAU-ACTIEN-GESELLSCHAFT, in Bamag, Dessau, Germany.—Mr. C. A. Matthews, 12, Newport-road, Chorlton-cum-Hardy, Manchester, the agent for the North of England of the above firm, has sent us a publication on "The Erection and Care of Shafting." The objects aimed at in the book are stated in the preface to be as follows:—"To state the general points of view to be observed in erecting shafting and gearing, and to indicate how the gearing, the whole plant and its several parts, are to be treated." The bulk of the book is, however, not unnaturally taken up with descriptions and particulars of transmission gearing, friction couplings, blocks, pedestals, hangers, pulleys, shafting, &c. The book is nicely produced and handy in size.

PHŒNIX DYNAMO MANUFACTURING COMPANY, Limited, Thornbury Works, Bradford.—The first of this company's new series of "Phœnix" bulletins has reached us. The first part is devoted to an illustrated description of the Thornbury Works, and the latter part is divided into seven sections, each giving many illustrations of plant recently erected by the company in England. The headings to the various sections are Large Central Stations, Power in Factories, Pumping and Mining, Engineering and Woodworking, Textile Mills, Electric Tools, &c. Each section shows plant which has actually been erected and working on site. This first bulletin is mainly illustrative of the general range of work covered by the company, but we are informed that six remaining bulletins, now in preparation, will give photographs, weights, and prices of all types of plant.

THE IRON, COAL, AND GENERAL TRADES OF BIRMINGHAM, WOLVERHAMPTON, AND OTHER DISTRICTS.

(*From our own Correspondent.*)

The State of Trade.

THE week has been devoted to holiday making. Many of the engineering establishments will not resume work until Monday next, although some have already begun again. In times of trade prosperity the interval is sometimes curtailed, but not so under present circumstances, as there is no pressure of orders to be got on with. The settlement of the coal crisis is greeted with a feeling of relief on all hands.

Pig Iron.

The blast furnaces have, as usual, continued production, though at low pressure. Stocks have therefore accumulated to some extent, but will doubtless soon be used up. Meanwhile, quotations are maintained; Staffordshire common forge is quoted 46s.; part-mine, 48s. to 49s. 6d.; best all-mine, 80s. to 81s.; and cold blast, 110s. With regard to Midland descriptions, Northamptons were quoted 46s. to 47s., and Derbyshires 47s. 6d. to 48s 6d. For these there is a fairly good demand. North Staffordshire sorts are quoted 49s. to 50s. Good pig iron news is that which comes from the North of England this week as to a stronger tone there.

Blast Furnaces.

In South Staffordshire and Worcestershire at June 30th there were 21 furnaces in blast out of 33 built. The position is without alteration on the quarter. In North Staffordshire there are 14 blowing out of 32 built. Northamptonshire has 11 blowing out of 20 built, or no change on the quarter. Derbyshire has 31 out of 44, or an increase of 1. There are 13 blowing in Lincolnshire out of 15 built, which is the same as three months ago.

Manufactured Iron.

The manufactured iron trade keeps very quiet. Marked bars are quoted £8, and unmarked £5 17s. 6d. to £6. There is very little demand for plain sheets, which are quoted £7 2s. 6d. to £7 5s. for doubles. The galvanised sheet trade is still disorganised, the general quotation being £10 10s. to £11. Some makers declare that they will rather remain off the market than sell at the present low prices.

Steel.

The steel outlook is somewhat improved, both on home and foreign account, and quotations are maintained at:—Angles, £5 10s. to £5 15s.; girder plates, £5 15s. to £5 17s. 6d., and boiler plates, £7. Bessemer sheet bars are nominally £5 12s. 6d., and Siemens £5 15s.

Foundrymen's Association.

At the University, Edmund-street, Birmingham, on Tuesday, the 3rd inst., there was opened the sixth Annual Convention of the British Foundrymen's Association. The chair was occupied by Mr. F. J. Cook, of Birmingham, who is the Association's president. The deputy Lord Mayor (Alderman H. J. Sayer) received the delegates, and gave them a hearty welcome to Birmingham. The chairman, in his presidential address, alluded to the foundry trade of Great Britain as occupying the premier position in the world, and said that, in order to retain that position, constant attention to education and to research work was necessary. It was also needful that there should be close and continuous observation of chemical processes. There should be careful study as to the effect of design upon the structure of the metal of a casting. A paper entitled "Twenty-five Years of Cast Iron" was read by Professor Thomas Turner, of the Birmingham University, and one entitled "The Production of Patterns for Light Castings," by Mr. W. H. Sherburn, of Warrington. In the afternoon the members of the Association visited the new University buildings at Bournbrook, and the municipal tramway generating station. On the following day (Wednesday) more papers were read in the morning, and a visit was then paid to the works of Messrs. Bellis and Morcom, Ledsam-street. On the following day (Thursday) the programme included a visit to the works of the British Thomson-Houston Company at Rugby.

NOTES FROM LANCASHIRE.

(*From our own Correspondent.*)

MANCHESTER, Thursday.

A Dull Market.

BUSINESS was resumed after the holidays on the Iron Exchange on Tuesday, but the attendance was meagre in the extreme, and there were few representative buyers present. Under the circumstances, therefore, it will be readily understood that trade was slow, and there was scarcely sufficient passing to test prices. Still the undertone continues good, and makers are holding out for full rates. Practically the only change of importance to note is an advance, chiefly owing to speculative influences, of 6d. to 9d. per ton in Middlesbrough brands. Scotch and other sorts remain steady, except hematite, which has a downward tendency. Forge iron is also dull and in buyers' favour.

Finished Iron and Steel.

In finished iron it is reported that some attempt has been made to induce Lancashire bar makers to reduce prices owing to outside competition. Inquiry, however, showed that instead of there being any reduction, the next move would be in an upward direction. Steel products are quiet generally, but foreign billets are scarce, and higher prices are asked in most cases by holders.

Copper, Lead, and Tin.

There has been no change in manufactured here, although the raw metal ruled a little higher. Lead: Sheets were about 2s. 6d. per ton higher. Tin: English ingots were a shade dearer.

Quotations.

Pig iron: Lincolnshire No. 3 foundry, 52s. to 52s. 6d.; Staffordshire, 51s. to 51s. 6d.; Derbyshire, 52s. 6d. to 53s.; Middlesbrough, open brands, 58s. 4d. to 58s. 7d. Scotch: Gartsherrie, 59s. 3d.; Glengarnock, 58s. 6d.; Eglinton, 57s. 6d.; Dalmellington, 57s. 6d., delivered Manchester; West Coast hematite, 58s. 6d.; East Coast ditto, 56s., both f.o.t. Scotch, delivered Heysham: Gartsherrie, 57s. 3d.; Glengarnock, 56s. 6d.; Eglinton, 55s. 6d.; Dalmellington, 55s. 6d. Delivered Preston: Gartsherrie, 58s. 3d.; Glengarnock, 57s. 6d.; Eglinton, 56s. 6d.; Dalmellington, 56s. 6d. Finished iron: Bars, £6 10s.; hoops, £7 12s. 6d.; sheets, £7 15s. to £8. Steel: Bars, £6 5s.; Lancashire hoops, £7 5s.; Staffordshire ditto, £6 17s. 6d. to £7; sheets, £7 17s. 6d. to £8; boiler plates, £7 2s. 6d.; plates for tank, girder, and bridge work, £6 to £6 5s.; English billets, £4 12s. 6d. to £4 15s.; foreign ditto, £4 10s. to £4 12s. 6d.; cold-drawn steel, £9 5s. to £9 10s. Copper: Sheets, £71; tough ingot, £62 to £62 10s.; best selected, £62 to £62 10s. per ton; copper tubes, 8½d.; brass tubes, 6⅞d.; condenser, 7⅞d.; rolled brass, 6¼d.; brass wire, 6½d.; brass turning rods, 6½d.; yellow metal, 6d. per lb. Sheet lead, £17 7s. 6d. per ton. English tin ingots, £131 10s. per ton.

The Lancashire Coal Trade.

Like the Royal Exchange, the attendance on the Coal Exchange was exceedingly small. The settlement in the coal trade was regarded with great satisfaction. Quotations still remain very firm, especially for house coal. There is a fair, though not large, demand for slack, while the tone in shipping and bunkering coal remains good.

BARROW-IN-FURNESS, Thursday.

Hematites.

The demand for hematite iron is very weak, and no improvement in the conditions of the trade can be reported. The Furness Railway Company, owing to the depression in the iron and steel trades, is paying no dividend on the Ordinary shares for the half-year ended June 30th. On two previous occasions no dividend was paid, in the first half of 1892 and 1895, on the former occasion owing to the Durham strike, and on the latter owing to a period of keen depression in the iron and steel trades. The depression through which the trade has been passing has been acutely felt, because of the length to which it has extended. Latterly better conditions have arisen, and increases in traffic have been recorded in place of decreases week by week; but the market has not got back to its old conditions, and there is not any immediate prospect of its doing so, although the outlook is brighter than it has been. Makers have not much business in hand, but they are maintaining the output at their works, and some metal is going into stock in makers' yards. As regards warrant stocks, they remain low at 13,377 tons. Prices show no variation. Mixed Bessemer numbers are nominally at 58s. net f.o.b., but can, of course, be bought at a lower figure than this. Warrant iron is at 56s. 6d. net cash sellers, and 56s. buyers. Special hematite iron is in demand at 60s. to 61s. 6d. Spiegeleisen is only on slow sale, but a fair business is being done in ferro-manganese. Scrap is selling moderately well, and there is a good demand for charcoal iron. Iron ore is quiet at old prices, ranging from 11s. to 17s. per ton net at mines, according to quality.

Steel.

The steel mills throughout the district are closed down this week owing to the holidays, and also owing to a great extent to the scarcity of business which is being experienced. Mr. J. M. While, who has been general manager of the Barrow Steel Company for the past eighteen years, has resigned, and will leave the services of the company at the end of the year. He will, however, remain a director of the company.

Shipbuilding and Engineering.

There is nothing specially to note in the shipbuilding world, beyond the fact that much progress is being made at Barrow with the dirigible airship which is being constructed to the order of the Admiralty. A special shed is being erected at one corner of the Cavendish Dock at Barrow, and it is expected this will prove to be an important local industry. Several submarines at Barrow are now practically ready for delivery to the Admiralty, and other submarines are also being constructed in the private shed which has been built for that purpose.

Shipping and Coal.

The shipping trade is very quiet, and there is but a comparatively small export of iron and steel. The coal and coke trades are lifeless, and the settlement of the coal crisis has introduced a steadier feeling all round.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

Bank Holiday and Business.

THIS week is more or less a holiday week, not so much by choice as by the accident of things—a disposition in some establishments to make Bank Holiday a works trip holiday, with a few days added, and this year a decided dearth of employment. Works at the East End, being at best only partially employed, have in some departments shut down for the week, but not generally. At most works efforts will be made to resume operations before the week expires, several having started at the time of writing. Colliers, as a rule, do not observe Bank Holiday, but as August is chiefly the local "feast" month, there is much broken time throughout.

Steam Coal Still Firm.

Coal keeps in good demand for shipment at about 9s. to 9s. 6d. per ton for best grades, and pits are working fairly well. Steam nuts move steadily, values being moderately well maintained. The strong request for steam coal is, no doubt, to a considerable extent owing to the diminished outputs at various collieries on account of stoppages caused by difficulties with the pit lads. This has necessarily made the position more acute. The tonnage for export at Hull is very active, the Baltic season being at its full height, whilst the weight taken under contract for railway and steam trawler purposes is also at its maximum. For the week ended July 27th last, the quantity forwarded to Hull was 80,827 tons, compared with 74,364 tons for the corresponding period of last year. Cronstadt was again the principal market, taking 19,540 tons, Rotterdam second with 6585 tons, Hamburg third with 6541 tons, and Buenos Ayres fourth with 5009 tons.

House and Gas Coal.

For the period of the year the output of domestic fuel is distinctly larger than usual. This is no doubt caused by the call for stocking purposes, householders being induced to get in supplies through some apprehension of a general strike, though there were generally optimistic views on the question, which, happily, have been justified by events. All the same, customers, in many instances, prepared for the worst, and before going on their holidays looked well to the stocks in their cellars. A strong demand from London merchants is still maintained. This is mainly on account of the superior qualities, but secondary coals are also in improved request, more especially for the Manchester district. Best Barnsley is firm at 11s. 6d. to 13s. per ton at pit; secondary sorts, from 10s. to 11s. per ton at pit. Gas coal contracts are now mostly settled, at 6d. to 9d. per ton reduction on last year's prices.

Small Coal and Coke.

For good grade slack there is brisk demand, collieries having no stocks on hand. Values are steady, with an upward tendency. Best quality washed smalls make from 6s. to 6s. 6d. per ton at pit; hard slacks, 5s. to 5s. 6d.; and second hard slacks at 4s. to 4s. 3d. The qualities used in the cotton and woollen districts fetch from 4s. 6d. to 5s. 6d. per ton. Best washed coke, 10s. 6d. to 11s. per ton.; unwashed, 10s. to 10s. 6d. per ton.

Iron—Quiet Business.

Consequent on the holiday fever, business in iron and steel is flat. Sellers are not pushing, and buyers are not eager at any price. If anything there is a slightly firmer tone in pig iron, following on the settlement of the Scottish coal trouble, but business is small. Hematites, West Coast, 68s. to 69s. per ton; East Coast, 64s. to 65s. per ton, both less 2½ per cent., delivered in Sheffield and Rotherham. The Lincolnshire Ironmasters' Association had no meeting last Friday, and prices, therefore, remain as before. There is slightly improved inquiry for basic iron, but in foundry or forge qualities little or nothing is being done. Lincolnshire, No. 3 foundry, 50s. per ton; No. 4 foundry, 49s. per ton; No. 4 forge, 49s. per ton; No. 5 forge, mottled and white, 49s. per ton; basic, 50s. 6d. per ton. In Derbyshire irons some fair lots have recently changed hands. In most cases makers are asking and obtaining slightly better figures for next year's deliveries. Derbyshire, No. 3 foundry, 49s. 6d. to 50s. per ton; No. 4 forge, 48s. 6d. to 49s. per ton. Both Lincolnshire and Derbyshire irons net delivered in Sheffield and Rotherham.

Bars, Hoops, and Sheets.

Bars and other descriptions of finished iron are in very poor request. Consumers are pressing for lowering of price, which is not likely to be conceded, as the Association rates now in operation are generally admitted to be unremunerative. Quotations:—Bars, £6 10s. per ton; hoops, £7 10s. per ton; sheets, £8 10s. per ton.

Steel.

In the steel trade matters have not improved, but there is a fairly general hope that business will get better later on in the autumn. A serious labour trouble, involving the ironworks, has occurred in Sweden. The dispute, if unsettled, will have serious effects on Sheffield business, for if the Swedish ironworks are set down for any length of time, the local crucible steel trade will suffer from lack of supplies of its raw material. Local stocks of Swedish iron are about normal in quantity, and through the languid condition of trade generally a strike or lock-out in Sweden would cause less inconvenience to the manufactures dependent upon Swedish raw material than would otherwise be the case. All the same, an early settlement of the dispute is hoped for in the departments of Sheffield manufacture concerned.

The Heavy Industries.

Vickers, Sons and Maxim, Limited, are engaged on orders from the British and Japanese Governments, which, it is understood, will keep them busy in their big gun department for a considerable period. A good-sized order for rails—15,000 to 16,000 tons—has been secured by Cammell, Laird and Co., Limited, for the Soudan Government. Orders for railway material and marine work are scanty. There is some hope for marine work in the advance of freights, which may tempt owners to build new boats; but hope is all in all at present. A local wagon-building company has just issued its half-yearly report, and another has announced its interim dividend. These appear to indicate that wagon companies have done much better during the depressed trade than has been the experience in iron and steel companies generally.

NORTH OF ENGLAND.

(*From our own Correspondent.*)

Cleveland Pig Iron.

THE upward movement in the prices of Cleveland pig iron has been fully maintained this week, and a good business has been done; indeed, they are better off for orders now than they have been for some weeks, and statistics show that the position has improved. Consumers have bought rather freely for early delivery, and there has been more activity among the speculators than has been noticeable for some time. This would indicate that the trade is at last waking up, and naturally the tone is more cheerful. Higher prices for pig iron have this week ruled than have before been reported this year, the rates being fully 6d. per ton above the previous best. Cleveland warrants attained 49s. 8½d. cash buyers, and though there was a slight reaction, caused doubtless by speculators realising profits, buyers at the close on Wednesday were offering 49s. 7d. cash. No. 3 Cleveland pig iron for prompt delivery attained 49s. 9d. per ton, and has maintained it, a considerable number of orders having been placed at that figure, while 50s. was paid for delivery up to the end of September. The influences now are considered favourable, the chief being the encouraging reports from the United States, where there appears to be a general revival of trade. The settlement of the Scotch labour difficulty has steadied the iron market, as Cleveland's trade with Scotland is not likely to be interfered with now. Shipments are more promising this month, and stocks are not increasing so rapidly. It is true that Cleveland ironmasters have not yet had any orders from the United States, but this week an order for 3000 tons of steel scrap has been secured by one of the leading Middlesbrough firms of merchants. The reduction of the duties on pig iron and scrap will give traders in this district a better chance of doing business on the other side of the Atlantic. Pig iron is to be charged 2½ dollars duty instead of 4 dollars. No. 1 Cleveland pig iron is at 52s. 3d; No. 4 foundry at 48s. 9d.; No. 4 forge at 48s. 6d.; and mottled and white at 48s. per ton, all for early delivery.

Hematite Pig Iron.

When a revival of the shipbuilding industry can fairly be reported it might have been expected that a genuine improvement would have been experienced in the East Coast hematite pig iron trade, which depends so largely upon the condition of that industry, but it cannot be reported that trade is any better, and the spurt which appeared a fortnight or so ago is quite off again. All who make hematite pig iron for sale on the open market speak dolefully of the business and cannot get any advance. Their present selling prices hardly cover cost of production, and as they cannot well reduce that cost, seeing that the supplies of materials are in too strong a position to be forced to accept lower prices, higher quotations for the pig iron must be brought about, which will be a difficult task when the make is in excess of requirements. It must be conceded that all is not well with the makers of hematite pig iron at present. The current quotation for mixed numbers East Coast hematite pig iron is 55s. per ton for early delivery, but it is not easy to get it, especially when second hands will still sell small lots at 54s. 9d. Rubio ore is firm at 16s. 3d. per ton, delivered at wharf on Tees or Tyne, and pig iron makers cannot get average quality coke delivered equal to Middlesbrough for furnace purposes under 15s. 6d. per ton, as it has become somewhat scarce.

Cleveland Pig Iron Stock.

A worse return had to be issued by Connal's with respect to the stock of Cleveland pig iron in their public stores for July than has been made known since 1905, the increase having reached 21,289 tons, whereas in June it was 16,804 tons, and in May 16,338 tons; the total quantity held at July 31st being 259,171 tons, of which 252,994 tons were of No. 3 quality, 5086 tons No. 4 foundry, and 1092 tons iron undeliverable as standard. It is not likely that the increase will go on so rapidly this month.

Exports of Iron during July.

Disappointment is generally expressed that the record of exports of pig iron from the Cleveland district in July was so poor. They only reached 101,610 tons, and that is not even up to the average of July over the past ten years; indeed, it falls short of that average by 5513 tons, or 6 per cent. June was a bad month as regards export, but July was worse by 3593 tons, or 4 per cent. Compared with July of last year, last month was short by 18,455 tons, or 16 per cent., and with July, 1907, the decrease was 54,415 tons, or 36 per cent., while as compared with the best month on record—April, 1907—July this year was short by nearly 77,000 tons, or 43 per cent. Thus the figures for last month were unfavourable from almost every point of view, and were little better than are looked for in the depth of winter. The decline in deliveries was largely due to the decrease in continental, and particularly German, demands. Only 13,320 tons were sent to Germany, as compared with 25,903 tons in July, 1908, and 62,717 tons in July, 1907, this year's thus being little more than a fifth of what they were two years ago. Italian requirements likewise fell off, 10,301 tons being taken, against 27,217 tons in July last year. Business with France declined from 8529 tons in July, 1908, to 7425 tons last month, with Norway and Sweden from 8111 tons to 4714 tons, and with Belgium from 5452 tons to 3842 tons. But there were better deliveries to North America, Japan, Scotland, and Wales. To North America 11,525 tons were sent last month, against 4600 tons in July, 1908, and to Scotland 26,699 tons, against 21,015 tons. The seven months' exports of pig iron from the Cleveland district only reached 678,674 tons, against 825,359 tons last year, and 1,082,524 tons in 1907. This year's are the worst statistics since those of 1905, and only in four of the last ten years have poorer figures been reported. To Germany only 89,198 tons of pig iron have been sent from the Cleveland district, against 296,850 tons in the first seven months of 1907; the U.S.A. and Canada have taken 39,005 tons, against 227,000 tons in 1907; Scotland, 186,452 tons, against 237,990 tons in 1907. Last year Italy received 109,944 tons of pig iron from Cleveland between January and July; this year 77,164 tons. The oversea demands during the seven months have this year been 422,227 tons, against 785,550 tons in the corresponding period of 1907.

Manufactured Iron and Steel.

The demand for steel rails, plates, and angles shows considerable improvement, and producers speak hopefully about their prospects, but as yet they cannot realise improved prices. A fair number of orders for plates and angles have lately been secured, as a result of the improved demand for new steamers, and altogether there is a better outlook in these branches. For heavy steel rails the price is £5 5s. net f.o.b., and there are very good exports of these. Steel ship plates are at £5 15s., iron ship plates at £6, steel ship angles at £5 7s. 6d, iron ship angles at £6 15s., and packing iron and steel at £5 5s., all less 2½ per cent. f.o.t. Competition in the steel galvanised sheet trade has become very keen since the combination broke up, and this district has got a good share of the orders that have been offered, as its position is excellent for executing export indents, seeing that it is close to the sea, whereas those in inland positions are greatly handicapped. The bulk of the buying in this branch is on export account. Manufacturers in this district are quoting about £10 10s. per ton, less 4 per cent., for f.o.b. deliveries of 24 gauge in bundles. The galvanised sheet mills in the North-East of England are very well employed, as are also the black-sheet manufactories. The bar makers report a very quiet state of business. Exports of steel were good from the Tees last month, reaching 51,605 tons, against 37,510 tons in July, 1908, and for the seven months they were 305,316 tons, against 271,285 tons. So much cannot be said of the shipments of manufactured iron, for only 9605 tons were exported last month, as compared with 11,944 tons in July, 1908, and the seven months' exports were 70,199 tons, against 83,352 tons. The total of manufactured iron and steel exported during the month reached 61,210 tons, against 49,454 tons in July, 1908. To South and East Africa 17,340 tons were sent, to China and Japan 10,384 tons, to India 10,205 tons, to South America 6712 tons, and to Australia 2189 tons.

Shipbuilding and Engineering.

It is generally conceded that the shipbuilders have got at last into a better seam, and that there is good ground for believing that the worst has been experienced. Shipowners cannot expect to obtain cheaper steamers, and those who run regular lines are taking the opportunity to secure new vessels. It seems probable that the shipyards will in the coming autumn and winter be more fully occupied than they have been during the past two years. Some shipbuilders are now assured of full work until next spring. The change for the better is particularly marked at Stockton, where the yards have been badly hit by the depression. Further orders have been secured within the last few days by Messrs. Craig, Taylor and Co., R. Ropner and Sons, and Richardson, Duck and Co, while at Middlesbrough Sir Raylton Dixon and Co. have obtained orders which will keep them going throughout the winter. Employment is being afforded at most of the yards to increased numbers of men. At the marine engineering establishments likewise, trade is improving. Messrs. Blair and Co., at Stockton, have booked several orders, and Richardson Westgarth's, at Middlesbrough, are re-starting parts of their works which have been laid off.

Coal and Coke.

The steam coal trade is somewhat quieter, and prices are easier, but that was to be expected, seeing that quotations were inflated owing to the threatened trouble in the Scotch coal trade; in fact as much as 13s. per ton f.o.b. was asked for best steam coal, but now 11s. 6d. to 12s. will be taken. There is more tendency to buy for forward delivery. For gas coal the demand is brisk, and 11s. 3d. is asked for best, with 10s. 6d. for seconds. Coke is very firm and somewhat scarce, and fully 15s. 6d. has to be paid for furnace coke delivered at Middlesbrough.

NOTES FROM SCOTLAND.

(*From our own Correspondent.*)

The Coal Trade Settlement.

The termination of the coal dispute has caused great satisfaction throughout the industrial communities of Scotland. A general strike must have produced disastrous consequences, and the arrangement reached at the London conferences has accordingly come as a genuine relief, and its beneficial influences are already apparent in not a few directions. The feeling of renewal of confidence and expectation of a revival in business is exhibited in the improvement in railway and other stocks, and in the activity that has characterised the iron market. A decline in coal prices occasions no surprise, as the cause which led to the recent advance has been removed. The settlement of the dispute in the coal trade has, as we have said, been heartily welcomed; but the immediate effect on the market as been rather depressing than otherwise. Home consumers have shown little inclination to purchase in the last few days. Not a few had accumulated supplies in anticipation of a strike, and some weeks may elapse before these are exhausted. There have also been stocks laid up at some of the collieries which will have to be cleared away. The foreign demand has also become quieter, and there is an easier tendency in prices. Trade holidays, however, are still being observed in different localities, but it is anticipated that when these are at an end a gradual if not a very large improvement in business will be experienced.

The Pig Iron Market.

A good business has been done in pig iron warrants since the settlement of the coal trade dispute was announced. The business is, of course, largely speculative, and fluctuation in values may therefore be expected. In addition to the arrangement in the coal trade, the completion of the American tariff scales is believed to have not been without its influence on the iron market. Some authorities argue that the reduction of 6s. per ton in the import duty on pig iron is likely to lead to an increase in the shipments from this country to the States. From the point of view of the manufacturers of raw and finished iron, however, it seems to be doubted whether any substantial advantage can accrue; for whatever benefit may arise from the reduction of the duty on pig iron is not unlikely to be neutralised by the remission at American ports of the rates on ore and scrap, which is expected to increase the cost of these to the British consumer. Of course, these are so far only matters of surmise, and the effects now anticipated may be neutralised or modified by causes that do not at present come into view. In the meantime they are subjects of discussion, and are not without a certain influence, as hinted above, on the course of the speculative market. Since last report business has been done in Cleveland warrants from 49s. 1d. to 49s. 10½d. cash, 49s. to 50s. 1½d. one month, and 49s. 8½d. to 50s. 7½d. three months. Sales of Cleveland iron were also noted at 49s. 7½d. for delivery in seven days, 49s. 3d. to 49s. 4½d. two months, 49s. 6½d. September 2nd, 49s. 10½d. September 10th, and 50s. 3d. for delivery 5th October. A lot of Cumberland hematite warrants was sold a few days ago at 57s. 6d., but that rate has not been maintained, and the quotation has receded since to 56s. 3d. per ton. Scotch warrants are nominally 55s. 9d., without transactions recorded.

Scotch Makers' Iron.

There has been a firmer tendency in Scotch makers' pig iron, but it is not yet certain whether consumers are prepared to pay increased prices. During the last few weeks consumers at home and abroad have been, it is understood, anticipating their requirements to some extent, so that they are not now anxious buyers. Whilst I write the current quotations are steady to firm, but it is not unlikely that they may be modified to some extent in the next few days. Monkland, f.a.s. at Glasgow, No. 1, is quoted 55s. 6d.; No. 3, 53s. 6d.; Carnbroe, No. 1, 57s.; No. 3, 54s.; Clyde, No. 1, 60s.; No. 3, 54s.; Gartsherrie, No. 1, 60s. 6d.; No. 3, 54s. 6d.; Calder, No. 1, 60s. 6d.; No. 3, 53s. 6d.; Summerlee and Langloan, No. 1, 61s.; No. 3, 56s.; Coltness, No. 1, 88s. 6d.; No. 3, 56s. 6d.; Glengarnock, at Ardrossan No. 1, 62s. 6d.; No. 3, 56s. 6d.; Eglinton, at Ardrossan or Troon, No. 1, 55s. 6d.; No. 3, 53s. 6d.; Dalmellington, at Ayr, No. 1, 58s. 6d.; No. 3, 53s. 6d.; Shotts, at Leith, or Glasgow, No. 1, 60s. 6d.; No. 3, 56s. 6d.; Carron, at Grangemouth, No. 1, 63s.; No. 3, 56s. per ton. During the holidays ten furnaces have been out of blast, but it is likely that a proportion of these, if not the whole, will soon be again in operation. The accountant of the Board of Conciliation reports that, in accordance with the price of Scotch pig iron warrants during the months of May, June, and July, the wages of blast furnacemen will not be subject to change during August, September and October.

Pig Iron Shipments.

The shipments of pig iron from Scottish ports in the past week were 4361 tons, compared with 6970 in the corresponding week of last year. There was despatched to Canada 605 tons, Holland 485, United States 100, India 86 France 10, Italy 160, Germany 150, Belgium 25, other countries 975, the coastwise shipments being 1765 tons, against 3411 in the corresponding week. The arrivals at Grangemouth of pig iron from Cleveland and district amounted to 7673 tons, being 817 tons less than in the corresponding week of 1908.

Finished Iron and Steel.

Work is not by any means general in the finished iron and steel industries of the West of Scotland. Only a proportion of the works has been in operation this week, but it is expected that they will be generally employed during next week, although it is not anticipated that the available orders will be sufficient to keep all the furnaces and machinery in operation. There has been a little more done in finished iron. Fair orders for structural steel are in the market, but there is severe competition for these between Scotch makers and representatives of continental firms, who are undercutting price. Shipbuilding specifications are coming to hand a little more freely, although there is still room for improvement in this respect.

WALES AND ADJOINING COUNTIES.

(*From our own Correspondent.*)

State of the Welsh Coal Trade.

No sooner are we out of the "wood," figuratively, than alarmists are putting forward the likelihood of getting into another. In a few months, we are told, there will be another upset, leading to a severe strike. It is to be hoped that this will turn out to be, like one of the weather or almanack prophecies, of wide reference, and get more attenuated or "fizzle out" as the date is approached. At present there is a satisfactory return to old conditions, and as soon as holiday-making has ceased—and this is prolonged by the harvesting and other agricultural work tempting the colliers to their old avocations—then we may expect a fair resumption of the coal trade. On Monday and Tuesday there was little being done at collieries, and a poor attendance on 'Change. At the various ports quotations were being given with some degree of hesitation, for the prospects were not definitely named, and Saturday's list is the most substantial one to go by in the discussions between buyers and sellers. For the present the following may be taken as a guide:—Large steam, best Cardiff, price 17s to 17s. 6d.; best seconds, 16s. to 16s. 6d.; ordinary seconds, 15s. to 15s. 6d.; best drys, 16s. to 16s. 6d.; ordinary drys, 13s. 9d. to 14s. 6d.; best washed nuts, 13s. 9d. to 14s. 9d.; seconds, 12s. 9d. to 13s. 3d.; best washed peas, 12s. 6d. to 13s.; seconds, 10s. 9d. to 11s. 9d.; very best smalls, 9s. 9d. to 10s. 3d.; best ordinaries, 7s. 3d. to 7s. 9d.; inferior sorts, 6s. 6d. to 7s.; very best Monmouthshire black vein, 15s. 6d. to 15s. 9d.; ordinary Western Valleys, 14s. 9d. to 15s.; best Eastern Valleys, 13s. 9d. to 14s.; seconds, 12s. 9d. to 13s. 3d. Bituminous coal: Very best households, 16s. 6d. to 17s. 6d.; best ordinaries, 14s. 6d. to 15s. 6d.; No. 3 Rhondda, 17s. 6d. to 18s.; brush, 13s. 6d. to 14s.; smalls, 10s. to 10s. 6d.; No. 2 Rhondda, 12s. 9d. to 13s.; through, 10s. to 10s. 6d.; smalls, 8s. 9d. to 9s. Patent fuel, 15s. to 15s. 6d. Coke: Special foundry, 24s. 6d. to 27s. 6d.; foundry, 18s. 6d. to 22s.; furnace, 16s. 6d. to 17s. 3d. Pitwood, 20s. to 21s.

Newport Trade.

The holidays continue to exercise an adverse influence on regular employment at the collieries. There will be no full start, it is expected, until Thursday. Latest prices given are as follows:—Very best black vein, 15s. to 15s. 6d.; ordinary Western Valleys, 14s. 3d. to 14s. 9d.; best Eastern Valleys, 13s. 9d. to 14s.; other kinds, 12s. 6d. to 12s. 9d.; best smalls, 8s. to 8s. 6d.; seconds, 7s. 6d. to 7s. 9d.; inferiors, 7s. to 7s. 6d. Bituminous coal: Best house coal, 15s. to 15s. 3d; seconds, 14s. to 14s. 3d. Patent fuel, 14s. 6d. to 15s. Coke: Foundry, 18s. to 18s. 6d.; furnace, 16s. 6d. to 17s. Pitwood, 20s. to 21s.

Swansea Coal Trade.

No change in price. Prospects good, but resumption of work tardy. Few collieries reopened, but expressions of satisfaction were heard that now good, regular trade may be expected. In a visit round the anthracite collieries we were much impressed with the fine quality stocks. Wagon loads from the collieries waiting shipment when business begins again presented an excellent appearance. It would not be right to particularise, and I only note that there was great identity between the fine blocks of coal and the scarcity of small, the loading having been carefully performed. The route of the colliery from the valley, the "clearings"—so like American tracts—and the march home at night of the colliers gave a scene of an interesting kind; though not so industriously carried out as in the steam coal districts, it is evident that great developments are going on, and the fine brand of Welsh anthracite in growing demand. Latest prices, Swansea:—Best malting, hand picked, 23s. to 24s. net; seconds, 21s. to 22s. net; big vein, 18s. to 19s. 6d. net; red vein, 12s. to 12s. 6d., less 2½; machine-made cobbles, 23s. to 23s. 6d. net; Paris nuts, 23s. 6d. to 24s. net; French nuts, 23s. 6d. to 24s. 6d. net; German nuts, 23s. 6d. to 24s. 6d.; beans, 17s. to 17s. 6d. net; machine-made large peas, 10s. to 11s. 6d. net; fine peas, 10s. to 10s. 6d. net.; rubbly culm, 5s. to 5s. 3d., less 2½; duff, 3s. to 3s. 3d. net; steam coal, best large, 15s. 6d. to 16s., less 2½; seconds, 13s. 6d. to 14s. 6d., less 2½; bunkers, 10s. to 10s. 9d., less 2½; small, 8s. to 9s. Bituminous coal: No. 3 Rhondda, large, 17s. 6d. to 18s. 6d., less 2½; through, 14s. 6d. to 15s., less 2½; small, 8s. 9d. to 10s., less 2½. Patent fuel, 13s. 6d. to 14s., less 2½. Coal quotations are all f.o.b. net cash thirty days.

Last Week's Coal Trade.

There was a very fair shipment of coal from Newport, Swansea, and Cardiff last week, notwithstanding all the excitement and rumours. Perhaps there would have been larger exports, but a lurking feeling prevailed that all would end well; so small parcels and high prices were kept in the background. The crisis was not reached until Friday, and until that date buyers and sellers were very restricted and careful in their operations. As contrasted with the quotations of the previous week prices were not very dissimilar. Best and seconds showed an advance, and slight alterations were shown in dry coals. Small steam came in more bountifully, with the inevitable result that prices eased off fully a shilling, and others in proportion; but nut and pea descriptions showed an advance. No. 3 Rhondda, too, were better; but No. 2 and other coals approved for bunkering were down 3d., and pitwood fell from 1s. to 1s. 6d.

Iron and Steel.

The holiday week seems to have made the iron and steel industry look still more gloomy. Not a gleam of light was to be seen at Cyfarthfa, Dowlais was little occupied, and from Llanelly to Ebbw Vale there was little briskness. Still, the managers are to be complimented on the efforts they make and the resolute attitude to await the turn of the tide. Large cargoes of iron ore arrived and pig iron from Grimsby and other places, such as Middlesbrough, which sent 540 tons pig to Newport. Quotations continue to be put forward Newport. I note that heavy steel rails are now offered at £5 5s. to £5 7s. 6d.; light sections, £5 15s. to £6; Bessemer tin-plate bars, £4 10s.; Siemens, £4 10s. to £4 11s. 3d. At the local blast furnaces there has not been much activity. Welsh hematite is at 61s. 6d. to 62s. 6d., delivered locally. Iron ore continues firm at 16s. for best Rubio. Scotch warrants, 54s. 4½d. prompt and one month; Cleveland warrants, 48s. 5½d. to 48s. 6d. cash, closes 48s. 6d. buyers; hematite warrants, 56s. 7½d. prompt and one month; Welsh hematite, 61s. 6d. to 62s. 6d., delivered in district. Other quotations:—Copper, £58 12s. 6d. cash, £59 15s. three months; lead, soft foreign, £12 13s. 6d.; English, £13 2s. 6d. and £13 3s. 9d.; spelter, £22. Swansea: Block tin, £133 15s. cash, and £135 7s. 6d. three months; silver, 23$\frac{7}{16}$d. per oz. This week 1000 tons pig came to Newport from Newcastle-on-Tyne. Scrap iron from London; 1700 tons steel from Bruges; 977 Rotterdam.

Tin Plate.

Last week's make sent to works in Swansea district 94,906 boxes; shipped during week, 107,389 boxes; stocks remaining, 207,246. Imports of foreign sheet and tin-plate bars have been heavy. Business firm and brisk. Orders executed on the basis of 12s. to 12s. 1½d. for ordinary Bessemer, and 12s. 1½d. to 12s. 3d. Siemens. For 28 by 20: 24s. to 24s. 3d. and 24s. 3d. to 24s. 6d. respectively. Black plates steady at £9 5s. C.A. roofing sheets £8 5s. to £8 7s. 6d. per ton. Big sheets for galvanising, £8 7s. 6d. to £8 10s. Galvanised sheet, 24 g., £10 10s. to £11 nominal.

AMERICAN NOTES.

(*From our own Correspondent.*)

New York, July 28th.

The effort to finance a 65,000,000-dollar coke combination affecting seventy-five independent coke plants, has temporarily failed because of the unwillingness of bankers in this city to buy the properties outright. The refusal is based on the assumption that these plants could not be run to the same advantage by new and inexperienced workmen. The combination will probably be consummated later by purchasing a majority interest in each plant excepting a few small ones and leaving the present owners in charge to work them. The great event of the past week was the opening of the Hudson and Manhattan Railroad Company's transverse tubes between Jersey City, New York, and Hoboken. On account of the strike at the Pressed Steel Car Works, Pittsburg, enough cars cannot be had to accommodate all the traffic.

The enormous demand for steel plates has put prices up to 1.40. The contract offered by the Baltimore and Ohio for 6000 cars cannot be placed just at present, on account of the strike. Structural steel is fractionally higher. Light rails are now in very active demand, and the Carnegie Company is full to capacity. Its orders last week were for 2000 tons. The South Chicago Rail Mill is loaded up with business for steel rails, and had to turn part of its new business over to the Carnegie Company. Splice bars are also in active demand. Steel billets have advanced 1 dol. per ton. All the independent tin plate mills are now running to full capacity. All kinds of shafting are now in good demand, and the Republic Iron and Steel Company and Jones and Laughlins are making to full capacity in their shafting departments. Pipe manufacturers are trying to order for future requirements, but are unable to do so on account of the higher prices looked for. Pipe will continue in active demand for months to come. A large volume of business is now coming from the agricultural implement makers and stove manufacturers. Large sales of basic were made during the past few days. The blast furnaces have been booking large orders for delivery of pig during August and September. Deliveries for later dates are not encouraged.

The copper market is strong at 13½ for Lake; 13 for electrolytic and casting. The electrical companies have been making liberal purchases. Arrivals of tin so far this month, 1995 tons; afloat, 3000 tons. Large dealings are reported in iron ore and arrivals from outside countries are heavy. Coke is active; furnace, 1.75 dol. to 1.90 dol. Lead is quiet at 4.30 to 4.35.

LAUNCHES AND TRIAL TRIPS.

British Sun, petroleum steamer; built by Swan, Hunter and Wigham, Richardson, Limited; to the order of the British Sun Company, Limited, of Tower Buildings, Liverpool; dimensions, 424ft. by 52ft. 3in. by 31ft.; to carry 8230 tons; engines, triple-expansions, 27in., 45in., 75in. by 48in. stroke, pressure 180 lb.; constructed by the Wallsend Slipway and Engineering Company, Limited; trial trip, July 30th.

Gladstone, steel screw steamer; built by Ropner and Sons, Limited; dimensions, 378ft. 6in. by 53ft. by 27ft 3in.; to carry 7900 tons; engines triple-expansion, pressure 180 lb.; constructed by Blair and Co., Limited; launch, August 3rd.

Victor Hugo, cantilever steamer; built by Sir Raylton Dixon and Co., Limited; to the order of Messrs. Delmas Frères, of La Rochelle; dimensions, 301ft. by 43ft. by 21ft. 4in.; to carry 3700 tons; engines, triple-expansion, 22in., 35in., 59in. by 39in. stroke, pressure 180 lb.; constructed by Richardsons, Westgarth and Co., Limited; trial trip, July 30th.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

Mr. J. Mitchell Moncrieff, M. Inst. C.E., has removed his offices from Consett Chambers, Pilgrim-street, Newcastle-upon-Tyne, to Pearl Buildings, Northumberland-street, Newcastle-upon-Tyne.

James Pollock, Sons, and Co., Limited, 3, Lloyd's-avenue, E.C, have recently shipped a small steel boat to the West Coast of Africa, two to Cuba, and several to South America, and have a number under construction at the present moment. These boats are designed to displace craft built of wood, especially in tropical climates.

North of England Institute of Mining and Mechanical Engineers.—The annual general meeting of the members of the North of England Institute of Mining and Mechanical Engineers will be held in the Wood Memorial Hall, Newcastle-upon-Tyne, at two o'clock to-morrow, Saturday, 7th inst. The following paper will be open for discussion:—"A Short Description of the Various Types of Coal Cargo Steamers and of Doxford's New Self-discharging Steamer," by Mr. John Kirsopp, jun.

A report issued by the Navy Department on the navies of the world gives Great Britain a tonnage, built and being built, of 1,871,000; France, 801,000; the United States, 770,000; Germany, 693,000; Japan, 445,000; Russia, 320,000; Italy, 284,000; and Austria, 143,000. The Navy Department excludes all vessels over twenty years old, unless they have been re-armed and reconstructed since 1900, and also vessels authorised but not actually begun. Great Britain is credited with having 53 battleships built and being built of a tonnage of 887,000; the United States with 29 of a tonnage of 406,000; France with 24 of a tonnage of 337,000; Germany with 28 of a tonnage of 354,000; and Japan with 13 of a tonnage of 191,000.

British Association: Engineering Section.—The following is the provisional programme of the proceedings at the Winnipeg meeting of the Engineering Section of the British Association on August 25th, 1909:—After the address by the president, Sir W. H. White, the second report of the Committee on Gaseous Explosions will be read, after which Mr. Duncan MacPherson will read a paper on "The National Transcontinental Railway," Mr. Ormond Higman a paper on "International Electrical Standardisation," Lt.-Col. William P. Anderson a paper on "Improvements in the Navigation of the St. Lawrence," and Mr. C. E. Larrard a paper on "The Behaviour of Ductile Material under Torsional Strain." Sir John Thornycroft will discuss "Hydroplanes or Skimmers," and Mr. J. E. Schwitzer "The Great Engineering Works on the Canadian Pacific Railway;" Messrs W. M. Thornton and O. J. Williams are down for a paper entitled "The Distribution of Di-electric Stress in three-phase Cables," and Colonel Goethals for one on "The Engineering Works of the Panama Canal." "Losses from High Tension Overhead Lines due to Brush Discharge" is the title of a paper by Mr. E. A. Watson, while Mr. E W. Marchant has presented a paper on "The Calculation of the Charging Currents in Three-core Cables and Overhead Transmission Lines supplied with Three-phase Currents."

New Railways in Austria.—Arrangements have just been made by the Austrian Government for financing the construction of thirty-three local railways in various parts of the monarchy, and having a total length of 720 kiloms., about 432 miles. The lines will cost rather more than six millions sterling to build, towards which the Government will contribute in one form or another about four millions. The balance will be raised by the different provincial and local authorities and private capitalists. In the case of fifteen of the lines the Government will provide about a million and three-quarters sterling by guaranteeing the revenues. Towards the cost of building another eleven lines direct subventions will be granted of half a million sterling. The remaining seven lines will be built directly by the State at a cost of a million and three-quarters sterling. The new lines will be of different types, some with small gauges and some electric. A few of them will have an exclusively industrial value, whilst others, most of them in the Tyrol, are intended to develop tourist travel, a means of revenue which Austria is beginning to regard as very important. The Tyrolean lines will be very costly to build on account of the mountainous character of the country. One of the projected lines, for instance, will rise to an elevation of over two thousand feet. Work on some of the lines will be begun almost immediately, but in many cases some four or five years will elapse before the lines can be completed.

NOTES FROM GERMANY, FRANCE, BELGIUM, &c.

(*From our own Correspondent.*)

Rheinland-Westphalia.

There is nothing new or of interest to be reported concerning the business in iron and steel. A quiet tone prevails. Large orders are not expected to be placed this year, and the few contracts that have already been secured for next year had to be taken at prices lower even than that which is at present quoted. The business on foreign account is, on the whole, better than the inland trade. Quotations for bars are irregular. In railway material employment is likely to be pretty satisfactory, an order for 10,000 t. having been given out by the Prussian Railway Administration for the autumn, and from abroad some fair orders have also been coming in. The plate trade has decreased, and the mills complain of insufficient employment.

List Rates.

The following are the current list quotations per ton free at works:—Raw spathose ore, M. 10.90; roasted ditto, M. 15.50; Nassau red iron ore, M. 11.50 p.t. net at mines; spiegeleisen, 10 to 12 per cent. grade, M. 63 to M. 65; white forge pig, M. 55 to M. 58; iron for steel making, M. 55 to M. 59; German Bessemer, M. 56 to M. 58; basic, free place of consumption, M. 49 to M. 50; Luxemburg forge pig, free Luxemburg, M. 44 to M. 46; Luxemburg foundry pig, No. 3, M. 46 to M. 48; German foundry pig, No. 1, M. 56 to M. 58; No. 3, M. 55 to M. 57; German hematite, M. 57 to M. 59; merchant bars, common quality, M. 97 to M. 102; iron bars, good quality, M. 122.50 to M. 125; hoops, M. 120 to M. 122.50; steel plates, M. 104 to M. 110; heavy plates for boiler-making purposes, M. 114 to M. 120; sheets, M. 117.50 to M. 125; steel wire, M. 127.50.

The German Coal Market.

In Silesia a slight improvement in demand has already been noticed for some sorts of fuel, while the Rhenish-Westphalian coal trade remains quiet. The Upper Silesian Government pits declined to grant the reduction in the prices for coal which ironmasters had been demanding. Gas coal is at present quoted M. 12 to M. 13 p.t. Best steam coal, M. 10 50 to M. 12.85 p.t.; coal for coke making, M. 11 to M. 12 p.t.; anthracite, M. 21 to M. 24.50 p.t.; foundry coke, M. 17 to M. 19; blast furnace coke, M. 14.50 to M. 16.50; briquettes, M. 10 to M. 13.75 p.t.

Iron and Steel in Austria-Hungary.

Weakness prevails in all departments; at a recent meeting of the Heavy Plate Convention a reduction in prices was resolved upon. Twice already within a year quotations have been lowered. The highest price realised was 27 crowns p.q., and now 24 crowns will be quoted. Bars, having met with a reduction in price four weeks ago, will now remain unchanged for a while. All the mills and foundries are reported in moderate occupation, and an improvement is not likely to take place this year. The position of the Austro-Hungarian coal market is not favourable, a limited demand coming in generally. In the Ostrau-Karwin district a tolerably good trade is being done.

No Change in Belgium.

Since early in June the Belgian iron market has been in a fairly steady condition, but no business of importance has been transacted for a considerable time, and Belgian ironmasters are not likely to realise better prices so long as the competition of their German rivals continues keen and successful in nearly all articles of finished iron. In plates and in sheets competition is specially strong, but quotations have nevertheless been well maintained. Basic bars, being in good request, have shown some stiffness in price, while iron bars remain neglected. There is no difference now in the prices for iron and steel bars, £4 9s. being quoted for both sorts f.o.b. Antwerp. The rail works report a good trade generally, though export figures are not favourable; only 40,778 t. have been exported during the first six months of the year, as compared to 70,102 t. in the corresponding period last year. Export in girders is slightly improving, and the business in iron and steel manufactured goods is also a little more animated. Firmness characterises the pig iron market, forge pig alone showing some weakness. In coal, a moderate demand and depression in prices have been reported during the week. Stocks are rather heavy. The general dulness has influenced briquettes a good deal, and 15 50f. and 19f. p.t. are but nominal quotations. On foreign account a fair business is done, but here, too, rates are unremunerative.

Fair Accounts from France.

The tendency is improving. Consumers have less difficulty in disposing of their make, and the contracts booked mostly extend to the beginning of next year. In the East, German competition is very keen, and though producers maintain the raised list prices, they have to grant rebates to secure inland contracts. The physiognomy is bright in the Marne Departement, and in the Centre a good employment is secured for some months ahead; although the works only reluctantly quote higher rates, they have been able to carry the advances in most instances. In the Nord a fair amount of work has been secured in sectional iron, and the mills are provided with work till late autumn. Basis prices in Paris are 170f. p.t. for merchant iron, and 190f. p.t. for plates and girders; in the Nord 10f. p.t. less is quoted for merchant iron. As regards the pig iron market, a fairly satisfactory business is done. A firm disposition is shown in the coal trade, especially in the Nord. The Loire pits have resolved upon a reduction of 0.50f. to 1f. p.t. for all sorts of coal, and for coke.

International Automobile Guild.—This Guild is the latest organisation in the motor world for the benefit of automobile owners, hirers, manufacturers, traders, and chauffeurs. It aims at the commercial development, on mutual lines, of automobilism in every branch, for both private and trade use, in the United Kingdom and also on the Continent. It is claimed that the Guild will open up the many great advantages of motoring for all purposes and to all classes at a minimum uniform definite reduced cost, and thus at once bring it within the reach of the vast number who have hitherto been deprived of its benefits by the question of cost. Both home and trans-continental touring will be greatly facilitated by the organising of an international corps of chauffeurs, who, in addition to their varied linguistic attainments, will possess special local topographical knowledge. The Guild will act as distributing agents between manufacturers and traders, for whom a central commercial exchange will be provided.

Robert Band Pope.—The death took place at Dumbarton, on July 30th, of Mr. Robert Band Pope, a partner of the firm of Denny and Co., engineers and boilermakers, Dumbarton. Mr. Pope, who was in his seventy-fifth year, had been connected with Denny and Co. for considerably over half a century. A skilful engineer who combined the faculties of insight and application, he was so successful in the fulfilment of the posts of works manager and chief draughtsman from 1857 to 1885 that in the latter year he was taken in as a partner of the firm, and his name is associated with its numerous successes. His skill was reflected in the results obtained from the first of the British India Company's steamers. When the compound engine was introduced he designed those of the Batavia, the first compound engines supplied to the Cunard Company, and various others. In the subsequent advancement in marine engineering Mr. Pope's name was associated with that of the late Mr. Walter Brock in the development of the triple and quadruple-expansion marine engine.

BRITISH PATENT SPECIFICATIONS.

When an invention is communicated from abroad the name and address of the Communicator is printed in italics.

When the abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent-office Sale Branch, 25, Southampton-buildings, Chancery-lane, London, W.C., at 8d. each.

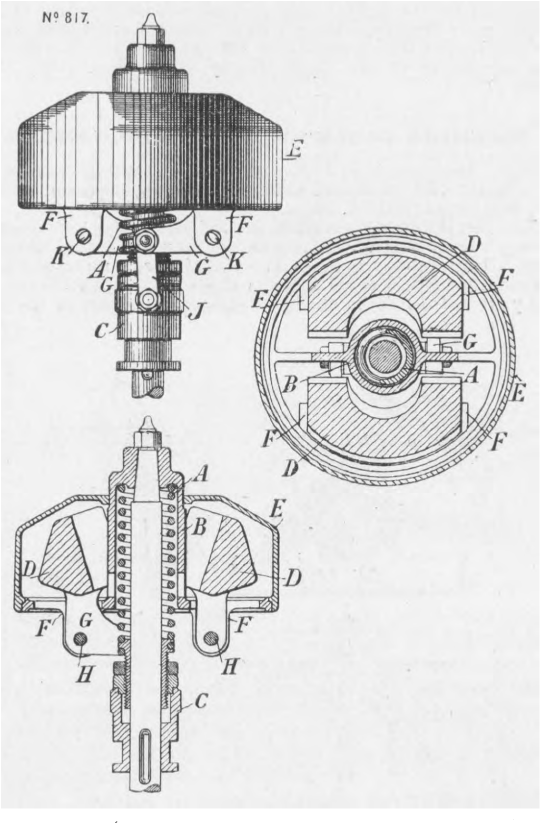
The first date given is the date of application; the second date at the end of the abridgment is the date of the advertisement of the acceptance the complete specification.

Any person may on any of the grounds mentioned in the Acts, within two months of the date given at the end of the abridgment, give notice at the Patent-office of opposition to the grant of a Patent.

STEAM ENGINES.

817. January 13th, 1909.—Improvements in Engine Governors, Herbert Reed Hall, 14, Lightwoods Hill, Smethwick.

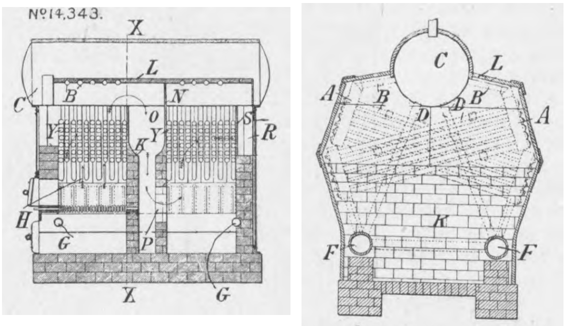
The object of this invention is to provide a compact governor of great sensitiveness. The governor is loaded by a helical spring A arranged to bear in a cup B of the head, its other end abutting on a sliding spool C, from which the valve control rods are carried in any suitable manner. The weights D of this governor are as shown, each being of chamfered semi-cylindric section with flattened sides. These weights lie snugly around the box part B and are enclosed by the cover E. The head carries at each side a pair of lugs F, and bell cranks G on the weights D are fulcrumed in these lugs by means of pins H. The bell cranks G are connected to the sliding spool C by links such as J. To eliminate friction, which greatly impairs the sensitiveness of the governor, the pin H is formed with lozenge-shape trunnions K to bear in the holes in the lugs F of the head. The rotation which is allowed the bell cranks amounts only to a slight rocking over the knife edges of the trunnions. Thus a knife edge is substituted for the rubbing friction of the surface of the pin against the lugs, and a much more sensitive governor is obtained.—*July 14th*, 1909.


Nº 817.

STEAM GENERATORS.

14,343. July 6th, 1908.—An Improved Water-tube Boiler, *Harry Del Mar, of* 428, *West* 124*th-street, New York.*

This boiler has side headers at the bottom, connecting by diagonally arranged cross-water tubes with the upper headers A, which also connect by tubes B with the steam drum C. This connects by downflow tubes D with the mud drums F, which are connected together by tubes G. The boiler has a fire-box H, at the back of which is a baffle K extending up nearly to the horizontal top L, serving as a baffle, and which extends from the steam drum to the boiler sides. A similar baffle N is arranged at the back of the baffle K, and extends up to the baffle L. The baffles thus form a vertical combustion chamber O between them, giving the hot gases a chance for further combustion, and therefore promoting higher efficiency. The baffle N has a passage P near the bottom for hot gases, and the smoke passes out of the rear compartment through the opening R, which is formed behind the baffle or plate S. Thus the gases pass first between the first section or bank of tubes, next to the chamber between the walls K and N, where re-combustion occurs, next between the second bank of tubes Y, and finally out. A modification is dealt with.—*July 14th*, 1909.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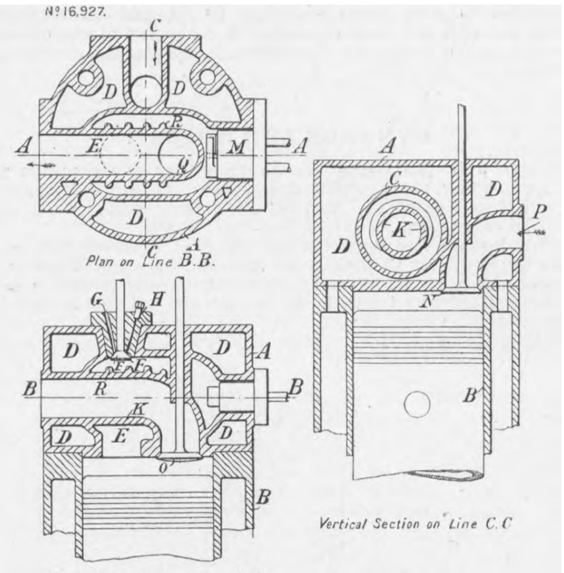
Cross Section on Line XX

INTERNAL COMBUSTION ENGINES.

16,927. August 12th, 1908.—Improvements in Internal Combustion Engines, Frank Arthur Goldsmith, of Marian Villas, Rhuddlan, Flint, and Francis Corbett, of Phœnix Ironworks, Rhuddlan, Flint.

This invention relates to internal combustion engines of the usual four-stroke type, using oil as fuel, and has for its object to provide means for keeping the combustion chamber at the required high temperature, whereby the oil fuel may be more effectively vaporised. The detachable head A of the cylinder B is cast with an internal egg-shaped combustion chamber C, the walls of which form, with the external walls of the cylinder head, a water jacket D. The combustion chamber is in communication with the cylinder through a contracted orifice E, and at the other side of the chamber, and opposite the orifice E, is disposed the inlet valve F controlling the fuel and auxiliary air supply, the ports for which, G and H respectively, are led to the valve seating. Passing through the centre of the combustion chamber is a curved tube K, which is adapted to conduct the exhaust gases from the cylinder to the atmosphere. Inserted into one side of the combustion chamber is the sparking plug M. The main air valve N and exhaust valve O control their respective air and exhaust ports P and K. Heat radiating fins R are provided round the exhaust tube to assist in more effectually dissipating the heat within the combustion chamber.—*July 14th*, 1909.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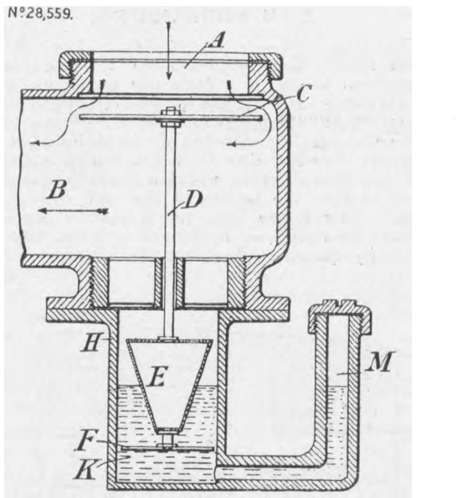
Plan on Line B.B.

Vertical Section on Line C.C

Vertical Section on Line A.A.

28,559. December 31st, 1908.—Improvements in or relating to Automatic Valves, *De Dion Bouton (Société Anonyme) of* 20, *Quai National, Puteaux, Paris (Seine), France.*

This invention relates to improvements in dash-pot regulators for the additional air valves of carburetters of the kind in which a float is mounted on the valve stem and immersed in a bath of mercury. The air enters the apparatus through the orifice A, then passes into the conduit B and thence to the carburetter.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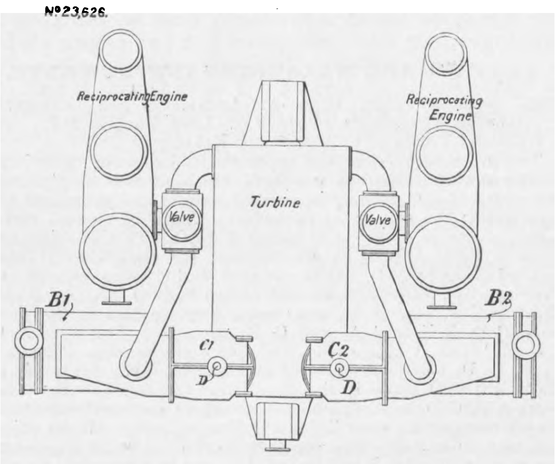
This conduit is adapted to be closed by a valve C fitted to a stem D. This stem has at its lower end a float E made of brass or other metal, and a disc F, also of metal, below the latter. In the lower part of the chamber H there is a bath of mercury K in which the float is partly immersed. The quantity of mercury placed in the receptacle H is such that the valve C closes the orifice when the motor is at rest. A filling duct M for the purpose of filling the receptacle H also enables the level of the mercury in this receptacle to be regulated.—*July 14th*, 1909.

TURBINE MACHINERY.

23,626. November 5th, 1908.—Improvements in connection with Combined Reciprocating and Turbine Installations, James Denny, of Denny and Co., Engine Works, Dumbarton, in the county of Dumbarton, North Britain, engineer, and John Irving, of Malmo, Cardross, Dumbarton.


Nº23,626.

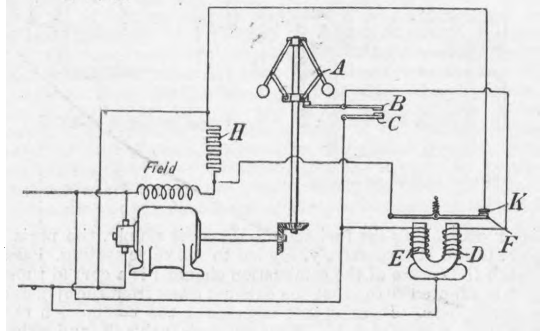
This invention has for its object to render it possible to repair a condenser or its air or circulating pump or other connection without its being necessary to stop any of the three propelling engines. A closure device, consisting of a stop valve, is arranged in each of the exhaust pipes or passages C^1, C^2 between the turbine engines and the condensers B^1, B^2, and should a condenser or its air or circulating pump or other connection on one side require repair, the stop valve in the exhaust pipe connected with that condenser is closed, thereby shutting off connection between the turbine and the defective condenser, so that the necessary repair can then be effected conveniently, the exhaust steam, of course, then passing entirely into the other condenser. The stop valves employed are preferably of the clack valve type. They are arranged to work across the pipes C^1, C^2, and are centrally attached, each to a vertical spindle D, connected at the outside to any suitable mechanism (not shown) for opening and closing the valve.—*July* 14*th*, 1909.

DYNAMOS AND MOTORS.

14,700. July 10th, 1908.—IMPROVEMENTS IN AND RELATING TO THE REGULATION OF ELECTRIC MOTORS, the British Thomson-Houston Company, Limited, 83, Cannon-street, E.C., and Edward Garton, of 171, Clifton-road, Rugby.

This invention relates to the regulation of electric motors, and has for its object to provide an improved regulator whereby a motor may be caused to run at a constant or nearly constant speed notwithstanding variations in the line voltage. At normal speeds the governor A holds the contacts B and C apart. These contacts being in the circuit of coil D prevent this coil from being energised, consequently the coil E, which is permanently energised, holds the contact F away from contact K, and the resistance H remains in the field circuit of the motor. If, however, the speed of the motor rises, then the governor causes the contact B to engage the contact C. This completes the circuit of relay coil D, and as the relay is differentially wound, the effect of coil E on the movable contact F is neutralised. Contact F therefore engages contact K, and the shunt circuit about the resistance H is closed, thereby allowing a greater amount of current to pass through the field, so that the speed of the motor is reduced. When the speed of the motor falls sufficiently the governor again separates the contacts B and C, and the coil E again holds the contacts F and K apart.—*July* 14*th*, 1909.

N°14,700.

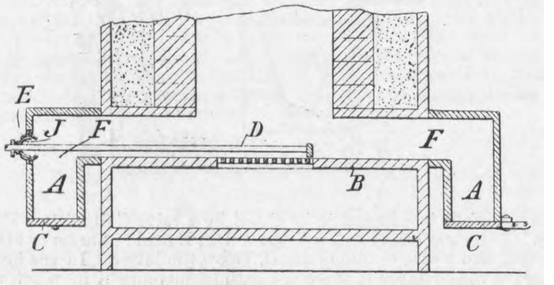


GAS PRODUCERS.

14,405. July 7th, 1908.—IMPROVEMENTS IN SUCTION GAS PRODUCERS, *Harold Berry, of Clementston, Victoria, Australia.*

This invention relates to suction gas producers of the kind wherein provision is made for the removal of ash and clinker without necessitating the stoppage of the plant. The apertures F open into a well or receptacle A attached one on each side of the grate. The upper end of each well is flush with the bed-plate or bottom B of the combustion chamber, whilst a pivotally mounted door C is arranged to close the bottom of the well, so that, after the clinkers and other refuse from the bottom of the combustion chamber have been collected in the well or wells, their doors can be momentarily opened to discharge the collected refuse therefrom, and then instantly closed before any excessive quantity of air has entered the generator. The precise shape and arrangement of the wells or receptacles A A can be varied considerably without departing from the spirit of this invention. A rake D, preferably having a T-piece at its end, is arranged to work through a hole or gland E in the wall of the refuse receptacle A, so that it can be used for withdrawing the clinkers, ashes, or other refuse from the grate or combustion chamber into the receptacle without admitting air into the said chamber. The rake, when not in use, can be drawn to the side out of the fire. The rake is preferably passed through a gland mounted in a ball-and-socket joint, as illustrated at J, in order to allow the rake a wider range of action. Several modifications are dealt with, and there are two other illustrations.—*July* 14*th*, 1909.

N°14,405.



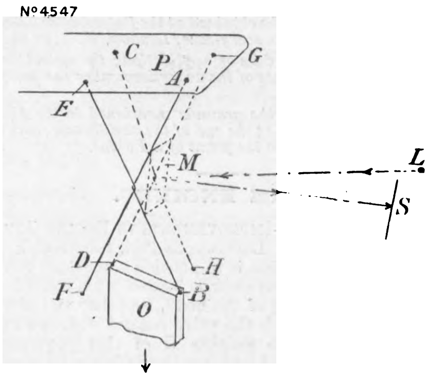
Vertical Section of lower part of Gas producer.

TESTING AND MEASURING INSTRUMENTS.

4547. February 24th, 1909.—AN APPARATUS FOR INDICATING MINUTE MOVEMENTS OF BODIES, John Thomas Irwin the Central Technical College, South Kensington.

This invention relates to an apparatus for indicating the minute movements of bodies, by means of which an exceedingly small movement of a body may be easily observed and the extent and direction of the movement indicated. The object whose movements are to be observed is indicated by O. To this object two wires or cords A B, C D, are attached, the ends B and D being secured to the body O, and the ends A and C being secured to a fixed point or points independent of the body O. A second pair of wires E F, and G H, are looped over or tied to the wires A B, C D, E F, to A B, and G H, to C D. The wires A B, C D, E F, and G H are held stretched under tension. The ends A, E, C, D, being conveniently attached to, say, a flat spring P. If the object O moves in the direction of the arrow it causes the wires A B, C D, to straighten out, owing to increased tension, so that they cause the wires E F and G H to sag more. If the object O moves up in a direction contrary to the arrow the tension on the wires A B and C D will be reduced, and therefore the sag will increase as they are pulled by the wires E F and G H. Across the wires A B, G H, or across any two points whose movements are determined by the sagging or stretching of the wires A B, C D, a mirror M is secured, shown in dotted lines. If the body O moves in the direction of the arrow the wire A B will straighten out and the side of the mirror attached to that wire will move towards the right hand in the drawing; at the same time the wire C D will straighten out and move the side of the mirror attached to it towards the left hand in the drawing. Thus the slightest movement of the body O will produce a double torsion of the mirror. By throwing a beam of light from any convenient source of light L upon the mirror M, and reflecting it on to the screen S, the movements of the object O may be observed.—*July* 14*th*, 1909.

N°4547

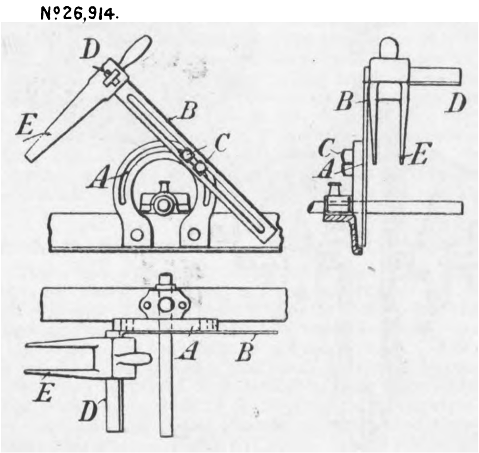


MACHINE TOOLS AND SHOP APPLIANCES.

26,914. December 11th, 1908.—NEW OR IMPROVED BELT SHIFTER, Ernest Edmund Bentall and George Cowley Bingham, both of Heybridge, Maldon, Essex.

This belt shifter support comprises a slotted plate A of approximately horseshoe shape secured to any convenient fixed part by screws, bolts, or other means. This plate forms a support to which a slotted bar B is secured by bolts C passing through the slot in the plate and the slot in the bar, so that the position of the bar may be varied as desired by loosening the nuts of the bolts, or it may be reversed by detaching. The outer end D of the bar B is shaped to stand at right angles to the remainder and on this part D slides the belt fork E. This part D is of I section, and the slot in the fork E is of X section, so that the fork may be arranged to project in any one of four different directions to suit the position of the supporting bar B and the direction in which the belt to be controlled runs. A modification is also dealt with.—*July* 14*th*, 1909.

N°26,914.

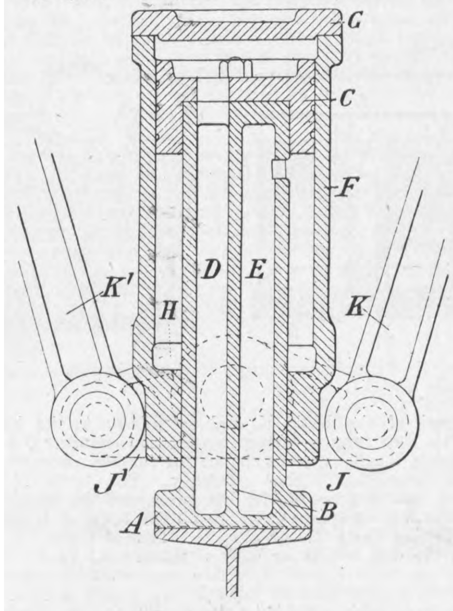


MISCELLANEOUS.

14,170. July 3rd, 1908.—IMPROVEMENTS RELATING TO HYDRAULIC LIFTING APPARATUS, Thomas Parker, of Wednesfield, Staffordshire.

A hollow standard A is provided with a longitudinal partition B forming two inlets for water or other liquid under pressure, and upon the top of this standard A there is a piston C, and communication is made from above the top of the piston C with one of the compartments D of the standard A, and communication through the side of the standard A from beneath the piston C with the other compartment E thereof. Upon the standard A and the piston a movable cylinder F is mounted, the lower extremity of which is provided with packing to ensure a good hydraulic joint, while similarly the piston C is packed for the same purpose, and the cylinder is provided with a cover plate G. On the admission of water under pressure to one compartment D in the standard A it will pass upwardly above the piston C and lift the cylinder F, while when water under pressure is led into the other compartment E of the standard, it causes the fall of the cylinder F. Such hydraulic devices are used for the operation of a set of closing cover plates or doors, the device being disposed intermediate of the doors or cover plates to be operated, and for the purpose a lever is provided, pivoted centrally at the lower extremity of the cylinder F, and at the extremity of one arm J pivotally connected by a link K to one cover, while the other, J, is pivotally connected by a link K^1 to another in such a manner that on the cylinder F being raised the set of covers is closed, while when the cylinder F falls they are opened.—*July* 14*th*, 1909.

N°14,170.



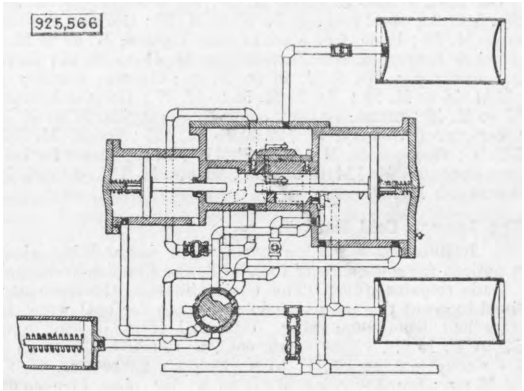
SELECTED AMERICAN PATENTS.

From the United States Patent-office Official Gazette.

925,566. AUTOMATIC AIR-BRAKE APPARATUS, *J. O. Dodge, Los Angeles, Cal.—Filed October* 22*nd*, 1907.

There are no less than twenty-three claims for this invention. One of the shortest of these—No. 4—sufficiently indicates its general scope:—In an automatic air-brake system, a train pipe, a supplementary reservoir, a piston exposed to pressure from the train pipe, a spring opposing said piston for a portion of its movement from train-pipe pressure, and a valve operated by said piston and adapted to open communication between the train pipe and supplemental reservoir upon compression of said spring.

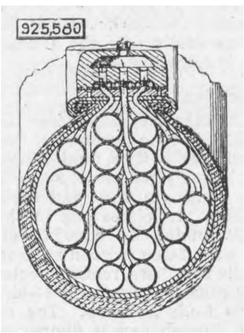
925,566



925,580. TIRE, *C. H. Keiffer, Akron, Ohio.—Filed January* 25*th*, 1909.

This curious invention proposes the use of a multiplicity of inner tubes inside an elastic outer cover. Each tube is to have its own air tube and valve, and these are all connected to one air chamber. There is only one claim.

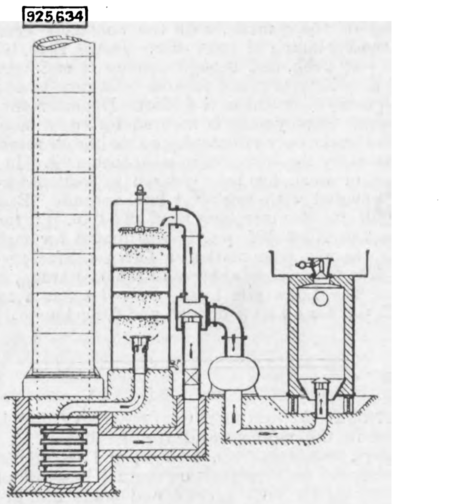
925,580



925,634. GAS PRODUCER, *G. Hatton, Saltswells House, near Brierley Hill, England.—Filed August* 21*st*, 1905.

This invention is adequately explained in its one claim. In combination with a gas producer, means for producing and supplying mixed atmospheric air and steam or water vapour thereto, comprising in combination, a chimney, a vaporising chamber containing a water spray and receiving into its interior the waste products of combustion from the chimney flue, a mixing box receiving the steam or water vapour and the waste products of combustion from said vaporising chamber, a heated atmospheric air supply to said mixing box, and a blower adapted to draw the atmospheric air into the mixing box and the waste products of combustion from the chimney flue through the vaporising chamber so as to vaporise the water spray therein and mix the same in the mixing box with the atmospheric air and deliver said mixture into the gas producer.

925,634



THE *Official Circular* of the Tramways and Light Railways Association contains in its July issue a translation of the paper on rail corrugation read by the chief engineer of the Great Berlin Tramways before the International Tramway Congress held at Munich last September. Among other matters bearing on the same subject are the experiences of nineteen tramway managers and engineers. The experience of Mr Blain, of West Ham, may be quoted as typical. He states:—"Rail corrugation developed rapidly on practically every route. They appeared especially on short lengths of single lines, which are frequently traversed by cars at a high speed. Several lengths have been ground out, some by hand filing and some by carborundum blocks fixed on a National Rail and Tramway Appliances Company's machine under one of our water cars, the latter being the least expensive method. The corrugations, however, appear to show themselves again after about six months.

EXPERIENCE WITH SUCTION GAS PRODUCERS.

No. III.*

Depth of fuel.—This should not be less than 1ft. 9in. in the smaller sizes, increasing to 2ft. 9in. or 3ft. in generators of about 150 to 200 brake horse-power when using anthracite "beans" of about $\frac{3}{4}$in. to 1in. cube, though for smaller fuel, which lies closer together and tends to check the free passage of the gas, the depth may be reduced 2in. or 3in. with advantage.

A plant of 200 brake horse-power size was tried on depths of 2ft. 6in. and 2ft. 9in. when using anthracite "beans," all other conditions remaining the same, but no difference could be discovered in the working. The deeper fire should be of advantage in warming the "green" fuel before it reaches the combustion zone, provided the vacuum necessary to draw the gases through the hot fuel does not become too high, causing dust to be carried to the scrubber and connecting pipes.

Although the depth should usually be kept at the figures given above in every-day work, gas can be obtained to work the engine when the fire is from 12in. to 18in. deep, but it should not be allowed to get so low as this if fresh fuel is to be added later, as the fire will be deadened, and probably give such poor gas as to stop the engine. If, however, it is decided to clean out the plant, the stoker may gradually reduce the level of the fuel in the generator until the fire is only 15in. deep when the time to stop the engine arrives, and thus reduce the amount of half-burnt fuel to be removed from the generator. If time admits when cleaning out, this hot fuel should not be immediately removed as this permits cold air to impinge on the hot fire-brick lining, and may cause cracks and air leaks to form in it; but the whole generator should be left for some hours to cool gradually before the fuel is taken out.

Fire-brick lining.—This should not be less than 6in. thick in the small sizes, and run up to 9in. thick in plants of 120 brake horse-power and upwards. The blocks should be specially made to suit the plants, of good hard material, and in as large pieces as can be conveniently handled, to reduce the number of joints to a minimum. The jointing should be made with fire-clay, and care should be taken in placing the blocks to ensure their fitting very closely, and with a minimum thickness of jointing material. The space between the fire blocks and casing should be packed with dry sand or other non-conducting material. If the lining shows signs of wear a spare set of fire-clay blocks should be ordered at once, to avoid having to make up a lining of ordinary fire-bricks, which has too many joints, and would only last a very short time owing to air leakages into the furnace.

A generator badly built up in this way has been known to admit so much air into the furnace as almost to fill the generator with hard clinker in a day's working; when suitable fire-clay blocks were properly built in the generator the plant worked quite successfully, the small amount of clinker could be taken out through the door, and it was only necessary to draw the fire for cleaning purposes every two or three weeks.

Air leaks.—In addition to the leakage through the lining, considerable trouble has sometimes arisen with plants owing to the joints between the various parts not being made air-tight; this applies especially to the joints connecting the hopper body to the top cover and the latter to the body of the generator. With suction plant all leakages when at work are into the generator, and the extra supply of oxygen causes partial or entire combustion of the gas above the fuel. If the leakage is small the gas supplied to the engine may be enough to enable it to run, but, as more of this poor gas is required for a given power, the suction on the plant becomes heavier, causing excessive generation of heat; this, and the extra heat caused by the combustion in the top of the generator, is liable to crack the casing or vaporiser if of cast iron, or to burn them away very quickly if made of thin steel sheets.

Excessive heating of generator or scrubber can generally be traced to air leaks into the generator, and the cause removed before much damage is done. This leakage is not likely to happen when plant is first erected by the makers, as their workmen know the places requiring air-tight joints; it usually occurs after one or two of the joints have been broken for greater facility of examination and general cleaning, as the attendant does not generally realise the necessity for preventing any leakage, and fails to ensure the joints being air-tight when remaking them.

In no case should the slightest leak into the top of the generator be tolerated or be allowed to continue, as it will quickly increase in size, and probably spoil the generator; in such a case it is well to take to heart the old proverb, "A stitch in time saves nine."

The use of steel or wrought iron plates should be avoided—unless they are of exceptional thickness—wherever they are exposed to hot gases on one side and vapour on the other, owing to their liability to rust quickly. Several generators with steel casting having air and vapour on one side, and hot gas on the other, were soon rendered useless owing to small pin holes developing, which permitted air to pass to the gas and quickly opened out into large holes.

Leakage is often found to take place through the cleaning doors of the generator, which, though not so serious as into the top of the generator, will cause the formation of clinker on the side of generator above the door; it is always well to ensure these doors being kept absolutely tight when at work by using an asbestos joint let into the door or casing; to prevent them being opened too often a small sight-hole with suitable cover should be provided, so that the fire may be examined at intervals without letting in too much cold air and thus upsetting the good working of the plant. These sight-holes are also useful for poking the fire just above the fire-bars and breaking up pieces of clinker whilst the plant is at work.

The piping between the generator and the scrubber should be of ample size to pass the volume of hot gas, which at 600 deg. Fah. will occupy about double the space it would take when cold, and thus prevent too much dust being drawn out of the generator and deposited in the scrubber and water seal pots. This feature should receive special attention in generators of small area per brake horse-power, which require pipes to pass the gas quite as large as those used by generators of larger proportionate area.

Cleaning doors, easily removed, should be provided at all bends and other places in piping where dust and tar may be deposited, so that the cleaning may be done without much trouble to the attendant; joints and elbows that cannot be easily examined are often neglected until they call attention to themselves by causing stoppages, which usually happen at most inconvenient times.

The connecting pipe between the generator and scrubber should have a water seal for use when plant is not working; this will prevent any escape of gas from the scrubber, and ensure good gas being ready for starting the engine again. Some makers arrange for a constant water seal of $\frac{1}{4}$in. to $\frac{1}{2}$in., through which the gas is always drawn; this helps to clean and cool the gas coming from the generator, but in several cases has not proved satisfactory. The hot gases have been known to carry a small amount of hot carbon, which floats on the water and gradually forms a hard deposit on the extreme edge of the pipe, this action being assisted by the alternate cooling and heating effect due to slight fluctuations in water level. This deposit gradually stops up the pipe—see upper part of Fig. 4. The carbon will not set on a dry hot pipe, but only when the latter is moistened by the water and dried by the hot gases alternately, so that the pipe should be quite clear of the water when working—as also shown in Fig. If the scrubbers are of ample capacity the smaller amount of cleaning required will more than compensate for the slight difference in cooling efficiency.

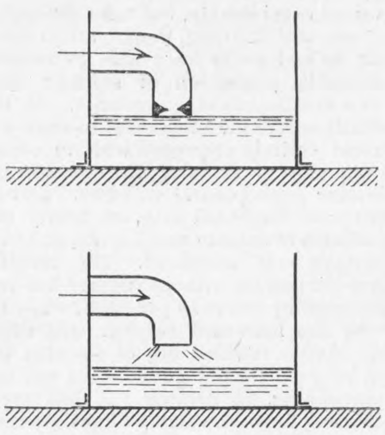


Fig. 4

A large plant with double scrubbers had this deposit form on the end of the inlet pipe, and it caused considerable inconvenience until the reason was discovered. Owing to the excessive suction to draw the gas through the small opening, the coke in the scrubber nearest the engine was found to be moving up and down in places with every pulsation from the engine. The position of the trouble was found by the application of vacuum gauges to each part of the plant. Temporary ones were first used, but permanent gauges have now been fixed, and periodic reading of these gives warning of any change taking place, in ample time to enable cleaning to be done at the next week-end.

Fan and chimney or waste pipe.—A fan should always be provided for blowing the fire and putting a small amount of pressure on the system when testing the gas before starting the engine. As the labour of working a fan for 15 or 20 minutes is heavy, care should be taken to have one both well made and efficient; the small extra cost that may be involved will be fully repaid in the time saved in blowing, and also in the satisfaction of the attendant. In the larger sizes it is customary to fix a power-driven fan for blowing, but if the waste pipe is really made into a chimney, not the small short pipe usually fitted, but of ample diameter and from 25ft. to 35ft. high, it acts almost as well as a fan, and the time of blowing may be much reduced.

In a 200 brake horse-power plant having a fire about 36in. diameter by 2ft. 9in. deep, a waste pipe, 4in. diameter, was originally provided, and a 4in. power-driven fan was fixed for blowing. Owing to the small area and long length of pipe, the fan was choked and of no use, so the waste pipe was altered to 6in. diameter by about 35ft. high to clear the roof. After this change the power fan would blow up the fire quickly, but was soon found to be unnecessary, as the chimney draught was ample in itself to force the fire to a heat suitable for gas making, and the power fan was removed at the attendant's request, the only fan used being a small hand fan, to put pressure on the plant for two or three minutes whilst the gas was being tested.

When the plant was not at work the chimney valve was kept almost closed, to avoid burning too much fuel, and keep down the standby losses. About thirty minutes before the time for starting the engine, the attendant opened the chimney valve to its full extent, and then did all necessary clinkering, stirring, and cleaning of plant. When this was done he tested the gas, using the hand fan to prevent back fires, and was always ready for starting with good gas in twenty to twenty-five minutes.

It is not suggested that such results can be obtained from all plants and engines; the conditions in this case were more favourable than usual, as the engine had high compression, enabling it to fire poor quality gas, and was fitted with a very heavy fly-wheel, to ensure steady turning of the direct-coupled dynamo; being started by compressed air, it would run light for several minutes, owing to the energy stored in the fly-wheel, and thus assisted in drawing up the fire in the plant. It does show, however, that a judicious arrangement of size and length of chimney can greatly reduce the labour entailed in using a fan, and modify what is often considered the most troublesome feature in using gas plants.

In moderate size plants the time taken for starting is usually 15 to 20 minutes; but under suitable conditions this can often be reduced. With one plant of 30 brake horse-power driving an electric light installation at a private house, the gamekeeper, who had never seen a plant previously, was able to start the engine in an average time, over three months, of 10 minutes, and in no case had he exceeded 20 minutes. In another case, with 20 brake horse-power plant and engine driving sewage pumping machinery, the attendant several times had the centrifugal pumps, which took from 1 to 2 minutes to charge, at work in 8 minutes from going in to the pump house; but, on one occasion when trying to do so, failed to get the engine to run for over 10 minutes, and was much chagrined when asked at the end of that time, "Why not try with the gas cock open?" an essential feature, which, in his haste, he had omitted, much to the amusement of the onlookers.

Scrubbers.—These are made of mild steel plates, having a grid in the base above the entrance for the hot gas to carry the coke. Doors of ample size must be provided at the top and bottom of the scrubber for convenience in emptying and refilling with the coke, which must be changed about every six months. When two scrubbers are used, that nearest the generator should be supplied with fresh coke about every three or four months, but the second one can usually be worked about twelve months before the coke becomes too dirty for good results. The coke should be clean and hard, from 3in. to 4in. cube in the bottom part of scrubber, gradually reduced to about 2in. cube in the upper portion.

The water for cleaning and cooling should run in the opposite direction to that in which the gas is moving, and about $1\frac{1}{4}$ to $1\frac{1}{2}$ gallons per brake horse-power will be required. Any ordinary water supply will be suitable for the scrubber, provided it is fairly clean, but if possible the water fed to the generator should be soft to avoid deposition of lime, &c., in the vaporiser. In larger size of plants the scrubber should have the coke in two tiers or two scrubbers of smaller size used in series, as Fig. 5. Though more expensive than a single scrubber, they are more convenient. If mounted on a cast iron base, as shown, with suitable cleaning doors, they will make a good substantial arrangement, and be less likely to corrode from the action of the water and hot gases in the base, which have in some cases quickly worn out the steel scrubbers. Even the smaller sizes would be improved by the use of such a base, and the extra cost would be fully repaid in the longer life and durability of the scrubber.

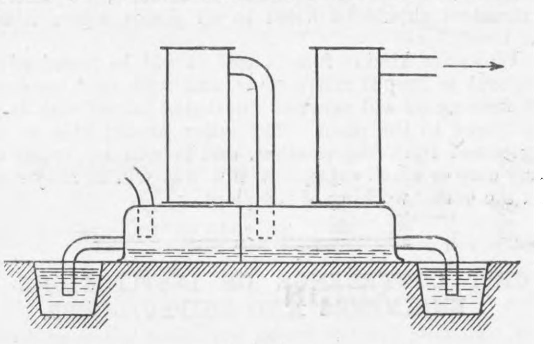


Fig 5

A capacity of about $\frac{7}{8}$ to 1 cubic foot per brake horse-power of engine will be ample for ordinary Welsh anthracite, although even larger sizes have no disadvantage, and will work for a proportionately longer time without requiring renewal of coke, &c. The diameter of scrubber may vary to a considerable extent, but usual sizes are about 1ft. 9in. to 2ft. for 20 brake horse-power; plants up to 4ft. or 4ft. 6in. for 200 brake horse power; Two scrubbers, each 4ft. diameter by 6ft. 6in. high, mounted on a cast iron base—as shown in Fig. 5—are suitable for a 200 brake horse-power plant.

When gas coke or inferior anthracite is used in the generator, the ordinary coke scrubber may not be found to remove all the tar, &c., from the gas, and a sawdust scrubber or tar extractor should be added to prevent dirty gas passing to the engine and causing its valves and spindles to become clogged.

Expansion box.—Most makers now include an expansion box in their plants; this should be placed close to the engine and at a lower level than the rest of the gas main, so that the latter will drain into the box. A drain cock should be fitted to it for drawing off condensed water, and a blow-off pipe with a good cock to admit of poor gas being blown out of the mains and scrubbers before starting engine. The capacity of the expansion box is usually made from a-half to three-quarters that of the engine cylinder, but where not inconvenient a much larger size will be found advantageous; it will enable the engine to get an ample supply of gas without excessive suction pressure, and will cause the suction action on the whole plant to be slower and easier, thus drawing the air and vapour through the generator at a slower rate. This gives a longer time for the chemical reactions to take place, and assists in obtaining a better quality of gas.

Use of town's gas.—In the earliest examples of suction gas plants and engines, arrangements were usually made to enable town's gas to be used for starting purposes and as a stand-by, but it was soon proved to be unnecessary, and most plants are now fixed without any such arrangement. Numerous installations are at work miles distant from any town's gas supply, and are quite as trustworthy as any steam plant.

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* No. II. appeared August 6th.

In some cases, where the maximum power is only required for a short time, gas engines have been arranged with a town's gas supply for the short period of maximum load. This has proved a convenience, but as gas authorities naturally object to providing such intermittent supply, especially when it occurs at their period of maximum demand, and may at some future time obtain powers enabling them to refuse to give such service except at greatly increased rates for gas, it is much better when putting down a new plant to make it amply large for any work it may have to do.

Many authorities have now reduced the price of gas when used for power purposes. In order to meet the competition of suction gas plants, and before putting down a new installation, the relative costs should be carefully considered. It will be found that with town's gas at 1s. 3d. per 1000 cubic feet there will be no advantage in driving gas engines from suction gas plants in sizes below 40 brake horse-power, and even in larger sizes, say, 40 to 70 brake horse-power, the economy in fuel may be almost lost because of extra attention required, increased first cost of plant and engine, and the extra room required for the plant and larger engine. In sizes above 70 brake horse-power the fuel cost is more serious, and town's gas becomes too expensive to admit of its competition with the independent gas producing plant.

Fuel for plants.—This has been referred to incidentally, but the quality and kind used will depend to a considerable extent upon the position of the town in which the plant is being used. Welsh anthracite is generally agreed to give the best results, and can be obtained in most English and Welsh towns, of suitable size and quality for use with suction gas plants. The great demand has caused the price to increase about 40 per cent. during the last three years, and many firms have taken up the use of gas coke, either using it in the plant alone or mixed with anthracite "peas," which are much cheaper than anthracite of larger size, and will give good results, provided means are taken to prevent tar getting to the engine valves, &c.

In the North of England and Scotland Scotch anthracite is mostly used; it is a good fuel for suction plants, and can be bought at a low price, but has rather more volatile matter and ash than Welsh anthracite, so that tar extractors should be fitted to all plants where it is to be used.

Whatever kind of fuel is used, it will be found advantageous to keep it under cover, and with such conditions of flooring as will prevent dirt being mixed with it and delivered to the plant. The latter should also be fully protected from the weather, and it will be found that any care or small expense in this way will be fully repaid in the better working of the plant.

JOINT CONFERENCE OF INSTITUTIONS OF ENGINEERS AND SHIPBUILDERS.

No. I.

It was a happy inspiration to mark the first year of the Institution of Engineers and Shipbuilders in Scotland in its new home in Glasgow by a joint Conference with the North-East Coast Institution of Engineers and Shipbuilders, and it is gratifying to record that the suggestion to hold such a Conference was very warmly taken up by members of both Institutions. There was a large attendance when the Conference opened in the hall of the Scottish Institution on Wednesday morning the 4th inst.

Mr. C. P. Hogg, the President-elect of the Institution of Engineers and Shipbuilders in Scotland, occupied the chair in the absence through illness of Mr. John Ward, the President. In a written address, however, Mr. Ward offered a welcome to the members of the North-East Coast Institution. He said that conferences of this character reacted upon the general prosperity of the industries concerned. The shipowner was not satisfied to-day with the results obtained yesterday. In merchant shipwork owners used to be satisfied with a coal consumption of 1.5 lb. per indicated horse-power per hour, but to-day the figure had fallen to about 1.25 lb. per indicated horse-power per hour. From a maximum of 20 knots for cross-Channel steamer service, there had been an advance which made 23 knots the ordinary speed for such vessels. For intermediate steamers, 16 knots was formerly considered a satisfactory performance when the capacity required a block coefficient of .76, but owners under the same conditions now called for 18 and even 20 knots, which required a high propulsive efficiency. It was the same in other engineering work. The bridge engineer was expected to give a higher load capacity per unit of area for a less quantity of metal and at lower cost, and to overcome difficulties in foundations which a few years ago would have been regarded as practically insurmountable. It was largely owing to the exchange of experience through the medium of technical institutions and the technical Press that there had been relatively more rapid progress made during the past twenty years than in preceding generations.

Mr. Summers Hunter, President of the North-East Coast Institution, in acknowledging the address of welcome, said that the Scottish Institution, established fifty years ago, had played an important part in the development of steam shipping.

The reading and discussion of papers was then proceeded with.

Sir Andrew Noble, who was very warmly received, had the first place on the programme in a paper bearing the title "A Slight Sketch of the History of Propellants." Sir Andrew first of all dealt with the question of gunpowder, the origin of which was, he explained, lost in remote antiquity. In England gunpowder consisted of 75 per cent. of saltpetre, 15 per cent. of carbon, and 10 per cent. of sulphur. In other countries the amounts of carbon and sulphur were equal—12·5 per cent. Sir Andrew then gave an account of the experiments on gunpowder which had been carried out by various investigators. He mentioned such names as De la Hire, 1702; Robins, 1743; Hutton, 1778; Count Rumford, 1797; Bunsen, Shisschkoff, and Piobert. The results arrived at by various workers varied widely—thus Robins estimated that the maximum pressure arrived at by exploding gunpowder when completely filling the space in which it was enclosed, would be 1000 atmospheres, while Rumford concluded that the pressure would be 101,000 atmospheres. Discussing the work of these investigators, Sir Andrew said that they much under-rated the rapidity of combustion of gunpowder under pressure. They assumed that the combustion was comparatively slow, and that due to this slow combustion the possible maximum pressure was never even approximated to in the bores of guns. In some experiments he had carried out in conjunction with the late Sir F. Abel, he had succeeded in determining for the three powders of the English service—pebble, rifle large grain, and fine grain—the tension of the exploded gases at all densities up to unity, and in altogether retaining the whole of the products of combustion, even of charges of several pounds, which filled entirely, or nearly so, the chambers of the explosion vessels. The result of these experiments gave for a density of unity a pressure of about 6500 atmospheres. The temperatures of explosion of the different gunpowders varied considerably, but were generally between 2000 deg. Cent. and 2230 deg. Cent. Sir Andrew went on to say that he had never been able to understand why the considerable proportion of sulphur was so long retained as a component of gunpowder. In the English service, shortly before the adoption of modern propellants, it was almost entirely dispensed with in cocoa powder; and with the view of studying the question he, in 1883, had made four experimental powders. In two of these the sulphur was dispensed with, or nearly so. In the third the amount of sulphur was halved, and in the fourth the percentage was increased. The result obtained showed that the powder without sulphur had its potential energy increased by about 13 per cent., while that of the powder with the increased sulphur was decreased by 9 per cent. As the readiest way of showing the striking differences between the old gunpowders and some of the modern propellants, Sir Andrew had had prepared two tables exhibiting first the volume of gas generated by the explosion; secondly, the units of heat generated; and, thirdly, the product of the units of heat and volumes of gas which represents approximately the comparative potential energy of the explosives. It was explained that in these tables the transformation was taken approximately at the pressures at which the propellants are generally used in guns.

Older Propellants.

	Pebble.	R. L. G.	F. G.	Mining powder.	Spanish powder.
Volumes of gas ...	278	274	263	360	234
Units of heat... ...	721	726	738	517	767
Comparative energy	200,438	198,924	194,094	186,120	179 478

Modern Propellants.

	Cordite Mark 1.	Italian ballistite.	M.D. cordite.	Norwegian 167	Nitro-cellulose.	Norwegian 165
Volumes of gas	875·5	810·5	913·5	899·9	934	909·9
Units of heat...	1246·0	1305·0	1030·0	1005·5	924	935·5
Comparative energy	1,090,873	1,057,703	940,905	904,850	863,016	851,212

With cordite, the first modern propellant adopted in England, artillerists have been able, with the same maximum pressure, to more than double the energy of the projectile. Commenting on these tables, Sir Andrew said:—

> It will be observed that the figures I give as representing the comparative energies of the old propellants vary from 200,438 to 179,478, while the similar figures for the modern explosives vary from 1,090 873 to 851,212, or more than four times as great, and the diagram—reproduced in Fig. 1—I also show exhibits the comparative pressures developed up to the density of ·5; thus, at the density of .5 the pressure of gunpowder is about 1700 atmospheres—amide powder 3500 atmospheres—while the modern explosives at the same density lie between pressures of 8600 and 7200 atmospheres. Turning now to the total volumes of gas generated and the units of heat developed by the explosion, I find in the various explosives I have examined the same general rules hold. With the increase of density the volumes of gas decrease, and the units of heat increase.
>
> Thus, taking one or two illustrations, with an Italian ballistite at the density of .05 the total volume of gas per gramme was 824 c.c., while at the density of .5 it was 780 c.c.; with M.D. cordite the corresponding figures at these densities were 955 c.c. and 789 c.c., and with a Norwegian ballistite 959 c.c. and 780 c.c., showing reductions in volume respectively for the three explosives of 44, 166, and 179 c.c. per gramme. The corresponding units of heat at the same densities are:—For the Italian ballistite 1228 and 1264, for the M.D. cordite 965 and 1178, and for the Norwegian ballistite 860 and 1092, or increments respectively of 36, 213, and 232 units, and I draw attention to the remarkable difference in the increments of heat in these three explosives. The pressures developed by these same explosives were at the density of .05 respectively 457, 457, and 389 atmospheres, while at the density of .5 the pressures rose to 7956, 7545, and 8536 atmospheres, or from about seventeen to twenty-two times as great. It is hardly necessary to say that the last-named pressures are greatly above those which are permissible in guns, but they are interesting as showing how greatly the pressure and temperature of explosion increase with the increase of density of charge.
>
> Thus, taking for the three explosives I have selected the density of .25 as representing approximately the maximum density permissible in guns, it is found that the pressure for the Italian ballistite is 3148, for the M.D. cordite 3193, and for the Norwegian ballistite 2896 atmospheres, while at the double density of .5 these pressures become respectively 7956, 7545, and 8536 atmosphere, the pressure last named being approximately three times as great as that at the density of .25. Now, I have pointed out that with the increase of density there is in all cases a decrease—in most cases a considerable decrease—in the volume of gas, and as the pressures developed, increase much more rapidly than the density, it is obvious that with increase of density there must be a very considerable increase of temperature. At a density of .5 I place the temperatures of the high explosives I have examined as varying between 4000 deg. and 5000 deg. Cent. I need not say that at less densities they are very much lower.
>
> I have mentioned that the percentages of the several gases generated by the explosion vary greatly, dependent upon the pressure under which the explosion takes place, and I shall exhibit to you three diagrams—reproduced in Figs. 2, 3, and 4—in two of which there are, with increase of density, large increases in volume, and in the third a considerable decrease. I shall take first carbonic acid, and it will be observed that in all cases the differences in volume between the low and high densities are large. In M.D. cordite, for example, the percentage varies from 14 8 to 32.4, and it will be observed that as the densities increase, the differences in the percentage greatly diminish. Thus, at a density of .05, there is a difference between the several explosives of 13 per cent., while at .5 density this difference is reduced to 3 per cent. The next diagram exhibits the percentage of marsh gas (CH_4); at the density of .05 the percentage in all cases is very small, under a half per cent., but the percentage, as will be seen, increases rapidly, and in this case instead of the percentage approximating at the higher densities, there is very considerable divergence. The last diagram I shall refer to shows the percentage volume of hydrogen. Here it will be observed that at the lowest density there is a considerable difference, the percentages varying from 8 per cent. to over 20 per cent.; the whole of the percentages slightly rise with increase of density and then rapidly fall, finally closely approximating, the difference at .5 density being only about 1½ per cent.
>
> But I must not fatigue you with these somewhat dry figures, and I will only draw attention to one other point. The whole of the new propellants develop on explosion a very much higher temperature than did the old gunpowders, and the introduction of armoured vessels has necessitated the employment of guns fifteen or sixteen times heavier than the guns in use fifty years ago, and capable of giving to their projectiles energies nearly fifty times as great.
>
> Now, as regards the serious question of erosion, in the case of the very large guns it is important to remember that while the surface of the bore subject to the more violent erosion increases approximately as the calibre or a little more, the charge of the propellant required to give to similar projectiles the same maximum velocity, increases as the cube of the calibre; and, consequently, unless special arrangements as to the projectile are made, or other means adopted, the life of the largest guns before relining must be short when compared with that of smaller guns. It, therefore, becomes a matter of great importance that attention should be given to the best method of reducing erosion when very large charges are used, either by lowering the temperature of explosion of the propellant, or possibly by introducing with the charge some cooling agent. As regards the first of these points some very considerable advance has been made, as will be seen by some specimens of the erosive action of a few different propellants I have placed upon the table, but I venture to think that the question of erosion has, at least in this country, hardly received sufficient attention, and that, in some respects, mistaken notions as to the amount of erosion with reduced charges are entertained.
>
> For instance, it has been stated that in a gun the erosion due to four three-quarter charges and sixteen half charges is in each case equivalent to that due to one full charge; and for several explosives I have tested, in the manner I have for many years adopted, the absolute capacity for erosion of several propellants, and as the temperature of explosion varies with the density I selected the density at which propellants are generally fired in guns. The propellants varied very considerably in their capacity for erosion, but all gave the same result, viz., that the erosion due to one three-quarter charge was less than that of a full charge, but that two three-quarter charges gave more erosion than one full charge, while two half charges gave less, but three half charges gave more erosion than one full charge; or, in other words, that the erosion was a little less than that due to the comparative weight of the charges.

Mr. H. A. Greer said that the paper explicitely stated the compositions of the older forms of gunpowder, and he would ask Sir Andrew to make a more detailed statement in his reply on the discussion as to the constituents of the modern explosives referred to in the paper.

Mr. Herbert B. Rowell said that considerable trouble had arisen in warships owing to the high temperatures experienced in the magazines. He would like to ask whether any steps had been taken in recently built warships to introduce any refrigerating arrangement.

Professor Archibald Barr, in moving a vote of thanks to Sir Andrew Noble, said there was a close connection between the branch of engineering discussed in the paper and ordinary departments of engineering. It was becoming increasingly difficult to make the requisite provision for ordnance in ship design, as the powers of guns became higher, and many of the advances in steel manufacture had grown out of the need of making proper provision for the requirements of the artillerist. It was interesting to note that while 1 lb. of gunpowder properly burned could raise 1 lb. about 200 miles against the action of gravity, the energy contained in 1 lb. of coal and the air it would consume would raise it 2000 miles against the action of gravity, so that the enormous power of gunpowder was small compared with the powers which had to be dealt with in ordinary steam engineering. Modern explosives gave about four to five times the energy obtained from gunpowder.

Sir James Williamson seconded the resolution of thanks, which was carried unanimously.

Sir Andrew Noble said that Italian ballistite contained 47.1 per cent. of nitroglycerine and 52.9 per cent. of nitrocellulose, M.D. cordite 30 per cent. of nitroglycerine, 65 per cent. of nitrocellulose, and 5 per cent. of mineral jelly, while Norwegian ballistite contained 36 per cent. of nitroglycerine, 52 per cent. of nitrocellulose, 6 per cent. of nitronapthalene, and 6 per cent. of a secret ingredient.

The second paper read was that by Engineer-Commander W. McK. Wisnom, R.N., "Notes on the Trials and Performances of the s.s. Otaki, Fitted with a Combination of Reciprocating and Turbine Machinery." The author explained that the Otaki was the first vessel fitted with a combination of reciprocating and turbine engines. She was built for the New Zealand Shipping Company, by Denny, of Dumbarton, was delivered in November, 1908, and has since made a voyage to New Zealand and back. She is virtually a sister ship to the twin screw vessels Orari and Opawa, which are fitted with reciprocating engines, the Otaki being about 4ft. 6in. longer. Her principal dimensions are:—

Length between perpendiculars ...	464ft. 6in.
Breadth, moulded	60ft. 0in.
Depth, „	34ft. 0in.

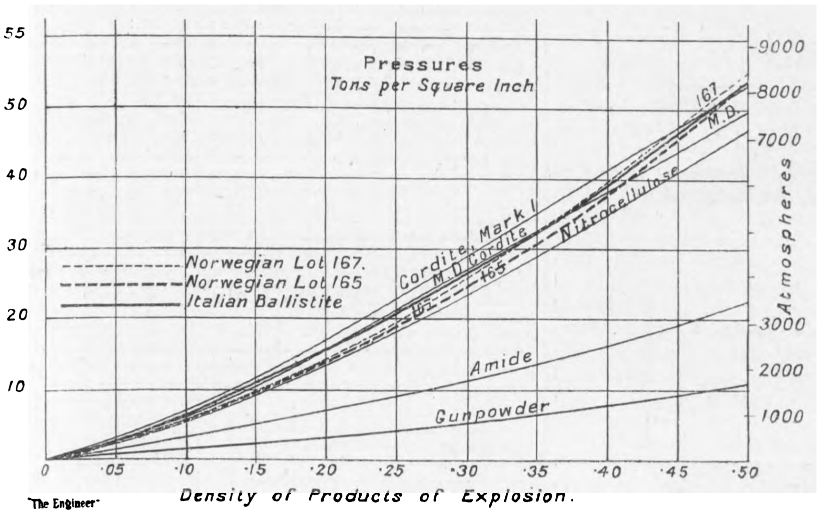


Fig. 1

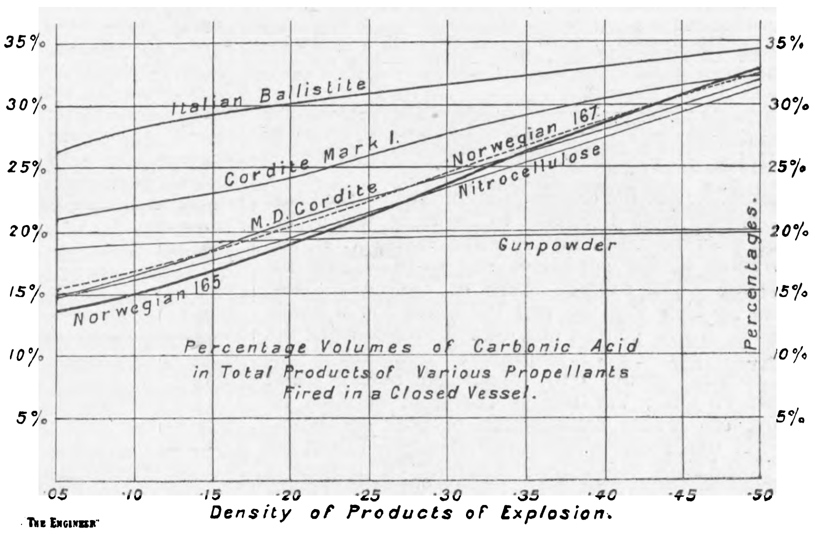


Fig. 2

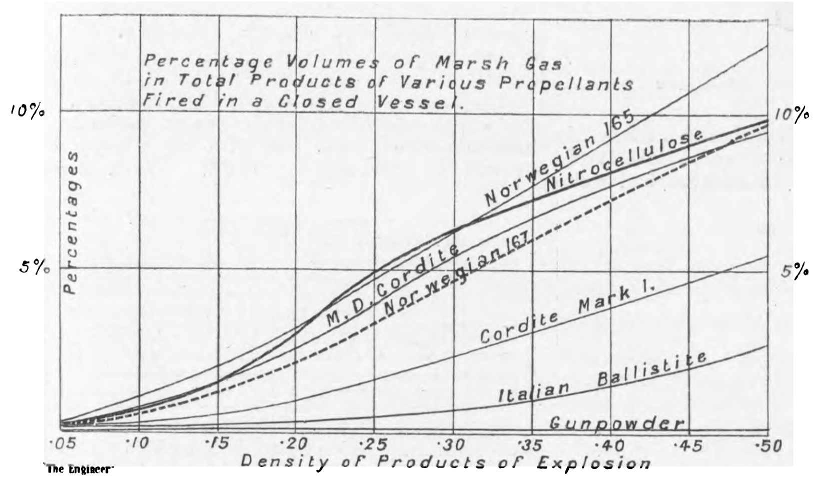


Fig. 3

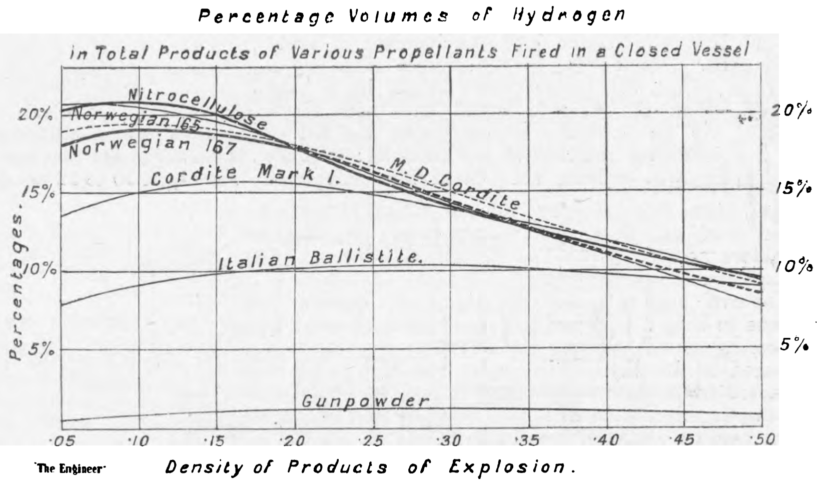


Fig. 4

Her deadweight capacity is about 9900 tons on a draught of 27ft. 6in. The engines consist of two sets of ordinary triple-expansion reciprocating engines driving wing propellers, and a low-pressure turbine driving a centre propeller, as shown in outline in Fig. 5. In ordinary ahead working the reciprocating engines exhaust into the turbine, which can only revolve in one direction, but change valves are also fitted so that the reciprocating engines can exhaust direct to the condenser, as shown in Fig. 6. The turbine is automatically cut out when going astern, and can be also cut out when going ahead, and the vessel manœuvred as an ordinary twin-screw boat. Two condensers are fitted, and each reciprocating engine exhausts into its own condenser when the turbine is not running. When the turbine is running it exhausts into both condensers. A shut-off valve is fixed in the exhaust from the turbine to each condenser, so that if either of the latter fail the turbine exhaust can be turned into the remaining apparatus. This valve is shown in Fig. 7. The diameters of the cylinders of the reciprocating engines are $24\frac{1}{2}$in., 39in., and 58in. respectively, and the stroke is 39in. The cylinders of the Orari and Opawa are $24\frac{1}{2}$in., $41\frac{1}{4}$in., and 69in. in diameter, and the stroke is 4ft. The ratio of high to low-pressure cylinders is thus 1 to 5.6 in the Otaki and 1 to 7.93 in her sister ships. The Otaki's turbine is, generally speaking, of the ordinary Parsons low-pressure type. The diameter of the rotor drum is 7ft. 6in., and the length of the blades varies from $4\frac{3}{4}$in. in the first expansion to $12\frac{11}{16}$in. in the last expansion. The drum is closed at both ends, and any leakage past the dummy is led away by an external pipe to the condenser. The turbine spindles are packed with soft packing separated into two parts by a metallic lantern ring—see Fig. 8. This ring enables the shaft to be surrounded by water between the two divisions of the packing, thus forming a water seal. The water is supplied under a slight head. The condensers were made to the design of the Contraflo Condenser Company, and the total cooling surface of the two is 6000 square feet. There is a single-acting air pump of the ordinary bucket type, worked from each set of main engines, the diameter of the bucket being 26in. and the stroke $19\frac{1}{2}$in. The circulating pumps have 16in. suctions and discharges, and the diameter of the impeller is 48in. The feed pumps are of the Woodeson's type. A surface feed heater is fitted in connection with the exhaust from the auxiliary engines. A general arrangement of the feed heater is shown in Fig. 9. The Otaki was designed for a continuous sea speed of 12 knots when fully loaded, but the contract provided for a trial speed of 14 knots with 5000 tons of dead-weight on board. Two lengthy tables are given in the paper, which set out the results obtained during a series of progressive runs on the measured mile at Skelmorlie, and particulars of various trials. These are too long to reproduce here, but they are full of interest. The Orari had obtained a mean of 14.6 knots on this measured mile. The Otaki, under the same conditions, and with apparently greater ease, obtained a mean speed of over 15 knots for a total water consumption of 6 per cent. less than that of the Orari. The total water consumption per hour in the Otaki at 14.6 knots was 17 per cent. less than that in the Orari at the same speed. In the Otaki the water was measured both by means of tanks and by counting the strokes of the feed pumps. The water consumption as calculated by strokes was in all cases greater than that obtained by tank measurements, the difference being about 3 per cent. at the higher speeds. In the case of the Orari tanks were not used, but the strokes alone counted. A correction was therefore made, and it was found that the total amount consumed at 14.6 knots was 88,300 lb. per hour, or 16.5 lb. per indicated horse-power per hour. The consumption of the Otaki on the Skelmorlie route was 82,000 lb. per indicated horse-power hour, with a speed of 15.02 knots. At 14.278 knots the consumption was 69,300 lb. The coal consumption during one of the trials at a speed of 11.7 knots worked out to 1.387 lb. per horse-power per hour, this amount including fuel for all purposes. The coal used was Scotch, and had a heating power in lbs. of water evaporated from and at 212 deg. Fah. per lb. of coal of about 14.0. A curve of water consumption of the Otaki is given in Fig. 10, and a curve of speeds and horse-powers of the Otaki, Orari, and Opawa is given in Fig. 11. The proportion of total power developed in the turbine of the Otaki was found to vary with the speed. At full power it was about one-third, while at very slow speeds the turbine was only doing a small proportion of the work. At 14.6 knots the indicated horse-power of the Orari was 5350, and the corresponding power of the Otaki was 5880. At this speed the E.H.P. was 3210 in the Orari, and 3350 in the Otaki, the propulsive coefficients being then 60 per cent., and 57 per cent. in the two vessels. The propulsive coefficient of the Otaki at full speed fell to 54 per cent. A table is given showing a comparison of trial results of the Otaki and Orari for a

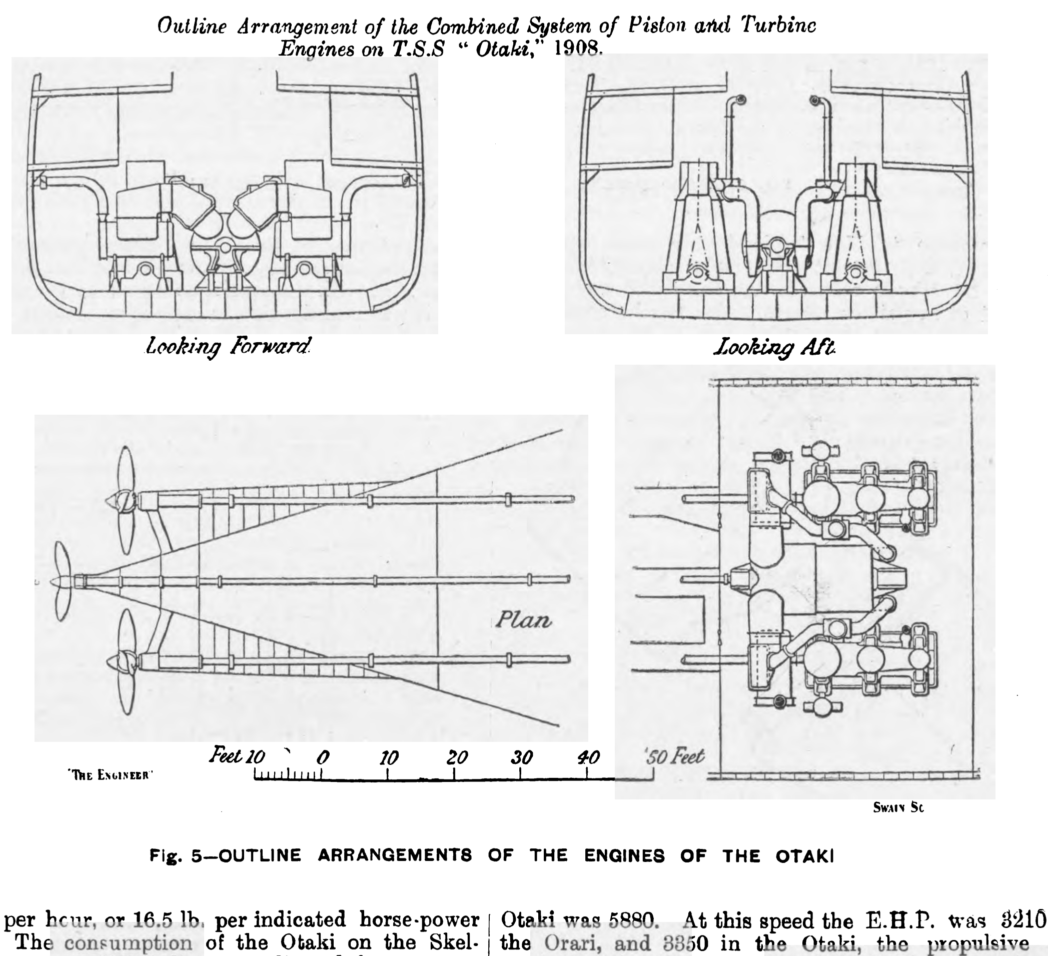

Outline Arrangement of the Combined System of Piston and Turbine
Engines on T.S.S "Otaki," 1908.
Looking Forward
Looking Aft
Plan
Feet 10
0
10
20
30
40
50 Feet
"The Engineer"
Swain Sc

Fig. 5—OUTLINE ARRANGEMENTS OF THE ENGINES OF THE OTAKI

speed of 14.6 knots on the measured mile. This is reproduced as follows:—

	E.H.P.	I.H.P.	Propulsive co-efficient.	Water consumption.		
				Total per hour.*	Per E.H.P. per hour.	Per I.H.P. of Orari per hour.*
			Per cent.	lb.	lb.	lb.
Otaki ...	3350	5880	57	73,300	21·9	13·7
Orari ...	3210	5360	60	88,300	27·5	16·5
Gain per cent. in Otaki				17	20	17

Note.—Columns marked * do not take into account the difference of E.H.P. in the two ships; these two methods of comparison should show the same gain.

On actual service the consumption of coal on the Otaki on the voyage from Liverpool to Teneriffe was 11 per cent. less than the mean for the sister vessels Orari and Opawa under similar conditions and at practically the same speed. The average speed of the Otaki, from Liverpool to New Zealand and back, was 11.09 knots. This speed, it was pointed out, did not represent the sea speed which the vessel is capable of maintaining, the power required being only about one-half of that developed on trial; nor was it the most suitable for obtaining the lowest consumption of coal per horse-power. It was, however, the speed arranged to suit the owners' conditions of service. A careful comparison of her coal consumption with that of her sister ships for the round voyage shows an apparent gain of 8 per cent., or about 500 tons as a total. As enough coal is carried from Liverpool for the round trip, some 250 tons could be spared, and cargo carried out to this amount. The engines made a non-stop run from Teneriffe to New Zealand, a distance of 11,669 knots as logged. The total weight of the machinery of the Otaki is about 30 tons more than that of her sister ships—an increase of about 3.25 per cent. But allowing for the greater efficiency of the former vessel, the boiler power might have been decreased, when the weights would have been about the same. As an appendix to the paper the author made the following remarks at the meeting:—"Since the foregoing was written the Otaki has completed another voyage to New Zealand at a mean speed of 12.35 knots, and the anticipations as regards improved economy have been realised. As the speed was greater than that of her sister vessels under similar conditions, it is difficult to make comparisons, but the gain in coal consumption in the Otaki, as compared with similar vessels, was not less than 12 to 15 per cent."

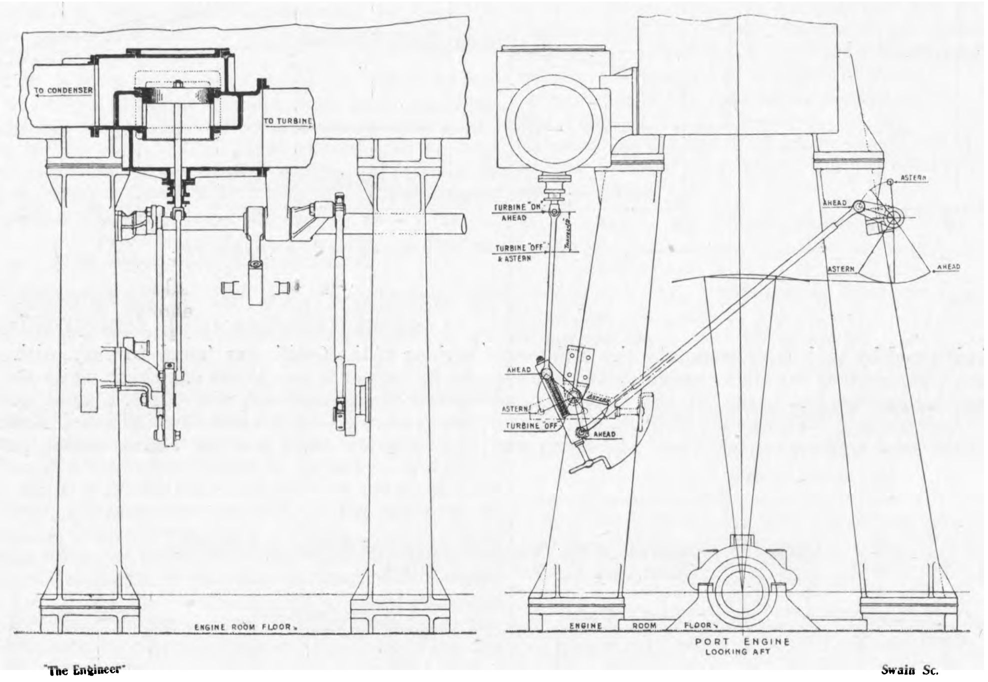


Fig. 6—ARRANGEMENT OF CHANGE VALVE ON THE OTAKI

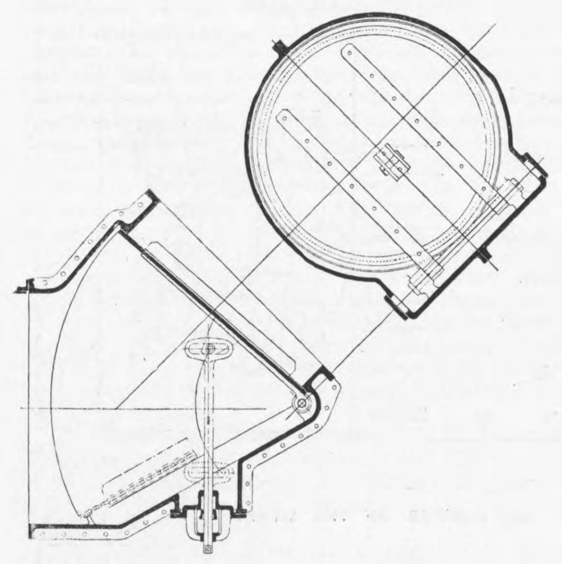


Fig. 7—SHUT-OFF VALVE

Mr. D. B. Morrison congratulated Messrs. Denny and the owners on their courage in making this distinct advance in marine engineering. It was extremely useful to have results so unreservedly published, and a study of them suggested that the economy which could be realised was about 10 to 12 per cent. That, he believed, had been the experience of the White Star Company with the Laurentic, and, at any rate, the White Star Company was so satisfied with the results achieved by the combination that it was its intention to install the system in its new Transatlantic liners. Whether any further gain in economy would be achieved was doubtful, so that the question for decision was whether an economy in coal of 10 to 12 per cent. was sufficient to justify the extra complication involved by the general adoption of the system on boats of moderate speed. He had been personally much interested with the problem in connection with cargo boats. Taking the case of a cargo boat of 1200 horse-power, there was available 200 horse-power, and the difficulty was to apply that 200 horse-power to the existing shaft, additional shafting being quite out of the question. Mr. Parsons proposed gearing, belt driving, and an electric drive. Belt driving was, in his opinion, quite out of the question. Engineers were not in sympathy with gearing on board ship, and the electric drive had its objectionable features, when it was remembered that the *personnel* of a cargo boat was not of a very high standard. He had seen a very interesting device for a magnetic drive of the worm-and-wheel type, but with no contact whatever between the worm and the wheel. When it worked it worked very well indeed, but when it stopped it stopped hopelessly. It got out of phase rather easily, and took time to get into step again, and he was afraid that the device was not adaptable to this particular problem. If, however, a method of applying the 200 horse-power to the main shaft in a simple and effective manner could be devised a decided forward step would have been made.

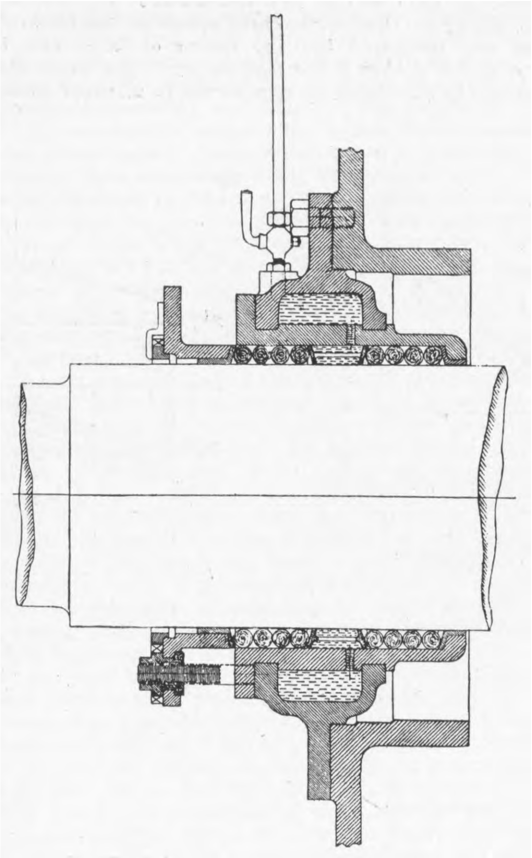


Fig. 8—PACKING OF TURBINE SPINDLES

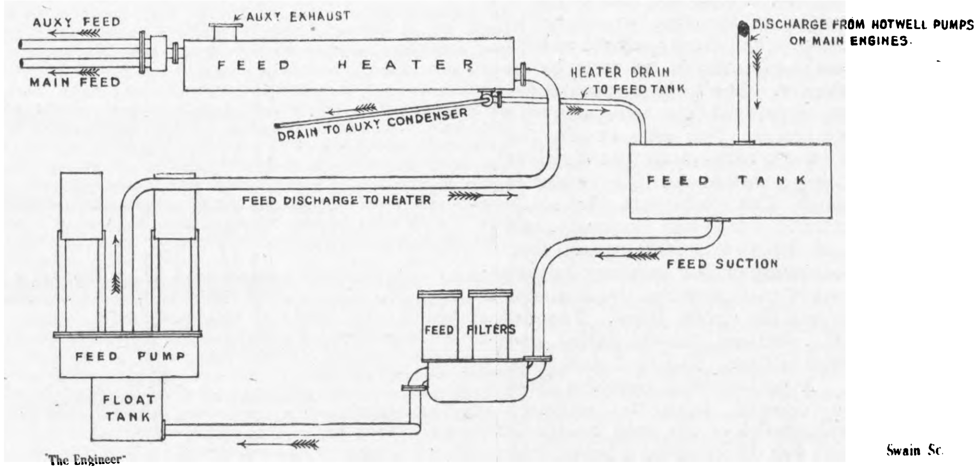


Fig. 9—FEED HEATING ARRANGEMENTS ON THE OTAKI

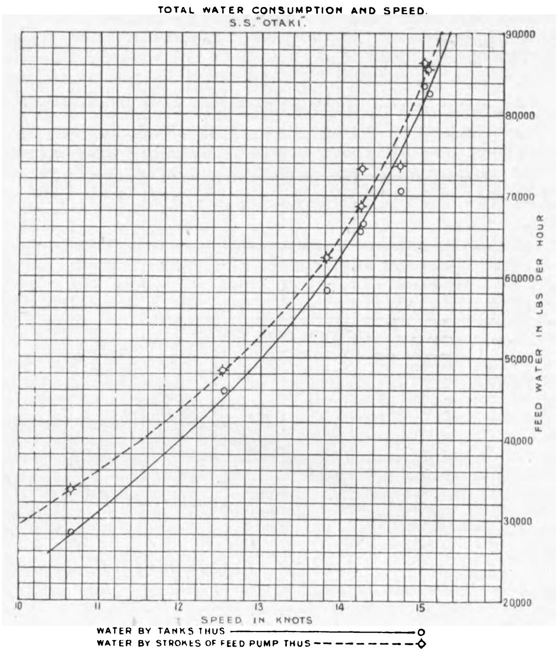


Fig. 10—CURVES OF WATER CONSUMPTION

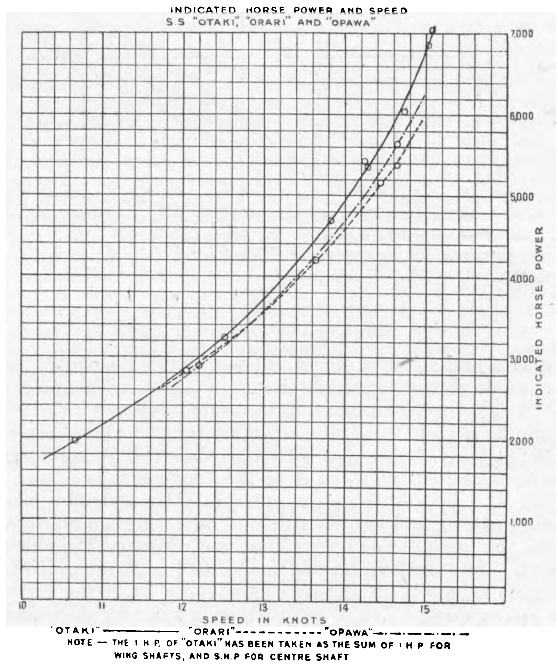


Fig. 11—SPEED AND POWER CURVES

Mr. W. B. Sayers exhibited the diagram which is reproduced in Fig. 12. He pointed out that the curve showed the size of plant required for a given amount of power to be much greater at the vacuum than at the pressure end. He was inclined to regard the combination system as a transitional design, the recourse to it being a confession that the Parsons' form of turbine was not really satisfactory for the high-pressure end unless for very large sizes and high speed. In other forms, such as the Curtis and the Rateau, the plant efficiency, or weight and bulk per horse-power, must be unnecessarily great, owing to large sections of the rotor and corresponding portions of casing being unproductive of power. The form which promised better results was that in which the steam at the high-pressure end was led through the same rotor discs and buckets a considerable number of times. In such a turbine the efficiency attainable was largely determined by the extent to which leakage between the rotor and stator could be minimised, which, again, depended largely upon the degree of truth to which the surface of the rotor could be made to run. He had devised a form of rotor presenting a smooth cylindrical surface with that object, so that the working efficiency would be largely under the control of the operator. He believed he could design high-pressure turbines to take the place of the reciprocating engines in s.s. Otaki to weigh not more than 25 tons each, including special gear to reduce the speed from 600 to 100 or 125 revolutions per minute, rendering them suitable for equally efficient propellers to those used with reciprocating engines. The gearing problem should be practically attacked, and he believed it could be solved. He was himself prepared to design a suitable gear.

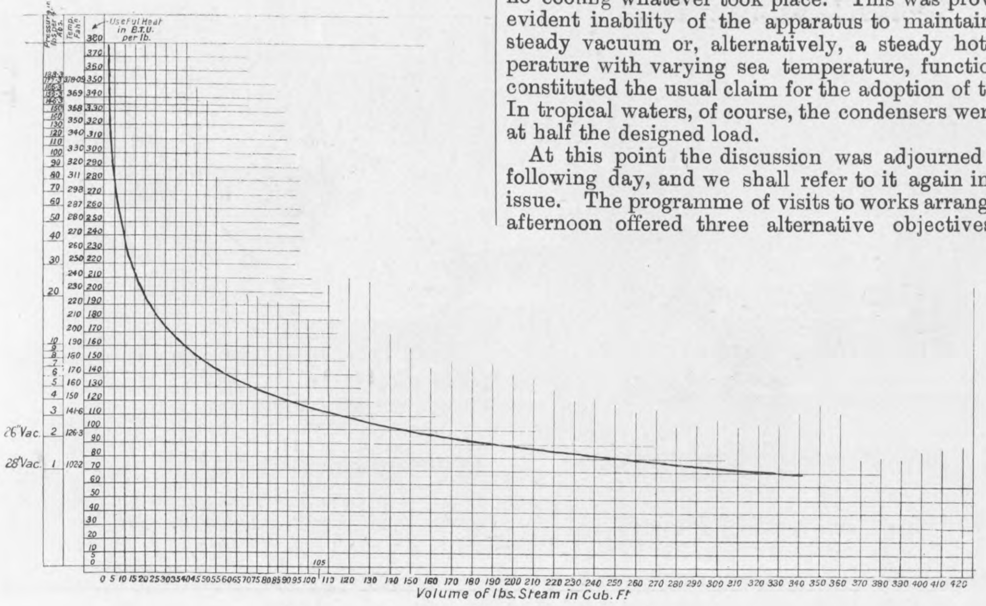


Fig. 12

Mr. H. A. Mavor said that the electrical engineer could solve the problem of applying the 200 horse-power referred to by Mr. Morison. Something had been said as to the difficulty of dealing with electrical gear on shipboard, but all round Glasgow motors of the size required were in service and were being looked after by the type of men who were employed on cargo boats. The weight difficulty was the real trouble, and he believed the solution of the problem before them was to run the turbine at the high speed it was customary to run it for electrical work on land. If that were done a cargo vessel could be driven with an economy of 20 per cent. on the present arrangement. All that was needed was an absolutely simple apparatus which any electrical engineer would undertake to make.

Mr. Wm. Weir said that the marine engineering profession was once again indebted to Messrs. Denny for the publication of the first definite results of the working of a new system, and the paper ought to give the lead to many shipowners in the adoption of the combination principle. Quite apart from the information as to the performance of the main propelling machinery, the paper was of value as giving the first public declaration of results which he had seen of the performance of a type of condensing plant (Contraflo type) which had attracted considerable attention recently. In analysing the results it was his desire to establish the degree of progress in design which the figures represented. The trial trip figures were the only ones of real scientific value, as they comprised vacua recorded by mercurial columns. Further, the trial trip represented four days' running over a period of almost a month, allowing occasion for making good any considerable air leakages which developed. On page 8, column 2, of the paper he found data which enabled him to establish a transmission rate of about 450 B.Th.U.'s, the thermal loss being 24 deg. and the condensation rate 14 lb. of steam per square foot per hour. At the lower powers on the voyage to Liverpool the transmission rate was 200 B.Th.U.'s, thermal loss 30 deg., condensation rate 7.63 lb. Such figures did not represent any advance on results frequently achieved with ordinary cylindrical condensers making no pretensions to special design. Indeed, the figures did not reach results recorded elsewhere. He would quote first the results for a turbine-propelled vessel of about 4500 horse-power where on careful trial the condensing plant gave a transmission rate of 960 B.Th.U.'s, a thermal loss of 20 degrees, and a condensation rate of 28.5 lb. per square foot. A later performance was at Clydebank Shipyard, on Monday of that very week, when a carefully designed plant gave the following:—Transmission rate, 1140 B.Th.U's; condensation rate, 18.5 lb.; thermal loss 3 deg. In this latter plant the inlet temperature was 59 deg. and the vacuum at 30in. barometer 28.9in. In both plants the proportions of the air and circulating pumps were such as could be easily fitted to any marine installation. The air pump capacity in the first plant was one-fifth of that fitted to the Otaki, and in the other case less than half that of the Otaki. With reference to the figures given in the paper of the performance of the Otaki's condensers in tropical waters, he regretted to find inconsistencies which rendered acceptance of the figures open to some question. His main point was that in each case the vacua, even when subjected to the author's deductions, were in exact agreement with the hotwell temperature. Accepting those figures, it followed that no air pump whatever was required on the Otaki, and, granting the absence of air leakage, the conclusion was reached as to the absence of air in the steam. This conclusion was, however, quite inadmissible. The design shown in the paper included a cooler situated in the base of the condenser, apparently of the non-controllable type. It followed that the cooler must have been out of action or no cooling whatever took place. This was proved by the evident inability of the apparatus to maintain either a steady vacuum or, alternatively, a steady hotwell temperature with varying sea temperature, functions which constituted the usual claim for the adoption of the device. In tropical waters, of course, the condensers were working at half the designed load.

At this point the discussion was adjourned until the following day, and we shall refer to it again in our next issue. The programme of visits to works arranged for the afternoon offered three alternative objectives for the visitors, one concerned with Motherwell, one with Johnstone, and a third with Renfrew.

DAVID COLVILLE AND CO., LIMITED, MOTHERWELL.

The works of David Colville and Co., Limited, at Motherwell, which are situated on the main line of the Caledonian system, have sidings, &c., equivalent to over eleven miles of single track railway. They are able to produce over 6000 tons of finished material per week. The number of men employed is from 2000 to 2500, depending on the state of trade. The firm's products are mild steel boiler and ship plates, high tensile boiler and ship steel, nickel steel plates and sections for ship and bridge building purposes, rounds, flats, locking bars, single and double-reeled bars, forging blooms, ingots, also cast steel rolls.

The smelting department contains twenty-one furnaces, and is housed in three shops. The two older shops have Siemens open-hearth furnaces, ranging from 25 to 30 tons capacity each, whilst the newest shop has furnaces ranging from 60 to 100 tons capacity each, some of them laid down two years ago. This latter shop is provided with Wellman-Seaver open-hearth charging machines. The gas producers, which are of the cylindrical continuous type, are all provided with mechanical feed, and gasify about 600 tons of fuel per day of twenty-four hours. The ingots are cast in pits in front of the furnaces, and those intended for plate-making are conveyed, after stripping, to soaking pits and reheating furnaces, which are served by automatic overhead electric cranes. The slab-cogging mill is able to deal with ingots up to 20 tons in weight, and has a capacity of over 60 tons per hour. It is driven through gearing by a pair of non-condensing reversing engines, and is provided with hydraulic manipulators and live roller racks, &c. At the end of the cogging mill rack is a steam-driven slab shearing machine, able to cut 60in. by 14in. The slabs, which are intended for the light plate mill, are cut to lengths in a set of steam hydraulic shears. The slabs are conveyed on racks, after being cut to length, and charged by means of electric charging machines, of which there are four, into the reheating furnaces, which are of the gas-fired type.

The plate mills are three in number, the largest having rolls 12ft. 6in. long on the barrel. It is driven through gearing by a compound tandem reversing engine. The mill is also provided with steam-driven live roller racks. The intermediate mill has rolls 8ft. long, and is driven direct by a pair of non-condensing reversing engines. It is also provided with steam-driven racks. The light plate mill, which roll plates as thin as ⅛in. thick, has rolls 7ft. long, and is driven direct by a pair of tandem compound condensing reversing engines fitted with Joy valve gear. The racks and screw gear are electrically operated. The capacity of the three plate mills is about 4000 tons of sheared plates per week. The plates, after cooling, are sheared to sizes, five sets of shears being continually at work; the heavy shears being provided with casters to facilitate handling of the plates. Plate flattening machines, and also annealing furnaces, having electrical self-recording pyrometers, are provided for the further treatment of the material.

The ingots which are intended for rolling into sectional material are conveyed from the smelting department on a narrow-gauge railway to the reheating furnaces, and are then rolled down into billets in the blooming mill, from which they are skidded across to the finishing mill, which has two stands of housings. The blooming and finishing mills are each driven by geared non-condensing reversing engines, and the live roller racks are steam driven.

In the steel foundry department heavy castings are made up to 50 tons in weight, including housings, plate, and bar mill rolls, mill pinions, heavy ingots for forgings, &c. The ironworks department contains puddling and ball furnaces of the usual type, two steam hammers, and a steam-driven pull-over puddle train. It has a capacity of about 350 tons of puddled and scrap bars per week. In this department are also installed a merchant and a guide mill, both steam driven, and having a capacity of about 600 tons per week of finished material, which includes steel as well as iron. Special features here also are the reeling machines, where single and double-reeled bars are made up to 4¼in. diameter.

Steam is raised for the mills, &c., throughout the whole works in 34 boilers of the water-tube type—24 Babcock and Wilcox and 10 Stirling—and 16 cylindrical boilers, which latter include the waste heat boilers used in connection with the puddling, ball, and reheating furnaces in the ironworks. There are also three separately fired superheaters.

The electric generating station contains two 400 kilowatts direct-current compound-wound dynamos, one direct coupled to a Bellis and Morcom triple-expansion condensing engine, the other direct connected to a three-cylinder Galloway engine. There has recently been installed a Rateau exhaust steam turbine which utilises the waste steam from the shearing machines, &c., and there is also here a Chloride electric storage battery having a capacity of 1200 ampère hours with an Entz automatic booster. The energy is taken from the station by overhead cables mostly bare, to the distribution boards in different parts of the works, where the circuits are subdivided for the several motors, &c. There is also in the station a small three-phase plant which drives the machinery in the engineering shops. The works are lighted by over 200 arc lamps and 1000 incandescent lamps. The roll turning department, in which steel rolls of all sizes and for any purpose are made, is housed in a building 375ft. long by 55ft. wide, served by an electric overhead crane. All the machines here are electrically driven by variable speed motors. The works, of course, have the usual mechanical testing department and chemical laboratory.

ALEXANDER FINDLAY AND CO., LIMITED, MOTHERWELL

At the Parkneuk Works at Motherwell of Alexander Findlay and Co., Limited, the manufacture of steel bridges, roofs, and all kinds of general structural iron and steel work has—since their establishment in 1888 by Mr. Alex. Findlay—been vigorously carried on. The works have been extended from time to time, and have now a capacity for an output of over 12,000 tons of manufactured work per annum. The main building for the department concerned with bridge construction is entirely roofed over, and is equipped with modern plant for the rapid handling and painting of work under cover from the weather. To deal with the manufacture of lighter work there is also a roof shop. The firm makes a speciality of the manufacture of steel trough flooring for railway and road bridges, and of fireproof floors for warehouses and other buildings, and for this purpose there is a special department. The hydraulic press for producing this flooring is specially heavy, and troughs up to 36ft. long by 18in. deep can be pressed from single plates up to ¾in. in thickness.

The covered-in shops of this company's works, and their equipment with modern tools, were inspected. Among the contracts being dealt with at the time of the visit the following may be mentioned:—The pier extension at Egremont on the Mersey, and bridgework for the Great Northern Railway (Ireland), the Highland and North-Eastern Railways, and the Great Indian Peninsular Railway. In addition, work was proceeding on contracts comprising locomotive erecting shops, running sheds, piers, water tanks and towers for various South American railway companies, as well as a number of road bridges for various Councils in Scotland and England.

BRANDON BRIDGE BUILDING COMPANY, LIMITED, MOTHERWELL.

The works of the Brandon Bridge Building Company, Limited, Motherwell, form one of the largest and most modern bridge building establishments in the country. They extend to over 10 acres in area, and comprise, besides bridge building, ironfounding and engineering departments. The more important work at present on hand includes bridges for the Argentine, Cape-to-Cairo Railway extension, swing bridge and dock gates for the new harbour at Kirkcaldy, as well as the steel work for the new naval base at Rosyth, the latter being a very extensive contract. In the engineering department work was seen in progress on a large number of pillar water cranes and turntables for foreign railways.

JOHN LANG AND SONS, JOHNSTONE.

The works of John Lang and Sons, at Johnstone, were laid out on the present site, which extends to about twenty acres, with workshops designed to embody as nearly as possible a model manufacturing system. For the production of lathes in quantities the firm enjoys a combination of advantages. The foundry is adjacent to the Glasgow and South-Western Railway, from which a siding supplies all raw material direct. Moulding machines are used whenever possible. When the castings, &c., are delivered into the machine shops, the various operations form a systematic progression with a minimum of transport, until the finished lathe is delivered into the show-room or dispatched to its destination. About 700 men are employed in manufacturing lathes by the most up-to-date methods with jigs and fixtures. In recent times, with the advent of high-speed steel, there came a general desire to improve the plant of workshops. To meet and encourage this, all the firm's lathes were re-designed and made from entirely new patterns throughout. A series of sliding, surfacing, and screw-cutting engine lathes is built, these ranging from

6in. to 16in. centres, and of surfacing and boring lathes with from 18in. to 48in. swing. Besides these, many special designs of lathes are made for different classes of work, where quantities are required to be machined economically. The question of correct speeds has also had very careful consideration.

THOMAS SHANKS AND CO., JOHNSTONE.

The Union Ironworks of Thomas Shanks and Co., which have in recent years undergone considerable extensions, have been in existence since 1824. The firm's reputation for heavy machine tools is world-wide, but it has made lathes as small as 10in. centres, while its largest—just lately completed—has a face-plate no less than 15ft. diameter, and could swing 15ft. clear over the saddles. This machine is, it is believed, the largest lathe without packing yet built. The firm make lathes of all kinds, single bed and double bed, for all purposes, such as machining crank shafts, propeller shafts, turbine rotors, &c. Their table planing machines range from 2½ft. square up to 14ft. square for armour plates, their horizontal and vertical planing machines from the smallest, 7½ft. by 6½ft., up to the largest, 32ft. by 23ft. In a similar way the various machines they make, such as those for turbine boring, horizontal drilling, tapping and studding, slotting, shaping, radial drilling, screwing, &c., extend over a great variety of sizes. The recent introduction of turbines has led to a very great demand for special machines, and to meet this demand Shanks and Co., some time since, extended their works by adding to the existing shop another bay 360ft. long by 70ft. wide, and equipping both with overhead electric cranes.

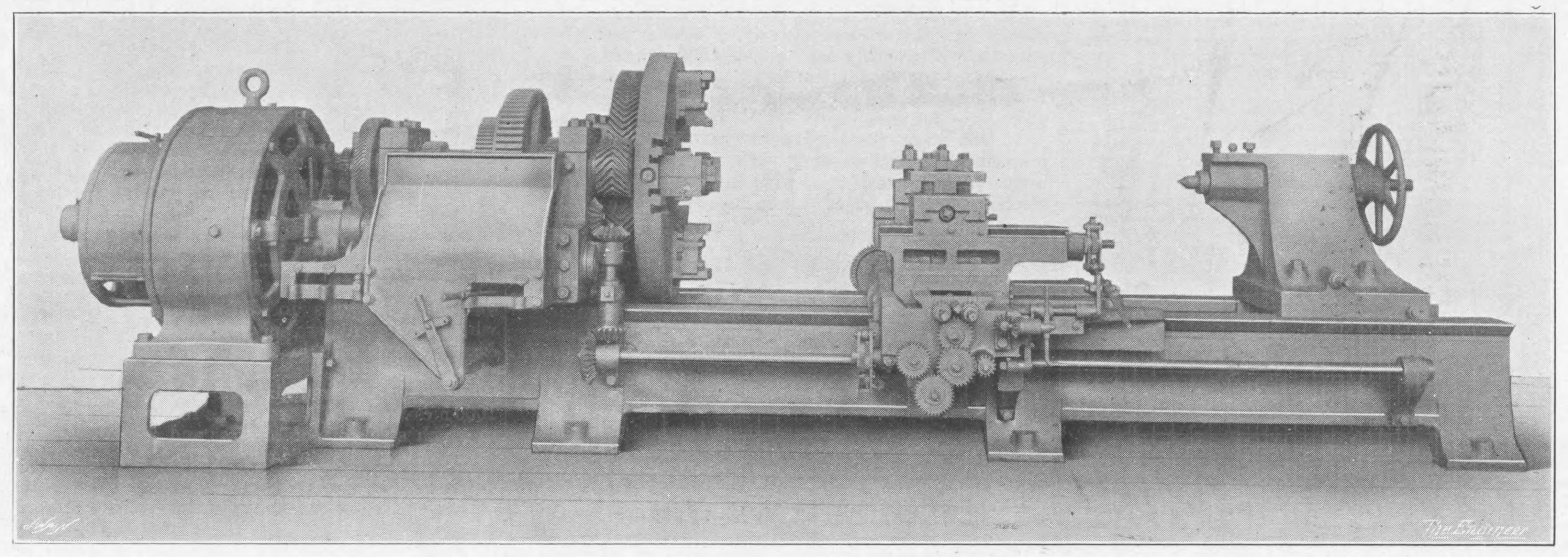


Fig. 13—MOTOR DRIVEN LATHE

Among the machines brought under the notice of the visitors in passing through the works was a very large turbine casing boring machine to the order of the Admiralty for Portsmouth Dockyard; a large vertical and horizontal planing machine; a 28in. stroke slotting machine; a motor driven lathe, and a number of the firm's radial drilling machines. Machines of these types are shown on page 166, and in Figs. 13 and 14. Other machines upon which work was proceeding included boiler shell drills, plate edge planers, various sizes of horizontal and vertical planing machines, slotting machines, and shafting lathes. Included in the latter class was a very long double shafting lathe, having a bed 104ft. long, in two lengths, capable of finishing a shaft 80ft. long when one loose head is removed. Of vertical drilling machines there was one example of a new design, having a 3½in. diameter spindle, with all-gear drive, positive feeds, and a very rigid framing.

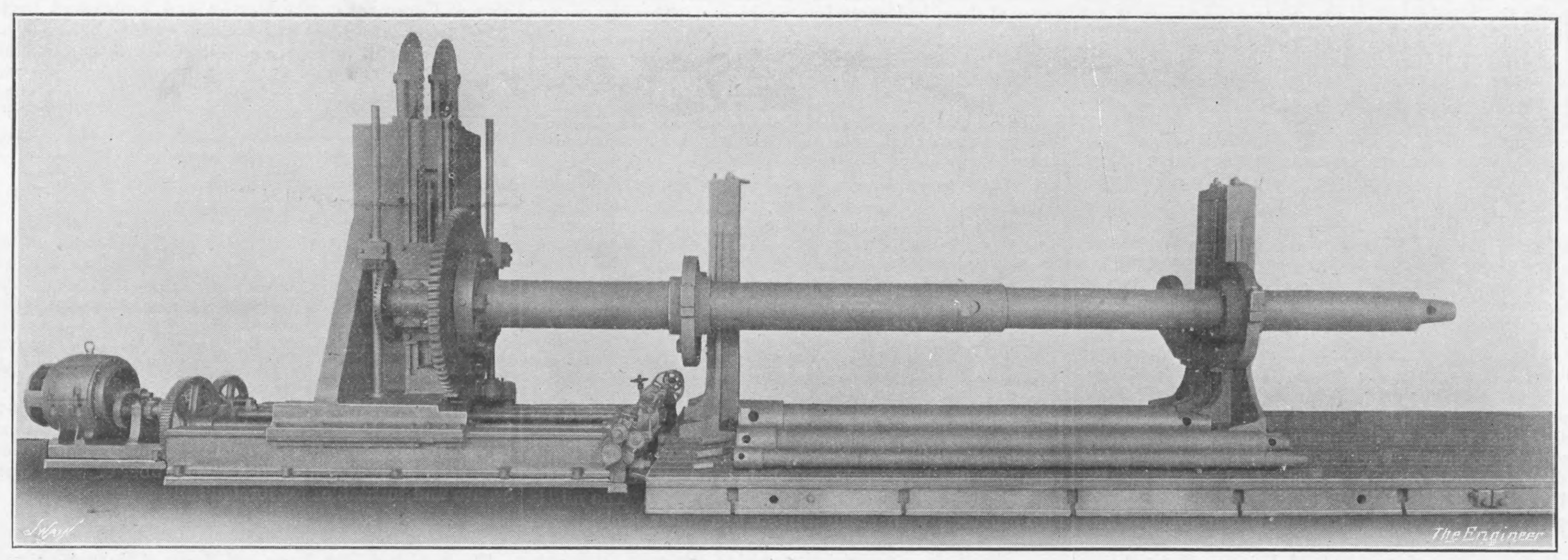


Fig. 14—TURBINE-CASING BORING MACHINE

The third alternative visit on Wednesday afternoon to the works of Messrs. Babcock and Wilcox, Limited, Renfrew, which was taken advantage of by a fair number of the members, and yielded many points of decided interest, must be left over till next issue.

SOME FOUNDRY HINTS.

(By a Correspondent.)

THERE is much waste of time and material in many foundries owing to an excessive number of defects in many castings, whether machined or not. This article will endeavour to point out some of the leading causes and suggest aids to prevent many, and so reduce the costs and increase the foundry output. First, then, what are the principal causes of defects in the machine tool or general foundry?

Blow-holes.—There are two distinct kinds, and both are to be found on the back or top parts of castings. This proves one fact, that the air or gases did not freely escape from the moulds, owing, perhaps, to sleeked, tough, water-logged sand. The blow-holes, however, may have been caused by the sand being over-ground in the sand mill and not sufficiently open. This close-ground facing sand on the back parts of moulds causes thousands of machinery castings to be rejected. Open, clean sand is required for parts to be afterwards machined. Not freely using the vent wires will assist in producing blow-holes; these are found when the first cut is taken on the machine of planers or turners. The parts to be machined should be marked, so that the moulders can take more precaution. Another kind of blow-holes, not so common or numerous, is that caused by the iron being overcharged with sulphur. These can be detected by their silvery interior. Carelessness in filling up moulding boxes with black sand not properly screened, or too much water-logged, may also cause trouble. Do not mind a rough surface on parts to be machined; what you want is a sound surface, free from blow-holes after machine operations have been performed. As for gear blanks, pulleys, cones, capstan slides, turret blocks, saddles, or gear boxes, all these castings for machine tools require the greatest possible care all round, including the facing sand on the back parts. Heavy sleeking with the trowels is quite unnecessary, and prevents the free escape of the gases. If a little more clearance on the back parts of many patterns were allowed by many patternmakers, this would save many castings from the defective scrap heaps. I refer chiefly to the machined parts, where the risks are greatest. Moulders could then often claim more credit for their work, as things can be cut too fine in this direction. Extreme hardness of green sand moulds will often produce blow-holes in the top parts, as the gases are obstructed in their exit from the mould. Vent well and use open sand with as little moisture as possible. Put on plenty of runner, and, where necessary, riser. Cast with well-skimmed hot metal, and keep the runners full when pouring.

Facing sands.—Here is a great study. For undried or green sand moulds, the moisture of the sand, the coal-dust, and the close or open nature of the sand, largely determine the appearance of castings. Many castings are spoilt by using weak sand, and filling the mould with extra hot metal; this often causes nasty seams. Study the quantity of coal dust according to the size and weight of the casting; seams and rough surfaces are both preventable if the facing sand mixing is properly studied. For machined castings two kinds of facing sand are required, one for a clean face where not machined, and the other for solid, sound iron underneath where steel tools will take cuts, and so expose any defects, if any can be found, by milling, planing, or turning. Put every bit of facing sand carefully through the sieves and well cover the patterns. Using too little facing sand and then filling around the patterns with wet black sand spoils many castings. Many men are very careless with facing sand on machinery castings. As the surface of the mould has to stand up against the metal, and be free from any kind of movement, it is necessary to avoid scab by taking every care with facing sands, and keeping the runners full when pouring the metal. For light castings ram firmly, but vent freely, and pour quickly. Facing sand for good, smooth surfaces is best used the day after mixing. Employ plenty of plumbago to give good surfaces where no machining is required.

Cores.—Core making has now become a great art in the foundry. So many castings are now made chiefly with dried core parts, as, for instance, parts of modern lathes, feed boxes, aprons, gear cases, gear boxes, beds, auto bodies, and parts of other machinery, some delicate, some heavy. Many defective castings are due to defective cores, probably not properly dried or vented, or not properly fixed, or made up too full in the prints, so as to produce a crush. Place the runners so as to avoid an undue rush of iron in one particular part against the cores, and so that all the cores take a fairly equal share of the strain when pouring the iron. Paint well, dry well, vent well; but to get away the gases properly is all-important. Moulders on cored machinery castings have great responsibility. The machine shops are the real examiners of their work.

Gases and air.—These are the moulder's greatest enemies; defeat them by giving them every facility to escape from the moulds. Avoid conflict as much as possible between these gases and the iron by placing the runners in the best positions. The chief troubles with gases and air, apart from the cores, are the top parts of the castings; so vent freely and shave the joints to get away the gases quickly, and use open sand where possible.

Skimming the iron.—Many castings could be saved if this question was considered more. Machine shop costs are increased and work delayed by this great foundry fault. More care is wanted in the use of the water brush, as many machined castings are spoilt by the too free use of water. It chills the castings and runs up extra costs with steel cutting tools in the machine shops. Many defects can be traced to this cause.

Moulding plant.—For the want of good moulding boxes much work is spoilt, and many moulders work under difficulties in this respect. Many founders make this question a vital one, others seem to hang on to the make-shift principle. Good plant is of first importance. Twist and strain, bad lifts owing to faulty bars in top box parts, or other defects in boxes, lead up to a number of faulty castings being produced. Firms which pay attention to and secure good moulding plant and good brands of pig iron are on the road to increased output, fewer defective castings, and lower foundry and machine shop costs.

Rapid and Easy Method of Obtaining Bevel Gear Figures.

Proportion of Wheels.	F. Large wheel.	F. Small wheel.	E.	D.	Centre Angle B. Large wheel.	Centre Angle B. Small wheel.
1 to 1	1·414 ÷ J	1·414 ÷ J	86° – 36′ ÷ K	93° – 20′ ÷ K	45°	45°
1 ,, 1·020	1·400 ,,	1·428 ,,	81° – 18′ ,,	94° – 14′ ,,	45° – 34′	44° – 26′
1 ,, 1·040	1·386 ,,	1·442 ,,	82° – 0′ ,,	95° – 9′ ,,	46° – 7′	43° – 53′
1 ,, 1·050	1·379 ,,	1·448 ,,	83° – 16′ ,,	95° – 35′ ,,	46° – 24′	43° – 36′
1 ,, 1·100	1·345 ,,	1·479 ,,	85° – 4′ ,,	97° – 39′ ,,	47° – 43′	42° – 17′
1 ,, 1·111	1·338 ,,	1·486 ,,	85° – 27′ ,,	98° – 5′ ,,	48° – 00′	42° – 00′
1 ,, 1·125	1·328 ,,	1·494 ,,	85° – 57′ ,,	98° – 39′ ,,	48° – 22′	41° – 38′
1 ,, 1·143	1·317 ,,	1·505 ,,	86° – 31′ ,,	99° – 19′ ,,	48° – 48′	41° – 12′
1 ,, 1·150	1·312 ,,	1·509 ,,	86° – 45′ ,,	99° – 35′ ,,	48° – 59′	41° – 1′
1 ,, 1·166	1·301 ,,	1·518 ,,	87° – 18′ ,,	100° – 13′ ,,	49° – 24′	40° – 36′
1 ,, 1·180	1·293 ,,	1·526 ,,	87° – 43′ ,,	100° – 41′ ,,	49° – 43′	40° – 17′
1 ,, 1·200	1·280 ,,	1·535 ,,	88° – 21′ ,,	101° – 24′ ,,	50° – 12′	39° – 48′
1 ,, 1·240	1·255 ,,	1·557 ,,	89° – 32′ ,,	102° – 46′ ,,	51° – 7′	38° – 53′
1 ,, 1·250	1·249 ,,	1·561 ,,	89° – 47′ ,,	103° – 4′ ,,	51° – 20′	38° – 40′
1 ,, 1·280	1·231 ,,	1·576 ,,	90° – 37′ ,,	104° – 1′ ,,	52° – 00′	38° – 00′
1 ,, 1·285	1·227 ,,	1·579 ,,	90° – 47′ ,,	104° – 12′ ,,	52° – 8′	37° – 52′
1 ,, 1·300	1·219 ,,	1·585 ,,	91° – 9′ ,,	104° – 38′ ,,	52° – 26′	37° – 34′
1 ,, 1·320	1·208 ,,	1·594 ,,	91° – 39′ ,,	105° – 12′ ,,	52° – 51′	37° – 9′
1 ,, 1·333	1·200 ,,	1·600 ,,	91° – 59′ ,,	105° – 35′ ,,	53° – 7′	36° – 53′
1 ,, 1·350	1·190 ,,	1·607 ,,	92° – 24′ ,,	106° – 4′ ,,	53° – 28′	36° – 32′
1 ,, 1·400	1·162 ,,	1·627 ,,	93° – 41′ ,,	107° – 25′ ,,	54° – 28′	35° – 32′
1 ,, 1·420	1·151 ,,	1·635 ,,	94° – 2′ ,,	107° – 56′ ,,	54° – 51′	35° – 9′
1 ,, 1·428	1·147 ,,	1·638 ,,	94° – 12′ ,,	108° – 7′ ,,	55° – 00′	35° – 00′
1 ,, 1·440	1·141 ,,	1·642 ,,	94° – 27′ ,,	108° – 25′ ,,	55° – 13′	34° – 47′
1 ,, 1·460	1·135 ,,	1·646 ,,	94° – 39′ ,,	108° – 39′ ,,	55° – 24′	34° – 36′
1 ,, 1·480	1·120 ,,	1·657 ,,	95° – 16′ ,,	109° – 22′ ,,	55° – 57′	34° – 3′
1 ,, 1·500	1·109 ,,	1·664 ,,	95° – 41′ ,,	109° – 50′ ,,	56° – 19′	33° – 41′
1 ,, 1·520	1·099 ,,	1·670 ,,	96° – 5′ ,,	110° – 16′ ,,	56° – 40′	33° – 20′
1 ,, 1·550	1·084 ,,	1·680 ,,	96° – 37′ ,,	110° – 54′ ,,	57° – 10′	32° – 50′
1 ,, 1·560	1·079 ,,	1·684 ,,	96° – 48′ ,,	111° – 7′ ,,	57° – 20′	32° – 40′
1 ,, 1·600	1·060 ,,	1·696 ,,	97° – 31′ ,,	111° – 56′ ,,	58° – 00′	32° – 00′
1 ,, 1·640	1·041 ,,	1·706 ,,	98° – 11′ ,,	112° – 42′ ,,	58° – 38′	31° – 22′
1 ,, 1·650	1·036 ,,	1·710 ,,	98° – 21′ ,,	112° – 53′ ,,	58° – 47′	31° – 13′
1 ,, 1·666	1·029 ,,	1·715 ,,	98° – 36′ ,,	113° – 11′ ,,	59° – 2′	30° – 58′
1 ,, 1·680	1·023 ,,	1·718 ,,	98° – 49′ ,,	113° – 25′ ,,	59° – 14′	30° – 46′
1 ,, 1·700	1·014 ,,	1·724 ,,	99° – 7′ ,,	113° – 46′ ,,	59° – 32′	30° – 28′
1 ,, 1·720	1·005 ,,	1·730 ,,	99° – 25′ ,,	114° – 7′ ,,	59° – 50′	30° – 10′
1 ,, 1·750	·992 ,,	1·736 ,,	99° – 50′ ,,	114° – 36′ ,,	60° – 15′	29° – 45′
1 ,, 1·760	·988 ,,	1·739 ,,	100° – 0′ ,,	114° – 46′ ,,	60° – 24′	29° – 36′
1 ,, 1·800	·971 ,,	1·748 ,,	100° – 31′ ,,	115° – 23′ ,,	60° – 57′	29° – 3′
1 ,, 1·840	·955 ,,	1·757 ,,	101° – 3′ ,,	116° – 0′ ,,	61° – 29′	28° – 31′
1 ,, 1·850	·951 ,,	1·759 ,,	101° – 10′ ,,	116° – 8′ ,,	61° – 37′	28° – 23′
1 ,, 1·880	·940 ,,	1·765 ,,	101° – 30′ ,,	116° – 32′ ,,	61° – 59′	28° – 1′
1 ,, 1·900	·932 ,,	1·770 ,,	101° – 45′ ,,	116° – 47′ ,,	62° – 14′	27° – 46′
1 ,, 1·920	·924 ,,	1·774 ,,	102° – 0′ ,,	117° – 3′ ,,	62° – 29′	27° – 31′
1 ,, 1·950	·912 ,,	1·779 ,,	102° – 19′ ,,	117° – 27′ ,,	62° – 51′	27° – 9′
1 ,, 1·960	·908 ,,	1·781 ,,	102° – 26′ ,,	117° – 34′ ,,	62° – 58′	27° – 2′
1 ,, 2·000	·894 ,,	1·789 ,,	102° – 51′ ,,	118° – 3′ ,,	63° – 26′	26° – 34′
1 ,, 2·040	·880 ,,	1·796 ,,	103° – 15′ ,,	118° – 31′ ,,	63° – 53′	26° – 7′
1 ,, 2·080	·866 ,,	1·802 ,,	103° – 39′ ,,	118° – 58′ ,,	64° – 20′	25° – 40′
1 ,, 2·100	·859 ,,	1·805 ,,	103° – 49′ ,,	119° – 10′ ,,	64° – 32′	25° – 28′
1 ,, 2·120	·853 ,,	1·809 ,,	104° – 0′ ,,	119° – 23′ ,,	64° – 45′	25° – 15′
1 ,, 2·160	·840 ,,	1·815 ,,	104° – 21′ ,,	119° – 46′ ,,	65° – 9′	24° – 51′
1 ,, 2·200	·830 ,,	1·821 ,,	104° – 40′ ,,	120° – 9′ ,,	65° – 33′	24° – 27′
1 ,, 2·240	·815 ,,	1·826 ,,	105° – 0′ ,,	120° – 32′ ,,	65° – 57′	24° – 3′
1 ,, 2·250	·812 ,,	1·827 ,,	105° – 5′ ,,	120° – 37′ ,,	66° – 2′	23° – 58′
1 ,, 2·280	·803 ,,	1·831 ,,	105° – 19′ ,,	120° – 53′ ,,	66° – 19′	23° – 41′
1 ,, 2·300	·797 ,,	1·834 ,,	105° – 27′ ,,	121° – 2′ ,,	66° – 30′	23° – 30′
1 ,, 2·333	·788 ,,	1·838 ,,	105° – 42′ ,,	121° – 19′ ,,	66° – 48′	23° – 12′
1 ,, 2·360	·780 ,,	1·841 ,,	105° – 52′ ,,	121° – 31′ ,,	67° – 2′	22° – 58′
1 ,, 2·400	·769 ,,	1·846 ,,	106° – 9′ ,,	121° – 50′ ,,	67° – 23′	22° – 37′
1 ,, 2·440	·758 ,,	1·850 ,,	106° – 24′ ,,	122° – 8′ ,,	67° – 43′	22° – 17′
1 ,, 2·480	·747 ,,	1·855 ,,	106° – 39′ ,,	122° – 26′ ,,	68° – 3′	21° – 57′
1 ,, 2·500	·743 ,,	1·857 ,,	106° – 46′ ,,	122° – 34′ ,,	68° – 12′	21° – 48′
1 ,, 2·520	·738 ,,	1·859 ,,	106° – 53′ ,,	122° – 40′ ,,	68° – 21′	21° – 39′
1 ,, 2·560	·727 ,,	1·863 ,,	107° – 7′ ,,	122° – 57′ ,,	68° – 40′	21° – 21′
1 ,, 2·600	·718 ,,	1·866 ,,	107° – 18′ ,,	123° – 11′ ,,	68° – 57′	21° – 3′
1 ,, 2·640	·708 ,,	1·870 ,,	107° – 32′ ,,	123° – 25′ ,,	69° – 15′	20° – 45′
1 ,, 2·666	·702 ,,	1·872 ,,	107° – 39′ ,,	123° – 34′ ,,	69° – 26′	20° – 34′
1 ,, 2·700	·694 ,,	1·875 ,,	107° – 50′ ,,	123° – 47′ ,,	69° – 41′	20° – 19′
1 ,, 2·720	·690 ,,	1·877 ,,	107° – 57′ ,,	123° – 53′ ,,	69° – 49′	20° – 11′
1 ,, 2·760	·681 ,,	1·880 ,,	108° – 7′ ,,	124° – 6′ ,,	70° – 5′	19° – 55′
1 ,, 2·800	·672 ,,	1·883 ,,	108° – 17′ ,,	124° – 18′ ,,	70° – 21′	19° – 39′
1 ,, 2·840	·664 ,,	1·886 ,,	108° – 28′ ,,	124° – 30′ ,,	70° – 36′	19° – 24′
1 ,, 2·880	·656 ,,	1·889 ,,	108° – 37′ ,,	124° – 41′ ,,	70° – 51′	19° – 9′
1 ,, 2·900	·651 ,,	1·891 ,,	108° – 43′ ,,	124° – 53′ ,,	70° – 59′	19° – 1′
1 ,, 3·000	·632 ,,	1·897 ,,	109° – 6′ ,,	125° – 14′ ,,	71° – 34′	18° – 26′
1 ,, 3·100	·614 ,,	1·903 ,,	109° – 26′ ,,	125° – 37′ ,,	72° – 7′	17° – 53′
1 ,, 3·200	·596 ,,	1·909 ,,	109° – 45′ ,,	126° – 0′ ,,	72° – 39′	17° – 21′
1 ,, 3·333	·575 ,,	1·915 ,,	110° – 8′ ,,	126° – 25′ ,,	73° – 18′	16° – 42′
1 ,, 3·400	·564 ,,	1·919 ,,	110° – 20′ ,,	126° – 38′ ,	73° – 37′	16° – 23′
1 ,, 3·450	·557 ,,	1·921 ,,	110° – 26′ ,,	126° – 46′ ,,	73° – 50′	16° – 10′
1 ,, 3·500	·549 ,,	1·923 ,,	110° – 34′ ,,	126° – 55′ ,,	74° – 3′	15° – 57′
1 ,, 3·550	·542 ,,	1·925 ,,	110° – 41′ ,,	127° – 3′ ,,	74° – 16′	15° – 44′
1 ,, 3·600	·535 ,,	1·927 ,,	110° – 48′ ,,	127° – 11′ ,,	74° – 29′	15° – 31′
1 ,, 3·631	·531 ,,	1·928 ,,	110° – 52′ ,,	127° – 15′ ,,	74° – 36′	15° – 24′
1 ,, 3·684	·524 ,,	1·930 ,,	110° – 59′ ,,	127° – 23′ ,,	74° – 49′	15° – 11′
1 ,, 3·736	·517 ,,	1·932 ,,	111° – 5′ ,,	127° – 30′ ,,	75° – 1′	14° – 59′
1 ,, 3·777	·512 ,,	1·934 ,,	111° – 10′ ,,	127° – 36′ ,,	75° – 10′	14° – 50′
1 ,, 3·789	·510 ,,	1·934 ,,	111° – 11′ ,,	127° – 37′ ,,	75° – 13′	14° – 47′
1 ,, 3·833	·505 ,,	1·935 ,,	111° – 16′ ,,	127° – 43′ ,,	75° – 23′	14° – 37′
1 ,, 3·888	·496 ,,	1·937 ,,	111° – 22′ ,,	127° – 48′ ,,	75° – 35′	14° – 25′
1 ,, 3·944	·492 ,,	1·938 ,,	111° – 27′ ,,	127° – 53′ ,,	75° – 46′	14° – 14′
1 ,, 4	·485 ,,	1·940 ,,	111° – 33′ ,,	128° – 3′ ,,	75° – 58′	14° – 2′
1 ,, 4·111	·472 ,,	1·943 ,,	111° – 45′ ,,	128° – 16′ ,,	76° – 21′	13° – 39′
1 ,, 4·176	·466 ,,	1·945 ,,	111° – 50′ ,,	128° – 22′ ,,	76° – 32′	13° – 28′
1 ,, 4·235	·459 ,,	1·946 ,,	111° – 54′ ,,	128° – 28′ ,,	76° – 43′	13° – 17′
1 ,, 4·312	·452 ,,	1·948 ,,	112° – 1′ ,,	128° – 35′ ,,	76° – 57′	13° – 3′
1 ,, 4·375	·446 ,,	1·949 ,,	112° – 6′ ,,	128° – 40′ ,,	77° – 7′	12° – 53′
1 ,, 4·428	·440 ,,	1·951 ,,	112° – 10′ ,,	128° – 45′ ,,	77° – 17′	12° – 43′
1 ,, 4·5	·434 ,,	1·952 ,,	112° – 15′ ,,	128° – 51′ ,,	77° – 28′	12° – 32′
1 ,, 4·571	·427 ,,	1·954 ,,	112° – 20′ ,,	128° – 57′ ,,	77° – 40′	12° – 20′
1 ,, 4·666	·419 ,,	1·955 ,,	112° – 26′ ,,	129° – 3′ ,,	77° – 54′	12° – 6′
1 ,, 4·8	·408 ,,	1·958 ,,	112° – 35′ ,,	129° – 13′ ,,	78° – 14′	11° – 46′
1 ,, 5	·392 ,,	1·961 ,,	112° – 45′ ,,	129° – 26′ ,,	78° – 41′	11° – 19′
1 ,, 5·142	·382 ,,	1·963 ,,	112° – 53′ ,,	129° – 34′ ,,	79° – 0′	11° – 0′
1 ,, 5·230	·375 ,,	1·964 ,,	112° – 57′ ,,	129° – 39′ ,,	79° – 11′	10° – 49′
1 ,, 5·385	·365 ,,	1·966 ,,	113° – 3′ ,,	129° – 46′ ,,	79° – 29′	10° – 31′
1 ,, 5·461	·360 ,,	1·967 ,,	113° – 6′ ,,	129° – 49′ ,,	79° – 37′	10° – 23′
1 ,, 5·538	·355 ,,	1·968 ,,	113° – 10′ ,,	129° – 53′ ,,	79° – 46′	10° – 14′
1 ,, 5·666	·348 ,,	1·969 ,,	113° – 16′ ,,	129° – 59′ ,,	79° – 59′	10° – 1′
1 ,, 5·75	·342 ,,	1·970 ,,	113° – 18′ ,,	129° – 2′ ,,	80° – 8′	9° – 52′
1 ,, 5·833	·338 ,,	1·971 ,,	113° – 20′ ,,	130° – 5′ ,,	80° – 16′	9° – 44′
1 ,, 5·916	·333 ,,	1·972 ,,	113° – 23′ ,,	130° – 9′ ,,	80° – 25′	9° – 35′
1 ,, 6·0	·328 ,,	1·972 ,,	113° – 26′ ,,	130° – 12′ ,,	80° – 33′	9° – 27′

EXAMPLE.

Wheels	60 teeth and 30 teeth ; 8 diametral pitch
Proportion	= 60 to 30 = 2 to 1
Outside diameter of large wheel	= Pitch diameter + F = $7\frac{1}{2}''$ + ·894 ÷ J = $7\frac{1}{2}''$ + ·894 ÷ 8 = $7\frac{1}{2}''$ + ·111 = 7·611
Centre angle wheel	= 63° – 26′
Face angle	= 63° – 26′ + E = 63° – 26′ + (102° – 51′ ÷ K) = 63° – 26′ + (102° – 51′ ÷ 60) = 63° – 26′ + (1° – 43′) = 65° – 9′
Cutting angle	= 63° – 26′ – D = 63° – 26′ – (118° – 3′) ÷ K 63° – 26′ – 1° – 58′ = 61° – 28′

BEVEL GEAR TABLES.

By CHAS. WATTS.

THE accompanying table has been arranged for the convenience of engineers and draughtsmen in calculating diameters, angles, &c., of all ordinary combinations of bevel gearing. Any proportion from 1 to 1 up to 1 to 6 may be obtained from the table. The table is only applicable to gears with their shafts at right angles, and 99 per cent. of bevel gear drives are so arranged. Where an exact proportion of wheels is not given, it is near enough in nearly every case to take the proportion between the one above and the next below.

This table is founded upon one originated by Mr. George B. Grant, of the Boston Gear Works. The author some time ago had a communication from Mr. Grant, who kindly suggested that any use considered desirable could be made of the original table. The accompanying table, while in the main following Mr. Grant's idea, has been very considerably enlarged and improved by the addition of many new proportions, and also of a new column "D."

The table is used in the following way :—

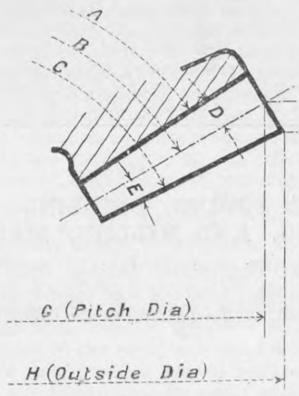
PROPORTION OF WHEELS.—To find proportion of wheels divide number of teeth of wheel by number of teeth of pinion.

CENTRE ANGLES.—Having found the proportion of wheels, the centre angles of wheel and pinion may then be read from columns "B."

OUTSIDE DIAMETERS.—Add to the pitch diameter the diameter increment, the total is the outside diameter. To find the increment divide amount in column "F" for large wheel by the diametral pitch. The result is the diameter increment. Treat the small wheel in the same way, using column "F" (small wheel).

FACE ANGLE.—The face angle is centre angle plus angle increment. To find angle increment, divide amount in column "E" by number of teeth in large wheel. The result will be angle increment in degrees and minutes. Add this increment to centre angle, and this will give the outside or face angle. The same amount added to small wheel centre angle will give outside or face angle of small wheel.

CUTTING ANGLE.—To find the cutting angle for the bevel gear-cutting machine, deduct the angle decrement from the centre angle. To find angle decrement, divide amount in column "D" by number of teeth in large wheel.



NOTE.—The cutting angle obtained will be the standard Brown and Sharpe depth for involute teeth.

A = Cutting angle = B – D
B = Centre angle
C = Face angle = B + E
D = Angle decrement
E = Angle increment
F = Diameter increment
G = Pitch diameter
H = Outside diameter = G + F
J = Diametral pitch
K = Number of teeth in large wheel
L = From pitch line to outside angle = ½ diameter increment of mating wheel

G + F = H
Angle B + angle E = angle C
Angle B – angle D = angle A
The values of F, E, D, B are shown in table

THE ALASKA, YUKON, AND PACIFIC EXHIBITION.

AN interesting exhibition is now being held at Seattle, which is one of the principal cities and ports of the North Pacific Coast. Its purpose is to give publicity to the modern commercial and industrial development of the great Pacific North-West region. The exhibition covers a site of 260 acres, with a natural scenic setting of lakes, forests, and mountains. Some of the large buildings are permanent structures, and will become the property of the University of Washington after the close of the exhibition. The site is about 20 minutes' ride from the centre of the city, by several lines of electric tramways and a branch line of the Northern Pacific Railway. The main buildings front on three sides of a rectangle, in the middle of which is a series of artificial waterfalls, down which the water flows into a large ornamental basin with a 6in. jet of water under 150 lb. pressure, as a "geyser" fountain. There are four miles of water mains for fire service, and four miles for a drinking-water system, besides four miles of sewers. The water is pumped by four-stage centrifugal pumps, each having a capacity of 60,000 gallons per hour and being driven by an electric motor of 200 horsepower. For the waterfalls there is a similar pump, having a capacity of 600,000 gallons per hour. For the illuminations there are 250,000 incandescent lamps, current being supplied at 13,000 volts, and transformed to 3000 volts for distribution. The city of Seattle has a population of about 300,000, and is peculiar in that its natural site has been artificially altered to make it more convenient by levelling hills, filling valleys, and reclaiming "mud flats," or tide flats, along the water front. With the recent completion of the Chicago, Milwaukee, and Puget Sound Railway, the city is served by six transcontinental railways, and it is the port of many lines of steamers to Alaska, the Orient, Australia, &c.

HORIZONTAL BORING, DRILLING, AND MILLING MACHINE

LOUDON BROTHERS, LIMITED, JOHNSTONE, ENGINEERS

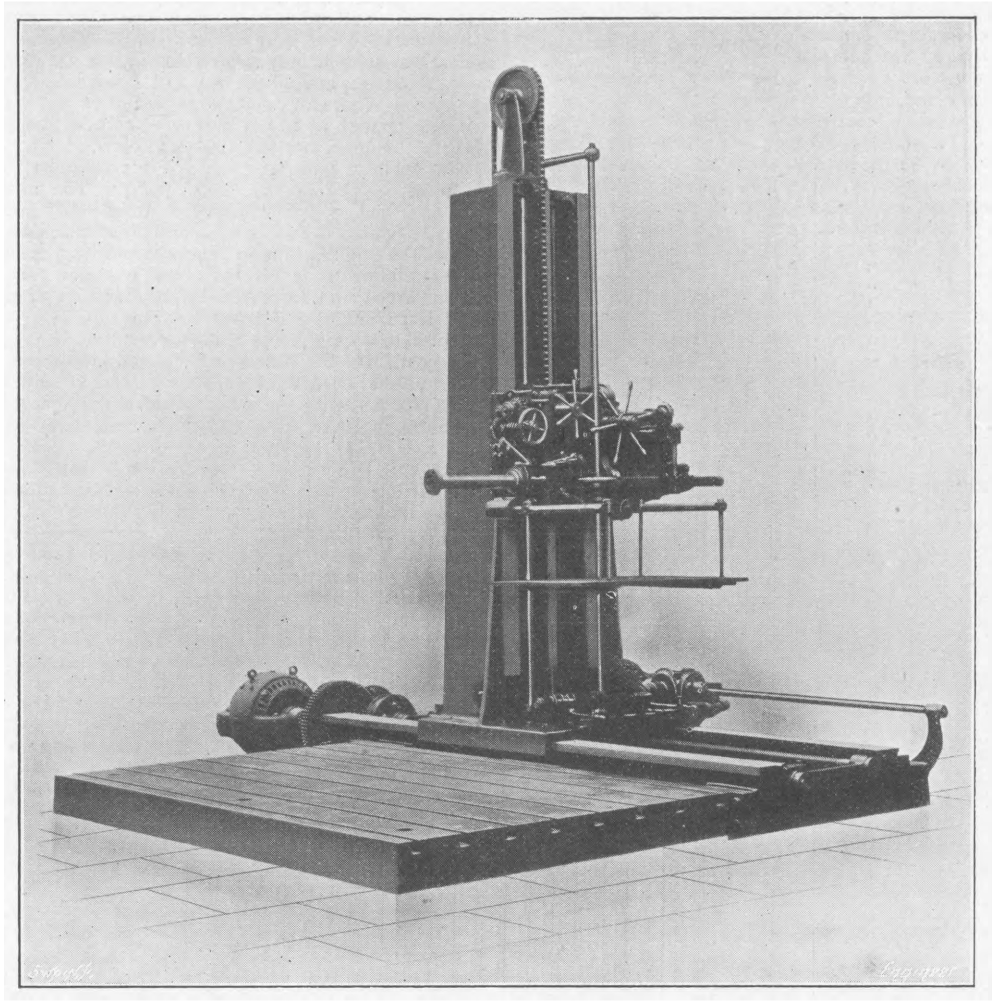


Fig. 1

HORIZONTAL BORING, DRILLING, TAPPING, STUDDING, AND MILLING MACHINE.

A HIGH-SPEED horizontal boring, drilling, tapping, studding, and milling machine has been made by Loudon Brothers, Limited, of Johnstone, to the order of one of the leading engineering firms in Glasgow. It is shown in the accompanying engravings and embodies several new features and details. All movements of the machine can be easily controlled from the saddle platform. The general construction of the machine may be regarded as consisting of a table to which the work is secured, a casting bolted to the table, as shown in the engraving, Fig. 1, having two horizontal sliding surfaces formed on it, an upright carrying the sliding tool saddle, and moving over the surfaces on the previously mentioned casting, and a bracket bolted to the table and carrying the electric motor and change-speed gear wheels.

It will be seen from a consideration of the purposes for which the machine has been designed that provision has to be made for the following movements of the tool spindle :—Rotation, common to all the operations; forward feeding for boring, drilling, tapping, and studding; vertical and horizontal feeding for milling. In addition, provision has to be made for bringing the spindle quickly into any desired position. Each of these movements has to be performed in either direction and at various speeds. Hence reversing and change-speed gears have also to be provided. Taking these operations in order, we purpose dealing with the details associated with each. To give rotational motion to the spindle, power is taken from the motor to drive a horizontal shaft A—Fig. 2—lying between the horizontal sliding surfaces and passing beneath the base of the upright. This shaft drives through spur wheels a vertical shaft B, which extends the whole height of the saddle column.

To permit of the movement of both the column and saddle, each of these shafts has a keyway cut along its whole length, thus allowing any connection to slide on it lengthwise. From Fig. 3, which shows the saddle details, it will be seen that the motion of the vertical shaft mentioned is transmitted through two horizontal toothed wheels C, D to a group of three mitre wheels E, of which the two side wheels revolve loosely on a common spindle, while the top wheel is keyed to the larger toothed wheel already mentioned. An ordinary clutch between the two side mitre wheels permits either to be utilised for driving the tool spindle, and thus allows for reversing the direction of rotation. Motion is transmitted from the upper spindle to the tool spindle through either of two series of toothed wheels F, G, the choice being controllable by a clutch on the main tool spindle itself. As shown on the engraving, the left-hand train of wheels would be employed for slow speeds, such as are required for heavy cutting, tapping, &c.; while for the quicker speeds required for drilling, withdrawing taps and other operations, the right-hand train would be used. The spindle itself, which is of 3½in. diameter, works in a sleeve H, which revolves with it, and on which the clutch, toothed wheels, &c., are mounted, driving connection being made between the sleeve and spindle by means of a key J and a keyway cut in the latter. Wear on the spindle is thus considerably reduced. Means are provided for mechanically feeding the spindle forward or backward, for quickly adjusting its position by hand and for slow hand feed. The mechanical feed is driven from a three-step cone K, mounted on the sleeve of the tool spindle; from this a belt drives on to a similar cone Z on a spindle working in journals formed on the top of the saddle. Two sliding toothed wheels M, controlled by a lever N, are mounted on this shaft, and either, or neither, can be brought into mesh with two corresponding wheels P keyed to a parallel spindle lower down. The end of this last-named spindle passes outside the saddle casting, and has mounted on it a worm Q, which in turn meshes with a worm wheel R. This worm wheel revolves loosely on a small spindle on which is mounted a clutch, which can be meshed with the worm wheel and thus cause the shaft to revolve; a second worm S and a hand wheel T for slow hand feeding of the spindle are also provided. The second worm drives a worm wheel mounted on—but capable of being easily disconnected from—a shaft U passing through the saddle parallel with the tool spindle. This shaft can be turned by means of a star handle V and mitre wheels so arranged as to give a quick horizontal adjustment to the tool spindle. Connection between the tool spindle and the last-named shaft is made through mitre wheels and a short vertical shaft with a pinion W mounted on its lower end;

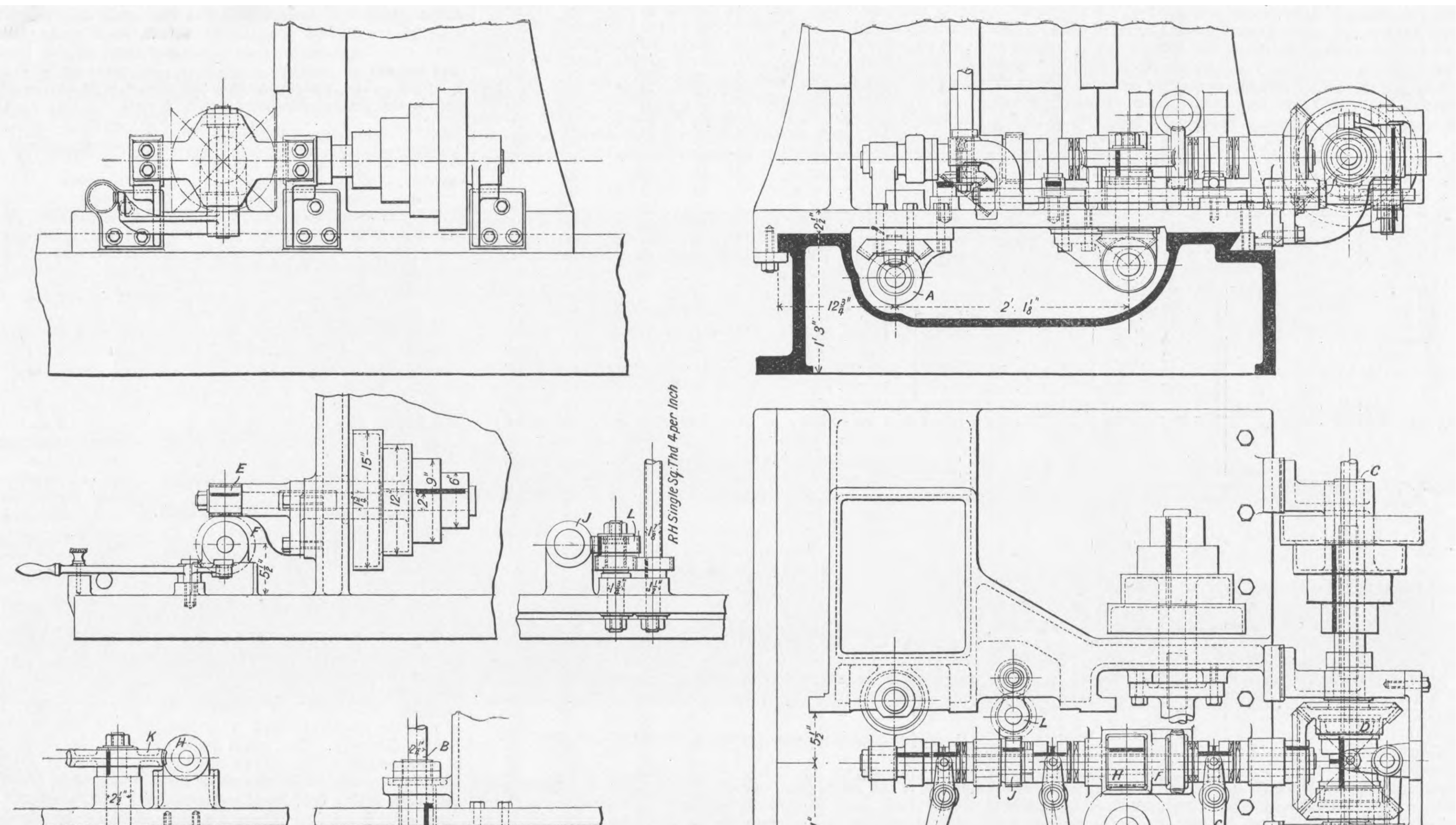
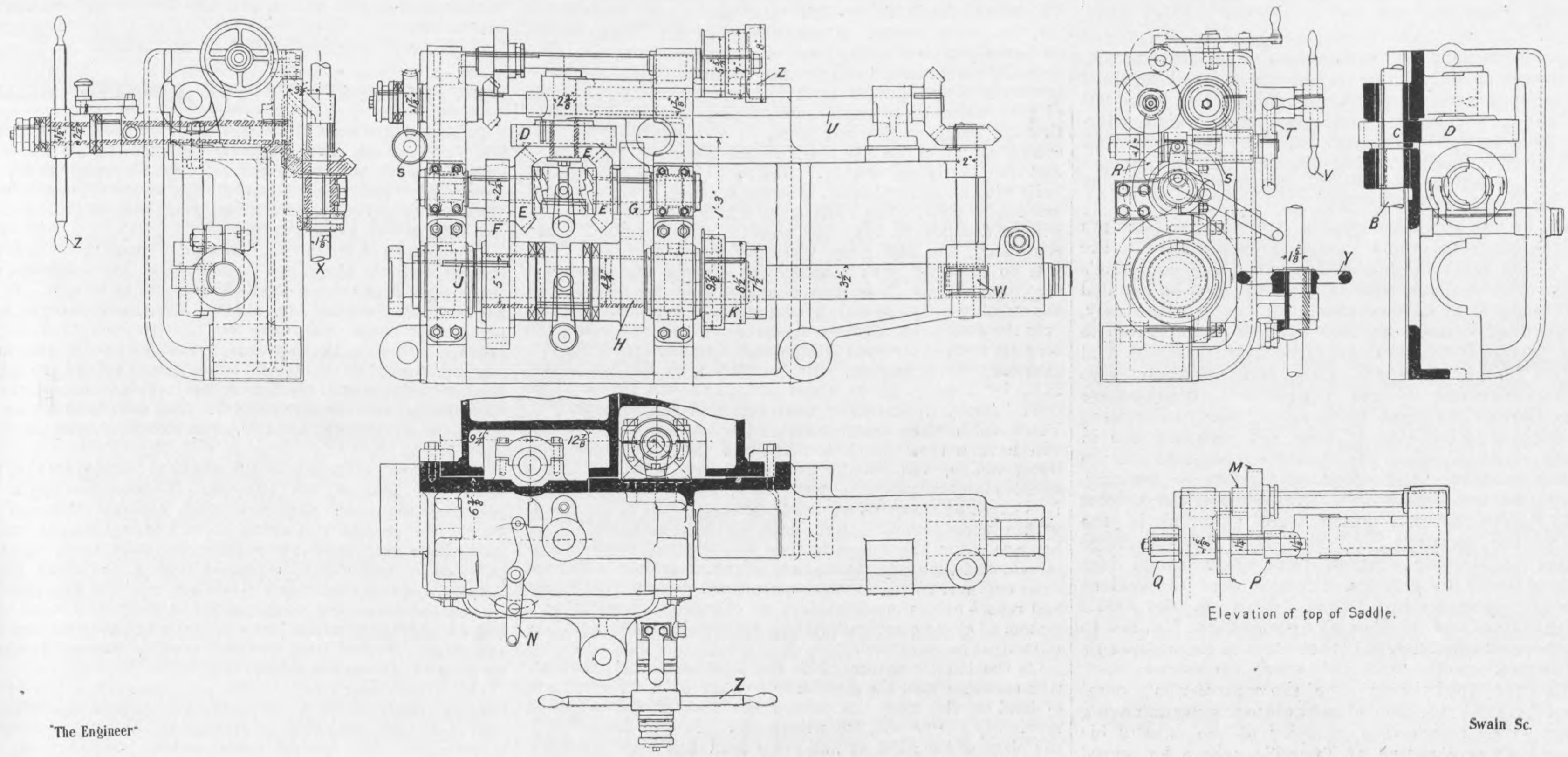

E
F
J
L
R.H. Single Sq. Thd 4 per Inch
K
H
R.H. Sq. Thd 2" Pitch Triple
B
A
C
D
N
M
G
P
2' 1¼"
12¾"
1' 9"
5½"
1' 1"
Horiz! Traverse Mitres
Driving Bevels under Column
"THE ENGINEER"
SWAIN Sc.

Fig. 2-GENERAL ARRANGEMENT OF THE FEED MECHANISM

HORIZONTAL BORING, DRILLING, AND MILLING MACHINE

LOUDON BROTHERS, LIMITED, JOHNSTONE, ENGINEERS



"The Engineer"

Swain Sc.

Fig. 3—DETAILS OF THE SADDLE

this pinion works on a rack formed on the side of the tool spindle. It will be seen that by means of the three-step pulley K and the gear wheels M six changes of speed of horizontal feed can be obtained. The total traverse is 42in.

Coming now to the feeds required for milling, the vertical motion is obtained by direct upward or downward movement of the whole saddle, while the horizontal motion involves the motion of the entire column. Both these motions can be given by hand or mechanical power, the devices adopted for these being, perhaps, the most interesting part of the whole machine.

The mechanical milling feeds derive their motion from a shaft mounted on brackets at the rear of the machine, and driven by belt from the motor. This shaft is provided with a keyway running its whole length, and it passes through a steel sleeve C—Fig. 2—on which are mounted a four-step cone and a mitre wheel. Brackets fixed to the rear of the base of the upright carry this sleeve, pulley, &c. To make connection between the driving shaft and the sleeve a friction clutch D is provided, and for reversing purposes this clutch can be thrown into gear with another mitre wheel, which drives the sleeve through the first-named mitre wheel and a third. Motion is taken from the four-step pulley to one corresponding, mounted on a short spindle at the base of the upright, and parallel with the feed driving shaft. This spindle drives through a worm E on to a worm wheel F running loose on a shaft journalled at the base of the upright, and lying at right angles to the former. A clutch G serves to connect in the usual way this worm wheel and shaft when desired. From this shaft motion both for traversing the column and saddle and for feeding the milling cutter is taken. For these purposes there are two worms H, J running loose on the shaft, and each working on to a worm wheel K, L. Clutches M, N again are provided for connecting these worms with the shaft. One worm and worm wheel H, K drive down on to two mitre wheels beneath the base of the upright and give horizontal motion to the column and feed to the cutter by means of a screwed shaft and nut, the nut being formed in the inside of one of the mitre wheels. The other worm wheel gears on to a vertical screwed shaft X—Fig. 3—which passes through a nut formed on the saddle, thus giving vertical feed and adjustment. It will be seen from the engraving of the clutch shaft details that, to set the vertical or horizontal milling feed—of which there are four speeds for each spindle speed, obtainable by means of the stepped cone—the operator first has to throw the right-hand clutch G on the clutch shaft into gear, thereby giving the shaft rotational motion, and then either of the other two clutches N, M, the one on the left if vertical motion of the saddle be desired, the middle one if the column is to be traversed. The friction clutch D controlling the starting, stopping and reversing of whichever milling feed is being used is worked through a sector arm P—Fig. 2—and horizontal and vertical shaft from a hand wheel Y—Fig. 3—attached to the saddle and movable with it. Thus these movements can be accomplished without necessitating the operator's leaving the platform. With the friction clutch open the feed movements, as already stated, can be controlled by a star hand wheel Z—Fig. 3—on the saddle, the one wheel serving for either motion, as will be seen from the figure. Thus either the inner or outer shaft, and in conjunction therewith the inner or outer set of bevel wheels respectively, can be given rotation according as the left-hand or right-hand clutch is used. In the figure the handle is shown out of gear for power feeding. The outer bevels, giving vertical motion to the saddle, work on to the screwed shaft X in a nut and bolt fashion, while the inner, giving traverse to the column, use the screwed shaft as a spindle and transmit through a key and keyway running the length of the shaft, motion to the clutch shaft at the base of the column and thence through the worm wheel, &c., H—Fig. 2—to the horizontal screw. When milling is being done it is necessary to lock the spindle securely against motion forwards or backwards, and for this purpose a suitable device is provided.

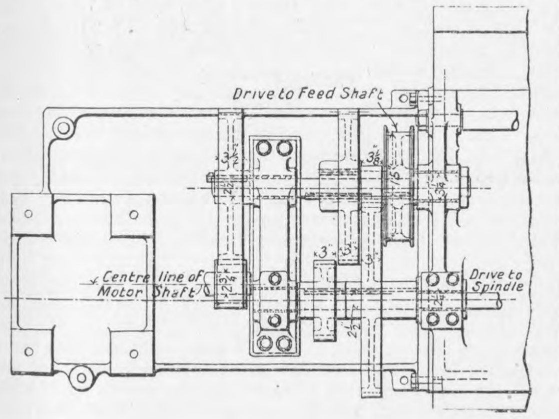


Fig. 4—DETAILS OF THE ELECTRIC DRIVE

The motor driving the machine is one of 10 brake horsepower and drives through gearing with raw hide pinions—see Fig. 4—both the shaft giving rotation to the spindle and the feed shaft at the back of the machine. Taking advantage of the change of speed which can be obtained by regulation of the current supplied to the motor in addition to the change speed gear, there is a full range of speeds of rotation of the spindle of from 3 to 320 revolutions per minute.

SHIPBUILDING NOTES.

AT the time of writing, the Institution of Engineers and Shipbuilders in Scotland and the North-East Coast Institution of Engineers and Shipbuilders have just concluded their joint meetings at Glasgow, and the unanimous verdict of those fortunate enough to have been present is that the meetings, themselves largely in the nature of an experiment, have been a great success. For this success there are many reasons, the principal of which, perhaps, is that no better place for meetings of this kind could be imagined than this sombre northern city. The river is thickly dotted with shipyards, and within easy distances by train or tram are engineering and other works of a widely diversified character—steel works, roof and bridge-building works, and mechanical and electrical engineering establishments. Another reason is that the secretaries of the respective Institutions appear to have a most admirable conception of the lines on which a summer gathering should be run. The mathematician, with his painful flight into the regions of the speculative, has been conspicuous by his absence, and the papers read have been characterised by an appeal to popular interest and to the practical difficulties and problems of the audience.

ON Wednesday, 5th August, the meetings opened in the new premises of the Scottish Institution in Elmbank-street, and it was a matter of universal regret that Mr. Ward was prevented from taking the chair on that occasion by indisposition. Mr. C. P. Hogg, however, admirably filled his place, and read the address which had been prepared by Mr. Ward. The address, which was largely retrospective in character, emphasised the utility of meetings such as these by means of which interchange of ideas and experience could most effectively be achieved. After Mr. Summers Hunter had suitably replied, the members proceeded to the consideration of the two papers for the day. The first of these was by Sir Andrew Noble on the "History of Propellants," and the second by Engineer Commander Wisnom on "The Trials and Performances of the Otaki, Fitted with a Combination of Reciprocating and Turbine Machinery."

THIS latter paper had been very eagerly anticipated. In this column some time ago reference was made to the Otaki and to the Orari and Opawa, to which vessels she is a sister. Mr. Wisnom's paper set forth the comparative trial results of the Otaki, together with a statement of the vessel's performances on her first voyage to New Zealand and back. With regard to the measured mile trials it was stated that the Otaki, which was required to obtain a trial speed of 14 knots with 5000 tons deadweight on board, really attained a speed of 15 knots as compared with 14.6 knots by the Orari, and with a less water consumption. With regard to the service conditions, the coal consumption of the Otaki on the voyage from Liverpool to Teneriffe worked out at 11 per cent. less than that of the sister vessel at the same speed, the average speed for the round voyage being about 11 knots. For the round voyage it appeared the Otaki's coal consumption was about 8 per cent. better than that of the sister vessel, and the author explained this reduction by certain adverse circumstances not connected with the machinery, as, for instance, the state of the ship's bottom. The longest non-stop run made was 11,669 miles, during which the machinery worked satisfactorily. It will be seen from the above that the figures given are somewhat meagre in respect of all the information one might desire to have effectively to compare two types of machinery, and moreover leave a little to be desired in the matter of consistency. Neglecting, however, these elements, it would appear that, broadly speaking, as stated here previously, a gain of 10 per cent. is secured by the adoption of recipro-turbine machinery in vessels working under similar conditions to the Otaki, and that this gain will be subject to variation depending upon the actual conditions. Short runs, with much harbour work, for example, might cause it to disappear altogether. Assuming this increased economy of 10 per cent., it appeared that the most pertinent contribution to the discussion came from Mr. W. B. Morrison, of Hartlepool, who raised the very significant point as to whether, in ordinary cargo vessels of moderate speeds, this gain would be a satisfactory set-off against the increased complexity of the machinery, and the extra demand on the intelligence—not already too high—of the engine-room staff. This appears to us to be a question which cannot yet be answered in the affimative. So far as the Otaki is concerned, however, the most effective comment on the general efficiency of the ship is, that the builders are to build a duplicate for the same owners.

ON the second day (Thursday) the papers were of a general interest. Dr. G. B. Hunter, associated with Mr. E. W. De Russett, read a paper on "Sixty Years of Merchant Shipbuilding on the North-East Coast," and Prof. J. H. Biles' paper (taken as read) was entitled "Fifty Years of Warship Building on the Clyde." Both of these were valuable and stimulating contributions—that of Dr. Hunter, concerned as it was with merchant shipbuilding, being especially so. His account of the working hours and pay of the old Sunderland shipwrights illustrates very vividly the change for the better which has taken place in the conditions of the shipbuilding industry. Prof. Biles' paper was an exhaustive *résumé* of the Clyde's contribution to his Majesty's Navy, and will be read with profit by those interested in the subject.

OUTSIDE the meetings in Elmbank-street there were the usual festivities of a public and private character. On Wednesday the members were entertained at a reception by the Lord Provost and Corporation of Glasgow, and on Thursday the British Corporation for the Survey and Registry of Shipping entertained the principal members at luncheon. There were also numerous expeditions to the engineering and shipbuilding establishments in the vicinity, of which advantage was fully taken. On the occasion of the visit to Parkhead Forge a prominent Scotch steel maker expressed surprise that the Admiralty authorities should experience difficulty in obtaining guns and armour when so much first-class plant was standing idle. Concurrently with this expression of opinion we notice with pleasure that Messrs. Wm. Beardmore and Co. have secured the contract for 1650 tons of armour plate for the new battleship Colossus, which is being built by Scott's of Greenock. We commence a detailed account of the meetings and visits in another column.

THE appointment soon to be made to the newly instituted Chair of Naval Architecture in Liverpool University will bring to completion a scheme long and carefully considered. With this appointment there will then be three fully endowed Chairs of Naval Architecture in the United Kingdom. It remains to be seen how far the Liverpool one will be successful in view of the relatively small amount of actual construction in the port.

OBITUARY.

THOMAS TURNER.

THE death is announced of Mr. Thomas Turner, managing director of the firm of Andrew Barclay, Sons, and Co., Limited. Mr. Turner had a wide and varied practical experience, and worked his way up from post to post, always steadily improving his position. He gained practical experience in engineering, not only at home but in India—an experience of foreign work which afterwards stood him in good stead. He also did good work for a time in journalism, being associated in the management of the *Mechanical World*, of which he acted as editor for about twelve months.

When he was appointed general manager of Barclays more than fourteen years ago, he threw himself into the work in the most whole-hearted way. The company's interests were ever foremost in his mind, and he handled the business as if it were absolutely his own property, and identified himself entirely with its interests. The purely technical matters which occupied a great deal of Mr. Turner's personal time and attention were the improvements of the design and manufacture of the Barclay standard locomotives; the modernising and bringing up-to-date of their old standard line in winding engines, so as to produce the best results in steam economy and speed, and safety in working. In the last connection Mr. Turner designed several special safety devices, which were patented in the name of the company, and have been fitted to large numbers of winding engines. The other special lines developed under his personal direction were the modern high-speed reciprocating pump known as the Oddie Barclay Patent and the Barclay drum-pattern fan, not to mention other smaller detail specialities of the company's manufacture.

Mr. Turner joined the service of the company as general manager on 1st April, 1895, afterwards becoming managing director, which position he occupied at the date of his death. He was a native of Tyneside, where he served his apprenticeship. He was a Whitworth scholar and a member of the Council of the Federated Mining Institute of Great Britain, and also of the West of Scotland Iron and Steel Institute. He was also a member of the Institute of Mining Engineers, of the Institution of Engineers and Shipbuilders in Scotland, and of the Institute of Mechanical Engineers. He was for some time back president of the Kilmarnock branch of the Engineering Employers' Federation. During his career he was successively steel works manager to Joseph Fenton and Sons, Sheffield; manager to Messrs. Nicholson and Wilson, Blaydon-on-Tyne; and works manager to the New British Iron Company, Corngreaves; and prior to his joining Barclays he was works manager of the Shelton Iron and Steel Company, Limited, Stoke-on-Trent.

NEWCASTLE QUAYSIDE IMPROVEMENTS.

THE Newcastle-upon-Tyne Corporation has for the past three years been actively engaged upon a comprehensive scheme of quay improvements and extensions, the amounts already sanctioned for which are £91,760 and £57,537 respectively. The first section of the improvement scheme includes the rebuilding of 22 yards of quay wall, opposite the Milk Market, and the building and equipping of sheds between the Milk Market and the Swirle, a distance of about 233 yards (£35,982); the provision of electric cranes, capstans, ducts, and cables (£6400); the paving of the quay between Broad Chare and the Ouseburn, a distance of 1116 yards, and the relaying of the old paving opposite the grain warehouse (£10,914); the remodelling of the railway between the swing bridge and the Ouseburn, a distance of 1473 yards (£27,123); and gas and water diversions, &c. (£8581). The rebuilding of the 22 lineal yards of quay wall aforementioned was completed in March, 1907, and progress has since been made with the other works. There will be shed accommodation over a length of 909ft. of quayside, comprising one 303ft. single-storey shed, varying in width from 20ft. to 66ft.; one 303ft. two-storey shed, with roof, 66ft. wide; and one 303ft. shed, 66ft. wide. These sheds are being fitted with a verandah 12ft. wide upon the land side, so that goods can be loaded under cover. The single-storey shed, the steelwork for which was supplied by John Abbot and Co., Limited, of Gateshead, has been completed, and the present equipment consists of one 5-ton portable electric crane, with a 40ft. radius, supplied by Cowans, Sheldon and Co., Limited, of Carlisle, and two 1-ton capstans, working at 100ft. per minute, supplied by C. and A. Musker, Limited, of Liverpool. The two-storey shed will be so arranged that the second storey will be connected to Sandgate by means of a bridge now being erected, so that by this means cart traffic will have direct access to the sheds, and the land adjoining Sandgate upon the north of the quayside will become of greater value for storage purposes. A contract has been let to Parkinsons', of Blackpool, for one of these sheds, as also for a steel girder bridge of 53ft. span, with approach works extending from the Milk Market to the first floor of the shed. On this portion of the quay the railways will consist of one line of rails between the shed and the river and two lines of rails on the land side of the sheds, and, in addition, the relaying of existing and the laying down of new sidings between the foot of Horatio-street and the Ouseburn has recently been completed. The points and crossings are of manganese steel, supplied by Edgar Allen and Co., Limited, of Tinsley. The section of the works now in hand is expected to be completed about the close of the year.

It is intended at an early date to take in hand the rebuilding, by monolith work, of the quay wall at the London wharf and various other sections, so as to give 25ft. below low water of spring tides, and also to provide up-to-date sheds and equipment between the grain warehouse and the Ouseburn. This involves the removal of the present sheds and the 80-ton hydraulic crane. With a view to coping with the congestion of traffic which will result when a commencement is made with this work, an extension to the quayside eastward of the Ouseburn was commenced in October, 1906. These works, estimated to cost £59,537, include provision of an additional berth 360ft. long, a new quay of 120ft. in length, and a heavy retaining wall at the northern boundary of the works, together with the construction of a new road connecting Burrell-road with St. Lawrence-road. The new quay is being constructed of a monolith wall 20ft. thick, carried down to a solid foundation so as to allow for 25ft. below low water of spring tides. The monoliths, 30ft. by 20ft., and spaced at distances of 2ft. 6in., were formed of concrete walls 5ft. thick, resting on a cast iron shoe in the form of a hollow rectangle. The monoliths were sunk to an average depth of 33ft. 6in. below low water of spring tides from temporary staging by means of grabs attached to cranes, and, owing to the clay passed through being exceedingly hard, it was necessary to blast continually, and use was made of as much as 600 tons of cast iron kentledge weights. The new quay walls are being built with an ashlar facing, concrete backing, granite coping, and fender piles. The 120ft. quay which faces the Ouseburn will be dredged to 12ft. low water of spring tides. When completed, the new quay will have a width of 145ft., and will be equipped with a double set of rails and warehouse accommodation. These new quays will be connected with the existing quayside railways by means of a low level bridge over the Ouseburn. This bridge, the contract for which has been let to the Cleveland Bridge and Engineering Company, Limited, of Darlington, will be carried on six monoliths, 22ft. by 15ft., sunk to about 31ft., and will have a single span 74ft. 6in. centres of bearings, and square span 55ft. There will be three heavy plate girders 7ft. deep. The bridge will have a total width of 62ft., and will carry two 30in. water mains, and smaller gas and water pipes, as also a double standard gauge railway track, and a 20ft. roadway. It is expected that this new quay extension will be completed within three months from date. The exact method of haulage upon the quayside has not yet been finally determined, and the Corporation have in the meantime instructed their engineer to visit several continental ports to investigate and report upon the advisability, or otherwise, of adopting a system of electric accumulator locomotives charged from the municipal power-house.

On the 4th December, 1907, the Newcastle City Corporation recommended the purchase of about 3274 square yards of land on the quayside beyond the area of the extension previously authorised, but within the limits of deviation of the plans of the 1904 Act, and this land has been acquired. The powers of the Corporation for the compulsory acquisition of land for the purpose of this Act expire on the 15th August, and the Trade and Commerce Committee of the Newcastle Corporation has had under consideration the desirability of acquiring certain portions of the remainder of the land authorised to be purchased by that Act for quay extension purposes, which will enable the Corporation to extend the quay for a length of 775ft. beyond the present extension when such extension is found to be necessary. At a special meeting of the Newcastle City Corporation held on Monday last, August 9th, it was decided to enter into negotiations for the purchase of this land, 8270 square yards, which, with a frontage of 223ft. to the river, is the property of Mr. T. G. Gibson, whilst another parcel of 5118 square yards, with a frontage of 136ft. to the river, belongs to T. and W. Smith, of the St. Lawrence Ropery. In addition to the foregoing, extensions have lately been carried out at the Newcastle Corporation pumping station on the quayside, and two 13in. turbine pumps, each driven by one of W. H. Allen, Son and Co.'s motors, capable of giving 135 brake horse-power, and two turbine pumps, each with branches 12in. diameter and developing 58 brake horse-power at 650 revolutions per minute have been installed. These are required for circulating water through the condensers in the municipal power station, which is situated a quarter of a mile away from the pumping station.

TESTS ON COMMUTATING POLES.

A METHOD of testing commutating poles of dynamos and motors so that they may be adjusted to give the correct strength at various loads in order to obtain sparkless commutation is described in a paper which was recently read before the American Institute of Electrical Engineers by Mr. John N. Dodd. It is stated that in the absence of facilities for making full load tests, it will be sufficient to adjust the auxiliary poles at the maximum current obtainable until the voltage between the two bars undergoing commutation is zero. Two metal points press on the commutator at one of the brushes. These contact points, which are a bar's thickness apart, are connected to a low reading voltmeter, and when this voltmeter registers zero the strength of the commutating poles is correct.

It is immaterial whether the machine is tested as a motor or as a generator, at full voltage or low voltage, or at full speed or low speed, provided that the results of calculation and of experiments with other similar machines make it certain that the cross section of the auxiliary poles is ample to carry the flux corresponding to the flux of the armature, self-induction at the extreme overloads to which the machine will be subjected. If in a generator under test the voltage of a bar under the trailing half of the positive brush is higher than the voltage of the preceding bar, the pole is too weak and more current is required in the auxiliary coil. If the voltage of this bar is lower than that of the preceding bar, it indicates that the pole is too strong. When the two bars have the same voltage—that is, when the volts per bar is zero, the pole is of the correct strength. Measurements can be made with a direct-current voltmeter with a maximum reading of 3 to 5 volts. It should be noted that this voltage should be measured under the centre of the brush, or between bars equi-distant from the centre.

As an example of the accuracy of this method of adjusting a high capacity machine at low currents, the author mentions a machine adjusted by him for no volts per bar under a load of 200 ampères. With the same adjustment the machine was able to carry 10,000 ampères very satisfactorily. If there is any danger of saturation under maximum conditions, a saturation curve of the auxiliary pole is desirable. With zero volts per bar under the brush, the auxiliary pole flux is exactly equal to the armature flux. The armature flux varies directly as the armature current. Therefore, if a series of readings are taken of armature current and the corresponding auxiliary pole current necessary for zero volts per bar, a curve plotted from these readings is the saturation curve of the auxiliary pole. Such a curve is of great value for checking the original calculations, and of particular value when it is necessary to supply new coils or poles, or both.

It shows the exact point at which even a slight degree of saturation is approached, and therefore the correct size of the new poles and the number of turns necessary on the coils at light loads, and hence on the new coils at all loads. A method of taking this saturation curve is illustrated where a low voltage separately excited booster is connected directly across the auxiliary pole coils of the machine. An ammeter is connected in this circuit, and also one in the main armature circuit.

NEW REGULATIONS FOR TINNING METAL.

IN accordance with the report made by the Commissioner, Mr. E. T. Lawes, after a public inquiry held in February and March of this year, the Factory Department of the Home-office has recently issued regulations relating to the operation of tinning various metal goods such as hollow-ware, iron drums, and harness furniture.

The coating of metal articles with a mixture of tin and lead or with tin alone has been certified as dangerous, and these regulations have been issued in pursuance of the Factory and Workshop Act of 1901. With one exception the regulations come into force on October 1st, 1909. This exception provides that all tinning shall be carried out under efficient draught, the latter term being defined to mean localised ventilation effected by heat or mechanical means for the removal of fumes or dust. The date from which the operation of this regulation will take effect is deferred until April 1st, 1910.

In addition to the above the duties of employers are prescribed to include the provision of lavatories with the necessary requisites, and of a room, separate from any in which the process of tinning is carried out, in which the workpeople may have their food—no such room need be provided if the works be closed during the meal hours. Persons under sixteen years of age are not to be employed in tinning, although the employment of women is now sanctioned. The skimmings from the dipping-bath and the dust and refuse collected from the floor must be removed from any room in which work is carried on.

Provision is also made for the periodical inspection of the persons employed by a duly qualified medical practitioner, who shall have the power of suspending them from engaging in tinning. The fees for these medical examinations and duties arising out of them are to be met by the employers as is prescribed in the Act of 1901.

The duties imposed by the new regulations on the workpeople include that of washing the hands before partaking of food or leaving the premises, and the preparation or consumption of any food or alcoholic drink in any room in which the process of tinning is carried out are prohibited.

It is not intended that these regulations should apply to any process of silver-plating or any in which a soldering iron is used. Further, the Chief Inspector of Factories is empowered to exempt from these regulations, by a written certificate, any process which he may adjudge as not requiring their enforcement on the ground of the infrequency or intermittency with which the operations are carried on.

HULL COAL TRAFFIC.

THE return of the Hull Chamber of Commerce and Shipping for July shows that the weight of coal received at the port during that month was 562,224 tons, as compared with 525,168 tons in July of 1908. The increase on the month is therefore 37,056 tons. For the seven months the weight forwarded to Hull was 3,268,288 tons, as compared with 3,461,632 tons for the corresponding period of last year. The difference, being a decrease of 193,344 tons, is accounted for by the smaller trade passing in the earlier months of the year. Denaby and Cadeby Main, as usual, head the list of contributing collieries with 120,488 tons, against 72,616 tons for July of last year; Hickleton comes next with 29,304 tons, against 19,680 tons; and Manvers Main is third with 28,456 tons, against 23,280 tons. Among other leading consignments during the month were:—Carlton Main, &c., 23,440 tons, against 35,896 tons; Brodsworth, 17,400 tons, against 8320 tons; Thorncliffe, 16,728 tons, against 8136 tons; Birley, 16,520 tons, against 11,896 tons; Dalton Main, 14,560 tons, against 11,864 tons; Staveley, 13,144 tons, against 7112 tons; Acton Hall, 10,856 tons, against 9800 tons; Elsecar, 10,424 tons, against 11,864 tons; Allerton Main, 10,304 tons, against 3648 tons. The export trade from Hull for the month amounted to 344,970 tons, compared with 300,558 tons for July of last year; for the seven months, 1,699,786 tons, compared with 1,550,801 tons for the corresponding period of last year. There is thus an increase on the month of 44,412 tons, and on the seven months of 148,985 tons. The principal foreign market was North Russia, which took a weight for the month of 114,934 tons, compared with 100,371 tons for July of last year; for the seven months, 349,456 tons, compared with 332,299 tons. Sweden is second with 43,701 tons, compared with 39,915 tons; for the seven months, 215,841 tons, compared with 211,551 tons. Germany is slightly under Sweden for the month—43,125 tons, compared with 32,572 tons—but for the seven months shows 260,617 tons, compared with 248,003 tons. Holland is close up on the month with 42,292 tons, compared with 32,314 tons, while for the seven months it is an easy second—281,433 tons, compared with 248,003 tons. Austria shows the most remarkable advance—6188 tons last month, compared with 931 tons for July of 1908; for the seven months, 61,286 tons, compared with 8859 tons. France on the month declined to 5707 tons from 25,053 tons, and for the seven months to 73,462 tons from 127,044 tons. Denmark advanced to 14,279 tons from 10,751 tons, but decreased on the seven months to 61,882 tons from 69,543 tons. Italy advanced to 12,567 tons from 4308 tons, for the seven months to 52,902 tons from 40,584 tons. Belgium decreased to 6548 tons from 6868 tons; for the seven months, to 44,305 tons from 50,591 tons. Norway increased to 5249 tons from 3100 tons; for the seven months, to 26,410 tons from 20,224 tons. Egypt increased to 18,800 tons from 16,660 tons; for the seven months to 96,666 tons from 55,722 tons. Another increasing market was South America, which took last month a weight of 22,455 tons, against 14,503 tons for July of 1908; for the seven months, 117,490 tons, against 98,561 tons. Turkey showed a decrease on the month to 2412 tons from 5157 tons, and on the seven months to 15,539 tons from 18,839 tons. Coastwise shipments amounted to 75,117 tons for July, and for the seven months to 485,949 tons.

RAILWAY MATTERS.

The Sudan is said to be developing steadily and satisfactorily. New parts of the country are fast being opened up through the railways and telegraphs. The great bridge over the Blue Nile at Khartum is practically completed, and the railway has been continued 70 miles south, as far as Pass Kamber, in Ghezireh. Thence it will run south and west to the White Nile. At Hallat Abbas, on the Blue Nile, 180 miles south of Khartum, a big railway bridge is in course of construction. It should be completed by the end of next year, at which time the railway is expected to reach there also.

A sum of about £240,000 was paid in 1908 by the Finnish Government to the Russian Treasury as the contribution of the Grand Duchy towards constructing a bridge over the Neva in St. Petersburg, with a view to establish a connection between the terminus of the Finnish railways and a Russian station, and thus to facilitate traffic between Russia and Finland. The Finnish railways are not able to carry the same weight as those of the Russian, and it has hitherto been necessary to have all goods unloaded and re-loaded in St. Petersburg. When the connection is made this will be avoided, probably to the great benefit of both parties.

The total length of the State railways in Sweden amounts to 4345 kiloms. (2698 miles). Their value is given as representing a capital of 518,882,880 kr. (£23,826,826), with an increase during the year of 19,600,000 kr. (over £1,000,000). Materials and supplies are estimated as worth about 15,800,000 kr. (£877,777). During the year 1908 gross receipts amounted to 64,300,000 kr. (£3,572,222). Of this sum about 57,300,000 kr. (£3,183,333) were expended on running and maintenance costs, 3,100,000 kr. (£172,222) for increase of materials, 500,000 kr. (£27,777) for tools, &c., and 4,700,000 kr. (£261,111) were paid into the State Treasury.

It is reported that the Swedish Riksdag has asked for renewed experiments to be undertaken in order to investigate the question of coal and peat used as fuel on railways, and new trials are now to be made. Between Elmhult and Alfvesta there will be run a special train, consisting of fifty wagons, loaded with coal and peat. This train will be running for a fortnight between the two places, using alternately as fuel English steam coal, peat and steam coal in different proportions, and peat only. There will also be used different types of locomotives. The results of the experiments are looked forward to with great interest, especially by those who are connected with the peat industry.

Presiding last Tuesday at the half-yearly meeting of the Great Northern Railway Company, Lord Allerton made reference to the continued loss on first-class traffic. The whole tendency, he said, was to show that more and more people were travelling third-class. That was due not only to the cheaper fares, but to the constantly increasing luxury which railway companies provided for third-class passengers. He did not know whether the time would ever come when they would only have one class, but he confessed that he hankered very much after trying some third-class trains for suburban traffic. First-class carriages were expensive to construct, expensive to haul, and were seldom occupied except at holiday times. He was sure something would have to be done, and the question was under consideration.

A consular report, in dealing with the Shanghai-Nanking Railway, states that the through service to Nanking was formally commenced on March 31st, 1909, and the line has been well patronised as far as passenger traffic is concerned. Trouble has been caused on various occasions by the stoppage of trains by villagers, in order to claim compensation for the death of or injury to some irresponsible Chinese who was trespassing on the permanent way, or who did not exercise due caution at a level crossing. The authorities have displayed regrettable lack of energy in preventing and punishing outrages of this kind. No freight worth mentioning was carried by the railway during 1908, as the arrangements had not yet been made with regard to the collection of likin or its substitutes.

At a meeting of the London County Council on July 27th, the Highways Committee recommended that parliamentary sanction should be sought during the session of 1910 for the construction of several new lines of tramways. In addition to the seven new lines, which are as follows:—Marble Arch to Harrow-road, Harrow-road to Cricklewood, Chalk Farm to Child's Hill, Seven Sisters'-road to Hanley-road, Herne Hill Station to Brixton Hill, Putney Bridge to Wandsworth, and Wood-lane to Harrow-road, it is intended that powers should also be sought for the construction of several small connecting lines intended to improve the working of the existing system. Altogether, the proposals involve an expenditure of about £417,000, excluding the cost of cars, car sheds, sub-stations, &c., while the total length of the new lines will amount to about 24 miles.

It is reported that the Western Railway of France has obtained authority from the Government to electrify its lines. A commencement is to be made with the lines which run from the St. Lazare Station in Paris to Argenteuil and Saint-Germain-en-Laye. Special tracks will be laid, so that the service can be effected without any interference with the steam-driven trains. Sub-stations will be erected which will supply continuous current at 600 volts. It is anticipated that from 12 to 20 trains, composed of a maximum of six double carriages 20 metres long, can be run per hour. It is estimated that the permanent way, equipment of line, &c., will cost £1,160,000; that the rolling stock and converter stations will cost £800,000; and that interest on capital and other expenditure will bring the total amount to £2,280,000 for the 33.5 kilometres of line to be constructed.

Direct communication with the centre of the city is to be made on another route of the Birmingham Corporation tramways system. Alterations are being carried out at Rea-street which will enable such of the Moseley cars as are put on the new service to turn off from Bradford-street and proceed *viâ* Deritend and Moor-street into High-street, as an alternative to the existing terminus in Hill-street. It is not at present contemplated to provide through communication between Moseley and Washwood Heath, in the same way as between Sparkbrook and Washwood Heath, and small Heath and Nechells, although the advantage of the new arrangement to those who wish to proceed from Moseley to the eastern side of the city will be obvious. It will also have the advantage of relieving the traffic in Station-street to some extent. The necessary junctions will be ready in about a month's time.

On Tuesday of this week a very peculiar accident, believed to be due to the expansion of the rails by heat, occurred on the London and North-Western Company's line between Huddersfield and Stockport, near the wayside station of Friezland, on the Yorkshire and Lancashire border. The train, which left Huddersfield at 9 20, was not timed to stop until it arrived at Stockport. Shortly after it had passed through Friezland Station at a speed of 50 miles an hour the passengers noticed that something was wrong. All the three coaches of which the train was composed began to rock violently, and shortly afterwards the engine left the metals, swinging completely round as it did so, and finally lodging, after travelling about 200 yards, alongside the up main line. The first of the three coaches went forward with one end partially ripped off. The two rear coaches were thrown on the down line. Fortunately, all three remained on their wheels, for had they not done so the thirty occupants must have been injured much more seriously than they were. It is reported that the funnel of the engine was afterwards found thirty yards away from the engine itself, which was a complete wreck. The driver and fireman were both killed.

NOTES AND MEMORANDA.

It is reported that Mr. Orville Wright has stated that he is completing the perfecting of his aëroplane. He considers the machine will soon be in daily use, and available to everyone, both as regards price and working.

A good example of the economy often accomplished by chemical investigation and discovery is furnished in the case of ultramarine. Many years ago when this was made by powdering the mineral lapis lazuli, it sold for more than its weight in gold. Now that the chemist has discovered how to make the same material from such cheap substances as kaolin, sodium sulphate and carbonate, charcoal, sulphur and rosin, the price is only a few pence per pound.

The *Engineering Record* states that bonding new and old concrete can be accomplished in the following manner:—Clean the surface of the old concrete with clear water and a stiff broom. Apply a mixture of one part of hydrochloric acid and three parts of water with a brush, making several applications one after the other. Then scrub the surface with clean water and a stiff brush until all the acid is washed away and the surface is perfectly clean and free from loose particles. While it is still wet apply the fresh concrete, and keep the new concrete damp for at least a week, being careful not to allow it to become dry at any time.

During the six months ending June 30th, Great Britain exported iron and steel and manufactures thereof to the value of eighteen and one-third millions; other metals, four millions; cutlery, hardware, &c., nearly two and a-half millions; machinery nearly fourteen millions; and ships, three and one-third millions. Our exports of iron and steel and manufactures thereof for June amounted to £3,073,091; of other metals to £632,876; of cutlery, hardware, &c., to £422,424; of machinery to £2,304,092; and of ships to £506,351. The total British exports for June amounted to £29,717,975. The total value of exports from the United Kingdom during the six months ending June 30th was £176,934,350.

The June number of *Terrestrial Magnetism and Atmospheric Electricity* contains a frontispiece showing the magnetic survey yacht Carnegie under full sail, and an article describing her construction and the work she is intended to do. She has a displacement when fully equipped of 568 tons, and is built almost without iron, her bolts and metal fittings being of bronze, copper, or gun metal. The observation rooms are amidships. The yacht is to make a magnetic survey of the oceans during the next fifteen years, with the object of correcting the magnetic charts and compass data at present available. Her first voyage will be to Hudson Bay and the North Atlantic Ocean.

The smelter production of lead in the United States in 1908, as given by C. E. Siebenthal, of the United States Geological Survey, under the date of May 24th, was 408,523 tons of 2000 lb., against 442,015 tons in 1907, and 418,699 tons in 1906. The production of refined primary lead, which embraced all desilvered lead produced in the country, and the pig lead recovered from Mississippi Valley lead ores, was 396,433 tons, against 414,189 tons in 1907, and 404,669 tons in 1906. The antimonial lead produced was 13,629 tons, and the recovered or secondary lead 18,283 tons. In 1908 the lead smelted from domestic ores was 310,762 tons, and from foreign ores and foreign base bullion—almost wholly Mexican—97,761 tons.

In connection with the design of certain special towers in wireless telegraphy, in which numerous guys, together with the tower, act as an aërial capacity, the necessity arose of finding a quick method of determining the sags and tensions in the guys at different temperatures. The author of an article in the *Electrical World* obtains a simple cubic equation from which the sag can be readily determined. A numerical example is worked out completely to illustrate the method. It is shown how the wind pressure can be taken into account, and useful practical diagrams showing how the wind pressure varies with the velocity of the wind are given. The effect of a coating of ice on the wires is also discussed. This coating is usually elliptical in section.

Volt scales for indicating the voltage to produce a desired candle-power have been used on photometers in many glow-lamp factories, as the public demand only a few candle-powers, but considerable latitude in the voltage. It would be extremely convenient to be able to ascertain the voltage required to produce the correct watts per candle by a direct reading, and if possible the corresponding watts or c.p. at the same time. A volt scale meter, described in the *Electrical World*, accomplishes this object. A watts-per-candle or "specific consumption" meter, designed by Hyde and Brooks, is part of the photometric equipment of the Bureau of Standards. Tables are calculated so as to reduce the labour required to find the "3.1-watt" voltage. The author of the article referred to diminishes this labour by using a volt scale on which the data given in the tables are indicated at once. It is shown how to combine a volt scale and a watts-per-candle meter so as to be able to read from one setting (1) the voltage to give a certain specific consumption, and (2) the c.p. or watts at that voltage.

Large-scale experiments on the underflow or sub-surface flow of water through saturated sand or gravel are being made by the United States Reclamation Service in the Arkansas Valley, Western Kansas. After a search and tests to find a supposedly heavy underflow a row of wells was sunk across a valley near Deerfield, Kan., and pumps were erected there. A Press bulletin issued by the Service states that the wells and pumps lowered the water plane 19ft. or 20ft. below the river level; also that during the latter part of 1908 the wells began to weaken materially, the total amount of water removed being 10,000 acre feet; that is to say, enough to cover 1000 acres 10ft. in depth, or sufficient to irrigate, say, 4000 acres. By April, 1909, the gravels had become filled again on the north side of the river, but in the valley on the south side the "underflow" was not sufficient to restore the amount pumped during the preceding year. During 1909 the pumps lowered the underflow much more rapidly than in 1908. Part of the wells, or groups of wells, are allowed to stand idle in order to recuperate while the others are being pumped. It is hoped that by this system as much water can be obtained in 1909 as in 1908. The experience, however, shows that the so-called underflow, even where best developed, is not a very reliable source of supply on a large scale.

An American has just patented in this country an invention for the manufacture of artificial nitrates. It is claimed that nitrate of lime can be produced at a cost of about £4 14s. a ton, the market price of Chili saltpetre being about £9 15s. a ton. Until now the principal attempts that have been made to fix atmospheric nitrogen may be classed as (1) processes in which atmospheric nitrogen is burnt to nitrous or nitric acid; and (2) processes in which atmospheric nitrogen is combined by means of carbides, obtained by fusing together in an electric furnace metals or metallic oxides and carbon. The cost of the nitrogen so obtained has been comparatively high, except where power can be obtained from waterfalls at a very low cost. The patent referred to above describes a process and apparatus by means of which sulphur may be burned on a commercial scale so as to remove all the oxygen from the stream of air supplied for its combustion. By this means, it is claimed, nitrogen of great purity can be obtained, and the inventor says that in practice he has rejected all nitrogen-gas which did not reach a purity of 99.6 to 99.8 per cent. Also by placing iron filings in the receiver for a few days the .2 of oxygen may be removed, leaving absolutely pure nitrogen. Cyanide of potassium can, it is claimed, also be produced at a cost of about 8½ cents a pound, the market price being about 22 cents per lb.

MISCELLANEA.

In a printed reply to Mr. Ginnell, Mr. Winston Churchill says he understands that the Royal Commission on Canals propose to report first on British waterways, and expect to do so before the end of the year. They hope to report on Irish waterways in the early months of next year, and, until the report has been received and considered, no statement as to possible future legislation can be made.

On the 9th July, the necessary material for the wireless station was landed at Kingston, Jamaica. The station will have a range of 300 miles by night and 200 miles by day. Great interest is being manifested in Jamaica in the new station, and some of the steamship companies trading in the Caribbean are having their steamers fitted, so as to be able to get into touch with the island as soon as possible. Most of the vessels in the West Indies are fitted with the De Forest system.

The parallel operation of hydro-electric plants connected by about 500 miles of 44,000-volt three-phase circuits is carried on in Utah and Idaho by the Telluride Power Company. The five generating stations have capacities of 18,000, 3000, 3200, 6500, and 10,800 horse-power respectively, and connected with them are seven sub-stations. All stations are, or soon will be, connected by at least two separate lines, and are so designed that the development of power does not interfere with the use of the water for irrigation.

The *Bulletin Commercial* (Brussels) of July 17th contains a long article on the electrical industry in Servia. The report draws attention to the good openings in that country for electric lighting and kindred appliances, and to the necessity not only for supplying articles of good quality at reasonable cost, but also for developing the market on the spot by means of personal visits. The establishment in Servia of a depôt where electrical material could be seen by persons interested would, according to this report, be the most efficient way of rapidly increasing business.

The use of lignite as fuel in generating stations, states the *Electrical Review*, is increasing in Germany, where stations continue to be erected in the vicinity of lignite deposits, or the electricity companies purchase the mines or lease the production. Combinations of lignite mines with power stations already exist in the Weissenfels district, at Helmstedt and Schwandorf in the Upper Palatinate, and the Electricity Supply Company of Berlin has now arranged with the Hercules Brown Coal Company, of Zittau-Hirschfeld, for the supply of lignite for the overland central station to be erected in Oberlausitz.

About the end of March, 1909, the Imperial Don-Kuban-Terek Agricultural Society, Russia, circularised some fifty United States agricultural machinery firms, stating that they had decided to organise at Rostoff-on-Don an experimental farm for testing farm machinery and implements by scientifically arranged experiments. With this object the Nahitchevan town council had given the society 50 dessiatines (135 acres) of land, on which the society intends to erect the necessary buildings and appliances. For this invites subscriptions on the ground of the benefit which the manufacturer is likely to derive from these tests.

Bolivian purchases of mining machinery depend on the development of the tin, silver, copper, and gold mines. The introduction of modern machinery is likely to be the result of the railway building which is now going on, since this will reduce the expenses of transportation, and render accessible regions in which heretofore the mines have been worked after the old methods and with limited means, on account of the very heavy charges incurred in carrying the products of the mines. According to the United States special agent in Bolivia, the tin mines are likely to furnish the best market. The Bolivian production in 1907 was approximately 16,000 tons of pure tin, slightly less than for the previous year.

A Paris correspondent of the *Times* states that a law has just been promulgated in the *Journal Officiel* prohibiting the use of white lead. The terrible ravages caused by plumbism in the manufactories of this article and among painters and other workpeople who use it have for a long time excited public notice. The question has been debated at great length in Parliament for upwards of five years, owing to the defensive measures adopted by manufacturers engaged in the white lead industry. The present law enacts that, after the expiration of five years, the use of white lead, or of paint composed of linseed oil and white lead, and of all special compounds containing white lead in any form, shall be prohibited for every description of painting work.

The coating of metal articles with a mixture of tin and lead, or lead alone, having been certified under the Factory and Workshop Act, 1901, to be dangerous, the Home Secretary has drafted a series of regulations which are to apply to all factories and workshops where tinning is carried on in the manufacture of metal hollow-ware, iron drums, and harness furniture. It is specifically laid down that no tinning shall be carried on except under efficient draught; that no person under sixteen years of age shall be employed in tinning; and that no person employed in tinning, mounting, denting, or scouring shall keep or prepare or partake of any food or alcoholic drink in any room in which work is carried on. Periodical medical examination is to be insisted upon.

Blackfriars Bridge is now all but completed. Only the east half of the granite paving remains to be laid down, and the builders will be able to calculate the amount of bonus they will be entitled to from the City Corporation, estimated at the rate of £20 per day, for completing the work before the beginning of next year, the time specified in the contract. It is reported that Mr. Anderson, who is acting for the Corporation on behalf of the City Engineer, has stated that the work ought to be finished in the early part of next month, so that the bonus will amount to between £3000 and £3500. It will be the widest bridge in London, measuring 105ft. from parapet to parapet. The footways will be 16ft. wide, the remaining 73ft. being thrown into the roadway.

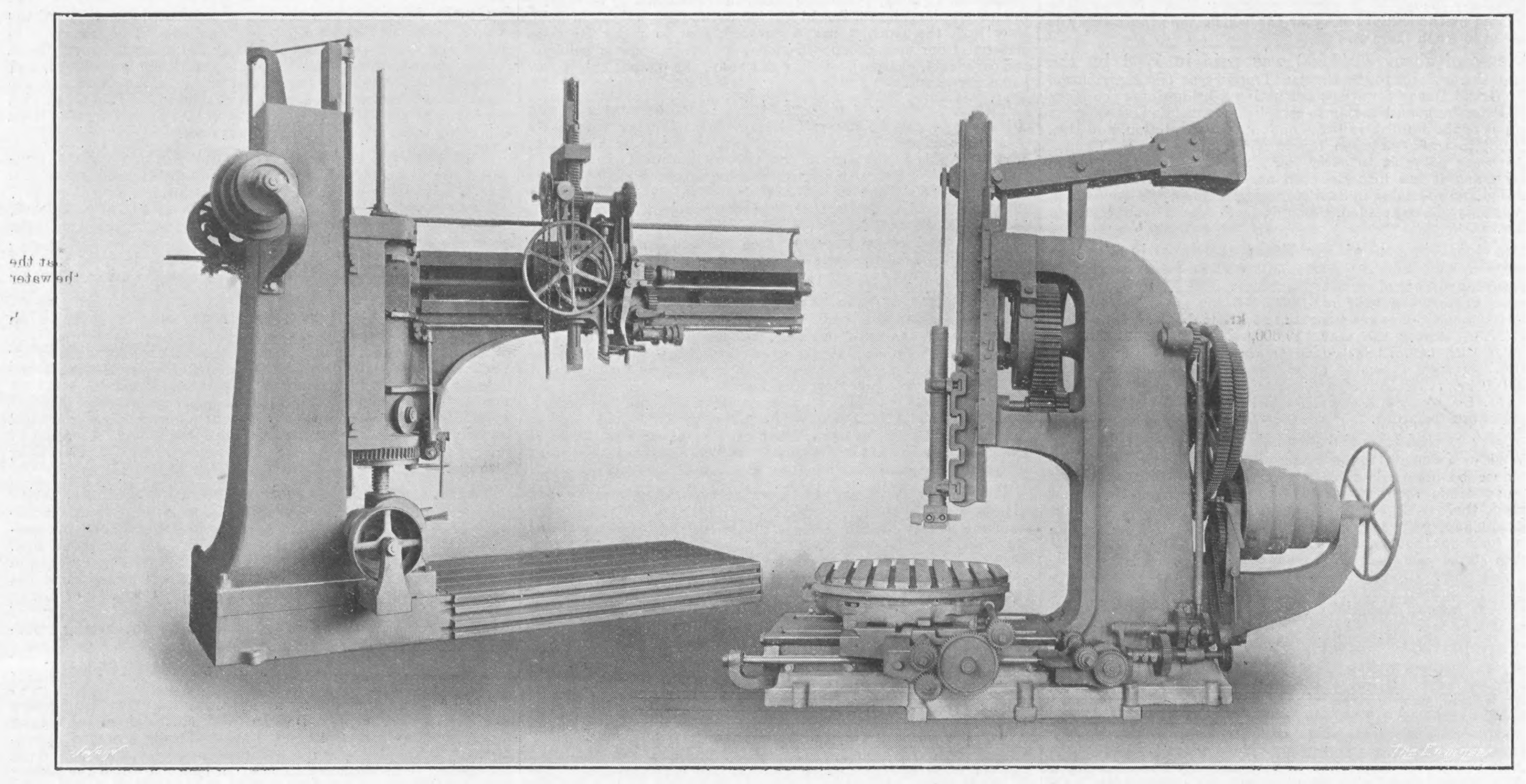
The following information is from the report by H.M Minister in Uruguay on the trade of that Republic in 1908, which will shortly be issued:—"The construction of the great embankment at Monte Video, the 'Rambla del Sud,' has been entrusted to a British syndicate. This great engineering work will take five years to complete, and will cost £1,355,000. The embankment, which will be 4000 m. in length, will consist of a stout sea wall, 4 m. above sea-level, and an esplanade 70 m. wide. The proposed line of embankment takes a gentle outward curve, and, as it will run a considerable distance from the present irregular natural coast line, a large area of land will be reclaimed from the sea. The total area of land thus reclaimed is calculated at not less than 125 hectares—about 310 acres."

A case which affects the regulations of railway companies for governing the use of railway level crossings has been decided in the High Court. The railway company involved, relying upon a regulation approved by all leading railways, gave instructions that the gates at a certain level crossing should be closed to special forms of traffic, no heavy motor vehicle being allowed to cross the railway without one day's previous notice having been sent to the nearest station master. The legality of this proceeding was challenged, and an action was brought against the company. The view of the Motor Union, which interested itself in the case, that the company had no right to make rules against particular classes of traffic which might be using the highway has been upheld in the High Court, the judge deciding that the regulation referred to was not binding upon the public.

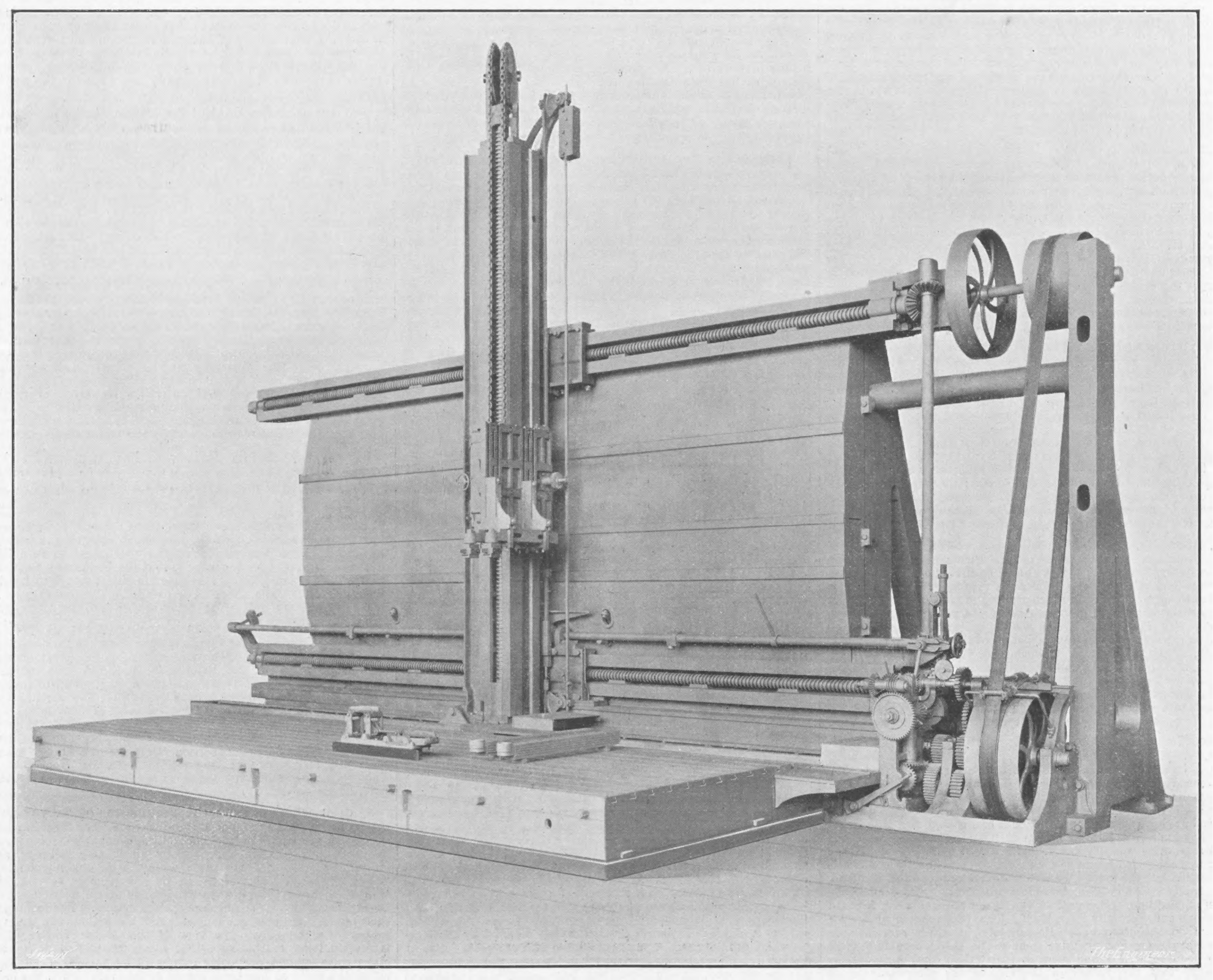
SOME NEW MACHINE TOOLS

THOMAS SHANKS AND CO., JOHNSTONE, ENGINEERS

(For description see page 160)



RADIAL DRILLING MACHINE SLOTTING MACHINE



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H.M.S. VANGUARD.

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HAIR CLOTH MANUFACTURERS.

SIR,—I shall be obliged by the names and addresses of firms making hair cloth in large quantities. TEXTILE.
August 10th.

MACHINE FOR MAKING BOLTS FROM COLD IRON.

SIR,—I shall be obliged by the address of English makers of machines for making bolts and nuts from cold iron. N. L.
August 9th.

MACHINERY FOR MAKING GRAPHITE CRUCIBLES.

SIR,—Can any of your readers inform me where I could get a full outfit of machines for making graphite crucibles? V. M.
August 10th.

THE ENGINEER.

AUGUST 13, 1909.

Employers and Workmen's Compensation.

THE burdens placed upon employers directly and upon insurance companies indirectly by the Workmen's Compensation Acts continue to be reflected in the many cases which are transferred from the County-courts or County-court arbitrators to the Court of Appeal in the majority of instances, or the House of Lords in a comparatively small number of actions. During the past two months no fewer than fifteen cases have engaged the attention of the Court of Appeal, and the decisions seem to have enlarged the responsibilities of employers in various trades. In 1907, which is the latest year for which official figures are available until the Home-office return for 1908 has been published, seventy cases in England and Wales were carried to the Court of Appeal, although fifteen were either abandoned, withdrawn, or settled out of court before the time arrived for the hearing. This number compares with fifty-seven actions which were brought before the High Court in 1906, and it therefore shows a fairly large increase, notwithstanding the circumstance that the Workmen's Compensation Act, 1906, was only in operation during the second half of 1907. The upward tendency in the latter year will probably be found to have continued in 1908 when the official report is issued, while the cases already heard in the course of the present year indicate a maintenance of litigation both on the part of employers and workmen who have failed to be satisfied with the findings of County-court judges or arbitrators. The extension of the liabilities of employers under the Act of 1906 is naturally responsible for the growth of actions which reach the Court of Appeal. Yet these cases only form a very low percentage of those which are brought before the County-courts in some way or other; and the latter in their turn also constitute merely a small proportion of the thousands of claims made under the Compensation Acts that are never brought into court, but are settled by agreement between employers or insurance companies on the one hand, and the workmen, or their representatives, on the other. One important insurance company, which carries on business in Scotland, although its sphere of activity is probably not restricted to that country, received, approximately, 25,000 claims in 1908 under policies issued under the Compensation Acts. A second company, bearing an English title, reports the reception of nearly 35,000 claims under the Acts in 1908, and the chairman recently stated that workmen's compensation risk is virtually a burden, and probably a loss to those who undertake it.

It is scarcely surprising to learn on the authority of the same company that a revision of the rates of premium is being taken into consideration having regard to the large risks involved. A statement of this kind has, of course, to be read in the light of the fact that the Act of 1906 has only been in operation for two years down to the present time, and that the experience gained of its effects only applied to the first complete year when the many thousands of claims were recorded. Nevertheless, it is easy to conceive that if two insurance companies were confronted with 60,000 claims in one year, the total number of claims for other companies and for those employers who assume their own risks must have almost reached figures representing hundreds of thousands in 1908 for the whole of the United Kingdom. With such numerous applications before us it is probable that some of the recent decisions given by the Court of Appeal will tend to increase the financial charges imposed upon employers throughout the country. In the case of Gane *v.* the Norton Hill Colliery Company, the plaintiff was a carting boy employed in the pit, and on the day of the accident he was told to ascend the pit earlier than usual owing to a defect in the machinery. He did so, and was run over by some trucks on a line which he was accustomed to cross on the surface on the way home. The County-court Judge held that the employment did not continue up to the time of the accident, and he consequently gave his award in favour of the employers. On appeal, however, the Court of Appeal decided that the accident happened in the course of, as well as arose out of, the employment, and the case was remitted to the County-court judge to assess the amount of compensation. A second instance, which is of considerable importance, relates to a workman named Hughes, who was employed by the firm of Clover, Clayton and Co. The man was engaged in tightening a nut with a spanner, when he fell back and was found to be dead. An examination revealed the fact that a large aneurism of the aorta had existed, and death was attributed to this cause. The County-court judge at Lancaster decided that the exertion of tightening the nut caused the rupture, and that death was produced by a strain arising out of the ordinary work of the deceased operating upon a condition of body which was such as to render the strain fatal. In the circumstances the judge considered there was an accident within the meaning of the Act, and he decided in favour of the man's widow. The employer lodged an appeal, but the Court of Appeal has dismissed it on the ground that the workman sustained an injury in the reasonable and ordinary discharge of his duties, and that the rupture of the aorta was the result of the work upon which he was engaged.

The two cases referred to in the Court of Appeal place further emphasis upon the responsibilities of employers under the Workmen's Compensation Act, 1906. In the instance of the carting boy employed in the pit the plaintiff had actually left his work and was on his way homewards, although he had not quitted the colliery company's premises. As the Court of Appeal has decided that the accident happened in the course of as well as proceeding out of the employment, the question arises as to where employment begins and where it ends. It is certainly impossible to say in view of this decision, which seems to place liability on an employer so long as workmen are to be found in or about his works. The second case is even of greater importance to employers, inasmuch as pre-disposition to illness is held to be no reason why compensation should not be paid in the case of accident. The Master of the Rolls, in giving his decision, quoted a judgment given with regard to a man who, while in a weak and emaciated condition, died of heat stroke in the stokehold of a steamer. It was then held that the fact that a man who died from heat stroke was by physical debility more likely than others so to suffer could have nothing to do with the question whether what befell him was to be regarded as an accident or not, and it was decided that the stroke was an accident which happened in the course of his employment. If, then, successful claims for compensation can be made by dependents in the case of workmen who are pre-disposed to illness, or who are liable to sudden death, it will soon become a question as to whether employers will, or will not, have to consider the advisability of introducing medical examination as an essential condition preceding the engagement of workmen.

The Rhymney Railway Boiler Explosion.

ENGINE No. 97 had just returned to the running sheds at Cardiff Docks on the 21st of April when it exploded violently. Three men were killed on the spot, and three others were injured. It was an eight-wheeled saddle tank goods engine, six-coupled, of considerable power. The circumstances of the explosion were peculiar, but in no sense mysterious. Briefly, there were two Ramsbottom safety valves on a cast iron "column" or manhole cover. The joint leaked, and a fitter was sent to re-make the joint. To do this he had to dismount the safety valves. He re-made the joint, put back the valves, and reported to the foreman. The engine was taken out next day and employed for a short time shunting. Then the pressure gauge indicated 200 lb., the hand pressing hard against the maximum stop.

There was plenty of water in the gauge glasses. Neither of the injectors would work. Next both the gauge glasses broke. The driver then took his engine back to the shed. Two men began to drop the fire and then the explosion took place. The facts that although the valves were nominally loaded to begin lifting at 145 lb., and to blow hard at 155 lb., they would not move; that the pressure was too high for the injectors, and that it split both gauge glasses, is apparently conclusive evidence that the boiler burst from over pressure. And yet the report which lies before us contains no less than thirty large pages closely printed containing the evidence given before the coroner's jury, with Mr. Carlton of the Board of Trade sitting as assessor. The jury brought in a verdict as follows:—"The deceased men were killed by the explosion of the boiler of an engine belonging to the Rhymney Railway Company, and that the cause of the explosion was, that the man left on the engine after the driver had gone from it, got the injector to work, and that the flow of cold water on to the already overheated plates suddenly generated a large amount of steam causing the explosion. They considered it purely accidental, and no one culpably to blame."

In order that our readers may understand what really happened, we give on page 171 a section of the safety valves. All Ramsbottom valves are fitted with a safety link to prevent the valves and lever from being blown away if the spring breaks. Washers of various thickness are used to regulate the tension of the springs, care being taken that the slot in the safety link shall be given a clearance of about three-quarters of an inch. It seems to be beyond question that the fitter referred to above, who was called away two or three times from the job, got muddled about the washers, and put the thick washer above instead of below on the central pin, and thus locked the valves hard down on their seats. There is nothing about the evidence to justify the verdict of the jury. That was the result of a surmise—nothing more tangible. The evidence was in certain respects confusing, inasmuch as some of the witnesses thought that there was evidence of overheating. The fire-box crown sheet weighed about 400 lb. The specific heat of copper is one-tenth that of water. That is to say, 10 lb. of copper cooled one degree would raise the temperature of a pound of water one degree, or 400 lb. of copper falling one degree would raise 40 lb. of water one degree. If we suppose that the crown plate was so far heated that it could part with 500 deg., a very simple calculation shows that it could convert 24 lb. of water already at 390 deg. Fah. into steam. Taking two cubic feet to the pound, we have a maximum production of 48 cubic feet of steam. These conditions assume that the plate must be red hot. No one attempted to say that it was. Indeed, neither of the lead plugs was melted or softened. But inasmuch as the injectors would not work, it is impossible to assume that water could have been got into the boiler. Our figures are only intended to show the very worst that could be brought about by a careful establishment of the necessary conditions, which certainly were not available. Mr. Carlton is emphatic on the question of overheating. He says: "I carefully examined the fire-box for overheating, but was unable to find any such indication. The lead was not melted in either of the two fusible plugs in the crown, there was no local bulging whatever between the boltheads in the crown, except at one place where a sling stay had been driven against the plate, and there was no discoloration of the metal. The soot was still adhering to the fire side of the crown plate, and the stay heads in the crown plate had the original bloom upon them which they obtained in the process of forging. Where the copper plate was torn transversely, it had a bright metallic lustre, and it was suggested that this was produced by overheating; but in my opinion it was produced by the manner in which the plate was torn, and an overheated plate would, I think, show a dull oxidised fracture rather than a lustrous one."

In certain respects the explosion was very instructive. The fire-box roof was carried by eight steel girders, into which were screwed 96 square headed stay bolts. The feet of the girders were bedded in the usual way on the tube and back plate. They were further supplemented by ten strap sling stays from the outer roof plate. The failure consisted in the driving down on the grate of the entire roof plate with its girders intact. The plate was ripped away all round from the side, back, and tube-plates. The girders must have deflected before the slings broke. Mr. Carlton calculates that these last had a united strength sufficient to carry 300 tons. Without going into minute dimensions, it appears that 100 lb. on the square inch put 109 tons on the crown, 219 tons for 200 lb., 327 tons for 300 lb., and so on. It is not at all improbable that the pressure had risen to 400 lb. or more at the moment of explosion. Nothing is more easy than to be wise after an event. It is worth while, however, to consider whether it is or is not possible so to make valves that they cannot be locked in error. This will always be possible while the adjustment depends on the use of washers of variable thickness. We cannot call to mind, however, any other railway explosion which was due to the locking of Ramsbottom valves by mistake. The overloading of such valves by putting shot into the cups and letting it get under the toes of the lever was common several years ago on the London and North-Western. The practice was stopped by Mr. Webb fitting his valves with a casing, and offering a reward of £5 to any driver who could overload one of these cased valves.

The precise mode of fracture of the plates in the Rhymney case deserves very careful consideration. We have no doubt but that it will receive it from Mr. Hurry Riches. It seems to indicate that the feet of the roof girders did not receive adequate support. The boiler was only made last year by Messrs. Hudswell, Clarke, and Co., Leeds. The working pressure was 160 lb., and it was twice tested by water to 240 lb. without producing any permanent deflection, and once with steam to 180 lb. It seems to have been very well made and of excellent material. Colonel Druitt entirely agrees with Mr. Carlton that the cause of the explosion was the fact that the safety valves were inoperative. That is also our conviction. No direct blame can, we think, be laid on anyone. It is more obvious than ever that engines should not be let out of the shed until the safety valves are known to be clear and to agree with the pressure gauges.

Double-beat Engine Valves.

It is not only Professors Nicolson and Callendar who hold that the distributing valves of steam engines leak. Indeed, it may be taken as almost universally admitted that hundreds of leaking valves are in existence. The whole question turns on the assertion that valves can never be made tight, which is in no way affected by the admission that they sometimes leak. A subsidiary question is, granting that leakage takes place, what is its amount, or in other words, what percentage of loss does it represent? Distributing valves are classed under two heads—beating, drop or puppet valves; and sliding valves, under which latter head are included piston valves, and various modifications of the Corliss type, as well as the normal slide valve. We have never yet met a practical engineer who maintained that the double-beat valve was absolutely tight; but we have met many who believe that slide valves are.

The reason why double-beat valves are not tight constitutes an interesting subject for study. There is no difficulty in grinding such valves into place dead tight, while hot; but this does not prevent subsequent leakage. The metal for the valve is taken out of the same ladle as that from which the valve chest or even the entire cylinder is cast, in order that the coefficient of expansion may be the same. In effect we have two discs on a rod and two seats for the discs in a box. When the valves are ground in, the distance between the valve faces and the seats must be the same to a very minute fraction of an inch. If it is not, one valve will be seated and the other will not. Suppose that the valve spindle expands more than the valve chest; then the bottom valve will be seated and the top valve will leak. On the contrary, if the chest expands more than the rod, then the top valve will be seated and the bottom valve will leak. It is evident that the smaller the distance between the two valves the less will they be affected by expansion. In practice double-beat valves are always made as short as possible, the central rods being replaced by a ribbed spider or a tube, usually cast in one with the two valves. It is unfortunate that minute accuracy is essential to tightness, for though it is not difficult to secure in the first instance, it is very hard to maintain in the second. The *Revue de Mécanique* for July contains an interesting study of the question by M. Lefer, who begins by asserting that while all well-made sliding valves in good order are tight, no double-beat valve ever is; and he ventures to say that the compound engine enjoys favour in France largely because the use of a second cylinder does much to neutralise the defects of the double-beat valve. He also points out that while no one ever sees a single-cylinder drop valve engine, single-cylinder Corliss engines are quite common, and well able to compete in economy with the compound engine. He contends that the top valve being larger than the bottom one, the effect of the steam pressure is to crush or shorten the valve, while further deformation is produced by the pressure of the steam inside the ring, which tends to expand it. Furthermore, the temperature of the valve and its seat vary continuously, and are never identical throughout a revolution, and it is impossible to provide for these changes of temperature when the valves are being ground into their seats. He goes on to add that if we withdraw and examine a double-beat valve which has been at work for some time we shall find evidence that it has been seating itself all right; but this evidence M. Lefer holds to be deceptive, in that it represents only momentary contact. He says:—"We have proved, then, that under the influence of pressure during the time the valve is closed it is crushed and shortened on the one hand, while on the other hand the valve seating is lengthened; and so it follows that it is practically impossible that the lower edge of the valve ring should rest upon its seat. The result is a leak, which is important, because the steam goes directly into the air or the condenser, and does no useful work."

In criticising these arguments it must be carefully remembered that the distances with which we have to do are extremely small. M. Lefer supposes, for example, that the shrinkage of the valve and the expansion of the valve chest leave the lower valve 0.1 mm., or, say, $\frac{1}{250}$ of an inch off its seat. We have, then, a space not greater than that of a sheet of very thin paper. Taking a valve ring with a lower diameter of 3.15in. and an upper diameter of 4.72in., he calculates that the loss by leakage would amount, with steam at 120 lb. pressure, to not less than 156 kilos. per hour, or for an engine indicating 128 horse-power a loss of 1.3 kilos., or nearly 3 lb. of steam per indicated horse-power per hour. We have not the least hesitation in rejecting the argument that the pressure in the valve causes deformation by crushing or compressing the valve. The load is comparatively small. The worst that it can do is force down the ring on the upper seat. The effective pressure comes to bear on the valve chest, and tends to force it away from the lower edge of the ring; but in any properly designed engine the parts are far too stiff and strong to be deflected. For the like reason we do not believe that the pressure inside the ring can distort the ring by enlarging it. When, however, M. Lefer speaks of the effect of temperature he is on much more certain ground. No doubt there is a continual change of temperature going on in the valve chest, while that of the valve remains fairly uniform, and the contractions and expansions which result may well make the accurate seating of the valve rings throughout the whole time the valve is closed doubtful. But, beside this, we have the almost certainty of distortion to consider. The valve ring, as a whole, alters its shape. In this connection we may refer our readers to the first report of the Steam Engine Research Committee, by Professor Capper, read before the Institution of Mechanical Engineers in March, 1905, and the discussion which followed it. It is clear that if the valve ring and its seats are inclined or mitred, any departure in shape from a true circle must cause leakage. For this reason, in the best modern practice—as, for example, the Lentz engine—the seats are flat and very narrow. Nothing in the way of distortion which can cause leakage is likely to take place in such a valve save a change in the distance between the two seatings, either in the valve chest or the valve. It is further to be remarked, as Professor Burstall pointed out in the discussion named above, that when superheated steam is used cast iron is peculiarly liable to distortion. It ought not to be impossible to produce a really satisfactory engine with single-beat balanced drop valves. These, with flat seats, ought to be quite independent of any change of form resulting from changes in temperature. Seeing, however, how well the piston valve worked by trip gear answers, it may be hardly worth while to spend time or money in improving the double-beat valve. It is also certain that even if it does leak a little, it is so cheap, lends itself so comfortably to trip gear of all kinds, and is mechanically so satisfactory, that it will probably only be wholly supplanted with great difficulty.

LITERATURE.

Steam Tables and Diagrams. By L. S. Marks and H. N. Davis. London: Longmans, Green and Co.

The difficulty experienced in giving an exact definition to the term "saturated steam" is widely known, and within recent years perplexity in this direction has given rise to doubts as to the accuracy of Regnault's results on its properties.

Basing their calculations on the researches of Dieterici, Joly, Grindley, and others, as far as saturated steam is concerned, and on those of Knoblauch, Thomas, and Henning with regard to superheated steam, the authors of the present volume have compiled a series of tables dealing with the properties of steam. A true estimate of the value of this book could only be obtained from an actual inspection; some idea, however, will be conveyed by an enumeration of its contents.

Saturated steam is dealt with in the first two tables, where the temperature, pressure, specific volume, density, heat of liquid, latent heat, total heat, internal energy, and entropy, will be found exhibited.

In the first table the steam temperature is taken as the independent variable, and values of the above quantities stated at intervals of 1 deg. Fah. from 32 deg. Fah. to 689 deg. Fah.

In the second table the pressure becomes the independent variable, and the figures given at intervals of 1 lb. from a pressure of 1 lb. per square inch to a pressure of 600 lb. The third table, which extends to 44 pages, gives the temperature, specific volume, total heat and entropy of superheated steam at all pressures from 1 lb. to 600 lb., and at intervals of 10 deg. in the amount of superheat over a range commencing at 10 deg. and finishing at 600 deg. Fah. Table 4 carries briefly the figures for the total heat and entropy of superheated steam over the range from 600 deg. to 2000 deg. Fah., and is intended to supplement the previous table. For thermometer calibration work, Table 5 gives the boiling points of water in English and metric units for pressures near that of the standard atmosphere, while Table 6 shows the thermal properties, such as density, specific volume, &c., of water over a wide range of temperature. Conversion and logarithmic tables bring the first part of the book to a close. In a pocket at the end of the book two charts are supplied, showing the total heat of steam plotted against its entropy in one and against its pressure in the other. The method of using these diagrams is explained in Part II., and the illustrative examples given show their utility and the wide range of problems to which they are applicable. The third and last section of the book treats us to a discussion of the sources of the tables and the methods of calculating and reducing the results.

The subject of steam calorimetry is at present attracting attention in various directions, and the advances being made are rapid, but this book will be found to embody all the most recent data on the subject, and is in every way most complete. It is carefully printed, and great pains have been taken in the arrangement of the matter so as to enable the figures required to be extracted with a minimum amount of trouble and chance of error.

SHORT NOTICES.

A Manual of Locomotive Engineering. By W. F. Pettigrew. Third edition. London: Chas. Griffin and Co., Limited, Exeter-street, Strand. Price 21s.—The third edition of this book has several new features, and it has been revised and in many instances new illustrations have been substituted for the old. Many of the illustrations of the locomotives given in Chapter II. have been renewed, and additional notes are given with reference to rail motor cars. The illustrations and particulars relating to the Belpaire fire-box in Chapter XIII., and the vacuum automatic brake in Chapter XVII., have been improved upon and brought up to date. Chapters XX. and XXI. of the old edition have been entirely omitted on account of American and continental practice being fully dealt with in so many books. Appendices A, B, and C have also been revised.

Carburetters, Vaporisers and Distributing Valves. By Edward Butler. London: Charles Griffin and Co., Limited. Price 6s. net.—The carburetter has probably received more attention at the hands of motor engineers than any other part of the internal combustion engine; in this book we find fifty-two different types of carburetters and vaporisers described and illustrated, and these, it is stated, are only to be regarded as representing various stages in the development of this all-important element in the anatomy of an internal combustion engine. For purposes of classification the author has divided his subject into groups dealing separately with surface and spray carburetters, automatic carburetters and vaporisers suitable for heavy oils. Of equal importance with the carburetter are the admission and exhaust valves and actuating gear; these next receive the author's attention, and his remarks thereon will be found suggestive by those who may be engaged on the design of these details. The descriptive matter in the book is clear and concise, and worthy perhaps of increased care in the execution of the accompanying diagrams.

Canada—Department of Mines—Mines Branch. Bulletin No. I.: Investigation of the Peat Bogs and Peat Industry of Canada during the Season 1908-9. By Erik Nyström and S. A. Anrep. Ottawa: The Government Printing Bureau.—The importance of the peat fuel industry to the central portion of Canada, where coal fuel is non-existent and its importation comparatively costly, requires no demonstration. The Mines Branch of the Department of Mines, Ottawa, issued a year ago a report on "Peat and Lignite: Their Manufacture and Uses in Europe," with the object of giving to Canadians as complete a review as possible of this industry in those countries in which it has been most successfully carried on. This report is now followed by a bulletin entitled "The Investigation of the Peat Bogs and Peat Industry of Canada during the Season of 1908-9." This bulletin comprises twenty-five pages of text, and includes six large scale maps of the following peat bogs:—(1) Mer Bleue, near Ottawa; (2) the Alfred peat bog, about 40 miles from Ottawa; (3) the Welland peat bog, about six miles north of Welland; (4) the Newington bog, on the New York and Ottawa Railway, and about 40 miles from Ottawa; (5) the Perth bog, a mile and a-half from Perth; and (6) the Victoria-road bog, about a mile from Victoria-road station on the Midland Division of the Grand Trunk Railway. The bulletin contains a descriptive report of each bog, showing the position, area, and structure, and giving an estimate of the available supply of peat fuel, with records of analyses, calorific values, &c. A fuel testing plant is now being erected at Ottawa, in which the value of peat for the production of power gas will be demonstrated, and the Department proposes to carry on a very thorough investigation of this subject.

INSTITUTION OF MECHANICAL ENGINEERS.

No. III.[*]

IN our last issue we brought the account of the excursions arranged for the members of the Institution of Mechanical Engineers during their recent stay in Liverpool down to the afternoon of Wednesday, the 28th ult. The whole of Thursday and Friday were devoted to visits. On the Thursday there were alternative excursions to the Walker Engineering Laboratories at the University, the dredger Coronation, the Docks, the Southport electrified railway, the workshops of the Lancashire and Yorkshire Railway at Horwich, and to salt mines and factories at Northwich. On the Friday there were alternative excursions to Chester and Southport.

WALKER ENGINEERING AND OTHER LABORATORIES.

In the Walker Engineering Laboratory building there is a large, well lighted, and ventilated main laboratory, containing a splendid equipment of appliances, including a Stirling boiler, a triple-expansion marine engine of 150 brake horse-power; a 60 horse-power Rateau turbine, coupled to a direct-current generator, the field magnet casing of which is mounted on ball bearings, and is used as a brake for the measurement of horse-power; a 15 horse-power de Laval steam turbine driving a high lift centrifugal pump which delivers water to a Pelton wheel. This water is measured in three different ways, namely, by a Venturi meter, by a rectangular weir, and by a V notch. Other apparatus includes a refrigerating plant by L. Sterne and Co.; a 24 brake horse-power National gas engine, with tube and magneto ignition, and means of varying the compression pressures for experimental purposes; an 8 brake horse-power Premier gas engine, gas producers, a Gardner paraffin engine, and air compressors. The testing appliances include a 100-ton Wicksteed machine, with alternative centres, cement testing, cross breaking, and impact machines. For the heat engine course the smaller experiments are carried out in the experimental laboratory on the first floor. This is fitted up with a Sirocco fan testing set, by Davidson and Co., Belfast, model boilers, fuel calorimeters, gas analysis, and other small appliances. On the third floor is the well lighted drawing-office. The chief applied mechanics laboratory is housed in a building in the quadrangle.

The George Holt physics laboratory, which Lord Kelvin opened in 1904, covers an area of 9600 square feet. In the basement there is a large workshop fully equipped with machine tools, and there are store rooms, a liquid air plant, furnace room, accumulator room, and rooms for research work. On the ground floor, close to the entrance hall and cloak rooms, are the doors of the large lecture theatre, a smaller lecture room, and a large laboratory for elementary students. This floor also contains the preparation room, the apparatus room, and a sitting room, office, and private laboratory for the use of the professor. The first floor is devoted to the instruction of senior students, and contains two large students' laboratories, four smaller rooms, suitable for optical and acoustical experiments, a student's workshop, library, and private rooms for demonstrators. The second floor consists entirely of research rooms of various sizes. The several floors are served by an electric lift, and all the rooms are lighted by electricity, and heated by low-pressure hot water.

The applied electricity laboratories were opened in 1905 by Sir Joseph Swan, and contain a lecture theatre, class rooms, library, laboratories, and test rooms. The most important laboratory is that used for testing dynamos and motors. It contains among other machinery a small Westinghouse gas engine, coupled to a dynamo, and used for lighting the laboratory, and the under truck with complete equipment of an electric tramcar. A self-exciting alternator, said to be the first of its kind built in this country, is worthy of special mention. Adjoining the dynamo room there is a workshop for the repair of machinery and other incidental work. In addition there are photometric laboratories, a high tension test room, with a 20,000-volt transformer, and a high-tension static machine, a standards room, and a range of special laboratories for research students. The laboratory is well equipped with all the essential electric measuring appliances, and a large battery of storage cells.

THE SAND PUMP DREDGER CORONATION.

The sand pump dredger Coronation has a length of 345ft., and a beam of 53ft. She has a capacity of 3500 tons, and is capable of loading herself from a depth of 60ft. in 50 minutes. The vessel was built by Vickers, Sons and Maxim, Limited, in 1904, and is fitted with twin screws and propelling engines of the triple-expansion inverted type. The pumps are centrifugal, and are driven direct by tripleexpansion engines.

THE NORTH DOCKS, LIVERPOOL.

To do much more than enumerate the places of interest visited during the excursion to the North Docks at Liverpool would be impossible in the space at our disposal. They were the Brocklebank graving dock and pumping station, the coal hoist at No. 3 Canada branch dock, the Canada graving dock and pumping station, the Huskisson pumping station, and the Sandon dock entrances. The Brocklebank graving dock was opened in January, 1906. It has a length of 804ft., and a width of 96ft The depth of water on the sill is never less than 30ft. On high spring tides the depth on the sill is 44ft. The coal hoist at Canada branch dock No. 3 has a capacity of 300 tons of coal per hour. It was designed to coal vessels up to 88ft. beam at a maximum height of 40ft. above coping level. It is movable, and is worked by hydraulic power at a pressure of about 750 lb. per square inch. It's maximum load is 30 tons gross. The Canada graving dock was opened in 1899. It is the largest graving dock in the port, being 925ft. 6in. long, 124ft. wide at the top, and 94ft. wide at the bottom of the chamber. It has a depth of water on the sill varying from 30ft. to 44ft. The pumps are three in number, each 51in. diameter. They are of the "Invincible" pattern, and were supplied by Gwynnes, Limited. They are capable of emptying the dock of 34ft. of water in $1\frac{3}{4}$ hours. To deal with heavy loads a 40-ton hydraulic crane is provided. This can travel the whole length of the dock. In the hydraulic pumping station at this place the machinery consists of three sets of triple-expansion engines of the marine type with cylinders 15in., 22in., and 36in. diameter, with a stroke of 2ft. driving ram pumps. Two accumulators weighted so as to give the requisite 750 lb. pressure per square inch are provided, the stroke of each being 16ft. and the rams 17in. diameter. The northern group of docks from Hornby to Sandon inclusive are worked on the impounded system, that is, the water is not allowed to fall lower than the level of high water of a low spring tide. The half-tide docks, which are run down to the level of the tide of the day, serve as locks for vessels to pass in and out at high water. The Huskisson pumping station attends to the level of the water in the docks first mentioned. There are four centrifugal "Invincible" Gwynne pumps, three of 51in. and one of 54in. diameter. All these pumps are driven by vertical compound steam engines. The Sandon dock entrances, together with the half-tide dock, were designed to afford a means of communication between the river and the docks south and north of them. They are 100ft., 80ft., and 40ft. wide respectively. Each is provided with two pairs of gates to form locks for the use of smaller craft between tides. The sills of the 100ft. and 80ft. entrances are 20ft. 6in., and of the 40ft. entrance 16ft. below Old Dock Sill datum. The two wider entrances have a depth varying from 30ft. at high water of low neap tides to 41ft. at high water of equinoctical spring tides. The gates are constructed of greenheart throughout, and are worked by cross chains attached to hydraulic rams.

THE LIVERPOOL-SOUTHPORT ELECTRIC RAILWAY.

The Liverpool-Southport electrified railway was so fully dealt with in our issues of 18th March to 15th April, 1904, inclusive, that it will not be necessary to make further reference to it here.

HORWICH LOCOMOTIVE WORKS.

This is the second occasion on which the members of the Institution of Mechanical Engineers have had an opportunity of visiting these fine works. The first was when the annual summer meeting was held in Manchester in 1894. Since that time certain extensions have taken place. These include a new heavy machine shop, a tinsmiths' shop, the boiler-house for Lancashire boilers, and the motor shop. The last named shop was formerly used for telegraph work, which is now carried on in the gallery of the stores. The building of the works was commenced in 1886, the land enclosed for the purpose measuring 116 acres, of which over 22 acres is covered by workshops. For the carriage of materials between the various departments there are $7\frac{1}{2}$ miles of tramway lines, and the haulage is performed by small locomotives with cylinders 5in. by 6in., and wheels 16in. diameter. These work at a pressure of 200 lb., their tractive force is about 1400 lb., and their weight when full 3.57 tons. The boiler shop, which is one of the largest buildings in the works, is 439ft. long by 111ft. wide, and contains a splendid equipment of appliances. There are a pair of hydraulic pumps and an accumulator, two large fixed hydraulic riveters for boiler work, each having a hydraulic overhead crane for lifting boilers; three portable hydraulic riveters on swing cranes bolted to walls and columns, and overhead electric travelling cranes. The tools include a quadruple multiple stay tapping machine, right-angle plate edge planing machine, pneumatic caulking and riveting tools, and an electrically-driven multiple drill with twenty-eight spindles, which drills five thicknesses of plates simultaneously, thus enabling 140 holes to be drilled at one setting. Most of the rivet-heating furnaces are fired by liquid fuel, which is sprayed on the fire by compressed air. The boiler shop smithy is 120ft. long by 111ft. wide, and contains the usual smiths' fires and hydraulic presses. The forge measures 452ft. by 111ft., and contains Siemens regenerative furnaces for re-heating, the doors of which are raised by pneumatic means. In addition to the various mills this shop contains a 35-ton duplex hammer, and one 8 ton and two 5-ton hammers.

The steel foundry is 150ft. long by 135ft. wide, and is fitted with Siemens-Martin regenerative melting furnaces, heated by gas from Wilson's producers. The furnaces have a high level tramway for carrying the ladle, and a narrow gauge tramway beneath for the mould trolleys. The "Tropenas" process for making steel castings is also in use. The ironfoundry measures 212ft. by 111ft., and is served by both hydraulic and electric cranes. A separate building is devoted to the casting of chairs, and measures 124ft. by 128ft. In this shop a staging is provided for fettling the chairs, which are then placed on an endless chain to be conveyed to the railway wagons for dispatch. In the carriage and wagon wheel shop the members saw the lathes for turning and boring wheels, a hydraulic press for tires, and a second press for forcing the wheels on to the axles. A special multiple drill for making holes in the retaining rings, wood blocks, and steel wheels at one setting was also noticed.

After glancing through the smithies, signal and points and crossings shop, the next large shop traversed was that for the fitters, which is 508ft. long by 111ft. wide. This is provided with a large number of milling and other machines for dealing with locomotive work, including several automatic machines and turret lathes for turning copper fire-box stays, bolts, pins, &c., also drilling and slotting machines. These machines are driven by wall engines bolted at the end of the shop, and giving motion by means of bevel gearing to four ranges of shafting running longitudinally. Four 5-ton high-speed electrically-driven jib cranes are provided to serve the tools.

The boiler-house contains a battery of Lancashire boilers with underfeed mechanical stokers and Green's economisers. The central power station is equipped with two 300-kilowatt Belliss and Morcom high-speed engines and dynamos, and four sets of 60-kilowatt capacity to generate current at 250 volts. A large portion of the works is supplied with power and light by this plant. In connection with the power station there is a barometric condenser by the Mirrlees Watson Company, which deals with the steam from several other engines of large capacity. Passing by several minor shops, we come now to the heavy machine shop, which is 360ft. long by 48ft. wide, and contains the necessary tools for dealing with frame plates, cranks, pins, &c. Many of these machines have been specially designed for particular work, and all are driven by separate 3-phase alternating-current motors. Two 10-ton three-motor electric overhead cranes serve the various tools.

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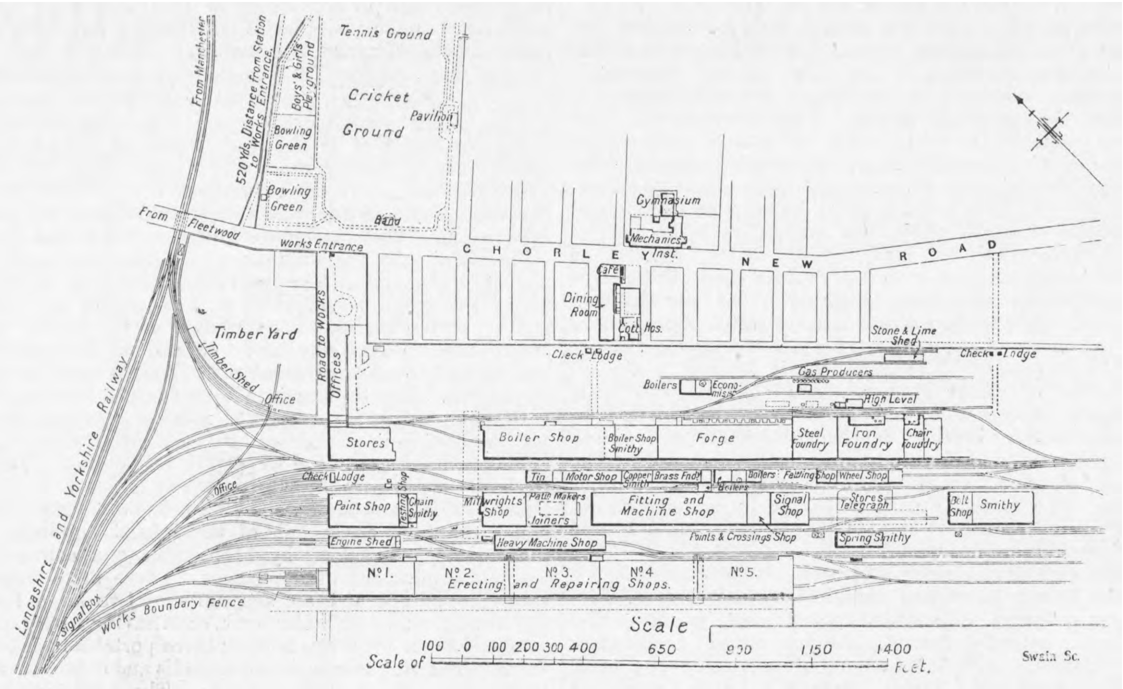
[*] No. II. appeared August 6th.

The erecting shop is by far the largest in the works. It is 1520ft. long by 118ft. wide, and is served by twenty 30-ton electrically-driven overhead travelling cranes. There are portable hydraulic riveters, flexible shaft drilling machines, operated by motors, and other tools. Access for engines to the centre portion of the shop is obtained by two electrically-operated traversers. Wheel lathes, some electrically driven, are provided for dealing with wheels taken from engines under repair. Other shops, not hitherto mentioned, are the paint shop, the test shop, and the chain smithy. The latter shops are fitted with a 100-ton hydraulic testing machine, oil spring and chain testing machines, steam hammer, &c. The accompanying plan of the works will assist our readers in following the foregoing brief description.

In connection with the visit to Horwich, the members were entertained to luncheon by the directors of the Lancashire and Yorkshire Railway.

Sir George Armytage, in proposing the toast of "The Guests," said that he had always had the feeling in his mind that it was a good thing for a railroad company that its general manager should, like Mr. Aspinall, be an engineer. That example, he noted, was being followed by other companies, and it was the right course to pursue. It was very important that every question coming before a general manager should be considered in all its aspects, both engineering and commercial. They had that day visited the electrified lines of the Lancashire and Yorkshire Company between Liverpool and Southport. That scheme was due to the initiative of Mr. Aspinall, and he was glad to say that the company had been able, by reason of the adoption of electric traction and the much better use of its terminal facilities which followed that, to carry an enormous number of passengers, and thereby to postpone for a considerable period large capital expenditure which would otherwise have been necessary.



The Engineer

PLAN OF THE HORWICH LOCOMOTIVE WORKS

The members were served with tea in the Mechanics' Institute, a large building which was built chiefly out of a grant of £5000 by the shareholders in the Lancashire and Yorkshire Railway Company. We have previously referred to the good work done in this Institute in the education of the apprentices of the company and the youths of Horwich.

THE SALT UNION WORKS, WINSFORD.

The members who availed themselves of the invitation of the Salt Union, Limited, to visit the huge salt works at Winsford had an excellent opportunity of comparing the production of salt from the brine by the old and new methods, namely, by means of coal-fired open pans and by vacuum evaporators. The company's works in this district extend for a distance of about three miles along the river Weaver, and find employment for practically the whole of the adult male population of Winsford and many females. The Union embraces nearly all the salt works in this district, some of which bear traces of old age, and afford a remarkable contrast with the modern works and plant which have been erected within the last four years. Some idea of the output of the Winsford works can be gathered from the facts that the Salt Union owns some thirty-eight steam and some sixty ordinary barges, each capable of carrying from 200 to 250 tons of salt, and that all of these are kept in constant service along the river Weaver and the Manchester Ship Canal. The company has its own slips for building these vessels, and the engines and boilers are built in its own engineering works.

The brine is pumped up from a depth of about 150ft. by pumping engines, of which there are fifteen distributed about the Winsford works. A typical pumping plant, however, was viewed by the members and consisted of a pair of pumps operated by rocking beams driven by spur gearing from a compound vertical steam engine. This is capable of delivering 16,320 gallons per hour. The brine is stored in huge reservoirs, and from these it gravitates to the open pans or to the vacuum apparatus. It contains 26 per cent. of $NaCl$ (salt), and a certain amount of calcium sulphate ($CaSO_4$), and magnesium chloride ($MgCl_2$). In the old process of evaporation underfired open wrought iron pans, measuring 80ft. by 30ft. by 2ft., are employed, and the amount of fuel used is about ½ ton per ton of salt produced. The salt made is classified and sold according to the size of the crystals, which depends on the temperature of evaporation. The temperatures at which the different kinds of salt are produced are generally as follows :—

Butter and domestic (fine salt)	226 deg. Fah.
Common (medium salt)...	185 ,, ,,
Fishery (coarse salt)	145 ,, ,,

The salt is raked by hand to the sides of the pan periodically, and is either shovelled out to drain on "hurdles," or is deposited in boxes to form the rectangular blocks of commerce. These blocks are afterwards transferred to a drying chamber, which is usually on a level with the floor of the pans, and is heated by the waste heat from the pan furnaces.

In his paper—No. 3725—read before the Institution of Civil Engineers, Mr. P. M. Pritchard gives 226 deg. Fah. as the temperature at which saturated brine boils under atmospheric pressure. In a vacuum of 28in. the boiling temperature is, however, reduced to about 140 deg. Fah. Evaporation in vacuo, therefore, enables low pressure steam to be used, and gives a much greater temperature difference, with a correspondingly increased duty per unit of heating surface of the evaporator tubes than is possible with evaporation at atmospheric pressure. By multiple effect evaporation great economies can be made in the amount of steam necessary. The vacuum evaporators at Winsford work on the triple-effect principle. The chief point of difference between the evaporation of brine and that of other liquors is that in multiple-effect apparatus each unit is supplied with brine independently of the others, and graining takes place in the pans, whereas in concentrating liquors the latter are fed from the first effect to the second, and from the second to the third. Provision has also to be made in each effect for the removal of the salt as it is produced. The pans at Winsford are about 56ft. in height overall and 18ft. diameter, and the output is 15 tons per hour. The brine enters the apparatus at about 12in. above the upper tube plate, the steam being efficiently distributed among the tubes by a steam belt or annular passage. The tube plates are 18ft. diameter, and each "effect" contains some 2500 copper tubes 2⅜in. diameter and 4ft. 6in. long. The steam dome of the first effect is connected to the calandia of the second, the steam dome of which is in turn connected to the calandia of the third. The steam from the latter goes to the jet condenser, just as in any ordinary multiple-effect evaporator. The salt as it is formed gravitates into the elevator boot at the bottom of each effect, and is elevated by buckets of special design, so as to give a clean discharge when these reach the top of the elevator. The body of the latter is jointed to the down-take of the effect, thus providing a water seal to exclude air.

In the building containing the vacuum pans nothing but timber is employed for the staging and supports, owing to the injurious action which salt has upon metals. The building is provided with 10-ton overhead travelling cranes for repair work. On the top platform is arranged the driving gear for the elevators, which deliver the salt by means of chutes into a storage building. There are also a line of shafting for driving the circulating propellers for the pans, and a water tank for the condensing water. On the next floor below are the open tops of the deep wooden bins for receiving the salt. The floors of these bins are built of wood laths to allow the water to drain away, while doors are provided to enable the salt to be removed. On the third floor from the top is situated the engine which drives the elevators. Such an apparatus requires a number of pumps for the supply of brine and condensing water, air and vacuum pumps, and a considerable amount of steam is required. The boiler-house for the vacuum plant contains a battery of seven Lancashire boilers, fitted with Green's economisers; some of these boilers are now being removed and are being replaced by Stirling water-tube boilers. The boiler-house has an equipment of recording pressure gauges, chimney draught gauges, pyrometric apparatus, and gauges for recording the temperatures of the chimney gases and a CO_2 recorder.

The salt which has to be dried for packing in bags is treated in a building adjoining the vacuum plant house. It is taken up from the stores by rubber conveying belts fitted with buckets to a floor above, and is delivered into a revolving inclined cylindrical vessel, in which it is dried by air passing over coils of steam piping. From the drier the salt is taken by a conveyor, which delivers the fine salt after separating the lumps. The visitors could not fail to be impressed by the mountains of snow-white salt stored in the admirably clean buildings. It may here be stated that improvements are constantly being carried out to bring the plant up to the highest pitch as regards production and quality of the output by the company's engineer, Mr. G. W. Malcolm, M.I. Mech. E., and an order has been placed with the Mirrlees Watson Co. for another complete triple-effect vacuum plant to make 25 tons of salt per hour, steam for which will be supplied by five Stirling boilers, each capable of evaporating 22,500 lb. of water from and at 212 deg. Fah. It is also intended to do away with fifty of the small steam power plants at present in use at saw-mills, brine pumps, fitting and wagon shops, &c., and to substitute one large electric power plant for the distribution of electrical energy, which will be generated by the steam at present used direct in the vacuum plant. Instead of passing from the boiler direct to the pans, it will be used in the power plant engines first, and then pass on at atmospheric pressure to the first effect of the vacuum plant.

Here every year some 15,000 tons of salt are packed in 1d. and ½d. packets. The works comprise grinding and packing rooms, paper bag and box-making machines. Scrupulous cleanliness is observed, and the salt finds its way to the consumer's table without having been once touched by human hand. A packet of Falk salt was handed to each visitor at the vacuum plant as a souvenir.

The Salt Union's mine at Northwich, which the visitors afterwards inspected, covers an area of 18 acres, and is situated 303ft. below the surface of the ground. It is of crescent shape, with no galleries, the roof being supported by pillars of salt 30ft. square and spaced 75ft. apart. All the salt is got by hand, with the exception of the work which is done by means of compressed air under-cutters. At Anderton, near Northwich, the members were enabled, through the courtesy of the River Weaver Navigation Authorities, to make an ascent in the boat lift which connects the river Weaver with the Trent and Mersey Canal. We must refer our readers to the issue of The Engineer dated July 24th, 1908, for a full description of this lift, which was converted by Mr. Saner from hydraulic to electrical operation. It may, however, be stated that since conversion it has worked with the utmost satisfaction. The two caissons have made no fewer than 14,869 operations, and the tonnage of vessels dealt with is 211,071. The maximum number of strokes in twelve hours is 102, and the maximum number of boats in twelve hours 147.

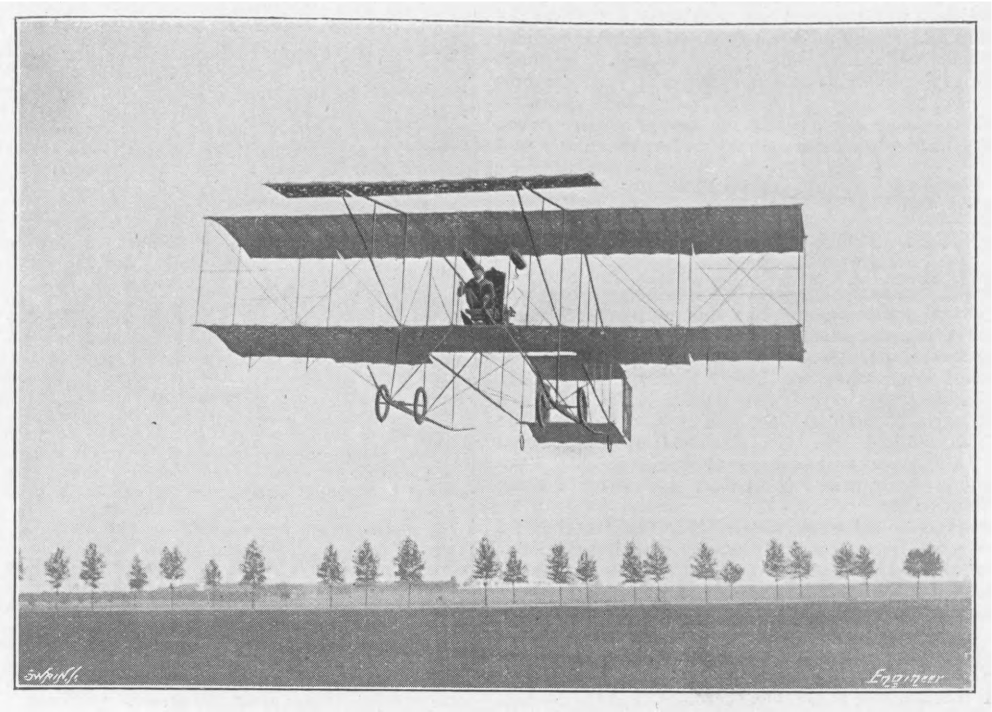
OTHER VISITS.

During the visit to Chester on the Friday, an opportunity was given for visiting the works of the Hydraulic Engineering Company, where amongst other things seen was the casting of a large accumulator cylinder, to take a ram 20in. diameter by 23ft. stroke. The city walls and the Cathedral also claimed attention, while in the afternoon a visit was paid to Iron Bridge. The objects of engineering interest in Southport are more or less limited, but as the Royal Lancashire Agricultural Society's Show happened to be held at the time, those members who made this excursion had an opportunity of visiting it.

During the continuance of the meeting, the members of the Institution had invitations to visit a large number of works, not only in Liverpool and Birkenhead and places already mentioned, but also in Garston, Prescot, and Preston.

Oil Transformer Explosion.—Referring to the partial destruction by fire of the station of the Trinidad (Col.) Electric Light and Power Company, the *Electrical Review* states that the total loss was somewhat under £20,000, and that the fire was primarily due to the arcing over of a rotary converter, which short-circuited coils in three oil transformers installed on a wood floor in the same building. Probably owing to low oil, an explosion took place in the case of one of the transformers, which blew the top off, rent holes in the side and scattered burning oil over the wood floor. Within a few minutes the engine-room was untenable, and by the greatest effort only were the fires drawn under boilers and danger of explosion averted before the boiler-house roof fell in. The fire department was helpless when it did arrive, as oil had been by that time blown about from all the transformers in the station. The switchboard was dropped through to the basement. The new high-tension portion of the station was not cut off by a fire wall, and was completely destroyed. The only pieces of apparatus in the entire station not seriously injured were the boilers, two steam turbine units and the storage battery, which latter was only partially cut off, and suffered considerable damage from broken plates and jars. No insurance policies were in force, as upon the reorganisation of the company a few years ago the risk was re-rated with increases owing to a wood floor in bad condition, oil transformers on a wood floor, and large masses of combustible insulation beneath the wood floor, from generators to switchboard. As a consequence the company decided to do its own insuring.

MONSIEUR R. SOMMER ON HIS AEROPLANE



THE RECORD AEROPLANE FLIGHT.

EARLY last Saturday morning a world's record in the matter of time for an aëroplane flight was established at Chalons, in France, by M. Roger Sommer. The aëronaut, who is a pupil of M. Farman and who was flying in a machine of the biplane type constructed by the latter, commenced his flight at 3.14 a.m., and remained in the air until 5.41¼ a.m. He thus flew for 2 h. 27 min. 15 sec., and has, therefore, broken the previous time record of 2 h. 20 min. 23 sec. held by Mr. W. Wright. It is reported that M. Sommer was compelled to descend to the ground after his flight on Saturday by his petrol supply giving out; other aëronauts have recently found their flights hindered by the same cause.

M. Sommer's flight is all the more remarkable when his previous occupations and training are taken into consideration. Originally a manufacturer of felt, he turned his attention to flying early this year, and until a month ago he had made no successful flights. The weather conditions on Saturday were very favourable for his purpose, an entire absence of wind greatly helping towards success. After running along the ground for about fifty yards, the aëroplane, which is provided with a six-wheeled landing chassis, rose to a height of about 50ft., and, circling over the military manœuvring ground, remained at this average height until the end.

Swain Sc.
Engineer

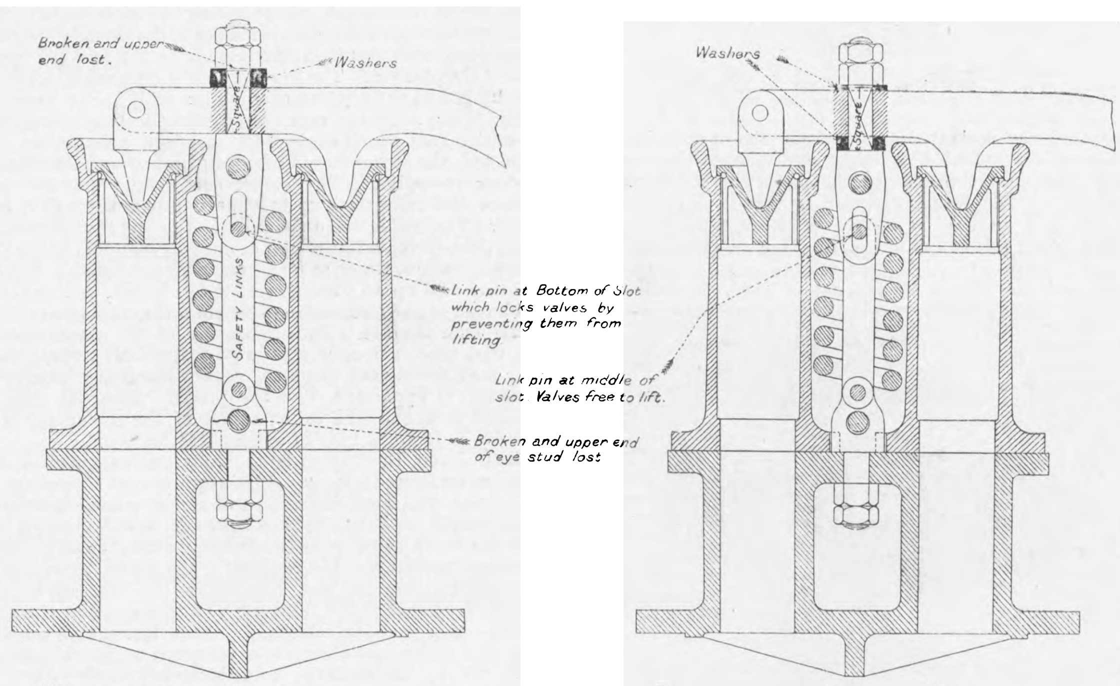
M. SOMMER IN HIS DRIVING SEAT

A minor accident is reported to have occurred shortly after the commencement of the flight. Some of the material forming the lower plane became loose and threatened to bring the machine to the ground, but the propeller blades catching on it removed it and permitted the aëroplane to rise again.

During the carrying out of a second flight on Sunday night the motor of the machine gave some trouble, and finally caused it to fall to the earth from a height of 25ft. Although the aëroplane itself was completely smashed, M. Sommer escaped uninjured. We are enabled to reproduce in the accompanying engravings two views connected with the latest aërial achievement. One shows the machine in the air during Saturday's flight; the other, from which some details of the construction of the machine may be gathered, shows M. Sommer seated in the chair ready to take flight.

THE RHYMNEY RAILWAY LOCOMOTIVE BOILER EXPLOSION.

WE have commented fully in another page on the collapse of a fire-box on the 21st of April on the Rhymney Railway. The accompanying sections explain themselves. We reproduce them from the Board of Trade report. It will be seen that the putting of a thick washer above the lever instead of below it locked the valves down hard on their seats.


Broken and upper end lost.
Washers
Square
Safety Links
Link pin at Bottom of Slot which locks valves by preventing them from lifting
Link pin at middle of slot. Valves free to lift.
Broken and upper end of eye stud lost
Washers
Square

VIEW SHOWING VALVES LOCKED BY SAFETY LINKS.

POSITION OF SAFETY LINKS AT USUAL WORKING PRESSURE.

The Engineer.

Swain Sc.

SAFETY VALVE ON THE RHYMNEY RAILWAY LOCOMOTIVE

THE EUSTON TO WATFORD ELECTRIC RAILWAY.

THE new line from Euston to Watford, under or alongside the present railway, is now well in hand. Power to make it was obtained by an Act of July 26th, 1907—the 7 Ed. VII., cap. 87. Whatever progress may have been made with the underground sections, at present the works begin to be visible, coming from London, just before the Midland Company's Acton Wells branch is reached. This point is nearly six miles from Euston. The new railway is on the north side of the main line; it is just behind the houses of Harley-road, Harlesden, and passes under the Midland embankment by a single arch, turned in blue brick. The arch is somewhat on the skew. A similar arch, but not skew, almost immediately follows, and is formed under the Acton-road. The line then keeps below the level of the sorting sidings, between them and the houses of Mordaunt-road and Milton-avenue. The shunting yard being made ground, considerably above the natural surface, a retaining wall of blue brick has been built for a considerable distance on its northern side. At the foot of the wall is the site of the new line. A temporary line of rails, with a passing loop at the Acton-road, is laid along it, by which the spoil from the tunnel is carried away. At the end of the shunting yard the line comes out behind the car sheds of the Metropolitan Electric Tramways, Limited, and will be upon an embankment of moderate height. This is partly tipped just here, and carries the temporary line across the Stonebridge to Alperton footpath. There is also a surface line just beyond, but it only leads up to the contractor's engine shed, on the level of the coal sidings. The embankment a little farther on is finished, and leads on to a two-arch bridge, the first arch spanning a new roadway and the other the river Brent. Both arches are of about 40ft. span. The whole work is in blue brick, and of rather neat elevation. At this point the new line is some 300 yards east of the old one, or, rather, from the last widening of it. A very little way beyond this short viaduct, as it may be termed, a cutting begins, and takes the line on to the point where it is carried under the whole of the old roads, so as to bring it to the down or western side. The passage is effected by a girder bridge, sharply on the skew, divided by a pier wall of blue brick. Curving round at as little distance as need be, the line comes to the present railway level at the south end of Sudbury and Wembley station. A long iron foot-bridge, leading over the fields from Wembley to Alperton, is being lengthened considerably to cover the new line close to where it emerges from beneath the fast roads, which at this point form the original railway of 1837.

So far as Sudbury station, the contractors for this work are Messrs. Monk and Newell, of Liverpool, but north of it Messrs. Naylor Brothers, of Huddersfield, are in charge. Additional platforms will be provided at Sudbury, and another opening made under the Harrow-road bridge. This work is in hand, as well as a widening of the bridge on the north side, long badly wanted in view of the growth of the district. The gardens of several houses will be abbreviated at the back of the station, and a few more to the north of it, whilst one or two houses have had to come down. There is enough room for the two extra roads under the Great Central Railway bridge. The contractors have their workshops and office just beyond this, abutting on the line, and an engine shed. From here the work is described in the Act as Widening No. 2 and continues on the down or west side, at about ground level, to East-lane bridge. Here there will be a new station, to be called East-lane, which will accommodate a rapidly rising neighbourhood. The widening will be carried under the bridge. Both the bridge itself and the approach to it on the station side will be broadened to 40ft.

Some nursery gardens come next to East-lane and will be invaded to some extent, as well as the back premises of a few houses beyond, but for about a mile after this not much is yet done. From the crossing of the Metropolitan Railway, where the cutting gets deeper, a large force of men, with two steam navvies, is at work down to Kenton-lane over-bridge. There is already a vacant arch under the Metropolitan, so that only excavation is required there, but Kenton-lane bridge will require an extra span, and is being broadened to 40ft. Here also a new station will be erected, called Kenton, to serve the new villas on the Northwick estate. The cutting here is about 15ft. deep, but is considerably more nearer London, and the clay formation necessitates a very flat slope. An iron footbridge further on is being lengthened, the new flight of steps being of blue bricks outside. A bridge over a narrow lane leading to the Harrow Urban District Council's sewage farm has been widened with girder work, with blue brick wing walls, and a short bit of embankment tipped.

This brings the new line to Harrow station, still keeping on the down side. The over-bridge here—now a very busy thoroughfare—will be lengthened at the east end and widened as well. It is considerably on the skew. On the west side the foundations for the wing walls are already in. On the east a steam crane is at work fetching up the clay, which is carried out in hand trucks on a narrow-gauge line to widen the Stanmore branch or provide an extra siding alongside it. At Harrow, of course, new platforms and buildings will be required for the electric line, but nothing has been done yet, nor are any works in progress further on. They will be light enough—as far as Bushey, at any rate.

A large piece of ground is being got out at Kenton-lane, on the up side of the line, for a goods and coal yard. A similar piece is staked out for a like purpose at East-lane, north of the bridge, and opposite the nursery gardens. This is mostly at about rail level, though the far end begins in higher ground, near Wembley cutting signal-box.

A GREAT improvement during 1908 in the Helsingfors tramway system can be reported, *i.e.*, the extension of the single track to double lines throughout the town, with the exception of some short distances.

A NEW COUPLING FOR HOSE PIPES.

SOME simple but effective couplings for flexible hose pipes have been brought to our notice by the firm of Livett, Frank and Son, Limited, of 22, Borough High-street, London. As will be gathered from the illustration—Fig. 1—and from the section—Fig. 2—they comprise parts forming male and female connections. The spigot forming the male connection has two tapered portions over which flanged sockets or glands fit, the bore of these sockets also being coned to correspond with the spigot. It will also be noticed that the double spigot is provided with a central flange, in which holes are bored to receive the bolts for drawing together the flanged sockets. In this way the parts are securely connected together, and any movement of the central spigot relative to the flanged sockets is prevented. In order to connect two lengths of hose pipe together, the sockets are first threaded over the pipes. Then the ends of the spigot are introduced into the pipes, and the sockets drawn towards the centre flange by means of the bolts. The spigot and sockets thus act as a clamp, and grip the ends of the pipes, thereby forming a tight joint. The coupling shown in Fig. 3 is suitable for connecting a hose to a service or other pipe, the spigot portion being screwed at one end. It is claimed that these couplings ensure an absolutely tight joint, and that they are suitable for all pressures of gas, steam, air, and water.

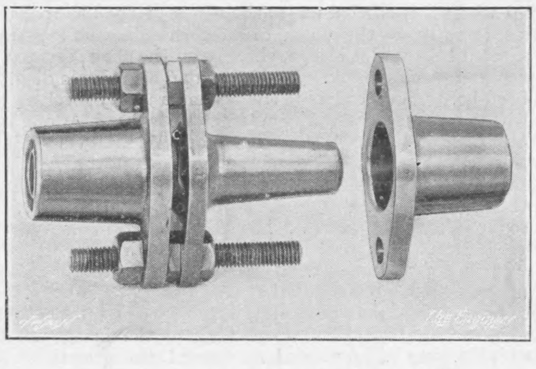


Fig. 1—THE LIVETT HOSE COUPLING

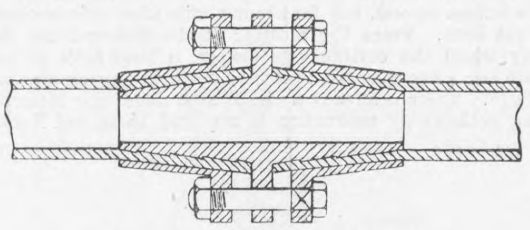


Fig. 2—SECTION OF HOSE COUPLING

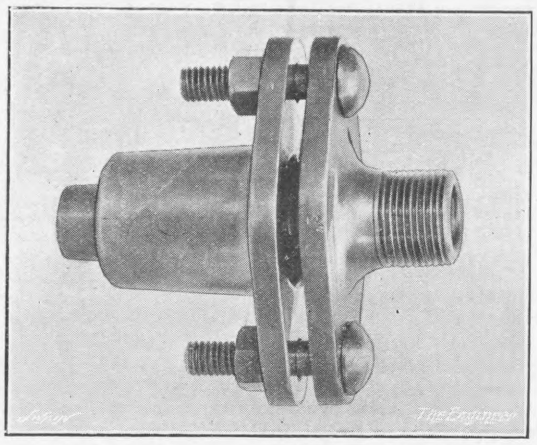
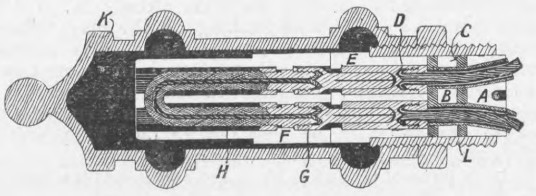


Fig. 3—HOSE COUPLING WITH SCREW ATTACHMENT

AN IMPROVED FUSE.

A WATER-TIGHT fuse for which several advantages are claimed, and which, among other things, is designed for use when gas lamp standards are wired for electric light, has been brought to our notice by the firm of S. W. Martyn and Co., of 11, Pratt-street, Camden Town, London. Referring to the section given herewith, L is a nipple which screws into the cast iron column, or it can obviously be screwed into a socket or T-piece of a conduit system. The lock nut on the nipple prevents the fuse from working loose. The wires are brought through the porcelain piece A, the rubber disc C, the porcelain disc B, and finally through another rubber disc to the left of B. The wires are then connected to the terminals D by means of cone joints in the manner shown. A brass wire clip with nuts embedded in the porcelain piece E presses these porcelain parts together, and expands the rubber discs against the inside of the nipple L and against the wire, thus making a water-tight joint. The fuse wire is enclosed in an asbestos tube H, which in turn is enclosed in a porcelain tube F. The ends of the fuse wire are joined by means of cone joints to split pin terminals G, which are fastened in the porcelain piece F as shown. Thus the fuse block can be withdrawn like a wall plug. A cast iron cover K fits over the various parts and screws on to the nipple L, a hexagon head being provided at the outside end to receive a spanner. Fuses of this type are made to take currents up to 15 ampères at 650 volts. Simplicity, reliability, safety, and complete protection against arcing are the makers' principal claims. For colliery work these fuses are said to be particularly well suited.



SECTION OF THE FUSE

MECHANICAL STOKERS FOR LOCOMOTIVES.

THE use of mechanical stokers for locomotives has been tried on several American railways, and a number of such devices has been used experimentally to a greater or less extent. A special incentive to their introduction is the great size of modern locomotives, requiring not only the shovelling of enormous quantities of coal, but making it difficult for a fireman properly to maintain the fire in a box of extreme length. The subject has been discussed at the annual meetings of the American Locomotive Superintendents' Association, and a report was presented at the recent meeting held at Atlantic City.

The report calls attention to the fact that mechanical stokers for locomotives are in their infancy, and that efficiency beyond that of hand firing can hardly be expected at this stage. But at the same time the results thus far obtained hold out great hopes for the future, especially as the matter has been taken up in earnest by a number of railways. With the introduction of stronger wagons and improved couplings and brake valves, it becomes practicable to increase the length of trains. It is reasonable to assume, therefore, that the average tractive power of locomotives will increase. This being the case, it is possible that the increased fuel consumption per mile will render it advisable to provide mechanical means of firing for two reasons :—First, to secure the development of a high sustained tractive effort ; and second, to render the service attractive to men who possess qualifications to become successful locomotive enginemen.

The report reviews some of the developments of the past year, and from it the following notes are taken :—

The Chicago and Alton Railway has equipped 22 of its engines with the Strouse mechanical stoker, which is of the steam-driven horizontal reciprocating plunger type. The coal is fed through a detachable hopper to the plunger distributor, which distributes it in the fire-box by the forward movement of the plunger. The fire-box door is replaced by a special door hinged at the top and opening inwardly, being operated automatically. In the event of resorting to hand firing, the suspension rods which support the stoker in position are disconnected, the stoker moved into the gangway and the original fire-door re-applied. The stoker successfully handles any grade of coal from slack up to what will pass through a 5in. screen. The coal is well distributed and raking is unnecessary.

The Pennsylvania Railroad is developing an underfeed stoker of its own design, which so far seems to give promising results. This uses coal up to sizes of 4in. or 5in. cubes, and requires no change of the locomotive other than the application of a special form of grate. The application of the mechanism is such that the fire-door is in no way obstructed, so that hand firing may be resorted to on the road without any change or removing of apparatus. At the present time the coal is shovelled from the tank to the hopper of the stoker, but it is intended to fit some kind of mechanical conveyor.

The Chicago, Burlington and Quincy Railway is using the Barnum underfeed stoker. This requires coal screenings of 1½in. size. The application of this stoker is such that hand firing cannot be accomplished without changes which involve the work being done in the shop. The installation of the stoker necessitates the removal of the grates, extension of the back frames, and the remodelling of the ashpan and draught appliance in the front end. The distribution of coal in the fire-box is such as seldom to necessitate raking the fire. With this stoker also the coal is delivered to the hopper by hand, but it is the intention to make it automatic later.

The Erie Railroad is developing the Dodge stoker, which is of the overfeed type. The only change to the locomotive necessary for the application of this stoker is the replacing of the fire-box door by a specially designed box-shaped door, in the centre of which is a pivoted shelf, which can be tilted to any angle to the plane of the fire by means of a lever at the front of the door. Two four-blade gears revolving at about 250 revolutions per minute on the top of the shelf spray the coal over the fire as it falls on the shelf from the hopper, which is attached to the top of the door and forms a part thereof. The distribution of the coal is controlled by means of tilting the shelf, and thus directing the spray of coal to any desired part of the grate. The whole operation can be observed through peep-holes in the fire-door. The coal is conveyed to the hopper by a worm conveyor extending from the forward end of the coal space in the tank to the hopper, coal being delivered to this worm from the full length of the coal space by means of another worm. In order to fire by hand, the front worm conveyor is thrown back on its hinge and secured to the tank. The door requires no change, as being all in one piece and hinged on the original fire-door hangers ; and it can be operated like the ordinary door. The size of coal for which this stoker is adapted is everything that will pass through a 3in. or 4in. screen. The Hayden automatic stoker is in use on the Erie Railroad, and a number of tests have been made, which showed its possibilities to be such as to warrant the construction and placing in service of five more machines.

MODEL OF HIGH-TENSION MAGNETO MACHINE.—From the *Car Illustrated*, Limited, of 168, Piccadilly, W., we have received a model of a high-tension magneto machine. On the driving side of the model there are the magnets, the armature and the condenser, and also the two wheels for driving the distributor which is situated on the opposite side. On the front of the model there is the contact breaker, with lever attached for advancing and retarding the spark, the insulated platinum point, the rocker carrying a second platinum point, a double cam wheel operating the rocker, the high-tension distributor, and the four sparking plugs. By holding the model up to the light an imitation spark can be seen at four spark plugs. We have also received a similar model of a carburetter which embodies most of the essential features of the majority of carburetters at present in use.

LETTERS TO THE EDITOR.

(*We do not hold ourselves responsible for the opinions of our correspondents.*)

BRITISH LOCOMOTIVE PRACTICE OF TO-DAY.

SIR,—From a footplate experience extending over twenty years with every notable system of engine employed in European countries during that time, I fail to find any objection to Mr. Riekie's proposal for very large cylinders, provided the boiler steam pressure is proportionately low, or the weight of the boiler increased so as to augment the adhesion weight. Mr. Riekie is merely suggesting what is now done regularly for low-pressure locomotives using superheated steam. In these it is usual to make the cylinders abnormally large to compensate for the low pressure, the mean effective pressure in such engines, as shown by cards, being little more than that attained in the low-pressure cylinders of compound locomotives of modern design ; but the very large size of such cylinders enables them even with a low M.E.P. to develop a considerable tractive force. The proposal to admit the use of abnormally large cylinders, where the existing boiler pressure is high, has been frequently rejected by engineers to whom abnormally large cylinders have been represented as necessary with superheated low-pressure steam, the objection to their use being the slipping difficulty. To overcome this objection the common practice is to reduce the pressure and provide enormous low-pressure boilers whose loaded weight furnishes the additional adhesion required. High-pressure boilers are compact and small for their power, and do not entail a great loaded weight. Mr. Riekie has referred to Serpollet boilers working at 1000 lb. pressure, and he is probably quite able to figure out the weight of a boiler which would replace them for working at, say, 50 lb. per square inch. In proper proportion, the same applies to locomotive boilers. The return to pressures of 150 lb. for superheated steam will account in one or two years hence for some locomotives of a weight wholly unparalleled with present high pressures. This heavy load will provide the requisite adhesion for cylinders of the extraordinary capacity to be adopted, and as suggested by Mr. Riekie. In one instance, the main lines of a railway will have to be reconstructed to carry a wheel load at least two tons heavier than at present in order to support these great low-pressure machines. In another case, some goliath low-pressure engines are already being built which will tax the heavily-railed existing lines for which they are intended.

Considering the success attained with modern British designed and built compounds in England, there appears no reason why this type should not be developed further, and with great advantage, if the most important condition, that of using low-pressure cylinders of about three times the capacity of the high-pressure cylinders, as recommended for many years by all eminent authorities, be respected. This ratio simplifies the engine. No intercepting valve is then needed. Two valves can be used in the place of four valves, and two-valve mechanisms can take the place of four-valve mechanisms, or their equivalents, as at present used for most British four-cylinder non-compounds. The saving in complication by such compound engines relatively to the simple expansion types is about 50 per cent. The range of steam expansion is also 50 per cent. greater—it is, just double. No more successful type than the Great Western Railway four-cylinder non-compounds is known in England, and with these engines, with full open regulator the cut-off averages 20 per cent. on a long run averaging 60 miles per hour with a train of 400 tons behind tender. The ratio of expansion is 5. Now, if the outside cylinders only were replaced with others of three times their capacity, the cut-off, under the same conditions of load and speed, would be 40 per cent. The ratio of expansion would then be 10 ; that is, steam of the same pressure would be expanded to twice the volume of that in the non-compound engines. Considering that the cut-off in the compound engine is double that of non-compound engines having H.P. cylinders of identical size, it might be thought that there was, in consequence, no saving of steam. The saving occurs not in earlier cut-off, but at the regulator, which is usually throttled down in compound engines. These facts are drawn from automatic records of compound engines closely resembling the non-compounds of the Great Western Railway, except that the outside cylinders have three times the capacity of the inside ones, the mechanical arrangements otherwise being the same. No such compound arrangement—the common one of most countries outside of France—is known in this country. Mr. Sisterson once showed readers how it could be effected for our small constructive gauge.

Mr. Holmes, on the North British, built his four-cylinder two-crank compound in 1886 with a ratio as low as 1 : 2.3. As British practice differs from continental, French excepted, in this most important particular, it is not impossible that improved results will be found to follow on the adoption of a greater ratio of volume H.P. : L.P. cylinders of about 1 : 2.95, according to the recommendations of Mallet and Goelsdorf, and now generally employed in Europe. I am led to believe that notable progress can be effected in this direction from the following instance of compound locomotive operation in England, and referring to an engine with two reversing gears and H.P. : L.P. cylinders having a ratio of 1 : 2.77. This ratio, it might be added, had been gradually increased, during years of practice, from 1 : 2.42 up to 1 : 2.77, obtaining better results with every increase. At full speed with a train of 300 tons, on the level, the running cut off of this engine, in England, is 30 + 60 per cent. With such exceptional relative admissions in the two groups the normal receiver pressure is only 25 lb., or less than one-ninth the boiler pressure. Admitting an initial pressure of 25 lb. on the L.P. pistons the mean effective pressure might perhaps be 16 lb. per square inch of piston area, and the total power developed in the L.P. cylinders under three-fourths of that developed in the H.P. cylinders. Whenever the driver decreased this ratio the receiver pressure augmented until, at 40 lb., the engine was liable to be disabled from a certain cause requiring too much space to mention in a letter, and certainly never experienced with the same system and type of engine worked under analogous conditions abroad. A previous driver had settled the matter in his own way : he started with both gears full forward and never touched the L.P. thenceforth. It has always been because of this possibility of what drivers may at any time do with their two independent distributions that every eminent engineer who has had great practice in compounding has most resolutely opposed the use of a separate reversing gear for the L.P. cylinders, which can be used as disastrously as were formerly intercepting valves for enabling such engines to work non-compound.

That compound engines operated in such manner that one side of the engine does little more than one-half of the work accomplished by the other should be found uneconomical surprises no one. But, now, examine the case of a compound engine having two high-pressure cylinders of precisely the same diameter as the one referred to, and only differing in the low-pressure cylinders, being 2.98 times larger than the H.P.

In this case there is no need for four sets of valve gears ; and two valves can be used to distribute steam to four cylinders. The reversing gear, being identical with that used upon all ordinary engines, the driver cannot interfere with the relative admissions of the two groups. The effect of this is at once apparent. With the same working boiler pressure as in the previous engine the receiver pressure averages as much as 72 lb. per square inch, or nearly one-third the boiler pressure. In the other case the pressure is only 25 lb., or one-ninth the boiler pressure, and acting on pistons only 23⅝in. diameter, whereas the 72 lb. per square inch relates to cylinders 24½in. diameter. The work done in the H.P. group is nearly equalled by that effected in the 24½in. L.P. cylinders, and the relative cut-off in both is invariable, this admission being from 40 to 45 per cent. with a gross load of 528 tons, run at an average rate of 60 miles per hour, with a maximum of 70 miles per hour on the level, as automatically recorded by the speed indicator, the engine weighing 66 tons, of which 32 tons are on the drivers. Using the same sized H.P. cylinders and the same boiler pressure, the engines now working in this country are limited to trains of 300 tons on easy sections of the line, whereas they should pull 530 tons gross load with ease at 60 miles per hour average.

The improvement which appears possible is, then, the increase of ratio H.P. : L.P. cylinders in the first place, followed by the abolition of duplex reversing gears, the suppression of all intercepting valves, and a general constructive simplification as, say, all cylinders in one line, suppression of heavy box casings between frames at level of outside cylinders, the use of one valve for each two cylinders, the adoption of one balanced axle instead of two driving axles, divided system, and thus to realise a total effective simplicity of the whole machine not attained in any non-compound engines having the same number of cylinders, and to increase the power of the engine all in reducing the weight of motions and frames, decreasing the first cost very considerably, and giving to the drivers engines which are not only simpler mechanically than the complicated ancient types usually adopted, but in no detail more trouble to manage than ordinary simple expansion engines.

Already Mr. Hughes has made a success of compounding in goods engines, his result of 25 per cent. coal saving at the same working pressures as his recent non-compounds being equal to the best average result of foreign compound locomotives. Mr. Deeley with express engines appears also to have been very successful—although his figures cannot yet be stated. Beyond these two cases of the Lancashire and Yorkshire and Midland Railways there are no railways using wholly British designs of compound locomotives to any large extent with experience sufficient to furnish conclusions against a system which abroad has long passed from the stage of experiment into an invariable practice fully justified by the average results which, whenever published, usually show an annual coal economy of 18 to 25 per cent. in slow moving trains, up to customary averages of 32 and 36 per cent. for fast express trains. This result is quite opposed to prevalent popular opinion, and to opinions that have been expressed by Mr. Hughes, who has no large experience of express compound engines, while Mr. Churchward, whose experience of very fast train services worked by compound engines is precisely similar to that of engineers throughout the whole of Europe, considers that the advantage of compounding is greatest at high piston speeds, and his reply to Mr. Hughes to that effect appears in your pages—see page 289, March 23rd, 1906. It is well known that a compound engine normally saving 30 per cent. of coal in ordinary passenger service will only save about 18 per cent. when it is put to working freight. Compounding goods engines has never taken anything but the second place as an economical system with continental railways.

Taking into account the low ratio of H.P. and L.P. cylinder volumes adopted so far, the success of the only two railways now employing the system to an appreciable extent in this country must be very encouraging to English designers in view, above all, of the considerable improvements that are within easy reach.

Hiterto the popular attitude has been to deprecate all that our engineers have accomplished by means of compounding, and to criticise their efforts. On this question I think most readers will concur with your correspondent, Mr. Dearberg, in his commendation of our engineers for knowing their own particular business better than outsiders, and agree with him heartily that "any course taken by these gentlemen must be taken as authoritative."

The personal experience of Mr. Riekie with compounding may have been the cause of his pessimistic statement that the "slight economy of fuel . . . . is not worth the extra complication;" but it has to be remembered that as there is no standard of economy for simple expansion locomotives, so there is none for compounds, results depending entirely upon excellence of design, and inferior results from mediocre designs cannot be more admitted as condemning single-expansion engines as a whole than they allow of the condemnation of the principle of double expansion in locomotives. I am sorry not to entertain the same views as expressed by Mr. Riekie regarding the absence of ameliorations in locomotive economy in the last forty years. The following published results of Austrian practice give quite another impression:—

Relative Coal Consumptions.

Three and four-cylinder compounds	79 and 66
Single-expansion engines...	100

The compounds, since fitted with Clench-King superheaters as modified in Austria, have now further lowered the compound-fuel consumption by 10 per cent., and without involving a penny for superheater repairs during two years. Still better fuel economy has been attained by applying Schmidt superheaters to such engines, both in France and in Austria, the result being in both cases a saving of about 14 to 15 per cent., the two means of economy combined in one engine effecting a total saving of about 50 per cent., and there is no reason to suppose that still further improvements for reducing the steam consumption per horse-power hour are impractical.

CHARLES R. KING, M.I.C.E., France.

Sir,—I have read Mr. Dearberg's letter which appears in your issue of 6th August with great interest, but see no reason to alter the views I expressed regarding the necessity for enhancing the cylinder capacity of all locomotives. He has, no doubt, made out a good case in defence of British locomotive practice, but only in so far as it can be defended; at the same time he bears out my contention by quoting instances where locomotive engineers have enlarged the cylinders of their engines. That cylinders had to be lined up through breathlessness of certain engines due to a misconception on the part of the designer does not alter the fact that enhanced power was the objective aimed at.

I have no doubt Mr. Dearberg is aware that double engine trains are frequently run. If he will quote a case where a second engine was used, because the one engine lacked the required adhesive weight to allow of the train being started from a state of rest, I will admit the necessity for the use of a second engine if, on the other hand, the assisting engine was required to enable the train to be run to time. I hope he will admit that enhanced power of the locomotive is desirable to enable it to do the work single-handed.

The time may not have arrived to design a locomotive with 50 per cent. greater power than the Great Western Railway 4–6–2 engine. All the same, such a powerful engine could only be designed on the compound system, since a boiler could not be made large enough to give requisite steam for a simple engine of such great power.

Mr. Dearberg asks if I think engines would be better or more efficient by adopting the compound system. My reply is yes, decidedly so, but only if the engine were designed on lines which would make it impossible for him to repeat the astounding statement he makes, viz., that with four high-pressure cylinders as good expansions can be got as with a four-cylinder compound. Regarding his reference to the gentlemen who so ably control British locomotives, after having read the letter signed "L. A. F.," which appears in the same issue of your paper, I prefer to remain silent.

I was quite aware that a simple engine with two 19in. cylinders could do better work than the Worsdell compound, for the reason that it can, when necessary, pass twice the weight of boiler steam through its cylinders.

Mr. Dearberg states he does not wish to make odious comparisons, and then, to my way of thinking, proceeds to do so by explaining how a simple engine with a large cylinder capacity can do better work when pitted against a compound having, for the latter, a very small cylinder capacity. The De Glehn type of compound I had in view was the one with 24in. low-pressure cylinders.

I was pleased to find Mr. Dearberg had a kind reference to make about the late eminent engineer, Mr. Webb. I agree that the failure of this eminent engineer's type of compound was largely due to lack in cylinder power.

I will now deal with what I consider the most important statement made by Mr. Dearberg, and one made at the commencement of his letter, viz.: Unless the adhesion power exceeds the cylinder effort, the engine can never develop its maximum tractive effort. My quarrel with the modern locomotive is that it is designed with a tractive effort up to which it is impossible to work. For instance, the maximum tractive effort is based on a 75 per cent. cut-off in the cylinders—a condition under which we know it is impracticable to work the engine; consequently, it can never be worked to its earning capacity, although the boiler power and adhesion weight is ample to allow of this.

The most favoured cut-off used by all drivers, and one taught them from long experience in their endeavour to economise in fuel consumption, is at about 30 per cent. of the stroke of the piston. To bring about the last word in this discussion, it is only necessary, therefore, to design all locomotives, both simple and compound, taking this workable cut-off as a basis. As 30 per cent. would then be the maximum used by the driver when working a train, it follows that very much larger cylinders could be arranged for without in any way considering the engine as over-cylindered.

In conclusion, if a compound engine be fitted with two 19in. cylinders, so as to be on an equal footing with a simple engine having the same size of cylinders, as regards making use of an equal weight of boiler steam, and if the former be supplemented with two 28in. or the largest low-pressure cylinders admissible, thus enabling it to more than double the number of steam expansions of the simple engine under all conditions of work, it surely must be obvious that there can be no comparison as to which will be the better engine.

Argaith, Dumbreck, August 10th. JOHN RIEKIE.

LATENT AND SENSIBLE HEAT.

Sir,—As no one has brought forward any evidence in support of Régnault, as asked for in my letter of July 2nd, are we to understand that the scientific world has accepted Régnault, Rankine, and Clausius entirely upon trust and without any corroboration of any sort or description, and this in spite of the fact that actual engines and independent evidence contradict their statements? I ask again for evidence corroborating Régnault, if it exists. I can find none, although I have honestly, conscientiously and to the best of my ability tried to do so.

The present position cannot be better summed up than by this quotation from your leading article on "The Tyranny of Scientific Dogma." "If Régnault is right, then steam in an engine ought to behave in one way. It insists on behaving in a different way." This is the fundamental fact which I feel sure has to be realised. Practice and theory are playing a terribly complicated game of cross purposes, owing to the fact that actual engines deal with actual steam, whilst the theorist and mathematician does not deal with actual steam, but what he believes is actual steam, and our text books do the same thing.

I have already shown that Carnot's fundamental basis can be arrived at by a totally different line of reasoning to Carnot's, and that Carnot's fundamental basis confirms Southern's Law, although neither Carnot nor Southern knew of the other's existence.

Again, I have shown that Despretz—one of the greatest experimental physicists who ever lived—and Southern, by carrying out in practice what Régnault declared essential instead of what Régnault actually did, made the total heat in saturated steam at atmospheric and above atmospheric pressure more than Régnault, whilst Willans, who wire-drew his steam—that is, measured the heat in superheated steam—like Régnault, a thing which Régnault says must not be done if the heat in saturated steam is to be measured, agrees closely with Régnault. I have also pointed out this obvious fact, if their methods are examined.

Despretz and Southern measured the heat in saturated steam. Régnault and Willans measured the heat in superheated steam. This means that the present steam tables are wrong, except for the temperatures equivalent to the pressures. Perhaps it will be thought that this is simply reiteration, but I have been asked to explain why the fact of Régnault having measured the heat in superheated steam instead of saturated steam, as he believed, owing to his not knowing that steam can superheat itself, makes such a difference in steam calculations.

If steam is superheated steam when the heat is measured, obviously to arrive at the latent heat the superheat must first be deducted, and then the sensible heat in steam at the pressure which the steam would be at if it was saturated steam instead of superheated steam. That is, two distinct quantities of heat must be deducted to arrive at the latent heat if the steam is superheated steam. It is also quite obvious that it is immaterial whether the superheated steam has been produced by its receiving external heat, or by saturated steam being wire-drawn. It is the actual condition of the steam when the heat is measured which counts, not its previous condition.

What Régnault did was this, he measured the heat in low-pressure superheated steam producing by wire-drawing steam, but instead of arriving at the latent heat as above, he deducted from the quantity of heat in the low-pressure superheated steam the sensible heat in the original steam, and called the balance of the heat the latent heat in the steam before it was wire-drawn. Obviously it is nothing of the kind. It is no definite kind of heat at all.

Not only does Régnault's own description of his experiments show that this is what he actually did, but the values he obtained show the same thing, as anybody can see in two minutes for himself if he looks at the steam tables, as all the total heats are for superheated steam at a low pressure, as they are less than the values for superheated steam at atmospheric pressure and at saturated steam temparature. The same thing is found if Willans' results are examined, viz., they are superheated steam values Here is a perfectly clear issue, and a definite statement of fact. Now what does this mean when steam is dealt with mathematically? It means: (1) That when latent heats are being dealt with, actual latent heats are not used. (2) That when dry saturated steam is being dealt with, actually the values for superheated steam at a totally different pressure are being used. (3) When superheated steam is being dealt with, actually the values for superheated steam at a totally different pressure, and containing a totally different amount of superheat are being used. (4) That when volumes are dealt with they are volumes which do not exist, except in theory, as they are calculated from these false latent heats.

Now I ask this perfectly plain question—how can theory and practice be expected to agree under these circumstances? The above only applies to steam at above atmospheric pressure, as Régnault made a different mistake at below atmospheric pressure which caused his error to reverse—that is, his values became too high instead of being too low for the total heat in saturated steam. Why I have such confidence in Southern cannot be better stated than by altering the quotation from your leading article. If Carnot, Despretz and Southern are right, then steam in an engine ought to behave in one way. It insists on behaving in this way.

Blackheath, August 3rd. FRANK B. ASPINALL.

EXPERIMENTS WITH A GLASS CARBURETTER.

Sir,—As a carburetter maker, anything relating to this subject is eagerly read by me. The article by Mr. Bickford in this week's issue is extremely disappointing, since it follows the usual course of ascribing the results obtained by the various carburetter makers to "pot luck" and "hit or miss" methods. Not only does the writer make such assertions, but proves them by experimenting with lamp glasses, tubs, tubes, pieces of metal plate, &c., under conditions utterly unlike those which occur in actual practice.

When an apparatus is constructed so that the actual volume weight of air may be measured, and then, in order to make the figures come right, the experimenter has recourse to calculation, something is very much out, especially in the light of recent remarks made in The Engineer, which stated that no reliable method of measuring the flow of fluids had ever been discovered.

In his extraordinary observations of the behaviour of petrol when passing along lamp tubes, does Mr. Bickford really believe that the same thing occurs in the induction pipe? If so, can he explain why an engine ceases firing instantly if petrol is cut off and air only admitted? Surely it should continue firing for a considerable time, until all the waves, &c., were used up.

He shows that if the petrol, after leaving the jet, passes with the air through a small opening the high velocity helps atomisation, and he instances one or two carburetters which follow this arrangement when throttle is nearly closed. Will he kindly tell us of any carburetters which do not present a small area when the throttle is nearly closed? Will he go into the temperature changes which take place when petrol is injected? I find in the Gillett-Lehmann carburetter there is a drop of about 50 deg. Fah. between the inlet and the outlet of the carburetter; what allowance did he make for this in his calculations for quantity? Does he really think that a constant proportion should exist in the mixture, or that some allowance should be made for varying amounts of compression in cylinders; and is it necessary to consider the proportions as affecting the length of time taken by inflammation in relation to piston speed?

When reading an article, apparently the same, in one of the motor papers, I passed it by as being suitable for the motoring public; but when I find it taking up valuable space in The Engineer, the paper accepted as the one technical organ, I must be excused for "kicking" at what, to me, as a carburetter maker, adds insult to injury.

August 10th. WALTER GILLETT.

Sir,—I have read Mr. J. S. P. Bickford's article on the above subject with great interest, and it has certainly deepened my convictions, that two characteristics are essential to get a reliable explosive mixture under all conditions, first, partly to atomise the petrol, and secondly, to vaporise the mixture.

Most carburetters will atomise sufficient to get an explosive charge under certain conditions, which vary with different types, and not till the combustion chamber is well warmed up can any reliance be placed on an explosion. The best results during my experiments were got by having a petrol-control valve. This admitted a small quantity of petrol into the suction pipe (this supply being regulated by the governors), which was partly atomised by the air, and the mixture being carried through a heated tube vaporised it. I found this plan very reliable and economical.

A very striking similarity is Patent 16,927 in this week's issue of The Engineer.

London. August 7th. FRANK ELLENGER.

EARLY BALANCED LOCOMOTIVES IN AMERICA.

Sir,—Replying to Mr. Brewer's inquiry in The Engineer of July 16th, it may be said that one of the earliest American designs of four-cylinder balanced locomotives was the Shaw locomotive with all outside cylinders, which was built and used experimentally about twenty-five years ago. Some years later the Ball locomotive was designed, but it does not appear that it was actually built. This also had the four cylinders outside, and those on each side were tandem, but offset laterally so that the long piston-rod of the forward low-pressure cylinder was alongside—and on the inner side—of the high-pressure cylinder. The two connecting-rods drove the same axle, that of the low-pressure cylinder being attached to the usual crank pin, while that of the high-pressure cylinder was attached to a return crank. The cranks on each side were placed at 180 deg. with each other, and at 90 deg. with those on the other side. The Strong engine, 1897, had two inside high-pressure cylinders and two outside low-pressure cylinders, all connected to the first driving axle of an engine of the 4–4–2 type. The first Baldwin four-cylinder balanced compound was built in 1902, and had all cylinders driving on the first driving axle of an engine of the 4–6–0 type. The high-pressure cylinders were inside.

Since then many balanced compounds have been built, but they are not now used to any great extent, the advantages being considered apparently as not warranting the increased cost. Three-cylinder simple locomotives were used many years ago to give a more equable turning moment, and avoid stalling trains on heavy gradients. A fast passenger engine of this type has been built recently for experimental work. RAILWAYS.

HOLLOW AXLES, CRANK PINS, AND STUD PINS.

Sir,—Concerning the practice of boring out the crank pins of locomotive wheels, of which you, in the recent article on "Flexible Crank Axles" are unaware of any instance, will you allow me to point out that the boring out of crank axle pins and outside wheel pins is the rule rather than the exception in modern locomotive practice of the Continent, and nearly all examples you have illustrated for some years past show this detail. Notable instances occur on page 94, July 27th, 1906; page 311, September 28th, 1906; page 570, December 7th, 1906, &c.

France. CHARLES R. KING.

Wreck Statistics for 1908.—The statistical summary of vessels totally lost, condemned, &c., now published by Lloyd's Register, shows that, during 1908, the gross reduction in the effective mercantile marine of the world amounted to 800 vessels of 809,292 tons, excluding all vessels of less than 100 tons. Of this total, 382 vessels of 566,487 tons were steamers, and 418 of 242,805 tons were sailing vessels. The figures for various periods, which are given in the report in tabular form, show that steamers have a much greater immunity from disaster than have sailing vessels. The tables exhibit interesting data as to the relative frequency of the different kinds of casualty, &c., which conclude the existence of vessels. Strandings and kindred casualties, which are comprised under the term "wrecked," are much the most prolific cause of disaster. To such casualties are attributable 43.5 per cent. of the losses of steamers and 33.8 per cent. of the losses of sailing vessels. The next most common termination of a vessel's career is by condemnation, breaking up, &c., 20.4 per cent. of the steamers and 27.8 per cent. of the sailing vessels removed from the merchant fleets of the world being accounted for in this manner. Cases of abandoned, foundered, and missing vessels are no doubt frequently more or less similar in the circumstances of loss. If these be taken collectively, they comprehend 19.4 per cent. of the steamers, and 24.2 per cent. of the sailing vessels removed from the mercantile marine during 1908. The return has been compiled by Lloyd's Register in such a manner as to enable a comparison to be made between the percentages of loss suffered by each of the principal merchant navies in the world. Great as the absolute annual loss of vessels belonging to the United Kingdom appears to be, it is seen to form a very moderate percentage of the mercantile marine of the country, and to compare favourably with the average of the losses sustained by other leading maritime countries.

LOCOMOTIVES DESIGNED AND BUILT AT HORWICH, WITH SOME RESULTS.*

By Mr. GEORGE HUGHES, Member, Chief Mechanical Engineer, Lancashire and Yorkshire Railway, Horwich.

(*Concluded from page* 150.)

APPENDIX I.

CONDITIONS OF SERVICE.

It is important that some of the conditions under which a given set of locomotives are designed and employed should be known; consequently the author gives in this Appendix an idea as to gradients, obstructions, junctions, rolling stock required, character of trains negotiated, and intensity of traffic, represented by miles of line and quantity of rolling stock required.

The total mileage maintained by the Lancashire and Yorkshire Railway Company is 585¼, divided as follows:—

	Miles.
Six or more lines	11¾
Five lines	7½
Four lines	64¼
Three lines	21¾
Double lines..	440¼
Single line	39¾
Total	585¼

A map of the railway is shown in Fig. 2, and 337 miles of gradients in Figs. 3 to 10 [page 119, *ante*], and the following is a table of gradients up to 1 in 500 (Euxton Junction to Preston, Maudlands Junction, excepted):—

Gradients.	Mls.	chns.	yds.
Under 1 in 30	1	5	7
1 in 30 and under 1 in 50	12	1	19
1 in 50 ,, 1 in 75	49	22	3
1 in 75 ,, 1 in 100	61	17	10
1 in 100 ,, 1 in 125	54	33	17
1 in 125 ,, 1 in 150	36	52	14
1 in 150 ,, 1 in 175	38	15	16
1 in 175 ,, 1 in 200	21	16	4
1 in 200 ,, 1 in 250	41	3	20
1 in 250 ,, 1 in 300	28	55	20
1 in 300 ,, 1 in 400	55	61	12
1 in 400 and including 1 in 500	29	21	6
Total	428	67	16

Euxton Junction to Preston, Maudlands Junction:—

Gradients.	Mls.	chns.	yds.
1 in 100 and under 1 in 125	1	6	20
1 in 125 ,, 1 in 150	0	10	0
1 in 150 ,, 1 in 175	0	9	0
1 in 200 ,, 1 in 250	0	16	0
1 in 250 ,, 1 in 300	0	72	0
1 in 300 ,, 1 in 400	2	5	0
1 in 400 and including 1 in 500	0	67	21
Total	5	26	19

Total number of tunnels	50
Total number of under and over-bridges	2478
Total number of openings in same	5108
Signal-boxes (L. and Y.)	677
,, (Joint, maintained by L. and Y.) ..	61
Total	738
Ground frames (L. and Y.)	58
,, ,, (Joint, maintained by L. and Y.) ..	2
Total	60

Number of block signal-boxes between:—

Liverpool and Manchester	68
Manchester and Normanton	102
Manchester and Blackpool, *viâ* Bolton	107
Passenger stations (L. and Y.)	260
,, ,, (Joint, maintained by L. and Y.)	31
Total	291
Halts (L. and Y.)..	16
,, (Joint, maintained by L. and Y.)	2
Total	18

Junctions are frequent, and there are, from some of the stations, rising gradients as severe as 1 in 50.

The traffic moving in and out of large stations is considerable, as for instance at Victoria, Manchester, where 280 passenger trains arrive and 301 depart each day; in addition to which, 62 passenger trains and 80 goods trains pass through, but exclusive of specials and empty trains.

The number of engine workings per day is divided as follows:—

Express passenger workings	106
Slow ,, ,, ...	273
Passenger shunt engines	21
Express goods workings	163
Slow ,, ,, ...	341
All shunt workings	199
Total	1103

Total stock:—

Locomotives	1,517
Carriages	4,779
Wagons	32,793

The following trains are worthy of remark:—

Passenger:—2.10 *p.m. Liverpool to Hull* (Engine, Fig. 30, page 121 [*ante*]).—This train is run in connection with the company's steamers plying between Goole, Hull, and Zeebrugge, and the other continental ports. The train is formed of vestibule corridor stock, and frequently consists of equal to fifteen vehicles, or 375 tons behind the drawbar. The connection from Preston and East Lancashire district is attached at Brighouse, and a portion of the train is detached at Wakefield, to be worked forward to York. The train has five stops from Liverpool to Hull, and is run at an average speed on the total journey of 48.9 miles per hour. The return traffic from Hull is worked by the 9.5 a.m. train, which corresponds with the 2.10 p.m. from Liverpool. An engine that can haul equal to fifteen between Liverpool and Manchester, 36 miles 1653 yards, in 40 minutes, can do anything in this country.

10.55 *a.m. Liverpool to Newcastle* (Engine, Fig. 29 [*ante*]).—This train is worked by the Lancashire and Yorkshire Railway Company between Liverpool and York. It is formed of vestibule corridor and dining-car stock, and is made up to as much as equal to 11 vehicles, or 275 tons. The train has seven stops, and the average speed for the total journey is 46.1 miles per hour. The return train for this is the 12.42 p.m. from Newcastle, which leaves York for Liverpool at 2.36 p.m. This train has four stops, and the average speed for the journey is 48.9 miles per hour.

Leeds and Fleetwood Boat Trains (Engine, Fig. 29 [*ante*]).—The 8.5 p.m. from Leeds to Fleetwood is run in connection with the company's steamers between Fleetwood and Belfast. The train is formed of vestibule corridor and dining-car stock, and is made up to as much as equal to 14 vehicles, or 350 tons. The return traffic from Fleetwood is worked by a similar train leaving Fleetwood at 5.55 a.m.

Blackpool and Manchester Service (Engine, Fig. 29 [*ante*]).—The 8.10 a.m. from Blackpool to Manchester, with the return from Manchester at 5.10 p.m., is an important express train for business people residing in the Blackpool district. The train is formed of vestibule corridor stock, and two special club saloons, and is made up to as much as equal to 15 vehicles, or 375 tons. The first stop is at Lytham, and the speed between Manchester and Lytham is 45 miles per hour. The 7.13 a.m. from Blackpool Central and the 5.55 p.m. from Manchester are similar trains to the above, and are composed of vestibule corridor stock, and made up to as much as equal to 14½ vehicles, or 362 tons. The average speed between Manchester and Lytham is 44.1 miles per hour.

Southport and Manchester Service (Engine, Fig. 30 [*ante*]).—The 8.10 a.m. Southport to Manchester, and the 5.0 p.m. back, are important business trains for residents in Southport district. The trains are composed of vestibule corridor stock, and are made up to as much as equal to 13½ vehicles each, or 337 tons. The average speed for the total journey is 47.1 miles per hour, and 43.7 miles per hour on the return. The 8.30 a.m. Southport to Manchester and the 5.40 p.m. back are similar trains to the above, the speed being 47.1 miles and 43.7 miles respectively.

Blackpool and Colne Service (Engine, Fig. 27 [*ante*]).—The 7.40 a.m. Blackpool to Colne is an important express train for residents in the Blackpool district who have business in the East Lancashire district. The train is composed of 8 ordinary bogie stock, equal to 200 tons, and four bogie carriages are slipped at Blackburn. After leaving Lytham the first stop is at Rose Grove, a distance of 35 miles 215 yards, which distance is run at an average speed of 42.1 miles per hour.

Goods Trains:—11.30 *a.m. North Docks to Salford, and* 2.0 *p.m. Salford to Liverpool.*—These trains are worked by coal engines—Fig. 31 [*ante*]—and run from Aintree to Salford and back, a distance of 37¼ miles in each direction. On the return journey from Salford the load is limited to 350 tons, which is equal to 43 loaded wagons of goods, to enable the train to be run from Hindley Junction to Aintree sorting sidings at an average speed of 34 miles per hour. This includes travelling up the bank of 1 in 91 from Westwood to Orrell West. With 4-cylinder engines 6-wheel coupled—Fig. 30 [*ante*]—with loads of 50 wagons, equal to 400 tons, much higher speeds have been attained, an average speed of over 40 miles per hour having been run, and, for a distance of 6 miles, 60 miles per hour. The goods, which are brought in from the Manchester market the same morning, are loaded in the Salford Yard up to a few minutes before the departure of the train, and the quick transit to Liverpool is to enable them to be shipped on vessels leaving Liverpool the same day.

10.40 *p.m. Hull to Moston* (*Manchester*).—This train is worked by a coal engine—Fig. 31 [*ante*]—and conveys traffic from Hull and Goole, and also exchange traffic for the Hull and Barnsley line. It is classified to work a load of 800 tons, equal to 100 loaded goods wagons, from Hull to Hebden Bridge, and 745 tons from the latter point to destination. The train is frequently loaded up to its maximum of 120 wagons, and its booked speed throughout the journey averages 22 miles per hour. The train makes four traffic stops throughout its journey of 95 miles.

8.40 *p.m. Aintree to Horbury.*—This train is worked by a coal engine—Fig. 31 [*ante*]—and conveys important traffic from Liverpool for stations beyond Wakefield and North-Eastern line, York and Newcastle districts. It is booked to run from Aintree to Horbury without a stop, a distance of 71 miles, with a classified load of 400 tons, or equal to fifty loaded goods wagons at a booked average speed of 23½ miles an hour, and has to be hauled up gradients of 1 in 85 and 1 in 97. Great importance is attached to the prompt running of the train, and a good path is invariably provided.

10.45 *p.m. Goole to Liverpool.*—This train is worked by a coal engine—Fig. 31 [*ante*]—and conveys continental traffic loaded at the ports of Hull and Goole, which is consigned to Manchester and Liverpool and surrounding districts. From Goole to Liverpool, a distance of 102 miles, the train has one booked stop, and travels at an average speed of 22 miles per hour, with a load of 800 tons, equal to 100 wagons of goods, from Goole to Brighouse, a distance of 41 miles, afterwards running the remaining 61 miles without a stop, with a load of 745 tons, equal to ninety-three wagons of goods. The greater portion of the distance travelled is on the ascending gradient.

TABLE V.—*Summary of Trains Detailed above.*

Passenger or goods.	Train.	Load behind drawbar.	Average speed.	Maximum gradient.
		Tons	m.p.h.	1 in
Passenger	2.10 p.m. Liverpool to Hull	375	55.4 Liverpool to Manchester; 48.9 throughout	50
,,	10.55 a.m. Liverpool to Newcastle	275	46.1	50
,,	12.42 p.m. Newcastle to Liverpool	275	48.9	84
,,	8.5 p.m. Leeds to Fleetwood ..	350	—	50
,,	8.10 a.m. Blackpool to Manchester	375	45.0	100
,,	8.10 a.m. Southport to Manchester	337	47.1	93
,,	7.40 a.m. Blackpool to Colne ..	200	42.1	100
Goods	2.10 p.m. Salford to North Docks	350	34.0	84
,,	10.40 p.m. Hull to Moston	800	22.0	150
,,	8.40 p.m. Aintree to Horbury ..	400	23.5	85
,,	10.40 p.m. Goole to Liverpool ..	800	22.5	84
,,	10.20 p.m. Salford to Hull	960	22.0	50
,,	10.55 p.m. Aintree to Leeds	575	22.0	100

10.20 *p.m. Salford to Hull.*—This train is worked by a coal engine—Fig. 31 [*ante*]—and conveys traffic from Salford and Manchester for Goole, Hull, Doncaster, and the Hull and Barnsley line. It is booked to run from Miles Platting (Manchester) to Pontefract, a distance of 55 miles, without a stop, and conveys loads up to the maximum of 120 wagons at a booked average speed of 22 miles per hour. Throughout the journey from Salford to Hull, a distance of 100 miles, there are four traffic stops. The connectional traffic conveyed by this train is very important.

10.55 *p.m. Aintree S.S. to Leeds.*—This train is worked by a coal engine—Fig. 31 [*ante*]—and conveys fruit and other important market goods for the Halifax, Bradford, and Leeds markets. To Leeds is a distance of 80 miles, and the first stop for traffic purposes is at Halifax, 63½ miles; a stop, however, is made at Accrington for examination purposes. A through load of 575 tons, equal to seventy-two loaded wagons of goods, which is based on the rising gradient of 1 in 100, from Bamber Bridge to Hoghton, is conveyed by this train, and, as a good path is kept, a prompt arrival at Halifax and Leeds is regularly maintained.

TABLE VI.—*Loads Hauled by Goods Engines over Various Sections.*

Section of road (see page 119 [*ante*]).	Coal engines—Fig. 31.			6-wheeled goods—Fig. 25.		
	Through load.	Local goods vary according to grade.		Through load.	Local goods vary according to grade.	
		From	To		From	To
Fig.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.
3	429	429	1000	267	267	772
4	790	790	1000	475	475	750
5	440	440	956	275	275	600
6	509	509	737	319	319	468
7	341	341	1000	210	210	760
8	561	561	1000	353	353	645
9	341	341	1000	210	210	658
10	206	206	735	120	120	480

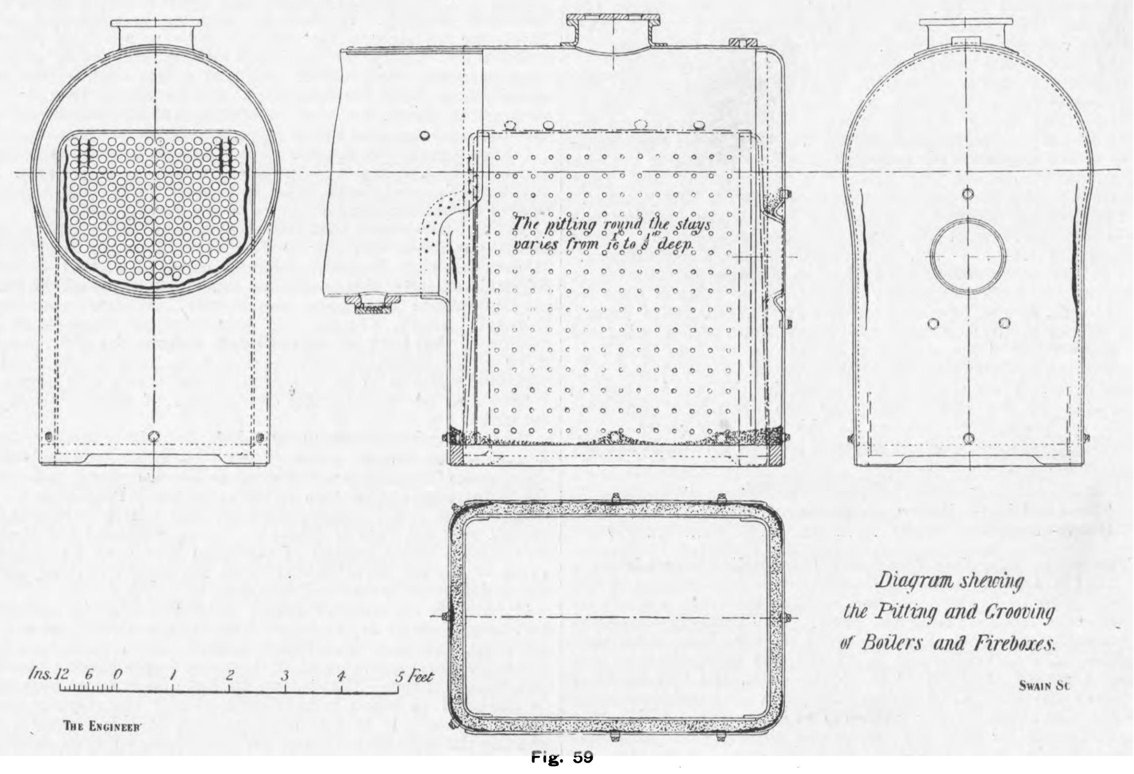

The pitting round the stays varies from 1/16" to 1/8" deep.
Diagram shewing the Pitting and Grooving of Boilers and Fireboxes.
Ins. 12 6 0 1 2 3 4 5 Feet
The Engineer
Swain Sc

Fig. 59

APPENDIX II.

WEAR AND TEAR OF BOILERS.

This may be divided under two headings, namely, Grooving and Cracking, by reason of expansion and contraction; and Pitting brought about by deposits which are carried in solution and suspension in the water. The pitting at the smoke-box end is produced by chemical reactions going on in the mud which is deposited, and pitting round the stays and sides of wrapper plates, probably by chemical and electrical actions. The diagram—Fig. 59—shows the pitting and grooving of boilers and fire-boxes. So serious, a few years ago, was pitting in the bottoms of boiler barrels that the author decided to carry out a number of experiments with a view to eliminating the same. For example, cementing the bottoms of the barrels, using nickel steel plates, inserting steel and copper tubes mixed, and also suspending zinc blocks, but without any material improvement. Subsequently, he then selected a number of boilers, and lined the barrel bottoms with thin Low Moor iron sheeting, also old copper plates and lead sheeting. In three years the Low Moor iron sheeting was completely eaten through, and when examined resembled a riddle. The old copper plate, of course, remained intact, but the lead sheeting in twelve months' time had entirely disappeared. Before this disappearance, however, complaints were made to the author that the gauge glasses were being coated with a white film, which obscured the water levels, and upon scraping sufficient from the inside of the gauge glasses, in order to make a qualitative analysis, it was discovered to be lead carbonate. The author was induced to try lead on account of his knowledge of its acid-resisting properties; as traces of acid had been found in some of the waters used, he did not anticipate that carbonic acid gas would be

TABLE VII.

Substance.	Bottom of barrel.			Side of barrel.			Crown of loco. fire-box.
	Smoke-box-plate.	Centre plate.	Fire-box plate.	Smoke-box plate.	Centre plate.	Fire-box plate.	
	p.c.	p.c.	p.c.	p.c.	p.c.	p.c.	p.c.
Silica	3.9	4.5	6.0	21.6	19.1	18.6	5.5
Oxides of iron and alumina..	71.5	60.0	26·5	9.9	24.9	6.9	3.0
Sulphate of lime	2.1	5.8	48.8	1.9	4.8	2.2	68.0
Carbonate of lime	16.0	18.3	4.2	21.5	15.3	10.7	0.4
Lime other than carbonate or sulphate, calculated as hydrate ..	—	—	—	29.9	10.1	34.1	—
Carbonate of magnesia	7.0	5.6	7.4	—	—	—	9.0
Hydrate of magnesia ..	—	5.7	7.1	12.5	26.0	21.1	14.0
Total	100.5	99.9	100·0	97.3	100.2	93.7	99.9

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* The Institution of Mechanical Engineers.

generated in the bottoms of the boiler barrels to such an extent as to combine with the whole of the lead. From this discovery, a cycle of chemical reactions was formulated, and recognised as a reasonable explanation of the immense amount of pitting that goes on in locomotive and other boiler barrels. Table VII. gives the analysis of deposit from six different positions of the boiler barrel

Priming.—To ascertain the real cause of priming, the author has carried out investigations which may be of interest. Observations were made on several boilers of different designs, when it was found that design had little effect on priming, and that the real cause—provided that care was exercised in handling the engine, and the water level in boiler not exceeded—depended on the quality and quantity of water evaporated. A chemical analysis of two waters experimented upon is given below:—

	Grains per gallon. No. 1.		Grains per gallon. No. 2.
Carbonate of lime	4.9	..	3.8
Carbonate of magnesia	0.5	..	0.5
Sulphate of lime	3.7	..	3.2
Sulphate of magnesia	2.5	..	2.0
Oxides of iron and alumina..	0.1	..	nil
Scale-forming matter	11.7	..	9.5
Sodium chloride	5.7	..	2.8
Total dissolved solids	28.0	..	16.0

It will be noticed that, so far as scale-forming matter is concerned, there is not a great variation in the two waters, but No. 1 caused priming much sooner than No. 2. The boiler fed by the former primed badly at the end of four days' work, whereas with the latter the engine ran six days before priming occurred. In both cases the daily evaporation was much the same. Seeing that priming occurred much sooner in the case of No. 1 than No. 2, and that the proportion of scale-forming matter was nearly the same in the two waters, the conclusions drawn were that these scale-forming constituents did not produce priming. The subject was next investigated in the light of salts other than scale-forming. These are best described as soda—or soluble salts—the predominating constituent being the sulphate. In order to ascertain to what extent these particular salts influenced priming, very accurate measurements were made of the water collected and evaporated. It was also analysed for the quantity of solids carried into the boiler.

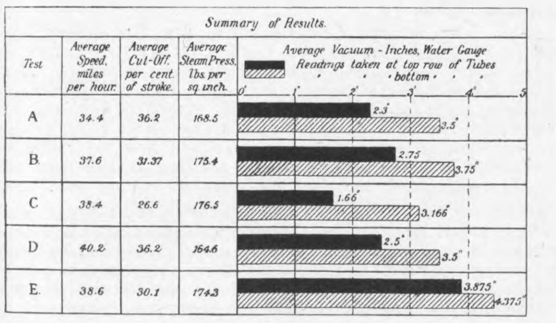


Fig. 62

TABLE VIII.—*Showing the Gradual Concentration of Soluble Salts up to the Point of Priming.*

Engine No.	Class of engine.	Day.	Grains of soluble salts per gallon of water in boiler.	Remarks.
1402	10-wheel bogie passenger	1st	46	No priming
,,	,, ,,	2nd	117	,,
,,	,, ,,	3rd	164	,,
,,	,, ,,	4th	210	,,
After 4th day boiler washed out to prevent priming.				
281	Radial passenger tank ..	1st	127	No priming
,,	,, ,,	2nd	194	,,
,,	,, ,,	3rd	269	Primed badly
262	,, ,,	1st	184	No priming
,,	,, ,,	2nd	266	Primed badly
806	,, ,,	1st	132	No priming
,,	,, ,,	2nd	230	Primed badly

APPENDIX III.

SMOKE-BOXES, BRICK ARCHES, AND ASHPANS.

The success of an engine entirely depends upon the boiler, and the excellence of the latter turns on the subject of this Appendix. The primary function of the smoke-box and its equipment is the production of draught, to economically burn the fuel at a proper rate, and at the same time to maintain satisfactory steaming when working under all conditions of service. These qualifications are dependent largely upon proper proportions, the location and diameter of blast-pipe nozzle, its relation to chimney and tubes, and height and diameter of chimney. Blast pipes require to have an orifice sufficiently large to prevent back pressure in cylinders, and at the same time small enough to produce efficient draught. A proper disposition of the blast-pipe orifice in its relation vertically to the chimney top, together with its right height from the boiler centre line and a correctly proportioned chimney, will enable the orifice to be increased in diameter.

It must be remembered that an enormous amount of air enters the fire-box, and is immediately expanded six to eight times by rise of temperature, and upon arrival at the smoke-box and exit from the chimney it is two or three times its original volume; and as the office of the smoke-box equipment is to deal effectually with this air, which is a variable quantity, a combination must be discovered for each class of engine which will produce the best all-round efficiency. With a view of arriving at some conclusions on this question, the author has from time to time carried out experiments on certain classes of engines, with the following results:—

Long versus short smoke-boxes.—To ascertain the value of long and short smoke-boxes, observations were taken on two radial passenger tank engines—Figs. 18 and 19, page 121 (*ante*). Particulars are given in Table IX.

Experiments on the position of Blast-Pipes.

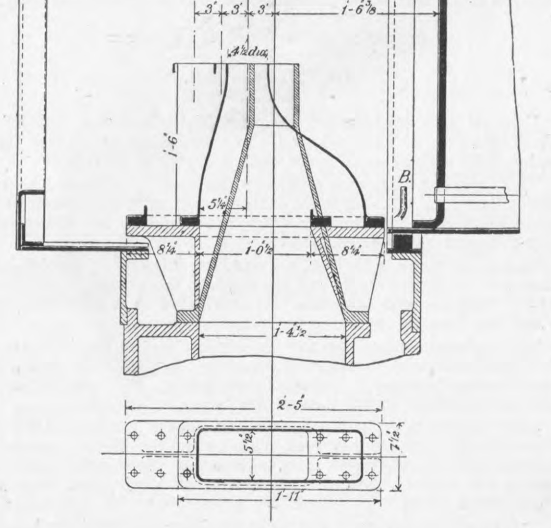


Fig. 63

TABLE IX.—*Long* v. *Short Smoke-boxes.*

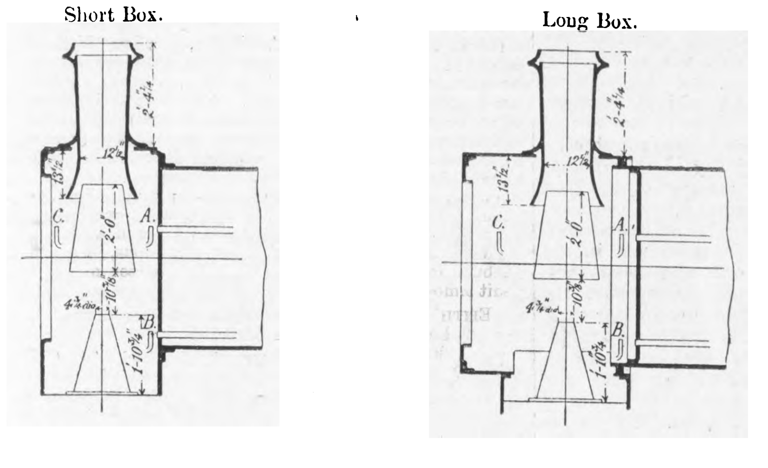
Engine.	Length of smoke-box.	Cubical capacity of smoke-box.	No. of tubes.	Length between tube-plates.	Area through tubes.	Grate area.	Air space through grate.	Per cent. of air space.	Area through ashpan door opening.
		cu. in.			sq. in.	sq. ft.	sq. in.		sq. in.
Fig. 18	32⅛	100,190	220	11-0	388.7	18.75	855.25	32	274.95
19	46½	111,390	220	10-9⅜	388.7	18.75	919.6	34	215·87

Both engines were equipped with identically the same blast-pipe, chimney, and hood, but the smoke-box of Fig. 19, page 121 (*ante*), had a capacity 11 per cent. greater than Fig. 18. The smoke-box arrangements of the two engines are shown in Fig. 60.

Vacuum readings were observed at points A, B, C, through pipes projecting into the smoke-box to the vertical centre line of the engine; the outer end of each pipe was connected by rubber tubing with one leg of a manometer, or "U" shaped glass tube, partially filled with coloured water, and the table underneath gives a summary of the results.

In perusing this table it will be noticed that the vacua are even, all over the tube-plate, indicating that the position of blast-nozzle, hood, and chimney appeared to be about right. With the extended smoke-box, a higher vacuum is recorded at C than at A and B, which tends to prove that the long box serves as a reservoir, thus assisting the maintenance of draught between each exhaust, and so modifying the intermittent character of the blast. This is verified by the action in the glass tubes. With the extended smoke-box the water remains quite steady, and only moves when the steam discharge up the chimney is altered; whereas with the short box the water is in a constant state of agitation, rising and falling with each exhaust. The vacuum in both smoke-boxes was about normal for the cut-offs of 39 and 51 per cent. respectively, but steam pressure was better maintained in the extended smoke-box engine.

Vacuum in Smoke-Box Tests.



Test	Between Manchester and Bolton.					Between Bolton and Entwistle.				
Type of Smokebox.	Vacuum in Inches Water Gauge. Top row of Tubes. A	Vacuum in Inches Water Gauge. Bottom row of Tubes. B	Vacuum in Inches Water Gauge. In front of Blast Pipe. C	Boiler Pressure, lbs. per sq. inch.	Cut-off, per cent. of Stroke.	Vacuum in Inches Water Gauge. Top row of Tubes. A	Vacuum in Inches Water Gauge. Bottom row of Tubes. B	Vacuum in Inches Water Gauge. In front of Blast Pipe. C	Boiler Pressure, lbs. per sq. inch.	Cut-off, per cent. of Stroke.
Short Type.	3"	3"	3"	157	39.2	3"	3"	3"	157	39.2
Long Type.	3"	3"	4"	175	39.2	4.4"	4.4"	5.2"	174	51.7

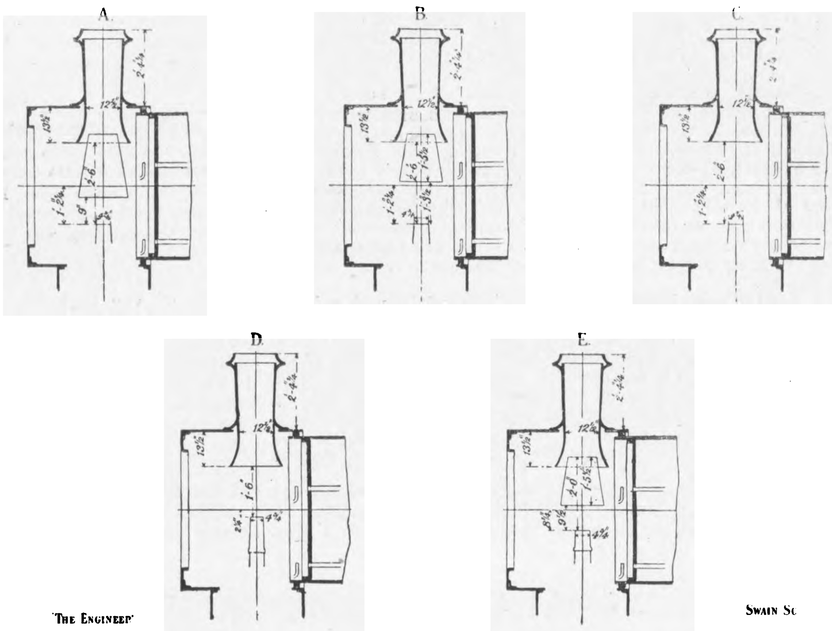
"The Engineer" Swain Sc.

Fig. 60

Experiments to determine the heights and lengths of hood and blast-pipe in relation to tubes.—A series of experiments were conducted on one of the radial passenger tank engines with extended smoke-box—Fig. 19 (*ante*). Five different arrangements—Fig. 61—were tested as follows:—

- A. Blast pipe 1ft. 2¼in. below horizontal centre line of boiler; hood 1ft. 11½in. long.
- B. Blast pipe 1ft. 2¼in. below horizontal centre line of boiler; hood 1ft. 5½in. long.
- C. Blast pipe 1ft. 2¼in. below horizontal centre line of boiler; without hood.
- D. Blast pipe 2¼in. below horizontal centre line of boiler; without hood.
- E. Blast pipe 9¼in. below horizontal centre line of boiler; hood 1ft. 5½in. long.

Experiments to determine the heights and lengths of Hood and Blast Pipe



"The Engineer" Swain Sc.

Fig. 61

On the first four tests the loads were the same, namely, 160 tons behind the drawbar, but on test E the train hauled was 200 tons. The same chimney was used on all trials, namely, 12½in. diameter choke, tapered, and increasing 1.4in. per foot towards the top, length, 2ft. 4¼in. The blast-nozzle was 4¾in. diameter in all cases. Diagrams, letters A to E, show the different arrangements tried, and the table—Fig. 62—gives the summary of results. The best conditions were obtained from test E arrangement, as regards the highest vacuum and least variation in the intensity of draught at the top and bottom row of tubes. Test C was also very satisfactory, considering the low vacuum maintained. This, however, is accounted for by the fact of the weather being calm on that occasion, enabling the engine to be operated at an earlier cut-off, and with less demand on the boiler.

Table of Results of Tests.					
Position.		Test No. 1.	Test No. 2.	Test No. 3.	Test No. 4.
Vacuum: Inches Water Gauge.	At top row of Tubes A.	6.5	6.3	5.6	6.9
	At bottom row of Tubes B.	5.0	6.8	6.0	5.9
Boiler Pressure.		LBS. 177.60	LBS. 181.50	LBS. 176.9	LBS. 180
Maximum Temperature.		880°F	860°F	860°F	850°F
Minimum Temperature.		600°F	620°F	580°F	560°F
Mean Temperature.		750°F	796°F	745°F	754°F

Fig. 64

Position of centre line of blast pipe in respect to smoke-box tube plate.—To ascertain the best position of the blast pipe in its relation to the tube plate, a number of experiments were carried out. The diagram—Fig. 63—shows the arrangement of the apparatus, and the table—Fig. 64—gives the results of the tests.

The tests were made under similar conditions in regard to route and load. The reversing lever was moved at the same places on the route, and vacuum readings taken accordingly. The weather was similar on all runs, and the same driver and fireman operated the engine. The table shows that No. 2 test gives the best results as regards even draught; so it may be concluded that the blast pipe placed nearly midway between the door and tube plate commends itself. The vacuum readings and smoke-box temperatures seem to be high, but this must be expected, owing to the class of work. Taking the four results, the moving of the blast pipe further from the tube plate has no very serious effect on the steaming of the engine; and if convenience is a consideration in designing smoke-box details, then the blast pipe may be removed without serious consequences.

Results of experiments on four-cylinder passenger engine—Fig. 30 (*ante*).—This engine when first put into service had a 5in. diameter blast nozzle standing 8in. below the centre line of boiler. The chimney was only 12½in. diameter at the choke, and had an extension in the smoke-box of 15in. This extension carried a hood 1ft. 6in. long. Further particulars are given below :—

Length of smoke-box..	68in.
Capacity of smoke-box	249,000 cubic inches.
Number of tubes..	235.
Length of tubes	15ft.
Area through tubes	564.0 square inches.
Grate area	27.0 square feet.
Air space through grate	9.47 „ „
Percentage of air space	35.
Area through ashpan, door open	394.0 square inches.
Minimum area of ashpan opening	63.0 „ „

On the first trial it was evident that the nozzle was too small, and it was decided to open it out to 5½in. This step, however, at first had a detrimental effect on the steaming, until the author tried a chimney of a different design. He retained the same pattern, but cut down the extension portion, to penetrate into the smoke-box 2in. only, which increased the choke to 13½in. diameter. He also belled out the entrance to 18in. diameter. It was apparent at once that this form of chimney, although not quite satisfactory, improved the steaming ; therefore further investigations were conducted on the best height of nozzle, and eventually it was found to be about 4in. below centre line of boiler. During these experiments, complaints were frequent that the fire burnt dead at the back end of the fire-box, and conclusions were drawn that this was due to the restricted air space opening in the ashpan, where it is narrowed down in depth to clear the trailing axle. The author next decided to give additional air supply to the back end of grate. He therefore connected the front and back portions of the ashpan by an air duct. This addition increased the air supply opening over 300 per cent., and has proved very beneficial in promoting combustion. The ashpan and firebar arrangement with air duct for a four-cylinder passenger engine is shown in Fig. 65.

A further experiment has recently been made with a larger blast pipe and chimney. The blast pipe is cast with a bridge, so that the exhaust from the inside and outside cylinders is led away independently, and does not meet until near the top of the nozzle. The nozzle is 6in. diameter, and the chimney choke 16in., the same design of chimney with short extension being adhered to. At first this combination was not successful, but after several trials with varied heights of blast pipes, a position was discovered—viz., 6in. below centre line of boiler—which produced an excellent steaming engine.

These experiments go to prove the importance of ascertaining the correct positions and proportions of blast pipes and chimneys ; for here is a case of an engine which would not steam with a 5½in. blast pipe, but which eventually, after numerous experiments, steamed well with a 6in. nozzle. Attempts have been made in America to standardise front ends, with some amount of success ; but it appears to the author that each new design of locomotive demands some experimental work, in order to arrive at the best steaming position of blast pipe, diameter of chimney, &c.

Ashpan and Fire-bar Arrangement for 4-Cylinder Passenger-Engine.

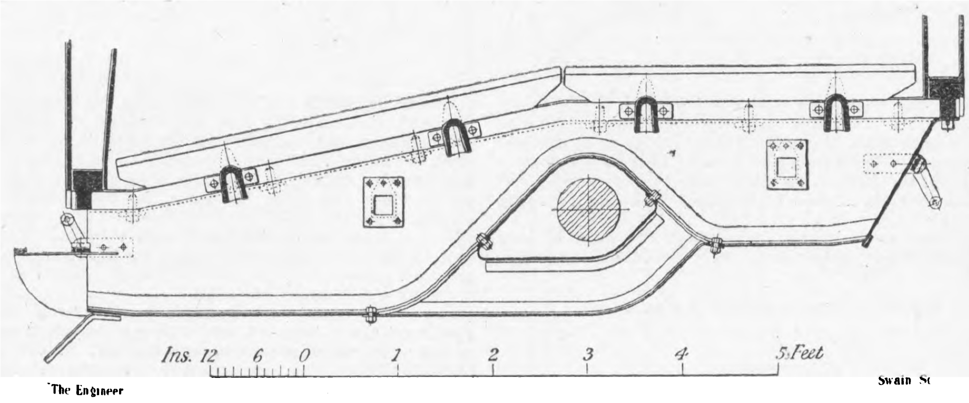


Fig 65

Smoke-box doors.—These are much larger than ten years ago. They cannot be kept perfectly tight by the single crossbar and central bolt arrangement, and a number of dogs pitched equally round the periphery of the door is essential. The wear and tear of smoke-boxes has increased of late years, particularly that class with the sides fastened to the main frames of the engine. The round smoke-box, supported on a cast iron saddle, has much to recommend it. The author has adopted this design on several tank engines, and also on the four-cylinder passenger engine. This latter smoke-box has been clothed with asbestos and a thin clothing sheet, for the purpose of reducing cost of maintenance.

Brick arches.—All engines are fitted with brick arches. These extend from the tube plate to about half the length of the fire-box. The rake of the arch is governed to some extent by the position of the fire-hole above the grate. When this distance is small and the fire-box long it is necessary to incline the arch, so that there is no chance of throwing the fuel upon it. With the fire-boxes which have horizontal grates the arch slopes upwards, pointing to the top side of the fire-hole. In the four-cylinder engine the slope points to the top corner of the back plate. The function of the arch is to assist combustion by maintaining a high temperature, and to direct the gases round the fire-box, especially so that they impinge against the top and back plates. The fire-hole deflector is used to prevent the air passing direct to the tubes.

Ashpans.—All ashpans are made of ample dimensions, so that the accumulated ashes do not hinder air supply. The damper doors open as wide as possible to allow a maximum air supply, and for convenience of raking. The bottom is made to retain water for quenching the ashes, a small pipe being connected to the injector feed pipe, and led to the ashpan for that purpose. The damper door-handles are fixed on the fireman's side of the engine, and have a screw arrangement for adjusting the amount of air and for closing the door practically air-tight.

There is ample room for discussion and experiment on the subject of this Appendix. It is remarkable what a small amount of information is available.

THE NAVAL REPAIR SHIP CYCLOPS.—We omitted to state in our article on the naval repair ship Cyclops, in our issue of the 23rd uit., that the blocks mentioned in line three of the centre column of page 77 were supplied by the Carron Company, of Carron, Stirlingshire.

MAIN DRAINAGE EXTENSION IN LONDON.—The tenders for the southern low-level sewer No. 2 from Deptford to Battersea have now been received by the London County Council, and it is recommended that one amounting to £473,416 13s. 6d. be accepted. This sewer will be over seven miles in length, and is intended to relieve the existing low-level sewer, and so diminish the possibility of flooding in the low-lying districts through which it will pass. In view of the fact that for about five miles of its length it will pass through water-logged ground, it will be necessary to use compressed air in its construction. The contract time for the work is three years. The sewer forms part of the scheme of main drainage extension adopted in December, 1899, and when this portion of the work is put in hand the whole of the new sewers provided for in the scheme will either have been completed or be in course of construction.

MECHANICAL TRANSPORT IN THE COLONIES.

A BLUE-BOOK has recently been issued dealing with mechanical transport in non-responsible Government Colonies and Protectorates, and containing the replies of the Governors, &c., to a series of questions grouped under the headings of roads, tracks, bridges, nature of goods carried, fuel, water, labour, workshops, &c., addressed to them by the Secretary of State for the Colonies.

The development of these colonies, and in particular of the possessions in East and West Africa, is intimately connected with problems of transport and communications, and, recognising this, the Colonial-office some time ago took the necessary steps for securing information on the methods of mechanical transport other than railways, and the facilities and suitability for such afforded in the various colonies. The co-operation of the Mechanical Transport Committee of the War-office was secured for advisory and other purposes.

In the replies it is shown that the majority of the colonies considered are unsuited for mechanical transport of the kind contemplated. The reasons for such unsuitability are various, but have chiefly to do with the poor class of roads in existence at present. In some cases, however, it is stated that in the future, when conditions have altered and improved, such means of transport may be introduced advantageously. In others, the introduction of traction engines and motor cars, lorries, &c., would be inadvisable owing to the strong competition which would be experienced from transportation by means of the adjacent rivers. In not a few cases the Governors report that their particular colonies are more or less well suited for the specified purpose, but that so far enterprise is lacking in this direction.

The Governor of the East Africa Protectorate makes the suggestion that in his opinion the most satisfactory and economical method of dealing with road transport is by employing some form of mono-rail erected at the sides of the public roads. He claims for this method that no metalling of the roads would be required, and that the only detail of construction requiring especial care during the rainy season would be the track on the road on which the "balance wheel" of the car would run. This, he adds, could be satisfactorily attended to by laying down a band of sand running parallel with the rail, say, 1ft. in width and 1in. deep. The mono-rail rolling stock can be drawn by mechanical, animal, or manual traction.

Not the least useful part of the present volume is that containing the remarks of the Mechanical Transport Committee of the War-office on the reports received from the Colonies concerned, and its recommendations as to the most suitable methods which might be employed in each particular colony for introducing or increasing the advantages to be derived from this form of transport.

CATALOGUES.

HASLAM AND SCHONTHEIL, Western Mail Chambers, Cardiff.—From this firm we have received a new price list of electric light water-tight fittings suitable for various classes of service.

THE GENERAL ELECTRIC COMPANY, Limited, 71, Queen Victoria-street, London, E C.—A little pamphlet giving prices, particulars, and illustrations of Freezor electric fans suitable for alternating and continuous current circuits.

CLARKE'S CRANK AND FORGE COMPANY, Limited, Lincoln.—All classes of cranks for steam and gas engines, motor cars, commercial motor vehicles, and launches, are illustrated in a little catalogue which has been forwarded to us by this company.

THE CONSETT IRON COMPANY, Limited, Consett, Co. Durham.—We have received a portfolio of circulars dealing with this company's manufactures. Illustrations, prices, &c., are given of chequered plates, sectional steel, fire-bricks, quarls, &c.

JENS ORTEN-BOVING, 72-74, Victoria-street, London, S.W.—A new catalogue from this firm deals with Dr. Horn's patented tachometers, tachographs, engine counters, &c. Prices and full particulars relating to these instruments are given, and there are many illustrations.

THE BRUSH ELECTRICAL ENGINEERING COMPANY, Limited, Loughborough.—The June issue of the "Brush Budget" is a special textile number, and it contains illustrations of dynamos and motors in operation in textile mills. Short and interesting articles accompany these illustrations.

JOHN CAMERON, Limited, Salford, Manchester.—A booklet of illustrations of the various kinds of machines made by this firm has recently been issued. It contains excellent photographic reproductions of ram and piston pumps, punching and shearing machines, gas engines, and gas producers.

COOKSON AND CO., Albion House, 59 and 61, New Oxford-street, London, W.C.—Some literature to hand from this company has reference to electro-magnetic separators suitable for various purposes. Illustrations, prices, and other particulars are given in a concise little pamphlet. Prices of dynamos, which may be used for working these machines when electric power is not available, are also given.

TANGYES LIMITED, Cornwall Works, Birmingham.—List No. 129 has reached us. It illustrates, describes, gives prices, weights, dimensions, and other particulars relating to Tangyes' "T" type gas engines and suction gas producers. We have also received a type-written report on a test carried out by R. Mathot on a gas engine and its producer manufactured by Tangyes Limited. The results given in the report are highly satisfactory.

THE CONSOLIDATED PNEUMATIC TOOL COMPANY, Limited, 9, Bridge-street, London.—A well-compiled catalogue having reference to Franklin air compressors has reached us. These compressors are described in detail, and there are illustrations of the component parts. The various types of Franklin compressors are dealt with, and there are tables giving capacities, dimensions, floor space required, piston displacements, &c., for each type.

THE AVONSIDE ENGINE COMPANY, Limited, Fishponds, Bristol—An illustrated catalogue of locomotive engines of all sizes, types, and gauges, has reached us. It is a well got up publication containing nearly 120 pages, which bear illustrations of locomotives, tables of dimensions, code words, &c. Full particulars are also given of Avonside steam railway motor cars and exhaust heat boilers. Instructions for cabling are included at the end of the catalogue.

CAPEL AND CO., 168, Dalston-lane, London, N.E.—This company has sent us its list pertaining to combined electric lighting sets suitable for either petrol, paraffin, alcohol, naphtha, methylated spirit, town or suction gas. Also lists having reference to a petrol or paraffin agricultural engine for farm work, pumping, &c., and the company's new continental type suction gas engine and regenerator gas plants. A complete specification with illustrations is given in each case.

ADAMS MANUFACTURING COMPANY, Limited, 106, New Bond-street, London, W.—This is a catalogue which illustrates and describes some standard types of "Igranic" motor starting and controlling apparatus for alternating and direct-current circuits. Numerous different kinds of starters are dealt with, including self-starting rheostats. Prices, dimensions, &c., are given in tabular form. From this catalogue a starter may be selected to suit almost every ordinary requirement.

ERITH'S ENGINEERING COMPANY, Limited, 70, Gracechurch-street, London, E.C.—From this company we have received a well got up little catalogue dealing with Erith's grateless underfeed stokers, which are claimed to respond automatically to widely varying loads. We are informed that these stokers are in use in connection with the steam plant at the Port Huron Tunnel, where the electrical load varies in 14 minutes from 0 kilowatts to 1950 kilowatts, and that they automatically respond to this remarkable load variation.

WITTING BROTHERS, Limited, 49, Cannon-street, London, E.C.—A pamphlet has reached us which has reference to a pump valve of which Witting Brothers, Limited, have acquired the rights of manufacture, and sale in Great Britain and the Colonies. These valves are suitable for all kinds of high and low-speed pumps, also for blowing engines, compressors, &c. They are claimed to increase greatly the capacity and efficiency of pumps, and to ensure silent working. The pamphlet gives a concise description of the valves.

THE CRADLEY BOILER COMPANY, Cradley Heath, Staffordshire.—A copy of this company's latest catalogue of steam boilers, &c., has been forwarded to us. It has reference to Lancashire boilers, Cornish boilers, colonial or brush boilers for wood fuel, colonial tubular boilers for burning wood externally fired, vertical boilers of various constructions, locomotive-type boilers, horizontal multi-tubular boilers, dry back marine return tube boilers, marine return tube, or Scotch boilers, Cornish Trentham hot water boilers, oil tanks, steel buoys, donkey boilers, &c. It is a well got up publication.

THE BRITISH STEEL PILING COMPANY, Dock House, Billiter-street, London, E.C.—A copy of this company's catalogue of steel sheet piling and pile driving accessories has reached us. The catalogue has been drawn up specially to meet the requirements of those residing in the Colonies and abroad, and full details are given to enable engineers to choose the machine or piling most suited for specific purposes without loss of time in writing home for particulars. There are many excellent illustrations, some of which show work which has been carried out with the company's steel sheet piling.

B. R. ROWLAND AND CO., Limited, Reddish, near Manchester.—This firm has sent us a copy of an illustrated catalogue of emery and corundum grinding wheels and machines. All grinding wheels are made of carbo-corundum, pure crystal Canadian corundum, and genuine emery. Carbo-corundum is made by an electro-chemical process, and is said to be much harder than emery and natural corundum. It is infusible at the highest heat and is insoluble in all liquids. In addition to full particulars and illustrations of machines turned out by this firm, the book contains full instructions for ordering abrasive wheels.

THE INDIA-RUBBER, GUTTA-PERCHA, AND TELEGRAPH WORKS COMPANY, Limited, Silvertown, London, E.—This company's latest price list of mechanical rubber goods has reached us. Among other things it has reference to india-rubber sheet, insertion sheet, washers, india-rubber buffers, special shaped buffers and pads, solid india-rubber cord, india-rubber valves, large roller covering, trolley wheel covering, steam hose, suction hose, hydraulic hose, vulcanised machine belting, steam packing india-rubber brake blocks, corrugated matting, india-rubber tubing, acid tubing, draught tubing, india-rubber gloves and gauntlets, &c.

THE A.E.G. ELECTRICAL COMPANY OF SOUTH AFRICA, Limited, Caxton House, Westminster.—Some useful price lists have reached us having reference to slow speed three-phase motors, lift controlling gear, large three-phase induction motors, electric annealing and tempering plants, iron switch cases, single-phase and two-phase induction motors, and small continuous-current motors and generators. The first part of each of these lists is devoted to illustrations and descriptions of the machines and apparatus with which they deal, whilst the remaining pages give tables of prices, dimensions, and other particulars necessary for ordering.

B. AND S. MASSEY, Openshaw, Manchester.—The fourth of this firm's admirable series of catalogues has just come to hand. It deals with drop stamps, &c., for die work, and is numbered 1600 H. Our readers are familiar with the three earlier catalogues dealing with steam hammers, power hammers, and hand saws. The contents of the newly-issued catalogue include, besides a well-written introduction on the art of stamping in dies, chapters on steam drop stamps, friction drop stamps, board drop stamps, double-acting steam stamps, trimming presses and furnaces, sundry notes and a telegraphic code. Engineers who are not fully familiar with the multifarious types of article which can be produced cheaply and efficiently as stampings will find on pages 40 to 45 some excellent examples of work with weights and dimensions. The book is equally as well produced as its predecessors.

CONTRACTS.—The Underfeed Stoker Company has recently received orders for its stokers from James Buchanan and Co., Limited ; Bryant and May, Limited, Bow (repeat order) ; the Treloar Cripples' Home, Alton ; the Western Infirmary, Glasgow ; James Keiller and Sons, Limited, Silvertown ; the General Post-office, Mount Pleasant ; the Carlisle Corporation, and the Bath Corporation.—The Mirrlees Watson Company has recently received orders for thirteen sets of condensing plants of different types, varying in size from 10,000 lb. to 43,000 lb. of steam condensed per hour, the last named plant being a repeat order.—John Booth and Sons, of Bolton, Lancashire, have recently completed an order, secured through their London agent, for steel-frame buildings, bunkers, &c., for a large generating station to be erected by them near Dawson City, in the Klondyke. The order includes engine-house, boiler-house, and 1000-ton capacity bunkers. The material has been forwarded by the new route across the isthmus of Tehuantepec, Mexico, to Salina Cruz, where it will be re-shipped and carried up the Pacific by special steamer to Skagway, Alaska.

THE IRON, COAL, AND GENERAL TRADES OF BIRMINGHAM, WOLVERHAMPTON, AND OTHER DISTRICTS.

(*From our own Correspondent.*)

Work Resumed.

THIS week work has been resumed since the holidays, so that the wheels of trade are once more beginning to revolve. There was rather more hopeful tone on 'Change in Birmingham on Thursday, but taking things all round business cannot be considered to be anything but quiet. However, here and there there are indications of better times ahead. The improved reports from America and the prospects of a good English harvest, now that the weather has picked up after the cold spring, are both factors in favour of commercial betterment.

Orders for Cable Iron.

Some good orders for cable iron are understood to have been placed in this district in connection with the equipment of the new "Dreadnoughts" These would be for best cable bars, which is one of the highest qualities of iron made in the Midlands. Rivet iron is also in better request than recently. The basic price for ordinary marked bars is still £8, with 12s. 6d. extra for Earl Dudley's L.W.R.O. brand. Unmarked bars are quoted £5 17s. 6d. to £6, with a moderate demand.

The Galvanised Sheet Trade.

The condition of open quotations in the galvanised corrugated sheet trade still obtains, there being no longer any Association figure. The general quotation in bundles f.o.b. Liverpool for 24 gauge is £10 10s. to £11, but instances have occurred of less being accepted. The foreign trade is much better than it was a year ago, the July shipments having improved from 28,081 tons to 39,501 tons, and the seven months' exports from 220,199 tons to 270,995 tons. The corresponding increase in value has been from £393,332 to £546,036, and from £3,075,767 to £3,750,049. So far this year there has been a considerable increase in the exports to the Argentine Republic compared with a year ago—from 37,920 tons to 56,200 tons. There has also been a slight increase with India—from 53,764 tons to 54,396 tons. Trade has also grown very much with Australia—namely, from 32,864 tons to 48,420 tons. Whether the Association will be re-formed or not remains to be seen, but at present there seems to be no encouraging prospect in that direction. Plain black sheets are in very quiet demand, and prices are weak, although quotations remain nominally as follows:—Singles, £7 to £7 2s 6d.; doubles, £7 2s. 6d. to £7 5s., and trebles, £7 15s. to £7 17s. 6d.

Other Kinds of Manufactured Iron.

There is a quiet inquiry for hoop iron at £6 15s., for gas strip at £6 5s. to £6 7s. 6d., and for slit nail rods at £7.

The Steel Trade.

A fair amount of work is in hand for steel sections, and quotations are maintained. Angles are quoted £5 10s. to £5 15s.; girder plates, £5 15s. to £5 17s. 6d.; joists, £5 10s. to £5 15s.; mild bars, £6 7s. 6d. to £6 17s. 6d.; and boiler plates, £7. The call for semi-finished steel has quietened down. Bessemer sheet bars are still quoted nominally £4 12s. 6d. and Siemens £4 15s., but there is a great deal of continental competition, and continental supplies are being obtained in increasing quantities at considerably below these figures.

The Pig Iron Trade.

Improved American advices are having a good influence upon the pig iron trade, which is, therefore, showing more life. Quotations are about the same as recently, cold blast being quoted 110s.; best all-mine, 80s. to 81s.; part-mine, 48s. to 49s. 6d.; and Staffordshire common, 46s. There is rather more inquiry than recently for Northamptons at 45s. 6d. to 47s., and for Derbyshires at 47s. 6d. to 48s. 6d. There is little life in North Staffordshire descriptions, which are quoted 49s. to 50s.

The Midland Railway Carriage and Wagon Company.

At the yearly meeting of this company, held in Birmingham on August 10th, Mr. H. F. James presiding, a dividend was declared on the ordinary shares at the rate of 7½ per cent., and a bonus of 10s. per share, also a dividend on the preference shares at the rate of 6 per cent. The gross profit was £26,830 7s. 6d., which, with £4152 0s. 4d. brought forward, made a total of £30,982 7s. 10d. The division on the ordinary shares (including bonus) is equal to 12½ per cent., or the same as has been declared for 12 years without a break. The large new works at Washwood Heath have been started. Colliery wagons forms one of the chief departments of the company's business.

East Worcestershire Water Supply.

In their sixtieth half-yearly report the directors of the East Worcestershire Waterworks Company state that during the half-year ended June 30th there have been laid on eighty-three additional services, making a total of 7581, exclusive of the districts supplied in bulk. Extensions of the mains have been made at Redditch in three new roads, and a new concrete coal-yard has been put down at Burcot. The directors have considered the question of increasing the yield of water at Burcot, and have decided to sink a shaft near No. 3 borehole, and to be connected therewith at a depth of 100ft. When this is completed, the borehole, which is now 400ft. deep, can be carried further, possibly into the pebble beds.

NOTES FROM LANCASHIRE.

(*From our own Correspondent.*)

MANCHESTER, Thursday.

A "Bullish" Market.

It would appear as if the long looked for "boom" in pig iron has at last set in. Although the attendance on the Iron Exchange yesterday was greatly under the average, there was no mistaking the fact that inquiry was strong, if not active, and it was reported that there had been some anxiety manifested by consumers to cover not only present but prospective wants over a fairly long period. The announcement that the duty on pig iron into the United States had been reduced 1½ dol. per ton, coupled with the settlement of the coal dispute in Scotland, has had much to do, it is said, with the long-deferred improvement. Shipments, especially from the East Coast, have been unusually heavy, and both foundry and hematite iron have registered higher figures on the week. There is also an advance of about 6d. per ton in Scotch brands, which buyers, however, pay very reluctantly. Lincolnshire and Derbyshire are also a shade firmer. West Coast hematite is held for full rates, although the demand is by no means brisk. Forge iron rules in sellers' favour, but there is little business on spot.

Finished Iron and Steel.

There is a quiet steady business passing, and plates for tank, girder, and bridge work are quoted 5s. per ton higher.

Copper, Lead, and Tin.

The position of manufactured continues quiet, and there is no change in price in any department. Lead: Sheet is dull and unchanged. Tin: English ingots are a turn dearer.

Quotations.

Lincolnshire No. 3 foundry, 52s. 6d.; Staffordshire, 51s. to 51s. 6d.; Derbyshire, 52s. 6d. to 53s.; Middlesbrough, open brands, 58s. 4d. to 58s. 7d. Scotch: Gartsherrie, 60s. to 60s. 3d.; Glengarnock, 59s.; Eglinton, 58s. to 58s. 6d.; Dalmellington, 58s. to 58s. 6d., delivered Manchester; West Coast hematite, 58s. 6d.; East Coast ditto, 56s., both f.o.t. Delivered Heysham: Gartsherrie, 58s. to 58s. 3d.; Glengarnock, 57s.; Eglinton, 56s. to 56s. 6d.; Dalmellington, 56s. to 56s. 6d. Delivered Preston: Gartsherrie, 59s. to 59s. 3d.; Glengarnock, 58s.; Eglinton, 57s. to 57s. 6d.; Dalmellington, 57s. to 57s. 6d. Finished iron: Bars, £6 10s.; hoops, £7 12s. 6d.; sheets, £7 15s. to £8. Steel: Bars, £6 5s.; Lancashire hoops, £7 5s.; Staffordshire ditto, £6 17s. 6d. to £7; boiler plates, £7 2s. 6d.; sheets, £7 17s. 6d. to £8; plates for tank, girder, and bridge work, £6 5s.; English billets, £4 12s. 6d. to £4 15s.; foreign ditto, £4 10s. to £4 12s. 6d.; cold-drawn steel, £9 5s. to £9 10s. Copper: Sheets, £71; tough ingot, £62 to £62 10s.; best selected, £62 to £62 10s. per ton. Copper tubes, 8½d.; brass tubes, 6⅞d.; condenser, 7⅞d.; rolled brass, 6¼d.; brass wire, 6½d.; brass turning rods, 6½d.; yellow metal, 6d. per lb. Sheet lead, £17 7s. 6d. per ton. English tin ingots, £132 per ton.

The Lancashire Coal Trade.

There was practically no business passing on the Coal Exchange on Tuesday. The hot weather caused a slump in house coal, and prices in all departments were quite nominal.

BARROW-IN-FURNESS, Thursday.

Hematites.

Although the hematite iron trade remains quiet, there is a stronger feeling, and the opinion is generally entertained from evidences which are presenting themselves on every side that the trade is on the eve of a much more active state of things. The home demand is largely regulated by the volume of steel makers' requirements. These are at present moderate, but they are expected to be greater. On continental account a fairly good business is being done with armour-making firms and with engineers. Sales to colonial users of metal are not large, and the business doing on foreign account is small. There are, however, better prospects from America, and it is expected good business will soon be done with that country. Prices are rather firmer, although quotations show no improvement, except in warrants. Mixed Bessemer numbers are at 58s. net f.o.b. nominal, and warrant sellers are at 57s. net cash, buyers 56s. 9d. The sales of warrant iron are few. Most of the trade being done between producers and consumers. In special hematite iron there is a moderate trade, and prices are at about 60s. to 61s. 6d. per ton, while specially good classes realise more money. There has been an increase of 500 tons in warrant stocks, which now stand at 13,510 tons. The stocks held by makers show slight increases, but the bulk of iron held in makers' yards is comparatively slight, and is well below a week's production of the twenty-six furnaces in blast. Ferro-manganese is selling fairly well, and there is a fair demand for spiegeleisen as well on home as on foreign account. Iron ore is in fair sale, but commoner sorts find but a poor market. Good average classes of native ore realise 11s. net at mines, medium 13s. 6d., and best 17s. per ton.

Steel.

No. 1 rail mill at the Workington Iron Company's works—Cammell, Laird and Co—has been restarted this week. It is probable now that the combine has been formed No. 2 mill will not again go into operation, but the company own also the Moss Bay Works, where the rail mill is working. The Bessemer and rail department of the Barrow Steel Works is running, but none of the firms in this district is over well supplied with orders. The outlook, however, is said to be better than of late. In merchant steel very little business is being done, while the plate mills are at a standstill, and probably will remain so until shipbuilding is better employed than at present.

Shipbuilding and Engineering.

Shipbuilders are expecting new orders, but business is difficult to get, and most of it takes a deal of negotiation. There is very little work at present in hand in the shipbuilding yard of the Vickers' works, but engineers are growing busier every week. This is mainly in the gun-mounting department. Marine engineering is quiet.

Shipping and Coal.

The shipments of iron and steel from West Coast ports last week amounted to 8149 tons—iron, 4970 tons; and steel, 3179 tons—as against 7310 tons in the corresponding period of last year, an increase of 839 tons. For the year to date the shipments aggregate at 359,379 tons, against 305,567 tons for the corresponding period of last year, an increase of 55,812 tons. Coal and coke in moderate sale at late prices.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

After the Holidays.

MOST of the large firms got back to work about the beginning of the week, but there is still a holiday feeling about, as is usual at this time of the year, and this, coupled with a general slackness of trade, causes an absence of briskness even after Bank Holiday. In a good many quarters there has been shown a disposition, owing to the broken time worked, to make Bank Holiday the vacation of the year.

Coal Shipments.

Shipments of coal at present are rather heavy, owing partly to the check experienced a few weeks back by the various stoppages. The majority of the pits supplying steam coal are working as much time as the local "feasts" will allow, and the miners, having, in football phrase, had their "kick-off," are settling down. Prices for immediate delivery, not on contracts, continue from 9s. to 9s. 6d. per ton at pit. From the figures supplied by the Hull Chamber of Commerce, referred to elsewhere, it will be seen that the export trade continues satisfactory. That tendency is maintained in the latest return available for the week ending August 3rd, which shows a total of 103,696 tons, compared with 55,166 tons for the similar period of last year. The exceptionally large trade done with North Russia keeps well up, Cronstadt, for the week concerned, leading the list of foreign deliveries from Hull with a total of 23,111 tons. Alexandria follows with 13,022 tons, and Rotterdam is third with 11,453 tons. The trade rupture in Sweden has thrown more material on the market, but this, again, has been counteracted to a considerable extent by the stoppages alluded to at certain pits. The demand for trawlers' purposes is stated to be scarcely as active as it was.

House and Gas Coal.

With the settlement of labour difficulties, the holidays, and the exceptionally warm weather, the demand for domestic fuel has naturally abated somewhat, both on metropolitan account and also from country stations. But a very good business is still doing, for the most part in the higher grades of coals, in which quotations are not affected. Best Barnsley, 11s. 6d. to 13s. per ton at pit; secondary sorts, from 10s. to 11s. per ton at pit. For secondary sorts are rather a slow market, and values are scarcely so firm. The trade at present is largely on account of householders laying in winter supplies. Gas coal contracts may now be considered settled, prices, as before remarked, ranging generally from 6d. to 9d. per ton lower than last year. Sales from the district have been fairly up to the average, but not more.

Small Coal and Coke.

Coal prices are maintained, best washed making from 10s. 6d. to 11s. per ton, and unwashed from 10s. to 10s. 6d. per ton. Small coal is also in fair demand, partly for coking purposes and Lancashire and Yorkshire cotton and woollen mills' requirements, which do not seem to have abated very much. For the latter qualities, the quotations previously given, from 4s. 6d. to 5s. 6d. per ton are maintained. Coking smalls are in rather better supply than during recent weeks.

The Iron Market: Advance in Lincolnshire Iron.

At a meeting on Friday last the Lincolnshire Ironmasters' Association advanced all pig iron prices 6d. per ton, except basic, which was not altered. The official quotations are now as follows:—No. 3 foundry, 50s. 6d. per ton; No. 4 foundry, 49s. 6d. per ton; No. 4 forge, 49s. 6d. per ton; No. 5 forge, mottled and white, 49s. 6d. per ton; basic, 50s. 6d. per ton net delivered in Sheffield or Rotherham. The much better trade reports from the United States, and the general impression that things are likely to improve here, are responsible for this slight advance in pig iron. So far, however, the advance has not stimulated the demand. The Derbyshire makers are also disposed to ask for a little more, but official quotations remain unchanged, with prices firm, and little disposition to press sales. Derbyshire No. 3 foundry, 49s. 6d. to 50s. per ton; No. 4 forge, 48s. 6d. to 49s. per ton net, delivered in Sheffield or Rotherham. The finished ironworks are no better off, more work being much wanted. Bars remain at £6 10s. per ton; hoops, £7 10s. per ton; sheets, £8 10s. per ton.

Steel, &c.

The position of the steel trade has not changed. Several of the works are moderately placed; others are not quite so well off. The trouble in the Swedish iron industry still continues, and is being watched with the liveliest interest in Sheffield, where Swedish iron is so largely used by steel manufacturers. Sheffield firms have received advices from Sweden that they must expect no more shipments at present, although consignments are awaiting despatch. On the question of delivery, the view is expressed in Hull—the port to which Sheffield shipments are sent—that there may be nothing more than a shortage of supply for a time, and that it is not likely to prove serious. This view, it is hoped, may be justified by events. The new armour-plate orders, mentioned in this column a fortnight ago, are finding work in the early stages, following on completion of the previous orders. There is nothing further being done in naval or military matters, and nothing is expected of any moment until the Budget is settled one way or another. Railway material and general marine requirements continue meagre. Generally, there is a feeling of expectation that the iron and steel trade may show better after October.

The Master Cutler Elect.

The annual meeting of the Cutlers' Company was held on Tuesday at the Cutlers' Hall, the Master Cutler, Mr. Douglas Vickers, presiding. Mr. Herbert Barber, of the firm of Daniel Doncaster and Sons, was unanimously elected Master Cutler for the ensuing year. The installation will take place on the first Thursday in October.

NORTH OF ENGLAND.

(*From our own Correspondent.*)

Cleveland Pig Iron.

TRADERS have become very cheerful about business matters, and the evidence is certainly in favour of the opinion that the depression is disappearing, and that a period of increasing demand and rising prices has been entered upon. The tone is now undoubtedly buoyant, and consumers who have long held back are in the market as buyers desirous of purchasing for delivery even further ahead than the producers care to go. The upward movement is enhanced by the good reports from the United States, the rise in the prices of other metals, particularly copper, which rose 30s. per ton on Wednesday, and the improvement in the Board of Trade returns. Added to this there is an increase of activity in the market for manufactured iron and steel. In the circumstances buyers will probably not reap any advantage by waiting; on the contrary, they are likely to have to pay more. The price of No. 3 Cleveland pig iron has this week for the first time this year touched 50s. per ton, the nearest approach to that prior to this month being 49s. 3d. early in January. Cleveland warrants have reached 49s. 11½d. cash buyers, and 50s. cash sellers, an advance of just 4s. per ton on the minimum of the year, that minimum being reported about the middle of March. A good many orders have been placed this week for Cleveland pig iron, and the tone of the market is more buoyant than it has been at any time this year, and, in fact, during last year also. Makers could readily secure orders for next year's execution if they would accept anything like the current price for early delivery, but that they are not prepared to do; they do not want to tie their hands in the face of a rising market, which seems to be influenced more by genuine orders than by speculation. Producers ask 6d. per ton more for delivery over the next three months than they will take for prompt, and 1s. more is asked for delivery up to the end of the year. No. 1 is at 52s. 6d., No. 4 foundry at 49s., No. 4 forge at 48s. 9d., and mottled and white at 48s. 3d., all for early delivery, the forward quotations being 6d. to 1s. above these. On the whole, it can scarcely be doubted that a period of improving trade has been entered upon.

Hematite Pig Iron.

After a long period of very unsatisfactory trade the makers of East Coast hematite pig iron are this week able to give more favourable reports of their business, as during the last few days they have booked fair orders, some of the leading consumers having come into the market. It is generally believed that consumers will not gain anything by holding out longer, for it is hardly likely that prices will be lower—on the contrary, the tendency is upwards, and the longer buyers wait the more they will have to pay. Consumers of hematite iron have themselves been able to book good contracts, and thus need the iron. On this account more disposition to buy is manifested than has been known for months, and it must be acknowledged that mixed numbers East Coast hematite pig iron at 55s. per ton for prompt delivery is cheap, compared with the prices ruling for other descriptions of pig iron. Mixed numbers in the ordinary course should be 10s. per ton dearer than No. 3 Cleveland pig iron, but now is no more than 5s. above. The price of mixed numbers for autumn delivery is 56s. per ton. No. 1, for prompt, is at 55s. 6d., and No. 4 forge at 54s. 6d., with 1s. more for autumn delivery. Orders having been secured for hematite pig iron, the makers have bought Rubio ore more freely, and the merchants have put up their quotations in consequence, 16s. 3d. per ton c.i.f. Middlesbrough having become the general price, and some quote 16s. 6d., the advance this week being thus 3d. per ton, though pig iron prices have not yet been put up. Ironmasters have also to pay more for their coke, the sellers having raised their quotations to 15s. 9d. per ton delivered at Middlesbrough furnaces.

Shipments of Pig Iron.

The exports of pig iron from the Cleveland district have begun to be brisker, and for the remainder of the year are likely to be better than they were in the corresponding months of last year, the second half of 1908 being a very poor time. Deliveries are increasing, though not yet to the Continent, except Italy, and the probabilities of their being active to Germany this year are not encouraging. Scotland and Wales are taking more. It is not likely that the reduction in the United States import duty on pig iron will lead soon to any American demand for Cleveland pig iron, for the pig iron producers in the States will be able to meet American requirements considerably in excess of the present, seeing that there is a good deal of idle plant. However, Cleveland makers are looking for active shipments during the coming autumn. Up to 11th inst. the August exports amounted to 36,162 tons, compared with 31,845 tons last month; 33,297 tons in August, 1908; and 40,633 tons in August, 1907, to 11th.

Pig Iron Stock.

Cleveland pig iron is not going so rapidly into Connal's public store as it was, which is a satisfactory feature, and it is likely that during the autumn this stock will be reduced. The quantity held on 11th was 264,556 tons, an increase this month of 5385 tons. At the end of August last year only 61,963 tons were held. The stock on Wednesday consisted of 257,601 tons of No. 3, 5349 tons of No. 4 foundry, and 1606 tons of other Cleveland iron not deliverable as standard. It is rather unusual to find the stock of qualities other than No. 3 increasing.

Manufactured Iron and Steel.

More cheerful accounts of business are given by producers of finished iron and steel than have been forthcoming for a long time, and in most branches demand shows improvement, and the output has increased. This is more particularly the case in the nail, sheet, plate, and angle making branches, and prospects of the increased buying going on are encouraging. No advances in prices can be announced yet in this district, but they are likely to be made soon in plates, especially as the Scotch plate makers have raised their prices for export half-a-crown per ton. In the North of England the makers quote £5 15s., less 2½ per cent., for steel ship plates for home consumption, but £5 12s. 6d., less 2½ per cent., will be accepted where the plates have to be exported. Steel ship angles are firm at £5 7s. 6d., less 2½ per cent. f.o.t. Iron ship plates are at £6, and iron ship angles at £6 15s., both less 2½ per cent. f o.t. A somewhat better inquiry is reported for iron and steel bars, the former of which is quoted at £6 15s., and the latter at £6, both less 2½ per cent. f.o.t. Owing to the revival of the shipbuilding industry there is more being done in rivets and packing iron and steel, as well as plates and angles. Iron ship rivets are £7 5s., packing iron and steel £5 5s. Next week most of the finished iron and steel works, engineering establishments, shipyards, and foundries on Teesside will be idle for the annual holidays which are given on the occasion of Stockton August races. The Eston Steel Works will be laid off as well as the Cargo Fleet Steel Works, and during the week alterations are to be made at the former establishment. The Ormesby Rolling Mills Company, Limited, has commenced the erection of its works on a site adjoining the Cargo Fleet Works. The concern, it is stated, is an offshoot of the Cargo Fleet Iron Company, and will utilise the crop ends, &c., from the Cargo Fleet Works.

Coal and Coke.

A steady and satisfactory business is being done in most branches of the coal trade, and prices have got back to something like the figures that ruled before the Scotch labour difficulty began to disorganise trade. Consumers are coming forward more freely and are disposed to buy further ahead than the colliery owners care to go. They are not keen about selling into next year, for they are inclined to wait until they can judge how the application of the Eight Hours Act is going to affect them. That Act does not come into force in Northumberland and Durham until half a year after it took effect elsewhere. For early f.o.b. deliveries of best steam coal 12s. 6d. per ton is quoted; for best gas coals, 11s. to 11s. 3d., f.o.b.; for bunkers and coking coal, 9s. 9d. to 10s. All are in fair request. The supply of coke is hardly equal to the requirements, and the price of furnace coke has been advanced to 15s. 9d. per ton, delivered equal to Middlesbrough, while foundry coke is up to 17s. 6d. f.o.b.

NOTES FROM SCOTLAND.

(*From our own Correspondent.*)

The General Trade Outlook.

A better and more hopeful feeling characterises almost all departments of trade. Not that there is yet any marked improvement in business generally, but the outlook is decidedly more encouraging. The settlement in the coal trade affords a guarantee that contracts may be undertaken with confidence. Advices from the United States continue satisfactory, and the increase in the Board of Trade returns goes to confirm the general impression that business is taking a turn for the better. The stronger tendency in the metal and stock markets is likewise of hopeful augury.

The Iron Market.

The Glasgow pig iron market has this week continued comparatively active, and prices have touched higher figures, although they show occasional fluctuations ascribed to operators taking profits on the rise. A feature of the business has been the apparent anxiety to purchase iron for future delivery. Business has been done in Cleveland warrants at 49s. 9d. to 50s. 0½d. cash, 50s. to 50s. 4d. one month, and 50s. 5d. to 50s. 8d. three months. Sales have also been made at 49s. 10d. and 49s. 10½d. for delivery in eight days, 49s. 11d. fourteen days, 49s. 9½d. and 49s. 10½d. twenty-one days, 50s. 0½d. for September 22nd, and 50s. 2d. thirty days. A lot of Cumberland hematite was done at 57s. 3d. for delivery in three months, and there are sellers at 57s. for cash. Standard foundry pig iron has been offered at 49s. per ton.

Scotch Makers' Iron.

The business in Scotch makers' pig iron has been on a rather better scale in the last few days. It is reported that the demand for No. 1 qualities of iron has improved, and that makers have been obtaining 1s. to 2s. per ton more than the prices recently current. The shipping business has so far been rather disappointing, but it may, perhaps, be inferred from current inquiries that an improvement in this respect may be experienced. The Germans are as likely to be sellers as buyers of pig iron, but an increase in the shipments to Canada and the United States seems to be anticipated. A Scotch firm is reported to have purchased a large quantity of German made basic pig iron for delivery in the United Kingdom towards the end of the present year. Fair quantities of Scotch pig iron are being taken for consumption in England, and, on the other hand, there is an increase in the quantity of English pig iron coming into Scotland. A number of the Scottish ironmasters have intimated an increase in their prices of 1s. per ton. It would seem that the figures of the makers' brands have recently been nominally somewhat above the prices at which actual business has been done, at least with merchants, so that the quotations do not show so much alteration as the makers' increase would seem to justify. Monkland, f.a.s. at Glasgow, No. 1, is quoted 56s.; No. 3, 54s.; Carnbroe, No. 1, 57s. 6d.; No. 3, 54s. 6d.; Clyde, No. 1, 60s. 6d.; No. 3, 54s. 6d.; Gartsherrie, No. 1, 61s.; No. 3, 55s.; Calder and Langloan, No. 1, 61s.; No. 3, 56s.; Summerlee, No. 1, 62s.; No. 3, 57s.; Coltness, No. 1, 88s.; No. 3, 57s.; Glengarnock, at Ardrossan, No. 1, 62s. 6d.; No. 3, 57s.; Dalmellington, at Ayr, No. 1, 59s.; No. 3, 54s.; Shotts, at Leith, No. 1, 61s.; No. 3, 56s.; Carron, at Grangemouth, No. 1, 63s.; No. 3, 56s. per ton. There are 80 furnaces in blast in Scotland, compared with 72 last week, and 76 at this time last year. Of the total 38 furnaces are making ordinary, 37 hematite, and 5 basic iron.

Pig Iron Shipments.

The shipments of pig iron from Scottish ports in the past week were small, amounting to 3329 tons, compared with 5427 in the corresponding week of last year. There was despatched to China and Japan 550 tons, Australia 365, Germany 230, Canada 170, India 80, France 20, Russia, Holland, and Spain and Portugal 10 each, other countries 243, the coastwise shipments being 1641, against 3646 in the corresponding week of 1908. The arrivals at Grangemouth of pig iron from Cleveland and district amounted to 11,848 tons, showing an increase over the imports of the corresponding week amounting to 5560 tons.

Finished Iron and Steel.

The demand for finished iron has been more encouraging, although it still leaves much room for improvement, taking into account the capacity of the Scottish works. The outlook in the steel trade is more satisfactory. Considerable sales of steel material are reported to have been made for shipment to Canada and elsewhere, and the inquiries would indicate that there is further business to be done. The price of steel ship plates for export has been advanced 2s. 6d. per ton, and is now £6, less 2½ per cent.. An increase in specifications for shipbuilding steel is reported. The 2000 tons of steel plates, which are to be made at Parkhead for the Dreadnought Colossus, now being built at Greenock, will materially add to the employment at the East End works. It is said that there is considerable difference of opinion between sellers and buyers of Scotch hematite as to prices. Stocks are known to be large, but makers seem inclined to hold for firm prices. The current quotation is 57s. per ton for delivery at the West of Scotland steel works, and local steel makers have been purchasing more freely as their requirements are increasing. The difference of opinion as to prices has reference to future delivery rather than to cash transactions.

Tubes and Sheets.

The trade in tubes has been improving, and makers are now doing a large business. This has not been obtained, however, without keen competition and a beating down of prices, which are said to be hardly remunerative. There is an increasing demand both for plain and galvanised sheets.

The Coal Trade.

There is a moderate business passing in the coal trade. A number of consumers have stocks in hand, and are therefore not in the market. The coastwise and Irish trades are dull, owing to former extra purchases in anticipation of a strike. Still there is a hopeful feeling in the market, and prices are fairly well maintained. At Glasgow harbour the f.o.b. prices are for ell coal 9s. 6d. to 10s., and steam and splint, 9s. 9d. to 10s. 3d. per ton.

WALES AND ADJOINING COUNTIES.

(*From our own Correspondent.*)

Present Coal Trade, Cardiff.

It is gratifying to record a growing strength and solidarity of trade, and if supplies had only come up to needs, the week's return would have been substantial. On Monday higher figures were talked of on 'Change, Cardiff, and on Tuesday were put into execution, and in some cases obtained. Best quality coals, steam, still command the chief interest; dry coals are in demand. In small coal there is no alteration; anthracite firm. Patent fuel commands about 15s. There is little movement either in No. 3 Rhondda or in house coals. The latest coal prices are as follows:—Best large steam coal, 17s. 9d. to 18s; best seconds, 16s. 6d. to 17s.; ordinary seconds, 15s. to 15s. 6d.; best drys, 16s. 6d. to 17s.; ordinary drys, 13s. 9d. to 14s. 6d.; best washed nuts, 13s. 9d. to 14s. 9d.; seconds, 13s. to 13s. 6d.; best washed peas, 12s. 6d. to 13s.; seconds, 11s. to 12s.; very best smalls, 9s. 6d. to 9s. 9d.; best ordinaries, 7s. 6d. to 8s. 3d.; inferior sorts, 6s. 9d. to 7s. 3d.; best Monmouthshire black vein, 16s. to 16s. 3d.; ordinary Western Valley, 15s. to 15s. 6d.; best Eastern Valleys, 14s. to 14s. 3d.; seconds, 13s. to 13s. 6d. Bituminous coal: Very best households, 16s. 6d. to 17s.; best ordinaries, 14s. 6d. to 15s. 6d.; No. 3 Rhondda, 17s. 6d. to 17s. 9d.; brush, 13s. 6d. to 14s.; smalls, 10s. 9d. to 11s.; No. 2 Rhondda, 12s. 9d. to 13s.; through, 10s. to 10s. 6d.; smalls, 8s. 9d. to 9s. Patent fuel, 14s. 6d. to 15s. 6d. Coke: Special foundry, 24s. 6d. to 27s. 6d.; foundry, 19s. to 22s.; furnace, 17s. to 18s. Pitwood, 19s. to 19s. 6d.

Last Week's Coal Trade.

The chief pits began to be worked on Monday and work was slowly resumed, but so many colliers were holiday-making, or occupied as volunteers, that the output and despatch were materially affected. As compared with last year there was a small increase. Swansea only despatched 44 000 tons of coal, a little less than 5000 tons patent fuel, and Newport's coal despatch was limited to about 37,000 tons. Port Talbot showed a great falling off, a decrease of close upon 12,000 in exports and 1530 in imports. In a visit to the minor ports at the end of the week and the districts of Neath, Briton Ferry, and Port Talbot I was impressed with the promising condition of all but one—Porth Cawl—which started on its career as a promising port, but is now diverted into a seaside visiting place with small and unfrequented dock so far as coal business is concerned. That and the Glamorgan Canal are taking little part in coal development.

Newport Coal.

Much to the satisfaction of the trade, there is an increased firmness visible, and more animation in business. Small steams are in strong request, the requirements being chiefly for bunkering. Latest quotations:—Best black vein, 15s. 9d. to 16s.; Western Valleys, 14s. 9d. to 15s.; Eastern Valleys, 13s. 9d. to 14s.; other sorts, 12s. 9d. to 13s. 3d.; best smalls, 8s. 3d. to 8s. 6d.; seconds, 7s. 3d. to 7s. 9d.; inferiors, 6s. 9d. to 7s. Bituminous coal: Best house coal, 15s. to 15s. 3d.; seconds, 14s. to 14s. 3d.; patent fuel, 14s. 6d. to 15s. Coke: Foundry, 18s. to 18s. 6d.; furnace, 16s. 6d. to 17s. Pitwood, 20s. 6d. to 21s. 6d. The latter is in steady request and firmer; merchants satisfied with the prospects of better trade and firmer prices. In the past time wood has been clinging to such low figures as 15s. or 17s. 6d. Italy, France and Ireland were marked contributors this week.

Swansea.

There was a large attendance when business was resumed this week, and the general opinion was that prospects were good. There was a firmer market. Complaints of short supplies were rife. Latest quotations were:—Best malting, 23s. to 24s. net; seconds, 21s. to 22s. net; big vein, 18s. 6d. to 20s. net, less 2½; red vein, 12s. to 12s. 6d., less 2½; machine-made cobbles, 23s. to 23s. 6d. net; Paris nuts, 23s. 6d. to 25s. net; French nuts, same; German nuts, 23s. 6d. to 25s.; beans, 17s. 6d. to 18s. net; machine-made large peas, 10s. to 11s. 6d. net; fine peas, 10s. to 10s. 6d. net.; rubbly culm, 5s. 6d. to 5s. 9d., less 2½; duff, 3s. to 3s. 3d. Other coals:—Best large, 15s. 6d. to 16s., less 2½; seconds, 13s. 6d. to 14s. 6d., less 2½; bunkers, 10s. to 10s. 9d., less 2½; small, 8s. to 9s., less 2½. Bituminous coal: No. 3 Rhondda, 17s. 6d. to 18s. 6d., less 2½; through, 14s. 6d. to 15s., less 2½; small, 9s. 9d. to 10s. 3d., less 2½. Patent fuel, 13s. 6d. to 14s., less 2½.

Iron and Steel.

The Welsh industry—like that of other districts—continues to be interested in the developments that are taking place in the trade, which one of the old school, contrasting it by the side of the labours and successes of the Guests, the Crawshays, the Hills, and Vivians, says is more like a speculation than an industry. By the formation of a ring in which the leading ironmasters of the county are controllers and into which, I believe, the Americans and Canadians are entering, the whole trade is transformed. Dowlais and Cyfarthfa are now united, and if Dowlais gets more orders than it can manage, Cyfarthfa will have a share. On Tuesday there was a return to work after the long holidays, but, much to the regret of all concerned, they were notified that the outlook was bad on account of the stagnant condition of things, especially of the metallurgical trade. Swansea metal prices:—Welsh hematite delivered, 60s. to 61s; mixed numbers, 56s. 6d. cash, 56s. 6d. one month; Middlesbrough, 49s. 10½d. cash, 50s. 1½d. one month; Scotch, 55s. cash and month; Siemens steel bars, £4 8s. 9d. to £4 10s.; East Coast hematite, 59s. 6d. c.i.f. Rubio at Newport and Cardiff, 15s. to 15s. 6d.; seconds, 14s. to 14s. 6d. Pig iron has been coming in from Middlesbrough and Grimsby. Despatches of steel rails, which remain at syndicate price, were made this week from Cardiff to Madras and Colombo, cargo 3000 tons; 100 tons to Schull; 1700 tons steel received from Bruges. Other quotations:—Copper per ton, £59 cash; £59 18s. 9d. three months; lead, £12 17s. 6d. per ton; Spanish £12 7s. 6d.; spelter, £21 18s. 9d.; silver, 23¼d. per oz.

Tin-plates.

Midland works owned by the Morristown Tin-plate Works have been started after being idle for two years. There has been marked increase in the galvanised iron trade. Last week the business was as follows, according to harbour returns:—Received from works 66,909 boxes; shipped, 107,435 boxes; stocks, 166,719 boxes. Quotations: Block tin, £133 10s. cash; £135 5s. three months. C. A. roofing sheets, £8 5s. to £8 7s. 6d.; big sheets for galvanising, £8 7s. 6d. to £8 10s. per ton. Finished black plates, £9 5s. Galvanised sheets, 24 g., £10 10s. to £11, nominal, per ton. Lord Glantawe, on Monday, pointed out to the harbour meeting that, on the whole, the month's work was quite as satisfactory as the previous, and there was no reason to be despondent. In some cases there had been fallings off, and instanced the United States, where the loss was 2000 tons, but there was a total increase of 1875 tons. Swansea suffered less than other ports. The holidays have had a disturbing influence on trade. Another new mill will be started at Aber this or next week. Spelter works are recording continuous work. Five days' work registered at the Upper Bank and Morfa Copper Works.

The Newport Dock Accident.

The disaster now forms the subject of a coroner's investigation, and is expected to last another week. In the absence of two important witnesses there may be more delay, as it is imperative that the inquiry shall be of a most searching character. The death of Radcliffe is, on that point, much to be regretted. Lord Tredegar, referring to the occurrence in his usual sympathetic manner, said a few days ago that 35 men were still buried in the trench.

Important Contracts for Newport Dock.

These include a new pumping installation and electric light under one roof on the east side of the main entrance. This is to be one of the largest in the kingdom. There will be two pumps arranged to work independently of one another, each of which will be able to pump 50 million gallons of water from the river into the dock in five hours, and of pumping dry the new graving dock when constructed in 1 hour 10 minutes.

AMERICAN NOTES.

(*From our own Correspondent.*)

New York, August 1st.

A revival of building operations has recently set in which is calling for larger quantities of iron, steel, cement, timber, hardware, &c. Much of this activity was delayed for various reasons, political, commercial and financial. All restraining influences have disappeared, and work is now under way, which it is expected to be finished before the winter. The volume of railway traffic exhibits a favourable expansion, and as the crop moving season is near at hand the crop carrying roads will be overcrowded. The cotton movement when it begins will be heavy, but as much of it will be warehoused it will not reach this city as rapidly as in former years. A movement is being made to transfer the supremacy in cotton dealing from this city to New Orleans. It is largely a question of capital for iron. The demands for basic and Bessemer have taken up all capacity, and the probability of an advance of 50 cents per ton has stimulated negotiations for deliveries during the last quarter of the year. Steel making is now reaching towards its maximum output. All consumers are now looking forward to possible requirements of raw material with the thought of contracting before important advances occur. The present output of the blast furnaces is estimated to be within 8 per cent. of that of 1907. With the additional capacity of furnaces being and to be built the possible production for next year will be very much more than at present. The advances just made in Southern irons point to a probable advance in Northern irons.

A condition which is affording a strong undertone to the entire market is the knowledge of a multitude of contemplated improvements calling for iron and steel. The railway companies are earnestly considering extensions and re-equipment plans, which are significant of large business with the rolling mills. Wire products are very active, and the recent advance in prices seems to stimulate demand. Pipe makers continue to book large orders. The latest inquiry yesterday was for 10 miles of heavy steel pipe. The Philadelphia Company at Pittsburg has just placed an order for 20 miles of 8in. pipe. Exceptional activity in the locomotive plants has stimulated orders for tubes. Last month's daily average of copper exports was over 1000 tons a day, the figures being 33,800 tons. Lake is 13½; electrolytic, 12¾; and casting 12⅞. Tin, 29.20; receipts during the past month, 2847 tons.

PERSONAL AND BUSINESS ANNOUNCEMENTS

The British Asbestos Company, Limited, has transferred its warehouse and offices to 132, Commercial-street, London, E., to which address it is desired all future communications may be addressed.

Wm. Whitwell and Co., Limited, Thornaby Ironworks, Stockton-on-Tees, have appointed Mr. Frank Robinson, Exchange Buildings, Birmingham, as their agent in Birmingham and district.

Extension of Hango Harbour.—In December, 1908, the work on the quay of Hangö was terminated, and thus the greatest enterprise in harbour building in Finland was completed. In 1902 £140,000 were granted by the Finnish Senate for the extension. The work to be done was to unite the hill Drottningberget with the islet Högholmen by a pier across the water, which has a depth of up to 79ft., and to blast the rocks on Högholmen to a level with the pier, as well as to improve the surface of the islet. The granite arm now extending into the sea supplies the town with a safe quay 555 yards long. The granite wall sheltering the pier from the waves stands 18ft. above low water and 9ft. above the pier. In connection with these extensions, large modern warehouses have been erected, among which that intended for butter is the largest. Much care has been taken to make it proof against changes in the outside temperature, the inside chamber being kept at 7 deg. Cent. The total cost of this warehouse was £24,000. Further out in the sea, on the side where the waves are highest, there is a breakwater, built out of solid granite blocks. These extensions will probably satisfy the demand, not merely now, but also for some time to come.

NOTES FROM GERMANY, FRANCE, BELGIUM, &c.

(*From our own Correspondent.*)

Iron and Steel in Silesia.

QUIETNESS has been the order of the day in nearly all departments of the iron industry. Consumers do not care to purchase more than is required for the hand-to-mouth business they are doing, and, though the blast furnace works declare their intention to maintain firmly the present quotations all through the third quarter, concessions are likely to be granted in cases where forward orders are in question. An irregular business has been done in bars and sectional iron. At several rolling mills the working hours have been limited, but stocks nevertheless increase. Prices are complained of as being unremunerative. Girders remain dull, but the plate market has shown more life, demand having increased over that of last month. The attempt of the pipe foundries to bring about higher prices has met with but little success.

Rheinland-Westphalia.

Both raw and finished iron have been only moderately inquired for on the Rhenish-Westphalian market. Semi-finished steel is in steady but somewhat limited demand. On local account little is bought, for there is no life now in the building trade, and the keenness of English competition prevents a favourable business being done on foreign account. Though some extensive orders for the State Railways have been secured, employment at the railway shops continues unsatisfactory.

List Rates.

The following are the present list quotations per ton at works :—Red iron ore, 50 per cent. contents, M. 11.50 ; spathose ore, M. 10.90 ; roasted ditto, M. 15 50. net at mines ; spiegeleisen, 10 to 12 per cent. grade, M. 63 to M. 65 ; white forge pig, M. 55 to M. 58 ; iron for steel making, M. 55 to M. 59 ; German Bessemer, M. 56 to M. 58 ; basic, free place of consumption, M. 49 to M. 50 ; Luxemburg forge pig, free Luxemburg, M. 44 to M. 46 ; Luxemburg foundry pig, M. 46 to M. 48 ; German foundry pig, No. 1, M. 56 to M. 58 ; No. 3, M. 55 to 57 ; German hematite, M. 57 to M. 59 ; good merchant bars in basic, M. 97 to M. 102 ; iron bars, M. 122.50 to M. 125 ; hoops, M. 120 to 122.50 ; steel plates, M. 104 to M. 110 ; boiler plates, M. 114 to M. 120 ; sheets, M. 117.50 to M. 125 ; iron wire rods, M. 127.50.

Coal in Germany.

Coal for industrial puposes meets with fair demand, and altogether there has been more life in the coal trade since the beginning of the present month. House coal is likely to meet with improving demand now, for on September 1st the advanced winter quotations are to come into force.

Dullness in Austria-Hungary.

Local as well as foreign demand continues exceedingly limited, girders, however, forming an exception. German import of iron is reported to have been weaker than previously. While accounts from the iron market continue depressing, a pretty satisfactory condition is reported to prevail in the coal industry, though here, too, a falling off in demand has been felt. In pit coal 680,000 wagons have been produced in the first six months of the present year, or 20,000 wagons less than in the corresponding period last year. Export was 13,500 wagons lower, but 2000 wagons less have been imported than last year. In coke the decrease is more marked ; 9000 wagons have been produced, which is 4000 wagons less than in the same period last year. Imports from Rheinland-Westphalia and Upper Silesia are 8000 wagons less, but exports from Austria-Hungary have also been 1500 wagons less. This shows the decrease in the consumption of coal to have been 12,000 wagons. The falling off in the output of brown coal was 80,000 wagons, or 6 per cent.; this is partly due to the catastrophe in the pits of the Brüx district. Export in brown coal shows a decrease of 58,000 wagons, inland consumption being 22,000 wagons lower than in the corresponding period last year.

Improving Tendency in Belgium.

The situation has been a little more satisfactory on the iron and steel market, orders coming to hand more freely, and producers begin to show more confidence in the future. Quietness prevails in the pig iron trade, foundry pig is in slow request at 66.50f. p.t., while basic realises 67.50f. p.t., and forge pig 61f. p.t. Sales in semi-finished steel are effected at 95f. to 110f. p.t.; for orders of 1000 t. a discount of 7.50f. p.t. is granted to consumers, and for less than 1000 t. 5f. p.t. are given. Though the finished iron market is wanting in animation, a fairly regular employment has been maintained at the majority of the shops. For merchant bars £4 9s. 6d. is quoted as before, girders are in moderate request. The Belgian State Railway Administration has given out orders for 60,000 t. rails, and private companies placed contracts for 40,000 t., the Congo Colony has also granted contracts for about 39,000 t. to Belgian steelworks recently. The deliveries in house coal have continued extensive, and the Belgian coal market is altogether more lively than before. Foreign trade in coal during the first six months of the present year has been pretty favourable, 2,796,110 t. being imported, against 2,679.821 t. in last year ; exports were 2,456,029 t. against 2,177,821 t. in the corresponding period last year.

The French Iron Industry.

No change can be reported to have taken place on the iron and steel market ; all departments remain in good occupation. Quotations are the same as before. In the East and North the works are chiefly engaged in the production of basic, and three additional blast-furnaces have been blown in since the beginning of the year. The total output per day remains at 10,500 t.

Coal is in regular and pretty lively request in France.

THE JUNIOR INSTITUTION OF ENGINEERS.—The summer meeting of the Junior Institution of Engineers in the Midlands opens on Saturday morning, August 14th, at Leamington, with a welcome by the Mayor, Councillor Alfred Holt, J.P. In the afternoon Warwick Castle is to be visited, and in the evening there will be an illuminated concert in the Jephson Gardens, by invitation of the Town Improvement Association. On Monday morning the Muntz Metal Company's works and Joseph Gillott's pen manufactory in Birmingham are to be visited ; in the afternoon the James Watt Museum. On Tuesday morning the members will be received at Redditch by the Birmingham Local Section of the Institution, and will visit Shrimpten's needle manufactory, and J. Warner and Sons' fish hook and fishing tackle manufactory. Wednesday morning will be occupied in a visit to the mechanical, electrical, and civil engineering departments of the Birmingham University ; the afternoon being devoted to visits to the Austin Motor Company's works, and the works of the Birmingham Small Arms Company. On Thursday Coventry will be visited, the morning being spent at Herbert's machine tool works, and those of the Triumph Cycle Company, and the afternoon in visiting the new gasworks of the Coventry Corporation at Foleshill, and Rotherham's watch factory. Cadbury Brothers entertain the members on Friday morning at their Bourneville Works, and for the afternoon Elkington's electro plating works will be open for visiting. The Institution's summer dinner takes place in the evening at the Great Western Railway Restaurant, Birmingham ; and on Saturday morning the Summerlane Electricity Works of the Birmingham Corporation will be seen, the afternoon being occupied with a visit to the electrical signalling apparatus of the Great Western Railway at Snow Hill Station.

BRITISH PATENT SPECIFICATIONS.

When an invention is communicated from abroad the name and address of the Communicator is printed in italics.

When the abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent-office Sale Branch, 25, Southampton-buildings, Chancery-lane, London, W.C., at 8d. each.

The first date given is the date of application; the second date at the end of the abridgment is the date of the advertisement of the acceptance of the complete specification.

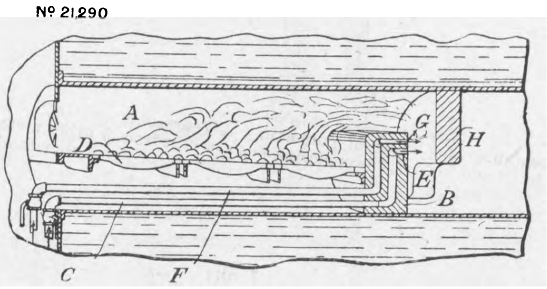
Any person may on any of the grounds mentioned in the Acts, within two months of the date given at the end of the abridgment, give notice at the Patent-office of opposition to the grant of a Patent.

STEAM GENERATORS.

21,290. October 8th, 1908.—IMPROVEMENTS IN MEANS FOR CONSUMING SMOKE, Sherard Osborn Cowper-Coles, of Grosvenor Mansions, 82, Victoria-street, Westminster.

This invention relates to means for consuming smoke in the furnaces of boilers and the like. A represents the furnace and B the fire-bridge thereof. C is a gas pipe which extends from the front of the furnace below the grate D to the fire-bridge B, up which it passes so as to supply gas to a series of outlets or nozzles E, through which the jets of gas issue in a rearward direction, as indicated by the arrow. F is an air pipe, which also extends from the front of the furnace below the grate D thereof, and passes up through the fire-bridge B, as in the case of the gas pipe C, the air pipe F communicating with a series of holes or nozzles G placed above the gas nozzles E through which a series of air jets issues in a rearward direction from the fire-bridge B. H is the firebrick partition which extends from the top of the flue downwards to the point below the plane of the gas nozzles E. This partition may be solid as illustrated, or perforated, or provided with a ribbed or corrugated surface. The gas and air jets are projected in a horizontal direction, and the fire-brick partition H is consequently placed upright, so that the jets are projected against it in a direction at right angles, or approximately at right angles, to its surface. A modification of the invention is also dealt with.—*July* 21*st*, 1909.

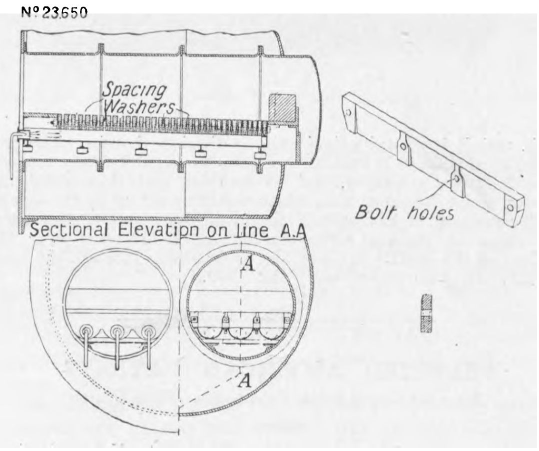
Nº 21,290



23,650. November 5th, 1908.—IMPROVEMENTS RELATING TO BOILER AND THE LIKE FURNACES, Richard Jackson Eskrigge, of 159, Victoria-road, New Brighton, Chester.

In certain types of forced-draught furnace arrangements it is found that the air pressure below the fuel is higher towards the rear or fire-bridge end of the furnace than it is towards the front end thereof. As a consequence (the air spaces between the fire-bars being uniformly wide throughout the grate area), it is necessary, in order to prevent the undue passage of air through the fire at the rear end, to keep the fire thicker there than elsewhere. This is objectionable, especially with hand firing, being a cause of imperfect combustion and emission of smoke. According to this invention, the fire-bars are arranged transversely to the furnace, and the width of the air spaces is graded, not by varying the thickness of the bars, but by spacing them further apart at the front and closer together towards the rear or fire-bridge end of the furnace. The bars are also bolted together into a single structure, and air troughs or ducts provided below the bars to convey the air under pressure to the fire.—*July* 21*st*, 1909.

Nº 23,650

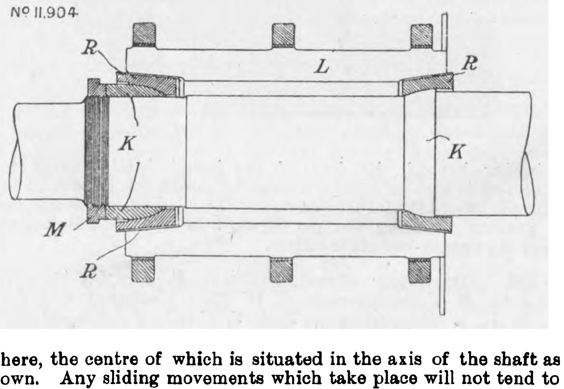


DYNAMOS AND MOTORS.

11,904. May 20th, 1909.—IMPROVEMENTS IN COMMUTATORS FOR DYNAMO-ELECTRIC MACHINES, *Siemens-Schuckert Werke, G.m.b.H., of Askanischer Platz* 3, *Berlin.*

The contact surfaces of the rings R and K are, according to this invention, shaped to conform to a portion of the surface of a sphere, the centre of which is situated in the axis of the shaft as shown. Any sliding movements which take place will not tend to impair the mechanical connection between segments L and shaft, as the spherical surfaces will slide over each other in an even manner without the production of severe local pressures between the surfaces, and with practically no tendency to grind parts of the surfaces away. One end of the commutator may conveniently be secured as shown at the right-hand side in the engraving. Here the ring K is turned with and forms a part of the shaft, and slots may be cut in it or not, as desired. The whole of the tightening up is effected by the nut M on the left-hand side.—*July* 21*st*, 1909.

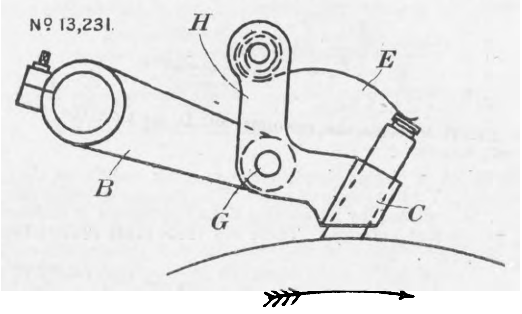
Nº 11,904



13,231. June 5th, 1909.—IMPROVEMENTS IN AND RELATING TO BRUSH HOLDERS FOR DYNAMO-ELECTRIC MACHINES, the *Allgemeine Elektricitäts-Gesellschaft, of Friedrich Karl-Ufer, Berlin.*

This invention relates to brush-holders for dynamo-electric machines and has for its object an improved device whereby the relative positions of the tensioning device and the brushes are not altered for various angles which the brush-holder box may make with regard to the commutator or slip-ring surface. The brush box C for guiding the brushes is carried by an adjustable member H, which also carries the tensioning device E. The member H is pivoted to the fixed member or yoke B at G, and is made adjustable, so that it can be set at varying angles. It will be seen that if the adjustable member H is moved, so as to alter the angles which the brushes make with the commutator or slip ring, the spring E will also be moved and will not alter its position with relation to the brush, and therefore for the various angles at which the adjustable member may be set, the direction and pressure of the spring E will be the same.—*July* 21*st*, 1909.

Nº 13,231.

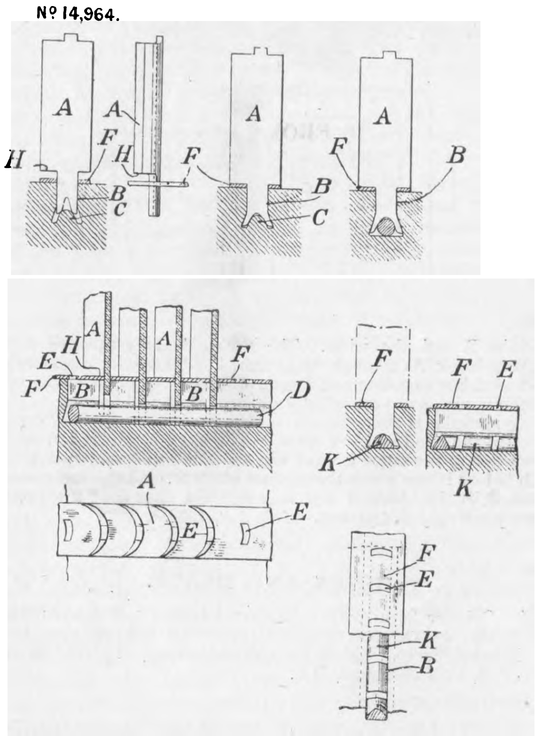


TURBINE MACHINERY.

14,964. July 14th, 1908.—IMPROVEMENTS IN TURBINES, Belliss and Morcom, Limited, and Reginald Keble Morcom, of Ledsam-street Works, Birmingham.

The present invention relates to means for spacing guide-blades and vanes of turbines secured by a crushing operation within grooves formed in the stator and rotor elements of turbines, the means for spacing also serving to cover unoccupied portions of such grooves. The blades A are secured by a crushing operation in undercut grooves B by the bifurcated ends of their shanks being spread apart by a central ridge C or by an inserted rod D. Previously to or whilst the shanks of the blades or vanes are being inserted into the groove, the shanks are threaded through apertures E, formed at a uniform distance apart in a strip F. Preferably the strip F is equal in width to that of the unreduced portions of the blades A. On the blades or vanes being forced into the groove B the strip F will be pressed by the shoulders H of the unreduced portions of the blades or vanes closely against the surface of the turbine element on each side of the groove, thus the strip not merely serves the purpose of spacing the blades or vanes, but also that of covering the unoccupied portions of the groove. As shown in the three lower right-hand engravings, the spacing strip F may be used in conjunction with a notched spreader rod K, which rod itself is adapted to space the lower extremities of the shanks.—*July* 21*st*, 1909.

Nº 14,964.

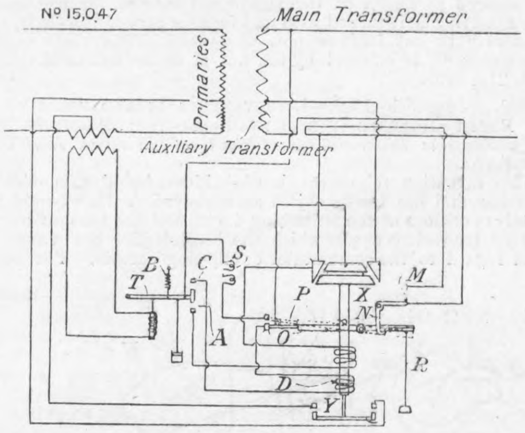


TRANSFORMERS.

15,047. July 15th, 1908.—IMPROVEMENTS RELATING TO ALTERNATING ELECTRIC-CURRENT DISTRIBUTION, John Sedgwick Peck, of Westinghouse Works, Trafford Park, Manchester.

This invention relates to alternating-current electric distribution systems, and in particular to systems in which main and auxiliary transformers are employed. If the load on the supply circuit be reduced below a predetermined value, the relay switch A is moved under the action of the spring B, so as to bring its contact member T into engagement with the contact C, and a circuit will thereby be completed through the opening coil D, so as to open the switches X, Y, and put in the main transformer. If at any time during operation under light-load conditions the current traversing the auxiliary transformer is sufficient to blow the fuse M, the bell-crank lever N will release contact member O of the switch P, and this contact member will be moved by the weight R so as to close the switches X and Y, and also break the circuit through the opening coil D, and complete a circuit through the indicating lamps S. The attention of the attendant will thus be drawn to the fact that the auxiliary transformer circuit has been interrupted, and it will be impossible

Nº 15,047



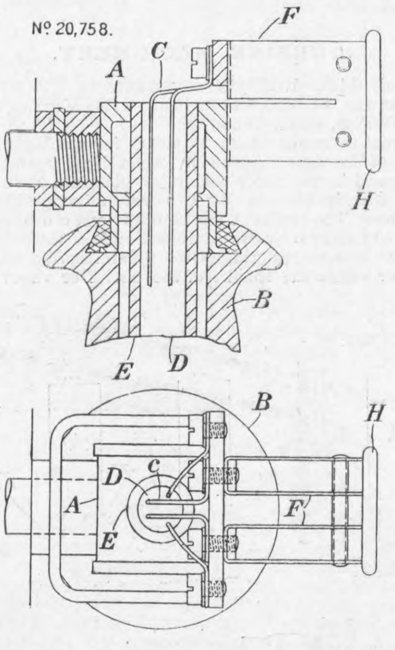
to complete a circuit through the opening coil D, so that the switches X, Y will remain closed. The indicating lamps may, of course, be replaced by an audible signalling device if desired, or may be omitted entirely. There are three other illustrations.—*July* 21*st*, 1909.

SWITCH GEAR.

20,758. October 2nd, 1908.—Improvements in Electrical Fuses, Bertram Thomas and Eustace Thomas, both of Worsley-street, Hulme, Manchester.

This invention has for its object the improvement of fuses for the protection of electrical circuits and may be applied to any suitable type of fuse, as, for instance, that known as the "tubular" fuse. The contact block A is cemented or otherwise secured to the insulating handle or tube B. The fuse wires or strips C pass through the aperture D, a tube of asbestos or other suitable material E being preferably interposed between the handle or tube B and the wires. The wires C are connected to the contact block A through the vanes F. These have preferably, as shown, large cooling surfaces exposed to the air, and the cross section is such as to cause little internal electrical heating. Insulating material H may be applied to prevent accidental contact between the hand and live metal. The heat conducted from the fuse wires to the outer ends of the vanes has to travel over a long path before it can reach the contact block A, and the temperature attained by the block A and any contact clips used therewith is correspondingly diminished.—*July* 21*st*, 1909.

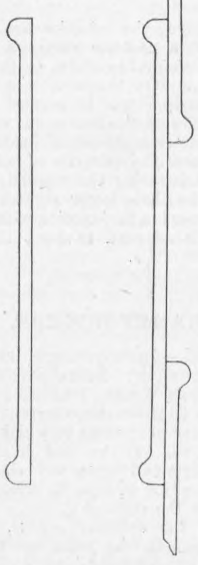
Nº 20,758.



SHIPS AND BOATS.

2855. October 24th, 1908.—Improvements in Building Iron, Steel, or Composite Ships or other Structures, James Edward Scott, shipbuilder and shipowner, of Greenock, and of 52, Coal-exchange, E.C.

Nº 2855^{09}



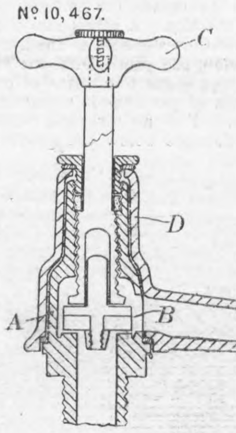
This invention relates to the forming of a bulb on each longitudinal edge of any size of plates or sheets manufactured of steel, iron, copper, zinc, brass, bronze, white metal, or aluminium. By the application of these bulbs the moment of inertia of each plate or sheet will be increased 40 per cent. In corrosive metals deterioration will be reduced to a minimum. In riveted landing of these double bulb plates it will be sufficient to have single instead of double riveting, with larger and wider spaced rivets, owing to the edges of the plates or sheets being 40 per cent. stiffer than ordinary plain rolled plates. The left-hand engraving represents the new section of double bulb plates, and the right-hand engraving represents double bulb plates overlapped for riveting.—*July* 21*st*, 1909.

MISCELLANEOUS.

10,467. May 14th, 1908.—Improvements in Taps and Valves, Moses James Adams, The Red House, Stocksfield-on-Tyne.

The object of this invention is to produce a tap which shall have the strength and utility of the taps usually employed, and yet shall be perfectly free from the trouble of tarnishing. A tap body of gun-metal or other suitable material is placed within a casing of cast iron or suitable material which is coated with a glass or porcelain enamel applied at great heat, thus presenting the appearance and effect of porcelain. A represents the tap with outlet B and head C, the enclosing body of cast iron or other metal enamelled or of porcelain material is shown at D, so that to all intents and purposes the tap is porcelain-like and can be quite readily cleaned.—*July* 21*st*, 1909.

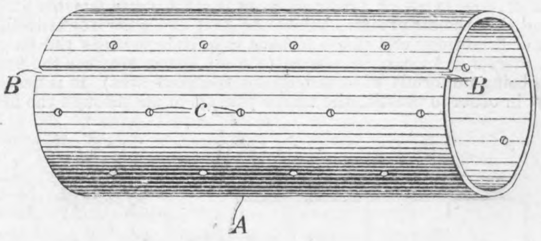
Nº 10,467.



24,495. November 14th, 1908.—Improvements in or relating to Bearing Bushes, James Bowack, of 45a, Temple-road, Cricklewood.

This invention relates to bushes for the reception of shafts, axles, and the like, and has for its main object to construct them so that they are free to expand circumferentially when heated, thereby avoiding undue friction and consequent wear. A is the bush, and B is a longitudinal split or division therein. The provision of this space B enables the bush to expand freely circumferentially when heated, and to contract and thus avoid the friction and consequent wear which would be set up by the axle or shaft revolving in the bush if the latter were solid. Moreover, the space or division serves to distribute lubricant over the surface of the shaft. C C are the perforations through the bush for lubrication purposes.—*July* 21*st*, 1909.

Nº 24,495.



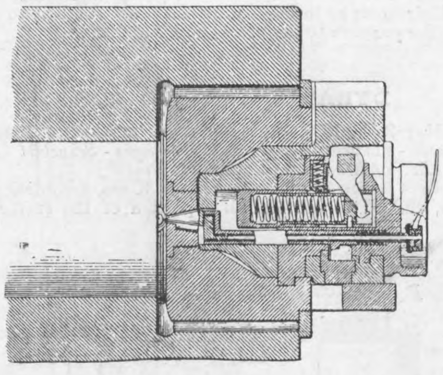
SELECTED AMERICAN PATENTS.

From the United States Patent-office Official Gazette.

925,642. Firing Mechanism for Guns, *A. Y. Leech, jun., Washington, D.C., assignor to United States Ordnance Company, Washington, D.C., a Corporation of Virginia.—Filed December 24th*, 1907.

The inventor claims the combination with the rotatable breech block of a gun, of a firing pin having a contact point normally projecting beyond the face of the breech block, means for connecting it with an electric conductor, means for retracting the firing pin before the initial rotation of the block in unlocking, and for gradually moving the pin forward as the block is locked. There are twenty-two other claims.

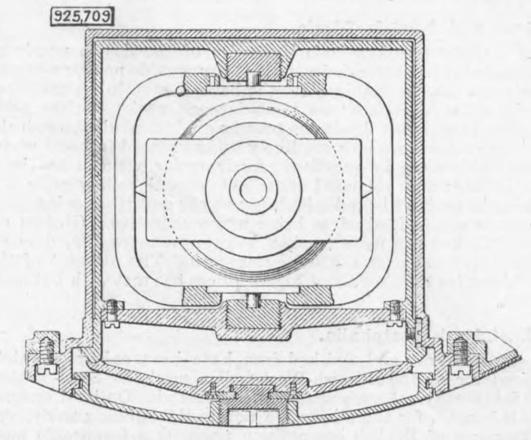
925,642



925,709. Gyroscopic Steering Gear, *F. M. Leavitt, New York, N. Y., assignor to E. W. Bliss Company, Brooklyn, N. Y., a Corporation of West Virginia.—Filed April 30th*, 1907.

This is an invention intended a parently for the steering only of torpedoes. There are ten claims, and the fifth of these gives a good general idea of the invention:—The combination with the shell or hull of a torpedo having an opening, a casing fixed therein with its interior chamber communicating with said opening, a gyroscope, and its support adapted to enter said chamber, a hand-hole cover for closing said opening, a movable part for holding said support in place, and a screw connection between it and the hand-hole cover.

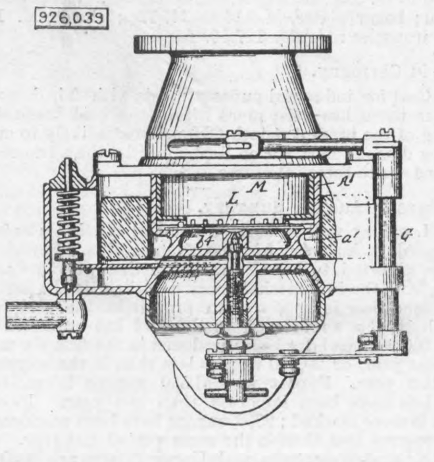
925,709



926,039. Carburetter, *E. F. Warren, Detroit, Mich., assignor of one-half to M. E. Garrett, Wayne County, Mich.—Filed July 22nd*, 1908.

There is only one claim. It is as follows:—In a carburetter, the combination of an annular gasoline reservoir, having a vertical portion A^1 of its inner wall and an annular ledge a^1 around its inner wall, said wall and ledge surrounding a central opening, leaves L pivoted on said ledge, a nozzle b^4 having its delivery end located adjacent to the centre of said opening, a needle valve in said nozzle, an annulus M having a vertical and a horizontal wall, the vertical wall of said annulus fitting against and within the vertical wall A^1 and its horizontal wall lying over and adjacent to said leaves and adapted to actuate the same, a shaft G pivoted in bearings on the outside of said annular reservoir, a lever on one end of said shaft connected and adapted to actuate the annulus M, and a lever arm on the other end of said shaft connected with and adapted to actuate the needle of said valve.

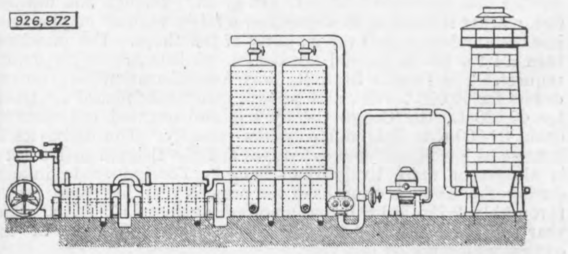
926,039



926,972. Method of and Apparatus for Drying Air, *D. Baker, Philadelphia, Pa.—Filed June 21st*, 1907.

This patent is for a method of treating air for metallurgical purposes, which consists in compressing it, reducing the temperature of the compressed air to remove the heat developed by compression, subjecting the air to a further cooling action, removing any mechanically suspended water carried by the air, maintaining the air at a constant pressure while being cooled and dried, and finally measuring and delivering the air thus tested under pressure to the place of use. There are fifteen claims.

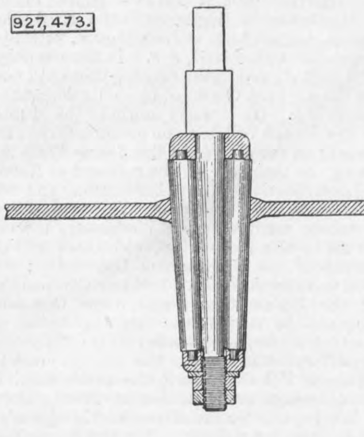
926,972



927,473. Method of Forming Openings for Wash-out Plugs for Boilers, *H. B. Ayers, Pittsburg, Pa.—Filed June 29th*, 1908.

The invention consists in drilling a hole in the boiler plate, and then enlarging it with a roller expander, which sets up the metal and thickens it as shown. There are two claims.

927,473.



THE CHOICE AND CONTROL OF FUEL SUPPLIES BY STEAMSHIP COMPANIES.

By JOHN B. C. KERSHAW.

THE importance of purchasing good fuel, and of exercising some check upon the delivery of the same into the ship's bunkers, is generally recognised by steamship owners in these days of keen competition and small profits, and efforts are no doubt made to see that the coal shipped is up to the contract standard of value. But, in the absence of any definite basis of value or comparison, this control of the fuel actually placed in the bunkers of the ship is not at all a simple matter, and in the majority of instances the presence of bad fuel is only found out after the ship has commenced her voyage, and the stokers have found it almost impossible to keep up the steam pressure to the figure required. Complaints are then made, which in time find their way to the ears of the superintendent engineer of the company; but the colliery company or agent supplying the fuel, when approached on the subject, can always argue that it is the ship's engines or boilers that are at fault, and in nine cases out of ten, therefore, where complaints are made, the fuel is finally paid for without any deduction from the contract price.

It is the writer's purpose in this article to show how the customary clause in steamship companies' fuel contracts can be replaced by one which affords much greater protection to the consumer against the shipment of bad fuel, or of fuel below the contract value, while it offers to the colliery company or middleman through whom the fuel is shipped a means of settling all disputes upon a perfectly fair and equitable basis. Indirectly, this method of controlling the fuel supplies provides a method for increasing the bunker capacity of the ship, and therefore its range of steaming power, for by the strict check upon the deliveries of fuel possible by this system—when efficiently worked—fuel of a higher calorific value than under the present system will in nearly all cases be obtained for the same cost.

The method briefly is to base the purchase clause of the contract upon the heat value of the fuel rather than upon its mere weight, and to make the standard of value, not the cwt. or ton, but the British thermal unit. In other words, the steamship owner buys and pays for heat units, in place of so many hundreds or thousands of tons of coal—which latter is an ambiguous term, covering a very much larger amount of non-combustible matter, like moisture, shale, and dirt, than the average purchaser realises.

The following more detailed description of this method of selection and control is based upon information which the writer has obtained from various sources during the past three years, and it may interest readers to know that the system is already being applied to fuel contracts in the North of England, in Germany, and in America.

I. *Description of the tests required.*—The heat liberated by the combustion of one pound of fuel can be accurately determined by a laboratory apparatus known as "a calorimeter," in which the coal is completely burnt to CO_2 and H_2O, and the heat liberated absorbed by the surrounding water. The result of this test can be expressed in the scientific units—used for measuring heat—known as the "British thermal unit," which represents the heat required to raise 1 lb. of water 1 deg. Fah. The sample of fuel used for the laboratory determination of its heat value is always dried; and therefore a calculation is necessary to find the heat value of the same fuel when charged into the boiler furnaces in its undried state.

In order to make the deductions due to the presence of this moisture, it is necessary to know the percentage of moisture in the fuel sample as delivered into the ship's bunkers, and for this purpose a small weighed quantity of the representative sample of the fuel is dried for two hours at 230 deg. Fah., at which temperature all the natural moisture of the fuel is expelled.

Finally, since the ash contents have a direct influence upon the amount of unburned fuel which passes away with the ashes and cinders from the boiler furnace—the higher the percentage of ash the higher being the proportion of unburned coal—it is necessary to make a laboratory determination of the ash contents of the fuel before calculating the net heating value of the same.

The ash determination is made by heating carefully a weighed portion of the dry fuel sample in an open porcelain dish over a Brunner burner until all the volatile gases are drawn off, and all the solid carbon has been burned to CO_2. The residue is then weighed, and is expressed as a percentage of the dry fuel.

With the laboratory figures for these three tests before the operator, the calorific or heat value in British thermal units (B.Th.U.), and the moisture and ash expressed as percentages, he can then proceed to calculate the net value of the fuel to the consumer.

II. *Calculation of the net value of the fuel.*—The net value of the fuel from the purchaser's point of view is represented by the British thermal units which can be purchased for one penny. This value is obtained from the above data in the following way:—

The British thermal units per lb. of dry coal is diminished by the number of B.Th.U. corresponding to the moisture, since, if the fuel contains 5 per cent. of moisture, there can only be 95 lb. of dry fuel in every 100 lb. of fuel as delivered. The figure obtained after making this deduction represents the B.Th.U. in 1 lb. of the wet fuel, and this is multiplied by 2240 to give the B.Th.U. in 1 ton of the fuel, as delivered in the ship's bunkers. Having obtained in this way the total B.Th.U. contained in 1 ton of the fuel as delivered, it is only necessary to divide this figure by the price of the coal, expressed as pence, in order to obtain the net B.Th.U. per penny of coal. Before doing this, however, the price per ton as delivered in the bunkers is increased by an amount in pence equal to one-fourth of the ash percentage, in order to compensate for the decreased burning efficiency of the coal due to this cause, as already explained.

The following formula is the algebraic expression of the above calculation:—

$$C\,g = \frac{\left\{H^d - (H^d \times M)\right\} \times 2240}{P + \frac{A}{4}}$$

$C\,g$ = contract guarantee, or heat units for one penny.
H^d = heat units found in dry coal.
M = percentage of moisture in decimals.
A = percentage of ash, in pence.
P = contract price per ton, in pence.

As a practical illustration of the above method of calculating the net value of the fuel, the following example may be taken:—

Test results:—

Moisture	4.95 per cent.	on dry coal.
Ash	11.65 per cent.	
Calorimeter test	13,329 B.Th.U.	
Contract price ...	8s. 8d. per ton	

$$\text{Net value} = \frac{\left\{13{,}329 - (13{,}329 \times .0495)\right\} \times 2240}{104 + \frac{11.65}{4}}$$

$$\text{,,} \quad = \frac{(13.329 - 659) \times 2240}{106.91}$$

$$\text{,,} \quad = \frac{(12{,}670 \times 2240)}{106.91}$$

$$\text{,,} \quad = \frac{28{,}380{,}800}{106.91}$$

$$\text{,,} \quad = 265{,}488 \text{ B.Th. Units.}$$

The net value, as delivered, is therefore 265,488 British thermal units, and this figure represents the B.Th.U. which are actually obtained for each penny expended on the fuel.

III. *The methods of using the net value of the fuel:* (a) *As a means of comparison.*—Since the figure obtained as described above takes into account four variable factors relating to the valuation of fuel, it furnishes the best basis for comparing coals from different sources. By the use of this method of valuation all costs are reduced to a common basis of comparison, and it is quite easy to select the coal which is really the cheapest, *i.e.*, contains most heat units per penny of cost.

The following series of tests taken from one of the circulars issued by the Fuel Engineering Company, of Chicago, shows the practical application and value of this method of comparison:—

Kind of coal. (Screenings)	Distinguishing letter.	Moisture.	Dry Ash.	Dry B.Th.U.	Price.	Net B.Th.U. for one cent.
		per cent	per cent		dols.	
Carterville	(A)	14	16	12 103	1.65	120,330
Pana	(B)	13	19	11,296	1.40	131,406
Sprongfield	(C)	11	20	11,346	1.35	139,282
Decatur	(D)	12	23	10,863	1.30	135,115

If the price only had been taken into consideration, the coal marked (D) would have been selected, while if the heat value alone had been considered, the coal marked (A) would have been chosen. The last column of the table, however, giving the B.Th.U. obtained for each cent expended shows that the coal marked (C) yielded the greatest number of heat units per unit of cost, and was, therefore, the cheapest and best. This table is incidentally of interest, since it shows the higher moisture and ash percentages of American coals as compared with British coals.

(b) *As a basis for the fuel contract.*—The fuel contract making use of the test for the net value of the fuel is so worded that the company or middleman from whom the fuel is purchased agrees to deliver coal that has given certain specified test results—which are included in the contract—at a certain price per ton delivered in the bunkers. The net B.Th.U. for 1d. is afterwards worked out from these figures, by the method described above, and is included in the contract as the "contract guarantee." Should fuel showing a larger or smaller number of B.Th.U.'s per penny of cost be actually delivered, the price to be paid for the fuel rises or falls in a corresponding degree, the principle of the contract being that 1d. is to purchase always the number of heat units specified in the "contract guarantee."

In this way the price paid for the fuel varies in an absolutely fair way with the quality of the coal delivered. Both the seller and the buyer are protected from those pecuniary losses due to variations or irregularities in the fuel, over which they may have no control whatever, but which, under the existing system of purchase, occur frequently, and lead to much friction and unpleasantness.

The delivered value of the fuel is obtained by taking a large number of samples during the delivery of the same, and by having each of these—or two very carefully prepared average samples—tested for moisture, ash, and calorific value in the manner already described. The delivered value $D\,v$ of the fuel, for each test result, is then calculated by aid of the formula given below, and the average of the delivered values gives the price which must be paid for the fuel as shipped.

$$D\,v = \frac{\left\{H^d - (H^d \times M)\right\} \times 2240}{Cg} - \frac{A}{4}$$

The following table, taken from the circular of the Chicago company already quoted, illustrates the operation of a heat value scale. The contract was for a period of thirty days, during which the consumer received two truck loads a day, each truck being sampled, and a composite analysis made of these samples once each week:—

	Moisture. Per cent.	Dry ash. Per cent.	Dry B.Th.U.	Delivered value. Dols.
First week ...	11·5	23	10,863	1·265
Second week ..	12·0	24	10,705	1·232
Third week ...	12·6	22	11,022	1·273
Fourth week	11·1	19·5	11,410	1·359
				4)5·129
Settling price for the month				1·282

During the first two weeks, in the illustration shown above the contractor was unable to deliver coal of contract grade owing to his mines being shut down, but the loss was sustained by him and not by the customer. At the middle of the second week he began delivering contract coal, which at once operated to increase his price.

JOINT CONFERENCE OF INSTITUTIONS OF ENGINEERS AND SHIPBUILDERS.

No. II.*

WHEN the Conference resumed its sittings on August 5th, Mr. Summers Hunter, the President of the North-East Coast Institution, occupied the chair.

The discussion was resumed on the paper dealing with the trials and service performances of the Otaki.

Professor Weighton said that his personal opinion of the paper would no doubt be endorsed by all members of both Institutions. The paper at last gave what most of those interested in the economics of ship propulsion had been in search of for some time past, namely, reliable data from actual practice—data which could, he believed, be accepted with a very considerable amount of confidence. It was shown that the propulsive efficiency of the ship when propelled by the new combination of machinery fell off from 2½ to 3 per cent., and in the absence of that definite information some of those interested in the combined system had been inclined to put the falling off in propulsive efficiency much higher than those figures. Diagram 15 in the paper showed that for any given speed the Otaki was consuming more horse-power than the sister ship, and therefore, if the economy of the system were read in terms of horse-power only, the Otaki would be inferior to the vessel fitted with reciprocating engines. That feature arose entirely from the falling off in the efficiency of propulsion, but Diagram 14 completely explained how it was that notwithstanding that disadvantage, which was inevitably associated with such a combination of machinery, the Otaki was still superior in performance to her sister ship. That raised the whole difficulty of adequately expressing the performance from the point of view of economy in terms of any horse-power at all. It must be expressed in terms of coal consumed or steam consumed, and when that was done, in spite of the waste of power, there was a superiority revealed because the combination system, as might be expected, gave more horse-power per pound of steam. If the paper brought out nothing else than these facts, then the author would have rendered great service to those engaged in the solution of problems relating to ship propulsion. That was the essential point of the paper; the condensing apparatus was not the point at all, but he was bound to refer to that subject after the speech made by Mr. Weir the previous day. Unless the matter were closely looked into, some of the observations made by Mr. Weir might be very misleading, and he felt compelled, in the interests of scientific accuracy and validity of comparison, to refer briefly to the subject. Mr. Weir compared two condensers which differed entirely in the conditions under which they worked. His basis of comparison was heat units transmitted per square foot per unit time for each degree difference of temperature. Every one who had experimented on the condensation of steam knew that unless careful allowance was made for the conditions under which the condensers worked, comparisons were absolutely valueless, if not positively misleading. Comparative figures, in his experience at any rate, largely depended for their value upon several factors, almost all of which were entirely independent of the design of the condenser in any shape or form. The performance of condensers was not capable of being compared on anything like the simple terms suggested by Mr. Weir. Reference had been made by one speaker to the combination system as something transitional in character, but although transitional in one sense, that must not be taken to mean that it was not a distinct step towards further improvement. The experience gained with the Otaki showed that a decided step in advance had been taken. For what had been achieved the shipbuilding industry was indebted to Mr. Parsons, and to the courage and enterprise of both the owners and builders of the Otaki.

Mr. D. B. Morison asked Mr. Weir whether he would present to the Scottish Institution a paper on condensing plants, so that the whole of the questions raised regarding the performance of condensers could be fully discussed. If Mr. Weir could not produce such a paper, then he—Mr. Morison—was prepared to do so.

Mr. R. M. Neilson said that in the paper the superiority of the Otaki over the Orari was given as 17 and as 20. The former was the figure of commercial importance. A reciprocating-engined boat to be of equal commercial economy would have to run on 13.7 lb. of steam per indicated horse-power. It meant that with the combination system a boat could be propelled at about 14 or 15 knots with 17 per cent. less coal than a fairly economical boat propelled by reciprocating engines. From the commercial point of view it did not matter what was the horse-power or propulsive efficiency in the two cases; the point of commercial importance was the coal consumption. Equal economy could, however, be obtained in other ways, notably by the adoption of the turbo-electric drive. The economy thus realised would, he anticipated, be practically the same as that obtained in the Otaki. Or an equal, if not a better, economy could be obtained by the retention of the ordinary reciprocating drive and the employment of superheaters. His view was that for cargo boats the turbo-electric drive was inferior to the combination of reciprocating engines and turbines, partly because on such ships it would be difficult to obtain engineers properly to look after the machinery, and partly because the initial cost would be much higher. He noted that in the Otaki installation the initial pressure in the turbine was only 4.5 lb. absolute, and a high efficiency could not be expected under these conditions. It was pointed out by the author that at full power the work done by the turbine was about one-third, while at low speeds the turbine was doing only a small proportion of the work. This suggested that it would have been better if the reciprocating engines had been made smaller and more work thrown on the turbines when steaming at 12 knots, with a possibility of greater economy at that speed. The propulsive coefficient might have been less, but the efficiency of the turbine, and probably also the mechanical efficiency of the reciprocating engines, would have been greater at the working speed of the ship, 12 knots. From particulars given in the paper, it would appear that at full power the effective efficiency of the turbine, or ratio of the brake horse-power to the available energy in the steam, was about 56 per cent. In view of the desirability of keeping down the size and weight of the condenser plant, this forming a considerable proportion of the total weight of machinery, it would be interesting to know what vacuum could be obtained at full power with a sea temperature of 80 deg. or even 75 deg. At full power the cooling surface would represent about one square foot per indicated horse-power. He would like to be informed how many square feet of cooling surface would be required with a condensing plant like that of the Otaki to obtain 28in. vacuum with a sea temperature of 75 deg. or 80 deg. With regard to Mr. Weir's criticism, it was extremely difficult to compare condenser performances satisfactorily unless the conditions were exactly similar, the behaviour of the condenser being influenced by too many factors. To refer to only one point, it was obvious that the air leakage conditions were very different in a boat with a reciprocating turbine combination of machinery to those obtaining in a ship propelled by turbines alone.

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* No. I. appeared August 13th.

Mr. A. F. White said that, judging by the growing application of the turbine, it might be imagined that the reciprocating engine was becoming obsolete. The multiple-expansion engine, save for an advance in size, had remained practically unaltered for the past fifteen years, and, as far as economy of operation was concerned, the engine of to-day was not more economical than those of fifteen years ago. At the same time, many engineers were of opinion that the multiple-expansion engine had not yet reached its highest form of development. The combination system appeared to be a move in the right direction, but it was evident that for ships of different types and speeds different means of propulsion should be employed. For that reason he urged the claims of the reciprocating engine, and that attempts should be made to improve its economy for ship propulsion. In this connection insufficient attention had been paid to the employment of superheated steam. The shipowner did not appear to be aware that an economy of at least 10 per cent., and of as much as 16 per cent., might be obtained from the use of superheated steam, or he would insist on his engineers making use of it. Not only would it improve the efficiency of the reciprocating engine, but it could also be applied to the combined system with, he believed, satisfactory results.

Mr. R. J. Walker said that Messrs. Denny had been closely associated with Mr. Parsons in the application of the turbine to the mercantile marine, and the special facilities which the company possessed at Dumbarton for obtaining scientific data rendered the results published in the paper of particular value. The figures put forward were calculated to remove certain doubts which existed as to the practical advantages to be gained in the economy in coal consumption to be obtained by the combined system. Whilst all engineers admitted that theoretically a greater efficiency could be obtained by utilising the exhaust steam of a reciprocating engine in a low-pressure turbine than in the case of a good quadruple engine, there were many very doubtful as to the practical utilisation of this increased steam efficiency. The reduced efficiency of the screw, of the shaft on which the turbine was placed, the loss of efficiency due to wetness of the steam entering the low-pressure turbine, the difference in thermal units expended to obtain the higher vacua essential to the turbine end of the combination as compared with that required with reciprocating engines; these and other points had been put forward as factors requiring consideration in estimating the probable ultimate gain. Notwithstanding that these questions had been raised, the author had tabulated his facts in a manner which showed the actual difference in efficiency between the Otaki and her sister ship. The increased gain at full power on the basis of given speed was 17 per cent. in favour of the Otaki. It was unfortunate that in service the Otaki had run below her designed sea speed on her first round voyage. The speed of 11 knots represented about half power, and a turbine designed for a pressure of 9 lb. to 10 lb. absolute, did not work under the most favourable conditions when running at half-pressure. A gain of 8 per cent. under adverse conditions was well worth having, and there would be a greater gain, as the author had shown, when the vessel was run at her designed sea speed. This was indicated by the experience of the second voyage of the Otaki. He might refer to experiments carried out by the Parsons Marine Steam Turbine Company in the yacht Emerald. The object was to see if in the combined system a greater economy could be obtained at cruising speeds, and to ascertain the possibilities in the way of reduced coal consumption. Extensive trials were carried out at the end of last year. The shaft horse-power developed by the low-pressure turbines at various initial pressures were as follows:—With 11.6 lb. absolute pressure and 27.4in. vacuum, the low-pressure turbines developed 30 per cent. of the total power, the total power being the indicated horse-power of the reciprocating engine plus the shaft horse-power of the turbines; with 10.6 lb. absolute pressure and 27.4in. vacuum the low-pressure turbines developed 28 per cent. of the total power; with 7 lb. pressure absolute, and 27.7in. vacuum, the low-pressure turbines developed 21 per cent. of the total power.

The author, in briefly replying on the discussion, said that there appeared to be little doubt that superheating could be employed with the combined system with some additional economy. The condenser results had been referred to by several speakers, and he would point out that those obtained on service were only sea-going observations, and made no pretension to scientific accuracy. With regard to the last diagram in the paper, it showed not only the difference due to propulsive efficiency, but the effects of the difference in length between the two ships and the difference in the shapes of the stern. He had no doubt that considerable improvements might be made in the design of ships following the Otaki on the combined system. With regard to the proper proportion of power to put into the centre screw, that was rather a wide question, and he was not at the present time prepared to deal with it in detail.

A cordial vote of thanks was accorded to the author for bringing the paper before the meeting.

Dr. G. B. Hunter then read the paper, of which he and Mr. E. W. De Rusett are the joint authors, on "Sixty Years of Merchant Shipbuilding on the North-East Coast." The following is an abstract of this paper:—

To begin with, some interesting particulars of the early days of the shipbuilding industry on the North-East Coast were given. Tracing the growth of shipbuilding from the time of the large East Indiaman of the end of the 18th century to the "composite" vessels of the sixties, the authors stated that the district in question had always been noted for the production and helped largely in the development of whatever class of vessel was for the time being regarded as constituting the most up-to-date practice. The first iron vessel constructed in the district was the steamer Prince Albert, built in 1842 for passenger service on the Thames, and from that date onwards the North-East Coast shipbuilders took a large share in the development of the new method of construction. In the earlier days, it was stated, the Clyde builders were much engaged on fast vessels for mail and passenger service, while the North-East Coast became noted for cargo-carrying vessels. Since 1883, however, the relative positions have become entirely changed, the latter having taken to the construction of fast and intermediate steamers of the highest class, while the former have turned their attention to cargo steamers. The lecturers claimed that the Terror, built by Palmer's in 1856, was the first iron vessel designed for war purposes, and stated that since then the district has given several new types of vessels to the world, among these being the class of "tramp" steamers known as "sixty-fourthers," well-deckers, self-trimming colliers, turret and trunk vessels, "side tank" steamers, and those built on the "cantilever" design. The development of oil-carrying steamers was also largely due to local enterprise, while it was here that the turbine system of propulsion was first successfully applied. The paper concluded with some statistics regarding the total tonnage returns of the North-East Coast and the output of the United Kingdom and abroad. Dividing the time from 1859 to 1908 into periods of five years, the figures given for the percentage share of the district in the world's shipbuilding are respectively 16, 17, 30.4, 30.7, 47, 45.6, 51.7, 50, 51.5, and 51.7.

There was no discussion on this paper, but Mr. C. P. Hogg formally moved, and Professor Weighton seconded, a vote of thanks to the authors.

The paper by Professor J. H. Biles, "Fifty Years of Warship Building on the Clyde," was, in the absence of the author, taken as read. We give an abstract of it in the following:—

Professor Biles began by giving some statistics regarding the displacement tonnage of war vessels built on the Clyde during the decennial periods from 1858 to 1908. As summarising the tables given in the appendix to the paper, he stated that during the ten years from 1858 to 1868, 13 per cent. of the total tonnage built for the British Navy was constructed on the Clyde. For the following four corresponding periods this figure was 23, 14, 19, and 26 respectively. He next discussed and gave statistics for the total weight and cost of hull and armour for the like periods, and reducing the figures to cost per ton showed that this had steadily increased during the fifty years in question, and that with one exception this figure was lower on the Clyde than that given by aggregating the vessels built elsewhere—the exception, which occurred in the period 1868-1878, amounting to no more than 1 per cent. Corresponding figures were given for machinery and cost per indicated horse-power. The author then passed on to describe briefly the outstanding features of the various vessels built on the Clyde, tracing the gradual evolution which has taken place, from the time of the Black Prince of 1862, which, he said, was a type of the period of transition from wood to iron, to the completion of the Indomitable. In concluding, Professor Biles made some remarks on the Dreadnought type of warship, and showed that the dominating cause which has led to the production of large ships has been the fact that the cost of a ship per gun decreases rapidly with increase in the number carried.

There was no discussion.

This concluded the business part of the Conference. An interesting programme of visits to works, to which some reference was made last week, and which is further dealt with in what follows, had been arranged for the afternoons of August 4th and 5th. The social events included a reception by the Lord Provost of Glasgow, a dance and a smoking concert. A pleasure excursion on the Firth of Clyde took place on Friday, August 6th. The Conference has proved a conspicuous success, and a repetition of the joint meeting of the two leading shipbuilding institutions is promised.

THE WORKS OF BABCOCK AND WILCOX, LIMITED.

Amongst the works to which a visit was paid on Wednesday, August 4th, as mentioned briefly in last week's issue, were those of the Babcock and Wilcox Company, Limited, Renfrew. About eighty members were of the party conducted through the works, the following being brief references to the outstanding features of the several departments. In the machinery shops the highly special plants for machining the pressure parts of the Babcock water-tube boiler, such as headers, cross-boxes, handhole fittings, &c., formed the principal objects of interest. The machines here, specially designed for their several purposes, work at high rates of speed and feed. The tools engaged on crane work, also installed here, such as gear-cutting machines, grinding machines for shafts, and automatic and semi-automatic machines for the smaller parts, were noticed with interest, attention being drawn to the very elaborate arrangements made for ensuring accuracy and interchangeability. The drum shop was next visited, where boiler drums in all stages of construction were seen, and thence the visitors passed to the section shop. Here the boiler tubes are expanded mechanically into the headers by specially designed machines.

The marine shop is entirely laid out for the manufacture of marine type boilers for our own and other navies, the mercantile marine, and for considerable numbers for electric light. In the crane shop a large number of different types of overhead and jib electric cranes were shown in course of construction. Interest was particularly evoked by a special electric over-head travelling crane with underhung jib, this being one of three on order for the Great Western Railway Company. In the structural shop were also seen parts of two transporters at present being constructed to the order of the Clyde Trustees for erection and use at their new Rothesay Dock at Clydebank. A recently erected shop at these works is that devoted to the manufacture of steam, exhaust, and water pipes.

In the extensive foundry department hydraulic machine moulding is very largely used. As many as 30,000 castings of one particular kind are turned out per week, and the total metal melted exceeds 400 tons weekly. The stoker and superheater shop in which the company's mechanical chain-grate stokers, as well as coal conveyers, superheaters, galleries, &c., are manufactured, was next visited. Of chain-grate stokers alone the company produce about 20 per week.

The boiler installation and the power-house generally formed a fitting and natural finish to the itinerary through the works. Here were Babcock and Wilcox boilers, both of marine and land type, fitted with mechanical chain-grate stokers and superheaters, a specially noteworthy feature being the latest type of stoker gear having a continuous drive, four different speeds being obtainable. An independently fired superheater and boiler in this department are kept entirely for experimental purposes. The visitors finally passed to the engine-house, where the numerous engines for power and light, hydraulic and air compressing plant, also a water cooler and de-oiling plant, were inspected.

The alternative visits on the Thursday afternoon were organised to the works, in one case, of the Steel Company of Scotland at Blochairn; the Parkhead works of Wm. Beardmore and Co., Limited, and the works of Sir Wm. Arrol and Co., Limited, Dalmarnock. In another case the works visited were those of the Albion Motor Car Company, Limited, and of Yarrow and Co., Limited. At Scotstoun, in a third case, the dredger building works of Wm. Simons and Co., Limited, and of Lobnitz and Co., Limited, Renfrew.

THE BLOCHAIRN WORKS OF THE STEEL COMPANY OF SCOTLAND.

The Blochairn works of the Steel Company of Scotland have been undergoing considerable improvement in recent years in the way of new roofing, electrical overhead crane equipment, electrical charging plant. The productive ingot capacity of the works exceeds 3000 tons per week. They make a speciality of the production of the highest class of structural steel—including high tensile, nickel, and nickel-chrome, &c.—in sheets and plates of all classes from the thinnest to the thickest in widths up to about 12ft. and in lengths to 50ft. There are five mills engaged in this work—two large reversing and three of the pull-over type. A universal-type cogging mill reduces the ingots to slab form suitable for the various mills. There is also a guide mill producing rivet and all classes of small sectional bars. An additional department of importance is that embracing the production of railway and tram tires of all classes and sizes, the plant equipment being very complete. The process by which the steel in the Blochairn works is made is entirely open-hearth acid, the melting plant consisting of 11 open-hearth furnaces, two of 20 tons capacity, four of 40 tons capacity, four of 50 tons capacity, and one just erected of 60 tons capacity.

Entering the works from main office buildings, visitors first entered the melting department, where the new furnace of 60 tons capacity, just completed, was seen, as well as four other furnaces of 40 tons, and four of 50 tons capacity. In the tire shop next visited steel is supplied from two furnaces of 20 tons capacity. Behind this shop are two rows of circular gas producers equipped with a mechanical feed for the fuel. In the rolling mill department one of the first objects of attraction was the guide mill. This is a 10in. mill for rivet bars, small squares, angles, and other sections, driven by a geared compound condensing engine. All the coal-fired heating furnaces are equipped with overhead Babcock boilers, for utilising the waste heat from the furnaces. The sheet mill, for the heavier classes of sheets, next seen, is driven by a single-cylinder condensing engine. Adjacent to the heavy sheet mill is the cogging mill, which is served by one gas-fired and two coal-fired soaking furnaces. The mill is of the universal type, having vertical rolls in place of the usual tilting gear. The guillotine is of the hydraulic-pressure type, and performs its work noiselessly. The hydraulic engines are in adjoining houses. The slabs are conveyed to the larger mills by a bogie railway worked by chain. A sheet mill for the thinnest class of sheets came next under observation, and then the tire mill, which is of the single type. In this the tire is both roughed and finished, being lifted from the roughing to the finishing roll by means of a lifting table. Before reaching the mill the tire ingots pass through two processes under two 8-ton hammers. The first flattens and punches the ingot, while the other roughly forms the flange and lip of the tire. In the heavy plate rolling mill are two mills of note; a high speed pull-over mill and a clutch-reversing mill, both driven by a compound condensing engine. The next and largest mill was for rolling the heaviest class of plates, up to about 12ft. in breadth, 50ft. in length, and of any required thickness. It is driven by a pair of high-pressure reversing engines. The heating furnaces of this mill are of Siemen's "new form" type, with combined gas producers. The shearing floor is equipped with two shearing machines—one capable of shearing plates up to 2½in. thick. An annealing furnace and levelling table were also features noticed here. The testing house adjoining the heavy plate department is provided with two tensile testing machines—the one of 100 tons capacity, the other 50 tons, of the compound lever type, by Joshua Buckham and Co. In addition to the waste heat boilers on the heating furnaces there are several blocks of boilers situated at various points in the works, adjoining two of which is the house containing the electric plant for power and lighting. This consists of two 250 horse-power sets, the fluctuations in power being controlled by a new installation of accumulator battery and booster.

THE WORKS OF WM. BEARDMORE AND CO.

The Parkhead Forge and Steel Works of William Beardmore and Co., which would require the better part of a whole day to do anything like justice to by interested visitors, was listed in the programme simply as "an incidental" with the Blochairn visit. The inadequacy of this arrangement was, of course, soon made patent, and only a hurried and scattered visit by members resulted. These extensive works have frequently been dealt with in the columns of The Engineer.

THE WORKS OF SIR WILLIAM ARROL AND CO., LIMITED.

The Dalmarnock Ironworks at various times have formed the subject of descriptions in the pages of The Engineer. Interest during the present visit centred chiefly in the newer and very extensive fitting and structural erection shops forming the eastern portion of the works. Here the long ranges of radial drills and operating tables for girder formation, the long and heavy plate edge planing machines, the cold saws, and other machines usual in preparing structural steel work, were much admired, as well as the provision of overhead and radial post cranes for transporting and handling materials. Occupying a large area of the floor of the erecting bay of these shops was an impressive piece of work of special interest to members of the North-East Coast Institution. This was the complete cantilever jib of the 150-ton electric cantilever crane which the Arrol Company are preparing for erection at the works of the Wallsend Slipway Company.

Other ponderous items under process of erection in this section of the works were dock gates of the caisson type for the dock being constructed at Newport, South Wales. Besides the Newport contract the firm has on hand dock gates—but not of the caisson type—for the new dock being constructed at West Hartlepool; the foundation caissons for another important piece of engineering work for the Tees district—namely, the transporter bridge about to be erected at Middlesbrough; and a huge pontoon for the new dock work at Portsmouth, for which Messrs. Morrison and Mason, Glasgow, are the contractors.

One of the specially devised tools manufactured in the works which attracted considerable attention in this department was the powerful hydraulic press, which deals at one operation with plates 30ft. long and 6ft. wide, shaping them into the trough or buckle form by means of former dies.

In the engineering or machining department of the works, is constructed the machinery connected with the pneumatic sinking of foundation for piers, bridges, &c., including the air-compressors, reservoirs, locks, &c., as well as jacks and other hydraulic appliances for lowering the caisson into position, for the erection of steam, hydraulic, or electrical machinery for opening spans of bridges of the swing or rotating type, of the bascule system, and of the newer Scherzer roller-lifting design. There are also made in this engineering department all types of hydraulic riveters and presses, cranes, hoists, &c. Special machine tools, prime movers of various kinds, coal elevators and conveyors, and the Arrol-Foulis charging and discharging machinery, now so extensively adopted in gasworks.

A noteworthy new tool being laid down at the time of the visit was the 8ft. planing machine of Messrs. Smith and Coventry's make, which should prove a highly serviceable item in the working forces of the establishment. This machine, of which, by courtesy of the makers, we give in Fig. 15, a view of it as erected in their works before dispatch is capable of admitting work up to 8ft. high and of planing 24ft. long. It is driven by a 40 horse-power motor.

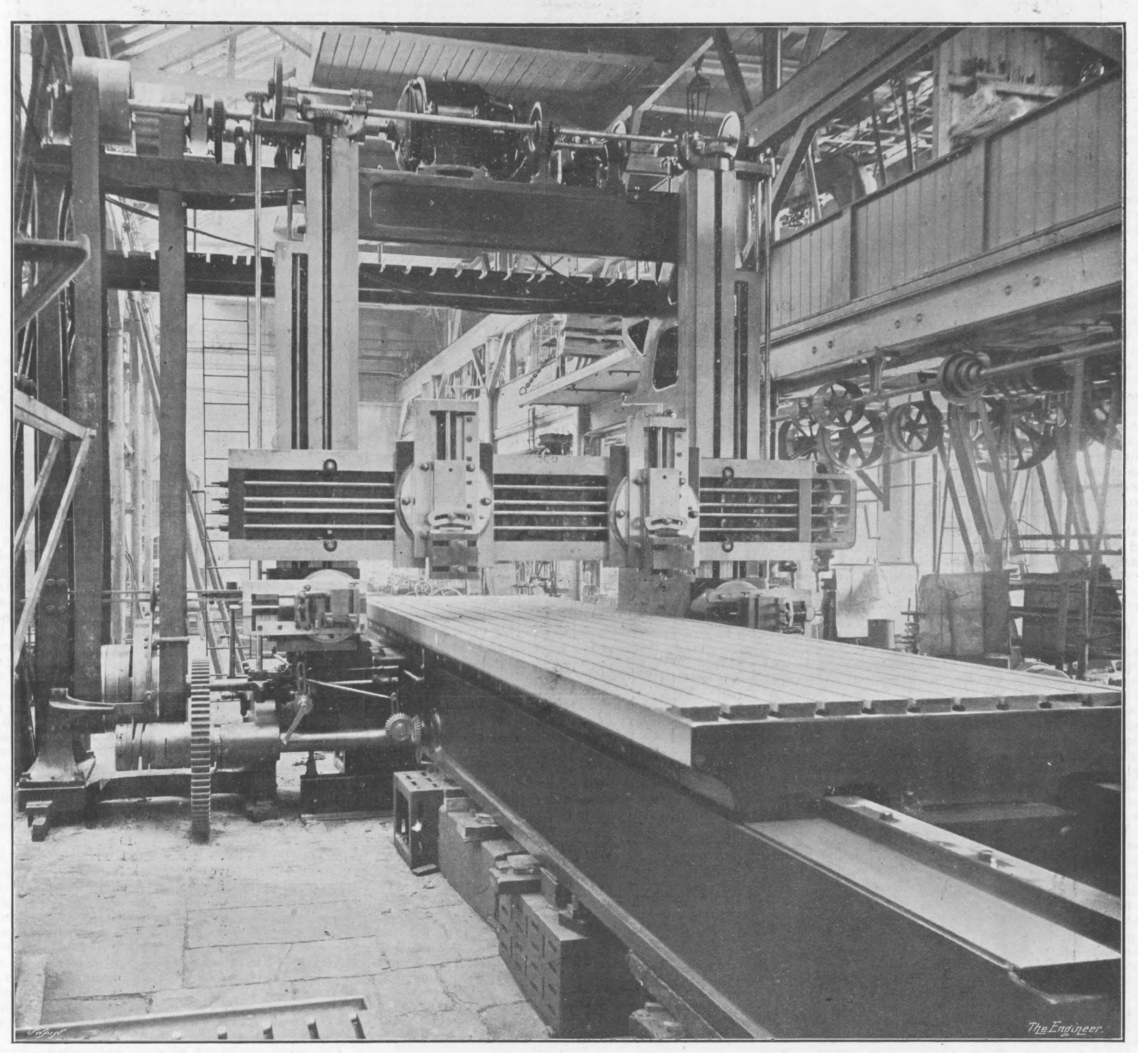


Fig. 15—SMITH AND COVENTRY PLANING MACHINE AT THE WORKS OF SIR WILLIAM ARROL AND CO., LIMITED

THE ALBION MOTOR CAR COMPANY'S WORKS.

Visitors proceeding west to Scotstoun and Renfrew were in a short time at the Albion Motor Car Company's Works. These are devoted to the building of both pleasure and commercial motor vehicles. In pleasure vehicles the chief productions of the works are a 16 horse-power two-cylinder and a 24-30 horse-power four-cylinder type of car. In commercial vehicles the works produce about half-a-dozen types ranging from 15 cwts. up to 2 tons carrying capacity. The complete motor and chassis, with all gear cases, mechanism, &c., are manufactured in the works at Scotstoun, which give evidence, even in a hurried inspection, of having been arranged for economical and high-class production. The Company at present employs about 350 men.

THE WORKS OF YARROW AND CO., LIMITED.

From the Albion Works the visitors proceeded on foot to the fine new works of Yarrow and Co., Scotstoun West. In view of the comparatively recent and fully illustrated description of the Yarrow Works given in The Engineer of November 15th, 1907, it is scarcely necessary here to give more than the briefest outline of the departments and object of outstanding interest which came under notice on the occasion of the visit. On the building berth of the yard the visitors saw in the later stage of construction three of the Brazilian destroyers of the ten similar vessels for which the firm received the contract from the Brazilian Government about two years ago. These vessels were illustrated and described at length in The Engineer as recently as June 25th last.

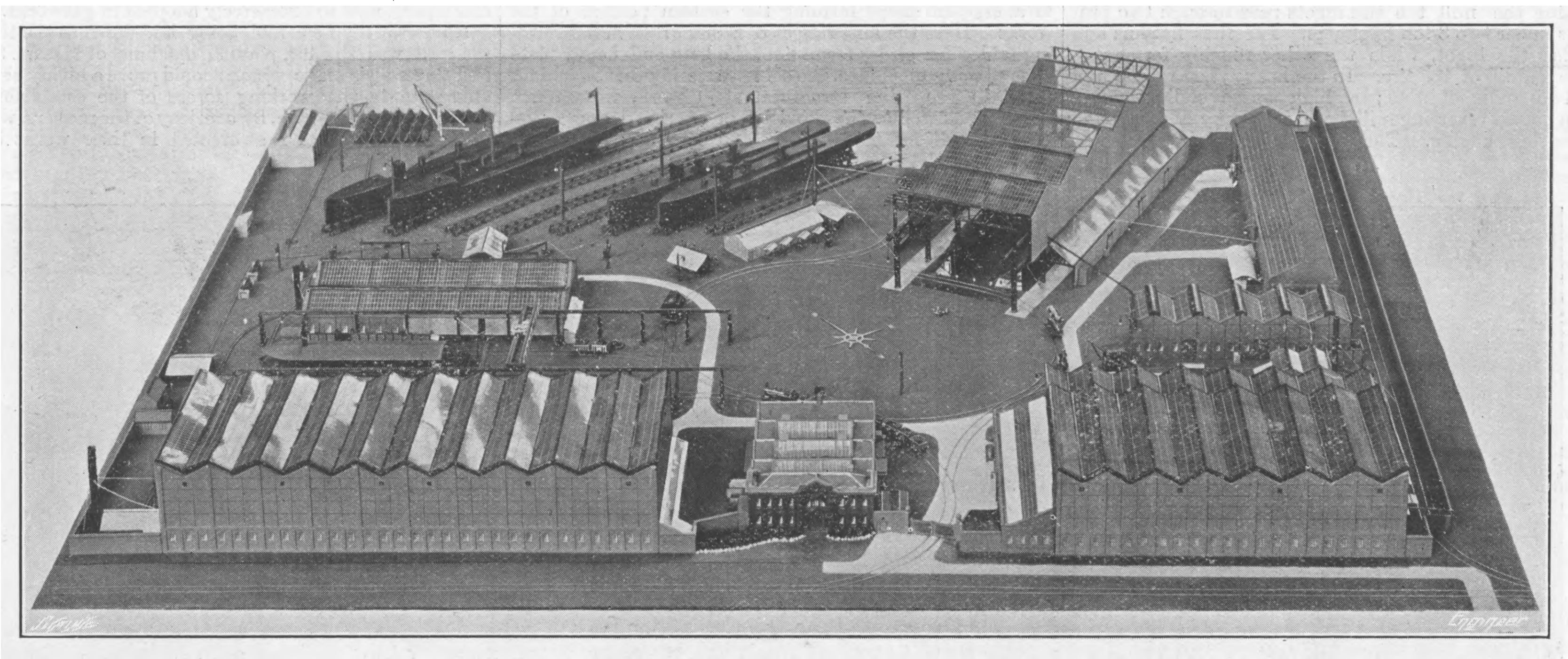


Fig. 16—BIRD'S-EYE VIEW OF THE WORKS OF YARROW AND CO., LIMITED

Another product of the Yarrow stocks brought under notice was the yacht Winchester, recently launched for an American owner. She is somewhat of the torpedo type, 165ft. long by 15ft. 6in. beam, and of about 125 tons displacement. The speed expected is 26 knots. Her propulsive machinery will consist of turbine engines of about 2400 indicated horse-power, and two Yarrow boilers. Items in the engineering department nearing completion and partly sent away were engines and boilers for a large shallow draught steamer for the navigation of the Tigris and Euphrates. Yarrow and Co, Limited, have also just completed two small side-wheel shallow draught steamers for the Portuguese Government, and they have in course of construction a number of Yarrow boilers. An interesting bird's-eye view of the works taken from a model is given in Fig. 16.

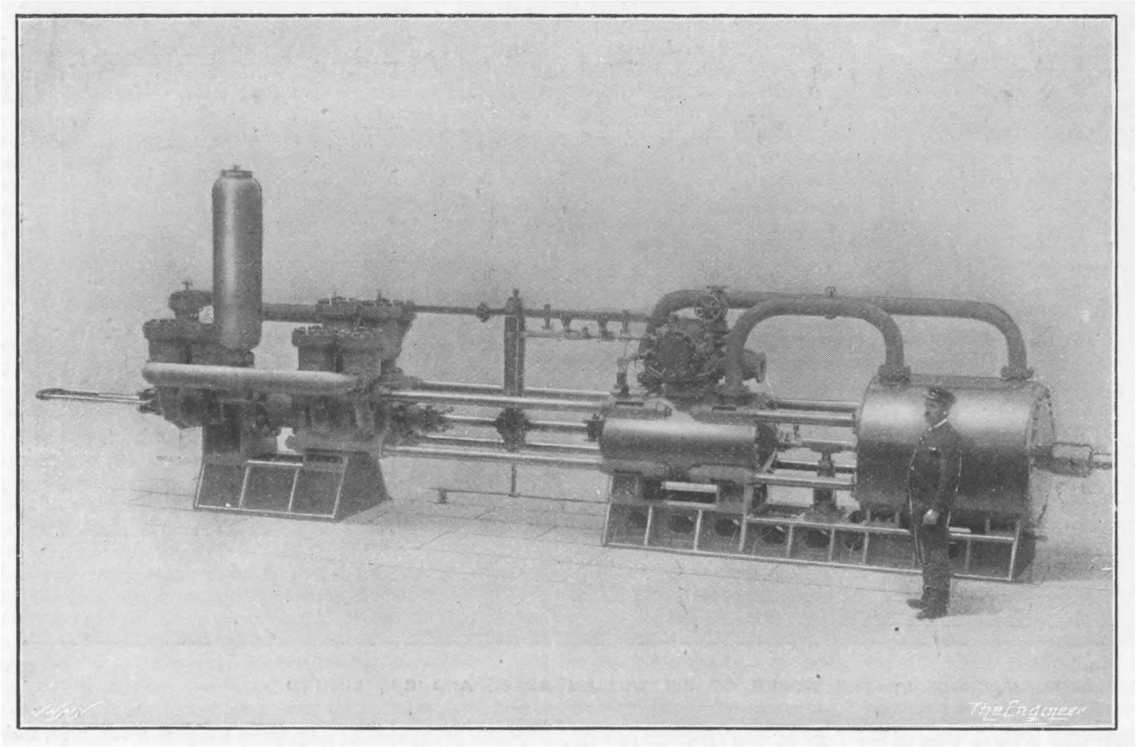


Fig. 17—WEIR'S OIL PUMPING ENGINE

THE WORKS OF WM. SIMONS AND CO., LIMITED, AND OF LOBNITZ AND CO., LIMITED.

With regard to these excellent works there is but little to add to that which has already been published, and with which our readers are familiar. As regards the first-named firm's works, reorganisation and extension have of late been proceeding, but only in minor departments, since our lengthy and fully illustrated description in The Engineer on February 16th, 1906. One noteworthy direction, however, in which alterations have been proceeding recently, is concerned with the introduction of electric power plant, and that not only as regards dispensing entirely with the use of steam plant but with the generation of electrical energy on the premises, and taking current from an Electrical Supply Company's mains. The new power-house, which will shortly be in operation, is part of this altered system, and included in it is a substation connected with the Clyde Valley Electrical Power Company's generating works on the north side of the Clyde, immediately opposite Simons and Co.'s works. From these works the firm is obtaining three-phase twenty-five-period alternating current. The feeders, at a pressure of 11,000 volts, cross under the bed of the river in duplicate for their ring main system. In the substation in Simons' yard there are installed two 500-kilowatt three-phase stepdown transformer units, reducing the pressure from 11,000 to 400 volts. Besides the substation, with the plant above indicated, there has been installed in the new power-house an alternating-current switchboard, a direct-current switchboard, two motor generators, and one rotary converter, as well as two powerful Ingersoll-Rand air compressors, motor driven by belt for the pneumatic apparatus throughout the works.

THE WORKS OF G. AND J. WEIR, LIMITED.

Many members took advantage of the opportunity afforded on Thursday afternoon of visiting the works of Messrs. G. and J. Weir, Limited, at Cathcart. Standardisation, as is well known to engineers, is one of the strong points of this firm's specialities, and many of the tools have been specially designed and constructed to perform automatically, and with the minimum of attention from the machineman, the many varied operations in their products. The excellent shop systems, and the cleanliness and orderliness everywhere observable in the well-lighted bays of the various departments, were the subject of special remark by the members. In addition to a large number of installations in hand for the mercantile marine and for land power stations, opportunities were given to observe, in all stages of progress, distilling machinery, feed pumps, oil fuel pumps, forced lubrication pumps, "dual" air-pumps, &c., at present under construction for H.M.S. Indefatigable and Neptune, the five City class cruisers, and the sixteen torpedo boat destroyers of the 1908-9 Naval Programme. An installation which attracted special attention was an oil-pumping plant just completed for The Burmah Oil Company, Limited. This consists of three Weir patent tandem compound pumping engines of the horizontal type, each pump capable of delivering 8000 gallons of oil per hour through 34 miles of piping, against a pressure of 1000 lb. per square inch with a pressure of 120 lb. per square inch in the steam supply pipe at engine, and with the engines exhausting to atmosphere. Each pumping engine, one of which we illustrate in Fig. 17, comprises a pump end 8in. diameter by 36in. stroke of the double-acting inside ram type, driven directly by tandem compound steam cylinders 22in. and 38in. diameter respectively by 36in. stroke When pumping 8000 gallons per hour the speed of the pumps will be 14½ double strokes per minute.

MACHINERY OF THE ITALIAN BATTLESHIP NAPOLI.

On April 3rd the Italian battleship Napoli started her official trials in the Bay of Naples. The Napoli is the third of the four ships of the Vittorio Emanuele class, the first of which was the Regina Elena, of which a description is to be found in The Engineer of January 10th, 1908. The propelling machinery of the Napoli was built by the Soc. Anonima Officine Meccaniche (già Miani, Silvestri and C.-A. Grondona, Comi & Co.), at their Naples works, which used previously to belong to the firm of Hawthorn-Guppy, well known as having constructed the propelling machinery for a good many warships for the Italian and Argentine navies.

The two main engines are triple expansion, have four cylinders of the vertical inverted type, balanced to the Yarrow, Schlick, and Tweedy system, and are placed in two separate compartments, divided from each other by a central bulkhead. They were designed to develop 19,000 indicated horse-power at 125 revolutions per minute, with a boiler pressure of 210 lb. per square inch.

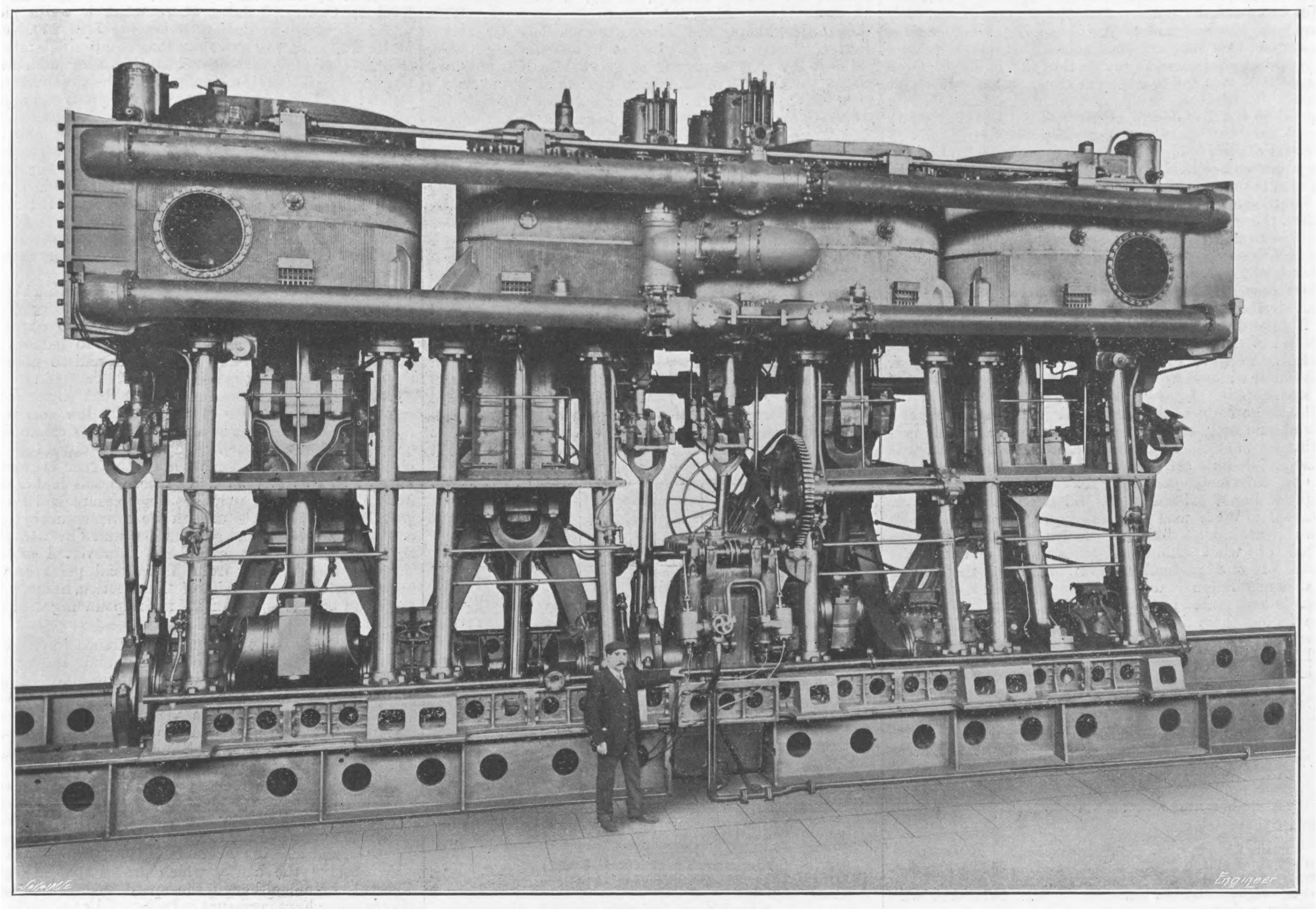
The diameters of the high-pressure intermediate, and of each of the two low-pressure cylinders are, respectively, 0.990 m.—say, 39in.—1.620 m.—say. 63¾in.—and 1.880 m.—say, 74in. The stroke is 1.170 m.—say, 46in. All the cylinders have steam jackets. The high-pressure cylinder liner is of wrought steel, those of the other cylinders being of cast steel. The high-pressure and intermediate-pressure cylinders have piston valves, while the low-pressure cylinders have double ported slide valves with compensators at the back. Balance cylinders of the Joy type are fitted both to the piston and to the slide valves. The valve gear is of the usual Stephenson link motion type. The reversing engines are of the all-round type. The pistons, cylinders, and steam chest covers, bed plates, and columns are of cast steel, the pillars being of wrought steel.

The crank shafts are of steel, and hollow. Each is composed of two parts, and there are two cranks on each part. Each crank shaft has six main bearings of 4.390 m. —say, 14.4ft.—total length. The outside and inside diameters of the crank shafts in the bearings are respectively 0.465 m.—say, 18.3in.—and 0.220 m.—say, 11.0in. The diameter of crank pins are 0.480 m.—say, 16.9in.—and their length 0.560 m.—say, 22in. The turning wheel is fixed on the coupling at the centre of the engine. The diameters of the thrust shafts and intermediate shafts are 0.440 m.—say, 17.3in. outside—and 0.220 m.—say, 8.66in.—inside. Each thrust-shaft has ten collars with a thrust surface of 1.5553 square metres. The screw-shafts have a diameter of 0.465 m.—say, 18.3in.—and a length of 22.332 m.—say, 73ft. 3in. The propellers are of bronze, with three blades each. Their diameter is 5.175 m.—say, 17ft.; mean pitch 6.2 m.—say, 20ft. 4in. —and the developed surface 8.72 square metres.

There are four main condensers, two for each engine-room, with a total cooling surface of 2000 square metres. In each engine-room the circulating water is supplied by two centrifugal pumps driven by compound engines. Each pump is capable of delivering the circulating water to each of the two condensers independently or to both of them, and to draw from the bilges 1000 tons of water per hour. There are in each engine-room also two twin air pumps of the Weir type. There is also in each engine-

ONE OF THE ENGINES OF THE ITALIAN BATTLESHIP NAPOLI

SOCIETÀ ANONIMA OFFICINE MECCANICHE, NAPLES, ENGINEERS



room an auxiliary condenser of 110 square metres cooling surface with independent air and circulating pumps. The revolution counters are of the Molinari type. The following other auxiliary engines and apparatus are also placed in the engine-rooms:—Two Weir evaporators complete with pumps, each capable of supplying 40 tons of fresh water during twenty-four hours; two independent bilge and fire pumps of Weir type; four main Weir hotwell pumps; four Harris filters; two auxiliary hotwell pumps; four Sirocco fans driven by compound engines of Furse type.

There are twenty-two Babcock and Wilcox boilers arranged in three compartments situated forward of the engine-rooms. The aft and central compartments contain each eight boilers of seventeen elements, and the forward compartment contains six boilers of twenty elements. The total heating surface is 5270 square metres, and the total grate surface 152 square metres. There are three funnels having a total area of 21.50 square metres. The height of the funnels above the grate bars is 29 m. Two Weir feed pumps are placed in each boiler compartment, each being capable of supplying the water necessary for all the boilers in its compartment. Forced draught of the closed stokehold system is obtained by means of twelve fans driven by Furse compound engines. There are besides six "See" ejectors with three duplex pumps for expelling the ashes, and six electrical ash hoists. The main and auxiliary steam pipes are of solid drawn steel.

As stated, the official sea trials took place in the bay of Naples during the months of April and May last. Three trials were prescribed by contract: One at one-tenth power, say, 1900 indicated horse power of 10 hours duration; coal consumption not to exceed 1000 grammes per indicated horse-power per hour; a second trial at forced draught with air pressure not exceeding 10 mm.; the indicated horse-power to be not less than 19,000 as a mean; duration one hour and a half; coal consumption not to exceed 900 grammes per indicated horse-power per hour; a third trial of 24 hours' duration to be divided off into two periods; during the first period of 18 hours' duration, at natural draught, the indicated horse-power to be not less than 15,200 mean, and coal consumption not to exceed 825 grammes per indicated horse-power per hour. During the second period of six hours the coal consumption was not to be measured, but the powers were to be varied as required from minimum to maximum, and the maximum power was to be sustained for at least half an hour with an air pressure not exceeding 20 mm.

The results obtained during these three trials were most satisfactory, as will be seen from the table given below.

The speed of ship measured during the maximum power trial was about 22·5 knots.

In a two-page supplement given in this issue we are enabled to reproduce drawings of the fine engines fitted in this vessel, and herewith and on page 192 are reproduced two perspective views of them.

We may add that the Napoli has a displacement of 12,425 tons; that she is 435½ft. long, and has a beam of 73½ft., and a draught of 27¼ft. She was built at Castellamare, and was launched in 1905. Her belt armour varies from ¾in. to 4in. thick, her deck plating is 2in. thick, and the thickness of the side armour above the belt, of the bulkhead, and of the armour of the heavy guns is, in each case, 8in. thick, the armour of the secondary guns being 6in. thick. She carries two 12in., twelve 8in., twelve 3in., and twelve 1.8in. guns, and is provided with two submerged torpedo tubes. Her ordinary bunker capacity is 1000 tons, and the maximum capacity 2000 tons.

Official trials.	Date.	Duration, hours.	Mean I.H.P.		Air pressure in mm.		Coal consumption gr. per I.H.P. per hour.	
			as per contract.	actually developed.	as per contract.	actually.	as per contract.	actually.
$\frac{1}{10}$th power ...	3rd April, 1909	10	1,900	1,956	—	—	1000	974
Full power ...	4th May, 1909	1½	19,000	19,705	10	10	900	645
24-hour trial ...	22nd-23rd May, 1909...	18 + 6	15,200 during	15,706 18 hours	—	—	825	804

Royal Naval College, Dartmouth.—The following is the result of the August passing out examination, Part I., of the naval cadets at the Royal Naval College, Dartmouth. The names are in the order of merit:—W. E. Parry, M. C. Platt, G. C. Lang, R. H. Allen, E S. R. Butlin, E. W. Hadingham, G. Curteis, J. C. Colvill, E. R. W. James, R. H. P. Laugharne, M. Faulkner, D. C. S. Evill, J. Hackett, Hon. D. C. Maxwell, C. V. Jack, C. A. W. Muir, S. W. Davis, R. S. Benson, D. R. Miller, W. Borrowes, L. G. Addington, P. J. Mack, E. F. Fanning, J. F. Bowyer, A. H. J. Stokes, J. H. Mitchell, K. M. G. Campbell, H. Hickling, E. L. Ruck-Keene, W. N. Gardiner, L. G. G. Grover, E. J. H. Sheppard, J. H. Sword, H. C. Bovell, J. T. Upton, D. H. Pasmore, W. N. Kingdon, L. E. H. Maund, N. H. Beaver, C. de N. Lucas, J. F. R. Chanter, A. E. M. Cunninghame-Grahame, I. S. Jefferson, D. W. Ryder, B. B. C. E. Jameson, N. L Veresmith, V. H. P. Molteno, E. H. T. Hubbard, G. A. M. Wilshire, J. W. M. Standring, A. Bakewell, B. S. Bickmore, A. H. S. Casswell, D. N. C Tufnell, E. D. Marston, H. E. Heaton, J. D. A. Musters, P. E. Fell, J. R. Poland.

SIMPLE *v.* COMPOUND: A FOOTPLATE EXPERIENCE.*

By a FIREMAN.

There is no doubt that the correspondence which has gone on for some time in The Engineer on the present controversy between simple and compound locomotives has aroused great interest; many of us have sought for some definite conclusion either one way or the other, but have looked in vain. However, this is not to be wondered at when we consider the numerous factors which determine the comparative advantages of these two types of engines. Now, these different factors can be summed up in three words, namely, pounds, shillings, and pence; that is to say, I mean that the comparative advantages of any class of engine, in reality, depend upon a matter of £ s. d.

The most important item in the working of trains is to get them along in booked time at the lowest possible cost. If one type of locomotive is found to be capable of hauling its load for less money than another, by all means let that one be adopted; but it must not be forgotten that besides running expenses—which include oil and coal consumption—first cost, upkeep, repairs, probable life, and every detail which must be put down to the account of the total expenses of the locomotive from the time it is built to the time it is scrapped have also to be taken into consideration. The maintenance of permanent way and wear of rails are items which, strictly speaking, should be considered; but it would be exceedingly difficult to set down an account against any individual class of engine, unless it were a particularly bad sinner in this respect. As an example, suppose one engine A burns less coal per ton-mile than another B, but it is found that A is continually in the shed for repairs, it is obvious that, if these repairs on the one hand cost more than the saving of coal on the other, B is more suitable until A's design is improved to such an extent that its repairs compare favourably with B's. Also if first cost is so high that it prohibits the adoption of a type that is known to be economical in running, then another type, cheaper in first cost, though not so economical in running, will have to be used. This was the case recently with the Italian State Railways, sixty superheaters being ordered instead of compounds being continued, as one correspondent pointed out. It is said that one advantage of a four-cylinder superheater locomotive is that the high pressure necessary with compounds is avoided. This, again, reverts to a matter of comparative cost; the question in the case of the compound being whether the saving in the coal bill balances the probably decreased life of the boiler, fire-box, and stays due to high pressure. Another correspondent expressed the opinion that the success of the Midland compounds is due to their proportions rather than to the fact that they are compounds. If this were true, it would be equivalent to saying that the failure of other compounds was due to improper proportions, and that the superiority of these compounds over simple engines is caused by the bad design of the latter. But I hope to prove that the success of these engines is not only on account of their being well proportioned, but also because they are compounds, by setting down a definite comparison betweeen them and simples.

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* Concerning compound and simple locomotives much has been heard from everyone but the man on the footplate. The accompanying article has been written at our request by a former Midland Railway pupil, who in the regular course of his training acted as fireman for several months. The work with which he deals was on the regular non-stop fast runs. There is absolutely no room to dispute the entire accuracy of his figures, which simply represent daily transactions. They show an indisputable and important economy in favour of the compound engine as compared with the simple. They refer to work done last year at a time when the author had not the smallest idea that they would be published in The Engineer or any other journal, a circumstance which much enhances their value.

From the description of the two locomotives given below, there is no reason to believe that the difference in expense of first cost, upkeep, repairs, and life, is important enough to be seriously considered, so that we may confidently say that "running expenses" are the main items, which practically means that the real comparison to be made is the coal bill.

The point of view to be taken is that of the performance of the locomotives in the hands of the men on the foot-plate, who have every opportunity to observe their behaviour while at work on the road, and benefit to a great extent thereby. I have absolutely nothing to gain in the ultimate outcome of the combat between simple and compound, and no interest in cracking up either of their performances, but merely desire to state, without bias, true facts and definite convictions. I have taken special care to be extremely accurate; that is to say, when the slightest doubt existed in my mind on any detail, the opinions of those who were fully qualified to give them were consulted. This is mentioned because the value of what follows depends mainly upon the truth of one particular point, namely, the actual coal consumption, and if my readers will concede that what is here stated is true, I shall have no difficulty in convincing them that in one case, at any rate, the compound is undoubtedly superior to the simple engine.

The leading dimensions and characteristics are as ollows:—

Compounds.

Cylinders—	
One inside H.P.	19in. diameter.
Two outside L.P.	21in. ,,
Stroke	26in. ,,
Valves—	
Piston valve for H.P. cylinder.	
Slide valves for L.P. cylinders.	
Diameter of driving wheels	7ft.
Boiler—	
Working pressure	220 lb. per sq. in.
Belpaire fire-box	
Weight of engine, loaded	59 tons 18 cwt.
Weight of tender ,,	45 tons 18 cwt.
Total weight engine and tender	105 tons 16 cwt.
Heating surface—	
Fire-box	153 sq. ft.
Tubes	1320 sq. ft.
Total	1473 sq. ft.
Number of tubes	216 (1⅞in. external dia.)
Grate area	28.4 sq. ft.

The engine is a four-coupled bogie, outside cranks at 90 deg., inside crank at 135 deg. to each of these.

Simples.

Cylinders (two inside)	19½in. diameter
Stroke	26in.
Piston valves.	
Diameter of driving wheels	6ft. 9in.
Boiler—	
Working pressure	180 lb. per sq. in.
Belpaire fire-box	
Weight of engine, loaded	54 tons 5 cwt.
Weight of tender ,,	41 tons 13 cwt.
Total weight engine and tender	95 tons 18 cwt.
Heating surface—	
Fire-box	145 sq. ft.
Tubes	1383 sq. ft.
Total	1528 sq. ft.
Number of tubes	262 (1¾in. external dia.)
Grate area	25 sq. ft.

The engine is a four-coupled bogie.

An identical run by these two types of engines hauling a similar tonnage is to be considered, and the details of the journey are not those of any special day, but an average of many; for a fair comparison is not made when one particular performance is chosen, because the conditions may, on that occasion, be uncommonly favourable or otherwise, and include factors varying from day to day, such as good and bad steaming, quality of coal, and handling of the same by the fireman, different drivers, and weather.

The train I deal with ran in the months of July, August, and September, from Leeds to London without a stop, and was worked by both the compounds and simples. The average weight behind the tender was 170 tons (the variation in weight being only a matter of two or three tons). Five tubs of coal were put on the tender of the compound, seven tubs on the simple. Each tub contained 10 cwt. That is to say, 2 tons 10 cwt. on the compound, and 3 tons 10 cwt. on the simple. Other coal besides this was, of course, on the back of the tender; but as the new lot just about occupied the empty space previously filled by the coal used the day before, or last journey, the amount left over out of these stated weights at the end of the run was clearly distinguishable. The fuel used was good Yorkshire coal. The weight of coal in the fire-box used for steam raising was practically the same, say 5 cwt., in each case, about sufficient to cover the bars, the difference in the grate areas of the two types being only 3.4 square feet. The starting fire was made from the fresh quantity put on, namely, the 50 cwt. and 70 cwt. respectively, the other coal on the back of the tender being out of easy reach. With the compound, the amount burnt on the journey of 196 miles was always within the 50 cwt. (not including that already in the box), and there was generally sufficient left for steam raising; but to be on the right side, I will say only 3 cwt. was left. The fuel remaining in the box at the end of the run covered the bars to a depth of 2in. or 3in., but this quantity must count as being consumed. Thus, with 5 cwt. in the box for steam raising, 50 cwt. put on the tender, and 3 cwt. unburnt, we get a consumption of 52 cwt. If anything, this figure is too large. With the simple there was always ample left for steam raising, but again to be well on the safe side, we will say that as much as 8 cwt. was left unburnt, whilst the amount remaining in the box at the journey's end was the same as in the compound; so that with the 5 cwt. in the box to start with, 70 cwt. put on the tender, 8 cwt. unburnt, the amount consumed was 67 cwt. It must be remembered that these figures are averages, for variations of 1 cwt. or 2 cwt. either way occurred on different occasions, due to the factors that have already been mentioned; but the fact that they are averages by no means detracts from their value, but rather enhances it. Calculating now the coal consumption per mile, we get a result of 29.7 lb. per train mile and 0.107 lb. per ton-mile (including weight of engine and tender) in the case of the compound; and 38.28 lb. per train mile and 0.144 lb. per ton-mile for the simple. The comparison is striking!

I will proceed to examine the details of a run. Some of these will be set down most clearly in tabulated form. The times passing each point are booked times, which the engines could and did maintain. It will, of course, be understood that signals, on certain runs, caused delays which interfered with these times being strictly kept, diminishing the average speed between individual places and between start and finish, but in no way altering that between the other points of the journey.

	Time.	Time taken between each point.	Distance between each point.	Average speed between each point.
		minutes.	miles.	m.p.h.
Leeds, depart	3·37	—	—	—
Normanton, pass	3·52	15	11	44
Rotherham ,,	4·19	27	23	51·1
Eckington ,,	4·29	10	9½	57
Chesterfield ,,	4·36	7	6½	55·7
Clay Cross ,,	4·41	5	4	48
Codnor Park ,,	4·55	14	9½	40·7
Trent ,,	5·9	14	12¾	54·6
Leicester ,,	5·31	22	20¾	56·5
Kettering ,,	6·0	29	27	55·8
Wellingborough ,,	6·8	8	7	52·5
Bedford ,,	6·22	14	15¼	65·3
Luton ,,	6·43	21	19½	55·7
Kentish Town ,,	7·11	28	28¾	61·6
St. Pancras, arrive	7·15	4	1½	15·7

From Leeds to St. Pancras—
Distance, 196 miles.
Total time, 3 h. 38 min. (218 min.).
Average speed, 53.94 miles per hour.
From Leeds to Kentish Town—
Average speed, 54.5 miles per hour.

The road between Leeds and Normanton is fairly level. Besides the fact of starting away from Leeds, there are slacks to 30 miles per hour over Altofts Junction, one mile from Normanton, and to 15 miles per hour through Normanton Station, so that the speed between these two points was really far greater than that stated. From Normanton to Royston, 7½ miles, there is a rising gradient of 1 in 360, from Royston to Cudworth, 2½ miles, falling 1 in 300, thence a gentle fall to Wath, six miles, and a gentle rise from Wath to Rotherham. There is a slack to 30 miles per hour over colliery workings at Roundwood, 2¾ miles from Rotherham, and one to 15 miles per hour over Masborough South Junction. From Rotherham to Kilmarsh, 7¾ miles, is practically level, then there is a rise to Chesterfield of 1 in 308, and a slack to 20 miles per hour over Tapton Junction, a few hundred yards from Chesterfield; then comes a rise of 1 in 327 to Clay Cross, and a slack over Clay Cross Junction to 20 miles per hour. From Clay Cross to Doe Hill, 3½ miles, the road rises 1 in 160, so that the speed hardly exceeded 30 or 35 miles per hour up the bank, giving the driver an opportunity to do some oiling to the driving boxes and motion by walking round the platform with comparative safety, on account of the moderate speed. There is a slack to 20 miles per hour over colliery workings, 1¼ miles from Clay Cross. From Doe Hill to Trent is all downhill, going with continual shutting of the regulator, owing to slacks over colliery workings; these are all slacks to 20 miles per hour, and are situated thus:—Approximate distances from Clay Cross: one at 5 miles, a second at 8 miles, a third at 9 miles, and a fourth at 12 miles; thence straightforward, running to Trent, where there is a slack to 15 miles per hour through the station. From Trent to Leicester there is a gradual rise, including gradients of 2½ miles 1 in 497, 5 miles of 1 in 508, 1 mile of 1 in 643, 2 miles of 1 in 500, the remaining parts of the road between these being level. Water troughs are situated a short distance before Loughborough, and water is picked up there. There is a slack to 15 miles per hour through Leicester. The rest of the journey, a distance of 99 miles, is accomplished in very fine time. From Leicester to Kentish Town, a distance of 97½ miles, the time allowed is 100 minutes; this gives an average speed of 58·5 miles per hour, which will be acknowledged to be an excellent performance, especially when the stiff road is taken into consideration. From Leicester to within half a mile of Kibworth, 10 miles, there is a continual rise, with the exception of half a mile down 1 in 210 about 2½ miles from the latter. The gradients vary. They include short distances of a mile or so of 1 in 199 and 1 in 161, the remaining parts averaging about 1 in 350. From Kibworth there is a fall of about 1 in 150 for three miles, rising slightly to Market Harborough, through which there is a speed restriction of 40 miles per hour. From here to within half a mile of Desborough, 4½ miles, a rise of 1 in 132 nearly all the way, thence a fall for the next 13 miles to Wellingborough, excepting a short rise of half a mile, about three miles from Desborough. The gradients vary considerably. There are eight miles averaging about 1 in 135, the remaining five miles not being so steep. A mile past Wellingborough the Irchester bank is encountered, 4¼ miles of mostly 1 in 120 up, the speed falling to 35 or 40 miles per hour, and giving the driver another chance for oiling. The next 3½ miles fall 1 in 119, thence, approximately, level to Oakley, 3 miles, where water is again picked up, and downhill to Bedford averaging 1 in 250. From Bedford to Leagrave there is a long climb of 17 miles of mostly 1 in 200, this heavy bank causing difficulty in keeping time if there is an inclination to be any shortness of steam; but this being absent the compounds and simples maintained a speed of over 50 miles per hour, though in the latter case there was much more noise about it. The last part of the journey, from Legrave to St. Pancras, is comparatively easy going, and although being rather of the nature of a switchback, with short, sharp, rising and falling gradients such as 1 in 163, 1 in 251, 1 in 180, 1 in 167, the road gradually falls the whole way, and there is no difficulty experienced in maintaining the stated average speed of 61.6 miles per hour between Luton and Kentish Town.

The above gives a comprehensive idea of the kind of road over which these trains ran, so a fair conception may be formed of the high speeds on certain parts of the journey, which were attained in order to balance the necessarily slower speeds up the banks, and so maintain the average between the said points.

It is contended by some authorities that compounding can only be utilised with advantage with low speeds, the reason given being that at a high speed the steam must be expanded automatically and efficiently down to atmospheric pressure, no matter whether the gear is notched up correctly or otherwise, because a great deal of wire-drawing takes place, reducing the pressure and leaving very little steam to be used in the low-pressure cylinder, consequently no advantage could be gained by admitting this steam into that cylinder. However, I advance the following reasons from a practical point of view in support of the other side of the question, namely, that there can be, and is, advantage in compounding with high speeds:—

(1) There is a most perceptible difference in the sound of the exhaust between the compound and simple. The former can hardly be heard when running 50 or 60 miles per hour, whilst the latter is noticeable to a much greater extent. This confirms the view that more work is obtained from the steam in the case of the compound, the pressure of the exhaust being lower than that of the simple, even though running at a high speed.

(2) If the gear in a simple engine is let down two or three notches there is a palpable difference in the noise of the exhaust. The fireman, though not seeing his mate make the alteration, immediately perceives the change of the beat, and his eyes involuntarily turn to the reversing gear, seeking the cause, which proves that a slightly different cut-off, although the speed is high, certainly affects the exhaust pressure.

(3) One driver who uses his engine more roughly than another—that is to say, does not notch her up as much as he should do—burns more coal on an express under similar conditions than the more economical man by reason of the greater quantity of steam used per stroke and fiercer blast on the fire. If it were true that at a high speed one or two notches made no difference in the efficient expansion of the steam, there should be no cause for the larger coal consumption.

(4) If one injector is just maintaining the water in the gauge glass at a constant level, and the gear is dropped slightly, the injector no longer keeps the water up to that level, thus proving that a larger amount of steam is being used.

(5) The receiver pressure indicated on the gauge, which will be referred to later.

Failure to start with these compounds is almost unknown. The arrangement of the regulator is as follows:—There are the usual two valves, the smaller one sliding on the back of the other. When the smaller valve is opened, steam is admitted, by means of a 2in. diameter pipe, to the receiver; but naturally, owing to the small diameter of this pipe, the pressure is greatly diminished, that registered on the low-pressure gauge in communication with the receiver, when starting, generally being about 90 lb. or 100 lb. per square inch, except in the case of a very heavy train causing an excessively slow start, when it rises higher. There is a non-return valve situated at both ends of the high-pressure cylinder, communicating with the receiver. These valves admit steam simultaneously to both sides of the high-pressure piston, so that the latter is floating in steam, and starting accomplished by the low-pressure cylinders acting as a simple engine. In order to compound, the regulator handle is pushed further over, cutting off the supply to the receiver by the small pipe and admitting steam by the main pipe to the high-pressure chest.

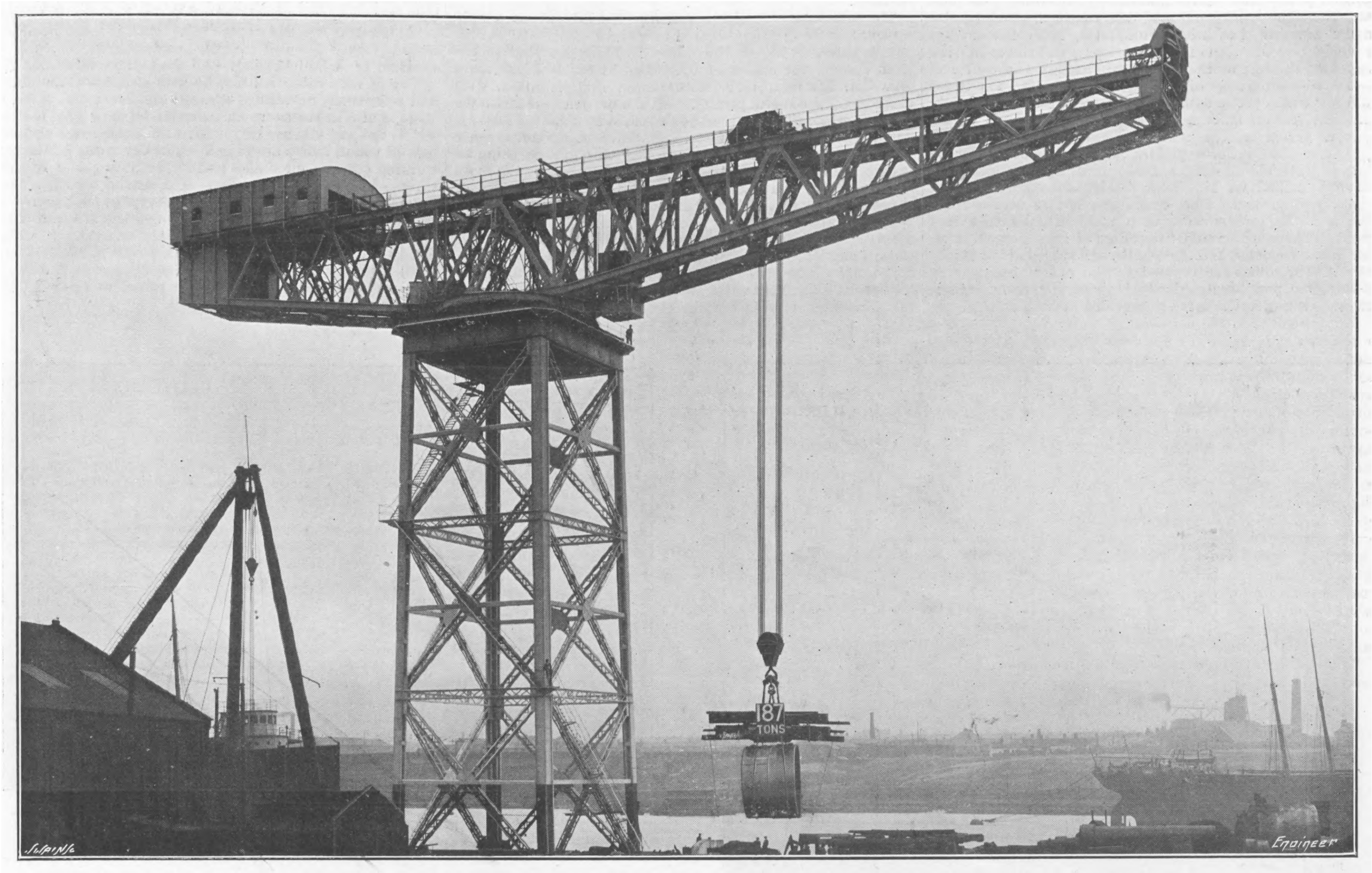
The reversing and linking up of both motions is controlled by one gear. The relations of steam distribution in the high and low-pressure cylinders are as follows:—

Notch.	H.P. cut-off. Percent. of stroke.	H.P. release. Per cent.	L.P. cut-off. Per cent.	L P. release Per cent.
12	81	92	83	93
9	72	89	75	89
6	58	82	58	82
3	36	71	35	69
Mid gear	16	55	15.5	48

When running, the gear was generally linked up to within four notches of mid gear, with the regulator right over. This would approximately give a high-pressure cut-off of 40 per cent., release 74.5 per cent., and low-pressure cut-off 40 per cent., release 73 per cent. Of course, practice varied with different drivers, but the above gave very good results. When climbing a bank the gear was dropped one or two notches, thus giving a distribution of high-pressure cut-off 58 per cent., release 82 per cent., and low-pressure cut-off 58 per cent., release 82 per cent. The receiver pressure indicated by the gauge was

150-TON SHIPBUILDING CRANE AT WALLSEND

SIR WILLIAM ARROL AND CO., LIMITED, GLASGOW, ENGINEERS



usually between 50 lb. and 60 lb. when compounding and running at a high speed.

Compounds are said to be in favour abroad because the conditions are vastly different, the inclines being stiffer, the loads heavier, and the speeds lower than in this country. I must admit that the road in discussion is certainly not easy, but I do say that the load was light and speed high, and yet the excellent performance was carried out. These compounds give even better results with heavier trains. On one occasion a load of 300 tons was hauled from Leeds to London, with one stop at Leicester, the average speed in this case not being so high. The coal burnt was not more than 70 cwt., giving a consumption of 0.092 lb. per ton-mile (including engine and tender). I ask if any simple engine could improve on this figure? In an experiment carried out some years ago by Mr. Ivatt on the Great Northern Railway, trials took place, extending over a period of nine weeks, between three engines, a 4-cylinder compound, a 2-cylinder simple, and a 4-cylinder engine which could be worked either simple or compound. The coal consumption resulted in 0.133 lb., 0.131 lb., and 0.126 lb. per ton-mile respectively, so that in this case the compound was not seen to advantage. The average speed was 48.15 miles per hour. However, in the case I have been discussing above, the compound beats all these figures. My aim has been to show that under certain conditions the compound engine, properly designed, is superior to the simple, and if I have succeeded in this my task is accomplished, and I see no reason to doubt that success with compounds could be gained anywhere under similar conditions.

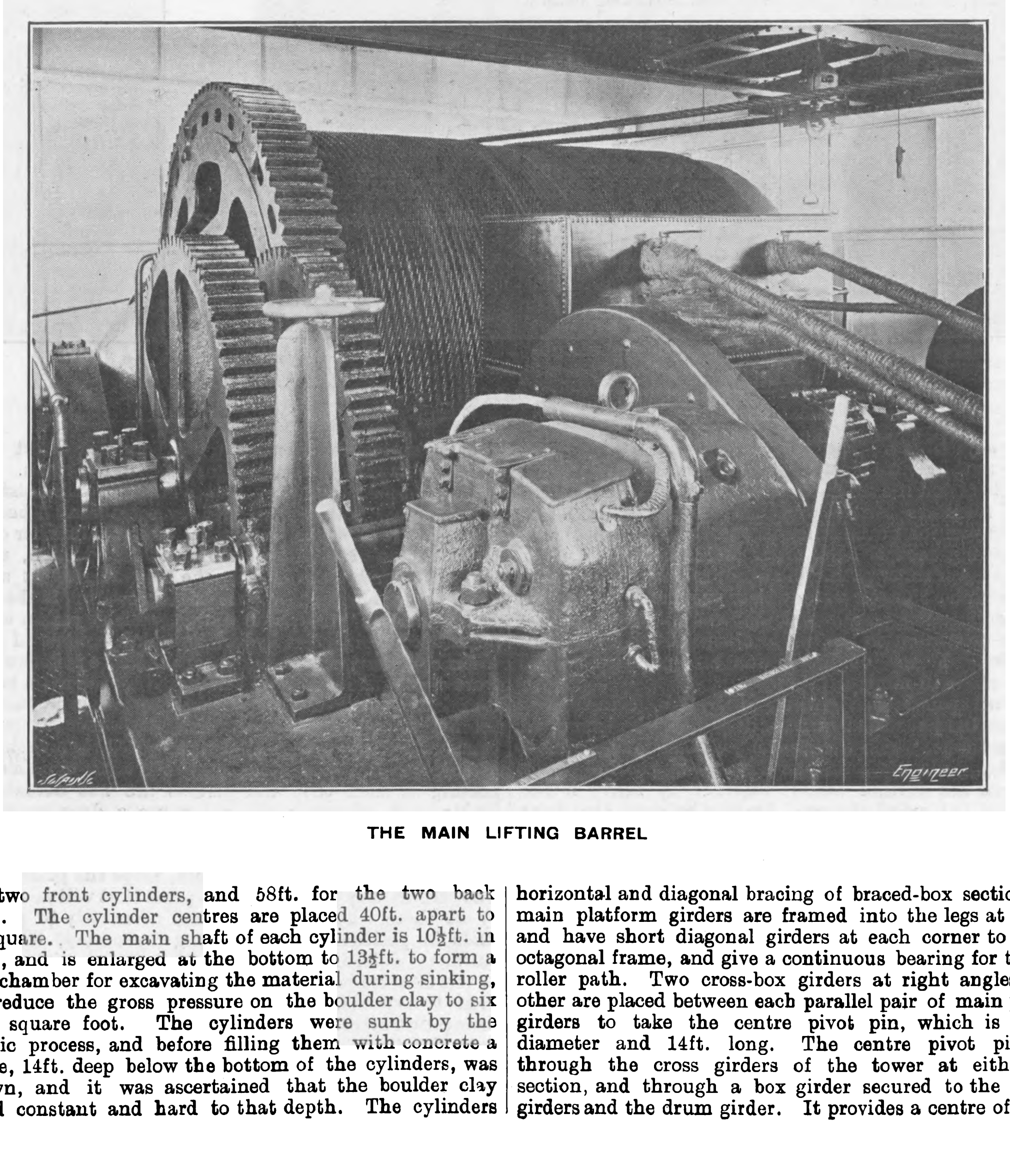
150-TON ELECTRIC SHIPBUILDING CRANE.

AN electric shipbuilding crane of 150 tons capacity has just been completed for the North-Eastern Marine Engineering Company, Limited, at its Wallsend yard by Sir William Arrol and Co., Limited, of Glasgow. It consists of a steel tower, 125ft. in height and 40ft. square at the base, and carrying a ring of live rollers on top upon which a horizontal jib, having a total length of 245ft., is supported. The long arm of the jib has a total radius of 150ft. The jib is fitted with slewing gear to revolve it in either direction, and has racking gear and separate lifting motions for the main and auxiliary hooks. The speeds of the various motions are as follows :—

Main lift	150	tons at	5ft.	per minute.
,, ...	100	,,	7½ft.	,,
Auxiliary lift	30	,,	12½ft.	,,
,, ...	7½	,,	50ft.	,,
Racking	150	,,	40ft.	,,
,, ...	30	,,	100ft.	,,
Slewing	150	tons one revolution in	10	minutes.
,, ...	30	,,	5	,,

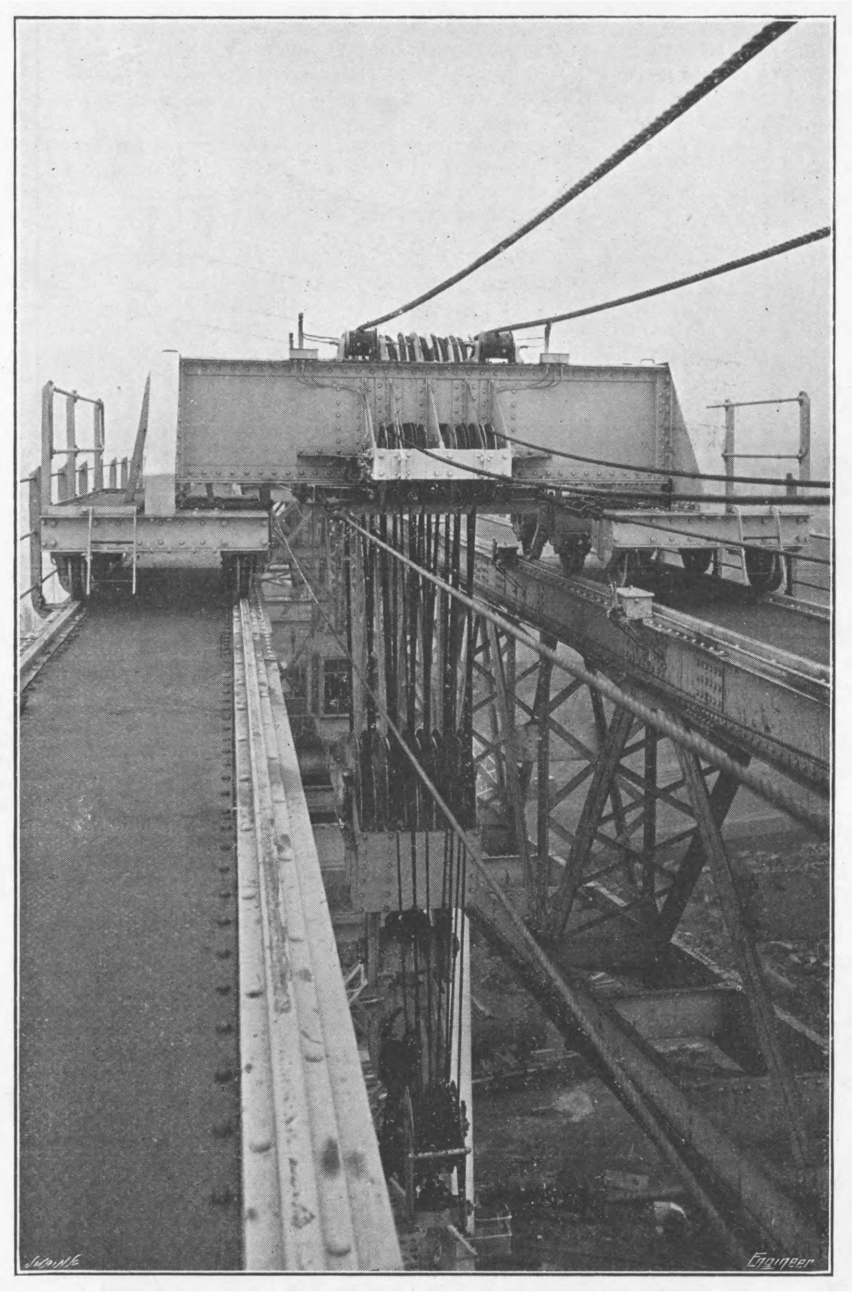
The total height of lift provided for is 173ft., viz., 143ft. above and 30ft. below quay level. The height from quay to rail level is 153ft. 6in. The racking and lifting machinery is placed in a steel-plated house at the tail end of the jib and assists in counterbalancing the crane. The slewing gear is placed in a steel-plated house over the circular rack at the back end. The operator's cabin, which is of steel plating, contains the controllers and resistances, and is placed on the right-hand girder of the jib. It is provided with projecting windows, so that a clear view is obtained of the load at all times. It is connected to the machinery house by speaking tubes, and by telephone to the ground.

The foundations of the crane are formed of four steel cylinders founded upon hard boulder clay at depths of 73ft. for the two front cylinders, and 58ft. for the two back cylinders. The cylinder centres are placed 40ft. apart to form a square. The main shaft of each cylinder is 10½ft. in diameter, and is enlarged at the bottom to 13½ft. to form a working chamber for excavating the material during sinking, and to reduce the gross pressure on the boulder clay to six tons per square foot. The cylinders were sunk by the pneumatic process, and before filling them with concrete a bore hole, 14ft. deep below the bottom of the cylinders, was put down, and it was ascertained that the boulder clay remained constant and hard to that depth. The cylinders were filled with cement concrete formed of six parts of fresh water gravel and one part of Portland cement, with the exception of 4ft. in the working chambers, and 4ft. under the tower bases where the proportions were four parts of fresh water gravel to one part of cement.

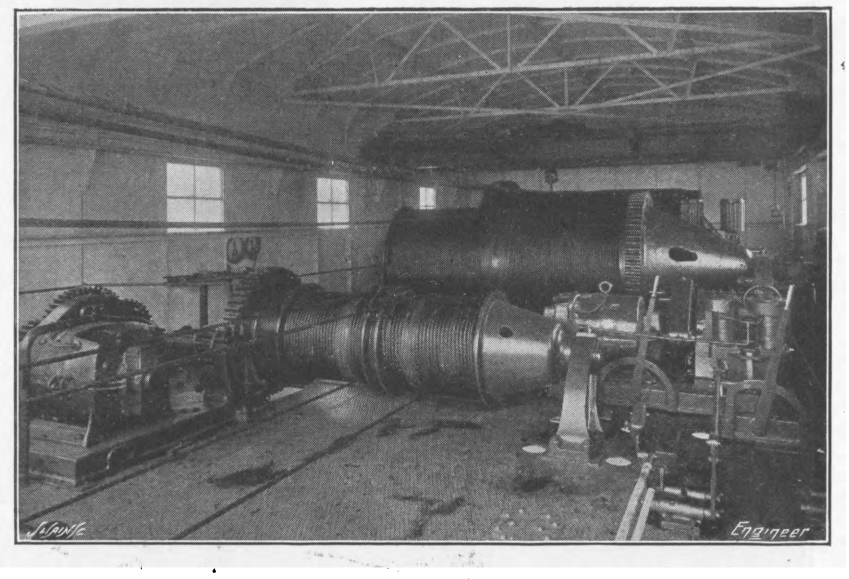


THE MAIN LIFTING BARREL

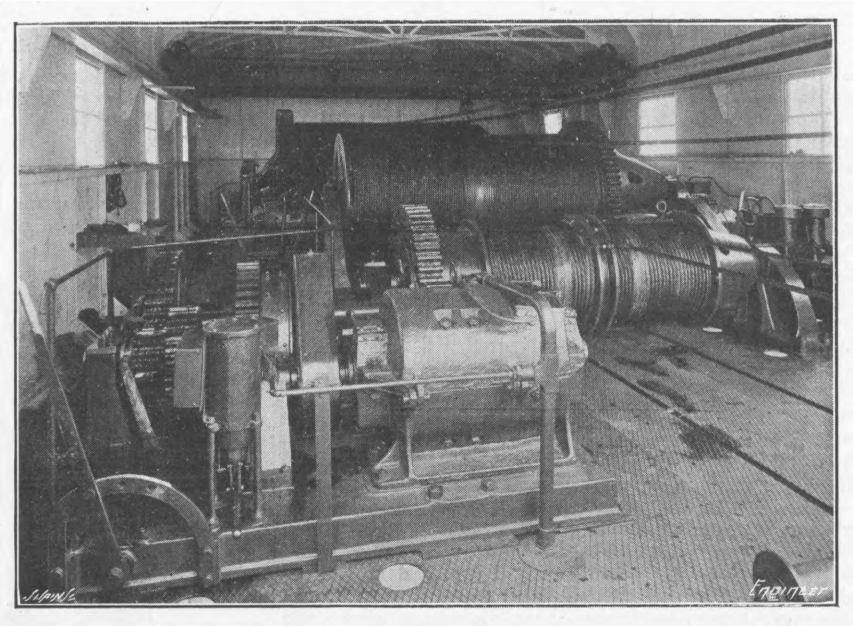
The tower is constructed of four legs of open-angle section, forming a square 40ft. at the base, tapering to 35ft. at the top. The four sides are braced together by three bays of horizontal and diagonal bracing of braced-box section. The main platform girders are framed into the legs at the top, and have short diagonal girders at each corner to form an octagonal frame, and give a continuous bearing for the lower roller path. Two cross-box girders at right angles to each other are placed between each parallel pair of main platform girders to take the centre pivot pin, which is 18in. in diameter and 14ft. long. The centre pivot pin passes through the cross girders of the tower at either intersection, and through a box girder secured to the jib main girders and the drum girder. It provides a centre of rotation for the jib and prevents its displacement. To provide for emergency loading and to secure a construction of a substantial and durable character, the centre pin, with the girders carrying it, is designed to resist a vertical or horizontal force of 100 tons, although by the construction of the crane no tension will be in the pin under any ordinary conditions of the loaded or unloaded jib, as the centre of gravity does not approach at any time nearer the centre of the roller path than about 3ft. The centre pin and the castings which revolve round it are bushed with hard gun-metal. The collector rings are fixed above the head of the centre pin, and the cables are brought up through a 5in. hole bored through the centre of it. The mean diameter of the roller path is 35ft. The upper and lower tracks are of cast steel $2\frac{1}{2}$in. in thickness, and their rolling surfaces are machined to form conical surfaces with a common vertex at the centre. They were levelled and adjusted to the platform girders and the drum girder by means of steel folding wedges about 18in. apart, which were afterwards drilled for 1in. bolts passing through the paths, wedges, and girders. The remaining spaces between the paths and the girders were then filled in solid with rust cement. There are seventy-five rollers of solid forged steel, 14in. mean diameter, 14in. in length, and spaced about $16\frac{1}{2}$in. centres. The rollers are secured to the outer spacing ring and the inner peripheral girder by bolts passing through their centres. Gun-metal collars are provided at both ends of the rollers for adjustment. The inner peripheral ring girder is connected to the centre pivot ring by fifteen radial channels. All radial bars and the roller frame of the live ring are formed of rigid members with tangential bars to maintain the relative position of the different parts of the frame. The circular slewing rack is $5\frac{1}{8}$in. pitch, and is bolted to palms cast on the lower roller path. The upper roller path is carried by a drum girder 35ft. diameter, 24in. deep, and 24in. wide. It is of sufficient strength and stiffness to distribute the maximum pressure from the full load being lifted over nineteen rollers. Means of lubrication are provided for all bearing surfaces in motion.



TRAVELLING JENNY



INTERIOR OF MACHINERY CABIN



INTERIOR OF MACHINERY CABIN

A pair of open lattice girders, with 14ft. centres, was adopted for the jib, which is 26ft. deep over the tower. A stiff lattice frame, which carries the jib head gear, connects the two box girders together at the end of the long arm. The girders are further braced together by heavy lattice frames, and horizontal diagonal bracing between the front of the drum girder and the tail end of the jib. The ballast tanks are placed under the machinery house at the tail end, and contain 65 tons of counterweight. Raking struts are placed between the centre vertical of the jib and the drum girder, to convey the wind stresses to the tower, and increase the lateral stability of the jib. The jib girders are secured to the drum girder by large gussets, of ample dimensions, to resist the severe torsional stresses due to the sudden starting and stopping of the jib. Four lines of bridge rails are provided, one over each web of the box girders, and are riveted to the top flanges. All the members of the crane are constructed of forms which are accessible for inspection and painting, and to allow a free circulation of air through them. No member has a thickness less than $\frac{5}{8}$in. To minimise vibrations, and to provide a substantial and rigid frame, all members of the crane are formed of sections capable of resisting tension or compression, and the diagonal members of the tower were designed as tension members only. The abutting surfaces of the compression members of the towers were machined after being riveted and before fitting the cover plates, so as to ensure perfect contact on the abutting surfaces.

The machinery of the crane was carried out as a subcontract by Stothert and Pitt, Limited, of Bath, and is constructed throughout in the manner usually adopted in the joint designs for cranes of this class by Sir William Arrol and Co., Limited, and Stothert and Pitt, Limited, with exceedingly successful results. All the motions are actuated by motors manufactured by the British Westinghouse Electric and Manufacturing Company, Limited, and for convenience these have been made of the same size throughout, being all of 50 brake horse-power. Two of the motors actuate the main hoisting gear, and these are arranged to run in series or parallel, giving further range of speed, besides that supplied by the change of gearing. The main lifting barrel is 10ft. in diameter. It is spirally grooved, and takes the whole of the rope in one lap. It is driven by a very fine steel spur wheel, keyed directly on to the barrel, and the teeth of this wheel are specially formed to give great strength at the root. The main hoisting rope is 5in. in circumference, and the load is lifted on twelve parts, two parts being led direct from the barrel, this giving a six-fall purchase in the ropes. There is a very complete system of brakes on the main hoist. There are magnetic brakes controlled by solenoids. These brakes are also fitted with mechanical releases to allow for operating them in case of failure of current. In addition, there are rheostatic braking points in the controllers, but a notable point as regards the arrangements for lowering is the adoption of "Matthews" hydraulic brakes, which give an extremely delicate control. The hydraulic brakes consist of a pair of water cylinders, containing pistons. These pistons are driven from cranks at right angles, actuated by the main gear when lowering. The cylinders are provided with a by-pass, with a specially-designed valve, allowing the water to pass from back to front of the pistons, as required for lowering at any desired speed. The connection of the water cylinders to the gearing is such that the pistons are not actuated when lifting, and, therefore, do not cause a drag on the lifting motors. The effect of the arrangement is that lowering can be performed with absolute smoothness; this, combined with the extremely rigid steel structure, keeps the pulsation of the load within very small limits, a point that will be appreciated by all those who have attempted accurately to place large loads in position, when lowering by cranes, with a great pulsating deflection. The auxiliary hoisting gear is worked by one 50 horse-power motor, and, as mentioned above, is fitted with two speeds. This also has magnetic, mechanical and rheostatic brakes. The brake drums of the magnetic brakes throughout are of cast steel. The racking motion is worked by a separate motor, actuating a barrel on which are wound the 3in. circumference ropes which propel the jenny. All ropes are of T. and W. Smith's "F" quality.

All the gearing throughout is of cast steel with the exception of some of the smaller wheels, which are of wrought steel, the motor pinions being of nickel steel. All the quick running gear is machine cut, the first reductions being in oil baths. The travelling jenny runs on twelve double-flanged cast steel wheels. These wheels are arranged and framed in such a manner as to secure proper distribution of the load on the lines of rails, there being two rails on each cantilever. Compensating pulleys are placed at the end of the jib to ensure equal stresses on the ropes. The load is lifted by a heavy forged loop, attached to the snatchblock, through the medium of a ball bearing. All the pulleys are of cast steel.

The driver's cabin is fitted up with switchboard, ammeter, and volt meter, no-voltage releases, and the usual fuses, and there is also in the cabin an indicator to show the radius at which the jenny is working. This indicator has a glass front behind which lamps are placed. The cabin also contains the working gear for the brakes and for actuating the hydraulic valves of the hydraulic brakes. The slewing gear is actuated by a 50 horse-power motor of the same type as the others; this drives the main slewing pinion, through the medium of a set of gear wheels, which are self-contained on a massive bracket, fitted to the upper slewing ring. A powerful solenoid brake is fitted to the slewing gear. Releasing gear is fitted to the brake, so that the crane may come round to the wind when not in use.

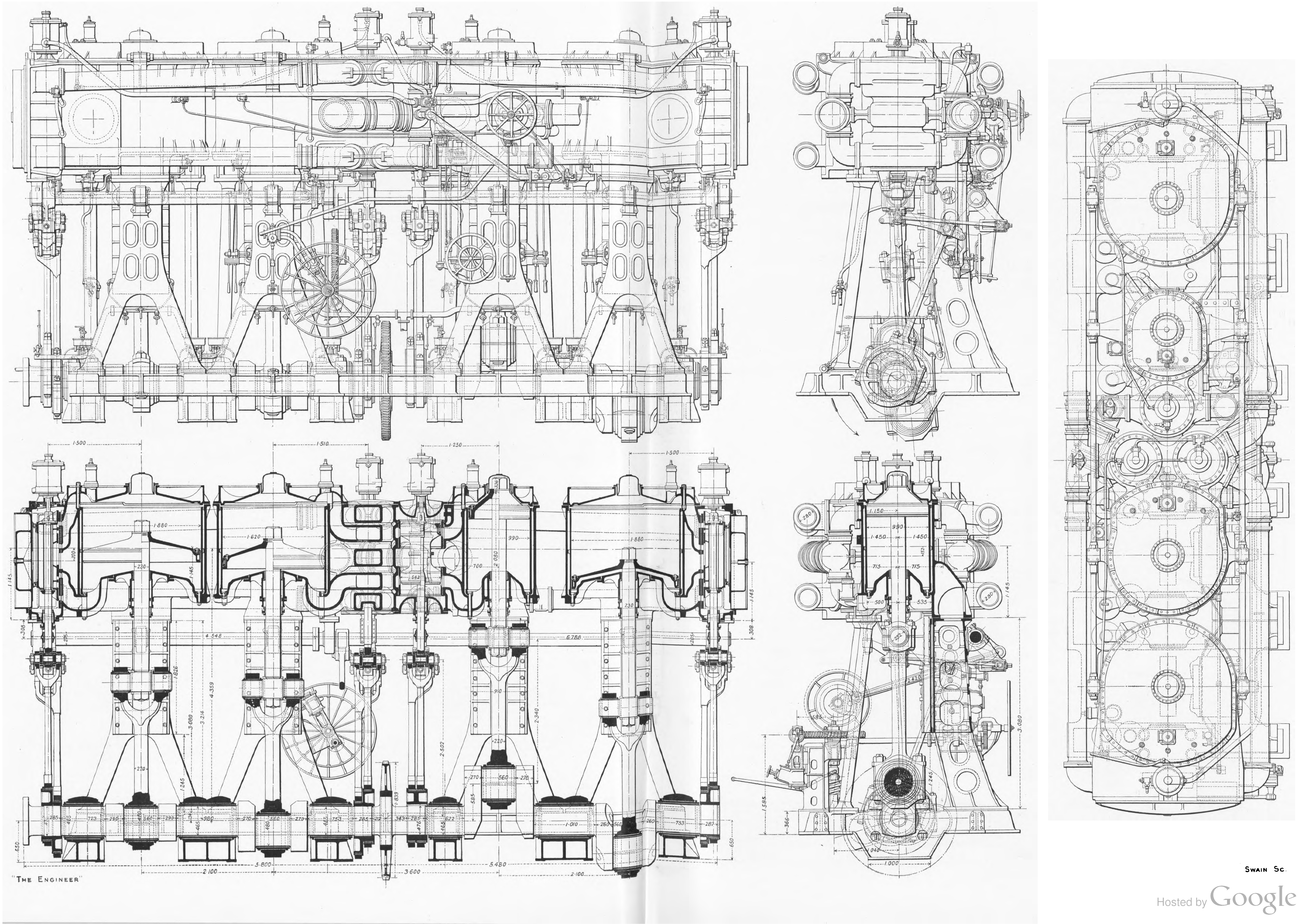
A new feature in this crane is the adoption in the machinery house of a complete electric traveller, a trap-door being so arranged in the floor of the house that a $2\frac{1}{2}$-ton load can be lifted right up from the ground to the machinery house. This is a great convenience for changing armatures or dismantling for repairs or cleaning.

At the test of the crane a load of 187 tons was lifted, lowered, and slewed with perfect ease, the steady lowering being a remarkable point. The crane was erected by means of a 15-ton steam crane placed on top of a travelling timber stage, which was about 100ft. in height. In its first position the crane erected the whole of the tower, live ring, and portion of the jib over the tower, and was gradually moved towards the tail end to erect the remainder of the jib and machinery. While the tail end was being erected, the long-arm was built from a 3-ton hand crane, which was pushed forward as the erection proceeded and the crane kept in balance. The tests of the crane were successfully completed on July 2nd, when it was put through all its evolutions with a test load of 187 tons, this being 25 per cent. over the maximum working load. The maximum deflection was $7\frac{7}{16}$in. under the 187 tons load and $6\frac{1}{2}$in. under 150 tons. The amplitude of the vibrations was observed during the tests and did not exceed $\frac{5}{16}$in. under the 150-ton load.

THE Bill to confirm a Provisional Order dealing with the electric lighting of the Urban District of Stourbridge on Thursday, August 12th, passed the Committee on Unopposed Bills at the House of Commons, and was sent for third reading. The Bill has passed through all its stages in the Lords.

THE ENGINES OF THE ITALIAN BATTLESHIP NAPOLI

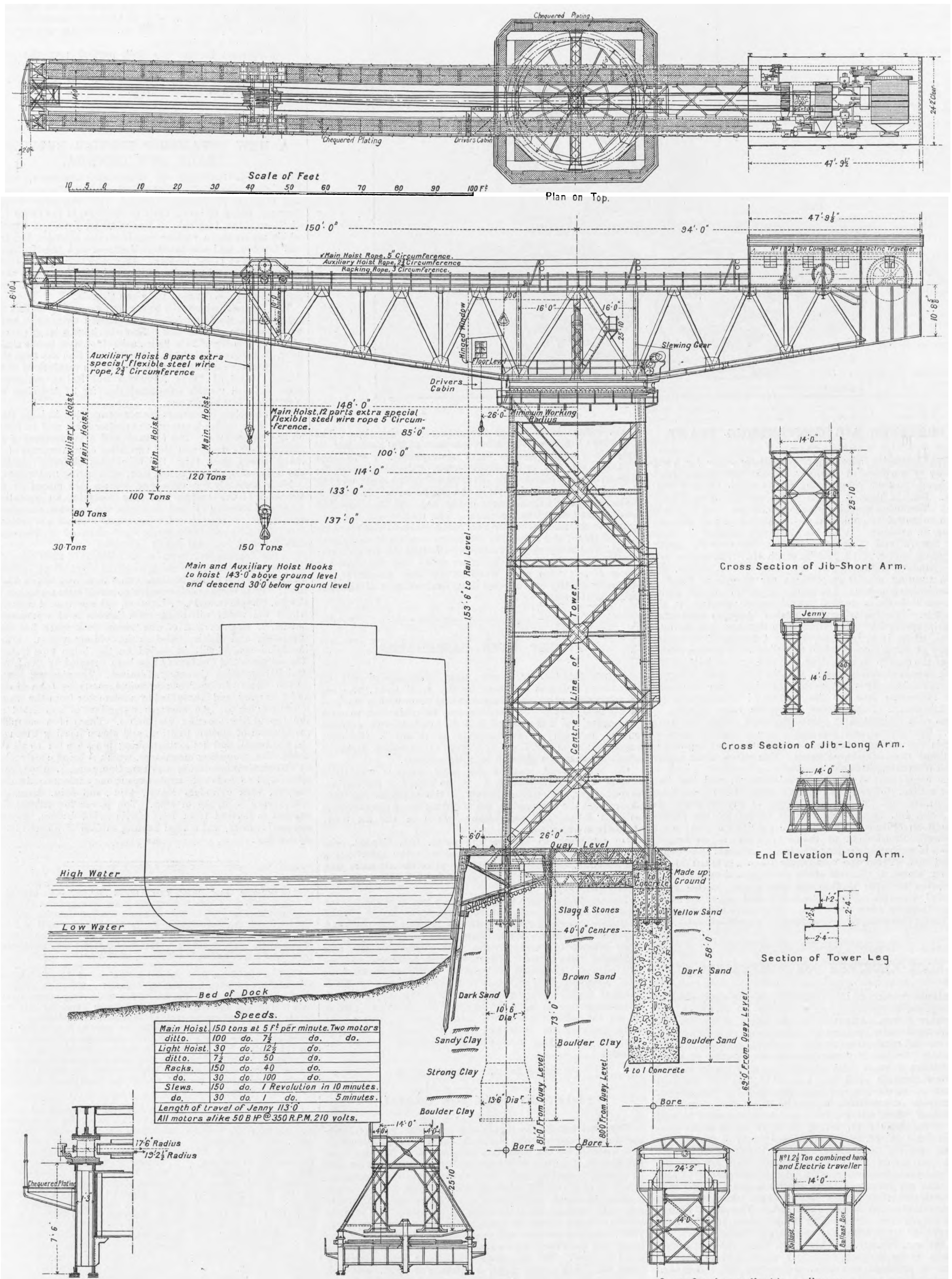
SOCIETÀ ANONIMA OFFICINE MECCANICHE, NAPLES, ENGINEERS


1·500
1·510
1·250
1·500
1·880
1·620
990
2·080
700
1·880
1·145
230
4·548
6·788
308
4·359
3·214
3·080
2·340
2·502
910
220
1·245
270
560
270
585
1·010
260
753
287
650
5·800
5·480
2·100
3·600
2·100
1·150
990
1·450
1·450
715
715
500
535
280
1·145
3·080
1·585
356
1·000
"The Engineer"
Swain Sc.

150-TON ELECTRIC SHIPBUILDING CRANE

SIR WILLIAM ARROL AND CO., LIMITED, GLASGOW, ENGINEERS

(For description see page 187.)


Chequered Plating
Chequered Plating
Drivers Cabin
2'0"
14'0"
24'2" Clear
47'-9½"
Scale of Feet
10 5 0 10 20 30 40 50 60 70 80 90 100 Ft
Plan on Top.
150'-0"
94'-0"
47'-9⅛"
No 1 2½ Ton Combined Hand & Electric Traveller
Main Hoist Rope, 5" Circumference.
Auxiliary Hoist Rope, 2¾" Circumference
Racking Rope, 3" Circumference.
6'10"
10'0" Minimum Distance
20'0"
16'0"
16'0"
25'10"
10'8"
Hinged Window
Floor Level
Slewing Gear
Drivers Cabin
Auxiliary Hoist 8 parts extra special flexible steel wire rope, 2¾" Circumference
148'-0"
Main Hoist, 12 parts extra special flexible steel wire rope 5" Circumference.
26'0" Minimum Working Radius
85'-0"
100'-0"
114'-0"
133'-0"
137'-0"
Auxiliary Hoist
Main Hoist
Main Hoist
Main Hoist
120 Tons
100 Tons
80 Tons
30 Tons
150 Tons
Main and Auxiliary Hoist Hooks to hoist 143'0" above ground level and descend 30'0" below ground level
153'-6" to Rail Level
Centre Line of Tower
6'0"
26'0"
Quay Level
High Water
Low Water
Bed of Dock
Made up Ground
Concrete
Slagg & Stones
Yellow Sand
40'0" Centres
58'0"
Brown Sand
Dark Sand
Dark Sand
10'6" Dia
73'0"
Sandy Clay
Boulder Clay
Boulder Sand
Strong Clay
4 to 1 Concrete
13'6" Dia
Boulder Clay
81'0" From Quay Level
86'0" From Quay Level
69'0" From Quay Level
Bore
Bore
Bore
14'0"
25'10"
Cross Section of Jib-Short Arm.
Jenny
14'0"
Cross Section of Jib-Long Arm.
14'0"
End Elevation Long Arm.
1'2"
2'4"
1'2"
2'4"
Section of Tower Leg
17'6" Radius
19'2½" Radius
Chequered Plating
1'3"
7'6"
14'0"
4'0"
25'10"
24'2"
14'0"
No 1 2½ Ton combined hand and Electric traveller
14'0"
Ballast Box
Ballast Box

Speeds.

Main Hoist.	150 tons at 5 ft per minute. Two motors
ditto.	100 do. 7½ do. do.
Light Hoist.	30 do. 12½ do.
ditto.	7½ do. 50 do.
Racks.	150 do. 40 do.
do.	30 do. 100 do.
Slews.	150 do. 1 Revolution in 10 minutes.
do.	30 do. 1 do. 5 minutes.
Length of travel of Jenny 113'0"	
All motors alike 50 B HP @ 350 R.P.M. 210 volts.	

Section of Girder at Top of Tower

Cross Section of Jib Through Centre Pin.

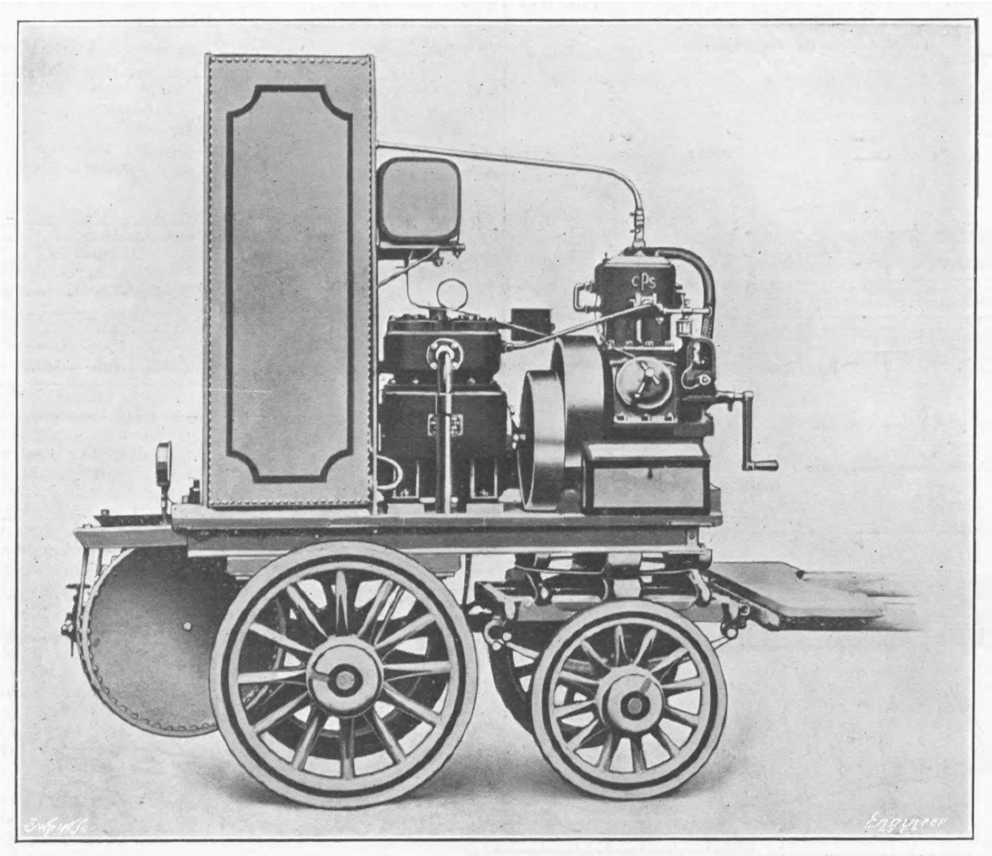
Cross Section at Machinery House.

"THE ENGINEER"

SWAIN Sc

PORTABLE AIR COMPRESSOR

CHARLES PRICE AND SON, BROADHEATH, ENGINEERS



PORTABLE AIR COMPRESSING PLANT.

THE increasing adoption of pneumatic power for a wide variety of purposes in recent years has been largely due to the handy portable compressing plants which are now available. Such a plant is shown in the accompanying illustration. The entire machine weighs but 30 cwt., and is capable of an output of 30 cubic feet of free air per minute delivered at 100 lb. pressure. It has been specially designed for access into narrow and awkward spaces. Its over-all length, excluding shafts, is 7ft. and its width 4ft. The engine is a two-cylinder paraffin motor, 4in. bore by 5in. stroke, and when running at 950 revolutions per minute is rated at 10 brake horse-power. The supply of paraffin to the engine is controlled by a conical seated valve operated by the governor. Ignition is by low-tension magneto apparatus, the trip mechanism being situated in the caps over the inlet valves, where it is easily adjusted. A feature of the engine worthy of mention is a spiral half-time train of gear which causes the engine to work silently. The upper half of the crank case is of special depth, and the crank shaft is carried in hornblocks. This allows the provision of an unusually large inspection door for the making of adjustments, &c. The lubrication of the engine is positive, being effected by means of a reciprocating pump contained inside the crank case. The engine and compressor are placed in series as regards the cooling arrangements, and the water required is circulated by a helical gear pump. The valves of the engine are all interchangeable and adjustable.

The compressor is of Tilghman's design, and has two single-acting cylinders. It runs at a speed of 400 revolutions per minute, and the bore and stroke of the cylinders are 4¾in. and 4in. respectively. It is driven by the engine through an ordinary spur reduction gear in the compressor fly-wheel. Lubrication of the compressor is automatic, while a large inspection door enables adjustments to be easily carried out. From the compressor the air is taken to the receiver, shown at the rear of the carriage, the outlet cocks, &c., being arranged so that the piping can be led away directly rearwards. The cooling and fuel tanks are sufficiently large for a ten hours' run. The plant has been built by Charles Price and Son, Broadheath, near Manchester.

A ROCK RECEIVER FOR COMPRESSED AIR.

AN interesting account of a method of storing compressed air in a rock receiver is given by a writer in our American contemporary *Power*. Attention is first called to the fact that modern electrically-operated air compressors for mining work are provided with unloading devices which overcome to a certain extent the loss of power through air blowing off at the safety-valve when a hoist or a number of drills are stopped for a few minutes. But with a device of this kind the daily capacity of the plant is very much less than if it were allowed to compress air constantly, and if the air could be stored and given back when all the drills and hoist happened to be at work at the same time, calling for more air than the compressor could deliver, a great advantage would be gained. The storage capacity of ordinary mining installations is very small. At one of the American mines there are two electrically-driven compressors with a combined capacity of 7500 cubic feet per minute. These machines are provided with automatic unloading devices which operate whenever the air pressure rises to 100 lb. per square inch. The idea of sealing up an unused cross cut in the mine and using it as a large underground air receiver was successfully carried out. The cross cut was, roughly, 9ft. high, 6ft. wide, and 400ft. long, and was driven through solid rock which had no cracks or seams. A bulkhead was built of concrete 10ft. thick and carefully pointed on the inner side with strong cement. A 6in. pipe connection and a manhole were built into the bulkhead, the manhole being sealed in the same manner as a manhole in a boiler. When tested it was found that the reservoir lost only 10 lb. in eighteen hours, one or two small leaks round the bulkhead accounting for this loss. The capacity of this reservoir is not less than 22,000 cubic feet. If free air is compressed to eight atmospheres, it will hold 176,000 cubic feet, or the entire output of the compressors for twenty-three minutes. The advantage of such a large reservoir is said to be very noticeable in the engine-room. It tends to balance the rapid fluctuations in the load, and the unloading gear comes into action less often. The motors are not subjected to the stresses of the load being constantly thrown on and off them, and a hoisting engine or a group of drills may be put into action without seriously affecting the air pressure. The idea is not new, but the writer states that he does not know of any other place where it has been successful, the difficulty usually encountered being the leakage of air through seams in the rock.

FLIGHT WITH PASSENGERS.

A SUCCESSFUL aëroplane flight was carried out on Saturday evening at Aldershot by Mr. S. F. Cody, who has for some time past been experimenting there with a machine of his own design. On this occasion he undertook to carry passengers, and it is reported that the machine with a double burden behaved as satisfactorily as it did a few days previously when Mr. Cody by himself made several flights of about 1½ miles at a speed of 30 miles an hour.

On the present occasion the same distance was twice covered with Col. Capper, R.E., of the School of Ballooning, as passenger. Complete control of the machine was kept throughout the experiment, the alighting being accomplished without shock, and the balance while in the air being perfectly maintained.

On returning to the starting point, Col. Capper, who expressed himself as entirely satisfied with the behaviour of the machine, descended, and in his place the aëronaut took his wife for a short flight, the experiment being again completely successful.

The aëroplane, which weighs nearly a ton, is of the biplane type and is fitted with an 80 horse-power motor. Some trouble is being experienced with the radiator and overheating in the bearings. When these have been overcome, Mr. Cody intends to enter for the prize offered for the first successful flight between Manchester and Liverpool, and for this purpose, it is stated, he proposes to convey his machine from Aldershot to Liverpool by making a series of short-distance flights. For Saturday's experiments several minor alterations were made in the design of the machine; among others, the radiator was moved further back to balance the extra weight of the passenger, who sat in a seat of the type used on agricultural machines, placed directly behind the operator.

FLOATING DOCK FOR BRAZIL.

THE contract for the supply of a new large pontoon floating dock for the harbour at Rio de Janeiro has just recently been awarded by the Brazilian Government to Vickers, Sons and Maxim, Limited, of Barrow-in-Furness. This dock will be capable of dealing with the new Brazilian Dreadnoughts. It will be of the double-sided self-docking type, known as the "bolted sectional," and consist of a pontoon and two parallel side walls built on and forming part of the same. The pontoon will be divided into three sections, the centre one being about 165ft. long and the two end sections about 170ft. long. The latter will have their outer extremities built in the form of a point or bow. The Rio dock will have a total length of 550ft. 6in., with a clear width of entrance of 100ft., and will be capable of receiving vessels drawing up to 36ft. It will have a lifting power of 22,000 tons. The pontoon will be divided into six compartments by longitudinal water-tight bulkheads. Situated about 20ft. below the top deck of the walls is the engine deck, on which are to be placed the boilers, engines, dynamos, and pumping machinery. On each wall of the dock there will be a travelling crane, lifting about eight tons. The pumping machinery and other engines of the dock consist of two identical installations, one in each wall. The plant in each wall consists of three boilers and three engines and pumps, one in each section. The boilers will be of the Babcock and Wilcox portable type. The main pumps are of the horizontal type, seated directly on the top of the main drain running along the bottom of the walls. There will also be an extensive equipment for fire extinguishing and washing down, and a complete direct-current electrical plant. The whole of the dock will be lighted by electricity, and provision will be made by means of flexible wires to carry clusters of lamps to illuminate any portion of the interior of a docked ship.

The contract for the Rio dock partook somewhat of an international competition, inasmuch that tenders for the work were submitted by three British, one American, one French, and three German firms.

A NEW STEAMSHIP SERVICE BETWEEN ITALY AND CANADA.

THERE was launched, on Wednesday afternoon, August 18th, from the Wallsend shipyard of C. S. Swan, Hunter, and Wigham Richardson, Limited, the twin-screw steamer Tortona, which is being built to the order of the Cairn Line of Steamships, Limited, of Newcastle-on-Tyne and Dundee, which maintains a regular weekly service between Montreal and London, and also between Montreal and the North-east Coast ports of Great Britain. Its connection with the trade between Italy and Canada commenced fifty years ago, and a decision was recently arrived at for the starting of a direct passenger service between Italy and Canada.

The Tortona, which will be the first steamship of this new service, is a finely-modelled, four-masted twin-screw vessel, with complete shelter deck. She will have a length overall of 464ft., a beam of 54ft. 2½in., a depth of 40ft. to the shelter deck, and a gross tonnage of about 7600. She has been built to the highest class at Lloyd's, and to the regulations of the British Board of Trade, American and Italian emigration laws, and will provide accommodation for 37 first-class and 1082 third-class passengers.

The first-class passengers are accommodated in large staterooms in a bridge house on the shelter deck, and in houses on the bridge deck. The forward and after portions of the shelter 'tween decks and the two after compartments of the main 'tween deck form the third-class sleeping quarters, the beds being of galvanised iron, with spring mattresses.

Main hospitals for men and women are placed at the after-end of the bridge, and they comprise an operating-room and dispensary, and rooms for the hospital attendants and nurses. Hospitals for infectious diseases are isolated from the cabin accommodation, and situated in a separate deck-house at the after end of the vessel.

As the Tortona will carry a dead weight of 8300 tons, she is fitted with a complete cargo-handling plant which includes 14 derricks, one lifting 20 tons, two 8 tons, and eleven 5 tons each; whilst there are also twelve powerful steam winches by Clarke, Chapman and Co., Limited. As a portion of the cargo which the vessel will bring from Canada is of a perishable nature, a large section of the 'tween deck space has been insulated, and will be cooled on the cold-air system. Other insulated spaces will be cooled on the brine pipe system. The refrigerating machinery has been supplied by the Liverpool Refrigerating Company, Limited. The steering gear is on the latest Wilson-Pirrie principle, made by John Hastie and Company, and is actuated by a telemotor from the wheel-house amidships. An emergency standard is also fitted on the top of the steering gear-house. There is a complete installation of electric lighting, and steam heating throughout the vessel, and fire-extinguishing pipes are led to all the holds. The propelling machinery, which is being constructed by Palmers' Shipbuilding and Iron Company, Limited, consists of two sets of triple-expansion surface-condensing engines, with cylinders 25½in., 41in., and 68in. diameter, and having a stroke of 48in. The power for driving the engines is derived from four single-ended boilers, having sixteen furnaces, and a total heating surface of about 13,200 square feet.

Manchester Geological and Mining Society.—An excursion of the members of this Society has been arranged for the 23rd August (Monday), when the Gresford Colliery sinking will be visited, under the leadership of Mr. D. H. F. Mathews, H.M.I.M., and Mr. T. H. Cockin, manager at Gresford for the United Westminster and Wrexham Collieries, Limited. The train starts from Exchange Station, Manchester, at 12.5 p.m.

Lloyd's Register Scholarship.—The second Lloyd's Register Scholarship in Marine Engineering, founded under the auspices of the Institute of Marine Engineers, for which examinations were held in July last at Glasgow and Newcastle-on-Tyne, has been won by Mr. Frank Duncanson, of 15, Harold-street, Sunderland. The scholarship is of the value of £50 per annum, tenable for two years, and is open for competition to graduates and associates of the Institute. Mr. Duncanson is the son of the late Mr. F. Duncanson, Board of Trade surveyor, and is at present serving his apprenticeship with George Clark, Limited, Southwick Engine Works, Sunderland. He will attend the Sunderland Municipal Technical College.

Cadetships for Osborne.—The following candidates for cadetships are declared to have passed the July qualifying examination and will enter the Royal Naval College at Osborne in September next:—F. H. Alderson, C. B. Allen, J. H. A. Anson, D. K. Bain, J. S. Black, J. P. M. Blissett, J. W. Bond, G. M. Bradley, D. M. Branson, H. V. Briscoe, A. F. Brooke, P. W. B. Brooking, R. A. Bryan, R. G. Campbell, G. A. Cavis-Brown, D. P. Christie, C. S. Coltson, M. M. Denny, J. A. Dicken, H. V. Drew, F. J. Durnford, M. W. W. Eppstein, H. M. R Fairfax-Lucy, C. A. Fellowes C. A. T. Galbraith, R. B. Gibb, B. T. Godfrey Faussett, D. H. Griffiths, J. R. S. Haines, M. H. Hopkins, W. K. Hudson, B. P. Hulbert, R. N. Johnstone, L. D. Jones, S. B. Klein, W. B. Luard, H. C. Macdonald, L. D. Mackintosh, W. St. Aubyn Malleson, J. P. Mandeville, M. J. Mansergh, I. H. H. Meiklejohn, C. M. Napier, W. B. Nicholson, J. P. Nickalls, J. G. D. Ouvry, W. M. Phipps Hornby, A. R. T. Pipon, J. de C. Richards, C. H. Rider, F. T. Roche, the Hon. J. H. Russell, M. G. Saunders, A. G. M. Small, V. C. D. Smith, J. D. Spiller, D. Theodore-Smith, D. F. C. L. Tottenham, R. L. Tuffnell, J. P. F. Turner, C. C. M. Usher, P. H. G. I. Vance, G. M. Walker, G. F. P. Watkins, E. G. Watson-Smyth, W. E. N. Westall, G. P. C. Wetherall, C. L. W. Williams, F. C. Wood, F. J. Wylie.

RAILWAY MATTERS.

The Board of Trade have recently confirmed the Order made by the Light Railway Commissioners for the Dover, St. Margarets and Martin Mill Light Railway Order, 1909, authorising the construction of Light Railways in the Borough and Rural District of Dover, in the county of Kent.

An American contemporary states that an electric rail grinder has been devised by the Albany and Hudson Railway for use in grinding the wing rails of frogs to ensure smoother passage of car wheels. A motor is carried on an ordinary hand car, a sort of small barrow carrying the emery wheel being suspended from a crane overhanging the end of the car, and the operator supplying the necessary pressure upon the grinding wheel through the handles of the barrow.

The Indian Railway Board has issued its report for 1909 showing that during the year 616 miles of line were opened to traffic, bringing the total mileage of open line in India up to 15,951 miles on the broad gauge, 12,863 miles on the metre, 1394 miles on the special, and 368 miles on the narrow, and a total of no less than 30,576 miles of all gauges. The financial results of the working of the State railways for the year was a net loss to the State of 233.64 lakhs of rupees.

The Royal Commission on Canals and Waterways is about to issue a third interim report. It has already issued two interim reports and four volumes, three of evidence and one of reports and statistics as to canals. The interim report shortly to be issued is of a purely formal character, and will be accompanied by one volume of evidence and a report on foreign waterways. The Commission has lately been sitting on the main report, and is doing its utmost to secure publication at the earliest possible moment. The Commission is investigating the cost of improving the canal route connecting Birmingham, Wolverhampton, and the Midlands with the ports of London, Liverpool, Bristol, and Hull.

Traffic at Waterloo Station, London, was somewhat dislocated on Thursday evening of last week owing to an engine running off the metals about 100 yards from the end of one of the main-line platforms. It was a large express locomotive that had just brought in an empty train, and at the time of the mishap it was shunting out, without any coaches, preparatory to being attached to another train. From some causes unexplained it ran off the lines, leaving its tender on the metals, however. A very powerful travelling crane was procured from the locomotive department at Nine Elms, and in a little more than two hours the engine was replaced on the line. No one was injured, and practically no damage was done; but the blocking of the line considerably delayed a number of trains, and one which was penned in by the derailed locomotive started nearly three hours late on its journey to Woking.

An inquiry was held at Friesland on Thursday, August 12th, by Col. Von Donop, Board of Trade Inspector, into the railway disaster on the London and North-Western line which resulted in the death of the driver and stoker. Joseph Pemberton, guard of the train, stated that they passed through Friesland Station at a speed of 50 miles an hour. Directly afterwards the van in which he was riding oscillated violently. He applied the brakes and, looking out of the window, saw that the middle coach had left the rails and the coaches were all twisted. He rushed back to the brakes, which he held till the train came to a standstill. On leaving his van, he saw the dead bodies of the driver and stoker. He at once told the signalman to block all the lines and wire for assistance. The inspector complimented Pemberton on his promptitude, which, he said, had done much to mitigate the force of the accident. Two other witnesses, a chief permanent way inspector and a locomotive fireman, expressed the opinion that the accident was due to the second coach leaving the rails. The inquiry was concluded, the inspector stating that he would make further inquiry into the speed of the train.

According to the ninth "Financial and Economic Annual of Japan," issued by the Department of Finance, the railway system of Japan until lately comprised over thirty private railways in addition to the Government lines. The nationalisation of seventeen of the former has been decided upon. Their aggregate length is 2812 miles, and cost of construction about £23,455,905. The total amount of goods carried on Japanese railways in 1907-8 was 23,000,000 tons, of which 18,000,000 tons were carried on State lines and 5,000,000 on private lines; and the total receipts from the traffic reached £8,399,058, of which £7,169,927 was earned by State lines and £1,229,130 by private lines. The total mileage of railways open in 1907-8 was 4899 miles, of which 4453 miles were State lines and 446 miles private. With regard to the railways in South Manchuria, the Government established the South Manchurian Railway Joint-Stock Company in November, 1906, with a view to utilise them for commercial purposes. The capital of the company is £20,485,506, of which £10,242,753 was contributed by the Government, and £2,048,551 was subscribed by the public. The objects of the company include mining, and especially the working of the collieries at Fushun and Yentai.

A consular report dealing with the trade of Bahia, Brazil, states that a section of line 19 miles in length on the Nazareth Railway, between José Marcellino (Santa Isabel) and Areia, was completed and opened for traffic during 1908. The railway in question is one of those owned by the State of Bahia; the completion of the extra 19 miles brings the total length of this line up to 117 miles. During the past year work was commenced in connection with a projected line of railway to extend from Ilheos to Conquista. A concession to construct the line was granted some three years ago to a Brazilian syndicate, but the actual work of construction had been deferred for lack of capital. The Governor of this State has granted an extension of two years, as from October 27th, 1908, for completion of the first section of the projected railway, namely, from Ilheos to Tabocas, a distance of some 31 miles. A British firm has undertaken to finance the undertaking, and work in connection therewith has been commenced at the Ilheos end. It is anticipated that the section as far as Armada, a distance of some 15½ miles, will be completed within the present year, and that the section to Tabocas will be completed within a period of two years from the present time.

Parliamentary powers having been obtained, the work of extending the Central London Railway from the Bank to Liverpool-street will be pushed forward with all possible despatch. It is anticipated that the new line will bring a large amount of additional traffic to the railway, there being at present no direct train service from Liverpool-street to the West End. A new subway is to be constructed giving direct access to the Bank station from the street, and the scheme includes one matter, which although unconnected with the extension, will be of great convenience to passengers on the line, and is in itself a notable and interesting experiment. This is the construction of a movable platform connecting the British Museum station of the Central London Railway with the Holborn station of the Great Northern, Piccadilly, and Brompton Railway. At present through bookings are in vogue which involve changing at these stations, and there being no subway between them passengers have to ascend to the street and walk some distance along Holborn from one station to the other. The projected platform will be a continuously moving one, similar to those to be seen at various places of public entertainment, and by its means travellers will be able on alighting at either of the stations to travel easily and rapidly to the other, avoiding the trouble and loss of time caused by the present method of changing.

NOTES AND MEMORANDA.

Electrolysis in water mains at Winnipeg has been investigated by Professor L. A. Herdt, of McGill University, who reports that the soil there has a very low electric resistance, and only a very small difference of potential can be allowed in rail returns. He states that all bonds whose resistance is greater than that of 4½ft. of rail must be improved.

According to a paper read by Mr. A. M. Feldman before a meeting of the American Society of Heating and Ventilating Engineers, steam heating coils are being used for cooling purposes in the summer in a bank building in New York. Two sets of headers were provided with shut-off valves, separate steam and brine mains leading to the coils, which were galvanised to prevent rusting.

The following test, which can be made by anyone with simple apparatus, is recommended by an American contemporary for detecting acidity of lubricating oil. Procure a solution of sodium carbonate in an equal weight of water. Take a small quantity of the oil and an equal amount of the sodium solution. Place them in a bottle, shake, then allow to stand. If there is any acid present it will settle to the bottom as a precipitate, the amount of precipitation indicating the amount of acid present.

In floating completed bridge spans to their final position in a railway bridge over the Siltong River, India, advantage was taken of the tide to lift them off the staging to which they were transferred after erection. Timber towers were erected on a pontoon, which was brought into position under the span at low tide, and lifted it, as the tide rose, clear of the staging. Two sets of anchors had been placed in the river, the one in mid-river, opposite the site of the span in the bridge, the other above the bridge. The pontoon was first hauled straight out to mid-river by means of lines attached to the first set of anchors, and then up to its position in the bridge by lines to the second set. The span was then lowered, partly by the falling tide and partly by taking water into the pontoons through cocks.

A concrete wall 200ft. long, 16ft. high, and 4in. thick, forming one side of a new quartermasters and ordnance warehouse, was placed in position on July 16th at Camp Perry, Ohio, by the Aiken "jack" system, according to which the wall is poured in an inclined position, and later tilted to its upright position by revolving the frame or "jack" on which it rests. The wall was reinforced with ¼in. twisted bars on 4in. centres in each direction, held by National spacing chains on 4ft. centres. The rods were placed in the centre of the wall. It is stated that the reinforcement was placed by two men in one day, that the pouring took 5 hours and 10 minutes, and that five men finished the surface in one day. It was raised 48 hours after pouring, without developing cracks. This wall is reported to be the longest thus far erected by the system.

On a property in California, situated in a district where quartz mining has been carried on for many years, and where the only power in use is water power on Pelton wheels, a local millwright was told to set and house a small Pelton to run a few concentrators. The main pipe line was tapped, and a 3in. line run from it to the concentrator building. The millwright set his wheel, and worked two days framing a wooden casing. When the work was done the wheel would not give nearly the speed required. Different nozzles were tried, the pipe line taken apart in search of possible obstructions, and in all two more days were consumed in a fruitless effort to ascertain the seat of the trouble. It was finally discovered that the housing was so small that the waste water choked the wheel. A new housing was then built, necessitating a new setting for the wheel.

A large number of British sailing ships have been sold recently, mostly to Norwegian and Italian owners. The feature of the sales has been the low prices that have been accepted. A vessel of 1499 tons register, built in 1885, which changed hands in August, 1906, for £4400, has recently been sold for £2800. A steel barque of 1352 tons register, built in 1890, was sold in April of last year for £3 6s. 7d. per ton register, whereas in June this year a steel barque of 1346 tons register, but built in 1895, was sold for only £2 9s. per ton. A steel barque of 1519 tons register, built in 1893, fetched £3 4s. 6d. in June last year, but last month all that could be obtained for a similar vessel was £2 9s. 8d. per ton. In July last year an iron ship of 1742 tons register, built in 1885, realised £2 7s. per ton. Last month a German iron barque, 2250 tons register, which was sold in July, 1907, for £7500, or at the rate of £3 7s. 8d. per ton, only fetched £3350, or £1 9s. 9d. per ton. These figures demonstrate the heavy depreciation which has taken place in the value of sailing ships recently, due, of course, to the great difficulty of making them pay with the freight market in its present condition.

The water for the great system of canals and ditches of the Mercedes, Tex., irrigation system is pumped from the Rio Grande by means of electrical energy, which is supplied from a central power plant situated in the town of Mercedes, seven miles from the pumping station. The Mercedes enterprise will be one of the largest electrical pumping irrigation propositions in the world. Water will be supplied for more than 200,000 acres of land, situated in the valley of the lower Rio Grande. The central power plant at present generates at 6600 volts, the three-phase currents being transmitted to the pumping station, situated upon the bank of the river, seven miles distant, and operating an induction motor-driven pump, which has a capacity of 60,000 gallons per minute. The equipment of the central power plant consists of two generators of 300 kilowatts each, and a 15-kilowatt lighting set for the town of Mercedes, when the main set is shut down. The main canal of this system is already completed for many miles across the valley land, and carries a stream of water 145ft. wide and 10ft. deep. The canal is capable of being navigated by barges and boats. There are numbers of other small electric pumping plants along the upper course of the Rio Grande River, particularly in the vicinity of Laredo, where a number of farmers receive electrical energy for operating their respective pumping stations from the electric power plant in the town.

In an article on the occurrence and utilisation of tungsten ores, the "Bulletin of the Imperial Institute" says: "Tungsten is a comparatively unknown metal, which a few years ago was merely a laboratory curiosity. During the last year or two it has come into prominence owing to a number of important new uses which have been found for it. Perhaps the best known of these is its use in the manufacture of the filaments of certain types of electric incandescent lamps. These "metallic filament" lamps are claimed to be more efficient and economical in use than the old type of incandescent lamp containing a carbon filament, and their use has extended enormously of late. From the point of view of consumption of tungsten ores and tungsten metal, however, a more important application is in the manufacture of very hard steels. It has long been known that the addition of small quantities of the somewhat rare metals, manganese, molybdenum, tungsten, &c., to steel conferred very valuable new and special properties on the latter, and, in particular, greatly increased its hardness. Such steels, of which "tungsten steel" is a good example, have come into large demand recently mainly for the manufacture of the powerful cutting tools used in engineering works, and it is on this account mainly that the demand for tungsten ores has increased. It is also stated that of late tungsten has been applied specially in Germany in the manufacture of bullets. An old-established use of tungsten is in the manufacture of compounds used in rendering timber fire-proof. In view of these multifarious uses of this metal it is satisfactory that large deposits of tungsten ores are available in British Colonies and dependencies, particularly in Australia and India."

MISCELLANEA.

The Admiralty are reported to have in contemplation the restoration of Falmouth as a naval station. Members of the Board will shortly visit Falmouth to consider, among other matters, the mooring accommodation for torpedo craft, the site of a proposed coaling depôt, and the berthing place for a guardship to be selected from the reserve at Devonport.

The *Boletin Oficial* of July 5th contains a copy of a Bill to provide for the execution of sanitary works in the city of Buenos Aires. The cost of these works is estimated at 18,000,000 pesos currency (about £1,575,000). It is proposed to include in the scheme the construction at Palermo of a new intake tunnel and tower; new filters; pumps, buildings, pipes, &c.; and pumping-house and main pipes at Recoleta, and extension of piping outside the Bateman radius.

The recently published interim report of the Army Advisory Committee for Aëronautics contained a programme of the research work to be undertaken at once at the National Physical Laboratory. Among the series of experiments included is one on the behaviour of different materials with reference to the accumulation of electrostatic charges, and generally as to the means of protecting airships from the effect of lightning. The Executive Committee of the Laboratory have already made the necessary arrangements for carrying out this work.

The City engineer states in his annual report that notices to treat are now being served upon the various owners for the acquisition of their interests in order to effect the widening of Bishopsgate-street Without. Some progress has been made with the widening of Fleet-street; but the Corporation has decided to complete the whole widening forthwith at a cost of £500,000, subject to the London County Council's paying half. Negotiations with the Council are now proceeding. The work of increasing the width of Mansell-street to 50ft. from Aldgate to the City boundary has now been completed.

Recently, Mr. Bellairs asked the First Lord of the Admiralty whether, in view of the way the bulkheads in engine-rooms and boiler-rooms of his Majesty's ships suffer from continual damp and contaminated bilge water, the Board are in the habit of testing these compartments to ensure that the bulkheads will not give way if the ship suffers an accident from collision, grounding, or explosion. In reply, Mr. M'Kenna said that engine and boiler-room bulkheads are frequently surveyed, and due care is taken to maintain their necessary strength. They were not water tested except when first built, this being unnecessary.

An American contemporary states that micro-organisms have been causing trouble in the water supplies of two cities of Rhode Island. Early in May, Uroglena appeared in the filtered water stored in the open Hope Reservoir of the Providence water works, where they remained for about six weeks. Somewhat later a heavy growth of staurastium and cellular blue-green algæ appeared in one of the open reservoirs of the Newport Water Company. Dr. Gardner T. Swarts, secretary of the Rhode Island State Board of Health, reports that the treatment has consisted of reliance on Nature to afford a relief in due time, coupled with condolence with the public on the disagreeable condition of the supplies. The use of copper sulphate was suggested at Providence, and would have been approved by the State Board, but the matter never reached it on account of the opposition of some of the local authorities to the introduction of chemicals into the water supply

The British Consul at Stockholm, in the course of his report for 1908, refers to the electric smelting of iron ore in Sweden, and remarks that it will still remain a question whether it will pay better to smelt great quantities of iron ore in Sweden and export it as pig iron than to continue exporting ore as hitherto, unless, of course, Sweden can use the pig iron herself. Even if Sweden by this process can produce pig iron much more cheaply than hitherto, he states, it does not follow that such pig iron would be cheaper than pig iron produced from Swedish ore in other countries. Again, the total power to be developed from Swedish waterfalls is only estimated at 4,000,000 horse-power, and naturally much of this is not situated conveniently to the ore, so that additional transport must be considered. Another problem concerns the proportion of the electrical horse-power, which in view of other industries, can be profitably expended on producing pig iron.

In the House of Commons recently, Colonel Philipps asked the First Lord of the Admiralty, whether the delay in delivering the two destroyers ordered in the financial year 1905-6 arises from change in design ordered by the Admiralty or from delays on the part of the contractors; and, in the latter case, whether he would state the names of the contractors, and whether they have previously built destroyers for the Navy. In reply, Mr. M'Kenna said that as the question of what penalties, if any, for late delivery has yet to be decided for these two destroyers, a complete and definite answer could not be given at the moment; but it was to be borne in mind that in these and other similar instances, where contracts are entered into to advance beyond the ordinary speeds of a particular type, delays are likely to occur occasionally, as the experience of our own and foreign navies shows. Both of the firms concerned had large experience and knowledge of the problems dealt with.

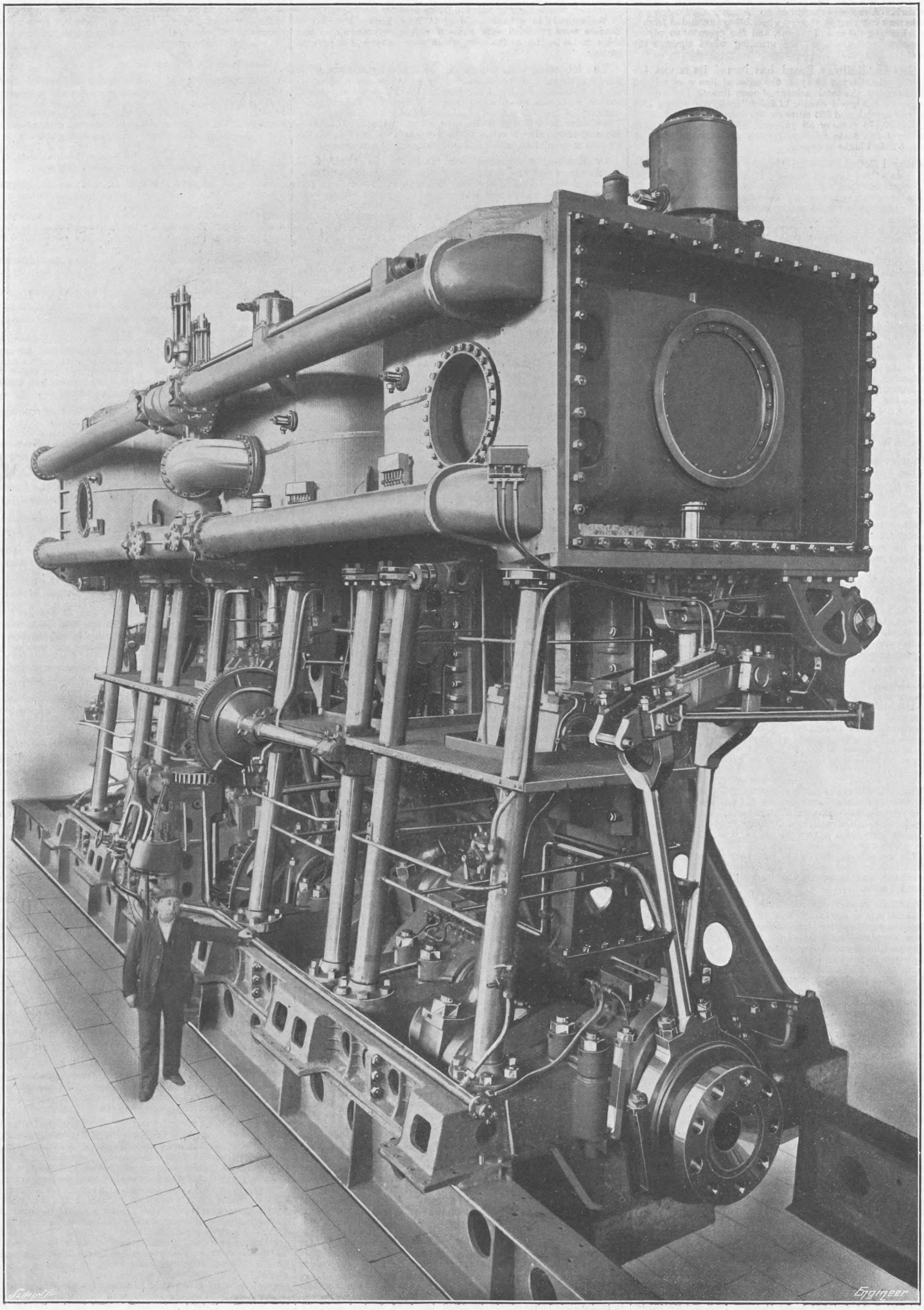
Despatches from Japan state that the new harbour at Miike, which has been constructed by the Mitsui Mining Company to facilitate the export of coal from mines in the island of Kiushiu, consists of an outer harbour, an inner harbour and passage, and a wet dock, the width of the entrance to the last being 66ft., with a depth of 28ft. on the sill at normal level. The outer harbour lies entirely outside the breakwater; the inner harbour has an area of 124 acres, but it is not as yet completely dredged out. It is bounded by two breakwaters about 3000ft. in length, and in height 3ft. above high-water line. The channel connecting with the sea is 6000ft. long, with a minimum depth of 18ft. at low water. The wet dock is reserved exclusively for the Mitsui firm, and is to be used mainly for coal loading. At the eastern end is the quay wall, 1380ft. long, where three vessels of large size can be accommodated simultaneously. Here are installed three sets of coal-loading plant, with a loading capacity each of 5000 tons a day. Adjoining the quay wall are ample coal storage yards.

In an address recently delivered at the first annual convention of the Brooklyn Company, N.E.L.A. Section, Mr. Caryl D. Haskins recalled some experiences of twenty-one years ago, when he was on the staff of the London Grosvenor Gallery central station. The station had no heavy-current ammeters, and the deficiency was supplied as follows:—A slot-like trough was cut in a block of wood, and terminals attached at either end of the slot, with a body of mercury connecting the terminals. This crude apparatus was calibrated against a Kelvin balance, using an ordinary glass-bulb thermometer immersed in the mercury, and in routine use the current passing through the "instrument" was determined by a reading of the thermometer. In the same plant knife-blade switches were used to handle the 2200-volt circuits, and for use in switching there were provided pieces of 2in. belting about 2ft. long, each with a wooden handle. The rule was to take the switch firmly in the right hand and the piece of belting firmly in the other, pull out the switch, and then "swat" the arc with the belting. Referring to early power service in this country, Mr. Haskins quoted the following rule established by a central station for testing recording meters on power service:—"Examine the installation. Estimate the work being done by the motor in horse-power. Multiply by 746. Test the meter by the customary formula. If meter checks within 10 per cent., correct. If not, estimate the horse-power again."

ENGINE OF THE ITALIAN BATTLESHIP NAPOLI

SOCIETA ANONIMA OFFICINE MECCANICHE, NAPLES, ENGINEERS

(For description see page 184)



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*** *With this week's number is issued, as a Supplement, a Two-page Drawing of the Engines of the Italian Battleship Napoli. Every copy as issued by the Publisher includes a copy of this Supplement, and subscribers are requested to notify the fact should they not receive it.*

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TO CORRESPONDENTS.

☞ *In order to avoid trouble and confusion we find it necessary to inform correspondents that letters of inquiry addressed to the public, and intended for insertion in this column, must in all cases be accompanied by a large envelope legibly directed by the writer to himself, and stamped, in order that answers received by us may be forwarded to their destination. No notice can be taken of communications which do not comply with these instructions.*

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REPLIES.

X.—There are several spark or cinder arresters on the market which can be fitted to locomotives with the object of preventing the emission of hot particles of partially burnt coal.

D. M.—The propeller would not, of course, revolve. You will understand that it could not if you will consider for a moment the action of a gauge glass, which is an exact equivalent of your pipe A. If there were a difference in pressure between the top and the bottom of the gauge glass you would never see any water in it.

A. W. M. (Oldham).—Gear is usually fitted to enable the wheels to be disconnected from each other. In some cases a pair of cylinders forming a compound engine is fitted to each crank. The two wheel shafts may either be connected by a clutch coupling or left independent of each other. In some boats, however, the two wheels are rigidly connected together.

INQUIRIES.

"ACME" BALL BEARINGS.

SIR,—Can any of your readers inform me where I can obtain a supply of Acme ball bearings? K. R.

THE ENGINEER.

AUGUST 20, 1909.

The Ideal Card of an Internal Combustion Engine.

IN most, if not all, branches of human knowledge the word ideal is synonymous with unpractical. The engineer has occasionally to use it for want of a better, but its meaning must then be taken in a "Pickwickian" sense as expressing, not idealism at all, but a degree of perfection which is the best obtainable under practical conditions; in other words, the best compromise between the theoretical and practical requirements. The ideal indicator diagram from an internal combustion engine must be such a compromise, for in some particulars the thermodynamic and mechanical factors in the problem are in conflict. A distinguished French engineer, M. Letombe, in a paper read at Liège in 1905 on the influence of the water jacket on efficiency, in the course of his summing up, remarked as follows:—"Le cycle le plus parfait est le cycle à compression aussi élevée que possible, à explosions à volume constant et détente complète." This may appropriately be taken as a text in considering this subject, which naturally falls under three heads: The period of compression, the character of combustion, and the period of expansion. The other two parts of the cycle, suction and exhaust, have mostly mechanical significance, and with ample valve area and properly disposed ports the effect of these two strokes on the ideal card may be dismissed with the remark that they involve certain frictional losses which, though not negligible, are at a minimum in all well designed engines. In badly designed engines the effect of these losses may upset the cycle altogether and affect the character of the explosion and expansion lines, but one does not expect an ideal card from such an engine.

The effect of increase of compression on efficiency is well known, but while thermodynamics knows no limit to the compression pressure, one must be assigned for practical reasons. With combustion at constant volume the compression pressure and maximum pressure of explosion are inter-related, though in what way it is not possible definitely to say, since a large portion of the available heat of the charge seems to disappear at the moment of explosion. Increase of specific heat may account for a part of this disappearance, which, however, is not material to our present subject. The practical point is that we find the maximum pressure of explosion usually from three to three and a-half times the compression pressure. This factor depends very much on the class of fuel and the richness of the charge, but it obviously determines the practical limit of compression. Very high pressures are practicable where the speed is low, and cold water the working fluid, as in hydraulic machines; but high pressures, high temperatures, and high speeds cannot exist together in a practical internal combustion engine. The reasons are obvious to every practical engineer, and accordingly we find that in the development of the modern gas engine speeds and compression pressures have been advanced very cautiously. The modern commercial gas engine runs mostly on producer gas, but must be designed alternatively for lighting gas without alteration, and as the latter will give richer charges and higher pressures, the compression pressure adopted is a compromise, being slightly higher than would be adopted for lighting gas alone, and generally considerably lower than is practicable with producer gas. The perfect cycle with compression as high as possible and combustion at constant volume has thus to be interpreted by the commentary of practice, and we are prevented from the full realisation of the higher thermal efficiencies. There is this, however, to be said, the increments of efficiency are not proportional to the increments of compression pressure, and even were much higher pressures practicable than have been found hitherto, it is quite certain that from a commercial standpoint the small increase of efficiency obtainable would be balanced by other considerations, such as slower speed due to increased weight of parts consequent on the higher pressures. Where the perfect cycle as M. Letombe defines it is departed from, and very much higher compression pressures are used with combustion at constant pressure, the loss due to the less efficient method of adding heat to the charge is balanced to some extent by the gain due to the higher compression. This cycle is only applicable where the fuel can be introduced under pressure at the end of compression, and precautions must be taken that no premature introduction of the charge is possible, otherwise combustion at constant volume would take place, with consequent excessive pressures in the cylinder. This cycle is well known in oil engines of the Diesel type, but has not been employed with the gas engine, as there are almost insuperable practical difficulties in the introduction of the gas charge into the cylinder under pressure. The combustion at constant pressure does not fulfil the requirements of our perfect cycle in that expansion is not complete. With combustion at constant volume the whole of the heat is added at the end of compression before the piston begins its expansion stroke, consequently expansion is complete. It is practically certain that no engine made exactly fulfils this condition. The changes of pressure during the first small fraction of the expansion stroke are so rapid that it is difficult to see from an ordinary indicator diagram what is really taking place, but if a very sensitive and accurate indicator be used and a distorted diagram drawn—such as can be produced by connecting the indicator drum to a small crank at right angles to the engine crank, whereby for this period of the stroke the horizontal scale is magnified—it will generally be found that for a sensible period after the maximum pressure has been reached the expansion curve is nearly an isothermal. In other words, a certain amount of combustion is going on after the peak of the diagram has been passed, and this feature will be more marked the later the ignition is set. In gas engines, where the ignition is set very late, and in oil engines, where the dense nature of the oil vapour makes perfect mixing difficult, there is no difficulty on an ordinary diagram in tracing this delayed combustion much further down the expansion stroke. This delayed combustion probably accounts for some of the missing heat—perhaps all that is not otherwise explained by the increase of specific heat at the higher temperatures. If the period of delayed combustion is small—say, for not more than 5 per cent. of the stroke—the effect on the efficiency is slight; but, on the other hand, such delayed combustion has considerable advantage from a mechanical point of view. Combustion entirely at constant volume, such as is contemplated in the perfect cycle, involves an instantaneous rise of pressure, and this cannot be obtained without shock, a continuation of which must not only be prejudicial to the life of the working parts, but bad also for mechanical efficiency. The ideal card will stop short at the point where mechanical efficiency begins to be sacrificed; for, after all, the ultimate test of efficiency is a commercial one, and is based on the brake horse-power, and should include also smoothness of running and long life of working parts. The slightly delayed combustion has also the advantage of giving a "fatter" card, but this advantage must not be pushed too far, for, if so, the exhaust gases are rejected at too high a temperature, and this raises the mean temperature of the cylinder, increases the jacket loss, and reduces the weight of charge taken in. An endeavour to obtain very high mean pressures by very retarded combustion defeats its own end, for the cycle becomes unstable, with, eventually, missed ignitions.

Let us for a moment get back to first principles.

We are taught in the very early stages of our study of Thermodynamics that in any heat engine the condition of maximum efficiency is that all the heat must be added at the higher temperature, and all rejected at the lower. No engine satisfies this condition, least of all the internal combustion type, but the principle points out what must be aimed at. The addition of heat must take place as much as possible at the in end of the piston stroke, and what we want to point out is that the existence of a peak on a diagram is no evidence that this has been accomplished. We have seen cards with such a peak which showed also delayed combustion right down the expansion stroke, while, on the other hand, some cards with a rounded top show that the combustion is practically complete as soon as the pressure begins to fall. Anyone with the exercise of a little mathematics can show that the flattening of the top of the card— in other words, combustion at constant pressure—for a small fraction of the stroke detracts very little from the thermal efficiency, providing, and only on this condition, that combustion is complete at the end of that fraction of the stroke. Such a card has many practical advantages, and is worth striving for. The perfect cycle, as defined by M. Letombe in the words quoted, will, if interpreted by the practical considerations we have endeavoured to set out, give us the ideal card.

Suburban Railway Traffic.

THE Board of Trade report on the railways of Great Britain and Ireland for 1908, recently issued, contains many statistics which are eminently instructive. One fact is that profits diminish as business extends. Put in another way, the capital invested in railways may be taken as about £1,398,000,000. The interest on this is earned by doing work; but the more work done the less in proportion are the net earnings. Another point is the enormous sum paid by third-class passengers—£32,111,000—as compared with first-class—£3,271,000—and second-class passengers—£2,715,000. It is not remarkable that several important companies propose to follow the example of the Midland, and do away with the second-class altogether.

During the recent half-yearly meetings speaker after speaker deplored the loss of suburban passenger traffic. In all cases this is attributed to the rivalry of Tramways and Tubes. These last carried no fewer than 161,000,000 of passengers last year. The question at once arises, Why should tramways be preferred to railways by the suburban population? Is it not that the railway fails to satisfy the conditions which prevail in modern business life? In outer London there is an enormous and ever augmenting number of empty houses. They are empty because facilities abound for getting to and from "the City," or more accurately, central London, in which may be included the great shopping districts of the West End. Leaving feminine and pleasure traffic on one side, let us confine our attention to that business traffic which is the mainstay of the various systems of locomotion which competes for it. Not one of the older railways ever contemplated traffic of this kind. The truth is that suburban transportation has been tacked on to main line work in a most haphazard fashion. Certain incompatibilities are encountered, and it has been found essential to make changes and enlarge stations at an enormous outlay. It is open to question whether the end justifies the means. It is possible that many railways would have been better off if they had avoided the expenditure of capital, and left the tramways severely alone. Competition has always been pushed to excess by British railway companies. The outlay has taken place, and is taking place. The policy essential to any success whatever lies in making the competition effectual. That is to say, if the passenger has a choice between the railway and some other mode of conveyance, then let the railway present superior attractions, and this will day by day become more necessary and more difficult, because competition will no doubt become keener. As an example, it may be pointed out that covering in the top deck of tramcars is said to have more than doubled the number of passengers. There is good reason to suppose that at no distant date motor omnibuses will be put on our streets and on suburban roads which will be as superior to the crude existing machines as a modern locomotive is to the Rocket or Invicta. We need not explain what these things will mean to the railway companies. These last labour under two great disadvantages. They lack accessibility, and they are two inflexible. These defects seem to be ineradicable. To these may be added a third, which is avoidable, namely, want of punctuality.

It is essential to the working of railways that there shall be fixed stopping places—stations—and no others, in so far as passengers are concerned. The typical City man using the railway has to find his way to the nearest station, at which he must arrive at a particular hour. At the other end, when he gets out, he finds himself at some distance from his office. His routine is carefully fixed for him. To the time spent on the railway must be added that required to unite his home at one end and his office at the other to the railway. On the other hand, the tramcar passes his door, or goes close to it. There is no necessity to catch any particular car at any particular moment. He can allow himself some latitude. In London proper he finds himself put down close to where he would be. The populations of great cities have been compared to ants, not inaptly. Ants do not move in batches, so to speak. The tramcars carry men a few at a time and very often. The railways many at a time and seldom. A further serious drawback to railways is that much time is required and inconvenience suffered in getting from the street to the train. A tired City man does not enjoy climbing steep stairs or a five minutes' walk inside a huge station to his train. In all cases it is a distinct advantage to have the suburban train as near the street as it can be got. It is impossible to overrate the value of accessibility. The tubes could have no commercial existence at all were it not for lifts.

We have referred above to lack of punctuality. Now there are real and pseudo-punctualities. A train is timed to arrive at a terminus at a stated hour. It is late; that is true unpunctuality. But, again, it arrives outside the station before it is due, and stops there; that is pseudo-unpunctuality. There is nothing to which the suburban passenger objects more strongly than to be kept waiting just outside a terminus. If we study the question with a little care we shall find that suburban unpunctuality is almost always terminal. The train cannot get out of London Bridge, let us say, or into Victoria. In clear weather there is no trouble along the line. If we examine further, it will be found that the delay is for the most part due to the way in which the roads are laid out. There are, for example, three platforms. The trains from a fourth have to cross in front of all three in getting out of the terminus, and all three are blocked both for incoming or outgoing trains by the fourth. The multiplicity of docks and platforms is of no use unless adequate access is provided. We hear a great deal about "bottle necks"; but the influence of a "bottle neck" on any particular train is really very short-lived in competent hands. It is not in the bottle neck, but in the maze of lines closer to the terminus that obstacles occur. Three suburban trains at a time may be found waiting to get in, and all detained by a single main line train waiting to get out. The permanent way engineer provides the roads; it is for the traffic manager and the signal staff to decide how they shall be used, and it is difficult to avoid the conclusion that in many cases incompetence is manifest in the sense that the most is not made of provided facilities.

We have said nothing about the electrification of lines so far. We doubt, however, that the running of local steam and electrical trains on the same lines can be commercially successful. But there is no room to doubt that electrical trains will not find that favour with the public which is desirable, unless care is taken that they shall not be kept standing on the line waiting for a chance to get into the terminus. That is, as we have said, in the eyes of the City man, *the* unpardonable offence. The tramcar cannot commit it. Beyond all question the traffic on some lines is worked with much more punctuality than it is on others. To secure this result much skill is required, and very special knowledge of what can and cannot be done. Excessive caution is no doubt manifest in many instances; but it is only too often an evidence of cowardice or indolence, rather than of true care for the lives and limbs of passengers. To keep a train waiting outside a station for another a quarter of an hour late, whose position is perfectly well known, is not consistent with ability on the part of the traffic manager and his staff.

Sand in Concrete.

SOME interesting statements regarding the use of sand in concrete were made in the paper on "Reinforced Concrete" read by Mr. Arthur C. Auden before the Institution of Mechanical Engineers at its recent meeting in Liverpool, and in the discussion upon this paper. There is a consensus of opinion that sand is an absolute necessity for the production of the best concrete. Moreover, nothing which is quite so good as natural sand has hitherto been discovered. Man may attempt by pulverising rocks, and by screening and washing the product, to produce a substitute, but he is not so successful as Nature. In what the difference lies it would be hard to say; nor is it quite clear in every instance why some sands give better results than others; nor, again, why some sands, which give results not so good as others, when tested soon after the cement has set, give better results than the others when the concrete is older. It is quite evident that we do not know all, or anything like all, there is to know about this material. Mr. Auden, in his paper, stated that sand "must not 'bind,' that is, retain any shape when compressed, and it must be incapable of being smoothed with a trowel to a bright surface, or of 'standing up' by itself when cut by a shovel." All these, he remarked, are rough-and-ready ways of "ascertaining that the sand has what is required, namely, large sharp grains." There are, however, a good many engineers, probably a majority of them, who will aver that a variation in the size of the sand particles is a necessity in order to obtain the best results. Some authorities state that extremely fine sand can be used alone, but that it gives a weaker result than either coarse sand alone, or a mixture of coarse and fine sand. Then again, what is a "sharp" sand? Mr. Priest, when discussing Mr. Auden's paper, remarked that though he had been using the term in his specifications for a quarter of a century, he was bound to say that he really did not know what it meant. He used to be under the impression that "sharp" sand when viewed under the microscope would look like broken granite; but there was probably no such thing as sand of that quality, as it all consisted of rounded grains. This lack of accurate knowledge has probably in the past led to much unnecessary expenditure; special sand from a particular district, which can only be procured by the payment of heavy carriage rates, being insisted upon, when a local material would have answered the purpose just as well.

Perhaps the point on which there is the greatest divergence of opinion is the cleanness of the sand. Probably 999 specifications out of a thousand will stipulate that the sand must be clean—many that it must be washed. This is the case not only in this country but abroad. The following is quoted from a well-known American Treatise on Concrete:—"The sand should be clean. One may obtain some idea of its cleanliness by placing it in the palm of one hand and rubbing it with the fingers of the other. If the sand is dirty it will discolour the palm. If the use of dirty sand is unavoidable, its effect upon the strength of the mortar should be investigated." Clearly a loss of strength is anticipated. Yet what does Mr. Auden say? He agrees that dirt in the form of slime, mud, or vegetable refuse is distinctly bad, but "a little loam, enough to soil the fingers when lightly rubbing the sand between them, but not enough to make the sand adhere to them, is no detriment." He even states that small particles or nodules of clay do not appear to affect the strength of the concrete provided they are very small both in themselves and in number. Here, then, we have two absolutely divergent statements. In one case the sand must not dirty the hands; in another it may do so, and may even contain minute pieces of clay. This question has of recent years attracted some little attention from investigators. One authority states that an amount of clayey matter up to about 12 per cent. does no harm, but may even be beneficial. Mr. Priest, however, in continuing the discussion already referred to, went a good deal farther than this. He pointed out that in his experience sand containing 15 per cent. of loam gave a result 20 per cent. better than a sand which had been washed free from loam. It was not, he explained, till an adulteration of 22 per cent. of loam had been reached that deleterious results were experienced. There are many who would absolutely forbid such, or anything approaching such a percentage of adulteration.

The matter is of no little importance both from the point of view of the engineer and of the contractor. It is eminently desirable on the one hand to spend as little as possible on constructive works, due regard being had to their safety and permanency; yet it would be a most dangerous policy to state that sand with 20 per cent. adulteration might be permitted under all circumstances. Mr. Priest spoke of the additional ingredient as loam, and loam has a fairly wide meaning. It would be quite reasonable to imagine that the loam of one district might act as Mr. Priest has described, while that from another part of the country might have an entirely different effect. Hence we are by no means inclined to endorse without qualification the statement which Mr. Priest is reported to have made, that "it was almost safe to assume that the strength of the combination increased with the amount of dirt in the sand." The engineer has too much responsibility to take such a step as this headlong. While we are quite ready to believe that Mr. Priest obtained the results he mentioned, we are emphatically against the wholesale permission of adulterants till more is known on the subject. There is a great deal of information available regarding the behaviour of concrete in which clean sand has been used; there is but little knowledge regarding the lasting qualities of concrete made with dirty sand. Still, as we have said, there are occasions on which local and possibly dirty material might be used instead of clean sand carried from a distance, and thereby a saving in money brought about. Hence, it would seem most advisable that really trustworthy investigations should be carried out as regards the effect for good or ill of dirt in the sand. It has been suggested that the committee undertaking the consideration of reinforced concrete on behalf of the Institution of Civil Engineers should go thoroughly into the question, and this proposal appears to us to be excellent.

MATTHEW BOULTON.

ON the 17th August, 1809, Matthew Boulton died, aged eighty-one. As the partner of James Watt his name has been immortalised, and we are glad to hear that very recently Birmingham has proposed that something shall be done in the way of honouring his name. He was buried in Handsworth Church, in which is a mural monument designed by Flaxman, and bearing an inscription in the composition of which Watt assisted. Various proposals have been made, among which may be named the following:—(1) The erection in front of the Handsworth Council House of a statue of Boulton, possibly to be followed in later years by statues of Watt and Murdock. (2) The establishment of a scholarship in mechanical engineering for the Handsworth Technical School to the Birmingham University. (3) The acquisition of land at Handsworth between the "Cricks" and the corner of Villa-road for the purpose of constructing a Boulton-square.

Matthew Boulton was the son of fairly well-to-do parents, and when thirty-four he married a lady with a good deal of property. He had taken much interest in light metal work, and not long after his marriage he spent £20,000 on the Soho works, and became one of the largest button makers in the world. It was a highly protected industry, and Boulton flourished.

In 1769 Watt took out a patent with Dr. Roebuck, of the Carron Ironworks. Roebuck was to have two-thirds of the profits. This first patent contains all that is essential to the steam engine of to-day—the separate condenser, the steam jacket, and expansive working. He began his first real steam engine with an 18in. cylinder, and encountered tremendous difficulties in its construction because of bad workmanship. About this time Roebuck lost much money, and sold his share to Boulton. After some trouble a special Act of Parliament was passed, and Watt's patent was extended from 1769 to 1794. Boulton was a man of considerable scientific attainments, and he had unlimited faith in James Watt, and, we may add, in Murdock, who was Watt's right-hand man. Machine tools were constructed such as had never been seen before; and the world possessed the steam engine. Very complete illustrations and a detailed description of the Old Soho Works, just before it came into possession of Messrs. Avery, will be found in THE ENGINEER, Vol. lxxx., 1895. The Soho Foundry stood on the bank of the Birmingham Canal, about one mile from Old Soho. It was begun in 1775, and was started on January 28th, 1776. A banquet was given by Boulton, who in an appropriate address exhorted his men to live industriously and frugally. Boulton sunk about £40,000 in Soho before any profit was earned. But things came right in the end, and the firm received the reward of their labours. A very moderate reward if it is compared with the value of the work accomplished. It does not appear that Boulton was in any sense an inventor, at least as far as steam machinery was concerned. None the less was his aid essential to Watt; and it is clear that he was a man of large mind and strong faith. Probably, in the first instance, neither he nor Watt had any definite idea of the part steam was going to play in the life of the world. They both lived long enough, however, to get at least a glimmering of the true character and importance of what they had done. In many ways Watt was incompetent as a commercial man—probably a fortunate circumstance. There was much rivalry, and many actions for infringements had to be fought; but Boulton had right on his side, and he knew how to make proper use of that great fact. It is regrettable that the last years of his life were years of suffering due to a painful and incurable disease. We trust that Birmingham will pay a proper tribute to the memory of a man whose life work specially contributed to the prosperity of the city and the surrounding district.

We reproduce from THE ENGINEER for October 4th, 1895, the statement of dates at the end of the article, which dates are believed to be accurate. Some doubt exists, however, as to the earliest developments at Soho for making steam engines. The metal works were there, and to these the engine works were apparently added, and subsequently the coining mill. For detailed information we must refer our readers to the series of illustrated articles on the Soho Foundry, which began in THE ENGINEER for September 27th, 1895. We can confidently recommend the study of these articles to our younger readers. As examples of early machine tool construction they are full of interest and information.

1728 ... Matthew Boulton born
1736 ... James Watt born
1741 ... A lease granted to Messrs. Ruston and Evans to construct a pool
1762 ... Mr. Boulton purchased the lease and mill, and enlarged the rolling mill
1764 ... Foundation of silver and plated metal factory constructed
1765 ... Factory completed
1745 ... Boulton invented inlaid buttons and chains
1754 ... Murdock born
1769 ... Watt's first patent
1778 ... Mill erected for coining copper money
1779 ... Murdock called at Soho in search of work

OBITUARY.

HUGH ERAT HARRISON.

WE regret to have to announce that Mr. Hugh Erat Harrison, the Principal of the Faraday House Electrical Standardising, Testing, and Training Institution, died on Thursday, the 12th inst.

Mr. Harrison was born at Westminster, on April 23rd, 1859, and was educated at University College School. He matriculated in 1876, and entered University College, where he gained a Clothworkers' Exhibition in Chemistry and Physics in 1877. He studied for a short time in Paris, and subsequently took took his degree in 1880 with Honours in Experimental Physics. In the following year he entered the service of the Anglo-American Brush Company, now the Brush Electrical Engineering Company, Limited, and subsequently became managing engineer of the Sheffield branch of the Hammond Electric Light and Power Company, Limited.

In 1882 Mr. Harrison organised and became principal of this company's Electrical Engineering College in Red Lion-square, London, and when it was closed in 1885 he became a partner in the firm of Phillips, Harrison and Hart. On retiring from this firm he was appointed clerk to the Research Committee of the Institution of Mechanical Engineers, but it was in 1889 that he carried out the work with which his memory will be associated, viz., the organisation and foundation of the Electrical Standardising, Testing, and Training Institution, Faraday House, London, of which he was principal at the time of his death. He drew up the scheme of studies himself, and to the close of last term lectured to the students on electrical engineering. In addition he organised the testing department and superintended its work, and in connection with this he was appointed Board of Trade Electrical Inspector for Croydon, Tunbridge Wells, Ealing, Wimbledon, Chatham, Godalming, and Clacton. From 1887–1901 he was Assistant Examiner in Magnetism and Electricity to the Board of Education, and he was one of the delegates sent by the Institution of Electrical Engineers to attend the International Electrical Congress held at St. Louis in 1904.

Mr. Harrison at one time contributed largely to the technical Press, and we may mention as articles coming from his pen those entitled "The Principles of Alternate Current Measurement," "Notes on Electrostatics Treated Opsigraphically," and "Electricity, Magnetism, and Electricity Supply." He also wrote two small text books for the pupils of Faraday House, one upon "Graphics" and another on "Armatures"—first part—and was engaged in the preparation of the second part of this latter at the time of his decease. He specialised very considerably in alternate current work and carried out some good work in this direction. He was elected a Member of the Council of the Institution of Electrical Engineers in 1906.

Mr. Harrison was a man of wide reading with well-balanced mind and singularly clear judgment. He was, however, reserved almost to shyness and shrank instinctively from anything approaching publicity. Nervous to a degree and highly sensitive, he was nevertheless possessed of great tenacity of purpose and strength of will, and those with whom he happened to come into active opposition were often astonished at the force he disclosed. He was an associate member of the Institution of Civil Engineers, and a Fellow of the Chemical Society.

WILLIAM FORD STANLEY.

THE death is announced of Mr. W. F. Stanley, who, although not himself actually an engineer, has done much for the advancement of the profession. Mr. Stanley had been in failing health, and some time ago gave up active control of the business which he founded fifty-five years ago. Always characterised by ingenuity and indomitable perseverance, he, in the early fifties, commenced business in partnership with his cousin. His father, under whom he received his early training in the mechanical arts, was an engineer, and in the early part of last century was identified with the construction of heavy weighing machinery, his ideas in this direction being still embodied in apparatus of this class manufactured at the present time.

In 1856, two years after starting in business, Mr. Stanley invented the simple form of stereoscope, which for a number of years had a large sale, and helped thereby to establish the young firm as a financial success. He later on turned his attention to improving the design and construction of mathematical instruments, the well-known bolt for holding the needle points of compasses, &c., being one of his earliest patents. In addition to the manufacture of superior drawing instruments, the making of surveying instruments was then undertaken, the firm becoming Government contractors and acquiring a world-wide reputation for satisfactory work.

Mr. Stanley, who was a Fellow of the Geological and Royal Astronomical Societies, invented in his later years the circular and logarithmic dividing engines, and wrote on many scientific subjects. Among the latter we may mention his works on fluids and the nebular hypothesis. Always keenly interested in educational matters, Mr. Stanley devoted a large share of his life to the encouragement of technical education and trade schools, and the Stanley Institute, which is the outcome of his ideas, has attracted considerable attention from education authorities. His death, which occurred last Saturday, at his home in South Norwood, will be keenly felt in the district, in the progress of which he had always taken an active interest, promoting its welfare by every means in his power. Mr. Stanley was in his eighty-second year.

LITERATURE.

Les Poussières de Houille. Par M. J. Daniel, Ingénieur des Arts et Manufactures, Docteur Special en Exploitation des Mines. Paris: Dunod et Pinat. 1909.

THIS is a large octavo pamphlet of 73 pages and an index, illustrated by 25 engravings. It is in effect an extract from the *Annales des Mines* for February last. A great deal has been written, and yet more said, about dust in coal mines as a cause of explosion. We have here collected in a very succinct form most of the essential information which exists concerning what is still a very obscure question. Dr. Daniel begins by referring to the "Proceedings" of the Royal Commission on Mines since 1891. He points out that the real problem is not whether dust can or cannot play the part of an explosive, but the degree in which it is mischievous. In France, at all events, this has been greatly under-estimated, and it was not until the dreadful catastrophe at Courriers occurred on the 10th of March, 1906, when 1009 men were killed and 6½ miles of galleries were wrecked that proper consideration was given to the part played by dust. M. Heurteau published a report on this explosion, in which he arrives at the conclusion that even in non-fiery mines the dust may be as dangerous as gas. So far all is plain sailing. When we push our inquiries, however, we find that difficult questions are involved; that there is no complete knowledge as to how dust explodes, or why it explodes, and what precautions can be taken to prevent such explosions. Before we have done it will be seen that highly promising schemes are complete failures, because they introduce evils incompatible with the working of coal mines on a commercial basis.

As to the lack of knowledge which prevails, Dr. Daniel gives examples, of which one will suffice. In 1893 Mr. Henry Hall carried out a series of experiments, numbering in all 129, with dust found in Somersetshire mines. As he could not obtain an explosion he pronounced these mines safe. But three explosions near Radstock—occurring at Camerton in November, 1893; Timsbury, February, 1895; and Norton Hill, April, 1908—flatly contradicted these conclusions; and it seems to be admitted that it is not possible to decide from a mere examination or trial of the dust whether it is or is not explosive. It is not at all necessary that dangerous dust should be coal dust. Thus the "stive" produced in flour mills is dreadfully dangerous. The phenomena are those of extremely rapid oxidation, brought about by the great superficial area of each molecule as compared with its weight. Cast iron filings sprinkled through a gas jet catch fire and burn with extreme brilliance. Pure iron reduced to an impalpable powder becomes brightly incandescent if air is permitted access. Ostensibly, the finer the coal dust is the more likely is it to explode; but even this is not certain. One point deserves more attention than it has yet received, namely, the part played by detonation. It is possible that whereas no explosion would be produced in a dust-laden atmosphere by a naked light, the firing of a detonating fuse might cause one.

Our author considers in elaborate detail the measures of prevention which have been tried with more or less success in different mines and various districts. These may be classified under three heads—the prevention of the distribution of dust; the removal of its explosive qualities; and its collection. That dust will be produced in the face of the workings while the coal is coming down goes without saying, but there it is not very dangerous. It is the distribution of dust all along the galleries, roadways, and up the shaft that is so perilous. To prevent this the corves, tubs, or wagons should be dust-tight, and half a dozen different methods of construction are illustrated. The screening of coal produces much dust, very fine and very inflammable. Dr. Daniel illustrates several installations for filtering the air and collecting this dust. Screening plants ought always to be at a good distance from the shaft.

At first sight it would seem that the simplest and best of all devices consists in watering the roads and the workings. This method is practised very largely, but it is by no means so satisfactory as might be thought. Our author goes fully into the reason why. One of the most remarkable is the effect produced sometimes by spray in the workings. Several illustrations are given. Thus, at Altofts, at a depth of about 500 yards, a gallery, 5ft. 6in. high and 7ft. wide, had required no repairs for three years. Spraying was introduced, and in half an hour heavy falls took place because of the crumbling of the side walls. In another case four out of five heavy traverses came down about an hour and a-half after the spray was put on. Another drawback is that at great depths the temperature is high, and becomes unendurable unless the air is quite dry. According to Dubois-Reymond a temperature of 104 deg. Fah. would be incompatible with existence unless the air was dry. When it is, a temperature of 122 deg. Fah. is endurable. In damp air the men can only do less work. Horses are more susceptible than men to high temperatures.

The conclusions of the author are summarised at the end of the pamphlet. They deal with the formation of dust, transport, screening, and coal cutting. Under a second heading we have the ignition of dust and the nature of explosives used in blasting, and the precautions to be taken with them. Lastly, we have the propagation of explosions, concerning which we give the author's own words:—

> La seule manière de pouvoir lutter avec succès contre la poussière consiste dans sa suppression et non dans sa neutralisation, que celle-ci soit basée sur l'action de l'eau (arrosage), sur l'addition de poussières incombustibles ou de sels hygroscopiques. Ces divers procédés présentent des inconvénients multiples. Leur efficacité est d'ailleurs aléatoire et leur action essentiellement temporaire. En somme, il convient de traiter la poussière de la même manière que le grisou, s'inspirant de ce principe : où il y a de la poussière, il y a du danger.

It is, perhaps, to be taken for granted that all mining students, and even a considerable percentage of mining engineers, are quite familiar with the problem of coal dust. But, even if this is true, they will still have in this little work a book of reference which they will find useful. All men practically engaged in coal mining will find collected in a compact form in its pages information which would have to be sought for elsewhere in a somewhat extended literature. Concentrated information is a very welcome thing to the busy professional man. In this case the concentration has been exceedingly well done.

SHORT NOTICES.

Motors and Motoring. By Professor H. J. Spooner. London; T. C. and E. C. Jack. Price 2s. net.—This is a new edition of Professor Spooner's earlier work, but it has been considerably revised and enlarged, and will be found even more useful than his earlier work to many non-technical owners and their chauffeurs. The drawings are clear, while the explanations given of the more complicated parts of the mechanism of a motor car and the various underlying scientific processes are stated concisely and clearly, an absence of unexplained technical terms being noticeable throughout the book.

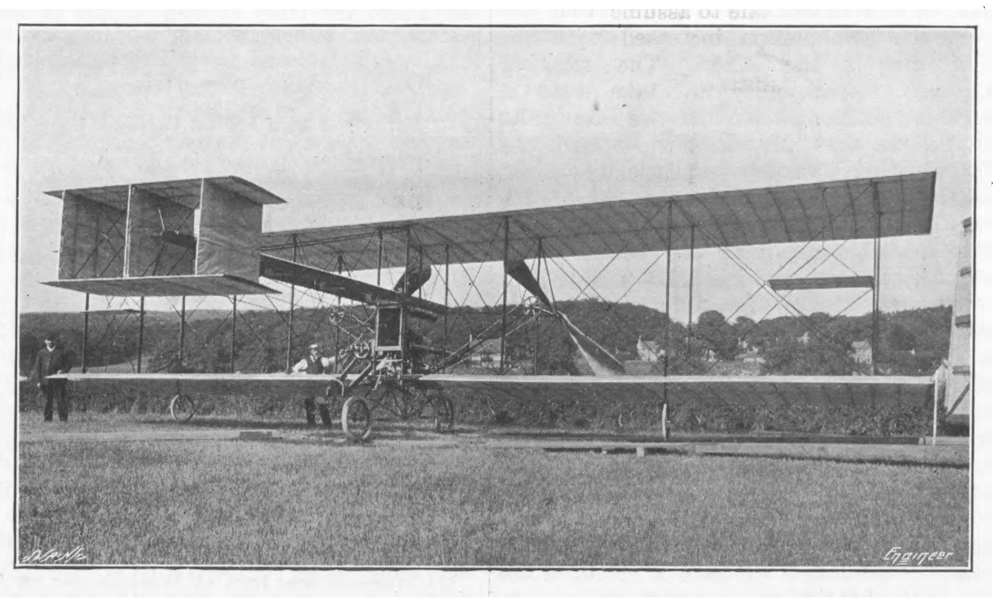
Bamboo for Papermaking. By R. W. Sindall, F.C.S. London: Marchaut, Singer and Co. Price 2s.—The idea of the utilisation of bamboo fibre for paper manufacture is no new one; as long ago as 1875 Mr. Thomas Routledge published a pamphlet dealing with the subject, while for many centuries hand-made paper in the East has been made from this material. Recently renewed attention has been devoted to the subject as a result of the likelihood of a wood-pulp famine, and the present volume is an outcome of some inquiries and experiments made by its author in Burma during 1905 at the instigation of the Indian Government. His investigations are here recounted, and will be found to be thoroughly scientific and convincing. The paper on which this little book is printed was made in this country from some bamboo fibre, and appears to us to be quite satisfactory, taking printed matter and block illustrations in a manner equal to the ordinary paper used in printing.

The Volcanic Origin of Coal and Modern Geological Theories. By Col. A. T. Fraser. London: Robert Banks and Son. Price 6s. net.—The author of this pamphlet undertakes in seventeen pages to propound an entirely new theory regarding the formation of the world's coal measures. Basing his arguments on an inspection of some stratified rocks in Java and elsewhere, which closely resemble red sandstone shale and conglomerate, but which, he states, are clearly of volcanic origin, he proceeds, without stating the intermediate steps of his reasoning, to enunciate the theory that we owe our supplies of coal to a period in the earth's history when volcanoes erupted bitumen and spread it over the land, enveloping the flora and fauna of the time being. He then elaborates this idea, and revolutionises accepted notions on the subject by accounting for the deposition of many sedimentary rocks, including marble, in a similar fashion.

The Law Affecting Engineers. By W. Valentine Ball, M.A. London: Archibald Constable and Co., Limited. Price 10s. 6d. net.—The author of this volume admits in his preface that to write on the subject of the law as it relates to engineers is no easy task. Unlike solicitors and medical practitioners, who are responsible for their actions to the Incorporated Law Society and the General Medical Council respectively, the engineer is more or less free from the control of a governing body. Hence a difficulty arises in dealing with questions which require a definition of the professional duty of an engineer. In this work, however, the author has in his earlier chapters brought together a considerable quantity of information, and quotes precedents for various decisions dealing with such matters as the status of an engineer, his fees, and his employment. He further deals with the vexed question of the duty and behaviour of an engineer when called as an expert witness. The remaining chapters are devoted to a discussion of the legal aspect of contracts, tenders, specifications, arbitrations, &c. An index in which the various items are grouped under common headings, and an appendix exhibiting suitable forms to be used for tenders, specifications, &c., will be found to add to the utility of the volume.

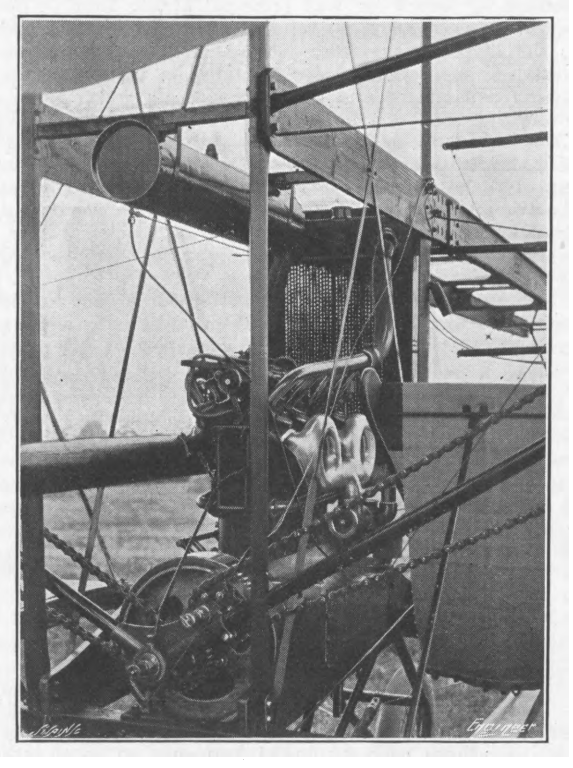
The Calculus and its Applications. By R. G. Blaine. London: A. Constable and Co., Limited. Price 4s. 6d. net. —It is intended that this book should be of assistance to students who wish to acquire an elementary working knowledge of the calculus and its applications. Being designed principally for the use of engineers, the author draws his examples largely from questions of a really practical engineering character, and makes good use of graphical methods. The differential calculus is treated in the first twelve chapters, and is carried as far as Taylor's theorem, considerable space being devoted to the subject of maxima and minima. In the following nine chapters the integral calculus is introduced, while the last three are devoted to the discussion of some simple differential equations, to Fourier's theorem and other matter. We notice that the author has a few remarks to make on the nature of the "practical" problems to be found in so many text-books, and are glad to see him exposing the solution among others of the problem dealing with the flow of water over rectangular notches, which is usually wrongly given in most text-books. The method of dealing with this as suggested by Professor James Thomson's theorem of similar flows might be introduced with advantage as showing the value of methods other than those of the calculus.

THE BAMWELL AEROPLANE



A SCOTTISH AEROPLANE.

PRIVATE enterprise in the Glasgow district has recently been directed to the construction and testing of a new aëroplane. The experimenters, Messrs. F. S. and R. H. Bamwell, whose father was works manager to one of the largest shipbuilding firms on the Clyde, are directors of a motor engineering firm in Stirling, and have, therefore, every opportunity of carrying out their experiments on a scientific basis. Recognising the importance of high-efficiency propellers, they devised a special testing plant to ascertain the best proportions, pitch, &c. Their first experiments were with a monoplane, but they abandoned this type for the bi-plane, and their present machine is on modified Wright lines. The engraving gives an idea of the general structure of the machine, the main aërofoils of which are 48ft. long by 8ft. in width, placed 7ft. 6in. apart. The planes are of the double skin type, the upper and lower surfaces of oil-proofed silk being attached to fore and aft lattice girder frames, which are in turn strung on two main transverse members. These planes are concave on their undersides, and on the Phillips' principle, the depth of camber being about 3in. The wooden struts between the planes are of torpedo section, and the tension stays are of steel strip in order to reduce wind resistance. The machine is carried on two strongly-built central wheels in line, and smaller castor-mounted wheels about half-way along either side of the bottom plane are fitted to prevent the aërofoil from touching the ground. In order to avoid damage to the frame due to shock on alighting the wheels are all spring mounted. The engine employed is a Humber of the Tourist Trophy type, giving 25.6 horse-power by the Royal Automobile Club rating, although the actual power developed is considerably more. The four cylinders have a bore and stroke of 4in. by 6in., and the weight complete is about 460 lb. The valves are of the inverted type set at an angle in the cylinder head, the cooling being on the thermo-syphon principle. From the engine two chain drives are taken, reversal of direction being obtained by means of pinions on the crank shaft. The chains drive two double-bladed propellers of 10ft. diameter and 10ft. pitch, made by the experimenters in their own shops from yellow pine on the lines recommended by Sir Hiram Maxim in his "Natural and Artificial Flight." Each propeller weighs 20 lb., and on a test with the machine stationary a thrust of slightly over 300 lb. was obtained from them. The control of the machine in both horizontal and vertical directions is effected by the cellular aërofoil structure mounted on a form of gimbal and the fore end of a boom projecting in front of the machine. Small warping planes are mounted between the extremities of the main aërofoils which together with the steering device are controlled from a single wheel.



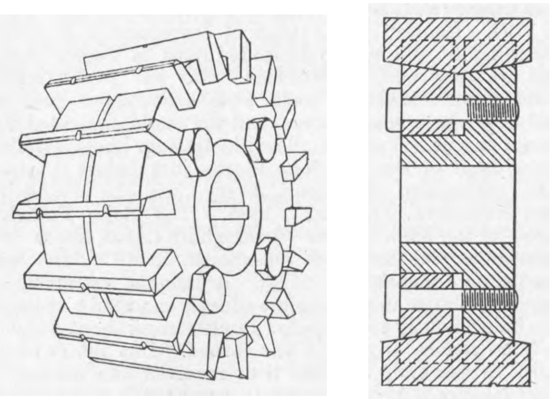
THE ENGINE OF THE AEROPLANE

The weight of the entire aëroplane with water and petrol, and without the aëronaut, amounts to 14 cwt. With the operator the weight carried by the supporting surfaces is about 2·8 lb. per square foot, a good figure for this type of machine, although much lower than the figure obtained with the Blériot monoplane.

A recent trial showed, we understand, that the machine was properly balanced, and that a greater degree of skill and experience on the part of the aëronauts alone was necessary to make sustained flights attainable. A speed of 40 miles an hour was reached at the end of a 100 yards run, and the machine rose quickly when the front planes were elevated. Not caring to risk too great an elevation on the first attempt, the aëronaut deflected the planes and the control was more sensitive than he foresaw, and the forward ceels touched the ground before a recovery could be made, injuring the boom, so that the main planes came into contact with the earth. The operator was bruised, and the machine somewhat damaged, but the brief flight had demonstrated the speed and easy rising properties of the machine, despite its heavy weight. Further trials are to be made as soon as the necessary repairs are effected.

A NEW FORM OF INSERTED TOOTH MILLING CUTTER.

A MILLING cutter which is now being manufactured by M. Eadon and Sons, Limited, of Sheffield, and is illustrated below, has recently been patented by Mr. J. H. Barker, of Sheffield. The construction of the cutter is simple, and can be understood readily by reference to the figure. The body of the cutter is made of cast iron or other inexpensive material, and is formed in two parts or discs, one of which is bored to fit the machine mandril, and is provided with a collar which fits into a corresponding hole in the other disc. These two parts are held together, and adjusted either by the screws shown in the figure or by a central nut on the mandril, which in this case is provided with a collar against which the cutter abuts. On the edges of these discs slots are cut, having their axes either at right angles to the faces, or inclined to them. These slots are dovetailed in shape, and are cut deeper on the inner face of both discs, as shown in the engraving, teeth of corresponding shape being supplied to fit into the slots. To insert the teeth the body portion is taken apart and the teeth inserted in the slots in one-half; the other half is then readily slipped on. The teeth are thus held firmly in position by tightening the screws provided.



INSERTED TOOTH MILLING CUTTER

We are informed that a test recently carried out with one of these cutters working on chilled cast iron at a speed of 100ft. per minute, and with a feed of 1in. per minute, showed that it was capable of removing 5 cwt. of stock in ten hours, the condition of the cutter at the end of the test being described as "good." Among other advantages the makers claim for this cutter that its diameter remains practically constant, and that the teeth are interchangeable and easily replaceable by unskilled labour.

SMALL OIL ENGINE

CAPEL AND CO., LONDON, ENGINEERS

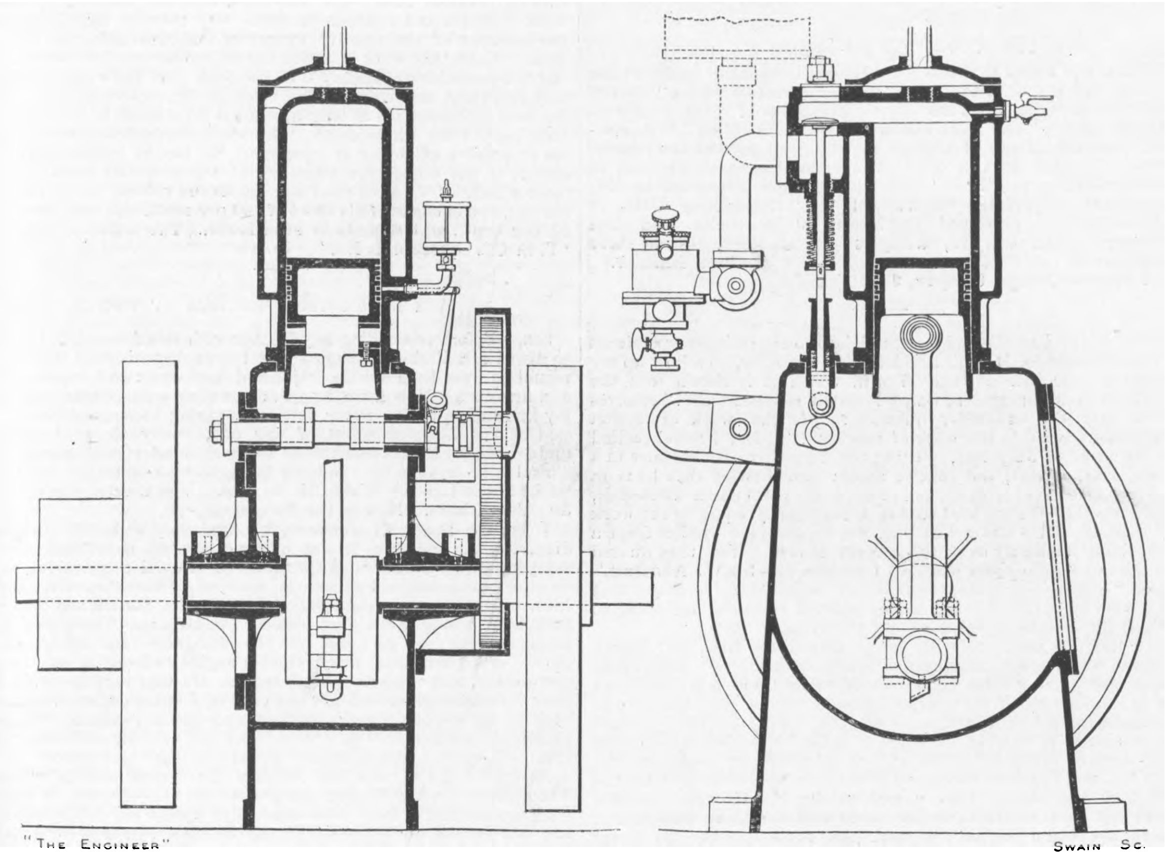


Fig. 1

SMALL OIL ENGINE ELECTRIC LIGHTING SETS.

THE popularity which attended the introduction of the combined small oil engine and dynamo for electric lighting led many firms to turn their attention to this class of plant. Amongst the pioneers may be mentioned Capel and Co., of 168, Dalston-lane, N.E., which firm has for some time past been paying special attention to this question. We recently had an opportunity of seeing one of the latest of this firm's sets at work, and on this occasion a carburetter was being used which has been giving good results. In fact, it may be said that this vaporiser is the chief feature of the plant, for the design of the engine follows the ordinary practice for this class of work, as will be seen from the accompanying engraving. The engines are made in different sizes, ranging from 3 to 7 kilowatt capacity. They have vertical cylinders, and run at the comparatively slow speed of 700 revolutions per minute. The plant illustrated in Figs. 1, 2, and 3, is of 3 kilowatt capacity. The engine has a cylinder 5in. in diameter by 6½in. stroke, and it is coupled direct, without the intermediary of a flexible coupling, to a shunt-wound dynamo. The valves, which are both mechanically operated, are placed on the same side of the cylinder. They are made of nickel steel, and are of large diameter. They are so fitted into the cylinder that, in order to withdraw them for inspection purposes or re-grinding, it is only necessary to unscrew one nut, an operation which requires very little time. Other features of the engine details include two balanced fly-wheels, and a balanced crank made of Siemens-Martin steel, cut out of the solid and finished all over. Specially large bearings have been provided, which for this class of work are not so frequently adopted as they should be. Splash lubrication is employed, and sight-feed lubricators are fitted for oiling the cylinder and gudgeon pin. A low-tension magneto is employed for ignition, with hardened steel make-and-break contacts, the rocking lever forming one of the contacts being operated by a lever worked from the half-speed shaft. For regulating the speed an ordinary ball governor which operates the throttle is used, and an extra spring is employed on the throttle spindle, which permits of small variations in speed being made without having to go to the tedium of altering the governor. All this spring does is to allow the throttle to be opened or closed more for the same throw of the governor balls. The cylinders are, as usual, water-jacketed, and the thermo-siphon system of cooling is employed.

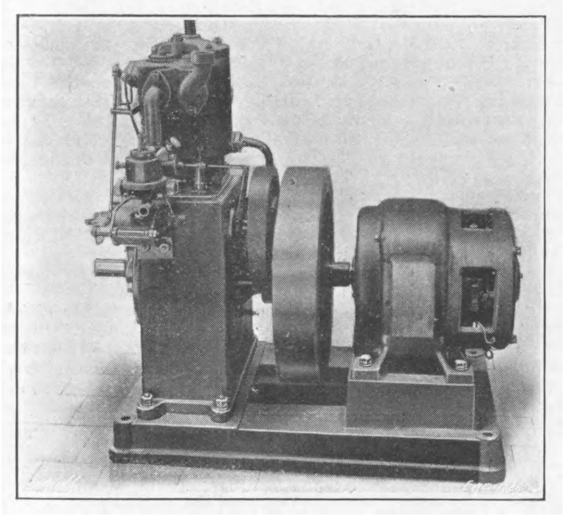


Fig. 2—3-KILOWATT LIGHTING SET

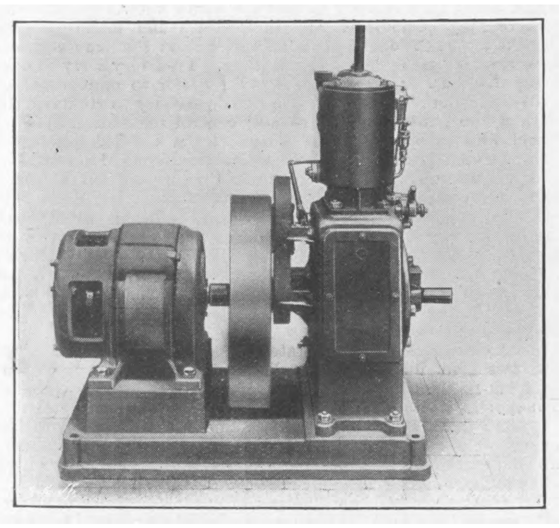
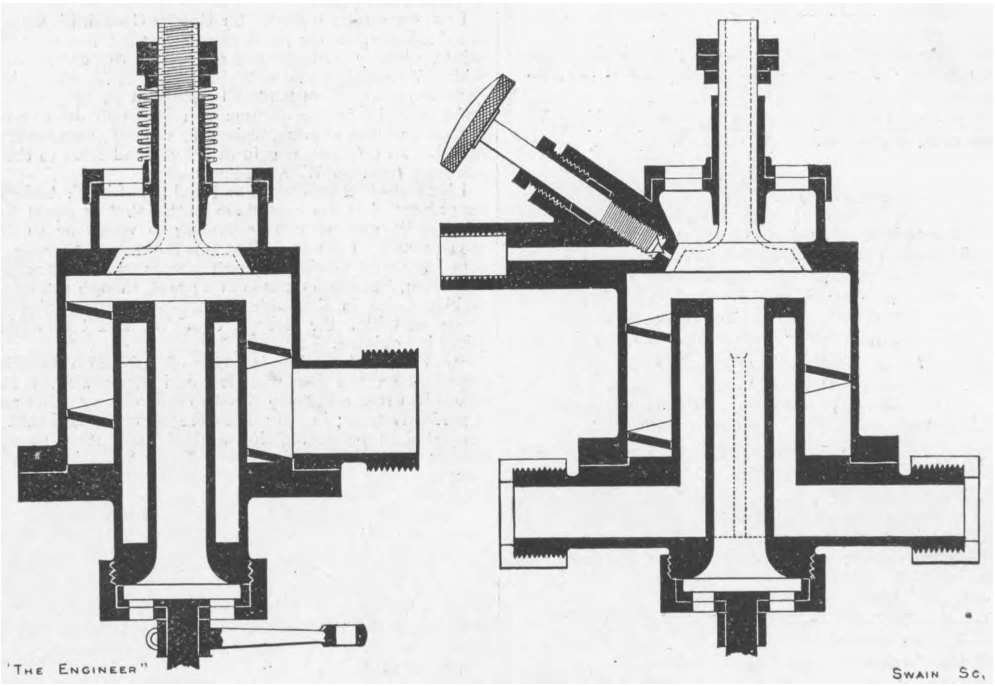


Fig. 3—3-KILOWATT LIGHTING SET



THE CAPEL CARBURETTER

Undoubtedly the most interesting part of the plant is the very ingenious carburetter. This we illustrate in Fig. 4, and from this engraving the chief features of the vaporiser will be gathered. It consists of a spring-loaded lift valve which is opened by the suction of the engine. The valve has a broad face, to the centre of which the petrol supply is brought, so that when the valve is closed both fuel and air are simultaneously shut off. Upon the valve being opened by the suction of the engine, the fuel is drawn in through a small jet in the face of the valve seat in the form of a fine spray; at the same time air is also drawn in through the louvre plate above the valve seat. The mixture enters the chamber below the seat, and is made to take a spiral course through the body of the carburetter. The spiral in the interior of the carburetter serves to atomise the fuel as it impinges upon it, so that the air and fuel are thoroughly mixed before being admitted to the engine. In this way it is claimed that a perfect mixture is obtained. Provision is made for taking in additional air by a tap in the bottom of the carburetter; the air passes through a central tube and enters the carburetter below the valve, thus being thoroughly mixed with the essence, which is admitted by the carburetter valve. A spiral groove surrounds a central tube, through which part of the exhaust gases may be led if desired, and in cases when the engine is working in exposed places this is desirable. It prevents, so we were told, all tendency to freeze, and not only heats the mixture, but also the additional air. In cases where heavier fuels are used it is essential, and it will be found that the carburetter will work well on any fuel having flash points up to 120 deg. Fah.

The carburetter automatically regulates the proportion of fuel and air to the speed of the motor; consequently, when the carburetter has once been adjusted for the engine on which it is intended to run, it requires no further regulation. The lift of the valve of the carburetter varies with different engines, but is usually about $\frac{3}{16}$in. to ¼in. This lift of the valve is important, as it determines the proportion of air and fuel admitted. A thumb-screw is provided for adjusting the size of jet, and the position giving the best results may be readily found while the engine is running, after which it is not necessary or desirable to alter it.

The louvre plate at the top of the carburetter is usually kept full open, and the proper mixture found by adjusting the additional air tap at the bottom of the carburetter. A greater suction on the jet may be obtained by partly closing the louvre plate, but if this is found necessary, it is usually because dirt has lodged in the jet of the carburetter, and prevented the free flow of fuel.

We have been supplied by the makers with the following figures regarding the output of the engine with various types of fuel, and also the consumption of petrol and paraffin per brake horse-power per hour. These, no doubt, will be found of interest. Engine 5in. bore by 6½in. stroke, speed 700 revs. per min. L.T. magneto ignition, with variable gear. Capel's patented carburetter. Output on fuels as follows:—

Petrol	4.5	k.w.
Paraffin	3.9	,,
Methylated spirit	3.8	,,
Naphtha	3.8	,,
Gas	5.0	,,

The above outputs are with continuous running. For short periods the outputs have, we are informed, been much greater excepting with gas.

Consumption of petrol	.8 lb.	per B.H.P. per hour.
Consumption of paraffin ..	.89 lb.	,, ,,

RHEIMS AERONAUTICAL MEETING.

FROM August 22nd to 29th a meeting will be held at Rheims at which aëroplanes and balloons, dirigible and otherwise, will be tested in competition.

Up to the present thirty-eight aëroplanes, representing the latest ideas of all the better known aëronauts, have been entered for the meeting, which will provide every facility for a fair trial of the various methods of flight. Prizes aggregating in value to more than £8000 will be offered. Among the various awards to be given the following are the most noteworthy:—A prize for the longest uninterrupted flight; one for the swiftest flight over a distance of 19 miles; two prizes for a passenger-carrying contest; and an altitude competition. The Gordon Bennett Cup will be awarded in a speed competition over 12½ miles, and for this representatives from Britain, France, the United States, Italy, and Austria have entered. The meeting, which, granted favourable weather, should do much for aëronautics, has been arranged by the Aëro Club of France, and will be under the personal patronage of the President of the Republic, the French Premier, and other ministers.

For the purpose in view the site chosen could hardly be improved upon. Situated on the Plain of Bétheny, the track is rectangular in shape, and one lap is 6¼ miles long. It is sheltered by the high ground in the neighbourhood from any disturbing wind, a factor which hitherto has led to many ascents being made in the early morning or late evening, as experience shows that at these periods the wind is less likely to cause trouble than at other times. It is probably in recognition of this that a rule will be imposed whereby no start may be made in a competition before 10 a.m. or later than 7 p.m.

LETTERS TO THE EDITOR.

(*We do not hold ourselves responsible for the opinions of our correspondents.*)

MARINE PROPULSION.

SIR,—With reference to the letter by "Fuse," which appeared in your columns of July 23rd, on "Marine Propulsion," it will appear to many readers that Mr. "Fuse" in writing out his long exposition has got confused in his notions from overlooking some fundamental principles of the science, and it certainly will appear to the younger engineers as if "the very foundations of our faith in dynamics and kinetics are being shaken" by such views.

"Fuse" in his long letter admits that "Time does not interfere, because the time is the same for the gun and the projectile."

The force due to the explosion of the powder acts during a small interval of time upon both the bullet and the gun, that their product is taken as an "impulsive force" acting on those two bodies and giving to each a "change of momentum," that is, impulsive force = change of momentum—

$$F_1 t = M (v_2 - v_1) = m (V_2 - V_1),$$

Where F_1 represents the average or equivalent uniform force acting for t seconds

$F_1 t$ represents the impulsive force in lb.-sec. or units of momentum

M, m represent the masses of gun and bullet respectively

v_1, V_1 represent the initial velocities of gun and bullet respectively

v_2, V_2 represent the final velocities of gun and bullet respectively, after the impulsive force has acted on the bodies.

But the velocity of the bullet and gun was zero to start with, therefore—

$$F_1 t = M v_2 = m V_2,$$

that is, the impulsive force is equal to the momentum developed in each body under the circumstances stated, where the initial velocity of the body is zero.

Hence, we see that the time does not enter into our calculations, since it is the same for the gun and the projectile.

In Sir George Greenhill's article, we are given that the muzzle velocity of the projectile, $V_2 = 3000$ft. per second, also weight of shot $w = 850$ lb., and weight of gun, &c., $W = 50$ tons $= 112{,}000$ lb. To find the velocity of recoil of the gun, v_2

$$F_1 t = M v_2 = m V_2$$

or

$$F_1 t = \frac{W}{g} v_2 = \frac{w}{g} V_2$$

$$i.e., F_1 t = \frac{112{,}000}{g} v_2 = \frac{850}{g} \times 3000. \quad \therefore v_2 = \frac{850 \times 3000 \times g}{g \times 112{,}000}$$
$$= 22 \cdot 7\text{ft. per second.}$$

Since the force ceases to act after the projectile just leaves the nozzle of the gun, then it will appear clear to the readers that the maximum energy stored in the projectile will be at this point, and is in the form of kinetic energy. Kinetic energy of the projectile,

$$E_k = \frac{w V^2_2}{2g} = \frac{850 \times (3000)^2}{2 \times 32}\text{ft.-lb.} = \frac{850 \times (3000)^2}{2 \times 32 \times 2240}$$
$$= 53{,}362 \text{ ft.-tons.}$$

Also,

$$\text{Kinetic energy of gun} = \frac{W v^2_2}{2g} = \frac{50 \times (22 \cdot 7)^2}{2 \times 32} = 402 \cdot 5 \text{ ft.-tons.}$$

As the kinetic energies of the projectile and gun are zero at the start, then the above numerical values represent the "change in kinetic energy" respectively.

$$\text{But, change of kinetic energy} = \left\{\begin{array}{c}\text{Uniform or}\\ \text{average value}\\ \text{of variable}\\ \text{force}\end{array}\right\} \times \left\{\begin{array}{c}\text{Displacement through}\\ \text{which point of applica-}\\ \text{tion of force has taken}\\ \text{place, in its line of action}\end{array}\right\}$$

That is, in the case of projectile—

$$\frac{w V^2_2}{2g} = F_1 \times x,$$

and for the gun, &c.,

$$\frac{W v^2_2}{2g} = F_1 \times y,$$

where x feet is the advance of the shot, and y feet is the recoil of the gun, &c.; also $x + y = l$, the length of the bore of the gun.

$$\therefore \frac{\text{Change in } F_k \text{ of projectile}}{\text{Change in } E_k \text{ of gun, \&c.}} = \frac{\frac{w V^2_2}{2g}}{\frac{W v^2_2}{2g}} = \frac{w V^2_2}{W v^2_2} = \frac{V}{v} = \frac{W}{w},$$

$$\text{since } \frac{W}{g} v = \frac{W}{g} V.$$

or

$$\frac{\text{Change in } E_k \text{ of projectile}}{\text{Change in } E_k \text{ of gun, \&c.}} = \frac{F_1 x}{F_1 y} = \frac{x}{y}.$$

$$\therefore \frac{x}{y} = \frac{V}{v} = \frac{W}{w}$$

But,

$$l = x + y$$

$$l = x + \frac{x w}{W} = x \left(\frac{W + w}{W}\right)$$

$$\therefore x = \left(\frac{W}{W + w}\right) l = \frac{112{,}000 \times 50}{112{,}850} = 49 \cdot 65\text{ft.}$$

$$\text{Similarly,} \quad y = \left(\frac{w}{W + w}\right) l = \frac{850 \times 50}{112{,}850} = 0 \cdot 3768\text{ft.}$$

Substituting the values of x and y in the above formulæ for "the change in kinetic energy" respectively, we will then obtain the numerical value of the average force F_1, due to the explosion of the charge, acting on the base of the shot or on the face of the breech piece.

$$F_1 = \frac{w V^2_2}{2 g x} = \frac{850 \times (3000)^2}{2 \times 32 \times 49 \cdot 65}\text{lb.} = \frac{53.362}{49 \cdot 65} = 1075 \text{ tons}$$

Also—

$$F_1 = \frac{W v^2_2}{2 g y} = \frac{112{,}000 \times (22 \cdot 7)^2}{2 \times 32 \times 0 \cdot 3768}\text{lb.} = \frac{402 \cdot 5}{0 \cdot 3768} = 1068 \text{ tons}$$

which give a percentage error of about 0·6 of 1 per cent., and this may be considered negligible.

Taking the average force F_1, acting through a distance x feet on the projectile, and through a distance y feet on the gun, &c., during an interval of time, t seconds.

Then, average pressure on face of breech-piece or base of shot

$$= \frac{F_1}{\text{Area of base}} = \frac{1068}{\frac{\pi}{4} d^2} = \frac{1068 \times 28}{22 \times 114} \doteq 11 \cdot 92, \text{ or } 12 \text{ tons/sq. in.}$$

Taking the average pressure as one-half of the maximum pressure at instant of explosion, we get—

Max. pressure on base of shot = 2 × average pressure = 24 tons per square inch.

The average velocity of the shot along the bore of the gun—

$$= \frac{x}{t} = \frac{F_1 x}{F_1 t} = \frac{\text{Change in kinetic energy of projectile}}{\text{Change in momentum of projectile}}$$

The average velocity of the shot along the bore of the gun—

$$= \frac{w V^2_2 / 2g}{W v/g} = \frac{V_2}{2} = \text{one-half the final velocity of shot}$$

$$\therefore \text{ time taken, } t = \frac{2x}{V} = \frac{2 \times 49 \cdot 65}{3000} = \frac{1}{30}\text{th of a second, very nearly.}$$

By the law of "Conservation of Energy"—

$$\text{Total energy} = \text{Sum of energy of each part}$$

or,

$$F_1 l = F_1 x + F_1 y$$

$$1068 \times 50 = 1068 \times 49 \cdot 65 + 1068 \times 0 \cdot 3768, \text{ assuming}$$
$$F_1 = 1068 \text{ tons, the lower value}$$
$$1068 \times 50 = 1068 (49 \cdot 65 + 0 \cdot 3768)$$
$$1068 \times 50 = 1068 (50 \cdot 0268)$$

Thus, it is hoped that one of Sir George Greenhill's followers has clearly demonstrated to "Fuse" and all engineers with a "similar train of thought," that the old, old principles of "the conservation of energy" and "the conservation of momentum" in connection with the science of engineering still hold good at the present time as in "the days of old." The writer has much pleasure in recommending to "Fuse" and all engineers interested in this important subject the recent book on "Engineering Units of Measurement," published by Messrs. John Smith and Son (Glasgow), Limited, 195, George-street, Glasgow, where these units are all dealt with.

JOHN RAMSAY.

Technical College, Glasgow, July 27th.

SIR,—May I be allowed, as one of the two original correspondents in this discussion, Mr. W. Preidel being the other, to follow up my letter in your issue of June 25th, in which it is shown that the question under discussion, viz., "Does slip represent loss?" resolves itself into the subsidiary question: "Is the work of action necessarily equal to the work of reaction?" Mr. Preidel replied in the issue of July 2nd, putting our respective contentions in a very clear, correct, and concise form; and showing that he is in perfect agreement with me as to what is the point under discussion, viz., whether the work of action is necessarily equal to the work of reaction. He also asked you, Sir, to obtain a verdict from a competent authority as to the correct answer. You then quoted in the same issue some passages from the late Sir W. Anderson's book "Conversion of Heat into Work," which state, in effect, that the work of action is equal to the work of reaction, according to which Mr. Preidel is right, while I am wrong.

In the next issue, July 9th, is an able letter from Mr. Henry Barnes disagreeing with the quotations from Sir W. Anderson's book, and proving them wrong beyond doubt; and in the following issue is an article by Sir George Greenhill, whom you asked, as an unchallengeable authority, to settle the question. The question to be settled is whether the work of action is necessarily equal to the work of reaction. This will be admitted by everyone who has followed the discussion, and it has been agreed to by both the original disputants. But, unfortunately, Sir George Greenhill does not give a direct verdict as to whether these amounts of work are equal or not; in fact, the word "work" is never mentioned in his article. It is true that he concludes by saying: "The energy of the gun and shot are equal only when the weights are equal, &c.," and I have no doubt that, as the energy of action and that of reaction are shown to be not necessarily equal, he leaves it as obvious that the work of action and that of reaction are also not necessarily equal, and thinks it unnecessary to say so as, no doubt, it would be in any ordinary case. But, unfortunately, Mr. Preidel does not admit, I understand, that the energy imparted is any measure of the work done; so that Sir George Greenhill's article leaves the question as to whether the work of action is necessarily equal to the work of reaction still unsettled.

May I, then, ask if you could obtain from Sir George Greenhill an answer—simply "Yes" or "No"—to this question. When a gun is fired is the amount of work in foot-pounds, which is done on the shot by the explosion, necessarily equal to the amount of work in foot-pounds which is done on the gun? In answering this simple question, all such secondary matters as friction, discharge of gases, &c., which obviously have no parallel in marine propulsion, should be disregarded; a simple theoretical reply, such as would be expected in an examination in elementary theoretical mechanics, will settle the question.

It is rather unfortunate that guns were ever introduced in this discussion on marine propulsion, since, although I quite agree that a gun and its shot make a good illustration, gunnery seems to be more attractive than propulsion; and there is some fear lest the original question under discussion, viz., "Does slip represent loss?" be lost sight of, while some question connected with gunnery be discussed instead.

I have carefully followed Sir George Greenhill's article, and it is in accordance, so far as it goes—allowing for two obvious misprints, where y is substituted for g, and the errors consequent on taking V roundly equal to 20 instead of 22 75, which, however, are quite immaterial—with what I have said in this discussion; but, unfortunately, for my argument, he gives no direct answer to the precise question at issue, although, as I say, an answer may be inferred. As inferred, it is in direct contradiction to the quotations you gave from Sir W. Anderson's book.

I have studied this book, and find that Sir W. Anderson takes it for granted that the work done on the shot is equal to the work done on the gun, without troubling to verify or to demonstrate the equality. I maintain that this is absolutely wrong, and that it is not a case of looking through glasses out of focus, or of lack of definition, but simply a case of a great, though not infallible, man making a slip in elementary mechanics; and, unless I am very much mistaken, Sir George Greenhill would corroborate this if asked his opinion.

Mr. Preidel shows in his letter of July 26th that if the shot impinged on the gun with its original muzzle velocity, the gun would be given a velocity equal to the velocity of its recoil. This is perfectly true; but Mr. Preidel infers from this that the energy expended in producing the original recoil must be equal to the energy expended on the shot. There is no justification for this inference, and it directly contradicts Sir George Greenhill's very conclusion. When the powder impinges on the gun, only a part of its energy is expended in giving motion to the gun; the greater part of its energy is dissipated in the form of heat, showing again, in fact, that the energy of the shot must be much greater than that of the gun. Seeing that Mr. Preidel's premises are quite wrong, it is unnecessary to criticise the conclusions he draws from them in his letter of July 26th. It will be seen that every argument that Mr. Preidel has so far used to show that the work of action is equal to the work of reaction is fallacious.

August 14th.

T. S. C.

"T. S. C.'s" letter has been submitted to Sir G. Greenhill, who has sent us the following for publication:—"The statement 'the work of action equal to the work of reaction is only another way of saying that 'the propulsive efficiency is one half, or 50 per cent.;' and in a screw propeller the effective slip will then also be one-half, or 50 per cent., so that 'slip represents loss' in the propeller efficiency. Now the marine engineer claims with justice that he can do better than this 50 per cent. efficiency, so that 'the work of reaction is not necessarily equal to the work of action.' The statement is incomplete in any case till some information is vouchsafed of the two bodies and their weight, upon which the action and reaction take place. Action and reaction are defined as the two aspects of the stress between two bodies. The analogy of gunnery and marine propulsion is complete when the unknown energy of the powder gas is contrasted with the complicated turbulence of the wake of a screw, but these are the refinements we are requested to disregard at present. Take, then, a simpler analogy, either of the motion of a train with no slip of the driving wheel, or an illustration, still simpler, of walking across a room, starting from rest and coming to rest again. The work put into the body in the shape of its kinetic energy is the equivalent of work done on it by the action of the feet through a certain distance; the reaction of the floor puts the other body in motion with which the floor is connected; if this is considered as forming part of the whole solid earth, the earth acquires the energy due to the work of reaction. In coming to rest again, the operation is reversed. But while the man walks across the room, the earth flinches through an insensible distance, inversely as the relative weight of the earth and man, and so the work of reaction is insensible, and the propulsive efficiency of the man is complete. Now let the man try to walk across the room over a mat on a smooth polished floor; the mat slips, and the difference of the work of action and reaction becomes very marked, depending on the contrast of the relative weight of mat and man, and if of equal weight 'the work of action is equal to the work of reaction,' and the propulsive efficiency is 50 per cent. As the weight of the mat increases relatively to the man, the propulsive efficiency of the man increases, till at length, when it is fastened to the floor to form part of the whole earth, 'the work of reaction is zero,' and his propulsive efficiency is complete. So, too, in marine propulsion it is the object for efficiency of the propeller to act on as large a body of water as possible; but as the volume can never be infinite, the efficiency falls short of 100 per cent., and may drop to 50 per cent, and sometimes even lower. The answer, then, to 'T. S. C.'s' question is No."

BRITISH LOCOMOTIVE PRACTICE OF TO-DAY.

SIR,—Before proceeding any further with this discussion, I wish to dispel Mr. Riekie's thoughts that I am antagonistic to the compound because I am a little prejudiced against extra complication and first cost. Now I am by no means thus antagonistic, and to my knowledge I have never written anything to suggest this. I said at the commencement of this controversy that "I think under present British conditions the compound is not desirable." This I still adhere to. Nobody has greater admiration for the works of the late Mr. Webb, M. De Glehn, Von Borries, Godsdorf, &c., than I have. Now to the discussion.

When Mr. Dean, Mr. Johnson, &c., first used cylinders of large diameter, the idea was to get better expansion, as at that time compounding was exercising the minds of most English engineers. Greater power was not aimed at, since at that period 17in. and 18in. cylinders were quite sufficient. If Mr. Riekie can prove that I am wrong, I shall be pleased to learn so. There was no misconception on the part of the designers—the affair was purely an experimental one. Double engine running is very rare now-a-days, and when two large engines are seen together with a train it is more often than not the pilot is a spare engine working back to its depôt. This is not an uncommon practice. When piloting is resorted to with a view to serious running the reason is this:—There is not sufficient power in the first place. To accelerate a train from rest requires the expenditure of work. The quicker the acceleration the greater the rate of work. I hope I am understood so far. Now then, Mr. Riekie asks, Why could not one engine do the work if the cylinder power were great enough? Of course it could, if—a very great "if"—the engine did not slip. Give the engine sufficient adhesion, then there is no reason for failure. According to Mr. Riekie there is no reason why a single-wheeler would not do all that is required if the cylinders were only made large enough. That is all that it amounts to. Of course, the one engine could start the train if it were given long enough to attain the speed, but as it is very necessary to observe schedule timing the second engine has to be run, because the greater the acceleration the greater the rate of work, consequently enhanced power is required. To get the higher tractive force greater cylinder power is required, and also the adhesion to allow of its utilisation. I sincerely hope Mr. Riekie will not misread this, as it is a most important consideration in the design of a locomotive. Mr. Riekie has never seen piloting with a four-cylinder 4–6–0 of Mr. Churchward's design, because of insufficient power. Has he ever seen a 4–6–0, a 4–4–2, or a large 4–4–0 of the latest design—the very latest—piloted, except under the most extraordinary circumstances? His knowledge of English railways and their work evidently cannot be very extensive, else he would not make such an accusation as "piloting or double engine trains are frequently run." They are rare, indeed; I should like him to prove otherwise if he can.

The time has not arrived for engines of 50 per cent. more power than the 4–6–2 type, and I think it rather unnecessary to discuss such an engine, as one will never be needed; duplication of trains would be resorted to before then, or else electrification.

Mr. Riekie thinks then that our engines would be better compounded. All I can say is I don't—most emphatically so.

My terribly astounding statement about four-cylinder simple engines is evidently shared by, at least, one authority. In the same issue of THE ENGINEER, in which my awful statement was made, Mr. Hughes, in his paper on "Horwich-built Locomotives," states:—"The author also preferred a simple to a compound engine, owing to the greater range of expansion obtainable with express trains. To obtain rapid acceleration and great adhesive power the wheels were made of moderate size and three pairs coupled." Compounds or any other engines of Mr. Riekie's suggested size are not required, so there is an end to the matter. Further on he says: "After having read the letter by 'L. A. F.,' &c., I prefer to remain silent." This is my view of the matter from my own experience and observation. The figures shown by "L. A. F." are got and computed in so many different ways that it is absolutely impossible to arrive at any standard form of comparison. There does not seem to me to be any feasible method by which figures can be collected from various companies—at any rate, each company's methods are different.

I view these figures with a perfectly open mind and cannot accept them as conclusive, as I know well enough the errors that creep in. I have never yet seen any such collection of figures that can be considered relative, as the conditions of different lines cannot be very well compared. It is all very well for certain people to talk about facts relating to railways with a knowledge gathered from reading periodicals, and then attack and make sarcastic remarks about the engineers in charge, but to the true engineer these remarks make humorous reading. I am very sorry to have to say this, but, as Mr. Riekie says "I prefer to remain silent" in a very insinuating manner, I think it necessary to vindicate the cause of the gentlemen who so ably control our locomotives. I should like to be present at a test with a 4–6–0 simple and a Riekie compound; the results would be astounding, I am sure.

I made no odious comparison with a Churchward simple and a De Glehn compound. The compound in the trials dealt with trains in proportion to its power, so the conditions were equal. Besides, to say "that the four-cylinder simple did better work than the splendid performances of the Frenchman" is surely anything but odious. Engines are not required to work at 75 per cent. cut-off, and, as 30 per cent. is usually sufficient, pray what more is required? It is just this fact that places the cause of the compound in a doubtful state.

In conclusion, Mr. Riekie states:—"If a compound be fitted with two 19in. high-pressure cylinders . . . . it is obvious there can be no comparison which is the better engine." Quite so, such engines are totally unnecessary for the British Isles.

In answer to Mr. King's letter, I am very pleased with the amount of reliable information it contains, and I have always entertained the belief in increasing the ratio of the diameter of the cylinders, and only employing one set of valve gear. Had Mr. F. W. Webb increased the diameter of his low-pressure cylinders there can be little doubt that an independent gear would not have been required. Of course, this gear was no doubt added as it was cheaper than new cylinders. I heartily agree with Mr. King that independent valve gears in uninitiated hands are dangerous weapons, but drivers now-a-days—at any rate, in England—can be relied upon. I think Mr. King will agree with me in this, that the conditions governing continental design are very different to those existing in this country. The simple engine, as built on the Continent, is not so well designed as in this country. The general design embodies, as a rule, the very worst features for accurate working, viz., outside valve gear and outside cylinders. I think many continental compounds decidedly inferior to British simple engines of the same power, but, on the other hand, there are many finely built engines on the Continent.

Summing up, I prefer, as I have said before, to retain a perfectly open mind with regard to superiority of simple or compound, and express what I think the best policy for British locomotive designers. It is very rash to state dogmatically that so and so is wrong or right, as the case may be, when such eminent men as our locomotive superintendents disagree, and still worse to insinuate that such men are not so capable as they ought to be. Our locomotives are doing every day work to be proud of, and until they fail to do their duty, or fall into disgrace, I, for one, shall always be a staunch upholder of present British locomotive practice.

Now, just a few actual facts. Mr. Riekie thinks our locomotives would be improved if compounded on his large cylinder system. Could he improve the performances of the magnificent "City" class? Has he read the writings of the late Mr. Rous-Marten? I think it totally unnecessary for me to recapitulate some of their wonderful performances, beyond saying that they have shown themselves capable of doing work much beyond what might have been expected. Their cylinders are 18in. by 26in. Of course, Mr. Riekie will say the cylinder power is deficient. Take the Caledonian Railway Dunalastair type. The work these have done could not be bettered by any compound in existence of the same power. The same applies to Mr. D. Drummond's splendid 4-4-0's. The work being daily performed by these is magnificent. Take Mr. Ivatt's 4-4-2 type cylinders, only 18$\frac{3}{4}$in. by 24in., with an enormous boiler. Could Mr. Riekie better this class? Now go back a few years. The little "Precedents," with cylinders only 17in. by 24in. and very small boilers, did work that was an eye-opener to the railway world; so did the famous old "Problem" class, with only 16in. by 24in. cylinders and only with about 11 or 12 tons of adhesive weight. And so on, the case of the British locomotive is far too sound to require any more evidence. I am very sorry I cannot agree with Mr. Riekie's views of British locomotive practice, as they are of such a nature as to be totally antagonistic to the present admirable system.

London, August 14th. HENRY W. DEARBERG.

SIR,—With your permission I should like to make a few remarks in reply to "L. A. F.'s" criticisms of Great Western locomotive practice. As a matter of fact, Great Western locomotives working fast trains to the West have to surmount gradients far more severe than are to be met with on any other line in this country over which express trains are run. It is useless to say that such gradients exist over only a mile or so of road. If the traffic department decides that it is not policy to stop important trains in a field at Newton Abbot, the locomotive department must provide engines capable of hauling trains over those short bits of 1 in 42 and 1 in 40 that exist between that place and Plymouth, and at the same time be capable of maintaining average speeds of nearly 60 miles an hour, with heavy trains, over the 173$\frac{3}{4}$ miles between London and Exeter. No other railway in this country expects such service from its locomotives. Moreover, the new Castle Cary route can hardly be described as a billiard table, with two very awkward service slacks close together at Westbury and Frome. "L. A. F." also makes the statement that average loads on the Great Northern are heavier and average speeds no less. The fastest trains on the Great Western are the heaviest, and loads of 400 tons are quite common, while the heaviest trains on the Great Northern are the Scotch trains, which are allowed from 120 to 124 minutes for the 105$\frac{1}{2}$ miles between London and Grantham. The only trains on this system to compare with the three-hour trains to Exeter or the two-hour trains to Bristol, or over 57 and 59 miles per hour respectively, are the 6 5 p.m. King's Cross to Grantham in 112 minutes, 56.5 average; the 5.56 p.m. Grantham to King's Cross in 110 minutes, 57.5, and the 2.21 p.m. Wakefield to King's Cross at 55.7, and all these are light trains.

With regard to the number of types lately built at Swindon, it must be remembered that until comparatively recent years the Great Western possessed practically no modern express engines. The transition from broad to narrow gauge placed the locomotive department in a peculiar position—so peculiar that Mr. Dean actually built twelve engines that could be run on both gauges. These engines—subsequently rebuilt with a bogie—and sixty-eight more embodied most of the chief features of the extinct broad-gauge design, whose work they took up. After some years of successful operation they became unable to cope with the work, and, against all Great Western traditions, the four-coupled type was introduced—successively in the "Armstrong," "Atbara," "City," and "County" classes. All these types handled in turn the heaviest and fastest traffic on the road, but, unfortunately for them, about this time the traffic, under energetic management, increased by leaps and bounds. Long non-stop runs at high speeds were introduced, and larger coaching stock, dining cars, &c., employed. The 4-4-0 type could not handle the trains with certainty. Hence the 4-6-0 type. Then came the De Glehn boom, and the world was told emphatically that nothing in the way of express locomotives could possibly equal a De Glehn four-cylinder compound. Three of these engines were tried, and 171 was converted to 4-4-2 to test the relative merits of compound and simple engines of similar dimensions. Unless I am very much mistaken the De Glehn engines do not possess the wide fire-box, so why comment on its absence in 171. Then came, as your correspondent says a batch of 4-4-2 and 4-6-0 engines simultaneously, but he does not say that these engines were identical in everything but wheel grouping, neither does he mention that in all the classes interchangeability has been continuously studied, also that the 4-4-2 tanks are merely "Counties" without tenders. Boilers are now standard on all 10-wheeled tender engines.

As to the conversion of several old 2-2-2 engines into 0-6-0, in this case useless and feeble passenger engines became very serviceable goods engines. If it be true that the 2-6-2 tanks were converted from 0-6-0 engines "of comparatively modern construction," by which I conclude is meant the standard inside framed goods, the conversion must have been rather remarkable, as neither wheels, frames, motions or boilers are in any way alike on the two classes. Possibly the old split pins came in. It is true that many engines of only a few years old have been fitted with standard-coned boilers, to bring them into line with later practice, which makes for uniformity. On the other hand, I believe that many of these discarded boilers have been put on engines getting on in years that needed re-boilering.

Experimental rebuilding is not unknown on other lines, as, for example, the conversion of some of Mr. Webb's 0-8-0 engines to 2-8-0 with new boilers, while others retain the original wheel arrangement with new boilers. The Lancashire and Yorkshire rebuilt a 4-4-0 simple as a four-cylinder compound, and back again into a two-cylinder simple with superheater.

With regard to multiplicity of types, the South-Western has introduced 4-4-0 types with and without W.T. fire-boxes, with various wheel diameters, with two cylinders and with four, and finally a 4-6-0 type. On the Midland, compounds and non-compounds are being turned out impartially. On the Great Northern itself the present "Atlantics" are a gradual development of 990. On the North-Eastern, 4-4-0, 4-6-0 and 4-4-2 engines, simple and compound, with wheel diameters of 6ft., 6ft. 8in., 6ft. 10in., 7ft. 1in. and 7ft. 7$\frac{1}{2}$in., and with all sorts of boiler and cylinder dimensions. The Great Central seems equally undecided, for here again we find 4-4-2 and 4-6-0 simple and compound, one a three-cylinder simple, working the same traffic.

To what the high cost of maintenance of Great Western locomotives is due I, of course, do not know; but I do not think it is due to such causes as are instanced by "L. A. F." It is not possible to say unless all the facts are known. One thing is certain—that the locomotives on the Great Western are in every way up to their work, and highly efficient in all that concerns the public—that is, ability to keep time under all conditions. It is just possible that the department has been badly starved in the past.

Berry Wood, Northampton, A. HOCKLEY.
August 10th.

SIR,—When I started this discussion in the columns of your esteemed journal, I did so with the hope that the locomotive question would be thoroughly thrashed out. I have been more than pleased at the result. No less than forty letters have appeared on this interesting subject, but in what a whirlwind of confusion they have left us. I will not occupy valuable space in your columns by repeating my views on the subject—interested readers can refer to back numbers—but I should like to ask Mr. Riekie and Mr. Chas. R. King a pertinent question, viz.: "Is it not a fact that compound engines when running fast are sluggish in working as compared with four-cylinder simple engines running at the same speed?" Indicator diagrams show that compound engines suffer from an excessive amount of back pressure in the high-pressure cylinders, and the low-pressure steam from the receiver would appear to be sluggish in getting into and out of the low-pressure cylinders. Of course, I am speaking now of fast running. Now, it seems to me that a four-cylinder simple engine behaves much better at high speeds, for the following reasons, viz.:—Each cylinder is supplied with steam—very much alive—direct from the boiler; moreover, each cylinder exhausts straight into the atmosphere, so that, comparatively speaking, there is no back pressure. It is this excellent quality that enables the Great Western four-cylinder engines to score over the De Glehn compounds.

I am fully aware that the diameter of the driving wheels of a locomotive has a marked effect on the draw-bar pull at high speeds. It is a well-known fact that as speed gets up the draw-bar pull falls off, the rapidity of the falling off being governed by the diameter of the driving wheels; the smaller the wheels the more rapid is the falling off. Mr. H. A. Ivatt has shown us that his 0-8-0 mineral locomotive can give a 10-ton pull at starting, but at 20 miles per hour the pull falls to about 4$\frac{1}{2}$ tons, whilst at 53 miles per hour there is no pull at all. Every locomotive has a limit with regard to pulling; hence it is that modern express engines have driving wheels as large as possible, which, with the large-diameter boilers now in use, is somewhere between 6ft. 6in. and 6ft. 10in. diameter. It is worthy of note that the four-cylinder simple and four-cylinder compound locomotives on the Great Western Railway have driving wheels of the same diameter, viz., 6ft. 8$\frac{1}{2}$in.

Birmingham, August 14th. CHAS. W. DAUNCEY.

SIR,—I have been struck with the sense of Mr. Riekie's arguments respecting the cylinder dimensions of the earlier compounds in this country. Take the case of the Worsdell-von Borries compounds. The practice was to give the engines a boiler similar to that of the simples, and to retain one of the cylinders as the high-pressure, the other one being replaced by a low-pressure cylinder of the necessary larger size. One of the London and South-Western 4-4-0's, No. 446, built in 1883, was so altered in February, 1888. Before being converted it had 18in. by 24in. cylinders, 7ft. wheels, 1162 sq. ft. of heating surface, and 160 lb. steam pressure. As a compound, a 26in. low-pressure cylinder was substituted for one of the 18in. cylinders. No other material change was made. The cylinder capacity was, therefore, equal to that of two simple cylinders 17in. by 24in. As the engine was expected to do the same work as before, it is not to be wondered at if the reduction in power was found to be non-compensated by a saving in steam and coal consumption. Whatever the results may have been, the fact remains that the engine was re-converted to simple in February, 1891. F. W. BREWER.

London, August 13th.

RHYMNEY RAILWAY LOCOMOTIVE BOILER EXPLOSION.

SIR,—When reading the report on the Rhymney locomotive boiler explosion, it reminded me of what I did thirty odd years since when I put two safety valves, two water gauge glasses, and two pressure gauges on all vertical boilers on the steam hoists in use at the docks in Liverpool. I refer to those made by me. When the Mersey Dock Board Authorities noticed it they made it compulsory that every vertical boiler in use on hoists on the estate should be fitted with a duplicate set of each, and this ought to be the case on all boilers. J. W. MARTIN.

Manchester, August 14th.

THE TAXATION OF MOTOR CARS AND THE BUDGET.

SIR,—It is proposed to tax motor cars according to their horse-power. On the face of it, if taxation is to be accepted, the basis appears equitable. But what is the horse-power of a motor car? The rating of the Royal Automobile Club is admittedly tentative, and relates to the horse-power of the engine. The only horse-power which concerns the user or affects the roads is that delivered at the road wheels. Most people believe that a car rated by the makers at, for example, 20-30 horse-power is of considerably higher power. The present Royal Automobile Club rating encourages this idea, because in the recent trials in the Isle of Man cars of this nominal rating attained racing speed. The fact is exactly the contrary. Cars of the best makes deliver, as a rule, from two-thirds to three-quarters of their rated horse-power at the road wheels. A 20-30 horse-power car, popularly credited with something nearer 40, gave at the maximum 17 horse-power at the road wheels, a 28-36 car about 18, a 14-22 about 12, a 40-50 38 to 41. Examples might be multiplied, but it is evident that if horse-power is to be adopted as a basis for reckoning a tax it must be the true horse-power on the road and not a fancy value. Criticism without construction is apt to be fruitless, and to avoid this fault I suggest that for Budget purposes all cars should be rated by the actual horse-power which they possess at the road wheels, and that this power should be determined by the Royal Automobile Club, of course under official supervision. Any other method is haphazard and erroneous, and is inequitable alike to the motorist and to the national revenue. BERTRAM BLOUNT.

London, S.W., August 13th.

THE QUALIFICATIONS OF A ROAD SURVEYOR.

SIR,—Applications are being invited for the post of road surveyor to a certain county. After stating particulars as to emoluments of the office, the advertisement continues, "Preference will be given to candidates having some qualifications as civil engineers." In these days the public roads are returning to their legitimate purpose as arteries of traffic, and their construction and maintenance have become matters of more serious moment than ever before. It is generally agreed that the old methods are no longer suitable to the altered conditions. Surely it is time that the authorities began to realise that what they require is a civil engineer "with some knowledge of the management of main roads;" that the construction and maintenance of highways is as much the domain and function of the civil engineer as that of railways and canals; and that the same training and experience is needed to grapple with new problems arising in the one case as in the others.

Is it wise to keep the door too tightly shut in favour of men whose sole claim to the office is the past experience gained in a similar capacity, but in a smaller sphere?"

August 16th. Q Q.

REINFORCED CONCRETE RETAINING WALLS.

SIR,—When perusing the paper read before the Institution of Mechanical Engineers by A. C. Auden, of Liverpool, in the report that you gave of his lecture in your last issue, the following remark jumped to my mind:—

One figure shows two retaining walls, one made of mass concrete, the other of reinforced concrete. Both walls are of the same height, consequently are subject to the same horizontal thrust. The weight of both structures being so absolutely different, how is it that the lines of pressures are shown parallel and intersecting the base of the walls at the same distance from the toe?

Evidently the reinforced concrete wall is not stable, although it may have been calculated for certain stresses, and be strong enough to resist these stresses—if they ever act on the wall.

Reinforced concrete seems to be somewhat of a puzzle to many theoreticians, who want high refinement in formulæ, as Mr. C. Auden justly remarks. But this difficulty in finding the internal stresses does not lead to miscalculation of the external stresses.

Perhaps you will insert the above remark to prevent any misapplications of the reinforced concrete. A. V. M.

August 13th.

EXPERIMENTS WITH A GLASS CARBURETTER.

SIR,—I have reason to think that what Mr. Bickford describes takes place in many cars. I have a French car, 10-12 horse-power, with Longuemare carburetter.

About two years ago the engine was troublesome to start, and ran irregularly. On seeking for the trouble, petrol was noticed dropping from a joint between the carburetter and the engine; this joint had somehow got loose, and the asbestos flange was slightly drawn into the induction pipe, leaving a small opening through which air was sucked in. This, being at the lower part of the joint, was not noticed till the petrol was seen leaking out, thus showing that some solid petrol must have been in the pipe. I may add that this engine often fires two or three times after petrol is shut off. It is, however, quite possible that the circular slide is not perfectly tight, for the car has seen a good deal of service, but I am convinced that petrol hangs about the lower part of the induction pipe.

In a car that I owned at one time I on several occasions removed the cover above the jet, and replaced it with a glass plate. When the engine was running this glass was covered with drops of petrol. There seemed to be but little actual spray, the petrol striking the glass and falling back in large drops.

Farnham, August 16th. JOHN HENRY KNIGHT.

SIR,—The conversion of petrol into gas is very far from being the simple matter some people think. My experience is that the two principal troubles connected with motor cars are to be found in the carburetters and the sparking plugs. I can confirm Mr. Bickford's statement in one respect at all events. I have a 6-8 horse De Dion which now and then will fire several times after the petrol is quite cut off. The valve is quite tight.

August 18th. D. B.

SIR,—I am sorry that I seem to have stepped on Mr. Gillett's toes, but after reading his letter I feel content to leave myself in the hands of your readers. I have published not only my conclusions but the data on which they were founded, and if Mr. Gillett or any other of his professional brethren feel that the former are incorrect or the latter insufficient the remedy is in their own hands; let them publish more accurate data and juster conclusions.

Most of Mr. Gillett's conundrums can be far better answered by himself than by me, and to him I leave them; but I would add one to the number. What effect on the temperature of the mixture in the induction pipe is produced by raising the temperature of the incoming air? J. S. V. BICKFORD.

Camborne, August 17th.

THE INSTITUTION OF CIVIL ENGINEERS: NEWCASTLE-UPON-TYNE ASSOCIATION OF STUDENTS.—A visit will be made on Wednesday, the 1st of September, to John Spencer and Son's steel works at Newburn. Members will travel by the train leaving the Central Station, Newcastle-on-Tyne, at 2.47 p.m.

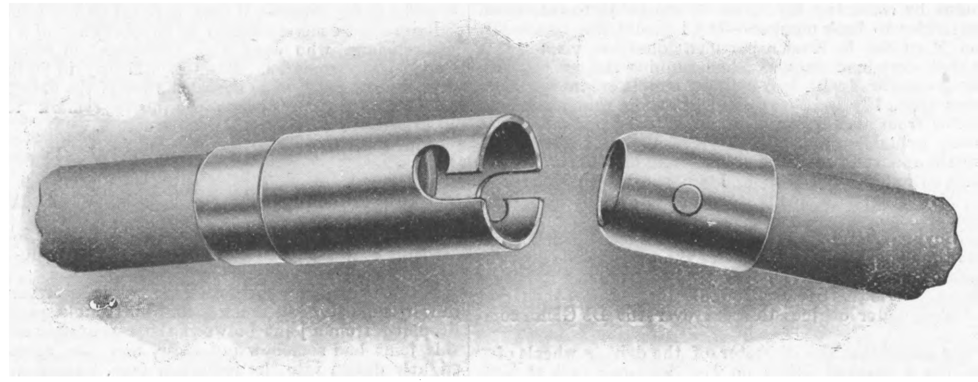
IN HIS REPORT on the trade of Honduras, Mr. Consul Campbell writes that the only public railway in the country, running 56 miles inland from Puerto Cortes on the Atlantic side, has not been repaired and remains in so bad a condition as to make it probable that, unless steps are shortly taken, it will become permanently useless. Recently several different groups of enterprising people have made offers to the Government to undertake the repair of the road under certain conditions, but the competition has had the effect of retarding the taking in hand of the repairs which are so necessary. Several concessions have been applied for with the object of building railways in various parts of the country, but none of these proposals seem to have resulted in serious work. The private railways for the conveyance of bananas from plantations near La Ceiba, on the Atlantic side, to the port are slowly being increased.

AN AMERICAN CONSULAR REPORT states that the electrification of the Grand Trunk Pacific or National Transcontinental Railway from the St. Lawrence River to Moncton is now under the serious consideration of the railway company, the Dominion Government, and the New Brunswick Cabinet. Electrical engineers who have given the subject consideration declare the conditions to be entirely favourable. The distance between the St. Lawrence and Moncton is about 460 miles, and for a considerable part of the distance the road passes through dense forests of spruce and fir in lower Quebec and northern New Brunswick, as well as through the rich farming country along the upper St. John Valley. At the Grand Falls on the St. John River, 170 miles from the St. Lawrence and 160 miles from Moncton, there is water power sufficient to develop electrical energy for working the whole road. At this point the river has a natural fall of about 130ft., and a flow that it is estimated will be sufficient to furnish from 100,000 to 125,000 horse-power continuously.

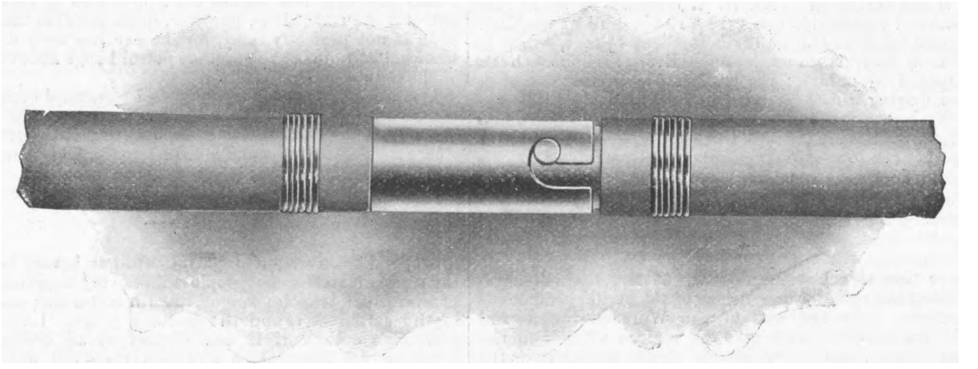
UNIVERSITY OF LONDON.—Professor J. D. Cormack has been elected Dean, and Professor J. A. Fleming, Vice-Dean, of the University College Faculty of Engineering for the session 1909-10. The Chadwick scholarship and medal has been awarded to F. L. Thompson. A. M. Simms has been declared *proxime accessit* and has been awarded a silver medal. The session will begin on Monday, October 4th. Special and post-graduate courses have been arranged to meet the needs of the following classes of students:—(*a*) Postgraduates and engineers in practice; (*b*) others whose qualifications are, in the opinion of the lecturer, such as to enable them to follow the courses. Each course will include lectures and exercises, and the numbers admitted will be strictly limited. The following are some of the special courses for next session:—"Steam Turbines," by Mr. W. J. Goudie and Mr. E. G. Izod; "Railway Engineering," by Mr. H. Deans, of the Great Western Railway; "Waterways, Harbours and Docks," by Mr. A. T. Walmisley, Engineer of Dover Harbour; "Roads, Street Paving and Tramways," by Mr. W. N. Blair; "Recent Methods and Instruments in Surveying," by Mr. M. T. Ormsby; "Electrical Design," by Mr. H. M Hobart; "The Ideal Arch, Metal and Masonry, Theory and Design," by Professor Karl Pearson.

AN INSTANTANEOUS HOSE COUPLING.

A NEW and convenient form of hose coupling is now being manufactured by "Max," Limited, Westcombe Hill, London, S.E. Two forms of this coupling are made, one for outside and the other for inside attachment to the hose pipe, both forms being shown in the engravings. The construction is simple, and will be readily understood from the engravings. To secure tightness of the joint the external half of the coupling is formed with a recessed shoulder on the inner surface, into which a ring of suitable packing material is placed, and against which the nose of the other half bears. When the outside pattern is adopted the pipe is secured to the brass coupling pieces by cement; in the case of the inside pattern the ends of the brass pieces are fluted, and are fastened to the pipe either with wire, cement, or a specially designed clip. The couplings, which are patented, are made in all sizes from ½in. to 2½in., and can be supplied with compression rings of various materials to suit particular purposes and to enable them to be used for oil, petrol, steam, &c.



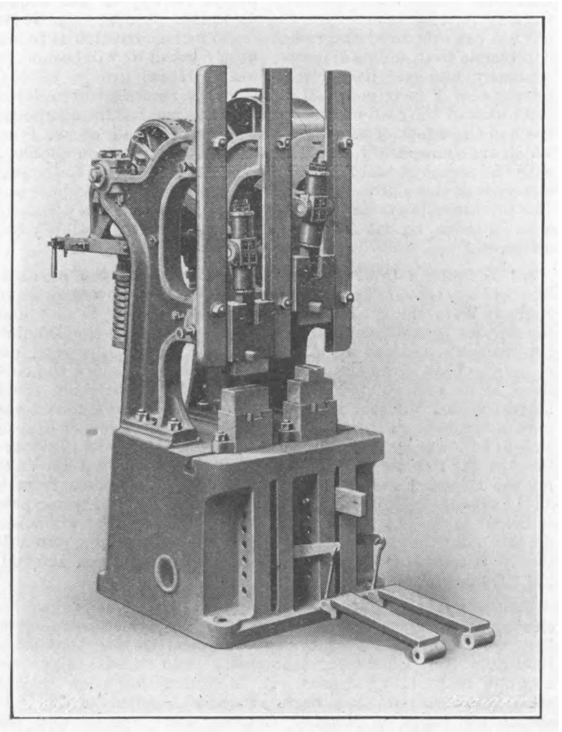
THE OUTSIDE PATTERN COUPLING



THE INSIDE PATTERN COUPLING

DUPLEX MECHANICAL STRIKER.

A NEW form of hammer specially designed to deal with work which has hitherto been done on the anvil by manually worked hammers, "Olivers," or small drop stamps, is being introduced by Messrs. B. and S. Massey, Openshaw, Manchester. From the engraving of the appliance here given it will be gathered that there are two hammers arranged side by side, so as to enable different operations on the same article to be dealt with in quick succession. For instance, a roughing die may be used on one and a finishing die on the other hammer, or plain pallets may be fixed in one and a special forming, bending, or cutting-off tool in the other. The two hammers are quite independent as regards their control and adjustment. Each tup is accurately guided in V slides, and is attached to a lever centred on the driving shaft by means of a short-cushioned connecting-rod. A strong helical spring is also connected to the lever, and this is compressed on the upward stroke of the hammer to give increased energy to the force of the blow. The base is arranged with a T-slotted table for holding the dies, and an adjustable knocking out arrangement or "kicker" is provided for removing the work out of the dies, and may be used in either hammer. The main driving shaft is provided with fast and loose pulleys and a belt shipper, so obviating the use of a countershaft.



DUPLEX MECHANICAL STRIKER

The operation of the hammer is controlled by means of foot levers, which engage with or release band brake clutches so arranged that the movement of the tups exactly follows that of the foot levers but on a larger scale. When the lever is depressed the tup rises, when it is released the tup falls, and when the lever is held stationary in any position the tup will remain suspended in a corresponding position. When the hammer is out of action the tup remains suspended clear of the work, and the height of suspension can be readily adjusted to suit dies of different thicknesses. From the foregoing it will be understood that each blow is under complete control, while the regulation is both simple and sensitive.

The following are the leading particulars of this new appliance:—

Length of stroke	2ft.
Clear space between slides	6in.
Height of die table	1ft. 11½in.
Die table to bottom of slides	11½in.
Driving pulley (diam.)	2ft.
Width of belt	5in.
Size of base	2ft. 8in. × 2ft. 7in.
Revs. per min...	80
Weight of falling parts	½ cwt.
Weight of complete machine	2¼ tons.

TESTS OF HEADLIGHTS.

IN our issue of August 6th we briefly referred to a series of trials of headlights for motor cars and motor cycles, which was commenced at the Crystal Palace on the evening of Monday, July 19th, by a Technical Committee of the Royal Automobile Club. The report of this Committee giving the results of the tests has just been issued. As we previously stated, it is believed that one of the causes which contribute to the unpopularity of motor cars among a certain section of the public is the use of headlights, which are a source of annoyance owing to their dazzling effect. These tests were therefore carried out for ascertaining the power and range of illumination, and the dazzling effect of the lamps entered for the trials. The judges state that they are pleased to report that the principal lamp makers responded to the invitation of the Club to submit their productions for the tests.

There were thirty-three acetylene lamps, twelve electric, one petroleum, and one petrol-oxygen. Each entrant was invited to set his lamp to the best advantage in every respect, both the height and the angle of elevation being left to his discretion, and note was made of the height of each lamp above the ground. The distance at which the lamp gave a certain standard of illumination (one-tenth of a candle-power) was measured down a line along which the entrant had centred the beam of the lamp. The methods of arriving at the horizontal dispersion of the beam, the dazzling effect and back reflection are described, and the design and general construction of the lamps also receives attention.

The measurement of the candle-powers of the sources of light has brought out the fact that the generally accepted idea of the intense candle-power of headlights is erroneous. The naked light of a headlamp such as is usually employed is from 15 to 25 candle-power, and this light is collected and directed by lenses and mirrors. A table given in the report shows that only two acetylene burners exceeded 30 candle-power, while in the case of electric lamps the number was the same. In the opinion of the judges so long as the optical arrangements of the lamps are efficient, ample illumination is afforded by about 20 candle-power, which can be obtained in the case of an acetylene lamp with a consumption of about .7 cubic feet of gas per hour (about 2.8 ounces of calcium carbide), and in the case of an electric lamp, with a consumption of about 21 watts. The larger the mirror and the smaller the source of light, the easier it is to avoid undesired dispersion of the beam. For the purpose of the tests the relation of both pressure and consumption of gas to candle-power was investigated and some examples of these tests are given in a table. From these experiments it was observed that the candle-power of an acetylene burner varied but little between pressures of 3in. and 6in. of water, but the consumption rose to an important degree. In the opinion of the judges, lamps and burners as now constructed require no pressure higher than 4in., and the most economical pressure is 3in. of water.

The effect of variations of voltage on electric lamps depends upon the substance of which the filament is made. The increase of light resulting from an increase of voltage in the case of metallic and carbon filament lamps is shown in a table. A 5 per cent. increase of voltage gives approximately a 31 per cent. increase of light in the case of a carbon filament lamp, and 23 per cent. in the case of one with a metallic filament. Another table gives the general results of the tests. Distances of the observer from the lamp, and at which he was no longer dazzled are given. This table shows that the least dazzle is obtained either when the lamp is very low down—2ft. from the ground—or when it is fixed above the canopy level—7ft. 6in. above the ground. When the lamp is at or about a height of 3ft. from the ground a downward tilt increases the dazzling effect. Undue tilt of the lamp causes considerable difference in the illuminating power, whereas height has an appreciable effect in diminishing the dazzle. The best position, the report states, would be at 2ft. As regards illumination the horizontal is the best position from the driver's point of view, except at a height of 7ft. 6in., when a slight downward tilt is desirable. The automatic anti-dazzling devices, other than specially designed mirrors or lenses, appeared in every case to diminish the range, but in one case this was only slight. Three lamps were provided with gold reflectors, a development which is expected in consequence of the colour to prove of advantage in time of fog. Attention is called to the fact that appliances can be added to almost any type of headlight whereby the light may be reduced. For example, with electric lamps by a switch diminishing the voltage or inserting resistance, and with acetylene lamps by partly or wholly obscuring the light by means of hand-actuated shutters or screens. The advantage of such a hand-actuated device is that on entering a town the intensity of the light from the headlamps can at once be moderated. The report contains a summary of results obtained, arranged in tabular form, and also illustrations of the lamps tested and other illustrations relating to the data obtained.

ROLLING MILL MOTORS.

AT the twenty-sixth annual Convention of the American Institute of Electrical Engineers held on June 28th, 1909, a short paper was presented by Mr. E. W. Yearsley on "Rolling Mill Motors." Protection, the author says, is extremely important in the steel mill, where conditions are necessarily uncleanly, and electrical apparatus must work in the midst of dust, moisture, and gases. Considered economically, the author believes main motor drives to be superior to engine drives, even when power is derived from a steam engine-driven generator plant fed by coal fired boilers. Where water power or waste gas is available there is no question of the greater economy of the electric drive. Mr. Yearsley is of opinion that the controlling apparatus for mill service is usually the weak part of the system. Heavier and more mechanical switches and circuit breakers, better protected and more durable rheostats, and longer lasting automatic controlling devices, requiring less attention, are, he maintains, badly needed.

For large main drive motors, the paper states, the advantage of continuous running at constant speed is so great that it would appear advisable to make the design of the mill suit the characteristics of the motor, and avoid the extra expense and complication of devices like the reversing drive. The tendency in America has been to build a machine and then to couple on a motor somewhere to drive it. There seems to be no great difficulty in designing mills for continuously running motors. By combining such motors with a suitable fly-wheel it is possible to keep the line load sufficiently uniform. This combination, the author considers, has not received sufficient attention, possibly because of lack of knowledge of power and speed regulations of the rolling operation. It is pointed out that tests to determine these characteristics are comparatively easy with electric rolling mills, so that data should rapidly become available for supplying the system with the proper inertia.

It seems that in some American installations the fly-wheel has been so badly proportioned as to be detrimental to the operation of the motor. The importance of low armature inertia for reversing motors is well recognised, but the opinion is expressed that designs could be improved by a still further reduction in speed. Mr. Yearsley is decidedly against the use of high speed motors for any kind of mill service, and believes the extra cost of slow speed machines well warranted. Another item of advice given is that electric motors subject to excessive vibration communicated from the gearing and other parts of the machine should be protected by flexible couplings. For mill apparatus, which must be handled directly, especially for direct current apparatus, the author favours a maximum pressure of 250 volts.

NAVAL ENGINEER APPOINTMENTS.

THE following appointments have been made by the Admiralty:—

Engineer Commanders:—F. T. George has been placed on the Retired List at his own request, with the rank of Engineer Captain; H. P. Vining, to the Victory, additional, for fourteen days' oil-fuel course.

Engineer Lieutenants:—C. E. Stone, J. G. Budge, and G. J. Mathews, to the Victory, lent for fourteen days' oil-fuel course; R. H. Grazebrook, to the Victory, additional, for fourteen days' oil-fuel course; A. E. E. Rayner, to the Cæsar; W. Rowe, to the Prince of Wales, to assist Engineer Captain; H. R Denson, to the Vivid, additional, for the Wolverine, and to assist on Staff of Admiral Superintendent of the District; and H. B. Main, to the Magnificent; J. G. Budge and F. J. Pedrick, to the Admiralty, for service in the Controller's department; G. J. Sisley, to the Senior List; W. A. Donovan, to the Senior List.

Engineer Sub-Lieutenant C. J. Gray has been promoted to the rank of Engineer Lieutenant.

THE *Diario Oficial* of 16th July contains a copy of a decree granting a contract for the construction of a railway in the State of Hidalgo from Temascalillo on the Central Railway to Agua Blanca, and thence to Harayacocotla and Zacualtipan. The whole railway is to be completed within a period of six years.

THE IRON, COAL, AND GENERAL TRADES OF BIRMINGHAM, WOLVERHAMPTON, AND OTHER DISTRICTS.

(*From our own Correspondent.*)

Raw Iron Revival.

THE improvement in the raw iron market advised last week is quite as conspicuous this. Indeed, the market has gathered strength. It is impossible now to buy at former minimum rates, and makers are pursuing a more independent policy towards consumers. Buyers are becoming more anxious than sellers to enter into contracts for forward delivery, and there has been a general stiffening of raw material quotations. On 'Change in Birmingham to-day—Thursday—the pig iron market wore an animated appearance and expressions of greater confidence were heard. Inquiries were much more numerous than usual both for large and for small quantities, and quotations were up by as much as 1s. per ton. There are signs that the market is becoming less cramped, and apparently it has been recognised by consumers that there is nothing to be gained by standing off the market any longer. Most makers are now inclined to take a more favourable view of the trade outlook, and the prospects of a general revival in the autumn are considered to be brighter. Some heavy orders have been placed during the past two weeks at the old level of prices, but on all new business an advance has now to be paid. Quotations are named this week as:—Forge pig iron: Staffordshire common, 46s; part-mine, 49s. to 50s.; best all-mine, 80s. to 81s.; cold blast, 110s.; Northamptonshire, 46s. to 47s.; Derbyshire, 48s. to 49s.; North Staffordshire, 49s. to 50s.

Finished Iron Prospects.

Prospects of the finished iron trade are improving a little, and prices should move up with those of pigs, though no definite movement can yet be said to have taken place. Better reports are to hand from North Staffordshire, where specifications have been freely sent in during the past week, and a similar improvement is hoped for in this district. There is a slightly larger inquiry for bars, common iron, and strip, although selling rates are so low as to yield but the barest margin of profit. Prices are quoted:—Marked bars, £8; Earl of Dudley's brand, £8 2s. 6d.; second grade, £7; unmarked bars, £5 17s. 6d. to £6; North Staffordshire bars, £6 10s.; hoop iron, £6 15s.; gas strip, £6 5s. to £6 7s. 6d.; slit nail rods, £7; rivet iron, £6 15s. to £7.

Galvanised Iron Situation.

The disorganisation of the galvanised sheet trade caused by the breakdown of the Association price agreement continues. A few houses are in a position to stand out for prices above the £10 10s. modern basis, and are demanding £11, but there is still much underselling, and much hesitation on the part of buyers. Efforts have been continued to bring about a united action by the Association firms, not for the maintenance of prices, which, of course, is hopeless, but for keeping the trade in whole channels by cutting prices. These efforts have met with such little success that they may now be considered, as far as any combination is concerned, to have been abandoned. Black sheets continue in a disorganised condition, but there is little change in prices, doubles still being quoted £7 2s. 6d. to £7 5s., and trebles £7 15s. to £7 17s. 6d.

Steel.

There has been some movement in steel this week. The advance of the prices announced in Scotland has had a tonic effect, though it has not been followed by any corresponding declaration as regards the trade in the Midlands. The position has developed to some extent in favour of the seller, but what manufacturers want is more liberal distribution of specifications. Quotations are as follows:—Mild bars, £6 7s. 6d. to £6 17s. 6d.; angles, £5 10s. to £5 15s.; girder plates, £5 15s. to £5 17s. 6d.; boiler plates, £7; joists, £5 10s. to £5 15s.; sheet bars, £4 12s. 6d., Bessemer, and £4 15s., Siemens.

Railway Rolling Stock.

In the railway rolling stock industry there has been no new development recently, and orders are still few, and are keenly competed for both by British and Belgian makers. Prices consequently are cut very fine, and business generally is unsatisfactory. Local works are fairly well employed on wagon contracts, but there is very little work for the passenger coach departments. There are a few inquiries for wagons for the Argentine. All the year the carriage shops have been comparatively idle. The Board of Trade returns show that the exports of trucks of wagons for the seven months of this year, ended July last, were of the value of £1,204,709, as compared with £1,579,167 in the corresponding months of 1908.

NOTES FROM LANCASHIRE.

(*From our own Correspondent.*)

MANCHESTER, Thursday.

Improvement in Pig Iron.

THE improvement in the market for pig iron continues. Although the attendance on the Iron Exchange was not quite so good as usual for a Tuesday, yet the tone was exceedingly good, and some fair orders were booked mainly for prompt delivery, evidently to cover depleted stocks. Much of the present strong inquiry is attributable to the very favourable nature of American advices, coupled with heavy speculation in warrants. In some well-informed quarters there is a feeling that the present movement is only temporary in character; but, on the other hand, it is well to remember that under present conditions the price of fuel must if anything advance, and that pig iron is about 12s. to 15s. per ton lower than it was two years ago, although as compared with the same period last year prices to-day are about 1s. higher.

Advanced Prices and Indifferent Sellers.

The upward movement commenced practically in Middlesbrough iron, and since then Scotch brands suitable for this market have advanced. On Tuesday Glengarnock was fully 1s. per ton up on the week, and other sorts were 6d. to 9d., except Middlesbrough, which was fully 1s. to 1s. 3d. per ton higher. This reacted on Tuesday on Lincolnshire, Derbyshire, and other sorts of foundry iron, and makers' agents declined to book further orders for the present. Forge iron, in sympathy with foundry, is about 1s. per ton higher on the week.

Finished Iron and Steel.

There was only very ordinary movement, with no change to record in prices.

Copper, Sheet Lead, Tin.

This market was exceedingly dull for manufactured, and inquiry ran on small lots comparatively. The feeling altogether was quiet. Sheet lead: Dull, at late rates. Tin: There was a moderate demand for English ingots at 20s. to 30s. per ton advance.

Quotations.

Lincolnshire, No. 3 foundry, quoted 53s. 6d.; Staffordshire, 51s. 9d. to 52s.; Derbyshire, 52s. 6d. to 53s.; Middlesbrough, open brands, 59s. 4d. to 59s. 7d. Scotch: Gartsherrie, 60s. 3d. to 60s. 6d.; Glengarnock, 60s.; Eglinton, 58s. 6d.; Dalmellington, 58s. 6d. to 59s., delivered Manchester. West Coast hematite, 58s. 6d.; East Coast ditto, 56s. 6d., both f.o.t. Delivered Heysham: Gartsherrie, 58s. 3d. to 58s. 6d.; Glengarnock, 58s.; Eglinton, 56s. 6d.; Dalmellington, 56s. 6d. to 57s. Delivered Preston: Gartsherrie, 59s. 3d. to 59s. 6d.; Glengarnock, 59s.; Eglinton, 57s. 6d.; Dalmellington, 57s. 6d. to 58s. Finished iron: Bars, £6 10s.; hoops, £7 12s. 6d.; sheets, £7 15s. to £8. Steel: Bars, £6 5s.; Lancashire hoops, £7 5s.; Staffordshire ditto, £6 17s. 6d. to £7; sheets, £7 17s. 6d. to £8; boiler plates, £7 2s. 6d.; plates for tank, girder, and bridge work, £6 5s.; English billets, £4 12s. 6d. to £4 15s.; foreign ditto, £4 10s. to £4 12s. 6d.; cold-drawn steel, £9 5s. to £9 10s. Copper: Sheets, £72; tough ingot, £63 to £63 10s.; best selected, £63 to £63 10s. per ton. Copper tubes, 8½d.; brass tubes, 6⅞d.; condenser, 7⅞d.; rolled brass, 6¼d.; brass wire, 6½d.; brass turning rods, 6½d.; yellow metal, 6d. per lb. Sheet lead, £16 15s. per ton. English tin ingots, £132 10s. to £133 per ton.

The Lancashire Coal Trade.

Owing to holidays in the cotton districts attendance on the Coal Exchange was again of small dimensions. The demand for house coal has dropped to a minimum, but as production is comparatively small, prices are well maintained. Slack and steam coal generally also ruled slow, but there was a trifle more movement in the shipping and bunkering trade.

BARROW-IN-FURNESS, Thursday.

Hematites.

A much stronger feeling is asserting itself in the hematite iron market. All the conditions seem to be favourable to a much more active demand, and this has already been foreseen by speculators, who are aiming to buy stocks before prices make any material advance. This is shown this week in the running of 1000 into warrant stocks, and increasing the bulk to 14,510 tons. This is, of course, only a very small holding, especially as makers have not in hand much more than an ordinary holding of iron. The chances are that an increased production of iron will be necessary before long, and in West Cumberland, at any rate, two furnaces are expected to be put in blast at an early date. Prices show an improvement. Makers have raised their nominal quotation to 59s. net f.o.b. for mixed Bessemer numbers, and warrant iron is at 57s. 6d. net cash sellers, 57s. 10½d. three months buyers. Sales of special hematites are well maintained, and prices this week are quoted at from 61s. to 62s. 6d.—according to specification. Ferro-manganese is a steady and growing trade. Sales of charcoal iron are well maintained. Iron ore is rather firmer at 11s. for good ordinary, 13s. 6d. for medium, and 17s. 6d. for best classes. The latter commands the best sale.

Steel.

The demand for railway material is not brisk, but makers are enabled to keep their mills fairly well employed. They are not, however, working full time. A better demand is expected, not only on home but on colonial and general foreign account. Merchant steel is only in small demand. There is no immediate prospect of the restarting of the plate mills in the district, and it is thought this will probably be deferred until shipbuilders are busier.

Shipping and Coal.

The exports of iron and steel from West Coast ports during the week amounted to 15,453 tons—iron, 3435 tons, and steel, 12,018 tons, against 8124 tons in the corresponding week of last year, an increase of 7329 tons. The aggregate shipments this year have reached 374,832 tons, against 311,691 tons in the corresponding period of last year, an increase of 63,141 tons. Coal and coke in moderate sale at late prices.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

Steam Coal Active.

THE demand for steam coal is still maintained. Unfortunately, the operation of the Eight Hours Mines Act is found to affect the output very considerably. The labour troubles are mostly over, but the holiday feeling is still evident, and the limitations prescribed by the Act all tend to restrict the production. The contract prices are 8s. 6d. per ton at the pit. These are, to some extent, still in force, but coal bought in the open market readily fetches from 9s. to 9s. 6d. per ton at pit. The business with Sweden is diminished by labour difficulties, and the exports from Hull for the week ended August 10th last, the latest date for which statistics are available, show a falling off compared with the corresponding period of last year, the total weight forwarded from that port to distant markets for the week mentioned having been 62,172 tons, against 77,776 tons for the similar period of 1908. Cronstadt, which has recently headed the list of foreign markets supplied from Hull, now takes second place with 7538 tons, Hamburg being first with 9606 tons. Rotterdam is third with 6823 tons.

House Coal.

In spite of the warm weather lessening consumption, house coal continues in fair request, mostly in anticipation of winter requirements, and the restriction of output tends to keep the collieries producing domestic fuel in moderate work. In West Yorkshire it is reported that best quality house coal is almost completely neglected, with a falling off as well in the call for immediate deliveries of lower grades. In South Yorkshire the principal demand is for the better qualities, largely on London and local account, and quotations are maintained, best Barnsley making from 11s. 6d. to 13s. per ton at pit, secondary sorts from 10s. to 11s. per ton at pit. There seems no prospect of any reduction in prices this year, the chief difficulty at present being more one of supply than otherwise.

Small Coal and Coke.

Best slack and small nuts in good request at former quotations. Coke prices are hardening, owing partly to the limited supply of small coal. Best washed coke now ranges from 11s. to 11s. 6d. per ton, unwashed 10s. 6d. to 11s. per ton, these figures showing an advance of 6d. per ton on those given last week.

The Iron Market: Derbyshire Irons Dearer.

The better feeling in the iron trade referred to last week is still apparent, but buyers are not reported to be pressing in their purchases. Makers, on the other hand, are not eager to push sales at the present time, the business done being simply to meet requirements. Very little change has occurred in the prices of hematites during the last few weeks, prices being only quoted to requirement. Considerably more is being done, we are informed, in Derbyshire irons, sales being made more freely, and the tendency upward. Derbyshire No. 3 foundry, 50s. to 51s. per ton; No. 4 forge, 49s. per ton net, delivered in Sheffield or Rotherham. We announced last week an all-round advance of 6d. per ton in Lincolnshire irons, except in basic, which was not altered. These quotations still hold, as follows:—No. 3 foundry, 50s. 6d. per ton; No. 4 foundry, 49s. 6d. per ton; No. 4 forge, 49s. 6d. per ton; No. 5 forge, mottled and white, 49s. 6d. per ton; basic, 50s. 6d. per ton net, delivered in Sheffield or Rotherham. No improvement to report in the finished iron trade, and quotations continue as last given, viz., bars, £6 10s. per ton; hoops, £7 10s. per ton; sheets, £8 10s. per ton.

The Steel and Heavy Trades.

The strike in Sweden does not appear to have affected the local trade very much as yet, owing really to the lack of orders on the part of users of Swedish iron. The view taken at Hull, to which we referred last week, that the difficulty would probably be of short duration, appears at the time of writing likely to be realised. The situation, at all events, seems less acute at present, although those acquainted with the conditions in Sweden are not very optimistic about very smooth working in the immediate future. In the steel trade generally a considerable number of inquiries of small dimensions are reported, but nothing of any magnitude is coming forward. On the other hand, there is the feeling that, with the close of the holiday season, the influence of which is still apparent, more activity will result. This remark applies to steel for railway material in various branches, and also to engineering requirements. In marine material there is a little more activity, and local firms engaged in special lines report more inquiries, followed by orders.

Depressed Trade and Gas Consumption.

The half-yearly report of the Sheffield United Gas Light Company states that bearing in mind that the sale of gas in the half-years to June 30th, 1907 and 1908, showed increases of 9.33 per cent. and 6.59 cent. respectively, the directors hardly anticipated that in the present state of trade the rate of consumption would be maintained. They are therefore gratified to be able to report that instead of a falling off, as might have been expected, there has been an increase of 1.23 per cent. in the quantity of gas sold over the corresponding period of last year. The advantage to the company of the lower price of coal, which cost £8366 less, has been entirely nullified by the reduced receipts for residuals, which show a falling off of £8559.

NORTH OF ENGLAND.

(*From our own Correspondent.*)

Cleveland Pig Iron.

THE improvement in the market for Cleveland pig iron is fully maintained, and both demand and prices are becoming steadily more favourable to producers. For the first time since last November the price of No. 3 Cleveland pig iron has touched 50s., and on Wednesday of this week 50s. 9d. was the price for prompt f.o.b. delivery. The upward movement has brought in a good many speculators in Cleveland warrants, and this has helped the prices up. When the month began the buyers offered only 49s. 3½d. per ton for warrants; on Wednesday 50s. 8d. cash would be given, and the rise has gone on steadily upwards, with the exception that on Monday, when the price was 1s. 3d. per ton above the opening figure of the month, some of the speculators endeavoured to sell out and take their profits, and that brought the price down from 50s. 6½d. to 50s. 1½d. cash buyers. The market was not disorganised by this, because it is recognised that at intervals in every upward movement there must be such "set-backs," when speculators secure their profits. The 50s. 8d. cash offered on Wednesday by buyers shows a rise of 1s. 4½d. this month, and of 4s. 8½d. on the minimum figure of the year, which was 45s. 11½d. on March 16th. The general impression is that the upward movement will go on, as in most branches of trade which consume pig iron business is reviving, and besides this, the autumn season is at hand—that is a period when almost invariably demand improves and prices rise. It is not improbable that the improvement now being experienced is the usual autumn rise coming a little before its time. All the month consumers have been more ready to do business than makers, and the prospects appear so much better at present that buyers are endeavouring to place orders for execution well into next year; but, if it is advisable for consumers to buy for delivery well ahead, it is probable that sellers' best policy is to wait, rather than tie their hands in a rising market, especially when there are such encouraging reports from the United States, and in our own markets the tone has become distinctly hopeful, with confidence increasing. Producers, who towards the close of last week were readily accepting 50s. for prompt delivery, and, indeed, did a large business at that, were asking 50s. 9d. on Wednesday this week, with 51s. 3d. for delivery up to the end of October. No. 1, for prompt delivery, has risen to 53s., No. 4 foundry to 49s. 6d., No. 4 forge to 49s. 3d., and mottled and white to 48s. 9d.

Hematite Pig Iron.

The makers of East Coast hematite pig iron speak more favourably than for a long time about the business being done, for what is evidently a genuine revival is being experienced. It is certain that the greater activity is not induced by any speculative operations, such as affect the markets for ordinary Cleveland pig iron, for there is not, nor has there been for years, any hematite iron in the public stores in this district. The improvement in business would seem to justify the quotation of higher prices for hematite iron than now rule, especially as late quotations have been unprofitable. The price of mixed numbers has been advanced to 55s. 6d. per ton for prompt delivery, and in some cases to 56s. while 56s. 6d. is asked for delivery up to the end of the year, and 57s. 6d. for the first quarter of next year. No. 1 hematite is 6d. per ton above mixed numbers, and No. 4 forge 6d. less, and the tendency is towards higher rates. Makers badly need better prices, and if they were doing as well as the producers of ordinary Cleveland iron they would be realising 60s. 9d. for mixed numbers instead of only 55s. 6d. Rubio ore is becoming dearer, the merchants now asking 16s. 3d. per ton c.i.f. Middlesbrough, and others will not sell under 16s. 6d. Some good sales of ore have been made this month. Furnace coke is likewise becoming dearer, 15s. 9d. per ton being now the lowest price for delivery at Middlesbrough or equal thereto, but 16s. is quoted by most of the sellers, since the supply is hardly equal to the requirements, and the stocks that were recently held have disappeared.

Stock of Pig Iron.

The stock of Cleveland pig iron in Connal's public store is increasing heavily this week, because the local consumption has been greatly reduced, for almost all the local works which consume pig iron are laid off for the annual holidays on Teesside, which are given on the occasion of Stockton Races. As the blast furnaces do not cease production during the week, naturally a good deal of what is made goes into stock either with the makers themselves or in Connal's store. The quantity of Cleveland pig iron held on Wednesday by Connal's was 271,905 tons, an increase since the month opened of 12,734 tons. The stock consisted of 263,468 tons of No. 3, 6018 tons of No. 4 foundry, and 2419 tons of other pig iron not deliverable as standard. Thirteen months ago the quantity held in Connal's was under 48,000 tons, and the tonnage now is larger than it has been since the middle of 1907. The large increase this week, arising as it does from exceptional circumstances, has no disquieting influence on traders and does not prevent the prices improving.

Exports of Pig Iron.

Though shipments of pig iron from the Cleveland district to the Continent are disappointing, there are increases to other destinations, and the deliveries by sea on the whole are this month better than they were last month, and exceed those of the eighth month last year. It is expected that over the rest of this half year the exports will exceed those of the corresponding months last year, for trade was then very bad. The shipments this month to 18th reached 62,090 tons, compared with 53,826 tons last month; 53,195 tons in August, 1908; and 80,307 tons in August, 1907, all to 18th.

Manufactured Iron and Steel.

The improvement in the steel trade is giving much satisfaction, for it is regarded as an indication of the genuine character of the revival. Very fair orders have lately been booked for rails, plates, angles, sheets, hoops, &c., and the mills rolling them are more regularly employed than for a long time. On Teesside, however, this week, almost all the mills are stopped for the annual holidays. In other parts of the district works are running as usual, and generally more confidence in business is being manifested all round. But as yet the manufacturers have not announced any advances in prices. Steel ship plates are at £5 15s.; iron ship plates at £6; steel ship angles, £5 7s. 6d.; iron ship angles, £6 15s.; packing iron and steel, £5 5s.; steel bars, £6; iron bars, £6 15s.; steel hoops, £6 5s.; steel strip, £6 2s. 6d.; steel sheets (singles), £7 5s., all less 2½ per cent. f.o.t. Galvanised and corrugated iron and steel sheets, 24 gauge, in bundles, are at £10 10s. per ton f.o.b., less 4 per cent. Heavy steel rails are at £5 5s. net f.o.b. The export demand for steel has considerably improved, and the outlook generally is encouraging.

Shipbuilding.

The shipbuilders generally give sanguine reports of their business, and there is no doubt that orders have been booked rather freely of late, so that the position of builders is more satisfactory than it has been for more than two years past. It is reported that during the last few weeks orders for something like thirty steamers have been placed with Sunderland builders. It cannot be said that there is improvement enough in freights to warrant this, but it suits owners of regular lines to get rid of their old vessels and replace them by the most up-to-date craft, which they can do at prices which are as low as anything that are likely to be accepted. It is reported that two Tyneside builders have been invited to tender for a new Cunarder for the Atlantic service. It is expected that the new shipyard of Messrs. Smith's Dock Company, at Southbank, near Middlesbrough, will be ready within the next two or three months for building vessels, and it will supersede the firm's building yard at North Shields. The new yard, which adjoins the firm's new graving docks at Southbank, will be considerably larger than that at North Shields.

Coal and Coke.

In the gas coal trade there is much activity, and likely to be still more, but there is no doubt that the steam coal business has become slacker. Considerable inquiry is reported for gas coal for next year's delivery, and the outlook is encouraging. Best gas coals are generally quoted at 11s. 3d. per ton f.o.b. Best steam coals, which were recently 12s. 6d. to 13s. f.o.b., can now readily be obtained at 11s. 3d.; but buyers are slow about giving even so much, and it is rather difficult to secure orders. The supply of steam coal is ample, and while best qualities are at 11s. 3d., ordinary seconds can be got at 9s. 9d., and smalls at 4s. 9d. Coking coals are in fair request at about 10s. per ton. There is more doing in coke, and the prospects are brighter than for some weeks. Foundry coke has risen to 17s. 6d. and even 18s. f.o.b., and furnace coke is strong at 15s. 9d. to 16s., delivered at Middlesbrough. Bunker coals are quoted 9s. 9d. to 10s. per ton, and are in improving request.

NOTES FROM SCOTLAND.

(*From our own Correspondent.*)

The General Condition of Trade.

THERE seems to be a pretty wide-spread impression that we are not likely at once to experience a boom in trade. Upward movements in markets, it is recognised from the fluctuations taking place, are the result mainly of speculative causes. The improvements that have occurred in prices paid by consumers have mainly been dictated by these speculative influences rather than by expansion in legitimate demand. It is, therefore, recognised that in raising prices manufacturers should proceed with caution, in order that any real progress that is taking place should not be arrested. There is a disposition on 'Change to look on the trade situation in this spirit, while welcoming every substantial indication of improvement.

The Pig Iron Market.

There was a further advance in the prices of Cleveland warrants at the end of last week, but this was partially lost by sales that were made in the early part of the present week. The buying influence seems to have come from the South, where there has been a disposition to take a sanguine view of the situation. It is pointed out here that the statistics of pig iron are rather against a forward movement in buying and higher prices, stocks continuing to show an increase, and it is not unlikely that iron may fluctuate in values. A very considerable proportion of the business being done is for delivery at future dates up till November. Since last report, Cleveland warrants have sold at 50s. to 50s. 6½d. cash, 50s. 4d. to 50s. 9½d. one month, and 50s. 8½d. to 51s. 4d. three months, the higher rates not having been maintained. Transactions are also noted at 50s. 6d. for delivery on September 28th, and 50s. 10½d. for November 10th. A lot of Cumberland hematite warrants was done at 57s. 9d. for delivery in three months, and the cash quotation has risen from 56s. 9d. to 57s. 4½d. Standard foundry pig iron has risen from 48s. 9d. to 49s. per ton.

Scotch Makers' Pig Iron.

There has been a general advance in the prices of Scotch pig iron. Monkland is now quoted f.a.s. at Glasgow, No. 1, 57s.; No. 3, 55s.; Carnbroe, No. 1, 58s. 6d.; No. 3, 55s. 6d.; Clyde, No. 1, 61s. 6d.; No. 3, 55s. 6d.; Gartsherrie, No. 1, 62s.; No. 3, 56s.; Calder and Langloan, No. 1, 62s.; No. 3, 57s.; Summerlee, No. 1, 62s. 6d.; No. 3, 57s. 6d.; Coltness, No. 1, 88s.; No. 3, 58s.; Glengarnock, at Ardrossan, No. 1, 62s. 6d.; No. 3, 57s. 6d.; Eglinton, at Ardrossan or Troon, No. 1, 57s.; No. 3, 55s.; Dalmellington, at Ayr, No. 1, 60s.; No. 3, 55s.; Shotts, at Leith, No. 1, 62s.; No. 3, 57s.; Carron, at Grangemouth, No. 1, 64s.; No. 3, 57s. per ton. There has also been an advance in the prices of Scotch hematite, one firm intimating a rise from 47s. to 49s., while some merchants quote 58s. 6d. per ton for delivery at the West of Scotland steel works. There are 80 furnaces in blast in Scotland, compared with 76 at this time last year. Since last report one furnace has been taken off ordinary iron, and an additional one has been placed on hematite, and there are now 38 furnaces making hematite, 37 ordinary, and 5 basic iron. The ironmasters are doing a good steady business with English consumers, and the local trade appears to be improving, while the exports are still below the average.

Pig Iron Shipments.

The shipments of pig iron from Scottish ports in the past week amounted to 4371 tons, against 3393 in the corresponding week of last year. To Australia 315 tons were despatched, Canada 175, South America 180, India 75, Germany 150, Italy 105, Holland 152, Russia 30, Belgium 10, Spain and Portugal 165, China and Japan 100, other countries 100, the coastwise shipments amounting to 2814 tons, compared with 1096 in the corresponding week of 1908. The arrivals at Grangemouth of pig iron from Cleveland and district were 12,482 tons, being 2177 tons more than in the corresponding week of last year.

Finished Iron and Steel.

The question of prices has been considered this week at meetings of the finished iron and steel makers held in Glasgow. The rise in the cost of raw material forms a serious consideration, for it is not so long since values of manufactured iron and steel were reduced. No doubt there is at the moment some relief from cheaper fuel, but it is doubtful how long this advantage may continue. On the other hand, there is a danger of arresting whatever improvement has taken place in the demand by an increase in prices at this juncture. Only a few days ago the Scottish steel makers raised their prices for exported steel material 2½ per cent., in order that they might work in concert with makers in the North of England. From every point of view, therefore, it has been felt desirable to act cautiously. Boiler plates have been done at £6 15s., less 2½ per cent., for shipment to Australia. There is an improved call for shipbuilding material for home use, and it is considered likely that this class of business will now bulk more largely than for some time past. A fair inquiry exists for structural steel material for export to the Colonies, South America, and Canada. The makers of finished iron report a rather better inquiry, but the works have still only partial employment. The Canadian demand for steel appears to be developing to a considerable extent beyond what had been anticipated. But with all the orders available there does not appear to be an early certainty of the steel and iron plant in the West of Scotland being fully employed. Everything, except extreme bull reports, seems to point to a gradual improvement, and this will be gratefully hailed by all connected with the manufacture of iron and steel.

The Coal Trade.

The coal markets have been a little more active this week, but prices are still somewhat uncertain owing to heavy supplies. A number of colliers have been thrown idle and many others are on short time on account of the market being unable to absorb the current output. In some districts the miners have not sufficient employment to earn the recently fixed minimum of 6s. per day, and a large vote has been taken in one portion of Ayrshire in favour of a strike to establish this wage. The Coal Trade Conciliation Board is to meet in Glasgow on Monday in order to consider regulations for carrying out the wages agreement during the next three years, in terms of the decision recently arrived at the Board of Trade offices in London.

WALES AND ADJOINING COUNTIES.

(*From our own Correspondent.*)

Coal Exports and Prospects.

BUYERS, who have been anticipating a slump in prices, are not likely to be gratified, for the prospects appear to be gradually improving and getting into an orderly track. Coalowners are now quoting firmly and the month promises well. Foreign demands are considerable. On Tuesday, Cardiff despatched 70,000 tons. Over 5000 tons went to Cronstadt; Colombo, Monte Video, and Marseilles figured well. Newport also sent away large foreign shipments. Notwithstanding the hot weather experienced, house coal has kept up well, and little alteration can be expected this month, possibly not until the second half of the next. The men are now returning more numerously to work. Those spoken to appear to be more satisfied with the condition of things, and do not expect much agitation until March, when they say the question of small coal is likely to crop up again.

Last Week's Coal Trade.

An old authority on the trade, and constant in his appearance on Cardiff 'Change, cannot remember such a time as the present, when supplies have been so scarce, and not attributable to holidays or action of colliers, or disputes between coalowners and men, but due, it is his impression, to the eight hours movement. This I find is the impression of many, and it is telling in various ways. Failing to get supplies of the best steam, there has been a run upon other grades, and last week and for second class there was a good demand, best seconds realising 18s., and in some cases 18s. 3d., while ordinary sold freely at 15s. 6d. to 16s. Dry coals were very scarce, and best Monmouthshire well maintained the excellent position gained for some time. Nut and pea varieties were in request. Smalls, however, did not move off freely.

Latest Cardiff Prices.

Best large steam, 18s. to 18s. 3d.; best seconds, 16s. 6d. to 17s. 6d.; ordinary seconds, 15s. 6d. to 16s.; best drys, 16s. 6d. to 17s.; ordinary drys, 14s. to 14s. 6d.; best washed nuts, 14s. to 15s.; seconds, 13s. to 13s. 6d.; peas, 12s. 6d. to 13s.; seconds, 11s. to 12s.; very best smalls, 9s. 3d. to 9s. 6d.; best ordinaries, 7s. 6d. to 8s. 3d.; inferior sorts, 6s. 6d. to 7s. 3d.; best Monmouthshire black vein, 15s. 9d. to 16s. 3d.; ordinary Western Valleys, 15s. 3d. to 15s. 6d.; best Eastern Valleys, 14s. to 14s. 3d.; seconds, 13s. to 13s. 3d. Bituminous coal: Best house, 16s. 6d. to 17s. 6d.; best ordinaries, 14s. 6d. to 15s. 6d.; No. 3 Rhondda, 17s. 6d. to 17s. 9d.; brush, 13s. 6d. to 14s.; smalls, 10s. 6d. to 11s.; No. 2 Rhondda, 12s. 3d. to 12s. 6d; through, 9s. 6d. to 9s. 9d.; smalls, 8s. to 8s. 3d. Patent fuel, 15s. to 17s. 6d., fluctuating. Coke: Special foundry, 24s. 6d. to 27s. 6d.; foundry, 19s. to 22s.; furnace, 17s. to 18s. Pitwood, 20s. to 20s. 6d. Prices keep fairly strong, French and Portuguese. In Spanish wood there has been more alteration, and sales have taken place at 19s. 6d.

Newport Coal.

There is a stronger demand than can well be met. Men have been backward in returning to work. Up to Saturday the almost tropical weather detained many in harvesting and at the health resorts, but the change this week has begun to tell, and in another week the absentees will be very few. Over 81,000 tons of coal were despatched last week. Some attempt is being made to promote the sale of German East Asiatic coal, to the detriment of Cardiff and Newport steam, but success is doubtful. It was the case with Russian coal to Russia. Wales continues to export freely. Latest prices:—Best black vein, 15s. 9d. to 16s.; Western Valleys, 15s. to 15s. 3d.; Eastern Valleys, 14s. to 14s. 3d.; other kinds, 12s. 9d. to 13s.; best smalls, 8s. 3d. to 8s. 6d.; seconds, 7s. 3d. to 7s. 9d.; inferiors, 6s. 9d. to 7s. Bituminous: Best house, 15s. to 15s. 3d.; seconds, 14s. to 14s. 3d.; patent fuel, 14s. 6d. to 15s. 3d. Coke: Furnace, 17s. to 17s. 6d.; foundry, 18s. to 19s. Pitwood, 20s. to 20s. 6d.

Swansea Coal.

There has been no new feature of late. The attendance is improving, and there is a trifle more animation in business. The holiday influence is, however, still visible and felt. Last week nearly 75,000 tons of coal were shipped, and there was a better despatch of patent fuel, close upon 17,000 tons being recorded. Latest prices:—Best anthracite, hand picked, 23s. to 24s. net; seconds, 21s. 6d. to 22s. 6d. net; big vein, 18s. 6d. to 20s. 6d., less 2½; red vein, 12s. to 12s. 6d., less 2½; machine-made cobbles, 23s. to 23s. 6d. net; Paris nuts, 23s. 6d. to 25s. 6d. net; French nuts, 23s. 6d. to 25s. 6d. net; German nuts, 23s. 6d. to 25s. 6d. net; beans, 17s. 6d. to 18s. net; machine-made large peas, 11s. to 12s. net; fine peas, 10s. to 11s., less 2½; rubbly culm, 5s. 6d. to 5s. 9d., less 2½; duff, 3s. to 3s. 3d. net. Steam coal:—Best large, 15s. 6d. to 16s., less 2½; seconds, 13s. 6d. to 14s. 6d., less 2½; bunkers, 10s. to 10s. 9d., less 2½; small, 8s. to 9s., less 2½. Bituminous: No. 3, 17s. 6d. to 18s. 6d., less 2½; small, 9s. 9d. to 10s., less 2½. Patent fuel, 13s. 6d. to 14s., less 2½. Swansea trade last week showed a total increase of 20,000 tons.

More Watersheds for Wales.

Aberavon is stated to be suffering from a deficient water supply. Hitherto relief has been afforded from Margam, but it is now intended to get aid from Neath, where the Neath Council are preparing a means of supply from Ystradfellte reservoir. At Merthyr, which has figured in past shortages of water, there is now, it is calculated, sufficient supply for two months. Cardiff, with its third reservoir in Cwmtaff Valley, will be admirably placed for any demand. It is a creditable illustration of engineering capacity that the Brecon Beacons watershed should now figure among the great reservoirs of the country, and up to the Cardiff venture was scarcely known. Inland users of water for manufacturing purposes are surprised that on the seaboard scientific developments have not advanced sufficiently apace to bring sea water into use more generally. Margam, Aberavon, and Swansea are well placed for experiment.

Iron and Steel.

A better tone is beginning to characterise trade, though, so far, practical evidences are few. Railway iron continues to be un-noted, and is not expected until after the railway season. Billets continue to arrive from Bruges, and parcels are being forwarded principally from Newport to Lydney. A cargo of machinery has come from Antwerp to Port Talbot. This is expected to be for the German colliery, which is steadily but quietly being equipped. Iron ore in much increased quantities is coming in from Bilbao, and other sources of supply, a large proportion for Ebbw Vale. Scrap iron, totalling a large quantity during the week, has come from Portsmouth, Falmouth, and Scotland. Basic slag is being received from Antwerp. Latest prices at Swansea Metal Exchange:—Pig iron: Hematite mixed numbers, 56s. 6d. cash and month; Middlesbrough, 49s. 10½d. cash, and 50s. 0½d. month; Scotch, 55s. cash and month; Welsh hematite, 60s. to 61s. 6d. c.i.f. delivered; East Coast hematite, 60s. c.i.f.; steel bars, Siemens, £4 8s. 9d. to £4 10s.; Rubio ore, Newport or Cardiff, 15s. 6d. to 15s. 9d.; seconds, 14s. to 14s. 6d. Other quotations:—Copper, £59 cash, £59 18s. 9d. three months; lead, £12 17s. 6d.; spelter, £21 18s. 9d.; silver, 23½d. per ounce.

Tin-plate.

Some results of the heat were the short supplies given from the works. The works in the Swansea district last week recorded a make of only 37,343 boxes. Shipments to home and foreign destinations totalled 67,027 boxes, and stocks now consist of 137,035 boxes. Good trade with little special to record. The heat last week was so great that operations were considerably affected. Prices much the same. Ordinary Bessemer and Siemens tin-plates, I.C., 20 by 14, 112 sheets, 108 lb., 11s. 10½d. to 12s.; I.C., 28 by 20, 56 sheets, 108 lb., Bessemer primes, 12s. 3d.; Siemens primes, 12s. 3d.; ternes, 28 by 20, 112 sheets, 21s. 3d. to 21s. 6d. C.A. roofing sheets, £8 5s. to £8 7s. 6d.; big sheets for galvanising, £8 7s. 6d. to £8 10s. per ton; finished black plate, £9 5s.; galvanised sheets, 24 g., £10 10s. to £11 nominal per ton. Block tin, £133 10s. It is said that the anti-dumping clause in the Canadian tariff, which came into operation in May, 1908, greatly benefited the Welsh trade in the Dominion, but the clause has now been withdrawn, with bad results to Wales.

Swansea Valley.

A number of furnaces remain idle. Upper Forest Mills, after a fortnight's delay from repairs, are again working well. Mond and Co.'s silver works, after repairs, are again brisk. Spelter works active.

AMERICAN NOTES.

(*From our own Correspondent.*)

NEW YORK, August 10th.

THE most interesting feature this week is the action of many railroad companies in making known their present, and, in some cases, their prospective requirements for steel cars. So far this month the orders for steel cars total 30,000. The Pressed Steel Car Company has contracted with the Carnegie Steel Company for 20,000 tons of steel. This company also booked an order for 2000 tons steel plates from the American Shipbuilding Company. Jones and Laughlins Company, Pittsburg, have contracted to furnish the American Car and Foundry Company with all the steel it will need. The tin-plate situation has been improved by the withdrawal of duties on tin-plate entering Canada, which had been in force two years. A very active demand has sprung up for light rails from 16 lb. to 45 lb. sections. July bookings of the Carnegie Steel Company were the largest for two years. Last week's orders amounted to 2600 tons. The Illinois Steel Rail Mill is sold up to December, and has been obliged to send an order for 8000 tons to the Carnegie Steel Company. The rail-making capacity of the Gary plant is sold up until November 1st. The Baltimore and Ohio Railroad Company is in the market this week for 30,000 tons of steel rails. Quite a number of inquiries are in the market from railroad companies for quantities of steel castings and minor equipments. The New York Central is asking for terms for 2000 cars, several of which are to have extra wide doors for the transportation of automobiles. The Erie Railroad wants 200 cars and the Atlantic Coast Line 200. The Pennsylvania Company is asking prices for 12,000 steel truck bolsters and the Baltimore and Ohio for 16,000 bolsters and 32,000 cast steel truck frames. An order for 13,500 tons of bridge material went to a Pittsburg firm to be used in the construction of a bridge at Kansas City, Missouri. This bridge is a part of a great enterprise involving the expenditure of 20,000,000 dols. in a terminus at Kansas City by which all the various systems of railroads can be centred. The Forged Steel Company, Butler, Pa., has ordered 6000 tons for a steel plant to be erected at once. Copper has been very active of late. Sales last week amounted to 20,000,000 pounds, mostly for export. The result is a hardening of prices. Orders for steel booked during July were over 150,000 tons. Tin is arriving freely. Arrivals expected this week 2178 tons. The entire market is stronger, and a general buying movement has set in. Tariff duties are fixed, and business interests see their way clearly. Prices will probably exhibit an upward tendency from now on.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

THE First Lord of the Admiralty has appointed Captain Herbert E. Purey Cust, R.N., assistant hydrographer, to be hydrographer of the Navy in the place of Rear-Admiral Arthur M. Field, F.R.S., whose term of office in that appointment has expired.

MR. A. W. BLAKE, A.M.I. Mech E., A.M.I.E.E., asks us to state that he is severing his connection with the firm of Mills, English and Co., Limited, of Castle-square, Swansea, and that his future address will be 66, Wind-street, Swansea, where he intends to practise as a consulting engineer, devoting special attention to colliery and works equipment.

MR. FRANK STUART-MILNE, who some time ago left the Newcastle-upon-Tyne Electric Supply Company, Limited, to take up an appointment in the Argentine in connection with the electrical department of the State Railways, has commenced business in Buenos Aires as commercial engineer and agent for British railway, mechanical and electrical engineering firms. Associated with him as British engineer and secretary is Mr. J. A. Seager, of Emerson Chambers, Newcastle-on-Tyne.

NOTES FROM GERMANY, FRANCE, BELGIUM, &c.

(*From our own Correspondent.*)

Rheinland-Westphalia.

Pig iron, as well as manufactured iron, remains in quiet demand generally. Here and there an improvement over the previous month can be stated, but it is of a passing nature, and the majority of the shops and factories are only very moderately occupied, and they are somewhat uneasy about the future because so little fresh work is given out. Accounts from Düsseldorf state that the sales of the Steel Convention in July of present year were 397,914 t., against 418,626 t. in June of present year, and against 388,709 t. in July, 1908. This shows deliveries to have been 20,712 t. lower than in June, and 9205 t higher than in July, 1908. Of the sales in July of present year, 123,456 t. were semi-finished steel, against 114,188 t. in June, and against 114,335 t. in July, 1908; railway material, 134,121 t., as compared with 146.588 t. in June, and 147,420 t. in July, 1908; sectional iron, 140,420 t., as compared with 157,850 t. in June of present year, and 126,954 t. in July, 1908.

Iron and Steel in Silesia.

A want of confidence prevails among consumers, and purchases have accordingly been limited. A fairly regular business of the hand-to-mouth sort is being done in finished articles, hoops showing much life, while the construction shops complain of being only very indifferently employed. There is hardly any business done for the fourth quarter. Export is languid.

List Quotations.

The following are the current rates as given on the Düsseldorf 'Change:—Raw spathose iron ore, M. 10.90; roasted ditto, M. 15.50; Nassau red iron ore, M. 11.50 per ton net at mines; spiegeleisen, 10 to 12 per cent., M. 60 to M. 63; white forge pig, Siegerland and Rhenish-Westphalian quality, M. 55 to M. 58; iron for steel making, M. 54 to M. 56; German Bessemer, M. 56 to M. 58; basic, free place of consumption, M. 48 to M. 50; Luxemburg forge pig, free Luxemburg, M. 44 to M. 45; Luxemburg foundry pig, No. 3, M. 45 to M. 46; German foundry pig, No. 1, M. 54 to M. 56; No. 3, M. 53 to M. 55; German hematite, M. 55 to M. 57; common bars in basic, M. 95 to M. 102; iron bars, M. 122.50 to M. 125; hoops in basic, M. 120 to M. 122.50; common plates in steel, M. 104 to M. 110; boiler plates, M. 114 to M. 120; sheets, M. 117.50 to M. 125; drawn wire in iron or steel, M. 127.50.

Production of Pig Iron in Germany.

According to official accounts given by the Union of German Iron and Steelmasters, the output of pig iron in Germany, including Luxemburg, was for July of present year 1,091,059 t., against 1,067,421 t. in June, 1909, and against 1,010,770 t. in July, 1908. Production in the different sorts was as follows:—Foundry pig, 211,928 t., against 185,563 t. in the same month last year; Bessemer, 35,065 t., against 29,680 t.; basic, 695,915 t., against 668,669 t.; steel and spiegeleisen, 91,054 t., against 68,845 t; forge pig, 57,097 t., against 58,013 t. Output during the period from January to July of present year was 7,340,548 t., against 7,060,491 t. in the same period last year.

The German Coal Market.

Sales in engine and house coal continue moderate, though here and there more inquiry has been noticeable. Sales of the Rhenish-Westphalian Coal Syndicate in June of present year have been 5,341,241 t.; total output of the Syndicate pits was 6,599 879 t., against 6,257,421 t., or 270,764 t. per day; in May, 6,499,930 t., or 270,830 t. per day, have been produced. During the first six months of present year output was 31,091,872 t., as compared with 33.319,501 t. in the same period last year; sales of the Syndicate were 22,485,938 t. coal this year, against 23,366,140 t. in the corresponding period last year.

Austria-Hungary.

No forward movement has taken place in the iron and steel industry since previous reports. Purchases are very limited, both in raw and in finished iron, and the condition of prices remains weak. Pit coal sells moderately well, and the brown coal trade has maintained its former liveliness.

More Business done in France.

Makers of iron and steel give a fairly good account of last week's trade, and prospects are brightening on the whole. Activity at the various establishments is satisfactory, and likely to continue brisk, as the orders booked are pretty numerous. The ironworks in the East are in especially good employment, also those of the Marne and Centre. Two to five months have been asked for delivery in several cases. Autumn trade is likely to show a good deal of life. Merchant iron stands at 175f. to 180f. in the East and Marne departments, but in the North and in the Ardennes rates do not rise above 155f. to 160f. p.t.; plates of 3 mm. obtain 190f. to 195f. p.t.; minimum price in the North being 165f. to 170f. p.t. The quotations fixed for the last two quarters of the year are very firmly maintained. The French coal trade is unchanged and firm, prospects are fair, and rates have been tending upwards.

LAUNCHES AND TRIAL TRIPS.

Alagoas, torpedo-boat destroyer; built by Yarrow and Co.; to the order of the Brazilian Government; dimensions, 240ft. by 23ft. 6in.; engines, triple-expansion; launch, July 29th.

Annaberg, steel screw steamer; built by Swan, Hunter and Wigham Richardson, Limited; to the order of the Deutsch-Australische Dampfschifffahrts Gesellschaft, of Hamburg; dimensions, 400ft. by 52¼ft. beam; to carry 7500 tons; engines, triple-expansion; constructed by the builders; trial trip, August 12th.

Harpeake, steel screw steamer; built by Wm. Gray and Co., Limited; to the order of J. C. Harrison, Limited, London; dimensions, 396ft. 6in. by 51ft. by 29ft.; engines, triple-expansion, 26in., 42in., 70in. by 48in. stroke, pressure 180 lb.; constructed by the builders; trial trip, August 12th.

Char, steel barge; built by Sir Raylton Dixon and Co.; to the order of the Rea Transport Company, of London; dimensions, 125ft. by 24ft. by 12ft. 6in.; to carry 550 tons; the machinery is being worked by a Cochran donkey boiler; launch, August 14th.

Woodmere, steel screw steamer; built by the Blythe Shipbuilding and Dry Docks Company, Limited; to the order of Falconer, Ross and Co., of Newcastle-on-Tyne; dimensions, 193ft. 8in. by 26ft. 6in.; engines, triple-expansion, 15in., 25in., 41in. by 27in. stroke, pressure 180 lb.; constructed by C. T. Grey, of South Shields; trial trip, August 14th.

Lancer, steel screw steamer; built by the Tyne Iron Shipbuilding Company, Limited; to the order of Fisher Renwick and Co.; dimensions, 240ft. by 34ft. by 24ft.; engines, the North-Eastern Marine Engineering Company, Limited, 18in., 30in., 49in. by 33in. stroke, pressure 180 lb.; constructed by the North-Eastern Marine Engineering, Company; launch, August 16th.

A railway motor inspection car which can be changed to a road automobile by substituting pneumatic tired for the flanged steel wheels has been built for the Chicago and North-Western Railway.

BRITISH PATENT SPECIFICATIONS.

When an invention is communicated from abroad the name and address of the Communicator is printed in italics.

When the abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent-office Sale Branch, 25, Southampton-buildings, Chancery-lane, London, W.C., at 8d. each.

The first date given is the date of application; the second date at the end of the abridgment is the date of the advertisement of the acceptance of the complete specification.

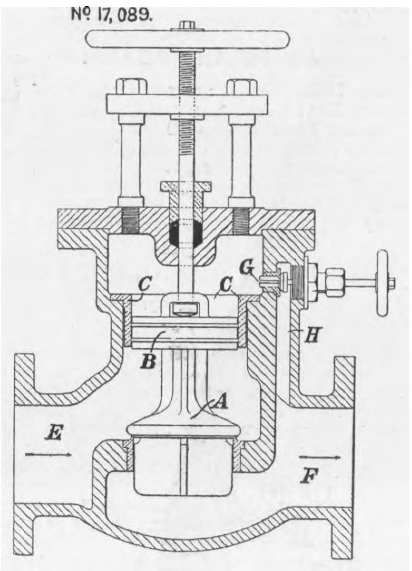
Any person may on any of the grounds mentioned in the Acts, within two months of the date given at the end of the abridgment, give notice at the Patent-office of opposition to the grant of a Patent.

STEAM ENGINES.

17,089. August 14th, 1908.—Improvements in and relating to Stop Valves, John Auld, of Whitevale Foundry, Rochester-street, Glasgow.

The piston B, which is connected to the valve A, may be situated within a cylinder C. The steam entering by the inlet branch E is conducted to the space between the top side of the valve A and the underside of the piston B. Assuming the valve A to be shut, the whole pressure of the steam on the valve keeps it tightly shut, and the steam pressure passing the balancing piston B exerts an equal force on both sides of the piston. In order to open up the main valve A a small wheel valve G, situated between the upper side of the cylinder C above the piston B and the outlet branch F, is opened up, thus putting the cylinder space above the piston B in direct communication with the outlet branch F of the main valve chest. The steam escaping past the piston into upper part of cylinder now flows through the open wheel valve G by a port H, through the outlet branch F into the piping or other steam chambers, so relieving the pressure off top side of piston B and establishing an equal pressure on top of piston B and bottom side of valve A. The pressure is also equal between bottom side of piston B and top side of valve A. Consequently the main stop valve is easily opened up by means of the hand wheel. A modification is dealt with.—*July 28th*, 1909.

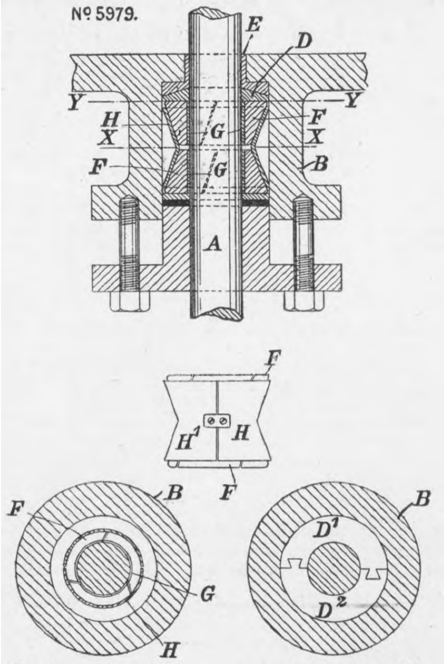
Nº 17,089.



5979. May 12th, 1909.—Improvements in Metallic Packings for Piston-rods and the Like, James Green, 82, Plane-street, Kingston-upon-Hull.

A washer D fits the usual neck ring E, as well as the rod A and the stuffing-box B. This washer, which may be either tapered as shown or have both sides flat, is made in sections D¹ D², which may be halves as shown or otherwise, which sections are dovetailed together as shown, so that the metal ring being held intact is not liable to fall out of the stuffing-box when the gland is removed. Another part of the invention consists in making the tapered segments F in brass or other suitable metal or material and simply lining them internally with strips or liners G of white metal, so that the tapered segments remain permanent and the cost of renewal is small, as only the white metal becomes worn; and a further improvement consists in making the brass casing H for enclosing the tapered segments F in sections and providing overlaps H¹ to tie them together by means of screws. The utility of this improvement is that the packing can be inserted in the stuffing-box without either removing the piston-rod crosshead or the piston from the end of the rod, thus, of course, saving much time and labour.—*July 28th*, 1909.

Nº 5979.

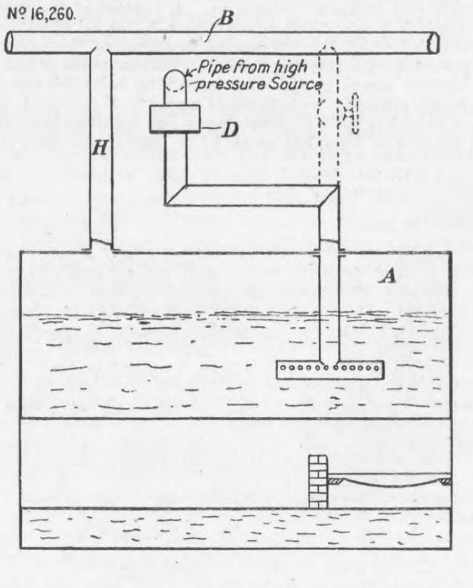


STEAM GENERATORS.

16,260. July 31st, 1908.—Improvements in or relating to the Utilisation of Low-pressure or Exhaust Steam for the Production of Motive Power, James Howden and Company, Limited, of 195, Scotland-street, Glasgow, and William Henry Owen, of 19, Home Park-road, Wimbledon, S.W.

This invention relates to the utilisation of low-pressure or exhaust steam for the production of motive power by means of turbines arranged to receive the steam on its way to the condenser. As long as the engine or other supply of exhaust steam is working normally, the exhaust steam flows through the pipe B to the turbine, and thence to the condenser in the ordinary way. If, however, the exhaust should be interrupted for any reason, as, for instance, owing to the stoppage of the engine from which it is derived, then the automatic valve D admits live steam direct from the boilers which may be working the engines. In this way the pressure of live steam will be reduced to that of the vessel A, and hence an interchange of heat between the live steam and the water in the vessel A will take place and the vessel will become charged with low-pressure steam and also act as a thermal reservoir. In this way a supply of minimum pressure steam accumulates in the vessel and flows through the pipe H to the turbine, and the working of the latter will be properly maintained. The vessel A serves as a low-pressure boiler, and can act as a third and further supplementary supply of low-pressure steam.—*July 28th*, 1909.

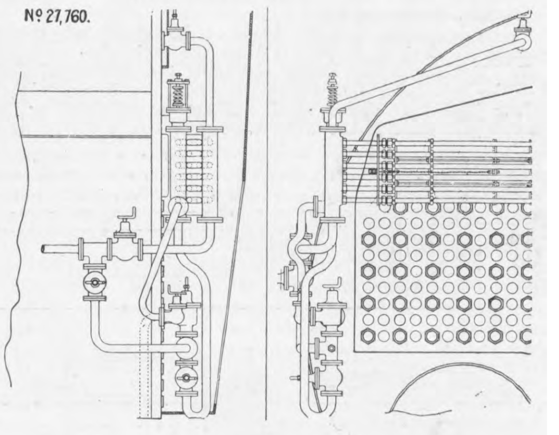
Nº 16,260.



27,760. December 21st, 1908.—Improvements in and relating to Economisers for Marine Boilers, Waldemar Harbinger, of Blackwall Ironworks, Blackwall, London.

This invention relates to economisers for marine boilers and has for its object to provide an efficient means for heating the feed water, or increasing the heating surface of the boiler. An economiser constructed, arranged, and adapted to operate in accordance with this invention comprises a series of pipes forming the economiser disposed in the smoke-box which carries off the products of combustion, pipe connections from the feed pump to the economiser, and from the economiser to the boiler, cocks to direct, and pipes to circulate the water from the feed pump directly to the boiler without passing through the economiser, pipes to put the economiser into circulation with the boiler when the economiser is not in use for the purpose of heating the feed water, and means for scraping the economiser pipes externally. There are five other illustrations.—*July 28th*, 1909.

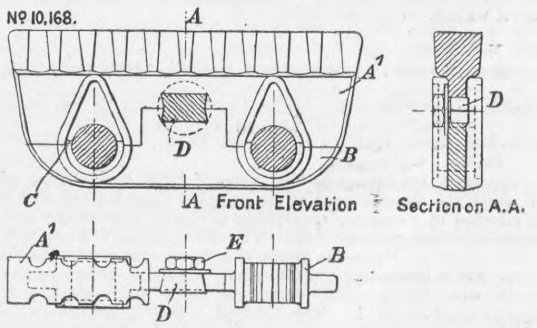
Nº 27,760.



10,168. April 29th, 1909.—Improvements in Chain Grates, *Friedrich Heinicke, of Chorzow, Kattowitz, Upper Silesia, Germany.*

By the present invention the changing of a link can be effected in six to ten minutes, with the labour of only one man, and it has been found by experiment that this can be done while the grate is in motion. The link has the same appearance as the ordinary link. It is, however, made of two parts A¹ and B, which are fitted together like a bearing; for instance, by means of the noses C. The two parts A¹ and B can be held together in various ways, a very advantageous method being the form of construction shown in the accompanying engravings. Here the parts are held together by a wedge D. The lateral surfaces of this are in the shape of a double dovetail, the one half engaging in the part A¹,

Nº 10,168.

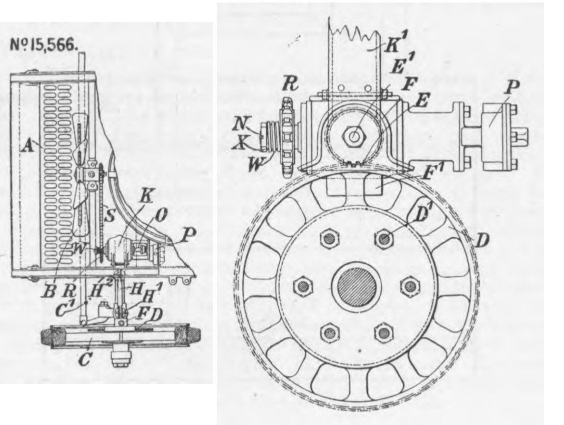


and the other half in the part B of the link. The wedge is also provided with a tightening screw E, by means of which it can be tightened up. The insertion of a link is effected by applying the two parts of the link to the round bars carrying the links, and then coupling them together by means of the wedge.—*July 28th*, 1909.

MOTOR CARS AND ROAD TRAFFIC.

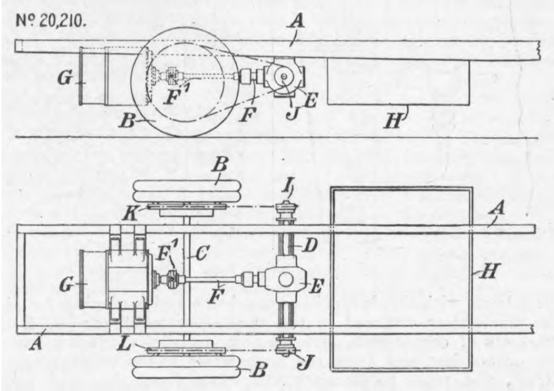
15,566. July 22nd, 1908.—Improvements in or relating to Self-propelled Road Vehicles, Thomas Clarkson, engineer, and William John Morison, both of Moulsham Works, Chelmsford, Essex.

This invention has particular reference to vehicles in which steam is used as a motive power, its object being the construction of simple and compact mechanism. A portion of the fore part of the chassis is shown, having a condenser A, behind which is a fan B. One steering wheel C is illustrated mounted in the usual manner and provided with steering gear C¹. On the inside of the wheel C is a toothed wheel or disc D attached by bolts D¹, the teeth of this wheel engaging with those of a pinion E mounted upon the end of a short spindle E¹, rotatable in ball bearings in a bracket F. This bracket is mounted as at F¹ so that it can turn about the vertical axis, about which the wheel moves when turned for steering purposes. Thus the pinion E and wheel D remain in gear however the road wheel may be turned. Connected to the spindle E¹ by a universal joint H¹ is a rod H joined at its other extremity by another universal joint H² to a spindle. This spindle is carried in bearings in a casing K secured to some portion of the frame as at K¹. Upon the spindle is mounted a bevel pinion gearing with another bevel pinion on a shaft N. This shaft N is mounted in bearings in the casing K and is connected to the spindle O of a rotary pump P. The end of the spindle N remote from the pump P carries a sprocket wheel R, which, through a chain S, drives the fan B. In order to allow for slip in starting and stopping, the sprocket wheel R is not mounted directly upon the spindle N, but is gripped friction-tight between two plates. The uppermost plate is mounted on a flanged sleeve pressed down by a spring W controlled by a nut X on a screwed portion at the end of the shaft N. There are two other illustrations.—*July 28th*, 1909.



20,210. September 25th, 1908.—Improved means of Converting Existing Petrol Chassis into Electric or Electric-Petrol Vehicles, William Arthur Stevens, of St. Peter's-street, Maidstone, Kent.

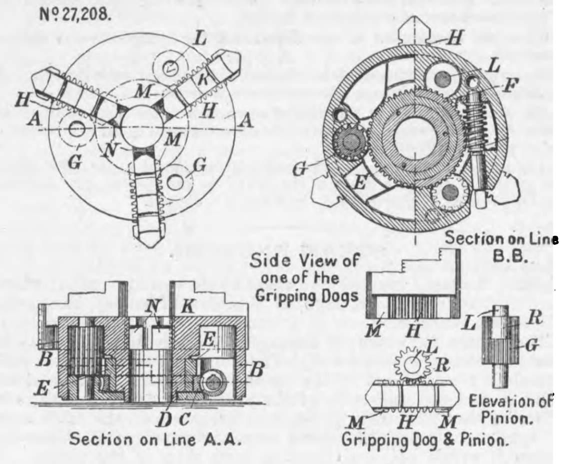
In the engravings A is the frame of the vehicle, only the back portion of which is shown. B B are the back wheels. C is the axle. D is the tubular casing containing the differential shafts. E is the bevel gear and differential casing for transmitting the drive. This gear casing is of well-known construction. The smaller gear wheel in the differential gear box is driven by the cardan shaft F, which is provided with the cardan or universal joint F¹. G is an electric motor bolted by means of four carriers in the centre of the frame behind the back axle. The electric motor G may receive its energy from a petrol engine and dynamo of usual construction preferably placed in the front of the vehicle. Or the electric motor may be driven by batteries placed within the housing or receptacle H secured to the frame A. The ends of the differential shaft are fitted with the sprocket wheels I J by means of which the chain wheels K L respectively on the wheels B B are driven. The chains fitted to these wheels are indicated by the dotted centre lines. A worm and worm wheel may be used within the casing E for driving the differential instead of bevel wheels.—*July 28th*, 1909.



MACHINE TOOLS AND SHOP APPLIANCES.

27,208. December 15th, 1908.—Improvements in or relating to Self-centring Lathe and Drilling Chucks, *The Maschinenfabrik Kleber and Siewerdt Nachf., of Oranienburg, near Berlin, in Germany.*

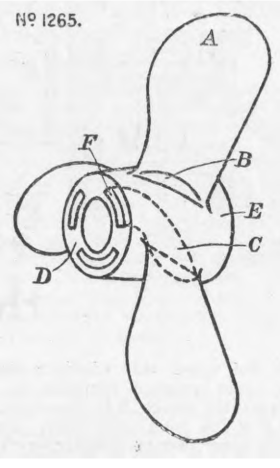
The invention relates to that type of lathe and drilling chuck in which the displacement of the gripping dogs formed with teeth is effected by a common controlling device so as to ensure the self-centring of the gripping dogs. The chuck casing is fitted with the usual cover C. Upon the hollow boss D is mounted a toothed wheel E for use in imparting simultaneous motion to other parts, this tooth wheel being rigidly connected to a worm wheel F driven by the usual worm F. The toothed wheel E engages with the pinions G, which latter engage in the teeth H of the gripping dogs K. The shaft L of each pinion is mounted cross-wise in the chuck and its cover C, and this is only made possible by reason of the side teeth H of the gripping dogs K. It is important to have plain feathers or keys M at each side of the gripping dogs in such a way as to exactly fit the guide grooves N and thus close the latter constantly in a perfect manner. By providing teeth H at each side of the gripping dogs with the keys M at each side and at each end thereof, it is made possible to reverse the gripping dogs and thereby enable them to serve for external and for internal gripping. This makes a second set of dogs unnecessary. In order to permit of the introduction of the dogs without having to take the whole chuck to pieces, it is necessary to make the driving pinions G of the dogs with a cut away surface or mutilated portion R.—*July 28th*, 1909.



SHIPS AND BOATS.

1265. January 18th, 1909.—Improvements in or relating to Propelling Devices for Ships, William Lovis, of 29, Totnes-road, Canning Town, London, E.

This invention relates to improvements in propelling devices for ships. Each propeller blade A has an opening or recess B at the root, the recess or opening having a core or passage C leading direct from the root of the blade to the rear end D of the boss E. The boss may be perforated from end to end, and is preferably, but not necessarily, formed tapering towards the rear end. The passage or core C leads to the rear end of the boss, where it terminates in a hole F preferably of elongated section situated between the blades. By this arrangement the fluid is drawn to the root of the blade whereby the centrifugal motion of the fluid set up by the revolving propellers is in part neutralised, and increased blade surface is brought into action. On account of the jets issuing from the perforations at the rear end of the boss and on account of the shape of the boss, cavitation and also the suction following the vessel is considerably reduced.—*July 28th*, 1909.

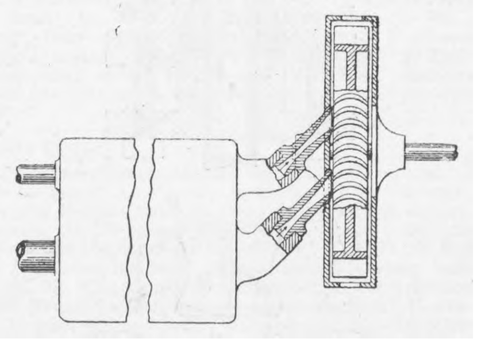


SELECTED AMERICAN PATENTS.

From the United States Patent-office Official Gazette.

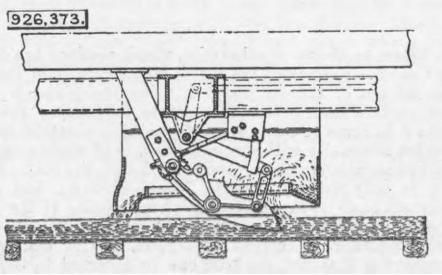
926,157. Turbine Engine, *C. W. Weiss, New York, N.Y.—Filed September 19th*, 1903.

The turbine is of the de Laval type. There are two nozzles, one of which delivers the products of combustion under pressure without preliminary cooling, and the other steam or compressed air, either at a much lower temperature. There are six claims.



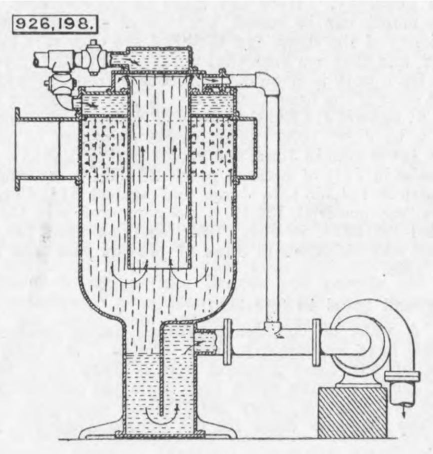
926,373. Water Supplying Device for Locomotive Tenders, *J. L. Wissinger, Gallitzin, Pa.—Filed October 10th*, 1908.

A pan is fixed to receive water splashed over by the scoop. This water returns at each side of the scoop back to the trough between the rails. There are seven claims.



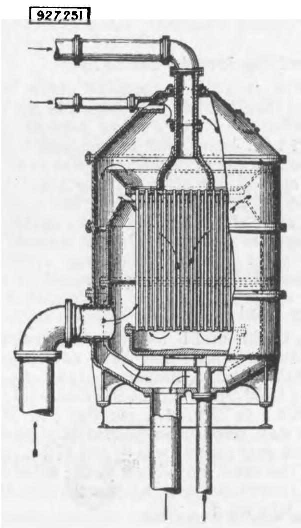
926,198. Steam Condenser, *E. Koerting, Pegli, Italy, assignor to Schutte and Koerting Company, Philadelphia, Pa., a Corporation of Pennsylvania.—Filed July 30th*, 1908.

This patent is for a condenser comprising a chamber containing a partition wall dividing it into inner and outer compartments which communicate at their bottom, and means for showering water through and discharging it from the chamber, in combination with a steam inlet into one of said compartments and an air exhaust passage leading from the other. There are eleven claims.



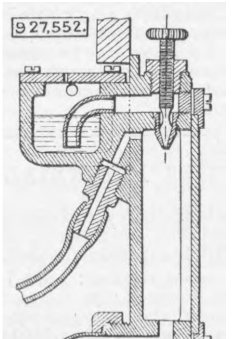
927,251. Condenser, *A. Kuylenstjerna, Philadelphia, Pa.—Filed March 16th*, 190-.

This patent is for a barometric condenser comprising an outer shell, an inner shell enclosed therein and spaced therefrom, a surface condenser mounted in said inner shell and delivering the distilled water to the inner shell and the cooling water to the outer shell, an exhaust pipe opening into the inner shell, a suction pipe connected to the top of the outer shell, a tail pipe for the cooling water connected to the bottom of the outer shell, a tail pipe for the distilled water connected to the bottom of the inner shell, and a hot well divided into two chambers for the cooling water and the distilled water, respectively, situated at a greater distance below the bottom of the outer shell than the height of a column of water maintained at normal barometric pressure, the hot well being provided with an overflow passage from the top of the distilled water chamber, and a draw-off pipe from the lower part of the chamber. There are nine long claims.



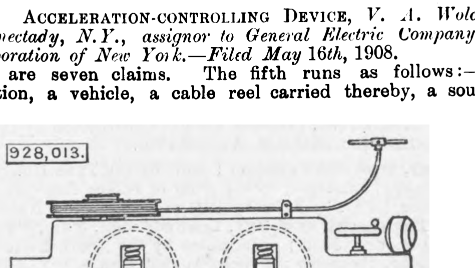
927,552. Engine Lubricating Device, *A. Krebs, Paris, France, assignor to La Société Anonyme des Anciens Etablissements Panhard et Levassor, Paris, France.—Filed February 15th*, 1908.

The patent is for the combination in a motor lubricator of an oil reservoir, a fixedly adjustable needle valve controlling the flow from the reservoir, a pipe connecting the valve with the carburetter, and communicating to the reservoir the variations of the vacuum in the carburetter. There is only one claim.



928,013. Acceleration-controlling Device, *V. A. Wolcott, Schenectady, N.Y., assignor to General Electric Company, a Corporation of New York.—Filed May 16th*, 1908.

There are seven claims. The fifth runs as follows:—In combination, a vehicle, a cable reel carried thereby, a source of current, a reel motor connected thereto supported on said vehicle, and arranged to rotate said reel, and means including an inertia operated device for increasing above normal the voltage applied to said reel motor during acceleration thereof.



THE TEHUANTEPEC RAILWAY AND TERMINAL PORTS.

No. I.

One of the most remarkable features in connection with the early conquests by the Spaniards was their knowledge of topography, and this in spite of the fact that the maps which existed in those days were of the very crudest character. It did not take Hernan Cortes, the conqueror of Mexico, who landed on the coast on March 4th, 1519, very long to appreciate the best way of getting across the huge continent. Those who study a modern map will see that the Spaniard selected the very narrowest neck of land; and the question is how he arrived at the knowledge which influenced him. In a letter which Cortes addressed to his Sovereign, Charles V. of Spain, after pointing out that he had "despatched an expedition to Guatemala" he says:—"I have received information, as well as of the great riches of that country, that in the opinion of my navigators there is a strait leading from that bay into the opposite sea, which is the thing above all others in the world I am desirous of meeting with on account of the immense utility which I am convinced would result from it to the advantage of your Imperial Majesty."

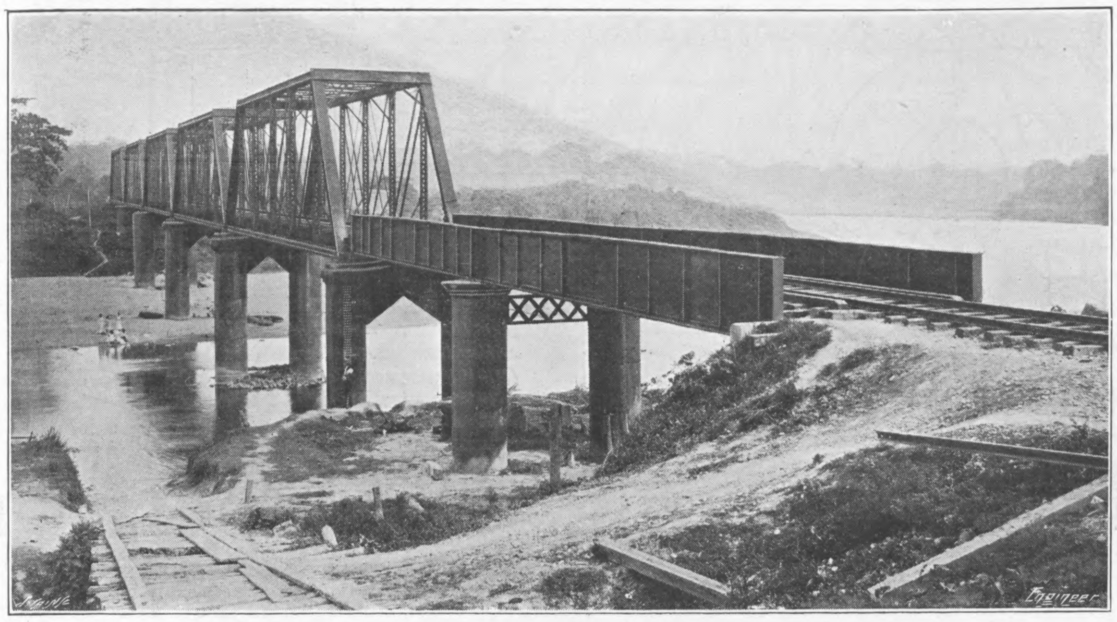


Fig. 1—BRIDGE OVER THE JALTEPEC RIVER AT SANTA LUCRECIA

After Cortes came the Colonial Governments of Mexico, which were also prompt to realise the geographical and strategical importance of the Isthmus of Tehuantepec. Again and again under successive governors, the route was explored and surveyed, the idea being, there can be no question—for documents prove it—to cut a canal through the isthmus in practically the same way as that at Panama is now being made. A certain Agustin Cramer, an engineer of some repute in his day, was commissioned by the Viceroy, Don Antonio M. de Bucareli, in 1774, to make the necessary surveys of the isthmus, and, this being done, he strongly advocated the opening up of a canal to connect the Pacific and Atlantic Oceans. Either the Government lacked the funds or the pluck to make the attempt; but, the advantages of such an undertaking being obvious, efforts were made by American capitalists to take up the project. A notable American civil engineer, Captain James B. Eads, having expended some time and much trouble upon surveying the ground in 1881, drew up plans for a ship railway, a scheme which, as it may be remembered, was at one time strongly recommended for the Panama route as also for that of the Darien. Experience now proves conclusively that a ship railway would have been impossible in practice.

Captain Eads finding no one sufficiently enterprising to support him financially, although the Government gave him every inducement by renewing his concession again and again, a Mexican named Don Delfin Sanchez endeavoured to raise sufficient funds to carry out a contract which he had made to do the work, but he failed, his contract being rescinded in 1888. Don Delfin Sanchez was a very much esteemed engineer, whose *bonâ fides* was unquestionable, and his railway connection eminently commendable. He was granted a regular contract to build the railway, for which he was to be paid at the rate of 25,000 dols. (£2500) per kilometre. The contract was signed in October, 1882, and the line was to be completed and opened for traffic by February, 1885. By the commencement of 1883, however, the arrangement was found to be unworkable; but, meanwhile, Senor Sanchez had received a considerable sum from the Government "on account," payments having been made to him amounting to 700,000 dols. at the offset, while a further sum of 733,134 dols. was paid—562,190 dols. for material used and work done upon 108 kiloms., and 170,224 dols. as an indemnity for having his contract cancelled. This brings us to the end of 1888.

To Don Delfin Sanchez succeeded Colonel Edward McMurdo, of London and New York, who, with that boldness and irresponsibility which characterised him through life, entered the lists as contractor; and there is no saying what might have been the result had not McMurdo died in 1892. That the issue might easily have been chaos is possible when one remembers what happened in connection with the Lorenzo Marquez (Portuguese South Africa) Railway concession, which was also secured by the same enterprising American engineer. At the time that Colonel McMurdo entered upon the scene, as already stated, about some 108 kiloms. of line had been laid—we cannot use the word "constructed"—by Don Delfin Sanchez, and paid for by the Mexican Government. There remained 288 kiloms. further to build, and only a very small proportion of this had been completed when death put an end to McMurdo's enterprise.

In January, 1892, his widow came to an arrangement with the Mexican Government to rescind the contract; and here attention may be called to the honourable manner in which the Government dealt with Mrs. McMurdo, offering liberal terms of compensation instead of demanding recompense for not carrying out the contract, a policy which contrasts vividly with the attitude adopted by the Portuguese Government towards the same lady, as executrix, in connection with the Lorenzo-Marquez Railway. A settlement in this latter case was delayed for years, and finally the question went to arbitration, when a most inadequate award was made in favour of Mrs. McMurdo.

With the disappearance of the American element, other *entrepreneurs* appeared upon the scene in the persons of Messrs. J. H. Hampson, E. L. Corthell and the Hon. Chandos S. Stanhope. In February, 1892, these gentlemen commenced to build and complete the remainder of the line, which they undertook to extend to Salina Cruz by June, 1893. It was a rash contract into which to enter, for, as any practical engineer could have seen, it was quite impossible that the line could have been finished in anything like this time. It is not surprising to learn that the combination soon collapsed, Messrs. Hampson and Corthell retiring from the contract, and Mr. Stanhope being left to carry it out as best he could. So much money had already been frittered away upon the undertaking, that Mr. Stanhope found himself almost hopelessly opposed at the outset by lack of funds. After much trouble he formed a small syndicate for the purpose of completing the remaining 60 kiloms. of line. His contract stipulated for a payment of 1,113,035 dols., and the time allotted to him was nine months. By dint of much perseverance and pluck the work was actually completed within the specified period, but, as may readily be assumed, it was of a makeshift character, and such as no practical railway engineer would have passed.

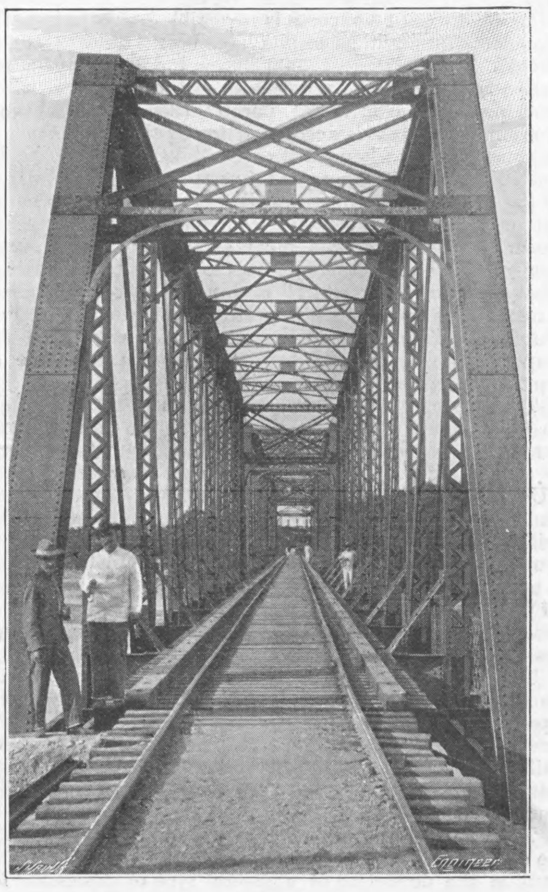


Fig. 2—BRIDGE OVER THE JALTEPEC RIVER

The Mexican Government, however, had never lost faith either as to the completion of the line or its eventual value, and when the opportunity presented itself for entering into an arrangement with a leading firm of British engineers it was taken advantage of, and then it was that S. Pearson and Son, Limited, who had already constructed the drainage works of the Valley of Mexico and the port works of Vera Cruz, two enormous engineering enterprises which had baffled the skill and resources of centuries, came upon the scene, destined to complete the undertaking and to bestow upon it the seal of permanency and prosperity.

This, then, is the early history of the Tehuantepec Railway, which now runs from Puerto Mexico—formerly known as Coatzacoalcos—on the Atlantic side to Salina Cruz on the Pacific side, a total length of 310 kiloms., with a branch line from Juile to San Juan Evangelista, a further 28 kiloms. To these may be added a recently opened branch from Carmen—37 kiloms. from Puerto Mexico—to Minatitlán, about 14 kiloms in length, a small branch which was constructed especially for the convenience of the oil refinery belonging to S. Pearson and Son, Limited, which is situated at the little town of Minatitlán.

In this article it is proposed to deal with the Tehuantepec enterprise in three sections—firstly, a description of the railway line; secondly, with the two terminal ports of Puerto Mexico and Salina Cruz; and thirdly, with the advantages of the Tehuantepec route as compared with those of other isthmus routes, and general conclusions with regard to the whole undertaking. In our issue of February 1st, 1907, we gave an article on this railway and its ports, in which we printed maps of the railway and of the ports, as well as a number of engravings showing various portions of the undertaking, some being in the text and some in a special supplement. We would refer our readers to this article in order that they may better follow the text of the present series.

RAILWAY ROUTE.

The Isthmus of Tehuantepec has a width at its narrowest point of 125 miles, and it lies between 16 deg. and 18 deg. north latitude and 94 deg. and 96 deg. west longitude. With the single exception of the Isthmus of Panama, this narrow neck of land forms the slenderest slip of territory on the Western Hemisphere, separating the waters of the Atlantic and Pacific Oceans. The engineering conditions for building a railway across this isthmus necessitate a gradual ascent from the mouth of the Coatzacoalcos River, crossing many effluents of that stream until a fairly flat tableland is reached. At a distance of 79 miles from Coatzcoalcos there is a depression at the Jaltepec River, and between this point and the Atlantic the gradients are about 60ft. to the mile. The heaviest climb, however, commences at the point known as Santa Lucrecia, at which point the Jaltepec River is crossed on a steel bridge 560ft. in length—composed of five spans—and of this an engraving is given in Figs. 1 and 2. The bridge crossed, the Malatengo Canyon is entered at a distance of about 38 miles beyond, and there the route is through rock-cuts and chasms leading up to Rincon Antonio, which is known as the "divide," and is, in effect, a junction of considerable dimensions. Here are found the extensive yards and shops of the company, the entire area having been rescued from a sandy waste and converted into a model township, occupied entirely by the railway and its workpeople.

Leaving Rincon Antonio, the line enters the Chivela Pass, which is crossed at a height of 730ft. above sea level, the highest point on the route, and from which the descent to the Pacific is decidedly abrupt in comparison, some of the steepest gradients on the section being here encountered. At the Chivela Pass, which extends from kilom. 209 to kilom. 247, a distance of 38 kiloms., the track runs over two horse-shoe curves and through one tunnel, the latter being stone lined and handsomely faced at both ends. During the reconstruction of the road, which was found necessary almost from beginning to end when Pearson and Son took it over, many of the heaviest gradients were reduced and the curves straightened. The whole line has been adapted to curves of a minimum radius of 150 m. compensated and a gradient of 1·6 per cent., except the track in the Chivela Pass, where the curvature comes to a minimum radius of 80 m. and a maximum gradient of 2.07 per cent.

CONSTRUCTION WORK.

Some of the heaviest construction work on the line is to be found on the Malatengo Canyon, from kilometre 188 to 202, namely, 14 kilometres. With regard to the bridges, whereas for the first two or three years that the line was working several wooden structures were employed temporarily, there are now to be found upon the route from end to end nothing but steel bridges of the finest construction, the most important of which are the following:—

Chacalapa Bridge, at kilometre 13, with three spans of 23.29 m. each, plate girder riveted.

Santa Lucrecia Bridge, at kilometre 127, five spans of 36.30 m. each, lattice girder, Pratt type.

Tolosa Bridge, at kilometre 159, three spans of 36.30 m each, lattice girder, Pratt type.

Sarabia Bridge, at kilometre 176, one span of 36.30 m., lattice girder, Pratt type, and four spans of 16.38 m. each, plate girders riveted.

Malatengo Bridge, at kilometre 190, two spans of 37.03 m. each, lattice girders, Pratt type.

Tehuantepec Bridge, at kilometre 291, three spans of 61.24 m. each, lattice girders, Pratt type.

There are some other and smaller bridges, having spans between 14 m. and 30 m., with lattice half-through girders, and still others, also small, with spans between

5.30 m. and 13 m., and plate deck girders. The culverts are of concrete on the northern division, and of masonry on the central and southern division. The total number of bridges and culverts is 846.

The finest steel bridge, perhaps, is that over the Jaltepec River, at Santa Lucrecia, the junction of the Tehuantepec with the Vera Cruz and Isthmus Railway. This handsome bridge, 560ft. in length, is composed of five spans, and is of steel throughout. The masonry abutments are of a thoroughly substantial and permanent character, and capable of carrying, with the bridge itself, a weight far greater than they will ever be called upon to sustain.

On the whole, it may be said that as it exists to-day the Tehuantepec Railway is one of the best constructed lines of its kind in the world, capable of sustaining all the freight traffic which can be obtained for it—and that is saying a good deal. The road is standard gauge of 4ft. 8½in., and where it passes over the clayey soil there are rock ballast and gravel. The ties, or, as we call them, the sleepers, are creosoted pine, California redwood and native hardwood. Eighty-pound steel rails are employed, and besides the 190 miles (304 kiloms.) of main track, there are 60 miles (96 kiloms.) of sidings, capable of handling three-quarters to one million tons of freight annually. Regarding the railway's business up to the present time, we shall speak more fully later on.

The cost of this undertaking, including both the railway and harbour works at Salina Cruz and Puerto Mexico (Coatzacoalcos), has up to date exceeded £9,000,000, and before finality is reached the figures will probably stand at a round £10,000,000, which may be divided up as follows :—

Reconstruction of railway, rolling stock, bridges, terminal facilities, plans, and buildings...	£3,000,000
Harbour works at Salina Cruz...	4,700,000
,, ,, ,, Puerto Mexico (Coatzacoalcos) ...	2,300,000

The Vera Cruz and Isthmus Railway joins the Tehuantepec National Railway at Santa Lucrecia; the Pan-American Railroad joins the Tehuantepec National at San Geronimo, and is now open for traffic to the important coffee centres of Huixtla and Tapachula, and as far as Mariscal, a distance of 714 kilometres. The old station buildings at Santa Lucrecia and San Geronimo were found to be inadequate to handle the great increases in the traffic moving over the Tehuantepec National Railway in connection with the Vera Cruz and Isthmus, and the Pan-American, and new and substantial masonry buildings have been built this year at both Santa Lucretia and San Geronimo. Between Puerto Mexico and Salina Cruz there are thirty-four stations, the most important being Juile, Santa Lucrecia, Rincon Antonio, and San Geronimo. The distance between port and port in kilometres is exactly 303.5, and the average time occupied in transit is 12½ hours up and 10¼ hours down. Trains leave Puerto Mexico daily at 6 a.m., arriving at Salina Cruz at 6.30 p.m.; and 6.15 p.m., arriving at Salina Cruz at 8.5, while others leave Salina Cruz daily at 8.5 a.m., arriving at Puerto Mexico at 6.15 p.m.; and 7.0 p.m., arriving at Puerto Mexico at 8.25 a.m.

At present the line is a single track only, but provision has been made for doubling it, and there can be no question that the track will have to be doubled very shortly. In this event it will be the only double-track line in the Republic of Mexico, and whenever the decision to build the extra track is arrived at the line will be constructed within a comparatively short time, and the expense attached thereto will be correspondingly light. Sir Weetman Pearson, in a speech made on the 23rd January, 1907, when the President of the Republic opened the line, said:—"I venture to make a prophecy of a double track within seven years, if not within five."

While the passenger rolling-stock used on the Tehuantepec line is necessarily small, in view of the comparatively limited number of passengers now being carried, it is very complete, and comprises the latest type of passenger coaches, with Pullmans running over the line from Santa Lucrecia to Salina Cruz, and *vice versâ*. On the other hand, the freight cars already number over 1200, and an additional 200 box-cars have been ordered this year, to cope with the ever-increasing traffic. There are also about 130 gondolas, each of 30 tons capacity, 80 stock cars, and 60 locomotives, and at the present time every single car, excepting those in the repairing sheds, is in requisition. The Tehuantepec Railway was the first Mexican line to introduce oil as fuel, and all the locomotives have been gradually converted from coal to oil-burning, by which means a saving of something like 30 per cent. is achieved. Throughout the railway workshops the stationary boilers are run by oil fuel, this being obtained from S. Pearson and Son's refinery at Minatitlán. At Puerto Mexico, the Tehuantepec Railway possesses a colossal tank constructed of steel, capable of storing 1,500,000 gallons of oil, from which the latter is distributed to smaller tanks along the line of railway, each of which has a storage capacity of 6500 gallons.

EXPERIMENTS WITH CENTRIFUGAL PUMPS.

By J. G. DAVIS, B.Sc., and W. R. HARDING.

Little is known of the frictional conditions prevailing and the losses occurring in centrifugal pumps, and, in view of this, the results obtained from systematic tests recently made, and the conclusions arising therefrom, cannot fail to do something towards connecting the several existing theories with actual results.

A general formula for the losses in a centrifugal pump—in terms of the discharge, peripheral speed, and head—has been obtained from quite general theoretical considerations, and has been applied successfully to actual practical cases within wide limits. The closeness with which theoretical and experimental results agree points to the soundness of the theory.

The first tests were made on a small pump, and these will be considered below in such detail as is necessary. The successful application of the formula to these very complete trials led to the attempt, in all cases satisfactory, to apply it to the published results* of the performance of other centrifugal pumps. The wide range of application of this formula leads to the conclusion that it is quite general in form, and applicable to any similar pump, large or small, with a suitable variation of the constants involved. This will allow of an accurate prediction of the performance of a pump under any conditions, once the constants have been determined in the manner indicated below. The possibility of such a prediction of results should render this method of no small interest to manufacturers and others.

It is proposed to deal here briefly with the derivation of the general formula, following with a description of the trials made on a small centrifugal pump, and the verification of the theory by the application of the formula to its performance, and also to the published results of trials on other pumps.

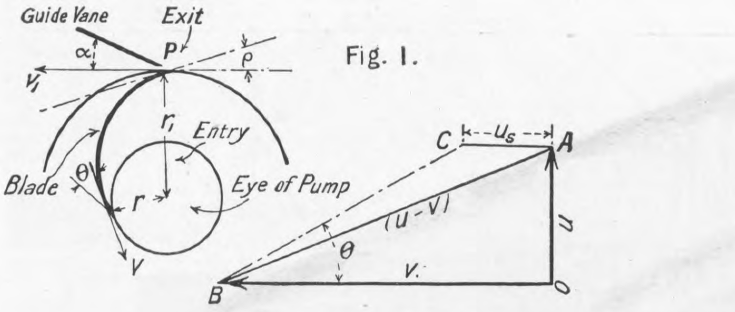


Fig. 1.

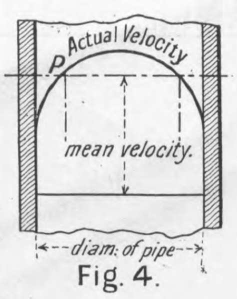


Fig. 4.

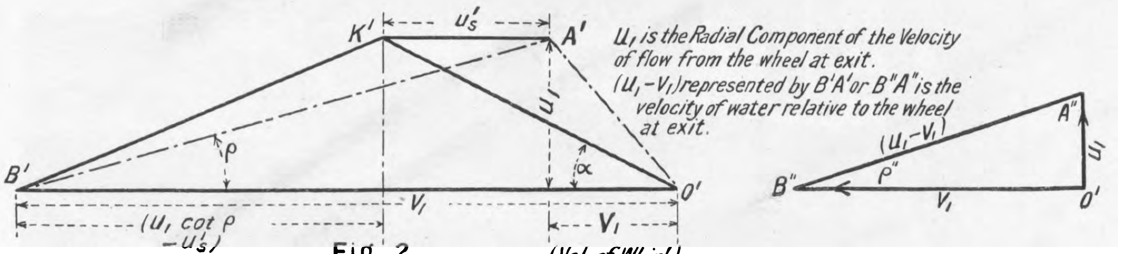

K'
u'_s
A'
U_1 is the Radial Component of the Velocity of flow from the wheel at exit.
$(U_1 - V_1)$ represented by B'A' or B"A" is the velocity of water relative to the wheel at exit.
B'
ρ
u_1
α
O'
V_1
$(U_1 \cot \rho - u'_s)$
V_1
(Vel. of Whirl)
A"
$(u_1 - V_1)$
u_1
B"
ρ"
V_1
O'

Fig. 2.

"The Engineer" Swain Sc

General Theoretical Considerations.—In hydraulic engines in general, where moving and fixed vanes are employed, the necessary conditions for the most efficient working are that there shall be no loss of head due to "shock"—incurred by abrupt change of velocity of the working fluid—and that the fluid shall leave the moving vanes with no velocity relative to them. On this hypothesis, the usual expressions for the theoretical performance of the various types of turbines are obtained, and, with suitable modifications to allow for frictional and other losses, apply to results obtained in practice. The question as to what extent a turbine is reversible has been greatly disputed, and practical results have been somewhat unexpected. For example, the 80 per cent. efficiency of a reaction turbine may be reduced to, say, 55 per cent. when working as a centrifugal pump. (See Dr. Stanton's Researches.) This is accounted for by the difficulty experienced, even when great care is taken to avoid shocks and sudden enlargements, in converting the kinetic energy of the water leaving the impeller or wheel of the pump into anything approaching the equivalent static or pressure head. Various methods have been adopted in pump design for the reduction of this loss, due to the partial dissipation of the "whirl" or tangential velocity head. Among these may be mentioned the addition of a "whirling chamber" (Thomson), the backward, or re-curving of the impeller blades (Appold), and the more recent use of "guide passages" outside the impeller (Reynolds).

The loss by "shock," due to more or less abrupt change in the absolute velocity of the water at the impeller exit, may be expressed in terms of the discharge velocity, and is conveniently denoted by discharge velocity head, or $\xi U^2/2g$, where U is the absolute velocity of discharge from the impeller vane tips, and ξ is Borda's coefficient, varying with the type of pump, but having an average value of from 0·5 to 0·6, including the loss in the impeller itself in a modern turbine pump. Especially in the older forms of pumps, where the discharge takes place into a body of water having a much smaller absolute velocity, is this loss exaggerated.

The head lost by friction in the case of a disc rotating in a fluid is proportional to the square of the peripheral speed. The friction is also stated to increase with the area of the pump casing; this is due, no doubt, to the stilling of the eddies by the surface of the stationary casing, and the reacting of this stilled water on the surface of the rotating wheel.

The above indicates briefly the nature of the losses to be expected in centrifugal pumps, and we now proceed to outline the deduction of a general type of expression for the actual working head in any pump. This is due to Mr. F. C. Lea, B.Sc., A.M.I.C.E., of the Central Technical College, S.W., to whom best thanks are due for this and other valuable suggestions.

DEDUCTION OF GENERAL FORMULA FOR THE WORKING HEAD IN A CENTRIFUGAL PUMP.

(1) *Loss of head at entry to impeller vanes.*—Assuming the velocity of flow u of water entering the impeller vanes to be radial—Fig. 1—v and v_1 being the linear velocity of the inner and outer tips of the vanes, which make angles θ and ρ at entry and exit respectively; the vector A B represents the velocity of the water relative to the wheel at inlet. Moreover, a velocity represented by u_s must be impressed by the vane on the water, in order to cause it to take the direction B C instead of B A. B C is the velocity of water relative to the impeller at entry to vane. Thus the loss of head due to the change of velocity impressed on the water by the vane is represented by

$$u^2_s/2g, \text{ where } u_s = v - u \cot\theta \quad . \quad . \quad . \quad (1)$$

(2) *Loss of head at exit from impeller vanes.*—Let α be the angle of guide vanes at the impeller exit, and let P be the point under consideration. The water clearly tends to flow along the tangent to the vane at P, namely, along B′ A′—Fig. 2. If the vane at exit had some other angle ρ'', so that B″ A″ represented the direction of the vane at P, and there were no velocity of whirl at exit, there would be no loss of head at exit. But in a practical case there is a velocity of whirl (or tangential component of the absolute velocity of the water) V_1, due to the blade having some other angle ρ at exit. B′ A′ is then the velocity of the water relative to the wheel at exit, and the ultimate absolute velocity of flow along the guide vanes at P will be represented by the vector O′ K′. But in order to cause the water to reach K′ instead of A′, the velocity A′ K′, namely, u'_s, must be impressed on it by the wheel. So that the head lost at exit is equal to

$$(u'_s)^2/2g, \text{ where } u'_s = v_1 - u_1 (\cot\alpha + \cot\rho) \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

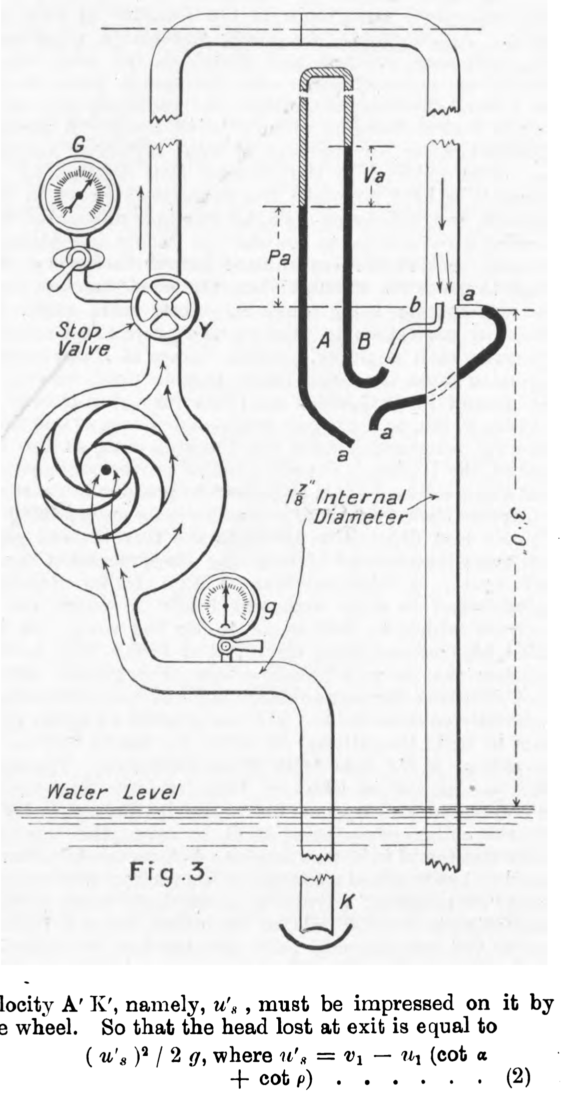


Fig. 3.

Other losses occurring in the pump.—Frictional losses, as yet unconsidered, may be taken as being proportional to the square of the velocity of flow through the wheel, also to the square of the peripheral speed. Thus frictional losses are represented by—

$$s\,(u_1)^2/2g - t\,(v_1)^2/2g \quad . \quad . \quad . \quad .$$

where s and t are constants . . . . (3)

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* Parsons: "Proceedings," Institution of Civil Engineers, Vol. xlvii., page 272.
Rateau: The Engineer, 1902.
Stanton: Institution of Mechanical Engineers, 1903.
Further details of the derivation and applications of the formula to the above trials will be found in the recently published treatise on "Hydraulics," by Mr. F. C. Lea. (Arnold.)

The centrifugal head will probably diminish as the discharge increases, for any given velocity of flow, since the water leaving the "eye" of the pump—assumed radially—from the suction pipe will have less chance of assuming the velocity proper to it at that particular speed of the pump, the greater the speed with which it passes through the impeller vanes. The centrifugal head thus depends upon v_1, and also upon u_1, and it is assumed reasonably that the change in the centrifugal head, as the discharge varies, may be expressed by—

$$(k v_1 - n u_1)^2/2g \quad . \quad . \quad . \quad .$$

where k and n are constants . . . . (4)

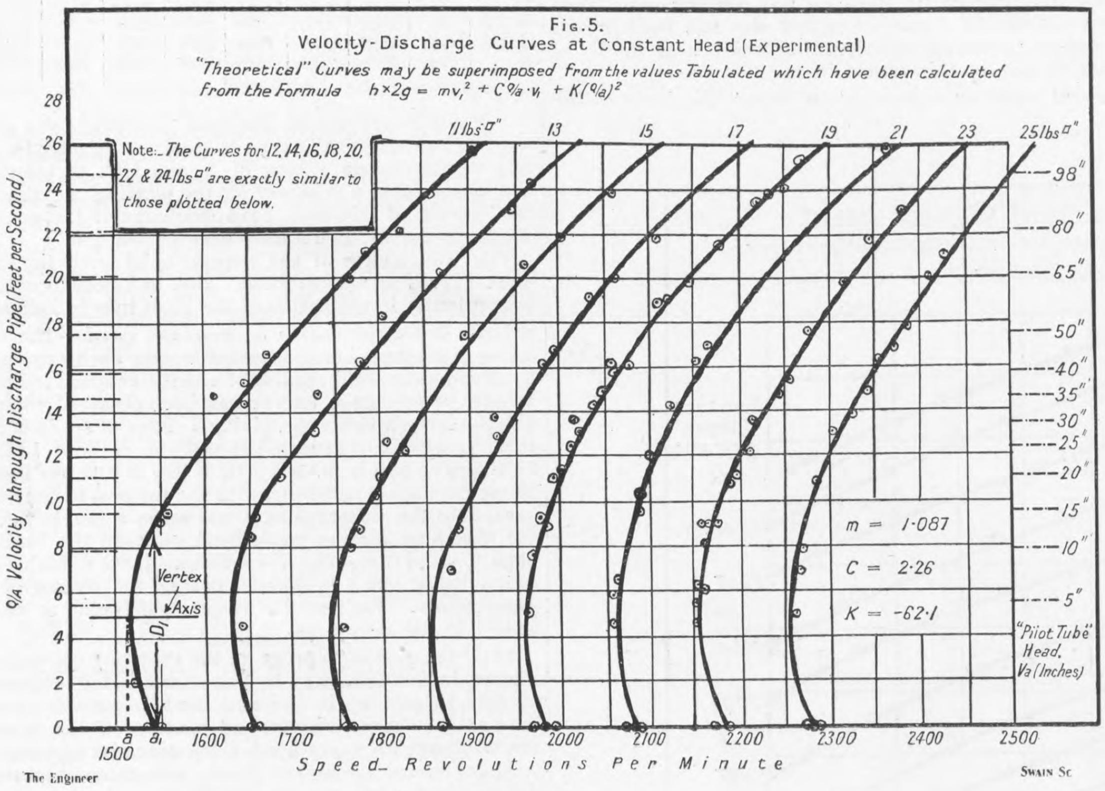


Fig. 5.
Velocity-Discharge Curves at Constant Head (Experimental)
"Theoretical" Curves may be superimposed from the values Tabulated which have been calculated from the Formula $h \times 2g = mv_1^2 + C\,Q/a \cdot v_1 + K(Q/a)^2$

Now (Actual head) = (Theoretical head) − (Head lost).

$$h = (V_1 \,.\, v_1/g) - (\text{losses 1, 2, 3, and 4})$$

$$= \frac{v_1(v_1 - u_1 \cot \rho)}{g} - \frac{(v - u \cot \theta)^2}{2g}$$

$$- \frac{\left\{ v_1 - u_1(\cot \alpha + \cot \rho) \right\}^2}{2g}$$

$$- \left\{ \frac{s u_1^2}{2g} + \frac{t v_1^2}{2g} \right\} \div \frac{(k v_1 - n u_1)^2}{2g}$$

Now to obtain a parabolic expression for h in terms of u_1 and v_1, we may write u_1 and θ for u and ρ respectively, by the introduction of suitable constant factors, since θ and ρ are themselves constant, and u is proportional to u_1, so that the expression reduces to—

$$2\,gh = m v_1^2 + C u_1 v_1 + K u_1^2 \quad . \quad . \quad . \quad . \quad (5)$$

where m, C, and K, are constants, depending on the dimensions and design of any particular pump.

These constants can always be determined by solving the simultaneous equation given by three independent experiments on the pump, each giving an expression similar to (5).

In the particular case investigated the values of the constants were determined as follows:—

h is the actual lift, or working head, of the pump in feet.
Q is the discharge in cubic feet per second.
a is the normal area of water passages at the periphery of the wheel in square feet.
v_1 is the peripheral speed in feet per second.

Then u_1 becomes Q/a, so that

$$2g\,h = m v_1^2 + C\,(Q/a)\;v_1 + K\,(Q/a)^2 . \quad . \quad . \quad . \quad (D)$$

Apparatus.—The experiments described below were carried out at the Central Technical College Engineering Laboratories. The centrifugal pump is by Messrs. Mather and Platt, and is of the makers' standard type, having a normal capacity of 85 gallons per minute against a head of 35ft., and running normally at 2020 revolutions per minute. Driven through an ordinary flange coupling by an electric motor, it is of the "guide passage" type—a turbine pump—the general arrangement being indicated in Fig. 3. The number of vanes in the impeller is six, and the approximate angles at entry and exit respectively are $\theta = 5°$ and $\rho = 30°$. There are four guide blades—not shown—at an angle $\alpha = 3°$ to 5°. The suction pipe, which must not exceed 34ft. in height above water level, terminates in a foot valve K about 3in. from the bottom of the tank, to prevent backward flow of the water before starting. In starting up a pump any air remaining in the suction pipe must be replaced with water, either by filling through a suitable aperture, or, in the case of large pumps, by exhausting the air by means of a steam ejector after closing the delivery valve. On leaving the pump the water passes through a throttle valve V, just below which is fitted a pressure gauge G, which provides an imaginary head. The delivery pipe takes the form of an inverted U, and terminates about 8in. from the bottom of the tank, which contains about 20in. of water. Since the pump is not at water level, the additional head due to suction must be measured, and provision is made for this by the vacuum gauge g, fitted some 9in. past the bend in the suction pipe. This precaution is necessary to avoid the centrifugal head in the bend being included in the gauge reading. The sum of the readings of the two gauges gives the existing head h in lb. per square inch.

Pitot tube.—For the measurement of the velocity, and, therefore, also of the volume of water delivered by the pump, a Pitot tube is employed. This consists essentially of a small tube a introduced into the delivery pipe, so as to record only the pressure of the moving water, and a second tube b at right angles to a, on the orifice of which the flowing water impinges, recording the sum of the pressure and velocity heads. The tubes are connected through suitable reservoirs to gauge tubes A and B, each of some 9ft. length, and in a continuous circuit with one another and with the delivery pipe. The pressure head P_a being common, the amount V_a by which the shaded water column in B exceeds that in A, measures directly the discharge velocity head in inches.

$$\text{Then } Q/A = k\,2g\,\sqrt{V_a/12} = j\,\sqrt{V_a}\,.$$

The velocity in the delivery pipe is, of course, variable over the section, following a parabolic law—see Fig. 4—and to obtain the mean velocity with a perfect Pitot tube—*i.e.*, one in which k is unity—the tube b would need to be at P, to dispense with an independent calibration. Any possible error due to deviation from this position is however eliminated—provided the pipe runs full—by an independent determination of k or j, readily effected by plotting a curve connecting corresponding values of V_a and Q. Q is measured by weighing, or by flow through an orifice or weir, or by any standard method.

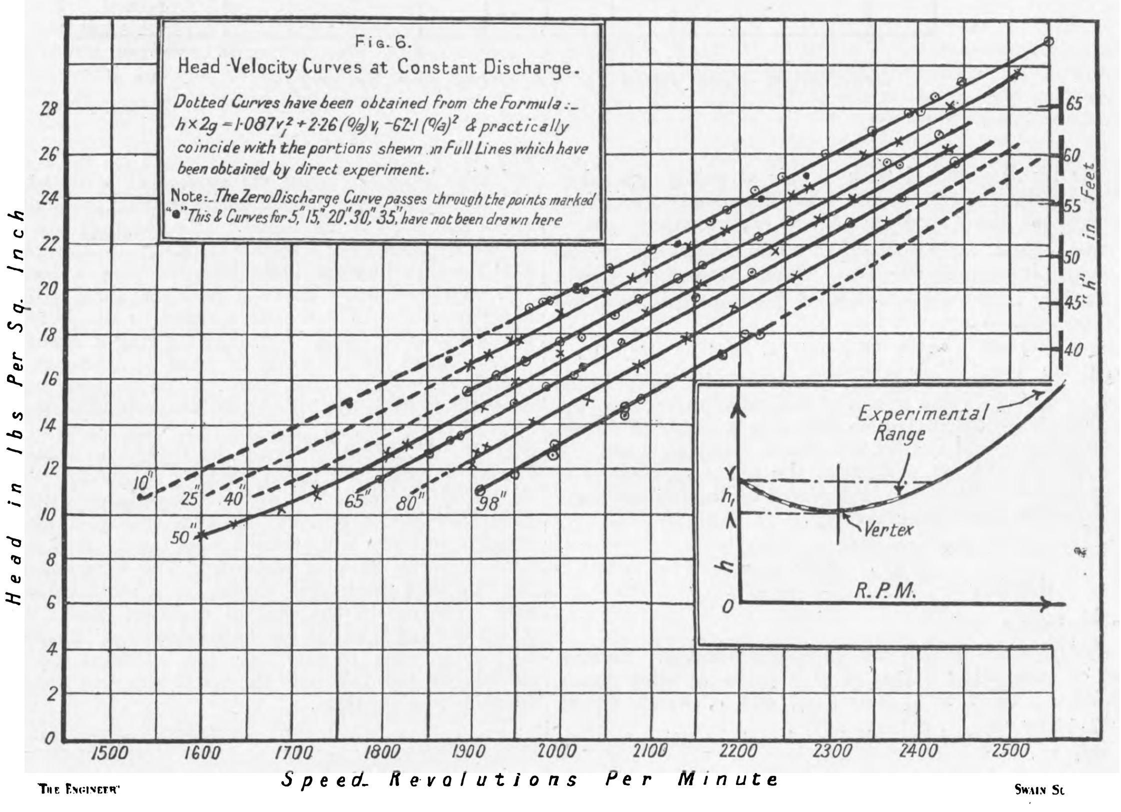


Fig. 6.
Head-Velocity Curves at Constant Discharge.
Dotted Curves have been obtained from the Formula:— $h \times 2g = 1{\cdot}087 v_1^2 + 2{\cdot}26 (Q/a) v_1 - 62{\cdot}1 (Q/a)^2$ & practically coincide with the portions shewn in Full Lines which have been obtained by direct experiment.
Note:—The Zero Discharge Curve passes through the points marked "●" This & Curves for 5", 15", 20", 30", 35", have not been drawn here

The motor is a 2 horse-power shunt-wound machine—type E. O.—by Messrs. Mather and Platt, and is stated to take 10 ampères at normal load on a 200-volt supply, running at 2020 revolutions per minute. It is of the two-polar construction, fitted with carbon brushes, and has the usual type of starting switch and field regulating resistances, by which the speed can be very finely adjusted. Sufficient electrical tests were made to give a complete knowledge of the working under various conditions; but although of interest in illustrating the accuracy with which it is possible to work with the apparatus employed, and the overall efficiency of the pump, the results have not sufficient direct bearing on the present work to justify their being given here. The normal brake horse-power of the pump is roughly 0.9, the combined efficiency of pump and motor about 34 per cent., the efficiency of the motor alone at normal load 75 per cent., and of the pump alone about 45 per cent. This efficiency is low, as the pump is small, and the losses consequently more exaggerated than in larger sizes.

In the following experiments, h, the head under which the pump is working, or lift, is measured directly in pounds per square inch, and converted to feet of water conveniently by means of a conversion curve. Q/a is calculated from the velocity Q/A in the discharge pipe, the latter being measured by the Pitot tube and converted to feet per second.

A is the area of the discharge pipe in square feet—equal to 0.0191, since the diameter is 1.875in.

a is equal to 0.096 square feet. Thus $Q/a = [0.1995\ Q/A]$. Experimentally it was found that $Q/A = 2.498\,\sqrt{V_a}$.

v_1 is directly proportional to the speed of the shaft, and since the periphery of the wheel is 1.54ft. in circumference, we have $v_1 = 0.0257 \times$ R.P.M. in feet per second.

General observations on experimental procedure.—In all cases both ascending and descending values of the variables have been observed and plotted. For convenience the quantities have been plotted as observed—that is, without conversion in the above manner—in every case where the mere introduction of a constant factor is necessary to convert quantities read from the curves to a form suitable for the calculation of m, C, and K.

Damping the vibration of the gauge pointers as far as possible by throttling with the adjustable cocks is found to give increased accuracy of reading. In all cases the "suction head" increases and the "pressure head" decreases as the flow through the pump increases, the sum of the two readings giving the lift h.

The speed and discharge can always be adjusted by suitable regulation of the field resistances and the stop valve to obtain any desired value—within limits—of the head; in the same way, throughout the experiments, any two of the three quantities measured—head, speed, and discharge—can be varied to obtain a desired value of the third.

In every experiment the "mean" of the readings over a period of one minute has been taken; the speed being registered in the case of "constant-head" and "constant-discharge" curves by means of a stop-watch and revolution counter, and in the case of the "constant speed" curves by a specially calibrated sensitive speed indicator.

The primary object of the experiments being to determine accurately the values of m, C, and K in expression (D), it is noted that when the discharge is zero the head h becomes $m\,v_1^2/2\,g$. The pump is therefore run with water in the volute space and wheel, having the stop valve closed. Any point on a curve plotted, connecting simultaneously observed values of v_1 and h, then determines a value of m—see Fig. 6.

The mean of a number of such values is found. The values of m for a curve determined from thirty-seven independent experiments vary between 1.058 and 1.096 for a range of speed from 1500 to 2050 revolutions per minute.

The mean value of m is 1.087.

C and K are now determinable from two experiments, from which simultaneous values of h, v_1, and Q/a are taken, the value of m already obtained being used in the solution of the simultaneous equation.

Velocity discharge curves at constant head.—By suitable adjustment of the speed and discharge, a series of fifteen curves has been obtained from 270 independent experiments with the pump working under constant heads of 11 lb., 12 lb., 13 lb., ... 25 lb. per square inch (25ft. to 60ft). The corresponding range of speed is 1500 to 2500 revolutions per minute, and of delivery pipe velocity 0ft. to 26ft. per second (0 to 177 gallons per minute).

The experimental points on eight typical curves only have been denoted. The mean curve in each case is very definitely outlined, and parabolic in form—see Fig. 5.

From the plotted curves C and K are now determined. For taking any two points, say, on the 20 lb. per square inch constant-head curve, whose co-ordinates are:—Speed 2049 and 2122 revolutions per minute, and $Q/a = 0.1995 \times Q/A = 2.485$ and 3.52ft. per second respectively, expression (D) becomes in the two cases—

$$2\,g\,(46.2) = 1.087\,(52.6)^2 + 52.6\,(2.485)\,C + (2.485)^2\,K$$
$$2\,g\,(46.2) = 1.087\,(54.5)^2 + 54.5\,(3.520)\,C + (3.520)^2\,K$$

From which $C = 2.47$ and $K = -\,58.8$.

The results show that C and K do not vary greatly, considering the wide range through which the experimental curves have been plotted, and that each solution is the result obtained from a pair of points not taken close together on the curves. Sixty independent solutions such as the above show that on the experimental curves

C varies from 1.80 to 2.81; mean of readings 2.26
K varies from − 50 to − 74.9; mean of readings − 62.1

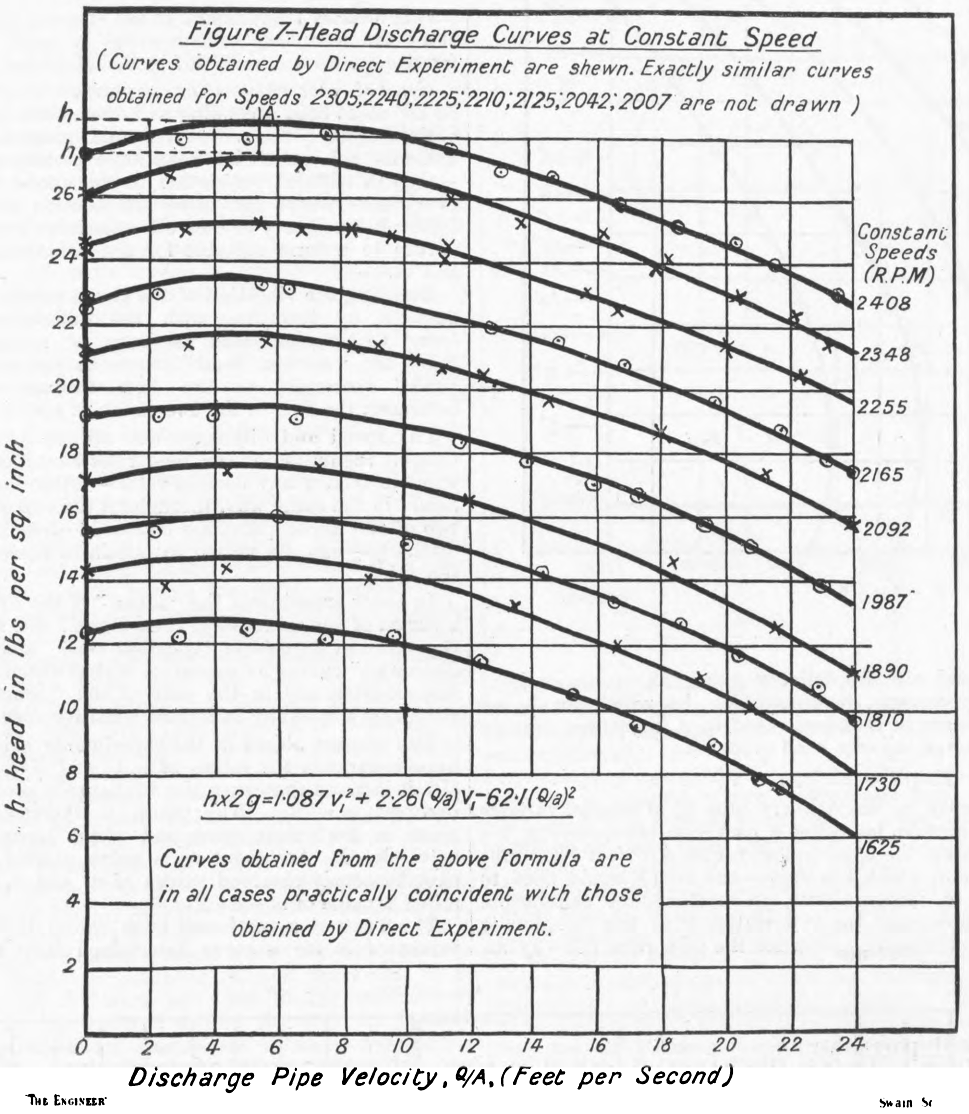


Figure 7—Head Discharge Curves at Constant Speed

(Curves obtained by Direct Experiment are shewn. Exactly similar curves obtained for Speeds 2305, 2240, 2225, 2210, 2125, 2042, 2007 are not drawn)

Putting in the mean values of the constants as above (D) becomes—

$$64{\cdot}4\,h = 1{\cdot}087\,v_1^2 + 2{\cdot}26\,v_1\,Q/a - 62{\cdot}1\,(Q/a)^2\;.\quad \text{(E)}$$

From this expression, giving h any definite fixed value, and assigning a value to one of the other unknowns, the second can be calculated, so obtaining a series of values connecting v_1 and Q/a for the chosen constant head. In the solution of these equations, the following method is convenient:—Divide (D) throughout by m, and we have an equation of the general form:—

$$a_1\,y^2 + b\,y + c = O;$$

$$\text{that is } y = \frac{-\,b \pm \sqrt{b^2 - 4\,a_1 c}}{2a_1}.$$

In our case a_1 is I.

Assign values to Q/A convenient for plotting. Each of the corresponding values of Q/a gives a value for b, which equals $2{\cdot}26\;Q/(1{\cdot}087\;a)$, and c, which equals $\frac{-62{\cdot}1}{1{\cdot}087}\left(Q/a\right)^2$, and the solution of each equation for v_1 is only a matter of substituting in the formula given above for y, which is identical with v_1. The speed in revolutions per minute, namely, $60\,v_1/1{\cdot}54$, is in each case plotted against the corresponding value of Q/A, and the values chosen for the latter are conveniently the same for each constant head curve so calculated from (E). The curves obtained in the above manner are found to agree so closely with the experimental curves already plotted that in most cases they are hardly to be distinguished from them.

A special point of note in these curves is the double value of the discharge possible throughout a range of speed $a\,a_1$—Fig. 5. The pump will not start up until the speed $O\,a_1$ has been exceeded; thereupon the discharge suddenly leaps to beyond D_1. On further opening the valve, D_1 increases, and the speed rises as the load is increased. On shutting down, the Pitot tube is seen to be in unstable equilibrium within the range of speed $a\,a_1$, and the least touch of the valve may give the double value of the discharge for that particular speed.

Impending delivery.—Denoting the critical peripheral speed—*i.e.*, the speed which is just sufficient to prevent downflow of water in the delivery pipe, the water being at rest in the impeller and in the suction pipe—by V_c, h being the available head, V_c should not greatly exceed $\sqrt{2\,g\,h}$, but is, of course, influenced by the frictional conditions and the shape of the blades. At low discharges the points are not generally so well in accordance with the regular outline of the curves as at the higher values, and this is probably due to discontinuity of action in the Pitot tube, caused by the pipe not running full. That such a condition is possible in this case has been proved by special investigations, details of which it is hardly of value to give in this article.

Head velocity curves at constant discharge.—The velocity head V_a being maintained at constant values 0, 5, 10, 15, &c., to 98 inches, corresponding readings of the speed and head h are noted. The readings are limited in some cases by the speed, in others by the gauge, so that the experimental limits differ for various discharges. For each discharge a curve of parabolic form is obtained experimentally—Fig. 6—the tangent to the vertex being parallel to the "speed" axis, again giving a double value to the speed for the range of head h_1, although this is outside the experimental range. The thirteen curves so determined from 162 independent experiments (the range of head being 9 lb. to 31 lb. per sq. in., and of speed 1600 to 2500 R.P.M.) could, of course, be utilised for determining C and K, using the mean value of m already obtained. It is more convenient, however, to superimpose the curves calculated from expression (E) for these experimental discharges, in order to determine how nearly they coincide. This might be done by proceeding with expression (E) at the constant discharges chosen, in a similar manner to that employed in the case of constant head. A more direct method is to cut the "constant head" curves with horizontal lines representing the constant discharges, reading off the values of the speed for every head, tabulating the values thus:—

Discharge through delivery pipe. (Q/A) in inches of water . . (Pitot tube)	Head in pounds per square inch.								
	11	12	13	14	15	16	17	18	
0	1535	1590	1648	1704	1760	1817	1875	1930	Speed—Revs. per min.
5	1520	1575	1631	1688	1744	1800	1857	1913	
10	1530	1586	1644	1699	1754	1810	1866	1922	
15	1547	1605	1662	1717	1770	1826	1880	1936	
20	1574	1630	1685	1740	1794	1847	1898	1954	
25	1598	1650	1703	1758	1813	1865	1915	1970	
30	1622	1673	1723	1777	1832	1883	1934	1985	
35	1647	1695	1745	1800	1852	1902	1953	2003	
40	1670	1718	1768	1820	1870	1920	1970	2020	
50	1713	1762	1809	1862	1910	1956	2006	2055	
65	1775	1820	1867	1915	1963	2010	2059	2110	
80	1835	1883	1930	1975	2020	2065	2115	2165	
98	1915	1958	2002	2049	2090	2139	2184	2228	

Discharge through delivery pipe. (Q/A) in inches of water . . (Pitot tube)	Head in pounds per square inch.							
	19	20	21	22	23	24	25	
0	1981	2030	2080	2130	2180	2228	2278	Speed—Revs. per min.
5	1965	2015	2065	2112	2158	2207	2254	
10	1975	2020	2071	2120	2166	2213	2259	
15	1987	2033	2081	2130	2180	2224	2269	
20	2003	2050	2095	2144	2193	2239	2285	
25	2017	2062	2110	2158	2206	2255	2300	
30	2032	2078	2125	2174	2221	2270	2317	
35	2048	2092	2140	2189	2235	2285	2332	
40	2063	2108	2156	2203	2250	2301	2347	
50	2098	2145	2187	2235	2282	2330	2375	
65	2150	2193	2235	2278	2323	2372	2416	
80	2205	2243	2283	2325	2370	2415	2460	
98	2265	2303	2343	2383	2423	2463	2505	

For any experimental constant discharge, the calculated or "theoretical" curve is obtained directly by plotting corresponding values of h and Q/A as tabulated. The above table also serves for the plotting of "theoretical" curves of constant head discharge, if the constant discharge curves should have been drawn first.

The coincidence of the experimental with the calculated curves is very marked. But, as before, occasional discontinuity in the action of the Pitot tube is indicated.

Head discharge curves at constant speed.—The regulating resistances being adjusted during each experiment to obtain a constant reading of a sensitive speed indicator, a series of seventeen curves has been obtained from 185 independent experiments, giving a range of speed of from 1625 to 2408 revolutions per minute, of head 12 lb. to 29 lb. per square inch, and of Q/A 0ft. to 24ft. per second. These curves are parabolic, with the tangent to the vertex parallel to the discharge axis, and again a double value of the discharge for the same head between the limits of head $0\,h$ and $0\,h_1$—Fig. 7—is obtained, the unstable condition being quite noticeable during the course of the experiments. The low discharges again point to discontinuity in the Pitot tube.

The "theoretical" curves for the above are conveniently plotted in a similar way to those for constant discharge, namely, by cutting the constant head curves with vertical lines at the speeds chosen, and reading off the values of the discharge for every head, tabulating and plotting.

These curves agree very closely with those obtained by direct experiment, almost coinciding with them in the majority of cases.

Efficiency curves (electrical).—These are of interest as a very complete test of the performance of the pump. The power required to drive the motor light at all speeds is constant; the same applies to driving the pump without water, the total losses in the motor—friction, eddy current, and hysteresis—being the same for all speeds. Sets of curves have been plotted, and from these—not given here—the efficiency of the pump under any conditions may be found.

General conclusions.—From the above, it is clear that the same parabolic expression for the lift of the pump gives curves which agree very closely with the curves obtained by independent experiments over the ranges indicated above. This expression may be termed the *Characteristic Equation* of the pump.

The above test has been a severe one, and it has seemed reasonable to suppose that, within limits, the same form of expression will apply to other pumps of a similar type.

It has been applied successfully to the following cases:—A centrifugal pump tested by Mr. Livens—"Proceedings," Institution of Mechanical Engineers, 1903—having a wheel 19.5in. diameter ρ about 13° and $\theta = 81°$, which running at 550 revolutions per minute gave an efficiency of 71 per cent. when delivering 1600 gallons per minute against a head of 25ft. The characteristic equation is found to be $1.18\,v_1^2 + 3\,u_1\,v_1 - 142\,u_1^2 = 2\,g\,h$.

Again, for a turbine pump having six vanes ($\theta = 5°$ and $\rho = 30°$) and four guide vanes ($\alpha = 3° -$), where the wheel diameter is 2·5 times the discharge pipe diameter, the characteristic equation is:—

$$0{\cdot}84\,v_1^2 + 48{\cdot}3\,u_1\,v_1 - 587\,u_1^2 = 2\,g\,h.$$

In the above cases v_1 and u_1 are the peripheral speed, and the radial velocity of flow at exit from the wheel—*i.e.*, Q/a—in feet per second respectively, h the lift in feet. For other particulars see "Hydraulics" (Lea). The results obtained from the test of a Mather and Platt high-lift turbine pump—see "Hydraulics and its Applications," page 618, Gibson, 1908—delivering 2200 gallons per minute at 1100 revolutions per minute against a head of 140ft., promise from the curves shown a result similar to that of the smaller pump here tested, but no details are forthcoming. The efficiency of this pump rises to 70 per cent.

It is probable that in the small pump tested above the losses are more exaggerated than they would be in larger pumps.

The smoothness of finish and accuracy of the vane angles are important features of pumps by continental makers in general, the reduction of friction by this means being very considerable. The pump on which the above described experiments have been made is not finely finished.

It would be of great interest in future experiments to determine the range of practical application of the characteristic equation in the case of larger pumps, but from the above results and applications there seems little doubt that this method of stating the performance of a pump under known or tried conditions, and thence forecasting with fair accuracy its performance under untried conditions, can be advantageously and easily adopted in most practical cases.

THE EFFICIENCY OF ELECTRIC POWER STATIONS.

In the generation of electric power, or more correctly speaking, in the transformation of the heat energy in coal into electrical energy, excellent opportunities are afforded for observing the inefficiency of the process. In order to sell electric power it is necessary to measure it accurately, and having done so, knowing the amount of fuel consumed, it is easy to arrive at what has been lost in the processes of transformation.

An American engineer, in referring to the boiler plant of the traction company which works the street car system of Cleveland, Ohio, recently said that the thermal efficiency of that plant was approximately 8 per cent. By this he meant that out of every 100 tons of coal burned the energy of but 8 tons was delivered to the switchboard in the form of electricity. As a matter of fact, 8 per cent. is a fair figure for some of the largest and best equipped power stations at present in operation. It has been estimated—by Mr. Hobart, we believe—that the average overall efficiency of existing British steam electric stations is from 3.5 to 4.5 per cent. The thermal efficiency of a generating station may be defined by saying that it is the ratio of the heat units supplied to the bus bars to the heat units in the coal. A kilowatt hour or unit is equivalent to 3412.66 British thermal units, so that we may write thermal efficiency equals

$$\frac{3412.66 \times 100}{\text{pounds of coal per unit} \times \text{calorific value.}}$$

It is interesting to calculate the thermal efficiencies of different stations and to endeavour to discover the reason for the varying results, but the main trouble lies in the collection of the necessary data. To take a single case, in one of the stations in this country, during a period of twelve months 10,217,158 units were generated and 18,417 tons of coal were consumed. Thus 4.02 lb. of coal were consumed in generating a unit. The estimated mean calorific value of the fuel was 12,500 British thermal units, so that the thermal efficiency of that particular station was $\frac{3412.66 \times 100}{4.02 \times 1250} = 6.78$ per cent.

During the year ending June 30th, 1904, the output of the Berlin Electricity Works was 113 million units, which were supplied from a number of distributed power stations. The overall thermal efficiency for those stations during that period works out at 9.6 per cent. In the following year, when the output had risen to 141 million units, the efficiency was 10 per cent., and in the year 1906, when the load reached 167 million units, the efficiency only rose to 10.3 per cent. Thus it will be seen that even with an enormous output such as that the thermal efficiency, though high in comparison with that of some plants, is at the same time in reality low. In the foregoing it will be observed that the units considered are those delivered to the bus bars of the station, and not to the consumers, and, therefore, the transmission losses have not been taken into account.

If we try to analyse the losses in a generating station by fixing a certain efficiency for the steam raising plant, another for the engines or turbines, and so on, it will be found that unless these assumed efficiencies are fixed low it will not be possible to get them to add up to a figure corresponding with that calculated as above. The actual result obtained by the formula will always seem too low. This, however, is a very natural result when it is remembered that the plant is only running at its full output during a portion of the time, and it is, therefore, somewhat difficult to estimate the average efficiency of each constituent. But that which adds to this discrepancy by a considerable amount is the question of banking. In the large lighting stations, and particularly during the winter months, when bad fogs are liable to come on with practically no warning, the quantity of coal used for banking purposes has a very appreciable effect upon the total consumption, and therefore upon the overall thermal efficiency. But quite apart from such questions as these, it is well known that under the best conditions an efficiency of much more than 11 per cent. cannot be expected.

From tests carried out on a large number of generating stations in America the various losses are estimated as follows:—Loss in ashes and leakage, 6 per cent.; heat lost in chimney, 22 per cent.; that delivered to auxiliaries and losses from pipes, 7.4 per cent.; main and auxiliary exhaust, 58.7 per cent.; and minor losses 1.47 per cent., giving a total of 95.57 per cent. Of this loss 5 per cent. is returned by the feed-water heater, so that the overall thermal efficiency becomes 9.43 per cent. Different investigators have naturally obtained slightly varying results, but where the discrepancy comes in is generally fairly evident, and, all things considered, the net results are not far apart.

Occasionally engineers are reminded that we are wasting our coal with enormous rapidity, and that a heat engine is essentially uneconomical. The unscientific public becomes alarmed; but when the newspaper announcement goes on to state that there is ample coal for at least another hundred years the story becomes less exciting. One of the greatest helps in the way of saving coal, although, unfortunately, not possible to a great extent in this country, is the utilisation of water power. In America, on the other hand, where they are exceptionally wealthy in this respect, the reduction in the coal consumption is enormous. This is brought to light in a statement made by Mr. L. B. Stillwell in a paper which he read before the American Institute of Electrical Engineers in May of this year. During the year 1908, he states, the plants of the Niagara Falls Power Company delivered an output of 560,000,000 units. Had this output been generated by large modern central stations using steam power the consumption of coal would have approximated 2000 tons per day. Were the users of Niagara power dependent to-day upon their own individual steam plants they would use in the aggregate not less than 3000 tons of coal per day—in other words, more than 1,000,000 tons per annum. If this power were replacing steam as used under average conditions in the manufacturing cities, instead of being used for the most part in supplying power to a comparatively small number of consumers using large amounts of power, it is estimated that it would replace and save nearly 2,000,000 tons of coal per annum. Whilst in this country we can never hope to benefit to an appreciable extent from natural sources of power we do, and have done for years, looked forward to improvements in the efficiency of our prime movers. It is not due to lack of energy on the part of English engineers, or indeed of engineers in any other part of the globe, that more economical results have not been obtained. No subject has, or in all probability ever will, receive greater attention, and yet to-day it is by no means easy to see where further improvements in the steam plant is to come from. In the gas engine we place great hopes, for in this direction the view is not so misty. That the thermal efficiency is higher all the world knows; that this type of engine will become still more economical is probable, and that the gas engine stations already in operation show an appreciably higher overall thermal efficiency than the steam stations was clearly shown in the paper recently read before the Institution of Electrical Engineers by Messrs. Andrews and Porter.

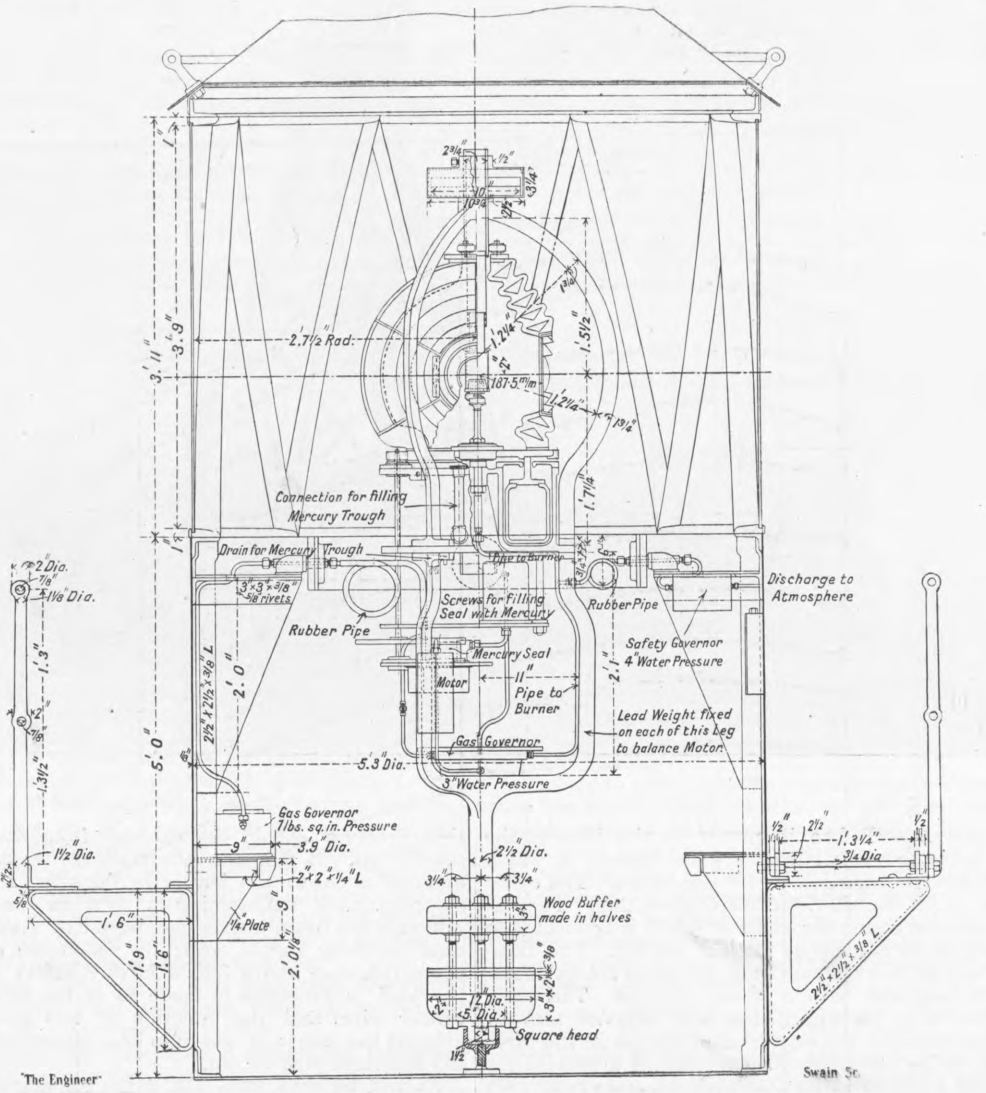


Fig. 1—DETAILS OF THE OPTICAL APPARATUS

UNWATCHED FLASHING GAS-LIGHTED BOAT.

Our readers will be aware that for a number of years now there have been stationed on the river Thames, and at numerous points round our coasts, flashing or occulting lights exhibited from gas buoys. The light in these has been produced by means of a fixed dioptric lens having an oil gas burner, and the occulting or flashing of the light has been brought about by means of Pintsch's regulator, which can be adjusted to turn the gas on and off at stated intervals with wonderful accuracy. The necessary gas is contained under pressure in the body of the buoy, and the light is being continuously lit and extinguished automatically day and night. We shall have something more to say regarding these buoys later on; but, meanwhile, we turn to a further development.

The Corporation of Trinity House, in whose hands is entrusted the lighting of the coasts and channels of England and Wales, have for some time been experimenting in the direction of obtaining something in between these buoys and the lightship proper. What has been aimed at has been the provision of a flashing light produced by a revolving lens in place of the fixed lenses used on gas buoys, thereby increasing the power of the light by condensing it into revolving beams, without the necessity of having men stationed on board the vessel.

After mature consideration Sir Thomas Matthews, engineer-in-chief to the Trinity House, decided to advise the Corporation to construct a vessel similar to, but considerably smaller than, an ordinary lightship. This proposal having been approved, the vessel was built and provided with a lantern carried on a structure which gave the focal plane of the lenses a height of 26ft., and the light a range of visibility of ten miles. In this lantern was fitted an automatically driven pair of lenses, which were illuminated by a constantly burning Argand burner receiving its supply of oil gas from large reservoirs contained in the hull of the vessel. On her completion the boat was anchored, for experimental purposes, off Southend for about a month, and gave every satisfaction; and afterwards, for a more severe trial in open water, was placed off the North Goodwin light vessel, during which time and whilst being towed back to Blackwall the mechanism worked most efficiently. We were recently courteously invited by the Trinity House to inspect it, and are permitted by them to reproduce the accompanying engravings, Figs. 1 to 4, and to give the following description of the boat.

As will be seen from the engravings, the hull has something the shape of a lifeboat. Its total length is 65ft., its beam 18½ft., and its depth 10½ft. The lantern is carried on a four-legged steel structure erected amidships. There are two holds—one forward and one aft—and each contains two gasholders each having a capacity of 375 cubic feet. These receivers, when fully charged with oil gas, contain sufficient for keeping the light in action for about 100 days.

The lantern is 5ft. 3in. in diameter, and the light gives a flash of 5100 candle-power intensity at intervals of ten seconds. The revolving mechanism, which is shown in Figs. 1 and 2, is exceedingly ingenious. The gas in the reservoir holders is compressed to 7½ atmospheres. This, of course, is too high a pressure at which to work the burner, and the gas is consequently first passed through a governor or pressure-reducing valve, which delivers it at a pressure of 7 lb. on the square inch. This governor is shown in the engraving, Fig. 1. It is fixed to the side of the lantern, and from a rigid pipe connected to it is taken a flexible rubber connection to

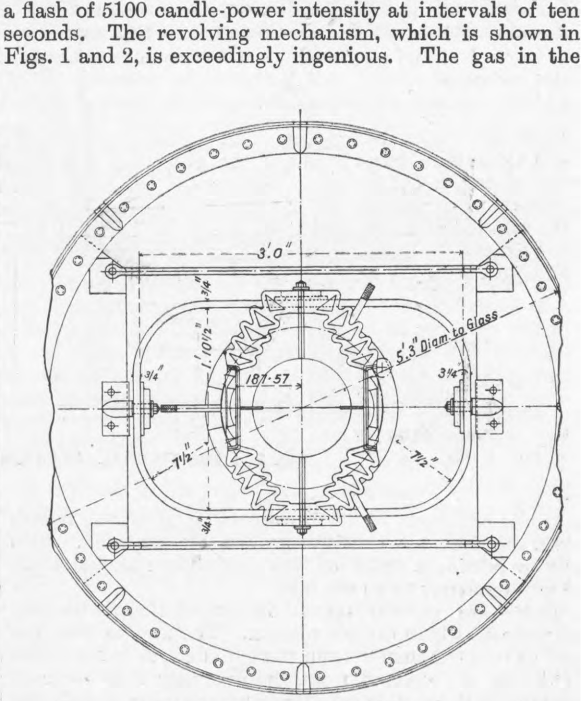
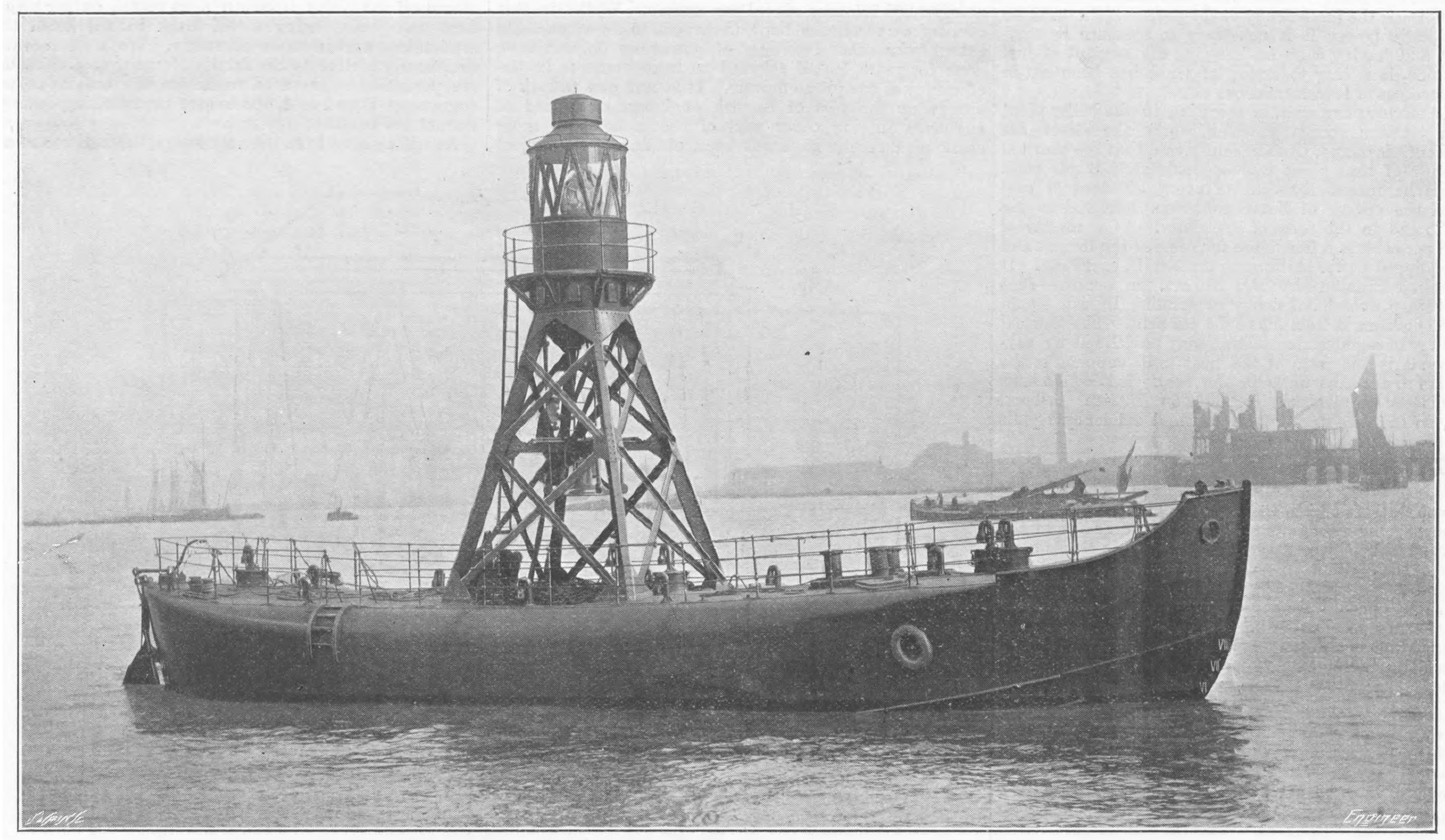


Fig. 2—PLAN OF LANTERN

UNWATCHED FLASHING GAS-LIGHTED BOAT

SIR THOMAS MATTHEWS, TRINITY HOUSE, ENGINEER



the apparatus. Before it passes to the burner, the gas is taken to a small three-cylinder motor, in which the cylinders are arranged at 120 deg. apart. The cylinders are ¾in. in diameter, and are single-acting. They all work on to one crank, the shaft of which is connected to the turntable of the lens by toothed gearing. The turntable is carried in a mercury bath, and there are ball bearings at the top and bottom of the carriage. The whole mechanism is so beautifully made and adjusted that the power developed by the expansion of the gas in the three cylinders of the motor is sufficient not only to revolve the lenses, but to do so at an absolutely accurate rate. We had an opportunity of observing this for ourselves, and the experiment was not carried out in the workshop, but on board the vessel itself, and with the mechanism just as it had come out of its unwatched trial of one month down the river. A sensitive governor is provided, which acts by putting a brake on the mechanism should there be any tendency to go too fast.

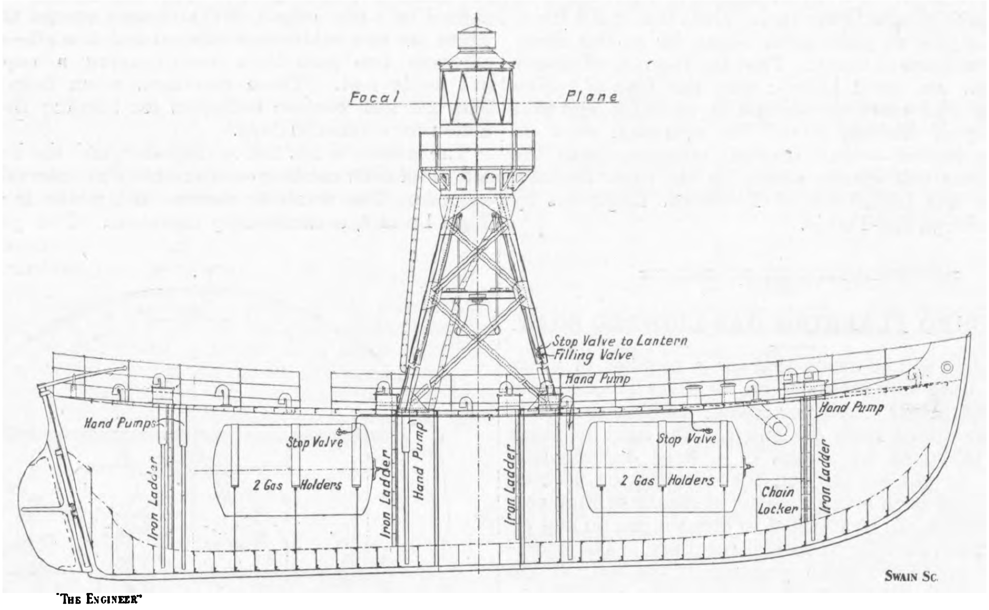


Fig. 3—LONGITUDINAL SECTION OF THE GAS-LIGHTED BOAT

There are several points in connection with the mechanism which call for remark. The first is that the gas, as it is exhausted from the cylinders, is burnt in the light. It is delivered from the cylinders into the case containing them, this case being hermetically closed, the mechanism spindle passing through a mercury sealed gland. From the case it is led to a cylindrical reservoir, this being provided in order to counteract any tendency to pulsation which there might be owing to the discharge of the cylinders of the motor. From this reservoir the gas passes to the low-pressure side of the governor and thence to the burner. The high-pressure side of the governor is connected with the feed-pipe to the motor, and the governor is set to give a pressure of 3in. of water on the burner, and will admit gas to make up that pressure should the exhaust from the motor be insufficient. It will also automatically supply the full quantity of gas to the burner in the event of the motor stopping, thus maintaining a light in the apparatus, although the beam in this case would be stationary. In case anything should occur by which the pressure on the burner rose above 3in., a further safety governor is provided. Connection is made to it through a flexible rubber pipe, and the function of this governor is to exhaust the excess of gas into the atmosphere through the discharge pipe shown.

As will be seen from Fig. 2 the apparatus is carried on double gimbals, so that, no matter how the vessel may roll, the lamp is always vertical. The trunnions of the gimbals work in ball bearings, and the whole mechanism is so accurately adjusted that it responds to the slightest motion of the vessel. A weighted rod is provided to act as a pendulum, and to prevent undue motion. On it is carried a wood buffer which can come into contact with a wood fender carried round the inside of the lantern. The balance is so arranged that an oscillation from one side of the lantern to the other occupies a period of five seconds.

The gas burner consumes 4 cubic feet of gas per hour, and as the light is in action continuously day and night this represents a no inconsiderable amount of gas in the course of the year. In order to reduce this consumption Sir Thomas Matthews has been experimenting for some considerable time with the use of incandescent inverted mantles, and has been very successful with them as applied to buoys, obtaining not only a largely increased illumination but a very decided decrease in gas consumption. It is proposed to adapt this system for use with the unwatched light vessel described above. If this were done, so great is the saving of gas that it would be necessary to fill only one of the four reservoirs with gas. The remainder might be filled with compressed air for driving the motor. The life of the mantle varies to some extent, but as far as experience has gone it is quite long enough to permit a period of, say, a month to elapse between inspections. The adoption of incandescent inverted mantles as contemplated would practically triple the intensity of the beam of light, while considerably reducing the consumption of gas. The Corporation of Trinity House are, moreover, quite sanguine that they may soon be able to apply this system of dioptric apparatus to light vessels generally, in lieu of the present catoptric method of illumination, which would prove a further stride of the utmost importance. The illuminant, however, in this case would be incandescent oil.

Then too—to recur to the subject of the gas-lighted boat—a further improvement will probably be added by means of an arrangement for automatically cutting off the gas supply to the mantle between sunrise and sunset. The principle of this device is that of a graduated cam which can turn on and shut off the gas at greater or less intervals, according to the variation in the length of day with the time of year. A pilot light would always be burning, of course; but this would consume a comparatively small amount of gas. With all these appliances the unwatched boat would look after itself for long periods, lighting up the burner when it got dark, and extinguishing it when it got light, and giving a regular flashing light during the hours of darkness.

Nor is this the full extent of the proposed automatism of the vessel. The hull has been constructed with a well, designed to accommodate an automatic submarine bell-signalling apparatus. This at present has not been fitted, but we understand that so successful have been the trials with the automatic apparatus of the Submarine Signal Company on the Nab buoy in the Trinity House service, that it is practically certain that advantage will be taken of the forethought in providing for the addition of one of these. In this case, with everything working well—and we see no reason whatever why it should not—the unwatched light vessel might take the place of some of the watched vessels, and much saving of expenditure be thus effected. As we saw the vessel, the fog signalling equipment consisted of a 6 cwt. bell, which was suspended in the superstructure, and was sounded, through the motion of the boat, by four hammers in the upper part of the superstructure. Our engraving shows this bell with its clappers in position.

The whole of the lighting apparatus in connection with the vessel, with the exception of the lenses, which were supplied by Chance Bros. and Co., of Birmingham, has been constructed at the Trinity House Engineering workshops at Blackwall.

We may add that the hull of the boat was built by H. and C. Grayson, Limited, of Liverpool.

THE following information is from the report by the British Vice-Consul at Emden (Mr. W. H. M. Sinclair) on the trade of that district in 1908, which will shortly be issued:—An undertaking which will be of interest has been initiated near Aurich with Government assistance. Works are being erected with a view to utilising peat, of which a vast supply is available, for the generating of electricity. The Government will, it is reported, require a supply of some 2,000,000 kilowatts yearly in connection with the harbour at Emden.

THE RHEIMS AERONAUTICAL MEETING.

No. I.

The official commencement of the Rheims aeronautical meeting now being held under the management of the Aero Club of France took place last Sunday. Throughout the previous week the aeronauts who had entered for the different competitions comprised in the programme had spent much time in the adjusting and testing of their machines and getting used to the conditions of flight imposed on them by the rules of the meeting. These rules add some new difficulties to those which already attend successful flight, but while doing so they call for the solution of problems which must be overcome before we can seriously consider aerial traffic and transportation.

Hitherto it has been found most suitable to make flights either in the early morning or late evening, as experience shows that at these time the atmospheric conditions are most likely to be such as to render the attempts successful. By the rules drawn up for the Rheims meeting it is made obligatory that no official start in any of the competitions be made before 10 a.m. and none later than 7 p.m.

The restrictions laid on starting from the ground work also for the ultimate progress of the art, and early in the week one aeronaut was disqualified, as far as the attempt in question is concerned, for occupying too much time in leaving the ground.

With regard to the path of flight the competitors are bound to follow the track laid out on the plains of Betheny. This track is rectangular in shape, and measures 10 kilometres to the lap. At the corners so-called pyramids have been erected to mark the course, while about half-way down one of the shorter sides accommodation has been provided for the judges and timekeepers. At this point also the starting and finishing posts are situated, and, on the outer side of the course, stands for spectators, garages, and manœuvring grounds for the aeroplanes are provided.

The programme for the week contains six principal events, for which substantial monetary prizes will be given. Although the direct scientific results will probably be of little value, since it is not for the accumulation of such data that the meeting is being held, there can be no doubt that the various competitions which have been arranged will test thoroughly the capabilities of the different types of aeroplanes at present in existence. Thus, the speed, endurance, and passenger carrying capabilities of the machines will be tested, and, in addition, a competition has been arranged in which the altitude to which the aeroplane can reach is taken as the point to be contested. There are three distinct competitions for speed—the Gordon Bennett International Cup Race of 20 kiloms., the Prix de Vitesse of 30 kiloms., and the Tour de Piste of 10 kiloms.; while the Grand Prix, which is exciting the largest amount of interest after the Gordon Bennett Cup, will be given as the reward for the greatest endurance. So far eleven entries have been received for the International race, but of these it would seem five only are likely to take part in this event, which has been set down on the programme for to-morrow (Saturday). Of the entrants likely to participate, three will be Frenchmen, one will represent this country, and the United States will contribute the fifth. As might be expected, the majority of the aeronauts at Rheims this week are French, and the Aero Club of France has found it necessary to institute eliminating trials to determine their choice of three representatives.

Where the success of the meeting is so entirely at the mercy of the chances of Nature it is necessary to economise the favourable moments in the meteorological conditions. To this end it has been decided that, wherever possible, a competitor may be held as having competed in several events with the same flight. The passenger and altitude competitions are, however, to be kept separate in this respect from each other and the rest, while the Gordon Bennett race is likewise a separate event.

When the meeting opened on Sunday morning at 10 o'clock the state of the weather was far from being satisfactory; but, despite the wind and rain, the committee expressed a desire that the Gordon Bennett elimination trials should be proceeded with if possible. In compliance with this request several aeronauts attempted to make a start, but up till mid-day all these, with the exception of one by M. Lefebvre, ended in failure. M. Lefebvre, on a Wright biplane, set out intending to complete the three laps required for the Prix de Vitesse, but after accomplishing $1\frac{3}{4}$ laps he was forced to descend, the cause not being stated. He was, however, entitled under the ruling mentioned above to enter this as an attempt for the Tour de Piste, and his official time for the 10-kilom. lap of this competition has been given as 8 min. $58\frac{4}{5}$ sec. During the afternoon all attempts had to be completely abandoned on account of the high wind, but towards six o'clock in the evening the atmospheric conditions improved somewhat, and in a short time several aeronauts were on their machines. Some of these succeeded in flying the 30 kiloms. for the Prix de Vitesse. From the particulars of these and other results, which we give below, it will be seen that M. Lefebvre's morning performance remained unexcelled. Thus the first day passed without any exceptional results being recorded, although sufficient was done to enable the committee to select two of the French competitors as their representatives for the Gordon Bennett race. Their choice fell on MM. Lefebvre and Blériot, while M. Latham's name was provisionally indicated as that of the third, the final decision being held over until the results of the succeeding days could be compared.

On Monday the weather had improved to a certain extent, although the state of the wind was still such as to give the officials and competitors cause for anxiety. As on the previous day, the flights attempted in the morning were on the whole unsuccessful. In the afternoon, however, several good performances were recorded, the most notable of which was M. Paulhan's flight of $49\frac{1}{2}$ kiloms. To accomplish this he remained in the air for 70 minutes. He had earlier in the day carried out a flight of 57 minutes' duration, and thus he made a double entry for the Grand Prix. M. Blériot, on his 50 horse-power Antoinette, succeeded shortly afterwards in establishing a new record for the 10 kiloms., reducing the time taken by M. Lefebvre on the previous day by $16\frac{2}{5}$ seconds. This, in turn, was quickly improved upon by Mr. Curtiss, the American representative, who flew over the 10-kilom. lap in 8 min. $35\frac{2}{5}$ sec., which remained as the best performance so far for the Tour de Piste.

Tuesday morning was entirely devoid of attempts, and it was not until nearly five in the afternoon that the first flight of the day was undertaken, as the weather again was unfavourable. The proceedings about this time were witnessed by President Fallières and other ministers, who had travelled to Rheims expressly for the purpose.

M. Paulhan again distinguished himself, and despite the strong wind blowing, completed the three laps for the Prix de Vitesse in 38 min. 12 sec. M. Latham immediately afterwards set out on a similar course, and succeeded in accomplishing the distance in 30 min. 2 sec., although a twentieth part of this will be added on as a penalty for not finishing a previous flight. Meanwhile M. Blériot had flown away on the single lap journey for the Tour de Piste, and, flying low, broke the record made by Curtiss on the previous day by doing the 10 kiloms. in 8 min. $4\frac{2}{5}$ sec. No other flights calling for special mention were made during the day.

The weather conditions on Wednesday morning were likewise of a nature to forbid any attempts at flight. About 3 o'clock in the afternoon several aeronauts brought their machines to the starting point, but none succeeded in getting off. Shortly before 4 M. Paulhan made a start in the Grand Prix contest, and was immediately followed by M. Latham. The latter, however, had only accomplished one round when he came back to earth again. At the end of Paulhan's second round, M. Fournier, on a Voisin biplane, set out to follow him, but only succeeded in flying a short distance, when he was caught by a gust of wind and fell heavily to earth. In addition to the entire wreck of his machine, he was himself stunned. Meanwhile Paulhan continued on his course, and it was soon apparent that he was likely to create a record for both time and distance. His flight was keenly watched, and towards the end all others were given up, even his rival aeronauts lending him their encouragement. On his eleventh circuit of the course, it was announced that he had beaten the world's record for duration of flight, which was made a few weeks ago by Sommer, who, on a Farman biplane, remained in the air 2 h. 27 min. In the middle of his fourteenth circuit Paulhan was seen to be descending, and it was learned that his petrol supply had become exhausted. He had, however, easily established a record for both time and distance, having remained in the air for 2 h. 43 min. 24 sec., during which time he flew a distance of 131 kilometres—about 82 miles.

This notable performance was practically the only event of the day, other aeronauts being on the whole unfortunate.

The table appended is necessarily incomplete, the more notable flights only having been entered, and the figures given are provisional, as the final results have not yet been issued. Three of the machines are illustrated on page 218.

Speeds and Distances at Rheims.

References:—G.P. = Grand Prix. P.V. = Prix de Vitesse. T.P. = Tour de Piste.

Date.	Competition.	Aeronaut.	Machine.	Distance 10 kiloms. to the lap	Time. m.	Time. s.
Aug. 22	T.P.	Lefebvre ...	Wright	1 lap	8	$58\frac{4}{5}$
,,	,,	Tissandier ...	,, ...	,,	9	$26\frac{1}{5}$
,,	,,	De Lambert...	,, ...	,,	9	$33\frac{2}{5}$
,,	,,	Latham... ...	Antoinette ...	,,	9	47
,,	,,	Paulhan ...	Voisin	,,	10	50
,,	,,	Sommer ...	Farman	,,	11	$24\frac{2}{5}$
,,	,,	Cockburn ...	,, ...	,,	11	44
,,	,,	Bunan Varilla	Voisin ...	,,	13	$8\frac{1}{5}$
,,	P.V.	Lefebvre ...	Wright	3 laps	29	2
,,	,,	Paulhan ...	Voisin	,,	32	$49\frac{3}{5}$
,,	,,	De Lambert...	Wright	,,	29	2
,,	,,	Tissandier ...	,, ...	,,	28	$59\frac{1}{5}$
Aug. 23	G.P.	Paulhan ..	Voisin	$49\frac{1}{2}$ km.	—	
,,	T.P.	Curtiss	Herring-Curtiss	1 lap	8	$35\frac{2}{5}$
,,	,,	Blériot	Blériot	,,	8	$42\frac{2}{5}$
Aug. 24	P.V.	Paulhan ...	Voisin	3 laps	38	12
,,	T.P.	Blériot	Blériot	1 lap	8	4
,,	P.V.	Latham ...	Antoinette ...	3 laps	30	2
Aug. 25	G.P.	Paulhan ...	Voisin	131 km.	163	24

ELECTROLYSIS.

The restrictions imposed by the Board of Trade have compelled engineers in this country to pay great attention to the bonding of rails on our electric traction systems, and it is thanks to these restrictions that the troubles arising from electrolysis have been reduced to their present low standard. The resistance of the return-circuit of an electric tramway is made up of the rails themselves and the bonds connecting them together. If this resistance is large, the current on its way back to the power-house will take up another path, provided, of course, that it can find one of sufficiently low resistance. Thus, as many engineers have often found to their sorrow, instead of the current returning to the power-house or sub-station by way of the rails, some of it finds its way back through the earth, or more correctly speaking, through things which are buried in the earth. Gas pipes, water mains, lead-covered cables, &c., are all more or less good conductors of electricity, and it is well known that with badly bonded rails they will readily act as such. It is equally well known that whenever current passes from a pipe or cable to the ground, or to another pipe or cable, corrosion of the metal takes place, holes and pittings are produced, causing leaky pipes, rotting away the lead covering on telephone and other cables, and so giving rise to a great amount of inconvenience, expense, and annoyance. The corrosion may be slow or it may be rapid, depending on the strength of the stray current. It is for good reason, therefore, that the Board of Trade requires that a continuous record be kept of the difference in potential between the point of the uninsulated return furthest from and nearest to the power station. Should at any time the difference of potential exceed 7 volts steps must be taken to reduce it below that limit. The usual method of reducing the drop at times of heavy loads is by means of a negative or return wire booster, which may be regarded as a pump for pumping back the current to the station. There are other requirements of the Board of Trade which have to be complied with, but we need not enter into them here; our object is merely to emphasise the importance of these restrictions, and to draw attention to what has happened at Winnipeg in consequence of no such rules being in force.

In January last the Board of Control of Winnipeg engaged Professor L. A. Herdt, of the McGill University, to report upon the electrical conditions existing in the city, particularly in connection with the return current of the Winnipeg Electric Railway Company's system and its connection with the Government telephone cable system, and to submit recommendations dealing with improvements of the present state of affairs, so that electrolysis or fire risks, if such existed, might be eliminated. His report, which has recently been issued, shows what a large amount of damage can be done to water pipes, &c., with badly bonded rails and a high resistance return circuit due to other causes. The Winnipeg Street Railway Company has two plants in the city. One of them is a steam plant, which is kept in reserve, while the other, which furnishes the whole of the electric current for the street railway, receives its power from a hydro-electric plant on the Winnipeg River. At times the current taken by the railway, reaches 9000 ampères, but the average current is 6000 ampères. It appears that the return circuit of practically the whole system is abnormally imperfect, and that the soil in the city has a remarkably low resistance, so that in order to prevent leakage currents a very small drop in the rail return would be necessary.

According to a report of the city electrician electrolytic action has mainly taken place in six districts. Lengths of water pipe and lead-covered cables taken from those districts have been examined, and there appears to be no doubt that the holes and breaks in them have been caused by electrolysis. The damage in four districts is believed to be due to the very bad condition of the bonding. The condition of which may be judged when it is stated that in one place, where the road bed is unpaved, the bond wires, which are No. 0 B and S soft copper wire, with bonding cap terminals, gave pressure drop readings equivalent to that of rails from 20ft. to 60ft. long. In this country nearly all specifications call for 98 per cent. conductivity in the bonds, and this is generally obtained. At some parts the bonds are uncovered, and many of these have been found to be broken altogether. Professor Herdt states that in another district the rails are bonded to the water pipes, and the heavy water mains in this street carry a large part of the current, until it reaches a point where the stray currents pass into the telephone cables, which are bonded to the negative bus bars of the sub-station, and also to the intricate network of mains and service pipes lying in another district. It seems that in their efforts to stop electrolysis a great deal has been done in the way of bonding water and gas mains direct to the rails. Indeed, one is led to suppose from the report that these gas and water mains, and the telephone cables, act just as much as return conductors as the rails themselves, or possibly even more so.

The practice of bonding the tracks to water and gas pipes, while affording local protection, has undoubtedly encouraged leakage currents, and there appears good reason to believe that the electrolysis troubles have been intensified to a great extent by adopting this practice. Professor Herdt, in his report, calls attention to this, and recommends that the practice be abandoned. A great number of American engineers appear to place reliance on this practice of relieving mains from electrolysis at badly affected places, but they seem to overlook the fact that it is inviting the current to leave the rails and take to the pipes, and it often gives rise to electrolytic action at the joints. The conditions of things is well brought out in a paragraph having reference to a test which was made in the basement of a building where a recording ammeter was connected between a water main and telephone cable. At one time 50 ampères were recorded and the water pipe was positive to the telephone cables.

In addition to the imperfect condition of the bonding in the greater part of the city, the general design of the system also appears to add materially to the electrolysis trouble. It is obvious that not only must the rails be well bonded, but that they themselves should be of ample section to carry whatever return current they may be called upon to deal with. And no less important is the question of low resistance return feeders, which should take the current from the rails at various points. But at Winnipeg the conditions in these respects are anything but ideal. Between the rails, which are 70 lb. and 90 lb., there is a 500,000 circular mil cable which is cross-bonded to the track. Readings taken along the line between the high-pressure hydrants and domestic water pipes show these positive to the rails. As a matter of fact, throughout the whole centre of the city this condition is met. At one point the tracks are bonded to return feeders of a total sectional area equal to 6,848,000 circular mils. The drop of potential between this point and the negative bus bars, if these carried the railway current altogether, would reach 12 volts at times. The distance is approximately 1200ft.; in other words, the drop of potential from these tracks to the station is one volt per 100ft., which is, of course, excessive. Other return feeders are bonded to the tracks at different points, but they are of comparatively small section, and little current can be carried by them.

The remedies for the trouble are naturally very evident. Professor Herdt, in drawing up his recommendations, has undoubtedly given sound advice, which if acted upon will, we feel sure, remove the unpleasant state of affairs at present existing at Winnipeg. First he recommends the erection of sub-stations at different points, with a view to diminishing the amount of current to be returned through the rails in the centre of the city. Proper re-bonding of all tracks that show defect, and special bonding and cross-bonding at intersections, is urged upon the company, and also a system of inspection of track returns. It is satisfactory to learn that the company has placed an order for electrical machinery, which will be erected in three new sub-stations, and which will reduce very largely the amount of current through the rails now very much overloaded. Its desire quickly to remedy matters is also evident from the fact that the company has now in operation a bonding car for electrically brazing copper bonds on the rail joints. The amount of copper in the return feeders will have to be increased, and it seems that the cost of removing electrolysis troubles from Winnipeg will amount to something considerable.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

THE annual meeting of the British Association for the Advancement of Science opened on Wednesday at Winnipeg, Manitoba. This is the third occasion on which the Dominion of Canada has witnessed the convention of the members, previous meetings having been held at Montreal and Toronto in 1884 and 1897 respectively. The meetings are being held in the buildings of Manitoba University, while other colleges and halls are being utilised for reception and other purposes. Sir J. J. Thomson is the president this year, and on the opening day delivered his address, part of which is given below.

ADDRESS BY PROFESSOR SIR J. J. THOMSON, M.A., LL.D. D.Sc., F.R.S., President.

TWENTY-FIVE years ago a great change was made in the practice of the British Association. From the foundation of our Society until 1884 its meetings had always been held in the British Isles; in that year, however, the Association met in Montreal, and a step was taken which changed us from an insular into an Imperial Association. For this change, which now I think meets with nothing but approval, Canada is mainly responsible. Men of science welcome it for the increased opportunities it gives them of studying under the most pleasant and favourable conditions different parts of our Empire, of making new friends; such meetings as these not only promote the progress of science, but also help to strengthen the bonds which bind together the different portions of the King's dominions.

This year, for the third time in a quarter of a century, we are meeting in Canada. As if to give us an object lesson in the growth of Empire, you in Winnipeg took the opportunity at our first meeting in Canada in 1884 to invite our members to visit Manitoba and see for themselves the development of the Province at that time. Those who were fortunate enough to be your guests then as well as now are confronted with a change which must seem to them unexampled and almost incredible. Great cities have sprung up, immense areas have been converted from prairies to prosperous farms, flourishing industries have been started, and the population has quadrupled. As the President of a scientific association I hope I may be pardoned if I point out that even the enterprise and energy of your people and the richness of your country would have been powerless to effect this change without the resources placed at their disposal by the labours of men of science.

The eminence of my predecessors in the chair at the meetings of the British Association in Canada makes my task this evening a difficult one. The meeting at Montreal was presided over by Lord Rayleigh, who, like Lord Kelvin, his colleague in the chair of Section A at that meeting, has left the lion's mark on every department of physics, and who has shown that, vast as is the empire of physics, there are still men who can extend its frontiers in all of the many regions under its sway. It has been my lot to succeed Lord Rayleigh in other offices as well as this, and I know how difficult a man he is to follow.

The President of the second meeting in Canada—that held in 1897 at Toronto—was Sir John Evans, one of the men who, like Boyle, Cavendish, Darwin, Joule, and Huggins, have, from their own resources and without the aid derived from official positions or from the universities, made memorable contributions to science; such men form one of the characteristic features of British science. May we not hope that, as the knowledge of science and the interest taken in it increase, more of the large number of men of independent means in our country may be found working for the advancement of science, and thereby rendering services to the community no less valuable than the political, philanthropic, and social work at which many of them labour with so much zeal and success?

I can, however, claim to have some experience of, at any rate, one branch of Canadian science, for it has been my privilege to receive at the Cavendish Laboratory many students from your universities. Some of these have been holders of what is known as the 1851 scholarships. These scholarships are provided from the surplus of the Great Exhibition of 1851, and are placed at the disposal of most of the younger universities in the British Empire, to enable students to devote themselves for two or three years to original research in various branches of science. I have had many opportunities of seeing the work of these scholars, and I should like to put on record my opinion that there is no educational endowment in the country which has done or is doing better work.

I have had, as I said, the privilege of having as pupils students from your universities as well as from those of New Zealand, Australia, and the United States, and have thus had opportunities of comparing the effect on the best men of the educational system in force at your universities with that which prevails in the older English universities. Well, as the result, I have come to the conclusion that there is a good deal in the latter system which you have been wise not to imitate. The chief evil from which we at Cambridge suffer and which you have avoided is, I am convinced, the excessive competition for scholarships which confronts our students at almost every stage of their education. You may form some estimate of the prevalence of these scholarships if I tell you that the colleges in the University of Cambridge alone give more than £35,000 a year in scholarships to undergraduates, and I suppose the case is much the same at Oxford. The result of this is that preparation for these scholarships dominates the education of the great majority of the cleverer boys who come to these universities, and indeed in some quarters it seems to be held that the chief duty of a schoolmaster, and the best test of his efficiency, is to make his boys get scholarships. The preparation for the scholarship too often means that about two years before the examination the boy begins to specialise, and from the age of sixteen does little else than the subject, be it mathematics, classics, or natural science, for which he wishes to get a scholarship; then, on entering the university, he spends three or four years studying the same subject before he takes his degree, when his real life work ought to begin. How has this training fitted him for this work? I will take the case in which the system might perhaps be expected to show to greatest advantage, when his work is to be original research in the subject he has been studying. He has certainly acquired a very minute acquaintance with his subject—indeed, the knowledge possessed by some of the students trained under this system is quite remarkable, much greater than that of any other students I have ever met. But though he has acquired knowledge, the effect of studying one subject, and one subject only, for so long a time is too often to dull his enthusiasm for it, and he begins research with much of his early interest and keenness evaporated. Now there is hardly any quality more essential to success in research than enthusiasm. Research is difficult, laborious, often disheartening. The carefully designed apparatus refuses to work, it develops defects which may take months of patient work to rectify, the results obtained may appear inconsistent with each other and with every known law of Nature, sleepless nights and laborious days may seem only to make the confusion more confounded, and there is nothing for the student to do but to take for his motto "It's dogged as does it," and plod on, comforting himself with the assurance that when success does come, the difficulties he has overcome will increase the pleasure—one of the most exquisite men can enjoy—of getting some conception which will make all that was tangled, confused, and contradictory, clear and consistent. Unless he has enthusiasm to carry him on when the prospect seems almost hopeless and the labour and strain incessant, the student may give up his task and take to easier, though less important, pursuits.

I am convinced that no greater evil can be done to a young man than to dull his enthusiasm. In a very considerable experience of students of physics beginning research, I have met with more—many more—failures from lack of enthusiasm and determination than from any lack of knowledge or of what is usually known as cleverness.

This continual harping from an early age on one subject, which is so efficient in quenching enthusiasm, is much encouraged by the practice of the colleges to give scholarships for proficiency in one subject alone. I went through a list of the scholarships awarded in the University of Cambridge last winter, and though there were 202 of them, I could only find three cases in which it was specified that the award was made for proficiency in more than one subject.

The premature specialisation fostered by the preparation for these scholarships injures the student by depriving him of adequate literary culture, while when it extends, as it often does, to specialisation in one or two branches of science, it retards the progress of science by tending to isolate one science from another. The boundaries between the sciences are arbitrary, and tend to disappear as science progresses. The principles of one science often find most striking and suggestive illustrations in the phenomena of another. Thus, for example, the physicist finds in astronomy that effects he has observed in the laboratory are illustrated on the grand scale in the sun and stars. No better illustration of this could be given than Professor Hale's recent discovery of the Zeeman effect in the light from sun spots; in chemistry, too, the physicist finds in the behaviour of the whole series of reactions illustrations of the great laws of thermodynamics, while if he turns to the biological sciences he is confronted by problems, mostly unsolved, of unsurpassed interest. Consider for a moment the problem presented by almost any plant—the characteristic and often exquisite detail of flower, leaf, and habit—and remember that the mechanism which controls this almost infinite complexity was once contained in a seed perhaps hardly large enough to be visible. We have here one of the most entrancing problems in chemistry and physics it is possible to conceive.

Again, the specialisation prevalent in schools often prevents students of science from acquiring sufficient knowledge of mathematics; it is true that most of those who study physics do some mathematics, but I hold that, in general, they do not do enough, and that they are not as efficient physicists as they would be if they had a wider knowledge of that subject. There seems at present a tendency in some quarters to discourage the use of mathematics in physics; indeed, one might infer, from the statements of some writers in quasi-scientific journals, that ignorance of mathematics is almost a virtue. If this is so, then surely of all the virtues this is the easiest and most prevalent.

I do not for a moment urge that the physicist should confine himself to looking at his problems from the mathematical point of view; on the contrary, I think a famous French mathematician and physicist was guilty of only slight exaggeration when he said that no discovery was really important or properly understood by its author unless and until he could explain it to the first man he met in the street.

But two points of view are better than one, and the physicist who is also a mathematician possesses a most powerful instrument for scientific research with which many of the greatest discoveries have been made; for example, electric waves were discovered by mathematics long before they were detected in the laboratory. He has also at his command a language clear, concise, and universal, and there is no better way of detecting ambiguities and discrepancies in his ideas than by trying to express them in this language. Again, it often happens that we are not able to appreciate the full significance of some physical discovery until we have subjected it to mathematical treatment, when we find that the effect we have discovered involves other effects which have not been detected, and we are able by this means to duplicate the discovery. Thus James Thomson, starting from the fact that ice floats on water, showed that it follows by mathematics that ice can be melted and water prevented from freezing by pressure. This effect, which was at that time unknown, was afterwards verified by his brother, Lord Kelvin. Multitudes of similar duplication of physical discoveries by mathematics could be quoted.

I have been pleading in the interests of physics for a greater study of mathematics by physicists. I would also plead for a greater study of physics by mathematicians in the interest of pure mathematics.

The history of pure mathematics shows that many of the most important branches of the subject have arisen from the attempts made to get a mathematical solution of a problem suggested by physics. Thus the differential calculus arose from attempts to deal with the problem of moving bodies. Fourier's theorem resulted from attempts to deal with the vibrations of strings and the conduction of heat; indeed, it would seem that the most fruitful crop of scientific ideas is produced by cross-fertilisation between the mind and some definite fact, and that the mind by itself is comparatively unproductive.

I think, if we could trace the origin of some of our most comprehensive and important scientific ideas, it would be found that they arose in the attempt to find an explanation of some apparently trivial and very special phenomenon; when once started the ideas grew to such generality and importance that their modest origin could hardly be suspected. Water vapour we know will refuse to condense into rain unless there are particles of dust to form nuclei; so an idea before taking shape seems to require a nucleus of solid fact round which it can condense.

I have ventured to urge the closer union between mathematics and physics, because I think of late years there has been some tendency for these sciences to drift apart, and that the workers in applied mathematics are relatively fewer than they were some years ago. This is no doubt due to some extent to the remarkable developments made in the last few years in experimental physics on the one hand, and in the most abstract and metaphysical parts of pure mathematics on the other. The fascination of these has drawn workers to the frontiers of these regions who would otherwise have worked nearer the junction of the two. In part, too, it may be due to the fact that the problems with which the applied mathematician has to deal are exceedingly difficult, and many may have felt that the problems presented by the older physics have been worked over so often by men of the highest genius that there was but little chance of any problem which they could have any hope of solving being left.

But the newer developments of physics have opened virgin ground which has not yet been worked over, and which offers problems to the mathematician of great interest and novelty—problems which will suggest and require new methods of attack, the development of which will advance pure mathematics as well as physics.

I have alluded to the fact that pure mathematicians have been indebted to the study of concrete problems for the origination of some of their most valuable conceptions; but, though, no doubt, pure mathematicians are in many ways very exceptional folk, yet in this respect they are very human. Most of us need to tackle some definite difficulty before our minds develop whatever powers they may possess. This is true for even the youngest of us, for our school boys and school girls, and I think the moral to be drawn from it is that we should aim at making the education in our schools as little bookish and as practical and concrete as possible.

I once had an illustration of the power of the concrete in stimulating the mind which made a very lasting impression upon me. One of my first pupils came to me with the assurance from his previous teacher that he knew little and cared less about mathematics, and that he had no chance of obtaining a degree in that subject. For some time I thought this estimate was correct, but he happened to be enthusiastic about billiards, and when we were reading that part of mechanics which deals with the collision of elastic bodies I pointed out that many of the effects he was constantly observing were illustrations of the subject we were studying. From that time he was a changed man. He had never before regarded mathematics as anything but a means of annoying innocent undergraduates; now, when he saw what important results it could obtain, he became enthusiastic about it, developed very considerable mathematical ability, and, though he had already wasted two out of his three years at college, took a good place in the mathematical tripos.

It is possible to read books, to pass examinations without the higher qualities of the mind being called into play. Indeed, I doubt if there is any process in which the mind is more quiescent than in reading without interest. I might appeal to the widespread habit of reading in bed as a prevention of insomnia as a proof of this. But it is not possible for a boy to make a boat or for a girl to cook a dinner without using their brains. With practical things the difficulties have to be surmounted, the boat must be made water-tight, the dinner must be cooked, while in reading there is always the hope that the difficulties which have been slurred over will not be set in the examination.

I think it was Helmholtz who said that often in the course of a research more thought and energy were spent in reducing a refractory piece of brass to order than in devising the method or planning the scheme of campaign. This constant need for thought and action gives to original reasearch in any branch of experimental science great educational value even for those who will not become professional men of science. I have had considerable experience with students beginning research in experimental physics, and I have always been struck by the quite remarkable improvement in judgment, independence of thought and maturity produced by a year's research. Research develops qualities which are apt to atrophy when the student is preparing for examinations, and, quite apart from the addition of new knowledge to our store, is of the greatest importance as a means of education.

It is the practice in many universities to make special provision for the reception of students from other universities who wish to do original research or to study the more advanced parts of their subject, and considerable numbers of such students migrate from one university to another. I think it would be a good thing if this practice were to extend to students at an earlier stage in their career; especially should I like to see a considerable interchange of students between the universities in the Mother Country and those in the Colonies.

I am quite sure that many of our English students, especially those destined for public life, could have no more valuable experience than to spend a year in one or other of your universities, and I hope some of your students might profit by a visit to ours.

I can think of nothing more likely to lead to a better understanding of the feelings, the sympathies, and, what is not less important, the prejudices, of one country by another, than by the youths of those countries spending a part of their student life together. Undergraduates as a rule do not wear a mask either of politeness or any other material, and have probably a better knowledge of each other's opinions and points of view—in fact, know each other better than do people of riper age. To bring this communion of students about there must be co-operation between the universities throughout the Empire; there must be recognition of each other's examinations, residence, and degrees. Before this can be accomplished there must, as my freind Mr. E. B. Sargant pointed out in a lecture given at the McGill University, be co-operation and recognition between the universities in each part of the Empire. I do not mean for a moment that all universities in a country should be under one government. I am a strong believer in the individuality of universities, but I do not think this is in any way inconsistent with the policy of an open door from one university to every other in the Empire.

It has usually been the practice of the president of this Association to give some account of the progress made in the last few years in the branch of science which he has the honour to represent.

I propose this evening to follow that precedent, and to attempt to give a very short account of some of the more recent developments of physics, and the new conceptions of physical processes to which they have led.

The period which has elapsed since the Association last met in Canada has been one of almost unparalleled activity in many branches of physics, and many new and unsuspected properties of matter and electricity have been discovered. The history of this period affords a remarkable illustration of the effect which may be produced by a single discovery; for it is, I think, to the discovery of the Röntgen rays that we owe the rapidity of the progress which has recently been made in physics. A striking discovery like that of the Röntgen rays acts much like the discovery of gold in a sparsely populated country; it attracts workers who come in the first place for the gold, but who may find that the country has other products, other charms, perhaps even more valuable than the gold itself. The country in which the gold was discovered in the case of the Röntgen rays was the department of physics dealing with the discharge of electricity through gases, a subject which, almost from the beginning of electrical science, had attracted a few enthusiastic workers, who felt convinced that the key to unlock the secret of electricity was to be found in a vacuum tube. Röntgen, in 1895, showed that when electricity passed through such a tube, the tube emitted rays which could pass through bodies opaque to ordinary light, which could, for example, pass through the flesh of the body, and throw a shadow of the bones on a suitable screen. The fascination of this discovery attracted many workers to the subject of the discharge of electricity through gases, and led to great improvements in the instruments used in this type of research. It is not, however, to the power of probing dark places, important though this is, that the influence of Röntgen rays on the progress of science has mainly been due; it is rather because these rays make gases, and, indeed, solids and liquids, through which they pass, conductors of electricity. It is true that before the discovery of these rays other methods of making gases conductors were known, but none of these was so convenient for the purposes of accurate measurement.

The study of gases exposed to Röntgen rays has revealed in such gases the presence of particles charged with electricity; some of these particles are charged with positive, others with negative electricity.

The properties of these particles have been investigated; we know the charge they carry, the speed with which they move under an electric force, the rate at which the oppositely charged ones recombine, and these investigations have thrown a new light, not only on electricity, but also on the structure of matter.

We know from these investigations that electricity, like matter, is molecular in structure, that just as a quantity of hydrogen is a collection of an immense number of small particles called molecules, so a charge of electricity is made up of a great number of small charges, each of a perfectly definite and known amount.

Helmholtz said in 1880 that in his opinion the evidence in favour of the molecular constitution of electricity was even stronger than that in favour of the molecular constitution of matter. How much stronger is that evidence now, when we have measured the charge on the unit and found it to be the same from whatever source the electricity is obtained. Nay, further, the molecular theory of matter is indebted to the molecular theory of electricity for the most accurate determination of its fundamental quantity, the number of molecules in any given quantity of an elementary substance.

The great advantage of the electrical methods for the study of the properties of matter is due to the fact that whenever a particle is electrified it is very easily identified, whereas an uncharged molecule is most elusive; and it is only when these are present in immense numbers that we are able to detect them. A very simple calculation will illustrate the difference in our power of detecting electrified and unelectrified molecules. The smallest quantity of unelectrified matter ever detected is probably that of neon, one of the inert gases of the atmosphere. Professor Strutt has shown that the amount of neon in one-twentieth of a cubic centimetre of the air at ordinary pressures can be detected by the spectroscope; Sir William Ramsay estimates that the neon in the air only amounts to one part of neon in 100 000 parts of air, so that the neon in one-twentieth of a cubic centimetre of air would only occupy at atmospheric pressure a volume of half a millionth of a cubic centimetre. Whan stated in this form the quantity seems exceedingly small, but in this small volume there are about ten million million molecules. Now the population of the earth is estimated at about fifteen hundred millions, so that the smallest number of molecules of neon we can identify is about 7000 times the population of the earth. In other words, if we had no better test for the existence of a man than we have for that of an unelectrified molecule we should come to the conclusion that the earth is uninhabited. Contrast this with our power of detecting electrified molecules. We can by the electrical method, even better by the cloud method of C. T. R. Wilson, detect the presence of three or four charged particles in a cubic centimetre. Rutherford has shown that we can detect the presence of a single α particle. Now the α particle is a charged atom of helium; if this atom had been uncharged we should have required more than a million million of them, instead of one, before we should have been able to detect them.

We may, I think, conclude, since electrified particles can be studied with so much greater ease than unelectrified ones, that we shall obtain a knowledge of the ultimate structure of electricity before we arrive at a corresponding degree of certainty with regard to the structure of matter.

We have already made considerable progress in the task of discovering what the structure of electricity is. We have known for some time that of one kind of electricity—the negative—and a very interesting one it is. We know that negative electricity is made up of units all of which are of the same kind; that these units are exceedingly small compared with even the smallest atom, for the mass of the unit is only $\frac{1}{1700}$th part of the mass of an atom of hydrogen; that its radius is only 10^{-13} centimetre, and that these units, "corpuscles" as they have been called, can be obtained from all substances. The size of these corpuscles is on an altogether different scale from that of atoms; the volume of a corpuscle bears to that of the atom about the same relation as that of a speck of dust to the volume of this room. Under suitable conditions they move at enormous speeds which approach in some instances the velocity of light.

The discovery of these corpuscles is an interesting example of the way Nature responds to the demands made upon her by mathematicians. Some years before the discovery of corpuscles it had been shown by a mathematical investigation that the mass of a body must be increased by a charge of electricity. This increase, however, is greater for small bodies than for large ones, and even bodies as small as atoms are hopelessly too large to show any appreciable effect; thus the result seemed entirely academic. After a time corpuscles were discovered, and these are so much smaller than the atom that the increase in mass due to the charge becomes not merely appreciable, but so great that, as the experiments of Kaufmann and Bucherer have shown, the whole of the mass of the corpuscle arises from its charge.

We know a great deal about negative electricity; what do we know about positive electricity? Is positive electricity molecular in structure? Is it made up into units, each unit carrying a charge equal in magnitude, though opposite in sign, to that carried by a corpuscle? Does, or does not, this unit differ, in size and physical properties, very widely from the corpuscle? We know that by suitable processes we can get corpuscles out of any kind of matter, and that the corpuscles will be the same from whatever source they may be derived. Is a similar thing true for positive electricity? Can we get, for example, a positive unit from oxygen of the same kind as that we get from hydrogen?

For my own part, I think the evidence is in favour of the view that we can, although the nature of the unit of positive electricity makes the proof much more difficult than for the negative unit.

In the first place, we find that the positive particles—"canalstrahlen" is their technical name—discovered by our distinguished guest, Dr. Goldstein, which are found when an electric discharge passes through a highly rarefied gas, are, when the pressure is very low, the same, whatever may have been the gas in the vessel to begin with. If we pump out the gas until the pressure is too low to allow the discharge to pass, and then introduce a small quantity of gas and restart the discharge, the positive particles are the same whatever kind of gas may have been introduced.

I have, for example, put into the exhausted vessel oxygen, argon, helium, the vapour of carbon tetrachloride, none of which contain hydrogen, and found the positive particles to be the same as when hydrogen was introduced.

Some experiments made lately by Wellisch, in the Cavendish Laboratory, strongly support the view that there is a definite unit of positive electricity independent of the gas from which it is derived; these experiments were on the velocity with which positive particles move through mixed gases. If we have a mixture of methyl-iodide and hydrogen exposed to Röntgen rays, the effect of the rays on the methyl-iodide is so much greater than on the hydrogen, that, even when the mixture contains only a small percentage of methyl-iodide, practically all the electricity comes from this gas, and not from the hydrogen.

Now, if the positive particles were merely the residue left when a corpuscle had been abstracted from the methyl-iodide, these particles would have the dimensions of a molecule of methyl-iodide; this is very large and heavy, and would therefore move more slowly through the hydrogen molecules than the positive particles derived from hydrogen itself, which would, on this view, be of the size and weight of the light hydrogen molecules. Wellisch found that the velocities of both the positive and negative parcels through the mixture were the same as the velocities through pure hydrogen, although in the one case the ions had originated from methyl-iodide, and in the other from hydrogen; a similar result was obtained when carbon tetrachloride or mercury methyl was used instead of methyl-iodide. These and similar results lead to the conclusion that the atom of the different chemical elements contains definite units of positive as well as of negative electricity, and that the positive electricity, like the negative, is molecular in structure.

The investigations made on the unit of positive electricity show that it is of quite a different kind from the unit of negative, the mass of the negative unit is exceedingly small compared with any atom, the only positive units that up to the present have been detected are quite comparable in mass with the mass of an atom of hydrogen; in fact, they seem equal to it. This makes it more difficult to be certain that the unit of positive electricity has been isolated, for we have to be on our guard against it being a much smaller body attached to the hydrogen atoms which happen to be present in the vessel. If the positive units have a much greater mass than the negative ones, they ought not to be so easily deflected by magnetic forces when moving at equal speeds; and in general the insensibility of the positive particles to the influence of a magnet is very marked; though there are cases when the positive particles are much more readily deflected, and these have been interpreted as proving the existence of positive units comparable in mass with the negative ones. I have found, however, that in these cases the positive particles are moving very slowly, and that the ease with which they are deflected is due to the smallness of the velocity, and not to that of the mass. It should, however, be noted that M. Jean Becquerel has observed in the absorption spectra of some minerals, and Professor Wood in the rotation of the plane of polarisation by sodium vapcur, effects which could be explained by the presence in the substances of positive units comparable in mass with corpuscles. This, however, is not the only explanation which can be given of these effects, and at present the smallest positive electrified particles of which we have direct experimental evidence have masses comparable with that of an atom of hydrogen.

A knowledge of the mass and size of the two units of electricity, the positive and the negative, would give us the material for constructing what may be called a molecular theory of electricity, and would be a starting point for a theory of the structure of matter; for the most natural view to take, as a provisional hypothesis, is that matter is just a collection of positive and negative units of electricity, and that the forces which hold atoms and molecules together, the properties which differentiate one kind of matter from another, all have their origin in the electrical forces exerted by positive and negative units of electricity, grouped together in different ways in the atoms of the different elements.

As it would seem that the units of positive and negative electricity are of very different sizes, we must regard matter as a mixture containing systems of very different types, one type corresponding to the small corpuscle, the other to the large positive unit.

Since the energy associated with a given charge is greater, the smaller the body on which the charge is concentrated, the energy stored up in the negative corpuscles will be far greater than that stored up by the positive. The amount of energy which is stored up in ordinary matter in the form of the electrostatic potential energy of its corpuscles is, I think, not generally realised All substances give out corpuscles, so that we may assume that each atom of a substance contains at least one corpuscle. From the size and the charge on the corpuscle, both of which are known, we find that each corpuscle has 8×10^{-7} ergs of energy; this is on the supposition that the usual expressions for the energy of a charged body hold when, as in the case of a corpuscle, the charge is reduced to one unit. Now, in one gramme of hydrogen there are about 6×10^{23} atoms, so if there is only one corpuscle in each atom, the energy due to the corpuscles in a gramme of hydrogen would be 48×10^{16} ergs, or 11×10^{9} calories. This is more than seven times the heat developed by one gramme of radium, or than that developed by the burning of five tons of coal. Thus we see that even ordinary matter contains enormous stores of energy; this energy is fortunately kept fast bound by the corpuscles; if at any time an appreciable fraction were to get free, the earth would explode and become a gaseous nebula.

The matter of which I have been speaking so far is the material which builds up the earth, the sun, and the stars, the matter studied by the chemist, and which he can represent by a formula; this matter occupies, however, but an insignificant fraction of the universe, it forms but minute islands in the great ocean of the ether, the substance with which the whole universe is filled.

The ether is not a fantastic creation of the speculative philosopher; it is as essential to us as the air we breathe. For we must remember that we on this earth are not living on our own resources; we are dependent from minute to minute upon what we are getting from the sun, and the gifts of the sun are conveyed to us by the ether. It is to the sun that we owe not merely night and day, springtime and harvest, but it is the energy of the sun, stored up in coal, in waterfalls, in food, that practically does all the work of the world.

How great is the supply the sun lavishes upon us becomes clear when we consider that the heat received by the earth under a high sun and a clear sky is equivalent, according to the measurements of Langley, to about 7000 horse-power per acre. Though our engineers have not yet discovered how to utilise this enormous supply of power, they will, I have not the slightest doubt, ultimately succeed in doing so; and when coal is exhausted and our water-power inadequate, it may be that this is the source from which we shall derive the energy necessary for the world's work. When that comes about, our centres of industrial activity may perhaps be transferred to the burning deserts of the Sahara, and the value of land determined by its suitability for the reception of traps to catch sunbeams.

This energy, in the interval between its departure from the sun and its arrival at the earth, must be in the space between them. Thus this space must contain something which, like ordinary matter, can store up energy, which can carry at an enormous pace the energy associated with light and heat, and which can, in addition, exert the enormous stresses necessary to keep the earth circling round the sun and the moon round the earth.

The study of this all-pervading substance is, perhaps, the most fascinating and important duty of the physicist.

On the electro-magnetic theory of light, now universally accepted, the energy streaming to the earth travels through the ether in electric waves; thus practically the whole of the energy at our disposal has at one time or another been electrical energy. The ether must, then, be the seat of electrical and magnetic forces. We know, thanks to the genius of Clerk Maxwell, the founder and inspirer of modern electrical theory, the equations which express the relation between these forces, and although for some purposes these are all we require, yet they do not tell us very much about the nature of the ether.

The interest inspired by equations, too, in some minds is apt to be somewhat Platonic; and something more grossly mechanical—a model, for example, is felt by many to be more suggestive and manageable, and for them a more powerful instrument of research, than a purely analytical theory.

Is the ether dense or rare? Has it a structure? Is it at rest or in motion? are some of the questions which force themselves upon us.

Let us consider some of the facts known about the ether. When light falls on a body and is absorbed by it, the body is pushed forward in the direction in which the light is travelling, and if the body is free to move it is set in motion by the light. Now it is a fundamental principle of dynamics that when a body is set moving in a certain direction, or, to use the language of dynamics acquires momentum in that direction, some other mass must loose the same amount of momentum; in other words, the amount of momentum in the universe is constant. Thus, when the body is pushed forward by the light some other system must have lost the momentum the body acquires, and the only other system available is the wave of light falling on the body; hence we conclude that there must have been momentum in the wave in the direction in which it is travelling. Momentum, however, implies mass in motion. We conclude, then, that in the ether through which the wave is moving there is mass moving with the velocity of light. The experiments made on the pressure due to light enable us to calculate this mass, and we find that in a cubic kilometre of ether carrying light as intense as sunlight is at the surface of the earth, the mass moving is only about one-fifty-millionth of a milligramme. We must be careful not to confuse this with the mass of a cubic kilometre of ether; it is only the mass moved when the light passes through it; the vast majority of the ether is left undisturbed by the light. Now, on the electro-magnetic theory of light, a wave of light may be regarded as made up of groups of lines of electric force moving with the velocity of light; and if we take this point of view we can prove that the mass of ether per cubic centimetre carried along is proportional to the energy possessed by these lines of electric force per cubic centimetre, divided by the square of the velocity of light. But though lines of electric force carry some of the ether along with them as they move, the amount so carried, even in the strongest electric fields we can produce, is but a minute fraction of the ether in their neighbourhood.

This is proved by an experiment made by Sir Oliver Lodge in which light was made to travel through an electric field in rapid motion. If the electric field had carried the whole of the ether with it, the velocity of the light would have been increased by the velocity of the electric field. As a matter of fact, no increase whatever could be detected, though it would have been registered if it had amounted to one-thousandth part of that of the field.

The ether carried along by a wave of light must be an exceedingly small part of the volume through which the wave is spread. Parts of this volume are in motion, but by far the greater part is at rest; thus in the wave front there cannot be uniformity, at some parts the ether is moving, at others it is at rest—in other words, the wave front must be more analogous to bright specks on a dark ground than to a uniformly illuminated surface.

The place where the density of the ether carried along by an electric field rises to its highest value is close to a corpuscle, for round the corpuscles are by far the strongest electric fields of which we have any knowledge. We know the mass of the corpuscle, we know from Kaufmann's experiments that this arises entirely from the electric charge, and is therefore due to the ether carried along with the corpuscle by the lines of force attached to it.

A simple calculation shows that one-half of this mass is contained in a volume seven times that of a corpuscle. Since we know the volume of the corpuscle as well as the mass, we can calculate the density of the ether attached to the corpuscle; doing so, we find it amounts to the prodigious value of about 5×10^{10}, or about 2000 million times that of lead. Sir Oliver Lodge, by somewhat different considerations, has arrived at a value of the same order of magnitude.

Thus around the corpuscle ether must have an extravagant density: whether the density is as great as this in other places depends upon whether the ether is compressible or not. If it is compressible, then it may be condensed round the corpuscles, and there have an abnormally great density; if it is not compressible, then the density in free space cannot be less than the number I have just mentioned.

With respect to this point we must remember that the forces acting on the ether close to the corpuscle are prodigious. If the ether were, for example, an ideal gas whose density increased in proportion to the pressure, however great the pressure might be, then if, when exposed to the pressures which exist in some directions close to the corpuscle, it had the density stated above, its density under atmospheric pressure would only be about 8×10^{-16}, or a cubic kilometre would have a mass less than a gramme; so that instead of being almost incomparably denser than lead, it would be almost incomparably rarer than the lightest gas.

I do not know at present of any effect which would enable us to determine whether ether is compressible or not. And although at first sight the idea that we are immersed in a medium almost infinitely denser than lead might seem inconceivable, it is not so if we remember that in all probability matter is composed mainly of holes. We may, in fact, regard matter as possessing a bird-cage kind of structure in which the volume of the ether disturbed by the wires where the structure is moved is infinitesimal in comparison with the volume enclosed by them. If we do this, no difficulty arises from the great density of the ether; all we have to do is to increase the distance between the wires in proportion as we increase the density of the ether.

(*To be continued*).

According to the *Nachrichten für Handel und Industrie* (Berlin) of July 29th, the city authorities of Belgrade are arranging to enlarge the drinking-water system, to defray the cost of which a loan will be issued. The intention is to build a reservoir on an elevation near Belgrade, in order to get the requisite pressure for taking the water to the city.

Meteorological Report for 1908-9.—The report of the Astronomer Royal states that during the twelve months ended April 30th last the highest temperature in the shade was 84.0 deg. on July 3rd. The lowest temperature recorded was 12.1 deg. on December 30th. During the winter there were 54 days on which the temperature fell below 32.0 deg., being two less than the average number. The mean daily horizontal movement of the air in the year was 266 miles, which is 16 miles below the average of the preceding 41 years. The greatest recorded daily movement was 776 miles on February 3rd, and the least 36 miles on January 28th. The greatest recorded pressure of the wind was 16.2 lb. on the square foot on September 9th, and the greatest hourly velocity 43 miles on November 23rd and February 3rd. The number of hours of bright sunshine recorded was 1752 out of 4458 hours during which the sun was above the horizon. As contributing to this exceptionally high proportion, it may be mentioned that in three of the months—October, November, and April—the amount registered was the highest for those months, reaching in April a percentage of 60 for the first time in any month, and in three other months—June, January, and February—the amount registered was the second highest for those months. The rainfall for the year was 22 60in., being 1.52in. less than the average of the 65 years 1841-1905. The number of rainy days—0.005in. or over—was 155. The mean temperature for the year 1908 was 49.8 deg., or 0.2 deg. above the average for the 65 years 1841-1905.

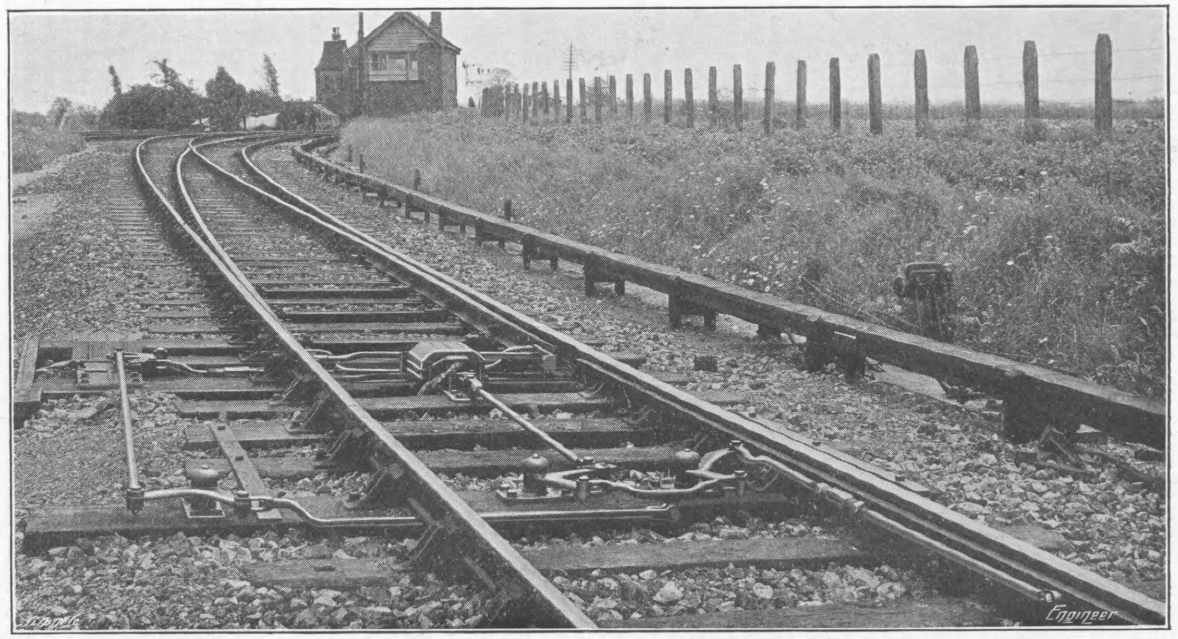
Dredging Plant for the Port of Para.—Last month (July) there sailed from the Clyde, bound for the Port of Para, Brazil, a powerful bucket dredger named Andre Reboucas, constructed by Messrs. Lobnitz and Co., of Renfrew, for the Port of Para. This dredger was ordered as recently as March 11th, the keel was laid on April 11th and the vessel ready for trial on July 9th, thus being completely manufactured and delivered within four months from the time of passing the order and creating a record in rapidity of construction for this class of vessel. The dredger is of the non-propelling type, very stiffly and powerfully constructed for dredging to a depth of 46ft. below water level in hard material. The 600 horse-power dredging engines are situated high up near the top tumbler, and their gearing is designed in so simple a manner that one may say they practically act directly upon the buckets, and thus work with the greatest possible efficiency in dealing with hard material. The huge shaft of the tumbler over which the buckets turn at the top is of solid steel 19½in. in diameter, similar to that of the great dredger Peluse, owned by the Suez Canal Company. All the gear wheels have their teeth machine cut from the solid steel. Three large vertical sided hopper barges were built at the same time by Messrs. Lobnitz and Co., Renfrew, Scotland, to serve this dredger, which will be used by the contractors, Messrs. S. Pearson and Son, Limited, of Westminster, together with the existing large self-propelling bucket dredger, two large suction dredgers, and other floating plant in connection with the important new port works under construction at Para.

POWER SIGNALLING ON THE GREAT WESTERN RAILWAY

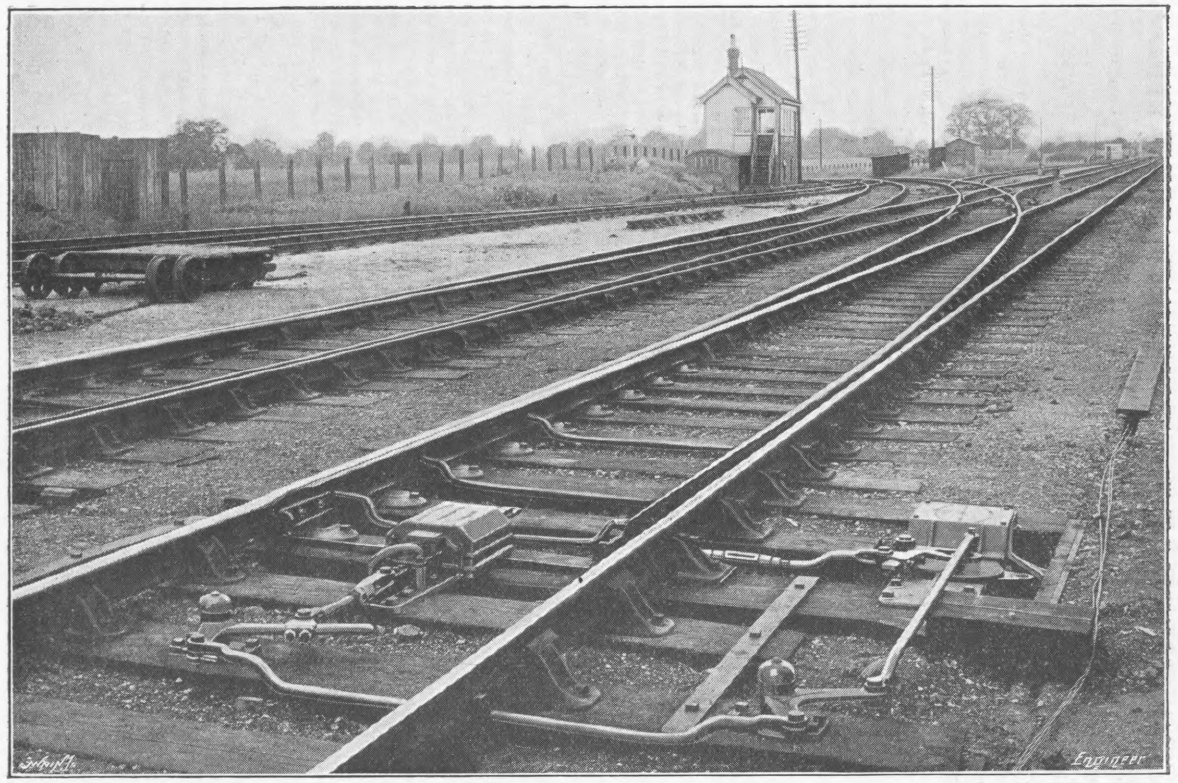
McKENZIE AND HOLLAND, LIMITED, WESTMINSTER, ENGINEERS

(For description see page 215)

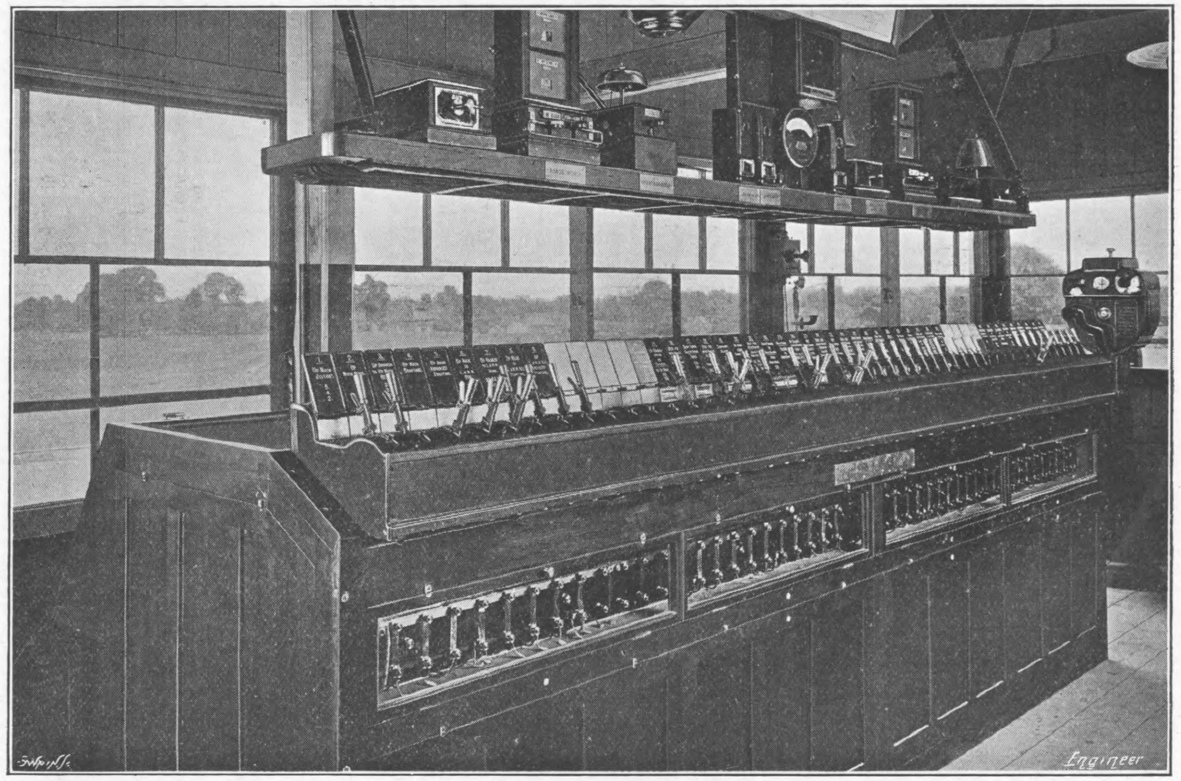
YARNTON SIGNAL BOX



FACING POINT



TRAILING POINTS



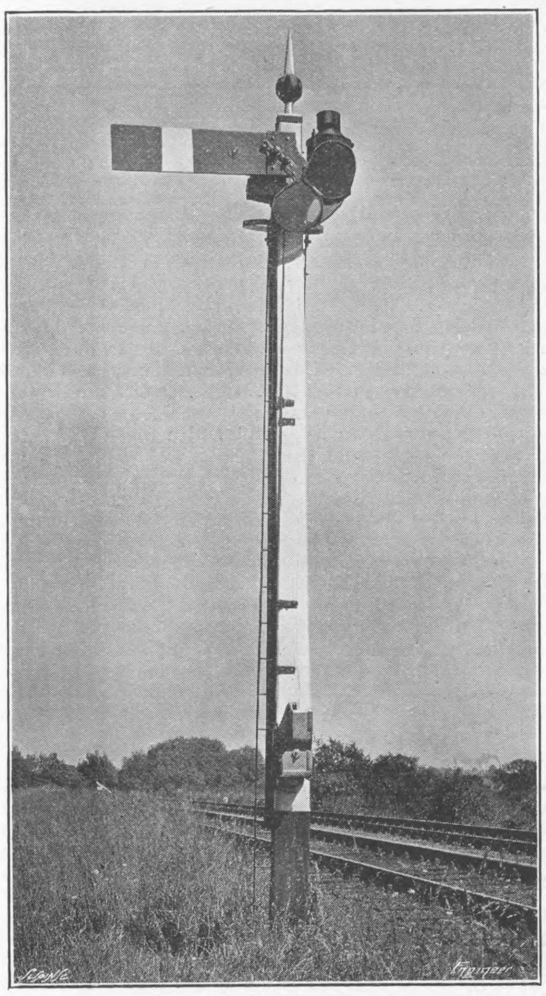
INTERIOR OF YARNTON SIGNAL BOX

THE LATEST SYSTEM OF POWER RAILWAY SIGNALLING.

THERE has recently been brought into use at Yarnton, near Oxford, on the Great Western Railway, an all-electric power-signalling plant which contains some novel features.

The locking frame—page 214—contains fifty levers, of which seven are spare. These levers are of the usual miniature type employed in power systems, but they differ from most of the others in that the lever can be pulled fully over, and point levers can also be put fully to normal at one stroke instead of there being a pause in the middle of the movement. This pause, it should be noted, arises through a check lock that stops the lever after it has travelled sufficiently far to switch in the electrical or other power to operate the points. This lock is taken out of the lever by power over a return wire or pipe from the points. The return current flows as soon as, but not before, the points are in their altered position, and—if facing points—duly plunged and locked. Unless and until, therefore, the lever has done its work the check lock cannot be withdrawn, and this not only gives an intimation to the signalman that the work is not done, but, as the lever is not fully over, the sympathetic levers—such as a siding signal following the opening of some siding points—cannot be pulled until all is in order. This "return indication," whilst very useful, is apt to spoil the otherwise beneficial effects of power signalling, in that the signalman has to pause in the middle of moving a lever.

In the new frame at Yarnton there is no such check lock, and the signalman is able to pull over the levers in the same way as in a mechanically-operated frame, but much quicker and with no exertion, of course; but the safeguards afforded by the "return indication" are to be found here, though they are provided in another way. These consist of electrical circuits to the corresponding signals, which are not completed until the point lever has done its work. There is also what is known as "constant detection" of the points, and this causes any signal at once to be thrown to danger, or, if already at danger, to be kept there, should any points such a signal applies to become damaged in any way. In order that the signalman may know how the "return indication" is, there is provided behind each point lever a visual indication with three screens—"normal," "wrong," "reversed."


ELECTRICALLY-OPERATED SIGNAL

Two views on page 214 show the lay out at facing points and trailing points respectively. The only difference lies in the fact that the former has a facing point locking bar. For each there is a plunger working through the casting seen in the "four-foot" into a divided stretcher rod. In this casting are the circuit controller—whereby the current is cut off when the points are over—the detectors, and return-indication circuits.

Above is a view of a signal. Signals are operated by a motor having a combined electric clutch gear and holding-off coil, and the signal goes on without rotating the motor or its gear wheels, and all risk of the latter jamming is eliminated.

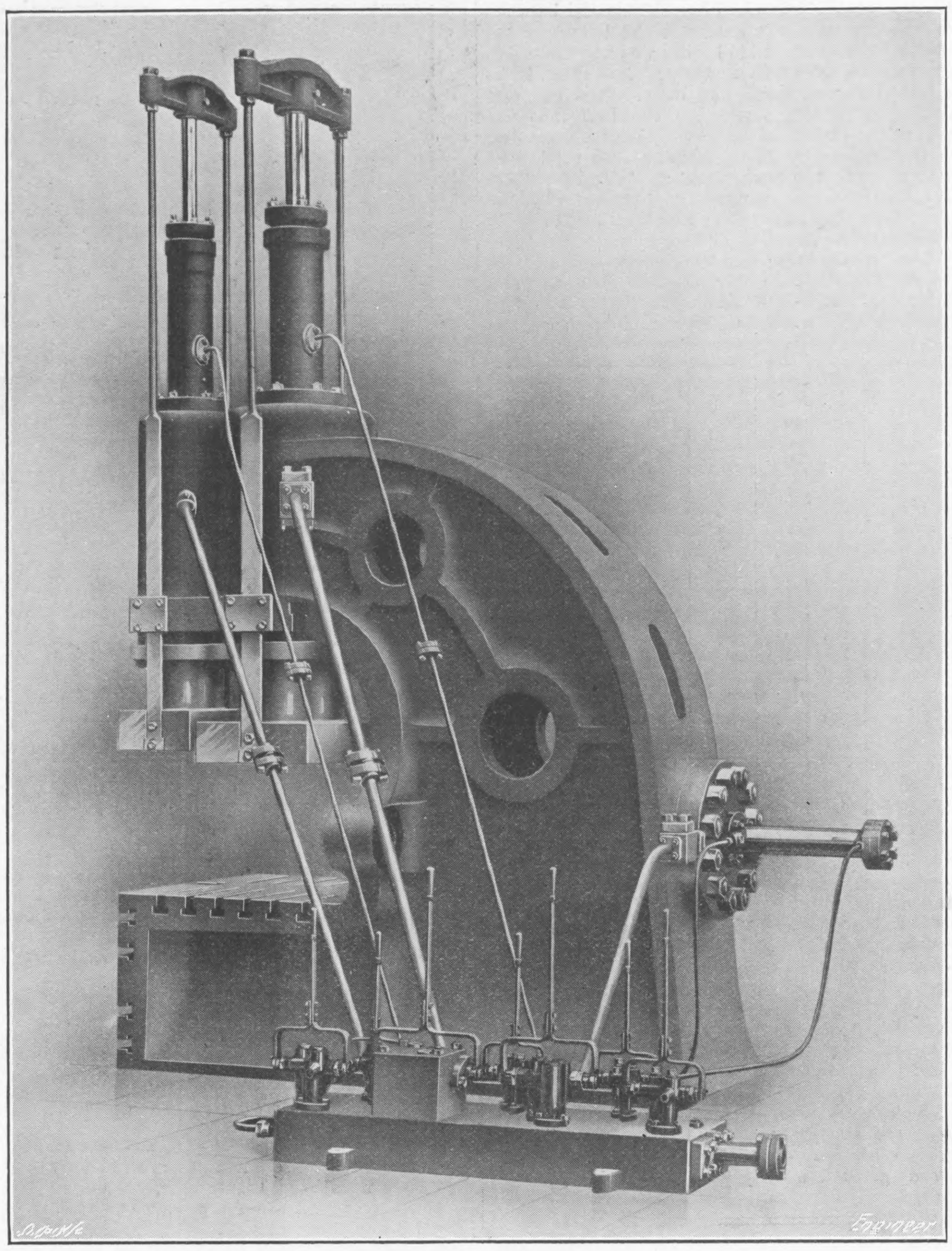
The exterior of the signal-box is also shown. Opposite to it is a small power-house containing a 10 horse-power oil engine connected to a generator, which supplies the necessary current for two batteries of 60 cells. Sufficient power is provided by charging three to four hours twice a week.

The work has been carried out by McKenzie and Holland, Limited, of Victoria-street, Westminster, and Worcester.

Admiralty Courses of Instruction.—The Secretary of the Admiralty announces that courses of instruction for officers will be held as follows:—Signals (Portsmouth), short course for Lieutenants, R.N., 2nd to 23rd October, 1909; short course for R.N.R. Officers, 23rd October to 6th November, 1909. Physical Training (Portsmouth), short course for Lieutenants, R.N., Captains and Lieutenants, R.M., and Warrant Officers, R.N., 11th October to 11th December, 1909. Gunnery and Torpedo, short course for R.N.V.R. Officers, 9th to 22nd October, 1909.

HYDRAULIC FORGING PRESS

HENRY BERRY AND CO., LIMITED, LEEDS, ENGINEERS



A NEW HYDRAULIC FORGING PRESS.

A NEW and powerful hydraulic forging press has recently been completed by Henry Berry and Co., Limited, of Leeds, for a foreign Government. It will be seen from the accompanying engraving that the frame is of the "overhung" type, and is in one piece, with the table and cylinders. Three cylinders are embodied in the design of the machine, two of these being vertical and one horizontal. Of the vertical cylinders, one can exert a total pressure of 500 tons, while the other gives 100 tons. The horizontal cylinder is capable of exerting a force of 250 tons, the stroke of all three cylinders being 2ft. Each of the vertical cylinders has attached to it a separate draw-back cylinder. To economise the consumption of high-pressure water, the 500-ton vertical and the horizontal cylinders are fitted with means whereby the rams may be brought up to the work by, and the cylinders filled with low-pressure water taken from a supply contained in an overhead tank. Thus, the high-pressure supply is only called upon to provide energy for doing the useful work of the press. The table is 4ft. square, and is provided on the top and front side with the customary slots for the bolts holding down the work, or, as may be sometimes desired, securing an extension to the front of the table.

The body of the press, which is made of Siemens-Martin cast steel, has formed on it, in line with the horizontal cylinder, two lugs which will be found of use in the manipulation of some jobs, such as tube staving. A set of Berry's patented working valves mounted on a stand, having inlet and outlet connections common to all the valves, is supplied with the press, and is placed near it, so that the operator has a good view of the work on the table.

MILITARY TRACTORS IN GERMANY.

IT may not be generally known that in order to promote the construction and use of heavy motor vehicles, with a view to these being available for the use of the army in the event of war, the German Parliament voted the sum of £40,000 as subsidies for this purpose in the Budget year of 1908-09, and the sum similarly appropriated for 1909-10 has been increased to £50,000. The State subsidy amounts to £200 towards the production of the tractor and £50 per annum towards the cost of maintenance. It is not quite clear whether the makers receive the total of these two sums, or whether they are awarded the former on the fulfilment of certain conditions, thus leaving the annual grant for the benefit of the purchasers of the lorries, but it is highly probably that the allocations are divided in the latter manner, and thus assist both the manufacturer and the users. As a result of the trials of heavy motor vehicles which took place in 1908, subsidies were granted to 11 engineering firms as makers, and the number of tractors concerned was 158, of which 88 were in the possession of breweries, 8 were employed in connection with agriculture, 7 were used by motor vehicle working companies, 6 by brickyards, and 5 by mining undertakings, whilst the remainder were distributed over a large number of industries.

The military authorities, after the trials which took place in 1908, decided to make further experiments this year under more exacting conditions and extending over many days. A route comprising a round trip between Berlin and Stuttgart, of a total distance of 1458 miles, was mapped out for trials under war conditions, and the tests took place between April 26th and May 21st, in conjunction with the international competition organised by the Imperial Automobile Club and the Association of Motor Vehicle Manufacturers. The coincidence of the two events proved to be an unsatisfactory arrangement, and it is improbable that a repetition will occur in the future, whilst the early period of the year chosen for the trials was also unfortunate, owing to the fact that the principal works of repairs to the roads were in progress, as is customary at the season, and this was not without influence upon the running of the vehicles.

The trials, which were extended over a considerably longer period than in the case of the preceding so-called subsidy experiments, lasted 27 days, of which 20 days were occupied in travelling, and 17 heavy vehicles participated and were submitted by the firms of Argus, Bussing, Eisenach, Nacke, Lloyd, Gaggenau, Soest, Daimler, Durkopp, Ehrhardt, Mulag, and the Norddeutsche Automobile Gesellschaft. Of these twelve firms, those of Argus, Ehrhardt and Soest had not previously become entitled to subsidies, and the entrance of their vehicles was intended to qualify for this position, whilst the other nine firms sought to test on a long endurance trial the results of the improvements which they had introduced. The trials were conducted and supervised by the military motor car division, as represented by 5 officers, 6 non-commissioned officers and 62 men, and the *personnel* placed at disposal by the makers accommodated themselves to the military requirements.

The route of 1458 miles was formed partly of level road, partly hilly and partly of a mountainous character with long and heavy gradients up to 13 per cent., and the varying conditions of the road surface placed considerable demands both on the vehicles and the drivers. Notwithstanding these matters, and with the exception of the Soest tractor—which was withdrawn by the firm on the first day of the outward journey—all the vehicles returned to Berlin at the proper time on May 21st. The departures were made every day at 6 a.m., and the arrivals always took place before darkness set in. A pause of from one to two hours was made at mid-day, and the work of replenishing fuel and attention to engines and vehicles had to be completed in one hour, soldiers rendering assistance to the representatives of the makers. The control of the fuel consumption in the case of each tractor was exercised by the officers appointed for the purpose.

The vehicles were divided into two columns for the purpose of securing better supervision, the intervening distance being 1 kilom., whilst a distance of from 33ft. to 66ft. was to be arranged between the vehicles. It was, however, found necessary to alter this arrangement on certain days, particularly from Frankfort-on-the-Main, in consequence of the raising of a large amount of dust, and the intervals between the tractors had to be increased to 660ft. and over. In addition to this, the authorities had largely—as, for instance, in the Bavarian Palatinate—prescribed longer distances between the vehicles, and this naturally extended the length of the column. The whole distance of 1458 miles was accomplished, including the mid-day stops, in 218 hours' travelling, or at the average rate of about 6 7 miles an hour. This low rate might be surprising, having regard to the fact that the average speed in the earlier trials was considerably greater, but it is largely explained by the condition of the roads and the regulations made by the authorities, specially in connection with the international competition organised by the Imperial Automobile Club, as already mentioned. The daily stages were calculated at 72 miles, although longer distances were travelled on certain days; and the greatest distance was accomplished on the fifteenth day between Stuttgart and Tauberbischofsheim, which is 86 miles. The following table, which is taken from the *Kolnische Zeitung*, gives particulars of the tractors engaged in the trials:—

	Normal number of revolutions.	Nominal horse-power.	Weight in kilogrammes	Class of fuel.	Total consumption in gallons throughout the trials
Argus..	800	30	4076	Light benzine	303
Bussing	850	28	4235	Benzol	—
Daimler I...	800	35	4050	,,	277
Daimler II.	800	35	4050	,,	298
Durkopp I.	800	38	4303	,,	323
Durkopp II.	800	38	4480	,,	311
Ehrhardt I.	850	36	4100	,,	366
Ehrhardt II.	850	35	4100	,,	307
Eisenach	800	35	4250	,,	317
Mulag I.	750	35	3980	Heavy benzine	340
Mulag II.	750	35	3980	,,	356
Nacke..	850	37	4346	Benzol	307
Norddeutsche Automobile I.	850	40	4200	,,	307
Norddeutsche Automobile II.	850	40	4200	,,	284
Lloyd..	800	35	4443	Light benzine	377
Soest	800	30	—	—	—
Gaggenau..	850	35	4314	Heavy benzine	249

It is necessary to explain that the Bussing tractor, of which no particulars are given respecting the fuel consumption, was only driven to Stuttgart, as the vehicle had been sold to the Hanover brick works, and had to be delivered; and that the name Mulag is an abbreviation of Motoren und Lastwagen Actien Gesellschaft, of Aix-la-Chapelle. The width of the tractors between the outside wheels ranged from 5ft. to 5.9ft., the military authorities having specified that the width should not exceed 6.56ft. The use of benzol and benzine as fuel is a result of the endeavours made by the military authorities to promote the use of native products so as to render the country more independent of imports from abroad, and by the end of the present year they will have about 300 heavy vehicles at disposal as a consequence of the increased subsidy granted in the current financial year.

ORE PROCESS AT THE OPEN-HEARTH PLANT OF THE DNEPROVSKY WORKS, SOUTH RUSSIA.

By M. PAVLOFF.

MUCH attention has been paid, in technical literature, to the ore process as conducted at the Yurievsky Works, South Russia, the records of some consecutive heats made in the Yurievsky open-hearth furnaces being described in German by R. Genzmer, C. Dichmann, and T. Naske, whose articles have been reproduced in many French and English journals.

Trusting that the results obtained at the Dneprovsky Iron and Steel Works, where the ore process is practised on a large scale, will also be of interest, the author presents the following table, to which it will be sufficient to add a short explanation.

Results of Operation of the Open-hearth Furnace No. 6, Dneprovsky Iron and Steel Works, Russia, April, 1909.

	Per month = 5 weeks = 28 working days	Per week.	Per day of 24 hours.	Per 100 of metal charged.	Per 100 of good steel ingots.
Number of heats made	100	20	3.63	—	—
Charged—	Tons.	Tons.	Tons.	Tons.	Tons.
Molten iron	3832.22	766.44	139.00	91.47	92.07
Solid iron	104.55	20.91	3.79	2.49	2.51
Steel scrap	239.10	47.82	8.67	5.71	5.74
Additions (ferro-mangan.)..	13.76	2.75	0.50	0.33	0.33
Total metal charged	4189.63	837.92	151.96	100.00	100.65
Used—					
Ore	876.39	175.28	31.79	20.92	21.07
Dolomite..	203.94	40.79	7.40	4.87	4.90
Limestone	432.62	86.52	15.69	10.33	10.39
Coal	824.47	164.89	29.90	19.68	19.81
Received—					
Steel in good ingots	4162.73	832.55	151.00	99.36	100.00
Steel in scrap	136.04	27.20	4.93	3.25	3.27
Total steel received..	4298.77	859.75	155.93	102.61	103.27

The iron, taken in a molten state from the mixer, is produced by smelting red hematites of Krivoi Rog with small proportions of mill cinder, open-hearth and Bessemer slag, and has the following composition:—Carbon about 3·75 per cent.; silicon from 0·7 per cent. to 1·8 per cent., and on an average per month, 1·35 per cent.; manganese from 1·2 per cent. to 2·1 per cent., and 1·82 on an average; sulphur about 0·05 per cent., and phosphorus ranges between 0·40 per cent. and 0·15 per cent.

A very rich portion of Krivoi Rog hematites, used in a lumpy state as an oxidising agent, contains 3 per cent. of silica, 1·0 per cent. of alumina, and about 93 per cent. of iron oxide—that is, 65 per cent. of Fe; other constituents may be found in negligible quantities.

The shed for the basic open-hearth furnaces in which the process is conducted is represented in detail by side elevation and three sections on the tables 46 and 47 of the author's album of open-hearth furnaces; but it must be mentioned here that the roof—to prevent the rapid corrosion during the boiling—at the present is placed higher, the distance between the bottom and roof being made 8ft. 3in.

Three furnaces, working with ore process and having the bed surface 30ft. 2in. by 10ft., may be rated as 32-ton ones; but they run with metallic charges of from 40½ to 43 tons.

In spite of the deep metal bath thus obtained, the average duration of one heat was, in April, 6 h. 30 min., thanks to the powerful oxidation performed by the ore. Thirty minutes were needed for the bed repairing, 34 min. for charging solid iron and scrap, 63 min. for charging molten iron by three ladles, thus leaving 4 h. 20 min. for the smelting and boiling periods.

The fuel consumption, shown in the above table, may be called low, taking into consideration the quality of coal used; the latter often contains 12 per cent. of ash and 6 per cent. of moisture.

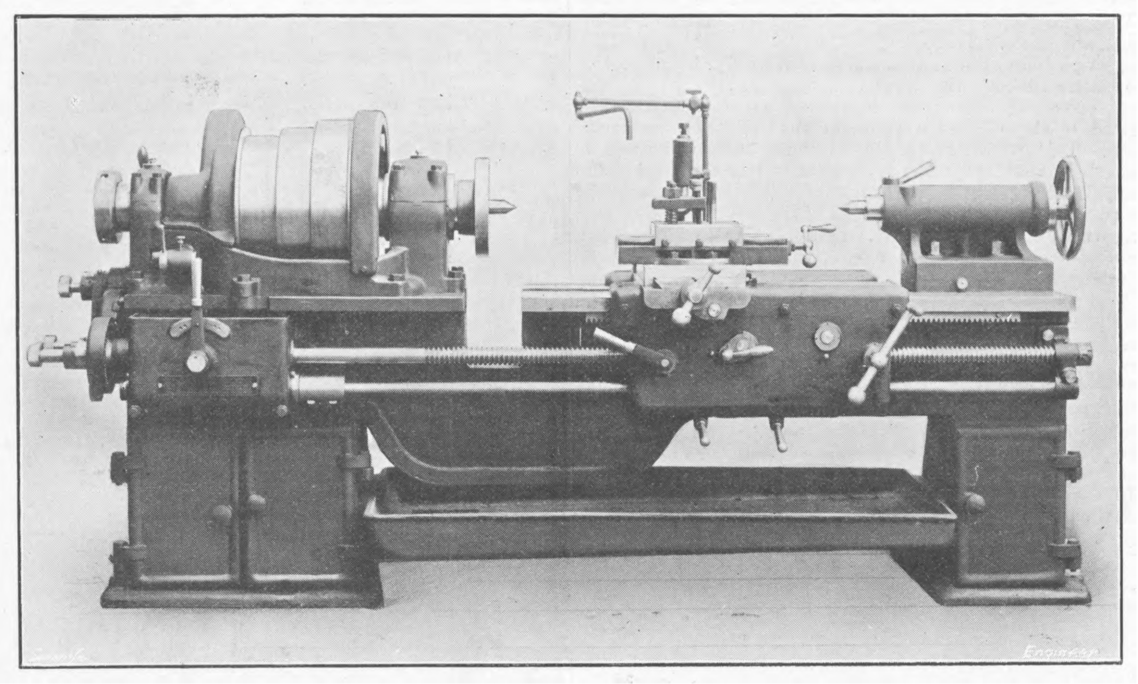
The amount of a single addition used—that is, ferromanganese—was also small, thanks to the high percentage of manganese in the iron treated.

As to the amount of scrap produced, it appears to be somewhat large, but its quantity is explained by the fact that a very large number of ingots must be poured from one heat, because each ingot, being of 6½in. by 6½in. in section, weighs only 325 lb.

In conclusion, it may be added that about 80 per cent. of iron introduced into the bath by the ore is reduced by the open-hearth process as conducted at the Dneprovsky Works.

8½-INCH GAP LATHE

COLCHESTER LATHE COMPANY, COLCHESTER, ENGINEERS



8½-INCH CENTRE SCREW-CUTTING LATHE.

THIS lathe, illustrated above, has been designed by its makers, the Colchester Lathe Company, to obtain a maximum amount of power at all spindle speeds. The headstock is fitted with a three-speed cone to take a 3½in. belt; the largest size step is 18in. diameter and the smallest 14¾in. The spindle, which has a 2⅝in. hole right through it, runs in adjustable parallel phosphor bronze bearings, the thrust being taken by a ball bearing against the rear housing. All the wheels are enclosed in guards. The reverse motion is fitted inside the headstock, and is arranged to be worked by a small lever, thus rendering it unnecessary to use a locking nut. Two back gears are provided, the ratio being 3.3 to 1 and 10.85 to 1. Countershaft speeds are 370 and 205, which give the following spindle speeds:—

451	370	303	250	205	167
137	113	92	76	62	51
42	34	28	23	19	15.5

The special features claimed for this lathe as being those by which its great cutting powers are obtained are as follows:—First, the size of cone, viz., 14¾in., 16⅜in., and 18in. diameter for 3½in. belt. Attention is called to the fact that if, say, a cutting speed of 70ft. per minute is required the back gear giving a reduction of 3.3 is used from 2½in. diameter up to 5in. diameter inclusive, and the 10 85 reduction from 5 upwards. Secondly, the loose headstock is very massive and is held down by two bolts. The spindle is ground, and the centre is adjustable sideways for taper turning. Thirdly, the bed is of strong box section and has square edges. The standards of the bed form change wheel and tool cabinets, each wheel having its own place and being easily accessible. Fourthly, the saddle has a long bearing surface. Fifthly, all the gearing in the apron is carried on double bearings, the rack pinion being cut from the solid and supported underneath the rack. Sixthly, that the feeds are positive and fool-proof; and lastly, that no friction clutches are used, and the screw-cutting, sliding, and surfacing motions can only be used singly. The gear-box gives three rates of feed—8, 16, and 32 cuts per inch. The leading screw is ½in. pitch. The following are the principal particulars of the tool:—Bed, 16½in. wide by 12½in. deep; front spindle bearing, 5in. diameter by 7¼in. long; the speed cone, 18in., 16⅜in., 14¾in. diameter for 3½in. belt, ratio of gearing 3.3 to 1 and 10.85 to 1, will swing over saddle 12in. diameter; admits between centres with 8ft. bed, 3ft.; approximate weight with 8ft. bed, 50 cwt. The lathe is supplied with catch plate, face-plate, stationary stay, and travelling stays; 22 change wheels, spanners, trough, pump, and piping. This latter is part of the design, and is made telescopic.

LITERATURE.

SHORT NOTICES.

Electrical Installations. By Rankin Kennedy. London: Caxton Publishing Company, Limited, Clun House, Surrey-street, Strand, W.C. A new edition, revised and enlarged, in five volumes. Price 7s. 6d. net per volume.—The appearance of this new and revised edition clearly indicates that the work is in demand among a certain section interested in electrical engineering. Students, amateurs, and others desirous of knowing just a little about practically everything met with in the various branches of the electrical profession, and who do not wish to be troubled with much theory, will find that the work suits them admirably. To those, however, who find it necessary to deal with things quantitatively, the work does not so much appeal. The highly coloured illustrations, the cardboard models of machines and apparatus which are to be found in the front of each book, coupled with the absence of mathematics, all serve to make the volumes attractive to young readers, and should at least stimulate a desire for more thorough and advanced knowledge. Many new illustrations have been included in this second edition, and, on the whole, the work is fairly well up to date, although too much attention and space is devoted to antiquated designs. The author would have done much better had he deleted a great portion of the historical matter and used the space for more fully describing the machines and apparatus now in use.

Sanitation and Sanitary Engineering. By W. P. Gerhard. New York: Published by the author.—The author of the present volume does not state for what class of readers he intends his book, nor does a perusal of it help one to arrive at a decision in the matter. It is difficult to say whether he means it to be a popular account of the work of the sanitary engineer, or a more or less scientific treatise on the subject. If the former be the correct view, we cannot refrain from expressing the opinion that he has under-estimated the intelligence of his readers; if the latter, then the book cannot be recommended as authoritative. Dealing first with the profession and practice of sanitary engineering, he catalogues a list of such operations as are to be seen daily in the streets of any large town, and dismisses them without any remark of importance. The work of the sanitary engineer in time of epidemics, war, and sudden calamities is discussed in the second chapter, a history of sanitation from 1850 to 1900 in the third—which is, perhaps, the most valuable part of the book—an account of the sanitation of Greater New York is given in the fourth, while the fifth is a translation of an article on the corresponding conditions in Russia, the author being indebted for this to a German medical journal of 1896.

Principles of Reinforced Concrete Construction. By F. E. Turneaure and E. R. Maurer. New York: John Wiley and Sons. Price 15s. net.—This book, which is a second and considerably enlarged edition, treats of the principles of mechanics underlying the design of reinforced concrete, and in the earlier chapters the results of many experiments are given which will assist in the establishment of coefficients and working stresses. While in the first five chapters the more or less theoretical side of the subject is dealt with, the sixth consists of a convenient collection of formulæ and diagrams, which will prove of great value as a source of reference to designers. The remaining chapters, five in number, treat of the use of the material in various structures, such as arches, retaining walls, chimneys, &c. Some typical examples of the types of structures discussed are given, and throughout the book numerous clear diagrams and sketches are inserted.

Elementary Mechanics of Solids and Fluids. By A. C. Jones and C. H. Blomfield. London: Edward Arnold. Price 4s. 6d.—The importance of a thorough understanding of the more elementary parts of dynamics and hydrostatics at the very outset of an engineer's career is now too well recognised to need emphasising. In the present volume there will be found a satisfactory treatment of the subjects, and it should prove of use to many classes of readers—first-year students, and to workmen whose duty brings them into touch with, and necessitates a knowledge of, some of the fundamental results of physical science, in particular. An elementary knowledge of mathematics is assumed as already among the acquirements of the student, but it will be found that the authors have treated their subject with discernment, and laid stress on those parts which experience has shown are likely to cause especial difficulty to the beginner.

RAILWAY MATTERS.

The Canadian Railway Commission has issued an order compelling every railway in Canada to have the whole of its right-of-way properly fenced in by January 1st, 1911. The order states that the fence must be of a minimum height of 4ft. 6in., and gates must be provided at every farm crossing. At every level highway crossing there must be adequate cattle guards. The width of approaches to level crossings must be 20ft. on concession and main roads and 16ft. on side and bush roads.

According to the *Railway Times*, the Great Eastern Railway Company will close to passengers on and after October 1st next, the Churchbury, Forty Hill, and Theobald's Park stations on the Cheshunt branch of the system, owing to the competition of the electric tramway cars. The district will continue to be served by the adjacent stations on the Enfield Town and Cambridge main lines, namely, Lower Edmonton, Bush Hill Park, Enfield Town, Ponder's End, Brimsdown, Enfield Lock, Waltham Cross, and Cheshunt.

The Mexico North-Western Railway Company has acquired the Rio Grande Sierra Madre and Pacific Railroad, extending from El Paso Terrazas, 160 miles. By constructing about 160 miles of line to effect a connection between the Sierra Madre and Pacific and the Chihuahua and Pacific, which were purchased some time since, the Mexico North-Western will get an outlet for its timber through Chihuahua on the Mexican Central, as well as through El Paso, Tex., on its own line. The management, it is said, proposes to build this connection next year.

The *Nachrichten für Handel und Industrie* (Berlin) of July 31st announces, on the authority of the German Consul in Valparaiso, that the concession for the construction and working of a railway from the Bay of Camarones to the Bolivian frontier, which was previously granted to Salvador Izquierdo, Ramiro Sanches, and Rodolfo Rothstein, and afterwards withdrawn, has now been transferred to the Comunidad Chilcaya y Ferrocarril de Camarones. It appears also that the same company has applied to the Bolivian Government for a concession in respect of a railway from Chilcaya to Oruro.

The circular railway which serves some portions of Berlin and its suburbs was the scene of a curious accident on Thursday, August 19th. An iron tower on the premises of the Imperial Gas Company at Schoneberg, which are skirted by the line, collapsed shortly before midday, just as a train was passing by. The tower was about 280ft. high, and was intended for the storage of material for a new gasometer. The fragments in their fall wrecked the last compartment of the passing train. One person was severely injured, while four others were slightly hurt. Traffic on the railway line was subsequently restored.

There has recently been considerable activity in the building of inter-urban lines in Mexico, and it has been announced that an American syndicate is planning a new line from the city of Guaymas to the suburban towns of Aurora, San Jose, De Guaymas, and Empalme. This road will be about 16 miles long. There is also a Canadian syndicate in the field, and it is planning a line between Mexico City and Puebla. The proposed line runs between the two volcanoes, Popocatepetl and Ixtaccihuatl, and parts of it will lie above the winter snow line. Power for its operation will be obtained from the electric plant of the Mexican Light and Power Company at Necaxa.

The Western Railways of France have obtained authority from the Government to electrify their lines. A beginning is to be made with the lines which run from the St. Lazare Station in Paris to Argenteuil and Saint-Germain-en-Laye. Special tracks will be laid, so that the service can be effected without any interference with the steam-driven trains. Sub-stations will be erected which will supply continuous current at 600 volts. It is anticipated that from twelve to twenty trains, composed of a maximum of six double carriages 20 m. long, can be run per hour. The permanent way, the equipment of line, &c., will cost £1,160,000; the rolling stock and converter stations, £800,000; interest on capital and other expenditure bringing the total amount to £2,280,000 for the 33.5 kiloms. of the line to be constructed.

The £1,230,000 which is to be spent by the Transvaal Government on railways will be divided up as follows:—The Selati line is to be bought for £300,000, and the following new railways constructed:—An extension of the Pretoria-Pietersburg Railway from Pietersburg to a point near Bandolier Kop, a distance of 64 miles, at a cost of £250,000; a railway from Welverdiend Station to near Lichtenburg, with a westerly extension from a point near Treurfontein, a distance of 154 miles, at a cost of £400,000; an extension from Ermelo to Piet Retief, 72 miles long, at a cost of £255,000; a line from Geduld Station, *viâ* Benoni, to a junction with the Germiston-Ermelo Railway at a point 8¼ miles east of Germiston, distance 13 miles, at a cost of £75,000; a line, being an extension of the Komati-Selati Railway, to a point near the Great Letaba River, distance 150 miles, at a cost of £250,000.

At last, states a consular report, the celebrated circular railway round Moscow, which has been in construction for so many years, and has cost so many millions of roubles, has been completed and opened. The results, however, have been anything but satisfactory. Firstly, as regards passenger traffic, owing to the high fares and even more owing to the stations being often built in the middle of fields without any means of getting to them, the line has proved a complete failure. The number of passengers was absolutely ridiculous, a few dozen per month, and in the autumn it was decided to suspend passenger traffic. Affairs are but little better as concerns goods traffic. Owing to the exceptionally high and unsatisfactory tariff, every merchant who can possibly manage it avoids using the line for transporting his wares. In a word, the line has in no way fulfilled the expectations of the Government, which financed the undertaking. Seeing that affairs are in a hopeless state, the Government are going to revise the tariff, when possibly the line may begin to exercise the influence hoped for by the constructors.

A report presented to the Board of Trade upon the accidents which occurred on railways in the United Kingdom during the year 1908 shows that during the year 1043 persons were killed and 7984 injured by accidents due to the running of trains or the movement of railway vehicles, the average figures for the previous ten years being 1155 killed and 7036 injured. During the year no passengers lost their lives in accidents to trains in which they were travelling, and the number injured—283—is very low compared with previous years. The average numbers for the past ten years have been 21 killed and 626 injured. So far as the records extends, there has only been one previous year, 1901, in which no passengers were killed in train accidents. In the class of accidents caused by the movement of trains and railway vehicles, exclusive of train accidents, 102 passengers were killed and 2242 injured, the corresponding averages for the ten years previous being 120 killed and 1784 injured. The casualties to passengers in this class largely arise from the carelessness of the passengers themselves. Of servants of railway companies and contractors, 376 were killed and 5976 injured. In this class of accidents the number killed shows a large decrease compared with the average for the previous ten years. In addition to accidents caused by the running of trains and the movement of railway vehicles, a large number of accidents unconnected with railway working occurred on railway premises. Accidents of this kind accounted for the death of 85 persons and injury to 20,501. The bulk of these accidents were due to misadventure, and comparatively few could be attributed to preventable causes.

NOTES AND MEMORANDA.

According to a parliamentary return of last Tuesday, the number of applications received from all countries for British patents from January 1st to July 31st last totalled 17,869, compared with 16,303 in the corresponding period of last year. Of the applications received during the first seven months of this year, 1735 were from Germany, 1579 from the United States, 560 from France, 192 from Austria-Hungary, and 118 from Canada.

The loftiest chimney in the world, states the *Scientific American*, was recently put into service at the large smelting works at Great Falls, Mont., where it will serve to carry off the gases from the greater part of the large plant. The chimney, which is built of brick, is said to be 506ft. in height above the ground. The flue includes a dust chamber in which vertically-hung wires serve to take out the dust from the smoke. The dust is removed from the wires by shaking mechanism and falls in hoppers in the floor, from which it is loaded into cars in a pit below.

In a printed reply to a question addressed to the President of the Board of Trade by Mr. Tyson Wilson, Mr. Tennant gives the value of the machinery imported into and exported from the United Kingdom during the years 1906, 1907, and 1908. The tables show that the total imports in 1906 amounted to £5,126,972; in 1907 to £5,311,681; and in 1908 to £4,552,904. Deducting re-exports, the net imports in the three years were £3,663,732, £3,878,911, and £3,452,361. Against these figures were to be set the total exports of machinery manufactured in the United Kingdom, which in 1906 amounted to £28,440,481; in 1907 to £34,293,955; and in 1908 to £33,594,796.

The British Consul at Stockholm, Mr. M. Villiers, in his annual report for 1908, says that it is now claimed that a commercially economical method of smelting iron ore by electricity is now in operation in Sweden, by which it is hoped that with the aid of the vast water power of the country its enormous mineral deposits of ore may be smelted without the importation of so much coal or such a consumption of charcoal. The cost of producing a ton of pig iron in this electric furnace is estimated to be about £1 12s. In addition, the life of the furnace will, it is stated, be considerably longer than that of a blast furnace. It is claimed that the product of the electric furnace is of excellent quality.

The introduction of labour-saving machinery on the farm has been one of the principal features of the modern revolution in agriculture, and has been rendered necessary by the difficulty of getting sufficient help. Few contrivances are more interesting than the milking machine. A lengthy test has been made at the Wisconsin Agricultural Experiment Station, and is recorded in Bulletin No. 173. The machine worked more quickly and more cheaply than a man; it yielded a cleaner milk, which therefore kept better, and, finally, was shown to have no injurious effect on the udders or the general health of the animals. The machine, of course, requires proper attention and careful working to get the best results, but proved decidedly economical in herds of thirty cows or more. There are already signs that the agricultural labourer of the next generation will be, in the main, an engineer.

A 30in. cast iron water main laid on a timber trestle in Devereaux-street, Philadelphia, was lowered last autumn to low concrete piers by the Bureau of Water, in connection with the grading of the street. The section lowered had a total length of about 1100ft., and the trestle was 27ft. high. The supply was shut off and the pipe cut into two sections, each approximately 550ft. long, so that the work was done in two successive operations. The trestle was of a simple two-post type, the bents being cross-braced and having diagonal bracing running longitudinally from bent to bent. A gallows frame was erected on top of each bent over the first half of the pipe to be lowered, and was fitted with a screw long enough to reach to the final resting place of the pipe. The screw was held by a nut, bearing on the top of the gallows frame, and having two handles. The lower end of the screw was attached to a strap passing under the pipe. Two men were placed at each screw, and the entire 550ft. of pipe lowered simultaneously.

A smart piece of work was recently carried out by the Knowles Oxygen Company, Limited, Walsall-street, Wolverhampton, at Pearson's Furnaces, Netherton, where, owing to an accident, the crank shaft of a large vertical blowing engine had broken. Amongst other damage the piston-rod had been bent in such a manner that it seemed impossible to remove it from the cylinder. However, the Knowies Oxygen Company, by means of an oxy-hydrogen blow-pipe, cut off the piston-rod, which was about 7in. in diameter, close to the gland of the cylinder. The work was one of particular difficulty, because the cut had to be made overhead, close under the large cylinder cover, and at a considerable height from the ground, with the result that the burning metal, while the work was being done, showered down on the men and their wooden staging, and made it impossible for the shaft to be cut through at one operation. In spite of this, and that it was, we understand, the first attempt of the kind the men had ever made, the work only occupied thirty-five minutes from start to finish.

It is frequently useful to have at hand approximate figures for the relative space occupied by the different departments of an engineering works. In a recent paper before the Glasgow Technical College Scientific Society Messrs. G. H. Gibson and A. Home-Morton give the following apportionment of covered area:—Pattern shop, 4 per cent.; foundry, 25 per cent.; machine shop, 35 per cent.; erecting and fitting shop, 20 per cent.; testing shop, 5 per cent.; stores and tool-room, 11 per cent. We presume that the figure for the pattern shop does not include pattern stores. The same gentlemen have analysed the cost records of a number of engineering and other factories, and find the average distribution of cost to be:—Labour, 37 per cent.; material, 52 per cent.; power, 3 per cent.; and other costs, 8 per cent. As might be anticipated, considerable variations from the average were found. It will be noted how small the cost of power is, and it is unfortunate that manufacturers by their policy of secrecy make it impossible for most factory costs to be discussed in a logical manner. If such discussions were usual considerable economies would certainly be effected, to the advantage of everybody.

An invention which, after expert testing, has been pronounced a valuable addition to the means of combating bacterial disease, is reported from Chemnitz. It is a highly lustrous paint, applied to all surfaces in the ordinary way, with a basis of white lead or zinc white. Its chief value is for disinfecting, and it is prepared and sold more specifically for use in rooms, &c where it is desired to combat pathogenic germs. German Officials have made exhaustive tests of the germicidal properties of "vitralin" under varying conditions. The results may be briefly summarised as follows:—When in contact with the vitralin coating the bacilli of tuberculosis (as found in saliva) are completely destroyed in three days. Diphtheria bacilli require five hours, typhoid bacilli eight hours, and those of pus from six to thirteen hours. No lethal effect could be observed upon the spores of anthrax, even when the contact lasted thirty days, although a distinctly retarding influence upon the development of the spores was noticed. Control experiments carried on simultaneously with surfaces covered with ordinary oil colours, whitewash, &c., showed either no germicidal power or a much less degree of efficacy. Direct sunlight renders the lethal action much more rapid than does diffused daylight. The investigator came to the conclusion that the specific disinfectant property of vitralin results from the oxidation of the linseed oil, which forms an important constituent of this paint.

MISCELLANEA.

Energetic efforts are being made in Logrono to bring to a successful issue the proposed extensive scheme for the construction of the "Victoria and Alfonso" dam works in Lodosa. The cost is estimated at 9,863,000 pesetas (about £352,250), and the work will involve the irrigation of an area covering about 74,000 acres, which will benefit five districts in the province of Logroño, eight in Navarre, and twelve in Saragossa.

A series of comparative tests on the case-hardening power of various gases, the results of which were communicated by Olsen and Weiffenback at the recent Brooklyn meeting of the American Institute of Chemical Engineers, have shown that the case-hardening effect of carbon monoxide is greater than that of acetylene or methane. It is stated that the carbon monoxide process has been applied to commercial case-hardening, and that a patent covering it has recently been taken out in France.

The new airship school which is being constructed at Friedrichshafen is nearing completion, and will be opened in October. The majority of the pupils there will be young cadets, who are obliged to bind themselves for a course of instruction for two years. Provision is also being made, however, for the instruction of senior officers, naval men, and military engineers. The Government's subsidy has been supplemented by the generosity of well-known industrial firms, and Count Zeppelin will present the school with a balloon, and steam launches, as well as motor cars, are to be used for following the flights of airships.

A serious high-tension accident occurred on Wednesday of last week at Olginate, a small village on the river Adda, near Lake Como. This place is supplied by overhead wires with electric current at 3000 volts from a water-power station in the neighbourhood. It appears that during a thunderstorm one of the overhead high-tension wires fell, and came into contact with the low-tension distributing mains, which are also carried overhead. The result was that the house fittings were all charged to the higher potential, and many persons were injured while attempting to switch off the current. It is said that twelve people were killed, and nearly thirty badly injured. There was considerable panic, which was increased by the fact that the lights were all extinguished.

As already announced, the Cunard Company has determined to make Fishguard a port of call for passengers and mails. The service will be started by the Mauretania, now on her way across the Atlantic, and she is expected to arrive on Monday morning next. The Great Western Railway Company is using every endeavour to make the new arrangement a success, and it is thought highly probable that a service of special trains will be run direct from Fishguard to Dover for the convenience of passengers travelling direct to the Continent. An experimental train will meet the first boat. At first, at any rate, the liners will not come alongside the quay at Fishguard; but the mails and passengers will be removed by tender. The vessels will then proceed to Liverpool.

Some interesting experiments are being conducted by the South Park Commissioners of Chicago in the lighting of the boulevards under their control. Several different types of lamps have been installed on temporary posts in order that the comparative illuminating effect may be observed and a determination made of how high the lamps should be hung and how far apart, and similar considerations. The lamps under test or about to be tested include incandescent gas lamps, enclosed arcs, magnetite arcs, flaming arcs, and incandescent tungsten lamps. The commissioners hope to obtain valuable data, both as regards illumination and economy, from these trials, the latter being an important factor, as it is estimated that 1,000,000 kilowatt hours per annum will be required for the lighting of Grant Park alone.

Recently the Lords Commissioners of the Admiralty had under their consideration the question of the emoluments of officers of the Royal Marines appointed to the charge of wireless telegraphy stations, and, as a consequence, they came to the conclusion that the extra responsibility imposed upon these officers merited additional remuneration. The final result is that his Majesty, by an Order in Council, has just sanctioned the grant of an allowance of two shillings and sixpence a day to officers of the Royal Marines when appointed to the charge of wireless telegraphy stations. In addition, there is to be a further allowance of one shilling a day in lieu of a servant to these officers while they are employed on telegraphic duty. The new allowances are to take effect as from November 14th, 1908, and they are to be in addition to the full pay of the officers employed.

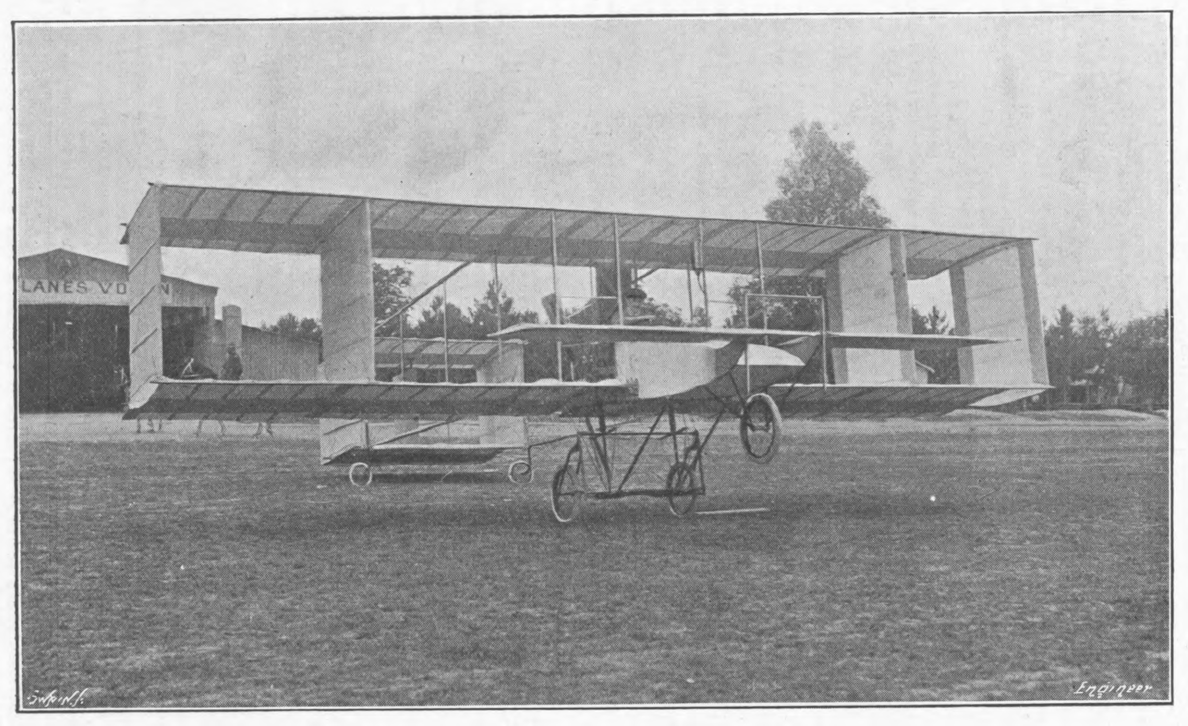
It has been decided, after an experiment extending over two years in the Place de la République, one of the busiest squares in Paris, to adopt the method for the laying of wood pavement which has been thus tested, along the entire length of the Rue de Rivoli. The process in question, which is the invention of M. Managnan, consists in a preliminary treatment of the wood blocks to give them the qualities of suppleness and strength. The wood is heated to a temperature of 80 deg. Cent. in a special bath, containing alkaline, carbonates, and wood tar. By this treatment it loses 20 per cent. of water and 10 per cent. of solid matters of various kinds, and there remains a timber, the density of which has been increased by 40 or 50 per cent. The new material prepared in this way avoids the necessity of repairs for two years at least, which, in Paris, entail a cost of not less than 1s. 3d. per square metre annually.

It is reported that the Transvaal Government have extensive improvements in hand with the telegraph and telephone services all over the colony, which will make it one of the best equipped in the world. It is suggested to link up every town, and main trunk lines are to be carried to every point where the railway lines cross the border, with a view to their ultimate extension to the coast ports when the other colonies are ready. It is regarded as certain that the Union Government will find telephonic communication between Cape Town and Pretoria absolutely essential. The scheme contemplates connections with farmhouses as well as the establishment of call offices at convenient centres. It is estimated that the coast extensions will cost £250,000. A concentrator has already been installed in Johannesburg to enable messages between minor offices to pass direct to their destination, without any necessity for taking off and re-transmission at central stations as heretofore.

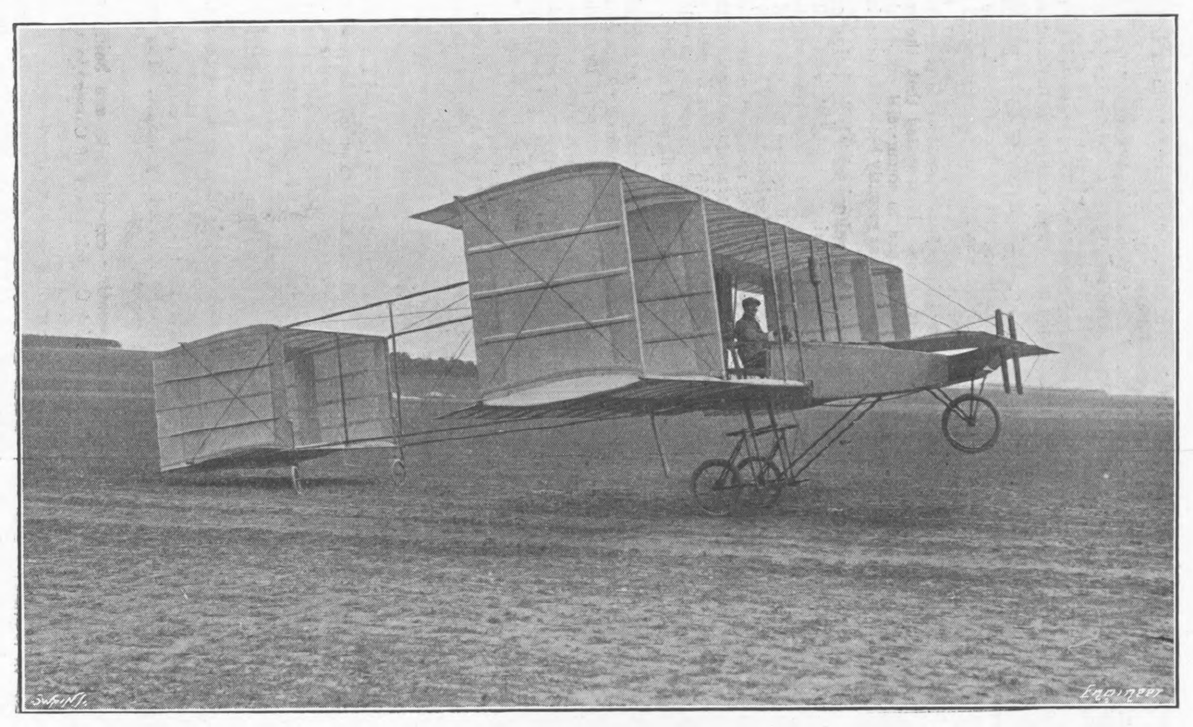
The text was issued last Tuesday of the Bill presented by Mr. M'Kenna to make better provision respecting naval establishments in British possessions. The memorandum of the measure states that the Colonial Fortifications Act, 1877, authorised the transfer by Order in Council to the Governor of a colony of "any fortifications, works, buildings, or land in the colony held in trust for the defence of that colony." Provisional arrangements have been made with Canada for the transfer to the Canadian Government of the naval establishments at Halifax and Esquimalt, but these arrangements cannot be carried into effect without legislative sanction, the naval establishments not being works "held in trust for the defence of the colony." The present Bill proposes to give the necessary legislative sanction to these arrangements, and to any proposals of a similar nature which may be made in the future. The transfer can be made upon such conditions and subject to such reservations as may be specified in the Order in Council, and, consequently, there is full power to make it a condition that the establishments shall be kept in a state of efficiency, and that the right of user for his Majesty's navy should be preserved.

AEROPLANES AT THE RHEIMS AËRONAUTICAL MEETING

(For description see page 211)



VOISIN BIPLANE—FRONT VIEW



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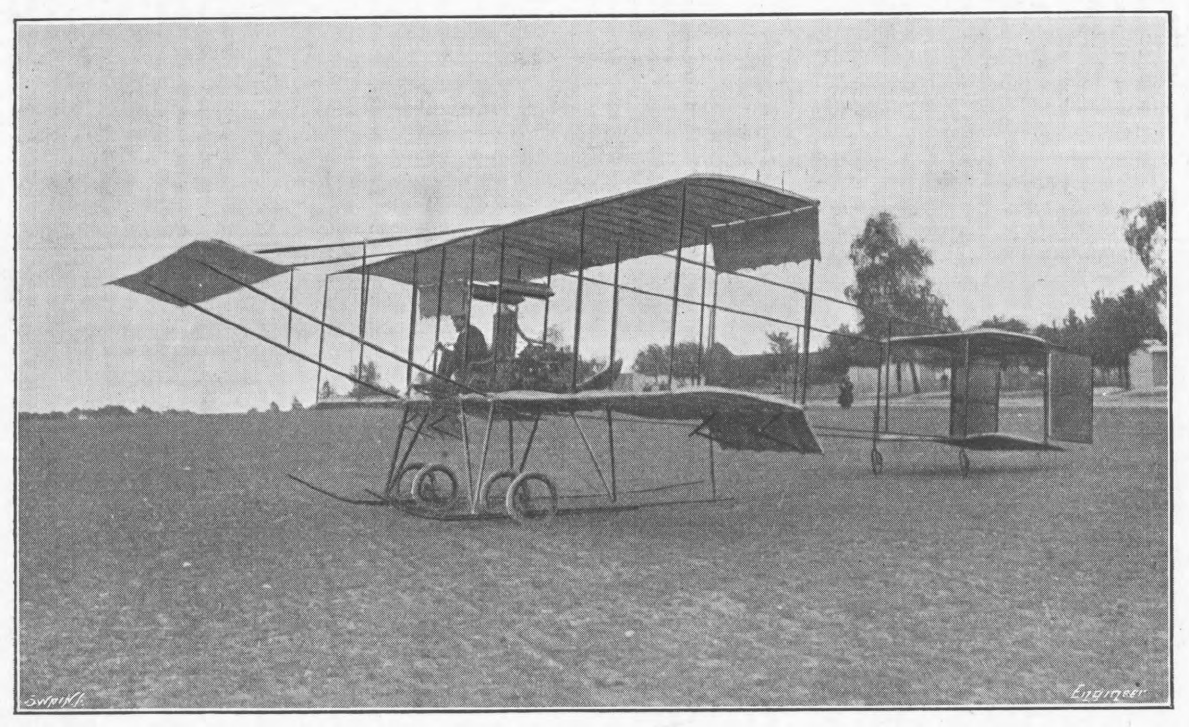
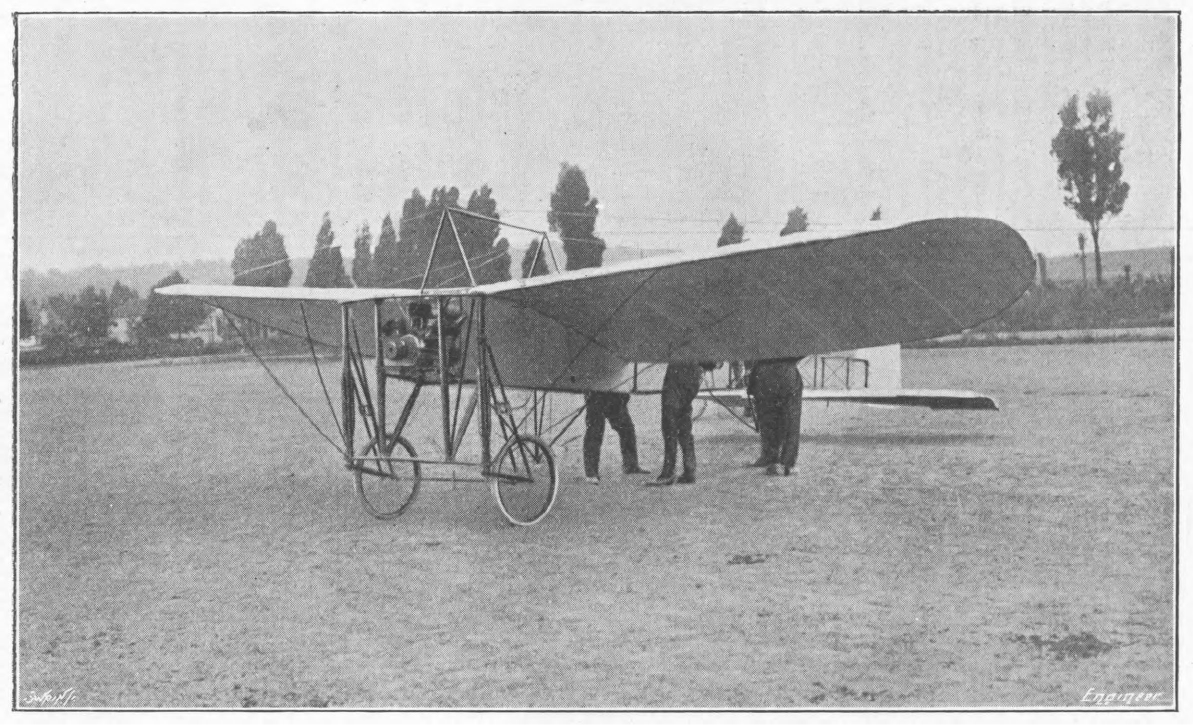


THE FARMAN BIPLANE



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TO CORRESPONDENTS.

☛ *In order to avoid trouble and confusion we find it necessary to inform correspondents that letters of inquiry addressed to the public, and intended for insertion in this column, must in all cases be accompanied by a large envelope legibly directed by the writer to himself, and stamped, in order that answers received by us may be forwarded to their destination. No notice can be taken of communications which do not comply with these instructions.*

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THE ENGINEER.

AUGUST 27, 1909.

Aeroplane Development in France.

ONE of the reasons for the success of the French in following up new lines of research is probably to be found in the fact that they often allow themselves to be influenced by imagination rather than by the practical aspect of the problems they are trying to solve. In some cases data are so entirely lacking, that it is impossible to reduce the problem to a scientific basis before undertaking a vast amount of experimental work. In other words, the experimenter has to take the materials he has in hand and "worry through" with them until he has evolved his machine in something like a practical form. It was so in the case of the motor car, which at first was so crude as to excite the ridicule of everyone not possessing the saving grace of imagination. Apparently the same influence is at work in the evolution of the aeroplane, which is arousing so much interest on the other side of the Channel. The meeting at Rheims this week is a case in point. Capital to an almost unlimited extent has been raised to make this ancient city a centre of the aeronautical movement, and while, of course, the science of aeronautics would not be given this support unless there was some hope of corresponding business advantages, it must be admitted that the risks of failure are so great as to make this expenditure something more than an investment. Many towns and centres are trying to identify themselves in the same way with aeronautics, and are offering encouragement that has probably never been accorded to any other movement.

Seeing that makers of aeroplanes are still working more or less in the dark, it may be interesting to deal briefly with the ideas which are influencing our French friends in evolving a satisfactory type of flying machine. These ideas have always been entirely opposed to those of the American school, in the sense that speed is considered an essential factor in mechanical flight. By the application of the cellular principle Voisin and other makers, and, to a less extent, the Wrights, have sought to obtain an automatic stability with relatively low engine powers, thereby allowing of the use of more trustworthy engines; but it is to be remarked that, following the example of the Wrights, the French makers of bi-planes have been modifying their apparatus, and rely more upon stability by bending the planes, and are employing higher powered engines. For the moment nothing practical has been done in the way of designing aeroplanes which will preserve their stability when being driven slowly. According to French experimenters, the stability of the aeroplane, in the present state of the art, must depend upon the speed at which it is propelled. However skilful a pilot may be in bending the planes, there is always a danger of air currents turning over apparatus designed upon existing principles unless they are opposed by the speed at which the machine is travelling. It is argued that with a high enough velocity the aeroplane can travel in any winds. Until quite recently the bi-plane had the reputation of being a relatively slow machine. For this reason a special impetus was given to the monoplane, which in France is regarded as essentially a speed apparatus, and during the past few months it has certainly shown to advantage. Nevertheless, the whole question seems to be one of engines and propellers, and in recent trials there has appeared to be little to choose between the two types of apparatus, although it may be assumed that as higher speeds are attained the lower resistance will give an advantage to the monopolane. It is to be hoped that some of these points will be elucidated at the Rheims meeting. Obviously an aeroplane cannot remain stationary in the air and travel at very low speeds; and although interesting experiments have been carried out with machines of the helicopter type, the difficulties in the way of providing sufficient power to raise the apparatus are so great that the principle has been abandoned by experimenters until the science of aviation has made greater headway. Until this system can be developed search will still continue for the aeroplane which will rise from the ground at as obtuse an angle as possible. It cannot become practical so long as it is obliged to run along the ground or be propelled by dropped weights. This necessitates conditions of surface for starting that it is not always easy to find. Some builders of aeroplanes are trying to solve this problem by varying the inclination of the propeller so that the pressure may be directed as much as possible under the planes for lifting. As research is thus confined to the simple type of apparatus, which relies for its sustentation upon gliding as opposed to lifting, the only way of increasing the carrying power of the machine is to increase its speed. The area cannot be enlarged unduly without necessitating much higher power, and with this power the same sustaining force can be obtained with smaller planes at greater speeds. M. Soreau has calculated that with its present surface increased by only 10 per cent. a bi-plane of the Farman type can carry a ton, including, of course, the machinery, when travelling at three times the present speed—that is to say, at from 110 to 125 miles per hour. As, however, the increase of resistance offered to the aeroplane varies as the square of the velocity, there is obviously a critical speed which would prove dangerous to the existing type of apparatus, and to attain the speeds necessary for carrying good loads the aeroplane would need to be of much stronger construction. Besides the design and the assembling of the planes, there is also the question of the motor, which at present offers the greatest difficulty to aeroplane makers. For the moment they have no alternative between an imperfect special type of aeroplane engine and the ordinary petrol motor modified to meet the special conditions. Under the impression that a minimum weight was absolutely essential to success in mechanical flight, builders of special engines with eight or more cylinders have in some cases been cutting the weight so fine as seriously to impair the reliability of the engine. The majority of troubles with aeroplanes arise from this cause. Monoplanes are usually fitted with these specially light engines, and few of them have been able to remain in the air, except under especially favourable conditions, for any great length of time. Experimenters with bi-planes have for the most part returned to the ordinary type of petrol engine, and as this limitation of motive power has necessitated a great deal of attention being given to the efficiency of the propeller, the shortcomings of the motor, in the present stage of aeroplane construction, have not been without their advantages. The performances of bi-plane apparatus fitted with such engines have certainly been more consistent. If speeds of 100 miles an hour and more are to be attained it can only be done with special engines which may be evolved from some of the types now being built, and as all the engine builders in France are now giving attention to specially light and powerful motors for aviation work, there is every reason for hoping that considerable progress will be made in this branch of aeroplane engineering at an early date.

Although there is undoubtedly a future for the aeroplane, it is probable that a considerable time will elapse before it develops into anything like a practical machine. The remarkable performances that have been accomplished from time to time are to be attributed mainly to the patience and courage of the men who have driven the machines. They have waited their opportunities when everything was in their favour, and it is because these opportunities are so rare that there are so few long-distance flights. On the first day of the Rheims meeting only a few succeeded in making flights between the squalls of rain and wind, some of them coming to grief mainly through irregularities of the engine, and it was only when the sun had set, and the wind died down to a perfect calm, that competitors tried their machines one after the other until there were eight apparatus in the air at the same time. On subsequent occasions competitors were more fortunate, but it was a common observation that the aeroplane was still the slave of the wind.

Higher Mathematics and the Engineer.

AS long as the battle for existence rages education will be a subject of undying interest, and we need make no apology for a few comments on part of the address which was delivered on Wednesday last at Winnipeg by the President of the

British Association. Sir J. J. Thomson, as a Cambridge professor, has had unrivalled opportunities of studying the effects of education upon young men of all nationalities, and he is able to speak with authority upon the faults and virtues of our present system. It must, however, be borne in mind that he himself has made the great reputation he enjoys in the fields of pure science, and it is desirable that all who read his words should be reminded that between pure science and ordinary work-a-day engineering a great gulf is fixed, which is only now and again traversed by the more gifted spirits on one side or the other. The pure scientist is rarely interested in the financial aspects of the problems he sets himself to solve; he is frequently independent of time, and he always comes to his task fitted with a peculiar mind—a gift of the gods—and a particular form of training. The work-a-day scientist, be he engineer, electrician, or chemist, has to make a living by the production of articles directly useful to man or by the prosecution of routine humdrum essential work. He is interested deeply and intimately in all the very things that the pure scientist cares nothing about. To him the financial value of his work is of far greater interest than its scientific value, and science is very truly and accurately his handmaid rather than his goddess. Whereas the pure scientist finds beatitude in her presence alone, the working scientist bustles her hither and thither with very little respect, and the only assistance he asks from her is that she will show him the means of making more money out of his engine, dynamo, waterworks, or what not. Both men have their sphere of usefulness, and it ill becomes either to reproach the other with shortcomings. But it is wholly impossible for the two ever to effect a complete amalgamation in a single brain, and we are convinced that as a whole better work is done by the two acting in complementary capacities to each other than by attempting such a union.

Sir J. J. Thomson speaks throughout the address which we are considering of physics, but he nowhere tells us what he wishes to imply by the term. In many schools and colleges physics mean sound, light, and heat, but we are certain that the President of the British Association takes a far wider view. Apart from the fact that he would of necessity include all those theories on the constitution of matter which are collected under the head of the new physics, he, no doubt, will permit us to number the practical applications of heat and the strength of materials upon which nearly the whole progress of the modern world rests. If we are right in regarding his use of the word in this light, then many of his observations apply as directly to the engineer as they do to the pure scientist, and whilst we can only commend many of them—as, for example, his remarks on the dangers of specialisation at an early age, and the disadvantages of scholarships, to the attention of our readers as the opinions of a man who has had unsurpassed opportunities of judging—one at least of the others we must be permitted to criticise. Sir J. J. Thomson writes:—"Again the specialisation prevalent in schools often prevents students of science from acquiring sufficient knowledge of mathematics. It is true that most of those who study physics do some mathematics, but I hold that, in general, they do not do enough, and that they are not as efficient physicists as they would be if they had a wider knowledge of that subject. There seems at present a tendency in some quarters to discourage the use of mathematics in physics. Indeed, one might infer, from the statements of some writers in quasi-scientific journals, that ignorance of mathematics is almost a virtue." If we are to take this as a blow directed at the many thousands of engineers who do not consider a very advanced mathematical training necessary to welfare in their profession, then we say that its force depends entirely upon the point of view. For scientific engineering a profound knowledge of mathematics is necessary; for ordinary engineering, and for what Sir J. J. Thomson would no doubt call quasi-scientific engineering advanced mathematics are not only wholly unnecessary, but they are apt to become an actual danger. Nearly all problems in engineering can be solved by the application of a great deal of common sense, plenty of experience, and a few simple mathematical operations. There are very few, if any, problems in practical engineering which do not surrender to the simplest mathematics once the conditions are fully understood. The difficulty is not so much in solving the problem as in stating it clearly, and if there is any aspect of mathematics that needs development in schools and colleges more than another, it is the ability to see precisely what is wanted, to know what is aimed at, and the road by which it is to be attained. Whether that is taught by a study of the higher mathematics or not we leave professors to say. But what "quasi-scientific journals" mean when they say that too much weight is laid upon mathematical knowledge by teachers is that the machinery and apparatus of the higher mathematics are not required in the ordinary affairs of engineers, and that a sound knowledge of precedent, a sound knowledge of physical facts, is much better worth acquiring than an intimate acquaintance with the abstruse properties of conic sections.

Need we, in conclusion, remind the mathematically minded that the problems of practical engineering are as open to them as they are to the rest of the world. They know as much about the steam engine, the gas engine, the dynamo and motor, the machine tool, the screw propeller and flying machine, as the rest of the world knows. Can we then doubt that if revolutions are possible in the construction of such things by the application of advanced mathematics, that such advances would have been made long ago? Mathematics must prove their pre-eminence by works before engineers will be disposed to concede to them the position which has been gained and is still held by the step-by-step progress of the practical man who looks upon mathematics as a handmaid and not as a goddess, and who, recognising the necessity of making something, goes along step by step, blundering, if you will, but getting gradually to his goal. Without mathematics engineering could scarcely continue, and no advances would be made; but look where we will, we see the truth of the fact that in all save a very few cases the progress of invention is due to men who have attacked their problems by the experimental method, and this in spite of the fact that there was a fair field for both parties. That Sir J. J. Thomson is himself not blind to this fact is proved by the following passage in his address: "How great is the supply (of heat) the sun lavishes upon us," he says, "becomes clear when we consider that the heat received by the earth under a high sun and clear sky is equivalent, according to the measurements of Langley, to about 7000 horse-power per acre. Though our engineers have not yet discovered how to utilise this enormous supply of power, they will, I have not the slightest doubt, ultimately succeed in doing so." We are content to leave the subject at that; the mathematician shows us where the power lies, the engineer abstracts it.

The Strength of Rolled Beams.

It is a popular fiction that we have nothing to learn concerning that type of rolled beams and girders which is largely employed in buildings, small bridges, and structures of secondary importance. They are freely bought like bricks or lime or boards, without question, save as to price, and loaded without much care as to their fitness for the work they have to do. So long as their general dimensions appear to be suitable, nothing more is asked. They are simply marketable commodities, and the user depends on the reputation of the makers for their quality. Now and again, however, tests are made, and the results are not infrequently anything but reassuring. The rolling of a fairly heavy double-flanged beam is by no means a simple matter, because of the various "draughts" put on the metal in going through the rolls. The edges of the flanges do not run as fast as the central portions, and they must either be dragged through the grooves, or else the central portions must be compressed. The roots of the flanges—that is to say, the places where the central web joins the flanges—tend to be unsound, and initial stresses are no doubt set up which may ultimately do harm.

To overcome difficulties like these the Bethlehem Steel Company, of Pennsylvania, has been turning out I beams with the Grey universal beam mill, for which it is claimed that "in the Grey mill the flanges and web of the beam are formed by the simultaneous operation of independent horizontal and vertical rolls, thus admitting of the effective rolling of the metal in the flanges as well as the web. This renders it possible to produce wider flanges than by beam mills of the ordinary type, in which the linear speed of rolling at different points of the beam varies inversely with the distance from the centre of the roll, resulting in a dragging action upon the flange metal, which becomes emphasised with increasing flange width." It is further claimed that in beams of "standard" section the webs are too thick for economy, but that they cannot be made thinner in the ordinary mill. This does not include all the points in favour of the product of the Grey mill, but it is unnecessary to specify them particularly, because they do not appear to possess the advantages claimed for them. Mr. Marburg, professor of civil engineering in the University of Pennsylvania, has carried out a laboratory inquiry intended to settle the comparative values of the Grey beams and the standard beams. The results were unexpected. It is asserted for the Grey beams (1) that the material in the flanges receives more work in rolling, and is, therefore, of better quality; (2) that the material throughout the section is more nearly uniform in quality; (3) that the beams are comparatively free from internal stresses. The tests are far from establishing the validity of these claims. For the sake of comparison, standard section beams were tested at the same time, and it was found that these also did not come up to the nominal excellence attributed to them. The *Engineering News* is not unnaturally disconcerted, seeing how largely I beams are used in the construction of "skyscrapers." Our contemporary says:—"No doubt most of us have always had a silent conviction that an I beam would develop practically the full strength of its material, *i.e.*, would not fail until its extreme fibres were stressed approximately as high as the ultimate strength of the steel composing the beam. In this connection we have been inclined to think vaguely of something like 55,000 lb. to 62,000 lb. per square inch, and to credit our beams, when stressed to a 16,000 lb. fibre stress, with a safety factor of 3½ to 4. When we see from Professor Marburg's tests, however, that 15in. I beams averaged only 42,600 lb. per square inch in ultimate strength, while 24in. I beams showed only 34,000 lb. per square inch, our tacit assumptions seem gravely over-optimistic, and our safety factor drops to a figure between 2.0 and 2.7!" Why are these beams so defective? Let us see what Professor Marburg has to say on the subject.

It will be remembered that his experiments were mainly intended to settle whether the wide-flanged thin-webbed Grey beam was or was not better than the normal or standard beam made by the Bethlehem Company. A curious fact demonstrated by the inquiry is that while the elastic limit of the standard beam is very constant at about 20,000 lb. per inch for all sections, that of the Grey beams fall off very rapidly, being only 10,800 lb. for girders 30in. deep. The method of failure is instructive. The 15in. Grey girder gave way by the twisting of the web, while the standard failed by the lateral deflection of the top flange. This was the case with all depths and sizes. In the standard beam the initial cause of failure appeared to be the lateral weakness of the top flange in compression. While the flange gave way near the centre of the length of the girder, the vertical position of the web near the ends was well maintained. The failure of the Grey beam was, on the contrary, generally speaking, marked by a sudden and considerable twisting of the web, usually in opposite directions at opposite ends, the beam, as a whole, assuming the shape of a very flat letter S. Taking generally the breaking stress of the beams tested, we find that, according to Professor Marburg, the use of a working stress of 16,000 lb, or 7.14 tons, as usually recommended for buildings, is indefensible. In his judgment, further inquiry is imperatively demanded. His investigations showed that very considerable differences in quality exist in the same section of the beam, depending on the locality. Thus, to cite two or three examples, specimens cut from the web of Grey beams had an elastic limit of 36,800 lb. and a yield point of 42,500 lb. per square inch, while the root of the flange gave 16,300 lb. and 34,400 lb. only. In all the girders tested there were discrepancies of this kind. Nothing was done in the way of reheating to get rid of initial stresses. The low elastic limit of the metal near the roots of the flanges is very peculiar. Its cause has yet to be ascertained.

So far as can be seen, the Grey theory of rolling is unsound, rather better results being got with the standard mill. It must not be forgotten that the number of tests made was small, but the girders may be regarded as quite representative. There have been some serious accidents in the United States, tall buildings collapsing in whole or in part. Possibly an exaggerated estimate of the strength of beams may have been a contributing cause. We do not suppose the inquiry will cease at this point. No doubt the Pennsylvania Steel Company will fall in with Professor Marburg's suggestion that an extended inquiry should be carried out to throw more light on:—The low elastic limit of the metal near the root of the flange; its cause and prevention. The low elastic limits in bending for the deeper beams; their cause and prevention, unless it can be proved conclusively that the values obtained in the present series are abnormal. The effect, both on the elastic limit in bending and modulus of rupture, of variations in the supports and lateral restraint at the ends and intermediate points. Extended tests should be carried out to settle the crippling strength of thin webs. An experimental inquiry is desirable relative to the existence and magnitude of internal stresses, and how these are affected by different methods of rolling, finishing-temperature, &c.

It is a long time since anything like a complete inquiry into the strength of rolled steel beams has been carried out in this country. A reference to text-books will show that investigation has been mainly confined to iron beams. Various individual and special tests have been and are being made, no doubt; but these are very far from covering the whole ground. They have been for the most part made with ship's beams, bulb, and angle steels. It goes without saying that British standard sections are the result of experiments, and yet it is possible that these experiments may not be in any way conclusive. It is not, we think, quite fair to take it for granted that the girders turned out by the Bethlehem mills are strictly exceptional.

The Stream Line Theory and Collisions at Sea.

There would at first appear to be very little connection, if any, between stream lines and collisions, but a curious and exceptional paper is in front of us, which shows that under certain conditions the nature of the reactions on moving vessels in close proximity may make it much more difficult to avoid a collision than one would suppose. The paper is called "Some Model Experiments on Suction of Vessels," and its author is Naval Constructor D. W. Taylor of the United States Navy, who is well known for his work in connection with the resistance of ships and researches in the screw propeller problem.

The paper gives the result of some investigations made at the experimental tank on the mutual reactions on models of vessels moving side by side at different distances apart and when passing one another, and as it is a subject which has hitherto received little attention, the paper is of considerable interest. The models were all 20ft. in length, and from the other dimensions given would appear to be of battleship proportions. The speed at which they were timed was from 2 to 3 knots, and the corresponding speed for a vessel 490ft. in length would therefore be $9\frac{3}{4}$ to $14\frac{1}{2}$ knots. The models had a displacement "in fresh water"—but why drag in the fresh water?—of 3000 lb., so that the displacement of the full-sized ship of the above length would be about 19,000 tons. In the general result it was found that the mutual action between the models varied with the speed, as the resistance of the models and the forces measured are indicated on the diagrams in terms of the resistance. The forces were measured at points near the bow and stern, and it is stated that the results cannot be regarded as highly accurate, owing to the difficulty in towing the models exactly straight, but they show the general tendency very clearly. When towed abreast about one-fifth the length of the models apart, representing about 33 yards in our full-sized ship, there is an attraction between the two varying from 1·2 times the resistance at the bow to 2·2 times at the stern. As one would suppose, this attraction reduces rapidly as the distance between the vessels is increased. At one quarter the length apart, say 40 yards, for the full sized ship, the attraction diminishes to two-thirds the resistance at the bow to a force equal to the resistance at the stern, and so on, until when the distance has increased to half the length of the vessel or more, the suction has almost entirely disappeared. When one vessel is overtaking another there is a change in the direction and magnitude of the forces, beginning with a repulsion which is greater at the stern than at the bow of the overtaking vessel. When the bow of the overtaking vessel is abreast of the overtaken, the force at the bow changes to one of attraction, but the repulsion at the stern has increased in magnitude. From this point onward the attraction at the bow increases rapidly, while the repulsion at the stern diminishes rapidly, and eventually changes again, so that both forces at bow and stern become attractive. This continues until the vessels are abreast, after which the forces undergo changes in reverse order as the overtaking vessel passes the overtaken. It is pointed out that the existence of these forces makes the avoidance of collisions difficult after certain positions have been reached. There is a strong course acting on the overtaking ship tending to swing its bow in towards the overtaken ship which it would be probably impossible to counteract entirely by putting the helms over, and it is also pointed out that the magnitude of the forces would also be greater in shallow water, such as in the fairway of a river, where these conditions are of practical importance owing to the nearness with which it is often necessary for vessels to pass one another. The general results could have been predicted from the application of the stream line theory, although it would not be possible to evaluate the magnitude of the forces. We know that if the particles in a stream line are diverted, there is no resultant pressure so long as the particles return to their original direction with their original velocity, for in that case there is no permanent change of momentum. In the case of two vessels close together abreast, the momentum of the water flowing between them is reduced to a greater extent than that of the water flowing outside them, and the result is a pressure on each tending to force them together. Everybody has probably seen this phenomena exemplified in the tendency of boats to drift together in a tideway. The case of vessels approaching one another in parallel lines is more complex, but the direction of the resilient forces can be seen by drawing the stream lines round the two vessels. The magnitude of the forces appears greater than one would suppose to be the case, and as the figures given in the paper make no great claim to accuracy, the subject may well receive further experimental investigation.

The practical application of the results may not be great. No seaman wants to pass another vessel within a distance less than half the length of his ship if he can possibly avoid it, neither does he require to be told that in a narrow channel in close proximity to other vessels, reduced speed is essential to safety. On the other hand, if the magnitude of the forces are as great as found in these experiments, some light may be thrown on such cases as the Gladiator and St. Paul collision, for the conclusion to be drawn from the results given in Naval Constructor Taylor's paper is that once a certain relative position between two vessels has been reached, it is impossible to avoid a collision unless the way on both vessels is instantly checked.

Iron Trade Revival.

The iron trade is reviving. Of that there is no doubt. News of the change comes from all parts of the country. And, better than all, the account of quickened buying from one district is simultaneous with equally satisfactory reports from competing areas. Look where one may, the market information is the same. To say that the intelligence is gratifying is to express only a fraction of the fact. Under any circumstances, prosperity, if only at the start, must be a pleasing substitute for bad trade; but the present revival is doubly welcome because so long delayed. Commencing in the iron manufacturing States of the great Republic across the Atlantic, where the depression had been unrelieved since the panic, now nearly two years ago, it had been a surprise to iron producers in this country that the revival had not earlier affected the works and furnaces, and attention had been strained to catch the first reliable indications of the improvement having reached the Scotch and English iron districts in sufficient volume to warrant sensible recognition. It is in the raw iron trade that, so far, the revival is most pronounced, and, happily, each week is adding to the number of those exchanges where a better state of things is appearing. The Midland market has been the last to be touched, but the reports of the pig iron situation emanating from that part of the kingdom just now are all that could be desired. In common with the West of Scotland and the North of England, prices in the Midlands are steadily moving up, and the hesitancy of masters to book forward as far as buyers would like is speaking evidence of the belief which producers entertain that the improvement will continue. This week news comes of the first kindlings of the revival in the manufactured iron industry. The Scotch malleable iron makers have put on 7s. 6d. a ton on all sections of bars, and the influence of the advance is bound to be felt in the other iron-making districts. Cleveland should be the first to benefit, and probably will be, and next Lancashire and Staffordshire.

PRUSSIAN RAILWAY ELECTRIFICATION.

After much procrastination, the Prussian Railway Administration has at last decided to take the first decisive step towards the electrification of the main Prussian railway lines, and the 2,000,000 marks required for the equipment of the first trial section were sanctioned by the Prussian Chamber of Deputies last month. The section on which the first trials are to be made is 30 kiloms. long, and extends from Bitterfeld to Dessau. The service is to be so arranged that the steam locomotives which draw the trains over the main lines to Bitterfeld and Dessau are to be changed at these stations for electric locomotives, this form of traction alone being employed to work the trains over the trial section. If the experiment proves a success, the electrification of the main lines extending between Leipzig, Bitterfeld, Magdeburg, and of the branch line from Bitterfeld to Halle will probably soon after be proceeded with.

There are several reasons for saying that the section for these first trials has been most happily chosen. The first is, because other parallel lines exist over which the traffic intended for the electrical line could be diverted in the case of a temporary breakdown on the latter. Secondly, the line is in the interior of the country, which precludes any possibility of the military authorities raising any objections to it from strategical reasons. Thirdly, the line chosen is a section of a main line running to Berlin, so that the electrification could be easily extended right up to the capital. Fourthly, there are large brown coal deposits near Bitterfeld which will provide cheap fuel for the power station.

In the elaboration of the entire scheme, the experience gained by the working of the Hamburg electric railway has been turned to account. The overhead trolley system and the power-house have been so projected as to allow of the electrification scheme being readily extended, and hopes are entertained that the 26,000,000 marks which would be required for the whole extension will eventually be sanctioned by the Chamber of Deputies. At a meeting which was held in the Prussian Ministry of Public Works, and attended by Privy Councillor Wittfeld and a number of distinguished engineers, the principal points in connection with the proposed electric line were fixed. It was decided that although a frequency of 25 periods is being used on the Hamburg city railway, 15 period single-phase current should be adopted on the new line, because it has been found that electric motors for 15 periods last longer than motors built for 25 periods. It was also urged that in America 25 periods had first been tried, and subsequently superseded by 15, this lower frequency having been introduced there by the Westinghouse Company. An objection raised against the application of 15 periods was that this lower frequency entailed a considerably higher expenditure for the central power station. But it was shown, on the other hand, that the losses in transmission were lower with 15 periods than with 25. The tension at which the current is to be transmitted is to be 60,000 volts, and it is thought probable that this tension will be used on all the main lines converted in the future.

As has been mentioned above, the present section is about 30 kiloms. long, and the current will be transmitted to the locomotives through overhead trolley wires. The initial equipment of the power station will consist of a steam turbo-generator, capable of developing 3000 kilowatts, power factor 0.8, 3000 volts, 15 periods, single phase. The turbine will, in accordance with the general practice in vogue in Germany, be of the horizontal type. Two transformers will be installed which will step up from 3000 to 60,000 volts. The transformers will be cooled by oil, which will itself be kept cool by means of water passed through spirally wound pipes immersed in it. It has been found by experience in Hamburg that extremely severe short circuits occur on electric railways, and for this reason special care will be taken to construct all parts of the switchboards, that will have to withstand the effects of these short circuits, as substantially as possible. This refers particularly to the oil switches, and it will be interesting to observe how the various firms will solve the oil switch question.

Since it will be necessary to reconcile the speed of revolution resulting from the given periodicity with the speed at which a favourable steam consumption by the turbine is obtainable, it is to be expected that a two-pole turbo-generator will be decided upon, and that the revolutions per minute will be 900. To develop the necessary power at this speed the generating set will have to be made heavy, and will in consequence be expensive. The steam turbine will be designed for a pressure of admission of 13 atmospheres, in accordance with the general practice in Germany. The exhaust steam will be condensed in surface condensers.

In the specifications recently sent to the various firms which were asked to prepare tenders it is required that the condenser pumps shall be driven by a separate steam turbine. For several months now this method of driving condenser pumps has been gaining favour—more in Germany, perhaps, than anywhere else. Compared with the electrical driving of condenser pumps, it is claimed to have the advantage of being more reliable, for with electrically-driven condenser pumps it has happened that, through heavy short circuits, these pumps have been brought to a standstill, and this has resulted in the stoppage of the whole generating set. Such contingencies need, of course, not be feared with steam-driven pumps. The cooling water for the condensers and the additional boiler feed-water will be drawn by the condenser pumps direct from the river Mulde. The boilers will be erected in a separate building adjoining the engine-house, and will have to be specially arranged for the burning of brown coal fuel. The boilers generally used for brown coal fuel in Germany have pipes which slope more steeply than in ordinary boilers. For electric power stations water-tube boilers only are used, and these will presumably be employed in the present case. Endeavours have been made in Germany lately to introduce a new type of boiler known as the "Garbe" boiler. The results deduced from practical experience of these boilers are not yet sufficient to enable a sound opinion of their merits to be formed; but it is stated that the experience gained with them in small power stations has so far been satisfactory. The space taken up by these new boilers is small, although this advantage is somewhat offset by their requiring a higher boiler-house than ordinary land boilers. Superheaters are to be provided, and economisers will also be installed. In view of the large quantities of brown coal required for a power station of such magnitube, hand firing will, of course, not be entertained, but mechanical stokers will be employed. The coal will be brought direct from the mine to the power station in railway trucks, and will be conveyed automatically to a bunker arranged above the boiler, whence it will fall through tubular chutes on to the grates.

It is hoped in engineering circles in Germany that the new trial plant described above will turn out a success, in order that the other railway lines, which would then be converted, may provide more work and better times for the electrical industry, which has been suffering severely from the effects of the present depression.

A NEW TYPE OF SELF-DISCHARGING COALING VESSEL.

A NEW system of belt conveyor discharge has recently been patented by William Doxford and Sons, Limited, and adopted in a new vessel—the steamship Pallion—which they have recently built at the Pallion Shipyard, Sunderland, to the order of the Dunrobin Shipping Company, Limited, of Newcastle-upon-Tyne. This vessel has a length between perpendiculars of 270ft.; a breadth, moulded, of 44ft. 6in.; and a depth, moulded, of 23ft. 6in. She is a single deck self-trimming steamer, with large hatches and subdivisions in the hold, and she has a carrying capacity of 3100 tons on a 17ft. 10in. draught. The machinery, comprising triple-expansion engines, 21in., 35in., and 59in. diameter by 39in. stroke, and multitubular boilers of 180 lb. pressure, is placed aft. The cabin accommodation is fitted in the bridge, and the crew space in the forecastle, whilst the navigation accommodation is about amidships. The after hatchways are extended by trunks to the poop deck level, and have been so arranged as to give the vessel a proper trim when loaded with full bunkers, and the usual high coamings are fitted on the poop deck and on the main deck forward.

The bottom of the vessel is constructed on the cellular system for a portion of the breadth, and the inner bottom is raised and sloped upwards in the wings and built into the sides of the vessel, forming a suitable incline for gravitating the cargo to the conveyors, and also giving the vessel the advantage of being about half-loaded when in ballast and bunkers. In the centre line is constructed a slope top fore peak throughout the hold, and between this tunnel and the tunnel—Figs. 4 and 5—extending from the engine space to the raised portions of the double bottom are placed the conveyor belts, of the Robins pattern, one on either side of the vessel. The sides of the tunnel below the level of the hatchways over the belts are open for free access to the belts and carriers at all times. Over these conveyor belts are placed strong iron guide plates extending the full length of the hold and partially covering the belts, leaving a 24in. hatch over a 36in. belt. This space is covered in the holds by cross-laid hatch covers, 9in. in length and 3in. thickness, which support the cargo and leave the conveyors free to work without carrying the load. At the after end of the hold a portion of the hatch, over which the 9in. hatch cover is omitted, is covered by a horizontal iron slide door, operated by a ratchet in the tunnel. On the foreside of the bulkhead is constructed an access chamber in free communication with the tunnel, which is of such a form as partially to protect the slide door from the cargo when loading, and in the floor of this projection of the chamber is fitted a flap hatch to give access to the hold from the tunnel. At the after end of the cargo space the conveyors rise from the horizontal and pass upwards in iron chambers through the machinery space, and thence into the conveyor-driving engine-room, and discharge the load into guide shoots in the stern of the vessel. These carry the load on to return belts, which are extended forward on both sides on the deck. In a simple form these conveyors would terminate at the fore end of the machinery space, or poop front, and the load would be delivered into side shoots which telescope and are adjustable for loading barges on either side of the vessel, the shoots being suspended from derricks or other suitable means. In cases where the discharge is required at a higher level than is attained at the poop front and a large range of elevation is necessary, as, for instance, for delivery on high quays into trucks and into barges alongside, the conveyors are carried forward and hinged at the poop front, and the delivery end is suspended by suitable tackle from twin masts or framework, and is raised or lowered according to circumstances, delivering the load into telescopic shoots suspended therefrom. When the delivery is into trucks, the "offside" belt delivers amidships into a cross conveyor suspended on the masts, which carries the load to the shore side and delivers by shoots into the trucks. A development of this principle has, however, been applied to the steamship Pallion, as, in order to obviate the use of delivery shoots, which result in considerable damage, the terminal conveyors are carried in swivel booms, which are raised or lowered and swung overboard to the points of delivery, thus permitting of the cargo being conveyed direct to the truck or barge without shoots. These booms may also be swung across to the reverse side of the vessel, so that both booms can deliver simultaneously into trucks or warehouse—Figs. 3 and 4. Another important feature of this discharging arrangement lies in the method of delivering the cargo on to the belts from the hold, and enabling the operator to have full control and free access at all times to the conveyors and to the face of the cargo. He may thus superintend and direct the continuous flow, and be in a position promptly to correct any tendency of the cargo to bridge or to choke the aperture leading to the belt, which

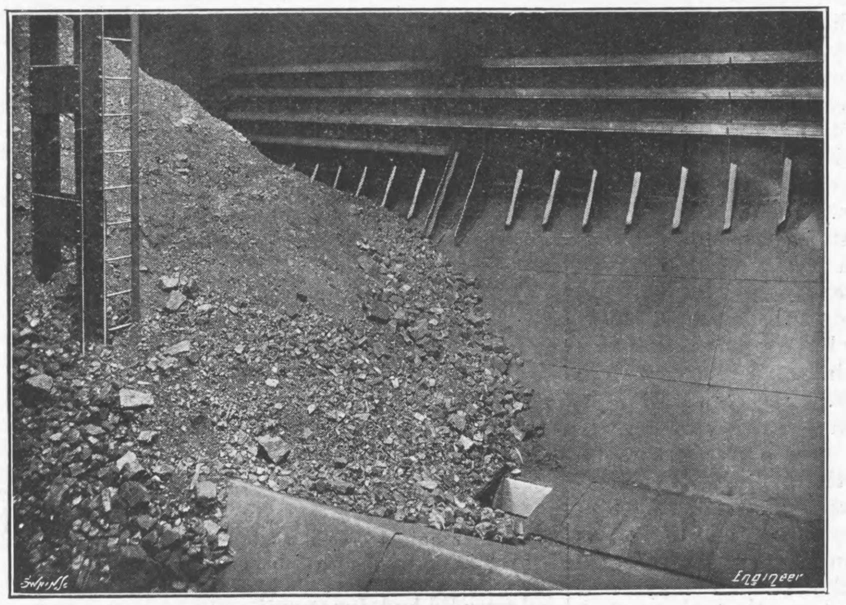


Fig. 1—VIEW SHOWING OPENING OVER CONVEYOR

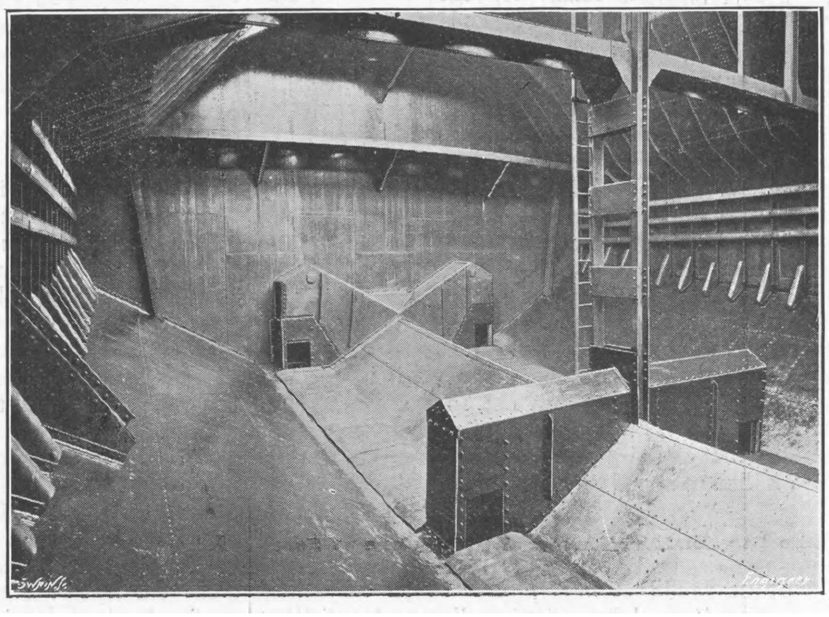


Fig. 2—VERTICAL SLIDE DOORS IN THE HOLDS

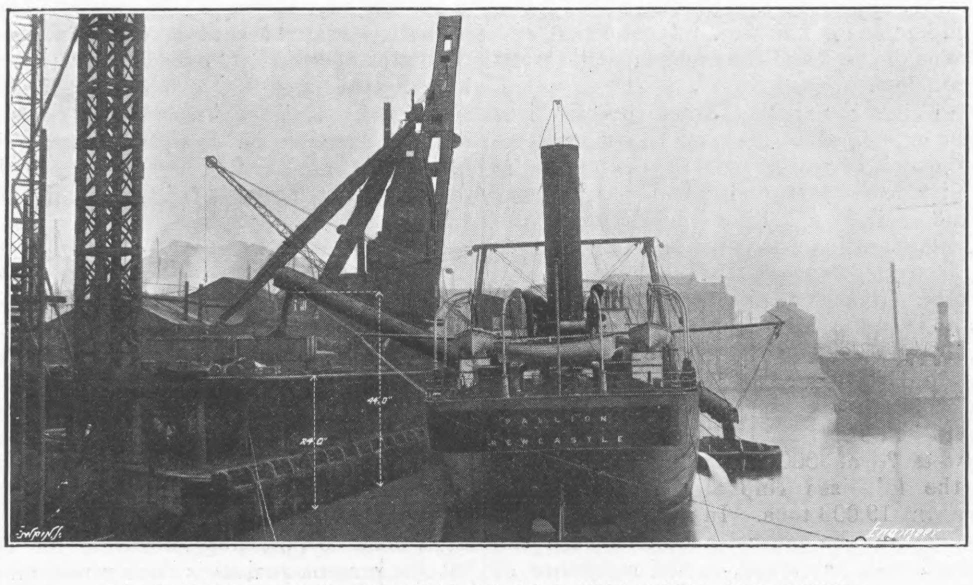


Fig. 3—SIMULTANEOUS DISCHARGE OF COAL INTO TRUCK AND LIGHTER

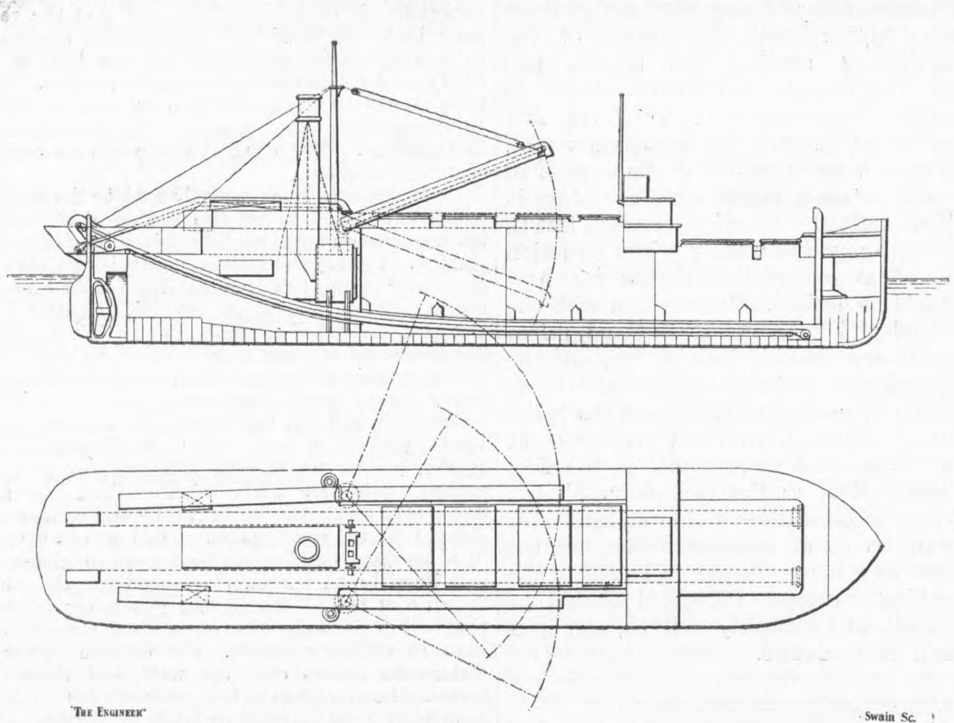


Fig. 4—LONGITUDINAL SECTION AND PLAN OF THE PALLION

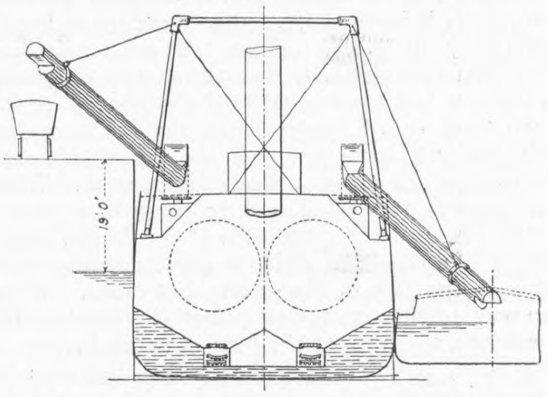
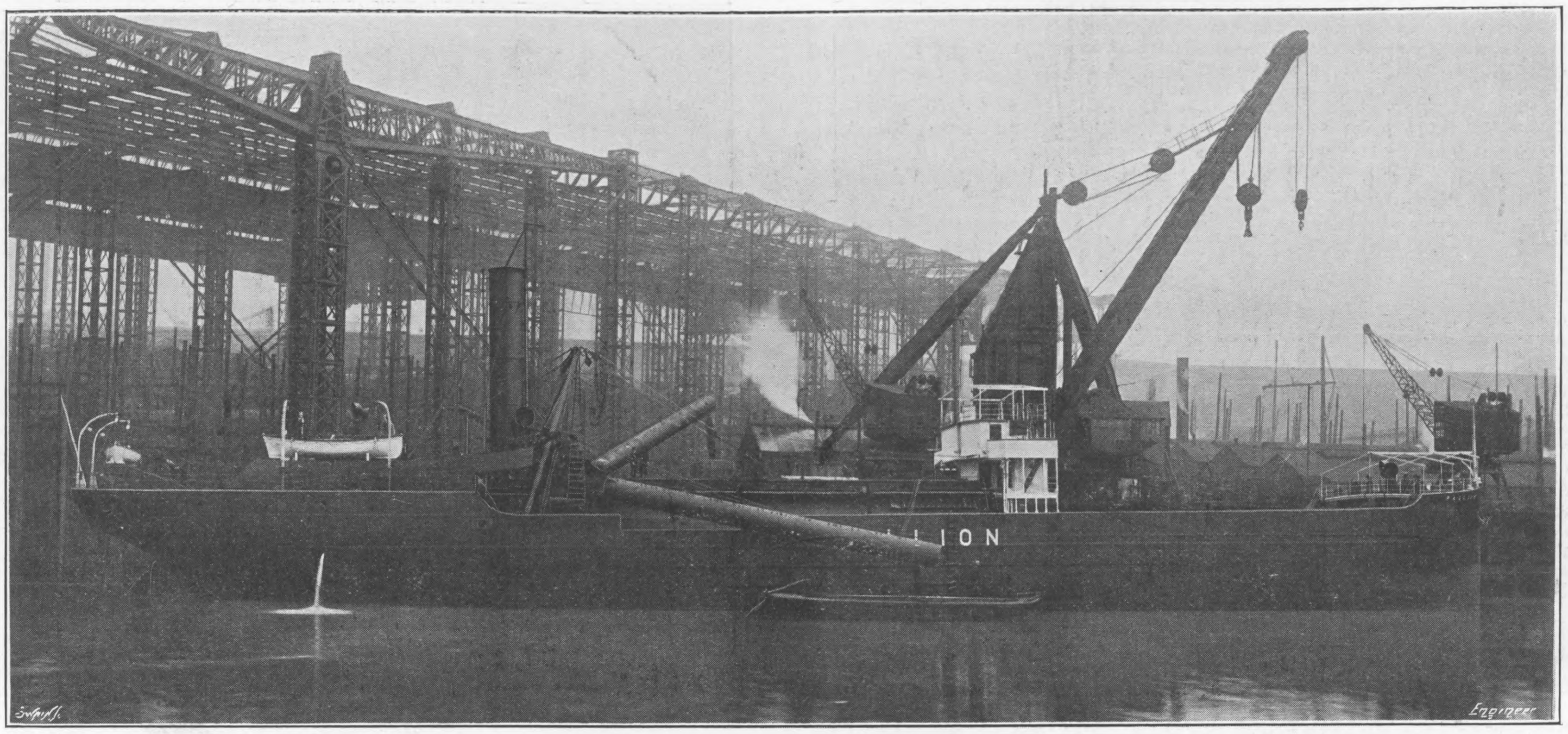


Fig. 5—CROSS SECTION OF THE PALLION

THE SELF-DISCHARGING COALING VESSEL PALLION

WILLIAM DOXFORD AND SONS, LIMITED, SUNDERLAND, BUILDERS



being the smallest space the load has to pass through, ensures a continuous and uninterrupted delivery.

For unloading a coal cargo the following is the *modus operandi*:—Presumably the holds are full and the cargo lying solid, except under the overhang of the chamber on the bulkhead over the slide door, at which point the space is naturally only partially filled. The slide door in the covers over the conveyors, Fig. 1, is drawn back by the operator in the tunnel, and the loose coal over it immediately travels on to the conveyors, which may or may not have been started. If running, then the flow continues; if standing, no difficulty arises because the conveyor is only filled at that point, and the aperture becomes blocked and only clears and flows when the belt is started. Then, if no "bridging" occurs, the after part of the hold is rapidly emptied on to the conveyor which is carrying it on deck and into the receiving trucks or barges. If, however, any "bridging" is threatened, the operator in the tunnel ascends to the chamber, and has free access over the aperture to correct any block. If bridging occurs higher in the hold, then he breaks it by means of a pinch bar through prick-holes in the chamber sides. When the after end of the cargo has run to its natural angle of repose, the operator now in the hold merely removes the first cover and places it aft of the aperture, allowing another portion of cargo to run, he being in a free position to maintain the run and correct any tendency to bridging and to abnormal rushes. If such do occur and incline to block the aperture, he again corrects this, and, having run so much more, he removes the next segment of cover, and so on, gradually transferring the aperture from the after end to the fore end of the hold. The wing tanks and central tunnel—Figs. 2 and 5—being sloped, the cargo gravitates to the aperture, and the finals are manipulated by the operator, one man being on each side of the hold.

An important feature is the inclined shoot, over which all the cargo passes on to the belt. This shoot is carried on travellers on the guide plate sides, and is moved by the operator in the hold forward from stop to stop to correspond with the movement of the aperture, thus allowing two men to manipulate a whole cargo at the rate of 500 tons per hour. The conveyor-driving engines are of the compound surface-condensing type, worked from the main boilers, and are under the direct control of the engineer of the vessel, who has at all times free access to all the gear for oiling, overhauling, or adjustments. The driving engines are connected to the conveyors, so that either can be run independently or simultaneously, the power arranged being sufficient to deal with a full load on both belts delivering at the rate of 500 tons per hour. Accordingly, it is estimated that in regular working the steamship Pallion will be unloaded in six hours, or, allowing for stoppages in moving barges, &c., seven to eight hours, and this, too, with but one stoker, one engineer, two labourers in the hold, and two adjusting the shoots or booms into the craft. The gear, being placed quite independent of the cargo, is free to run empty, and all may be made ready and waiting for a start before the vessel is moored and the barges in position. This alone will save considerable time as compared with the work of rigging derricks, platforms, and the handling of baskets, &c.

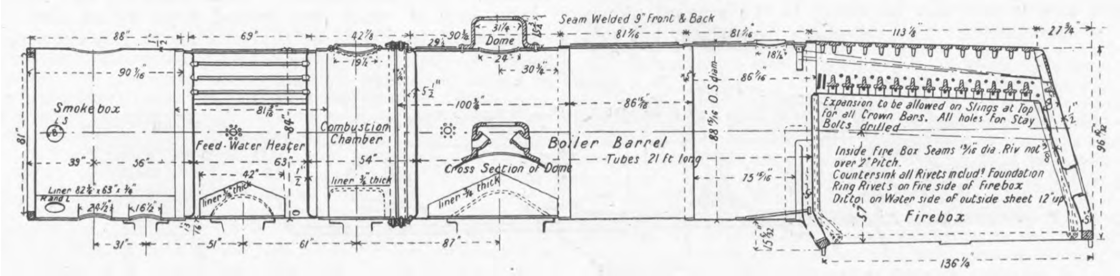
The total cost of discharging the cargo of the Pallion will not exceed £12, including the upkeep of the gear; and it is affirmed that the cost of discharging a similar cargo at, for instance, the port of Hamburg, is about £112, and that in the work no fewer than 110 men are employed for about eleven hours under favourable conditions. The Pallion has 1300 tons of water ballast carried in her double bottom and wing tanks, and the pumps are capable of discharging 300 tons per hour. There is a complete system of signal bells fitted throughout the tunnel at the various discharge doors, which enables the officer on deck to control the supply on either or both sides of the vessel. The vessel is fitted with an electric installation by the Sunderland Forge and Engineering Company, Limited. She is classed with the British Corporation Registry, Glasgow, and was built under the superintendence of Mr. G. Milne, of North Shields.

The advantages claimed by the inventors for this type of vessel would appear to be various. Harbour authorities will, it is urged, appreciate the accelerated despatch, as busy ports will be able to deal with a much larger import in a given area, and this will form an important factor as against the consideration of the probable increase of the harbour accommodation and facilities. Barge owners, again, will recognise the saving of time, and also the fact that the coal is delivered quietly from a reasonable height into the barge instead of being dropped in large grab loads as is frequently done. Coal merchants and consumers will reap an advantage, as there is no great fall, and, consequently, a minimum of breakage or loss of weight.

It should be here noted that the conveyors, whilst passing through the poop, are carried over two of Dennison's automatic weigh baulks, each of which give the actual weight of cargo delivered. The central tunnel in the hold, being under somewhat similar conditions to a mine, is electrically illuminated and fitted with a ventilating fan and upcast ventilator at the fore end, which is of such size as to form an access shaft to and from the deck. The tunnel also has free communication with the machinery space by means of a watertight door. A steamer such as the Pallion, is independent of shore labour, and so may avoid the frequent delays arising from labour troubles. The number of men required is so small, and the time occupied so short, that it would be a simple matter to agree with the crew of the vessel that they receive a fixed extra wage, and the discharge of the cargo become part of their ordinary duty. A liberal estimate of the cost of discharge, under such conditions, would not reach the sum of one penny per ton, and at this cost the cargo is also weighed.

A COMBINED LOCOMOTIVE BOILER AND FEED-WATER HEATER.

THE immense locomotives of the Mallet duplex compound system for the Southern Pacific Railway were described in THE ENGINEER of May 21st last, and reference was made to the fact that the boiler comprises both a combustion chamber and a feed-water heater. We are now enabled to give above a longitudinal section of this boiler.



"THE ENGINEER" SWAIN Sc

LOCOMOTIVE BOILER WITH FEED-WATER HEATER

The boiler has a total length, including fire-box and smoke-box, of 50ft. 3in., and it is 7ft. diameter in the barrel. The fire-box has a flat crown sheet carried by ⊥-shaped crown bars, which are suspended from brackets inside the arched shell of the outer fire-box by means of sling stays. The sides of both the inner and outer fire-box are flat and almost vertical. There are 27 cross-stays, $1\frac{5}{16}$in. in diameter; 987 screw stays, $\frac{7}{8}$in. and 1in. diameter; 298 Tate flexible 1in. stay bolts in the side sheets; 95 Tate stay bolts in the back head; and 44 in the throat. The fire-box is 10½ft. long and 6½ft. wide, with a sloping back head having a single fire door 13in. by 18in. The engine uses oil fuel.

The boiler barrel has first a 21ft. length filled with tubes in the usual way, at the end of which is a 4½ft. length forming a combustion chamber. Beyond this, again, is a length of 5¼ft., which forms the feed-water heater. This has tubes duplicating those of the main part of the barrel in size and number. The water is forced continuously into the heater by the injectors, and passes out by a pipe leading to the boiler check or feed valve. Beyond the feed-water heater portion of the boiler is the smoke-box; this is 8ft. long, and contains a superheater consisting of pipe coils against each side of the smoke-box shell.

The steam dome, with connections for outside steam pipes, is at the forward end of the barrel proper, about 3ft. back from the combustion chamber tube plate. A special dome for the safety valves and whistle is placed just forward of the fire-box tube plate. The combustion chamber has a manhole in the top.

Owing to the great length of the boiler it is made with a separable joint for convenience in making repairs. This, as shown, is at the combustion chamber. On the end of each section of the shell at this joint is riveted a heavy forged ring, the face of one being concave in V-shape to receive the convex V-shaped face of the other ring. This makes an annular dovetail. When the sections are put together with the ring joint entered and faired up, horizontal bolts are put through the rings parallel with the axis of the boiler.

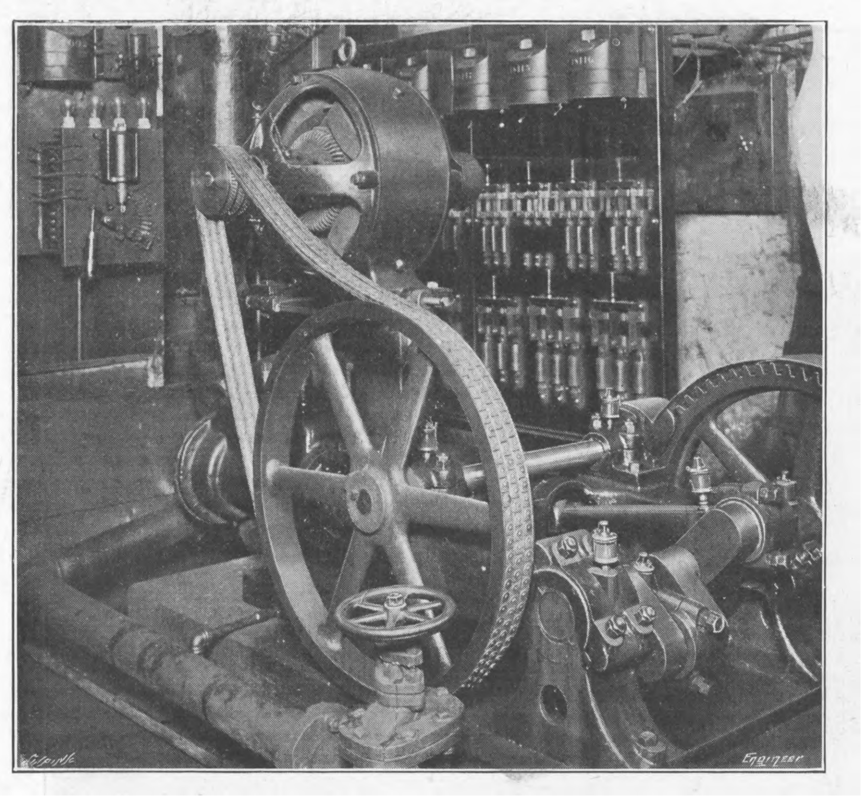
AMERICAN ENGINEERING NEWS.

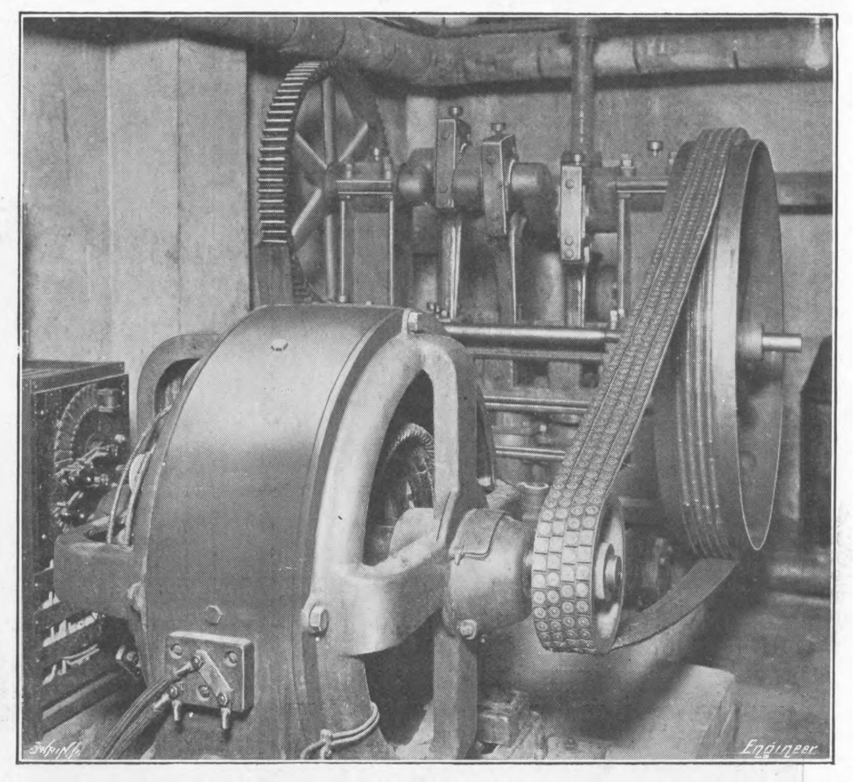
A waterworks filter plant.—A large number of American cities are treating their water supply by purification processes, and many others are building plants for this purpose. The city of Evansville, which built waterworks in 1872, is installing a filter plant with a capacity of 12 million gallons per day. The city's population is about 63,000. The water from the Ohio River is pumped to a channel across the ends of three coagulating basins, and fitted with hydraulically-operated gates for each of these basins. Two of the basins are 60ft. by 90ft., and the third is 30ft. by 90ft., the capacities being 1,000,000 gallons for each of the first and 500,000 gallons for the last. Their combined capacity equals five hours' total filtering capacity, but the basins may be operated singly or in combination to give periods of from one to five hours. The coagulants used are lime, iron sulphate, and hypochlorite of lime. From the basins the water is delivered to any of a set of twelve filters, which are concrete tanks, 14ft. by 22ft. At the bottom of each filter is a system of 2in. pipes with slotted-tube strainers tapped in at 6in. intervals. A bed of carefully selected gravel, graded in size, is laid so as to cover the strainers, and above this is a 30in. bed of filter sand. The water from the basins percolates downward through the sand and gravel to the strainers, and enters the pipe system, from which it is led to a clear-water basin having a capacity of 2,000,000 gallons. The rate of filtration of each filter is regulated by means of a controller fitted to the outlet. The filters are washed by an upward current of water or air pumped into the pipe system, the wash water overflowing into a conduit fitted with sand catchers. A building contains the pumping equipment, air compressors, machinery for mixing the chemical solutions, and a laboratory for making daily tests and analyses of the raw and treated water.

Land reclamation for park purposes.—The filling-in of low or submerged lands for park purposes is being

CHAIN-BELTS DRIVING PUMPS

PEERLESS V-BELT COMPANY, CHICAGO, ENGINEERS





carried out in some American cities. At Chicago a large hydraulic dredger is used to pump sand and clay into an area of submerged land enclosed by a masonry wall. At Omaha the Park Commission has recently purchased a hydraulic dredger for pumping sand from the Missouri River in order to reclaim a large area of lowlands. This work will continue for about five years. The dredger is designed to make a cut 100ft. wide and 24ft. deep, and has a capacity of 250 cubic yards per hour. The hull is 70ft. by 25ft., and 7ft. deep, built of Oregon fir. A 12in. centrifugal dredging pump, $7\frac{1}{2}$ft. diameter, directly connected to a marine engine having cylinders 14in. by 14in. and 22in. by 14in., is used. This engine is designed to run at 250 revolutions. Steam is supplied by a boiler of the semi-marine type, 21ft. long and 6ft. diameter, built for a working pressure of 125 lb. The ladder for the cutter and suction pipe is 30ft. long, built of steel, and hinged directly to the hull. Upon the ladder is mounted the engine which drives the 4in. cutter shaft by heavy cast steel gears. The cutters are of cast steel, 3ft. diameter and 3ft. long, built in sections and easily removable. The engines are run condensing, the vacuum being maintained by an independent jet condenser. The dredger is equipped with an electric lighting plant. The discharge pipe line is 12in. diameter and 2000ft. long, 800ft. being designed for floating. For the floating section the pontoons are 112ft. by 5ft., each supported by forty-eight oil barrels. The flexible pipe connections are 12in. diameter, 6ft. long, specially designed to withstand the abrasive effects of the materials dredged.

A NEW AMERICAN DRIVING BELT.

A NEW American driving belt for power transmission is a belt-chain formed of a combination of steel chain and rawhide belt. The chain transmits the power and eliminates trouble due to stretching. The rawhide forms a sheath or covering for the chain, furnishing the friction surface and giving a noiseless drive. The belt-chain is of V-section, running in grooved pulleys, any sufficient number of belts being used in each case according to the amount of power to be transmitted. The belt-chain runs slack, but gets a good friction hold in the pulleys due to the wedging action in the grooves, for which an angle of 28 deg. is used.

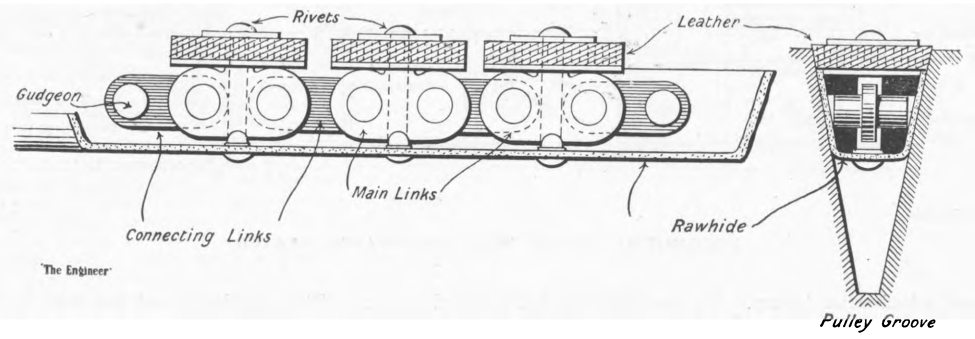


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Fig. 3—SECTION OF VEE CHAIN BELT

The construction of the chain-belt is shown in the drawing, Fig. 3. Each alternate link of the chain is composed of a pair of bevel-faced plates having holes drilled in the ends, and between them passes a rivet which serves also as a separator to prevent binding. The other connecting links are single plates having gudgeons at each end to fit into the holes in the side plates. A strip of flexible rawhide is secured to the bottom of the chain by the rivets, but the rivets grip it only against projections on the under sides of the plates, so that there is sufficient play between the ends of the links and the rawhide sheath to give proper flexibility and prevent wear, as the chain is bent in running to and from the pulleys. The rawhide is used on account of its high coefficient of friction, and its durability when not subject to tensile stress. This stress, of course, is all taken up by the chain. The strip of rawhide is of sufficient width to bend up against the sides of the chain, thus fitting the grooves of the pulley. On top of each double link is a leather block, having its sides bevelled to fit within the pulley grooves.

The links are of machine steel, drop forged and case hardened. The holes are drilled and the gudgeons turned to a close and true fit. Lubrication is required only at intervals of two or three months. This belt-chain is manufactured by the Peerless V-Belt Company, 219, South Clinton-street, Chicago. It is made in two sizes, $1\frac{1}{4}$in. and $\frac{7}{8}$in. wide.

The engravings—Figs. 1 and 2—show pumps driven from electric motors by these belt-chains. Fig. 1 shows a vertical triple-cylinder pump for boiler feed working against a pressure of 190 lb. It is driven by a 35 horse-power electric motor, with four belt-chains as the means of transmission. The pulleys are spaced 5ft. between centres, and the ratio of their diameters is about 1 to 5. The machine shown in in Fig. 2 is a horizontal duplex pump for the water supply service of an office building, and works against 100 lb. pressure. It is driven from a 15 horse-power motor, and the pulley centres are about 3ft. apart. This pump was originally driven from the motor by gearing, but the arrangement caused so much noise and vibration as to lead to complaints from the tenants. The belt-chain drive was then substituted, using three V-belts, and since then there has been no trouble.

Close spacing of centres is generally necessary in plants of this kind, where a large amount of machinery must be installed in the restricted space of a basement. This close spacing was the cause of trouble with pumps in another office building. A pump of the triplex type serves the passenger lifts and works against a pressure of 900 lb. It is driven from a 50 horse-power electric motor. The pulleys of the pump and motor are spaced 11ft. between centres, and the ratio of the pulley diameters is 1 to 10. Two sets of pulleys are used, and there were originally two 12in. flat belts, each of which was pressed down by an idler pulley equivalent to 230 lb. weight in order to give the necessary contact and friction. In spite of the use of these idlers there was so much slipping that a second pump was required, working intermittently to maintain the hydraulic pressure. Each 12in. belt has been replaced by four belt-chains, the pump fly-wheels being grooved, and grooved pulleys fitted to the motor shaft. These drive the pump without slipping, so that the pressure is maintained and the auxiliary pump has been disconnected. In addition to this, there is a saving of about 6 per cent. in electric power consumption.

The belt-chain has been used extensively for machinery driven from electric motors and gas or petrol engines. The applications include ventilating fans and blowers, pumps, coal conveyors, machine tools, refrigerating machines, air compressors, flour mill rollers, &c.

For the spacing of the driving and driven shafts with the belt-chain transmission it is recommended that the distance should be equal to the sum of the diameters of the pulleys for a ratio of 1 to 2 or 1 to 3 of the pulley diameters, and increasing with the ratio to the diameter of the larger pulley by four times that of the smaller pulley for a ratio of 1 to 10. Under these conditions the $\frac{7}{8}$in. belt-chain will need about 200 linear feet of contact per minute to transmit one indicated horse-power on pulleys of $4\frac{1}{2}$in. pitch diameter and over, while the $1\frac{1}{4}$in. belt-chain will require about 130 linear feet per minute for pulleys of 6in. and upwards. Where the spacing is shorter than that noted, of course the linear feet per horse-power must be increased. The maximum speed for the smaller belt-chain is about 3000 revolutions per minute, and the maximum travel about 6000ft. per minute. For the larger belt the maximum number of revolutions is about 2000 per minute and the maximum travel is about 4000ft. per minute.

LETTERS TO THE EDITOR.

(*We do not hold ourselves responsible for the opinions of our correspondents.*)

MARINE PROPULSION.

SIR,—In a previous letter I have shown that the conditions of marine propulsion are in one sense extremely simple—that, in a word, the energy expended or work done is measured in foot-pounds by the distance over which the force concerned acts. Thus, in the case of a paddle-wheel, the force exerted on the floats is precisely equal to the force exerted on the plummer blocks or their equivalent, but the force is exerted over a greater distance on the wheel than on the ship. The difference is slip, and is a dead but unavoidable loss. Not one of your correspondents has attempted to controvert the truth of this very obvious proposition.

Incidentally, a 12in. gun has been introduced. Sir George Greenhill, writing about this gun, gave the average gas pressure inside it as 6.25 tons per square inch. The muzzle energy of an 850 lb. projectile being 53,000 foot-tons, and the length of the bore 50ft., I showed in my letter that this must be wrong. Then Sir George writes to admit that I was right, and gives about 9 tons as the correct figure.

In last Friday's ENGINEER I find a letter from Mr. Ramsay, who first finds fault with me for saying that "Our faith in the very foundation of dynamics is shaken," and then proceeds to shake them, at all events for me, by a column of algebraical fireworks, which result in giving a gas pressure of 24 tons in the 12in. gun, and an average pressure of 12 tons. I may say here at once that nothing like 24 tons has ever been recorded in a modern gun, and I do not see how Sir G. Greenhill's figures are to be reconciled with Mr. Ramsay's. As a matter of plain fact all this algebra is entirely unnecessary. It is like using a steam hammer to break a butterfly. Mr. Ramsay has referred me to one book. May I be permitted to refer him to another, D. K. Clark's "Rules, Tables and Memoranda," pages 282-3-4, where he will find fourteen very simple equations dealing with every possible problem connected with force and motion.

But let us apply the simple principle which I have already recalled to the mind of your readers. We have in the case of the 12in. gun a muzzle velocity sufficient to give 53,000 foot-tons of energy to a projectile weighing 850 lb. With this weight we have, however, nothing to do. The velocity does not concern us. We only want to know what the average driving pressure behind the shot must be. That we get at once by dividing 53,000 by the distance over which the force moves I do not know what is the precise length of the chase of the gun; that is to say, of that part through which the projectile travels. I believe the total length of the gun is 51ft. 4in. The cartridge will take up about 8ft., leaving, say, 43ft. for the chase. We divide 53,000 by 43, and, get in round numbers, 1232 tons as the force which, moving over a distance of 43ft., represents 53,000 tons moving over 1ft. The area of a circle 12in. in diameter is 113 square inches, and $\frac{1232}{113} = 10.9$ tons as the average driving pressure, and 21.8 tons as the initial pressure.

Sir George Greenhill has taken the length of the chase as 50ft. The figures then stand $\frac{5300}{50} = 1060$, and $\frac{1060}{113} = 9.38$ tons average pressure. The initial pressure is double this, or 18.75 tons. The uncertain point is the precise length of the chase. It will be seen that no formulæ or anything beyond the simplest arithmetic is needed to determine, as far as calculation can, the pressures in the gun.

I am met, however, by a difficulty. Lieut. Dawson delivered the Gustave Canet lecture on "The Engineering of Ordnance" at the twenty-fifth anniversary meeting of the Junior Institution of Engineers on the 30th of June last, and in it he gives the maximum pressure in the bore of the 12in. gun as 18 tons. This figure is quite incompatible with a length of chase of 43ft. and a muzzle energy of 53,000 foot-tons. The explanation is, of course, that Sir George Greenhill and Mr. Ramsay are both wrong in assuming the initial pressure to be twice the average pressure. To assume that the average is half the initial is to postulate that there is no pressure at all in the gun at the muzzle, whereas, in point of fact, there is a very high one. I have followed Sir George Greenhill in his methods, and have taken the average as half the initial, but I think the time has come to call attention to the obvious error involved, which has not been discovered by Mr. Ramsay.

The range of pressures is determined by the rate at which the cordite burns, and the maximum is maintained for a considerable distance along the chase. Lieut. Dawson says, "In the old powders almost complete combustion of the explosive took place before the projectile had time to move far down the bore of the gun. High pressures were therefore set up in the chamber, necessitating a massive breech. As the pressure fell off rapidly the gun thinned down considerably toward the muzzle, and was comparatively short. For smokeless powders the guns are more uniform in outline to suit the more uniform distribution of pressure, and they are longer to enable the full effects to be obtained from the comparatively slow-burning explosive." All this may be beside the mark, but it is just as well that the facts should be stated. Mr. Ramsay is again wrong in giving the recoil of the gun as 0.3768ft. I do not know accurately what the recoil of the 12in. gun is, but a gun firing a 660 lb. projectile, and weighing 47 tons, recoils through a distance of 36in. in a quarter of a second with a maximum speed of 22ft. per second; a hydraulic buffer resisting recoil with a force of about 200 tons. The explosion lasts 75 ten thousandths of a second, the muzzle velocity is 2950ft. per second, and the energy in the projectile 47,000 foot-tons.

It is perhaps advisable to say that Mr. Ramsay has not in any way disputed the soundness of my views concerning the action of marine propellers.

Fuse.

August 24th.

Sir,—If Sir George Greenhill's ruling stands, that the work of action is not equal in all cases to the work of reaction, then it follows logically that work can be done without any action taking place. As:

Action = Reaction,
So Reaction = Action;
And Action = Work,
So that Reaction = Work − X,

where X represents an amount of work of action which has no counterpart in reaction.

In other words, according to "T. S. C.," work varies inversely as the masses, and, according to Newton, velocities generated by one force vary inversely as the masses acted on; then Work = Velocity. "T. S. C." knows what Euclid would say to that. As Sir G. Greenhill recommended us to consult "Mach's Mechanics," will you allow me to cite the following from page 198, &c.

"Perhaps the most important achievement of Newton with respect to the principles is the distinct and general formulation of the law of the equality of action and reaction, of pressure and counter-pressure. . . . . A body that presses or pulls another body is, according to Newton, pressed or pulled in exactly the same degree by that other body. Pressure and counter-pressure, force and counter-force, are always equal to each other. As the measure of force is defined by Newton to be the quantity of motion or momentum (mass × velocity) generated in a unit of time, it consequently follows that bodies that act on each other communicate to each other in equal intervals of time equal and opposite quantities of motion (momenta), or receive contrary velocities reciprocally proportional to their masses. . . . We know that we do not experience any resistance from a body until we seek to set it in motion. The more swiftly we endeavour to hurl a heavy stone from us the more our body is forced back by it."

What I maintain about marine propulsion is:—The more swiftly we endeavour to hurl a heavy mass of water from the propeller, paddle, or ship generally, the more the ship is forced the other way (as back is only relative to the other being forward) by it. Is Mach's interpretation of Newton wrong, or is it not possible that the prolific Professor Rankine overlooked the logical connections between his mathematics? The essence of Rankine's theorems amounts to "the pushing aft of a large amount of water without moving it." But, further, Mach:—"Pressure and counter-pressure go hand in hand. . . . There exist in the domain of statics very many instinctive perceptions that involve the equality of pressure and counter-pressure. The trivial experience that one cannot lift one's self by pulling on one's chair is of this character."

The endeavour, according to "Fuse," of a paddle wheel or screw propeller to do 80 per cent. to 90 per cent. of its work on the vessel to which it is rigidly attached, save rotation, is surely of the same character. Again, Mach, page 275:—"Two things, however, are confounded—the question of the measure of force and the question of the constancy of the sums $\Sigma\, m\, v$ and $\Sigma\, m\, v^2$. The two have in reality nothing to do with each other. With regard to the second question, the later investigations of Newton really proved that for free material systems not acted on by external forces the Cartesian sum $\Sigma\, m v$ is a constant, and the investigations of Huygens showed that also the sum $\Sigma\, m\, v^2$ is a constant, provided work performed by forces does not alter it."

So far Mach. Now Professor H. Hertz:—

Paragraph 511: "When a force acting on a system does a certain amount of work, the counterforce exerted by the system always does an equal and opposite amount of work."

Paragraph 683: "Proposition: An impulse and its counter-impulse are always equal and opposite—*i.e.*, their components along every co-ordinate are equal and opposite, whether we consider these quantities as vector quantities with regard to the one system or with regard to the other system.

"Every impulse which is exerted by or on a material system can be resolved into a series of elementary impulses."

Does this require further elucidation? If, when we choose to describe the result of any action as "work done," reaction does a different amount of work, wherein consists equality of action or reaction?

The difference in work of action and work of reaction can only be brought about by calling velocity work. Whereas work is the overcoming of, or the offering of resistance. These are, according to "T. S. C." my "wrong fallacious" premises, upon which no tenable theory of marine propulsion can be built. Seeing that with my opinions I am now in company with the late Sir W. Anderson, Professor H. Hertz, Dr. Aveling, and, as I imagine, that of Mach, Clerk Maxwell, and even Newton, I can rest content with "T. S. C.'s" denunciation. Does anyone really seriously object to that propeller being called the most efficient which will relative to the ship, with given energy, drive the whole ocean back quickest? My statement of greatest amount at greatest velocity back is really the same thing.

W. Preidel.

August 23rd.

AMERICAN TRAIN FERRIES, RAILS, AND PERMANENT WAY.

Sir,—In reference to the description of the interesting train-ferry steamer Drottning Victoria in The Engineer of July 30th, it may be of interest to note that while its journey is 65 miles, some of the American train ferries crossing Lake Michigan make journeys of 60 to 100 miles; they have to contend also with heavy storms and ice in the winter. These particular train-ferry steamers have a higher freeboard than the Drottning Victoria, the side plating being carried up to the deck which forms the roof over the train deck. The large boats, with four lines of rails, are 340ft. long, and carry thirty double-bogie goods wagons, averaging 35ft. to 40ft. over couplers. The train-ferry steamers crossing some of the straits connecting the Great Lakes have a low freeboard, the side plating extending only to the train deck, as they have not to encounter the heavy seas of an open stormy lake. One of these boats, with twin screws at each end, has three lines of rails, and can carry twenty-four long goods wagons, or twelve 70ft. passenger carriages. Some details of these American train ferries were given in The Engineer of March 23rd and April 6th, 1906.

In your leader on the treatment of rail steel—also in The Engineer of July 30th—you imply some doubt as to whether ingots are cropped in American rail-making practice. This cropping is universal, but for some years the engineers of the railways have contended that the amount is insufficient. The rail makers have to a great extent held aloof from discussion, and have contented themselves with their arbitrary power of doing as they pleased, the railways—as represented by the officers responsible for purchases—having in the main failed to support the demands of their own engineers for better rails and better rail specifications.

The question of cropping the ingots has been one of the actively fought points in all attempts by American technical societies to formulate standard specifications for rails. The so-called "manufacturers' specifications," adopted and followed by the rail makers, omit all reference to this, taking the position that the railway—or its engineer—needs to know nothing except the chemical and physical properties of the finished rail. The specifications of the American Railway Association require that "there shall be sheared from the end of the bloom formed from the top of the ingot 'sufficient' discard to ensure sound rails." The specifications of the American Railway Engineering and Maintenance of Way Association and those of the American Society of Civil Engineers say that "the shearing shall be not less than 25 per cent.," and shall be continued until the steel shows solid. The specifications of the American Society for Testing Materials leave the percentage blank, to be filled in according to agreement between the railway and the manufacturer. The reason for this is that the higher the percentage of cropping the greater will be the cost of the rails.

There has been vigorous discussion as to whether the specifications should require "sufficient" or a minimum definite percentage of cropping, and the weight of opinion appears to be in favour of the latter. Whatever specifications are adopted on the part of the railway, the great difficulty has been to ensure their observance by the manufacturers. The latter have entrenched themselves in the position that the railways have nothing to do with manufacture but are simply purchasers, and are, in fact, quite incompetent to say how rails should be made. There is no doubt that the manufacturers do know perfectly well how to make good rails, but the trouble is that they do not put their knowledge into practice. If rails break, it is due to some remarkable, mysterious, and quite undiscoverable cause, or else to the fault of the railway in operating heavy locomotives. Of course, some of the "big" railways enforce their own specifications to a greater or less extent, but most of them get their rails on the "take-'em-or-leave-'em" basis.

In your leader you refer to the spacing of sleepers as rail supports, and reduce this to the *reductio ad absurdum* of placing them too close to permit of proper packing of the ballast. But there is too wide a spacing as well too close a spacing, and it should not be so wide as to compel the rail to act as a girder supported on piers. It is very generally considered that the clear spacing should be not less than 10in., although where three closely-spaced sleepers are used under each rail joint, this is sometimes reduced to 5in. A few American railways, in districts where sleepers of varying width are furnished, specify a minimum number of inches of sleeper bearing for the rail, instead of an arbitrary number of sleepers.

For main lines with heavy traffic American railways use sixteen to eighteen sleepers per 30ft. rail, or eighteen to twenty sleepers for the 33ft. rail now in common use. The usual width is 8in., and the thickness 6in., but there is a strong tendency to increase the thickness to 7in. in order to give greater rigidity under modern loads. The 7in. thickness is used by many railways. Mr. Jacomb-Hood, in his paper for the International Railway Congress, suggests the advantages of flange rails over bull-head rails for heavy permanent way. Leaving this out of the question, and assuming the present chair road construction, the use of sleepers 8in. wide, 6in. or 7in. deep, and 8ft. long, spaced sixteen or eighteen to the rail, and well packed in good ballast, appears to offer a promising development in permanent way, and to relieve the rails from some excessive stresses to which they should not be subjected.

The rail is only one part of a permanent way structure, and should be relieved of its load by its supports. It is in the same position as the V's of a planing machine, serving to carry and guide the load, but well supported from beneath by a bed which rests upon the foundation. Apologies for the length of this letter.

Chicago. Railways.

PROPELLERS IN TUBES.

Sir,—My letter which appeared in your issue of June 11th, and to which Mr. Wadagaki takes exception, was not suggested by that gentleman's paper read at Liverpool, but by a letter from one of your correspondents, in which a proposal was made to put turbine propellers in tubes having an area of inlet very much smaller than the area of outlet. The letter referred to was illustrated by a sketch showing the form of tube proposed, and this sketch I reproduced in my letter.

Such a form could not possibly give good results for the reasons I gave.

With a Venturi tube of the form shown by Mr. Wadagaki in his letter in your issue of the 6th inst., in which the area of inlet is slightly larger than the area of outlet and the outside of the tube is made conical, we get a different condition of affairs.

There will be, as he says, an excess pressure on the outside of the tube, having a component in the direction of motion of the vessel, and such a tube would give a considerable thrust so long as it was not itself moving through the water; but I fear that the effect of the surface friction where it does so move would be the same as in the case of the stepped tube tried by Sir John Thornycroft, in which the friction outweighed the gain in propeller thrust.

Mr. Wadagaki is, however, quite justified in saying that this can best be judged by actual experiment. With his remarks on "cavitation," however, I cannot agree at all, and he would seem to have quite a different conception as to what "cavitation" means from that usually accepted. He says, "thus we have what is called 'cavitation,' and known as a serious cause of lost work with the common type of screw propeller, turned into a veritable boon in this system of propulsion."

Now I cannot conceive any circumstances under which "cavitation" can be anything but destructive to efficiency of propulsion.

Mr. Wadagaki objects to my statement that the limiting thrust per unit of area necessary to avoid "cavitation" would still be measured on the area of the propeller itself and not on the area of the discharge end of the tube, because, he says, the thrust on the propeller itself is not the total thrust in this particular system of propulsion, but only about two-thirds of it, and that therefore I am not justified in measuring its intensity by the area of the propeller alone. Now it must be remembered that with a tube shaped in the manner I was criticising, that is, with the largest area at the after end, the tube was actually pulling against the propeller and giving a negative thrust. With a tube of Mr. Wadagaki's form, I have already stated that the thrust shown by experiments made with the whole apparatus stationary is likely to disappear when the system is in motion; but if we admit that some effective thrust will be given by the tube, then undoubtedly the thrust to be measured on the propeller is less than the whole thrust, but the reduction in hydrostatic head at the neck of the tube where the propeller is situated causes "cavitation" to commence at a lower pressure per square inch of blade surface than if the tube were not there, and the result is the same. In fact, it is analogous to the case of a propeller working in a tunnel, the crown of which rises above the surface of the water. The limiting thrust to avoid "cavitation" is then reduced in proportion to the height to which the water is lifted in the tunnel, and, similarly, the limiting thrust which can be usefully applied per unit of blade surface of a propeller in the neck of a Venturi tube is reduced in proportion to the reduction of water pressure there.

Since writing my last letter I have read the article in your contemporary *Engineering* of April 30th, 1909, on Mr. Wadagaki's Newcastle paper, and I must say I am in complete agreement with the writer, who sums up by saying, "If the increased velocity at the neck of the tube could be obtained without reduction of hydrostatic head there would be something to be said for the idea but even then the energy would have to come from somewhere and to be paid for in some way or other. As we have already said, the idea is founded on a fallacy, though it is a very persistent one."

Southampton, August 17th. S. W. Barnaby.

LOCOMOTIVE CRANK AXLES.

Sir,—In the discussions at the recent meetings of the Institution of Mechanical Engineers at Liverpool, Mr. T. Hurry Riches suggested that results obtained from marine engines might be applied to locomotive work.

I am permitted to state that the Newburn Steel Works has supplied to several railway companies during the last five years a considerable number of built-up steel crank axles, some of which were designed to suit special requirements. Calculating these according to my communication in your issue of June 18th, page 637, on "The Diameter and Length of Bosses," to the formula (1),

$$\frac{D^4 - \delta^4}{D} = \frac{\delta^4}{l} \times \text{coefficient.}$$

Where D = outside diameter of boss;
δ = diameter of shaft in journal;
l = length of boss;

the resulting coefficients for these built-up crank axles range from 4.5, 4.8, 5.5 to 6.3. Since the coefficient 4.2 represents the average proportions prevailing among the webs of built-up steel marine crank shafts, where the thickness of the web generally is $= .66\,\delta$, the above resulting coefficients for built-up locomotive crank axles compare very satisfactorily, considering that the thickness of their webs is occasionally as low as $.43\,\delta$ and $.45\,\delta$, necessitating also an increased percentage of allowance for shrinkage.

I trust that these figures may be of interest to you, and to some who are taking advantage of the special benefit offered by built-up locomotive crank axles.

August 23rd.

R. A. Lewis,
Newburn Steel Works.

BRITISH LOCOMOTIVE PRACTICE OF TO-DAY.

Sir,—The article published in your last week's issue on "Simple *v.* Compound: A Footplate Experience," is very interesting, but somewhat misleading. Your contributor says he has been careful to obtain accurate figures, and I do not for one moment doubt their accuracy. However, any educated engineer will agree with me when I say that the tests cited by your contributor are by no means conclusive. It must be borne in mind that the compound had an advantage over the simple engine of no less than 40 lb. per square inch in steam pressure, besides the advantage of a larger fire-box. The value of the trials would have been enhanced if one of the newest simple 4-4-0 engines—999 class—had been selected. These engines, I believe, have boilers similar in all respects to those of the compounds. As a practical engineer, however, I contend that if locomotive trials are to be of any real value the engines to be tested must be on an absolute equality. Boilers should be of the same size and type, and worked at the same pressure. The engine wheels should be identical both as regards disposition and diameter. The cylinders also should be equal in number. Mr. Deeley would probably think it not worth while to alter one of his existing compounds into a three-cylinder simple engine; but it is interesting to note that Mr. J. G. Robinson has so altered one of his 4-4-2 express engines on the Great Central Railway, with, I understand, distinctly favourable results. Only under the above conditions can any test be considered satisfactory.

Birmingham, August 21st. Chas. W. Dauncey.

SAND IN CONCRETE.

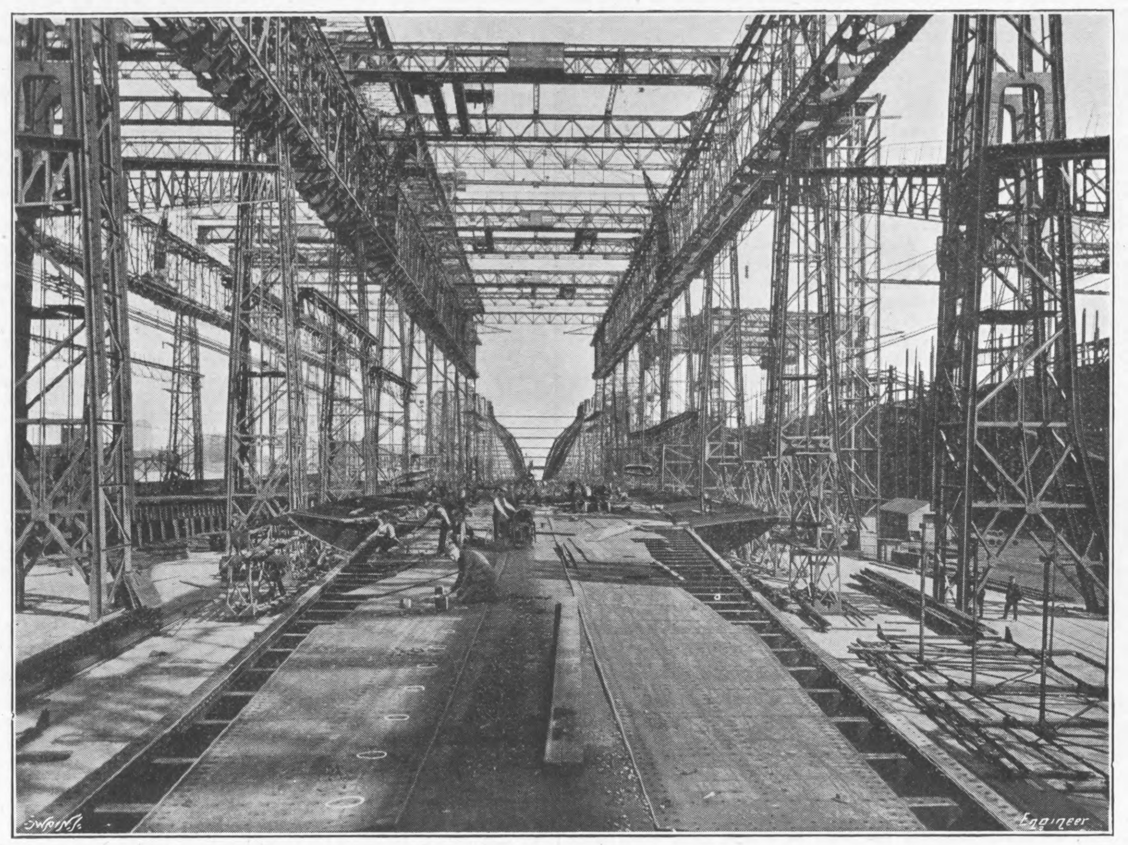
Sir,—With reference to your article in this week's issue of The Engineer on the above subject, seventeen or eighteen years ago I had occasion to make a number of experiments on the strength of concrete beams and arch ribs, the results of which were communicated to the Institution of Civil Engineers, and were published in the "Proceedings," vols. cxiii. and cxviii. The conclusions I then arrived at were:—(1) That a very small admixture of clay had a most detrimental effect, as it appeared to prevent the cement from adhering to the sand at all; (2) that pit sand was inferior to sand made by crushing sandstone; but (3) that the best results were obtained from an admixture of crushed sandstone and whinstone dust from the stone breakers, the last providing the greatest variety of size of grain, and therefore forming the denser mortar. I have in the course of my experience been occasionally unable to obtain sand free from dust, and no harm has apparently resulted from its use; but it has been dust of a gritty nature, not clay. Where dirt has a distinctly deleterious effect is where it envelops the particles of sand in a soapy film. In my opinion dirty sand should always be regarded with suspicion, and if circumstances render it impossible to wash it, it should certainly not be used without being first tested with cement.

Ealing, August 21st. A. Fairlie Bruce, M. Inst. C.E.

Sewers at Salt Lake City, states an American contemporary, are flushed by automatic flush tanks which discharge 280 gals. of water during each cycle of operations. The tanks are the Miller-Potter type, and are situated at various points along a sewerage system 106 miles in length, which is divided into a number of districts. An attendant starts at the beginning of one district, and proceeds along the line to its end, turning on the water at each of the tanks which he passes. When he has put the last tank of the district into action he returns to the starting point and shuts off the water successively in each tank, until he again reaches the end of the district. During the interval which elapses between the turning on of the water at any point and the closing of the valve after the attendant has completed the circuit of the district, each flush tank has had time to fill and discharge several times. This method is said to be economical, and effective in maintaining the entire system in a clean and satisfactory condition.

WHITE STAR LINER OLYMPIC UNDER CONSTRUCTION

HARLAND AND WOLFF, LIMITED, BELFAST, BUILDERS



THE WHITE STAR LINERS OLYMPIC AND TITANIC.

In the building of a modern liner there are well-defined steps in the construction besides the five familiar stages of the laying of the keel, framing, plating, launching, and completion. These are the terms used to denote the main operations, but in the larger and more complicated structures of the present day there are many intermediate stages that have an interest of their own, and afford an indication of the progress of the work. This, of course, is especially the case in such gigantic vessels as the new White Star liners Olympic and Titanic, now under construction at Belfast, and the reports that have already appeared describing one of these intermediate stages—viz., the construction of the cellular double bottom—have dealt with a number of interesting points regarding the keel, centre-plate (or inner vertical keel), floors, and other parts forming this portion of the ship, special attention having been directed to the large amount of hydraulic riveting and the appliances for carrying out this work.

The double bottom—which in these vessels is more extensive than usual, being carried round the bilge—as is well known, serves several purposes. It provides space for water ballast, which, being so far down in the ship, has an important influence on the stability, in that the latter can by its means be regulated as desired under certain conditions. Then, while contributing greatly to the strength of the whole structure, it forms an important element of safety in the event of the vessel grounding at any time, the ship, in fact, having, as the term implies, a double bottom.

It will be seen from the accompanying reproductions of photographs taken on July 30th, little more than six months after the laying of the keel, that the tank top plating is now well advanced, and that the next important stage is being proceeded with—viz., the main framing of the vessel. These frames form the ribs of the ship, and it will be observed that numbers of the Olympic's ribs have already been set up near the after end. It is expected that the stern frame will be placed in position shortly, when the progress of construction will be even more apparent than it is now.

TESTING CONDENSERS FOR LEAKAGES.

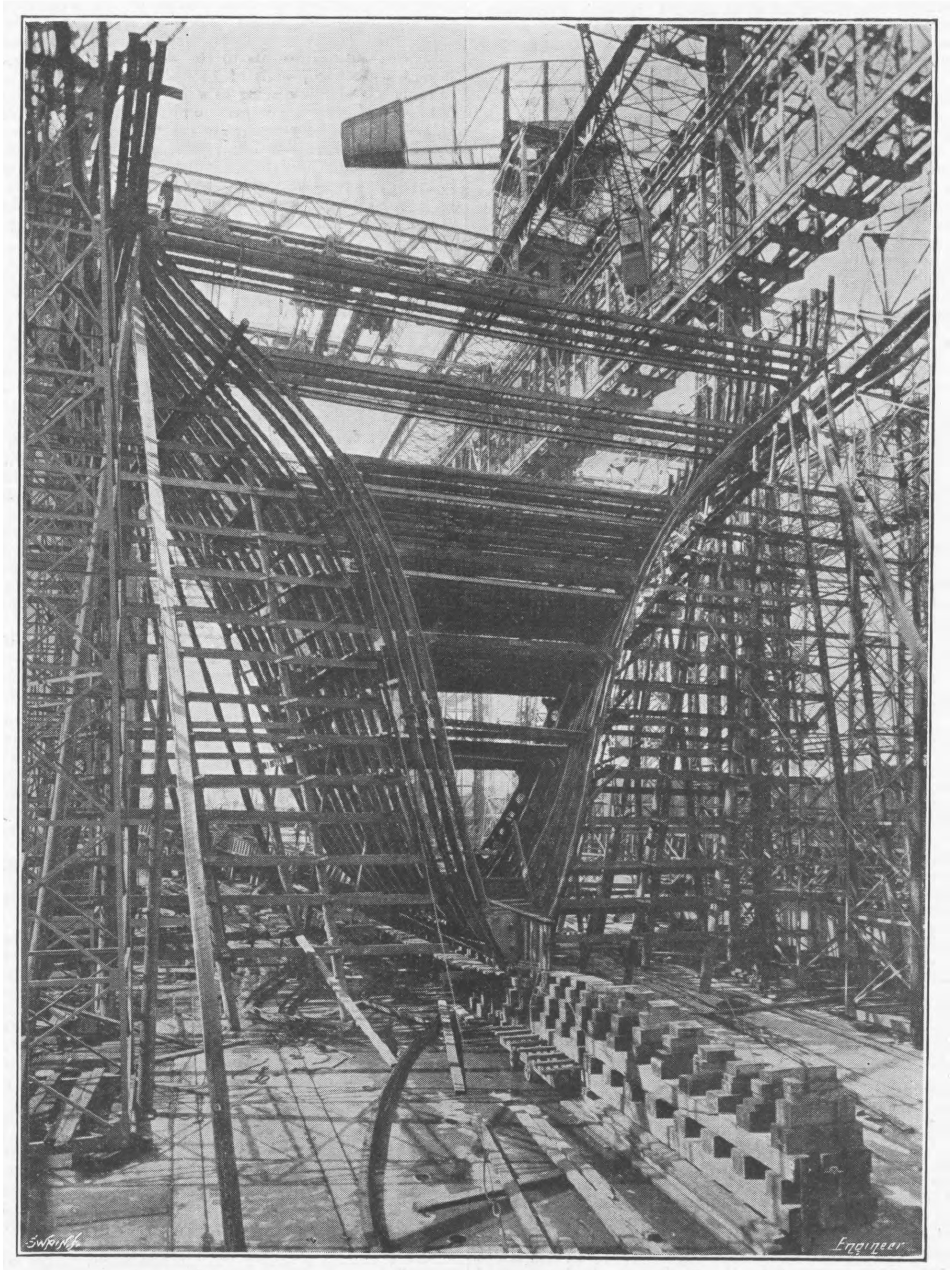
(*By a Correspondent.*)

In view of the fact that the number of condensing plants—chiefly surface condensers—yearly installed is rapidly increasing, also seeing the keen competition that is constantly going on between engine builders with regard to water consumption or pounds of water per B.H.P on the various engines, these tests are often carried to the third decimal place when speaking of pounds of water per B.H.P. or E.H.P., as the case may be.

If this minute estimation is likely to continue, I think it high time we had it more widely known how simple yet very reliable tests can be made for leaky condensers. The maker's usual practice is to put a light water pressure first on the cooling-surface side and afterwards on the condensed-water side, at the same time carefully looking out for any water trickling through.

The station engineer, if doubtful, will run the condensing plant for several hours with only the circulating water going through the cooling surface, and carefully note if any condensed water is thrown up by the pump. Both of these methods for ordinary working conditions may suffice, but for a close competitive test they would not be, to my mind, sufficiently accurate, because I have known the behaviour of leakages to be very different when both waters are going through than when only one. My contention is that a condenser, like any other machine, should be tested under its full-load working conditions, and, so far as I know, there is no mechanical means of doing this; it is purely one for chemistry, and personally I consider the silver-nitrate test for chlorine or chloride to be the most suitable.

Even in the hands of an amateur it is possible to trace salt in water, although it may be only one part to one hundred thousand parts. Therefore the leakage, however slight, is quickly disclosed by the test mentioned.



S.S. OLYMPIC—VIEW FROM COFFERDAM SHOWING FRAMES, ETC.

The water frequently used for cooling purposes is that generally known as surface water, drawn from rivers, canals, &c., and such is always found to contain—among other things—sodium chloride or common salt in variable quantities. This, together with the fact that condensed water should never contain sodium salts, enables one to make a very reliable test for any leakages in a condenser. To carry out the test we shall require a standard solution of silver nitrate, which can be purchased from any qualified chemist, or for those who care to make it themselves, the particulars are as follows:—Dissolve 2.394 grammes of pure re-crystallised silver nitrate in distilled water and make solution up to one litre. We shall also require a solution of potassium chromate made by dissolving potassium chromate in distilled water—one part chromate, ten parts by weight of water. This potassium chromate solution is used as a colour indicator. The principle upon which the indicator depends is, that silver combines with chlorine in preference to chromic acid, and that accordingly no red chromate of silver is capable of being formed so long as chlorides are in the water, but that red chromate of silver instantly forms the moment nitrate of silver is in the slightest excess. Therefore, if we take a sample of water known to contain chlorine salts and into this drop, spot by spot, the silver nitrate solution, a white precipitate of chloride of silver will form, and continue to do so, until all the chlorine in the water has been precipitated. But as will be seen upon making the experiment, there is a difficulty in observing the exact point at which the formation of the precipitate ceases; this difficulty is overcome by the use of the colour indicator potassium chromate.

The details of analysis are as follows:—Measure out carefully 50 cubic centimetres of the condensed water, which should then be passed through a filter paper into a clean porcelain dish. To this add about half-a-dozen spots of the colour indicator, potassium chromate, at the same time stirring with a glass rod, the colour of water then will be distinctly yellow; this being so, the silver nitrate solution, which should be contained in a properly graduated burette, is carefully dropped spot, by spot, into the water, which should be constantly stirred the whole of the time. As will be observed, the first few spots will become red instantly they touch water, and die away to a pale yellow on stirring, that is if sodium chlorides are present. The dropping in of silver nitrate solution should be continued, also the stirring, until the water becomes permanently red. The very earliest point at which the chromate of silver begins to form, or the redness becomes persistent, the addition of silver solution should be stopped, and the amount used read off from the graduated burette; from this we can ascertain the quantity of salt present in the water. One cubic centimetre of silver nitrate solution practically corresponds to one grain of salt per gallon of water. If, on adding the first one or two spots of silver nitrate solution, the condensed water—which had previously been coloured by indicator—becomes permanently red, it is quite certain that there is little or no salt in water, consequently the condenser might be considered quite bottle-tight. If, on the other hand, it requires several cubic centimetres of silver nitrate solution to bring about a permanent red colour, then the condenser is certainly leaking, to what extent may be judged by the quantity of salt found to be present.

THE BRITISH ASSOCIATION: SECTION G—ENGINEERING.

Address by Sir W. H. White, K.C.B., Sc.D., LL.D., F.R.S., President of the Section.

On the present occasion, when the meetings of the British Association for the Advancement of Science are held in the heart of this great dominion, it is natural that the proceedings of Section G (Engineering) should be largely concerned with the consideration of great engineering enterprises by means of which the resources of Canada have been and are being developed and the needs of its rapidly increasing population met. It will not be inappropriate, therefore, if the Presidential Address is mainly devoted to an illustration of the close connection which exists between the work of civil engineers and the foundation as well as the development of British Colonies and dominions beyond the seas.

British Colonies and Possessions have started from the sea front and have gradually pushed inland. Apart from maritime enterprise, therefore, and the possession of shipping, the British Empire could never have been created. An old English toast, once familiar, but which has of late years unfortunately fallen into comparative desuetude, wished success to "Ships, Colonies and Commerce." A great truth lies behind the phrase: these three interests are interdependent, and their prosperity means much for both the Mother Country and its offspring. As colonies have been multiplied, their resources developed, and their populations increased, over-sea commerce between them and the Mother Country has been enlarged; greater demands have been made upon shipping for the over-sea transport of passengers, produce and manufactures; there has been a growing necessity for free and uninterrupted communication between wildly scattered portions of the Empire, the maintenance of which has depended primarily and still depends on the possession of a supreme war fleet, under whose protection peaceful operations of the mercantile marine can proceed in safety, unchecked by foreign interference, but ever ready to meet foreign competition.

Now that our Colonies have become the homes of new nations it is as true as ever that the maintenance of British supremacy at sea in both the mercantile marine and the war fleet is essential to the continued existence and prosperity of the Empire. The trackless ocean supplies the cheapest and most convenient means of transport and intercommunication; continuous improvements in shipbuilding and marine engineering have abridged distances and given to sea passages a regularity and certainty formerly unknown. It is a literal fact that in the British Empire the "seas but join the nations they divide." Every triumph of engineering draws closer the links which bind together its several parts. Greater facilities for frequent and rapid interchange of information of what is happening in all sections of the Empire, and of knowing each other better, should lead, and has led, to increased sympathy, and a fuller realisation of common interest in all that affects the well-being of the Empire. Within the last few years the events of the Boer War have given remarkable proofs of the practical interest of the Colonies in Imperial concerns, and their readiness to share its burdens. The present year will always be remembered as that in which generous offers of assistance from the Colonies in the task of strengthening the Royal Navy at a critical period have led to a conference whose labours should produce important practical results, and make our future secure. Organised co-operation between the Mother Country and the Dominions beyond the seas in the maintenance of an Imperial Navy adequate for the protection of vital interests is essential to that security, and at last there is a prospect that this end will be attained.

While claiming for the shipbuilder and marine engineer an important place in the creation and maintenance of the Empire, it is recognised that the work of other branches of civil engineering has been equally important. The profession of the civil engineer was described in the Charter granted to the parent Institution in 1828 as "the art of directing the Great Sources of Power in Nature for the use and convenience of man; as the means of production and of traffic in states both for internal and external trade, as applied in the construction of roads, bridges, aqueducts, canals, river navigation, and docks, for internal intercourse and exchange; and in the construction of ports, harbours, moles, breakwaters, and lighthouses; and in the art of navigation by artificial power for the purposes of commerce; and in the construction and adaptation of machinery, and in the drainage of cities and towns." Since this description was penned there have been great and unforeseen developments in many directions, including those relating to improvements in the use of steam, the generation and practical applications of electrical power, the manufacture and extended employment of steel. The main ideas expressed eighty years ago, however, still remain applicable to the beneficent work of the civil engineer. His skill and enterprise, backed by adequate financial provision, are continuously being applied to improve and extend means of production, internal and external means of communication, inland and over-sea navigation, the use of mechanical power and appliances, the acceleration and cheapening of transport, the development and utilisation of natural resources, and the direction of the sources of power in Nature for the use and convenience of man. One of the chief fields of engineering operations at the present time is to be found in the Dominion of Canada, whose governing authorities have appreciated the fact that bold enterprise and generous financial provision for the execution of great engineering works are essential to the progress and prosperity of the country. Its vast extent, its magnificent lakes and rivers, its agricultural and mineral riches, its forests, its unrivalled water power, and many other potential sources of future wealth and progress, furnish exceptional incentives and opportunities to the engineer. From an early period in the history of Canada this fact has been realised, and attempts have been made to utilise natural advantages; while the same policy has been energetically adopted since the Dominion was established forty-two years ago. It is impossible in this Address even to enumerate the great engineering works which have been accomplished or are in process of execution; and it might be thought impertinent if the attempt were made by one who has only an outside knowledge of the facts. On the other hand, it may be of interest to illustrate by means of Canadian examples the truth of the general statement that civil engineering has exercised and must continue to exercise great influence upon the well-being and development of the British Empire.

By the kindness of the High Commissioner of Canada, Lord Strathcona—who has himself done so much for the development of the Dominion, including a great part in the construction of the Canadian Pacific Railway—the writer has been favoured with official reports and statistics bearing on the subject. These have been freely used in the statement which follows.

The subject is so extensive, and the time available for this address so short, that it will be necessary to omit detailed reference to important applications of engineering which are necessarily made, under modern conditions, in all great centres of population. Amongst these may be mentioned building construction, sanitation, water supply, heating, lighting, telegraphy, telephony, tramways, electric generating stations and their plant, and gas manufacture. No attempt will be made to deal with the important assistance given by engineers to the operations of agriculture, mining, and manufacture, or to the utilisation of the splendid forests of the Dominion, although the demands for machinery and mechanical power is, in these respects, exceptionally great, owing to the sparseness of the population and the magnitude of the work to be done. Notwithstanding the large immigration and rapid increase of population, these demands will certainly continue, and will probably become greater as the area under cultivation is increased, as manufactures are developed, and the natural resources of the country more largely utilised. The example of the United States places this anticipation beyond doubt, and demonstrates the great part which the engineer must continue to play in the development of Canada.

Even when the limitations described have been imposed upon the scope of this address, the field to be traversed is a wide one, and, without further preface, an endeavour will be made to describe a few of the most important services which the engineer has already rendered to the Dominion and will render in the immediate future.

Railways.

It has well been said that the great problem of to-day in Canada is that of providing ample and cheap transport for her agricultural, mineral, and forest products from the interior to the sea, and so to the markets of the world. Important as inland navigation may be as an aid to this enterprise, it cannot possibly compare with railway development in actual and potential results. Apart from that development, the one united Dominion must have remained a dream. Thanks to the rapid and efficient intercommunication furnished by railways, widely scattered provinces are knit together in friendly and helpful union literally by "bonds of steel," which stretch from the Atlantic to the Pacific, and reach farther and farther north each year. Regions which would otherwise have remained inaccessible and unproductive have been turned into new provinces, whose fertility and future development it is not easy to forecast, and practically impossible to exaggerate.

In this department successive Administrations, both Federal and provincial, have realised the facts and possibilities of the position, and have given substantial assistance to private enterprise in the execution of great engineering works. Progress in railway development has been remarkable since Federation was accomplished forty-two years ago. During the preceding thirty years the total railway mileage in operation had been raised to 2278 miles; in 1887 it was 12,184 miles; in 1897, 16,550 miles; in 1907, 22,452 miles. The number of miles of railway actually under construction in 1907 was officially estimated at 3000, exclusive of lines projected but not yet under contract. In 1906, when the lines in operation were 21,353, it was estimated by competent authorities that the railways under construction, and projects for extensions likely to be carried into effect in the immediate future, reached a total of at least 10,000 miles, while probable further extensions of about 3500 miles were under consideration. Further, it was estimated that the capital expenditure required to complete these schemes would be about 60 millions sterling. These figures may need amendment, but there are others representing ascertained facts which equally well illustrate the magnitude of the railway interests of the Dominion.* The total capital invested in Canadian railways in 1907 was officially reported to be about £234,390,000; the aid given to railways up to that date by Dominion and Provincial Governments, and by municipalities, considerably exceeded £36,000,000 sterling in money; the land grants from the Dominion Government approached 32 million acres, while the Provincial Governments of Quebec, British Columbia, New Brunswick, and Nova Scotia had granted about 20½ million acres. The Governments have also guaranteed the bonds of railway companies to the extent of many millions of dollars. The capitalisation per mile of railway lines owned by the Governments—amounting to 1890 miles—is reported as being £11,400; this is practically the same amount as that for Indian railways, that for the United States being £13,600, and for New South Wales and Victoria about £12,600. For British railways the figure given is £54,700 per mile. The freight carried by Canadian railways in 1907 amounted to nearly 63,900,000 tons—of 2000lb.—which included about 14,000,000 tons of coal and coke, nearly 4,500,000 tons of ores and minerals, 10,250,000 tons of lumber and other forest products, nearly 7,900,000 tons of manufactures, and 2,309,000 tons of merchandise. In 1875, when 4800 miles of railway were in operation, the corresponding freight-tonnage was 5,670,000 tons; so that while the length of railway increased nearly 4.7 times, the tonnage increased nearly 11.3 times. During the same period passengers increased from 5,190,000 to 32,137,000. For twenty-eight railways making returns the average revenue per passenger per mile was 2.232 cents, and for the four principal railways it was 2.07 cents. For freight fifty-nine railways showed an average rate of 2.328 cents per ton-mile; and for the five principal railways it was .702 cent per ton-mile. The average distance travelled by a passenger was 64 miles, the corresponding figure for the United States being 30.3 miles. The average distance a ton of freight was hauled was 183 miles, as against 152 miles for the United States. In Canada, as the official reporter remarks, there is a small amount of suburban railway traffic and a low density of population. The following table is taken from the official Canadian Railway Statistics for 1907:—

	For each mile of railway.	
	Population.	Square miles of territory.
United States	381	13.61
United Kingdom	1,821	5.29
France	1,590	8.46
New South Wales	686	146.09
New Zealand	358	43.42
Victoria	360	25.89
India	10,119	61.09
Canada	289	161.8

Canada has, therefore, the highest mileage measured against population and the lowest against territory.

The earliest great railway system of Canada, the Grand Trunk, had its beginnings in 1845; in 1907 it was working about 3600 miles within the Dominion. In association with the Government it is now engaged on the construction of the Grand Trunk Pacific Line, which will cross the continent wholly in Canadian territory, and have a length of 3600 miles, exclusive of branches.

The story of the Canadian Pacific Railway is well known, and need not be repeated; the influence which its existence and working have had upon the prosperity of the Dominion has been enormous and beneficial since its opening in 1885, and experience of its effect has led to the promotion of other trans-continental lines. In June, 1907, the total length in operation was nearly 9000 miles, and the company owned in addition great lines of steamships employed on Atlantic and Pacific services.

The Canadian Northern Railway system represents one of the most striking examples of recent railway development in the Dominion. In 1907 it was working nearly 2600 miles in the North-Western provinces, about 150 miles in Ontario, 500 miles in the Province of Quebec, and 430 miles in Nova Scotia and Cape Breton, making a total of nearly 3700 miles. In 1908 its mileage on the main system was reported to have increased to nearly 3400 miles, and the total length in operation had become 4800 miles. The North-Western Provinces have given substantial assistance to this great system, and its promoters are said to aim at a complete trans-continental route, as well as the development of railway communication to Hudson's Bay and the establishment of a line of steamships therefrom to Great Britain.

Besides these three great railway organisations, which in 1907 controlled about 75 per cent. of the mileage in operation, there are a large number of smaller companies, making up a total of about 80. Their total earnings in 1907 amounted to £29,350,000, the total working expenses being £20,750,000. Earnings from freight service were (in round figures) £19,000,000; from passenger service, £7,837,000; from express services, £655,000; from mails, £325,000, the balance coming from miscellaneous items. The total number of persons employed by the railways was 124,000; their salaries and wages amounted to £11,750,000. It was officially estimated that if to the railway employés were added persons employed in factories for rolling stock and railway materials, as well as those engaged in the casual service and shipping, with an allowance for their families, "quite 25 per cent. of the population win their daily bread from the carrying trade" of the Dominion.

The equipment of the Canadian railways in 1907 included 3504 locomotives, 3642 passenger cars, and 113,514 freight cars. In the opinion of the official reporter on railway statistics, based chiefly on a comparison of the proportion of rolling stock to mileage in Canada and the United States, a considerable increase of rolling stock is required, and there is a possibility of greater efficiency being obtained in the utilisation of existing freight cars. The manufacturing resources of the Dominion are declared to be fully capable of meeting all requirements, as in 1907 they produced 227 locomotives, 397 passenger cars, and 13,350 freight cars. A reduction of grades and curvatures has been carried out on the principal railways in recent years, and this has permitted the hauling of heavier loads. It is estimated that in 1907 the average earnings per ton of freight hauled were 1.472 dols., and the average earnings per passenger carried were 1.219 dols. The earnings per train mile were 1.953 dols., and the working expenses 1.381 dols. The total earnings per mile of railway were 6535.64 dols., and the working expenses were 4620.9 dols. The working expenses were divided as follows in the official report:—

Maintenance of way and structures	20.13 per cent.
„ equipment	20.88 „
Conducting transportation	55.25 „
General expenses	3.74 „

Allowing two cords of wood fuel to be equal to one ton, 5,609,000 tons of fuel—of which 5,578,000 tons were coal—were consumed by Canadian railway locomotives in 1907 in running 100,155,000 miles. The total cost was about £3,027,500, equal to 14.59 per cent. of the working expenses.

From this brief summary of facts some idea may be gained of the rapid development of Canadian railways, their immense capital value and traffic, and the remarkable influence they have had upon the progress and population of the Dominion. It is a matter for satisfaction that British capital and engineering skill have contributed in no small measure to produce this development, and it may be hoped that in the future they may render even greater service.

Inland Navigation.

The most important system of inland navigation which Canada possesses is primarily due to the existence of the Great Lakes and the St. Lawrence River; but the utilisation of these natural advantages and the construction of a continuous navigable channel from the sea to the head of Lake Superior is due to the work of engineers. The importance of such a navigable waterway leading to the heart of the Dominion was recognised long ago by the Government. The first canal is said to have been opened in 1821, and from that time onwards the canal system has been developed, but the greatest progress has been made during the last forty years under successive Administrations. Up to March 31st, 1907, the capital expenditure on Canadian canals, exclusive of outlay by the Imperial Government, has approached £18,350,000 sterling, of which more than ten millions have been spent on enlargements. Besides minor canal systems, many of which are important, a great "trunk system" of water transit has been created from Montreal to Port Arthur, at the head of Lake Superior, this all-water route being nearly 1300 miles in length, having a minimum depth of water of 14ft. and effecting a total vertical rise of about 600ft. from tidal water in the St. Lawrence to Lake Superior. In order to effect this rise forty-nine locks are provided, most of which are 270ft. long and 45ft. wide, enabling vessels 255ft. long to be accommodated. Out of the total length of more than 1200 miles only 73½ miles consist of artificial channels. The Welland Canal, connecting Lakes Erie and Ontario—with a total rise from lake to lake of 327ft., effected in twenty-five locks—is 26¾ miles long. This canal dates from 1824; its enlargement to present dimensions was begun in 1872, and occupied fifteen years; the total expenditure on the canal has been nearly five and a-half millions sterling. Another important section of the waterway is the Sault Ste. Marie Canal—about 6000ft. in length and from 142ft. to 150ft. wide between the pier ends, with a lock 900ft. long, 60ft. wide, having 20¼ft. of water over the sills. The difference of level between Lakes Superior and Huron is 18ft. Commenced in 1888, the Sault Ste. Marie Canal was opened for traffic in 1895, the cost being about £930,000. Like its predecessor on the United States side of St. Mary's River—the so-called "Soo" Canal affords free passage for the ships of both countries. In 1898 about two and three-quarter millions represented the tonnage of vessels passing through the Canadian Canal, and of this total about 403,000 tons was in Canadian vessels. In 1907 the total tonnage had risen to 12,176,000 tons, of which 2,288,000 was in Canadian vessels. The Soulanges Canal is 14 miles long, with a rise of 84ft., effected in four locks. Commenced in 1892, it was opened for traffic in 1899, and cost nearly £1,400,000. The Lachine Canal was commenced in 1821, enlarged in 1843 and 1873, and, as completed in 1901, is 8½ miles long, has 45ft. rise, effected in five locks, and has cost from first to last about £2,300,000.

In the construction of this great waterway many difficult engineering problems have been solved, and every modern improvement has been introduced; electricity has been utilised in its equipment, both for power and lighting, so that navigation can proceed by night as well as by day. For the years 1903-7 the canals were declared free of tolls, but it is estimated officially that if tolls on the ordinary scale had been collected, the revenue for 1907 would have exceeded £91,000. In these five years the water-borne traffic of the Dominion increased from 9,204,000 tons in 1903 to 20,544,000 tons in 1907; in the same period the increase in Canadian railway traffic was from 47,373,000 tons to 63,866,000 tons. The official reporter justly remarks that "these results are exceedingly encouraging."

It was recognised long ago that the utilisation of the waterways of Canada from the Great Lakes to the sea would yield considerable advantages by facilitating cheap transport of agricultural products of the fertile regions from the great North-West, but the Canadian portions of that territory were then regarded as "a great lone land." Subsequent developments of the corn-growing regions of Canada have emphasised the value of the water route and its great potentialities. In his "History of Merchant Shipping" (published 1876), Lindsay dwelt upon this point, and foresaw that if the waterways of Canada were made continuously navigable, a struggle for supremacy in over-sea trade must arise between New York and the Canadian ports of Montreal and Quebec. The struggle is now in full force, so far as the grain trade is concerned, and it is likely to grow keener. The quantity of grain passed down the whole length of the St. Lawrence navigation to Montreal increased from about 450,000 tons in 1906 to 685,000 tons in 1907, while the quantity carried to Montreal by the Canadian Pacific Railway was about 387,000 tons for 1906 and 384,000 tons for 1907. On the other hand, the quantity carried by canals in the United States to New York fell from 294,500 tons in 1906 to 230,800 tons in 1907.

An important addition to the Canadian canal system has been proposed, and its execution will probably be undertaken when great works now in progress have been completed. This route extends from Georgian Bay on Lake Huron to the St. Lawrence, and would utilise Lake Nipissing as well as the French and Ottawa rivers. The distance to be traversed would be 450 miles, less than that of the present all-water route. On the basis of careful surveys it has been estimtaed that a canal having 20ft. depth of water could be constructed at a cost of twelve millions sterling, upon which capital a reasonable dividend could be paid, even if the charges made for transport were one-third less than the lowest rates of freight possible on the United States routes to New York. It would, of course, be most advantageous to have the available depth of water increased from 14ft. to 20ft., thus making possible the employment of larger and deeper draught vessels between the Lakes and Montreal. Considerable economies in the ratio of working expenses to freight earnings would be effected, break of bulk in transit to the sea would be avoided, and the cost of transport greatly reduced.

The magnitude of the grain trade and its growth may be illustrated by the following figures for recent years:—In 1897 the grain cargoes passed down the Welland Canal to the ports of Kingston and Prescott numbered 377 and represented 515,000 tons; for 1907 the corresponding figures were 518 cargoes, weighing 841,000 tons. As to the elevators and mechanical appliances for handling economically these huge quantities of grain, nothing can be said here, although they involve the solution of many difficult engineering problems, and have been greatly simplified and improved as experience has been gained.

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* Most of these statistics are taken from the valuable Report for 1907, presented to the Minister of Railways and Canals by Mr. Butler, Deputy Minister, and Chief Engineer of the Department.

The bulk of the canal traffic, of course, moves eastwards and outwards from the interior provinces. For example, of the total quantity of freight (1,604,321 tons) passed through the whole length of the Welland Canal in 1907, about 75 per cent. moved eastwards, and more than 62 per cent. of the 2,100,000 tons which passed through the St. Lawrence canals moved in the same direction.

SHIPPING ON THE GREAT LAKES.

Canadian shipping and shipbuilding on the Lakes have made considerable progress in recent years, although they do not rival those of the United States. According to authoritative statements, there were not twenty Canadian steamers engaged in the transport of grain fifteen years ago; only three of these were steel built, and the largest carried only 90,000 bushels. The total carrying capacity of Canadian grain-carriers at the present time has been estimated at ten million bushels, and the capital invested in the fleet is said to be about three millions sterling. Between the harvest and the close of navigation in winter it is estimated that no less than sixty million bushels of grain can be moved from port to port in Canadian steamers.

Many special engineering features have been introduced into the structures and equipment of these Lake grain-carriers. They are really huge steel barges of full form, of uniform cross-section for a considerable portion of their length, and they possess enormous cargo capacity, moderate engine power and speed, with structures of a simple nature which can be largely standardised and made to resemble bridge construction rather than ordinary shipbuilding. They can be built in a short time, the largest vessels occupying about four months in construction. In this way the cost of construction is cheapened, but the rates for labour and materials prevailing in the Lake shipyards are so high relatively to British costs that at present these grain carriers are said to cost about 40 per cent. more (per ton deadweight carried) than the cost of ordinary "tramp" steamers built in Great Britain. Their holds and hatchways are arranged so as to facilitate the rapid shipment and discharge of cargoes. At their ports of call special mechanical appliances are provided for dealing with cargoes, most of which consist of grain, ore or coal.

In the design and construction of these cargo-handling appliances the mechanical engineer has displayed great ingenuity, and the results obtained in rate of shipment and discharge of cargoes of grain, ore and coal are remarkable. Cases are on record where vessels carrying 7000 tons deadweight have been loaded in four hours and discharged in ten hours; more than 5000 tons of ore have been discharged in about four hours. The draught of water of the steamers must be kept within moderate limits and the breadths of the locks are moderate, so that increase in carrying power must be chiefly obtained by increase in length; consequently, as individual cargoes are increased, a greater number of lifting appliances can be brought to bear simultaneously, and the rate of loading or discharge can be maintained or accelerated.

The season of navigation extends over only seven or eight months in the year; consequently, "quick despatch" is essential to success. A large vessel of this class has the following approximate dimensions:—Length about 600ft.; breadth, 58ft. to 60ft.; depth, 32ft.; draught of water, 19ft. to 19½ft. when carrying 10,000 to 11,000 tons of cargo; corresponding displacement, 16,000 tons. The engines of such a ship develop about 2000 horse-power, and drive her at eleven to twelve statute miles per hour in fair weather. The large size and moderate speed result in very economical conditions of working, and the freight rates are exceedingly low. From official returns it appears that for these deadweight cargoes the freight per ton-mile across the Lakes is from .04 to .05 of a penny per ton-mile, the corresponding railway rate being about ten times that amount. The multiplication of this type of vessel on the Great Lakes is a proof that it satisfactorily fulfils the conditions of service. Similar vessels would not be well adapted for ocean work, which demands greater structural strength, different proportions, and a more liberal equipment; but shipbuilders generally may benefit from a study of the Lake steamers.

The greater portion of the traffic on the Lakes passes through the "Soo" canals. The voyages are comparatively short, the average length of the trip being about 840 miles. Consequently, individual vessels make several passages during the season when navigation is open, and the total number of passages, as well as the total aggregate tonnage of the ships, reaches very high figures. In the season of 1907, for example, when the canals were open less than 240 days 20,440 vessels—counting as a vessel each passage—with an aggregate registered tonnage exceeding 44 million tons, passed through the United States and Canadian canals at the Soo. The aggregate freight tonnage carried exceeded 58 million tons, the weight of coal approached 11½ million tons, the iron ore carried weighed 39,600,000 tons, and the grain transported amounted to 136 million bushels. The conditions of the Suez Canal are, of course, entirely different, as vessels passing through are engaged on long voyages, and individual ships make few passages in the year. On the other hand, Suez Canal traffic proceeds uninterruptedly throughout the year, while the Soo canals are closed during the winter months. Subject to these differences in working conditions, it may be of interest to state that in 1907 4267 vessels of 14,728,000 tons passed through the Suez Canal, and paid transit dues which amounted to £4,460,000, whereas the passage of the Soo canals was free.

THE ST. LAWRENCE SHIP CHANNEL.

Closely allied with the waterway from Montreal to Lake Superior is the improvement of the channel of the St. Lawrence from Montreal to Quebec and beyond towards the sea. From the Straits of Belleisle to Montreal the distance is 986 miles; from Quebec to Montreal it is 160 miles. Formerly the minimum depth of water between Quebec and Montreal prevented the passage of vessels drawing more than 10ft. to 12ft. during the greater part of the season of navigation. In 1826 the question of deepening the river channel was raised; in 1844 the work was begun, but was abandoned three years later; in 1851 it was resumed, and has since been continued. In 1869 the minimum depth of the channel at low-water was increased to 20ft.; in 1882 it was 25ft.; in 1888 27½ft. for 108 miles from Montreal to a point within tidal influence. A channel having a minimum width of 450ft., and 550ft. to 750ft. wide at the bends, with a minimum depth of 30ft., was completed in 1906 from Montreal to tide water at Batiscan. Certain work remains to be done between this point and Quebec in order to complete the project adopted in 1889 and amended in 1906, but it is anticipated this will be finished in about four years. Below Quebec the channel is 1000ft. wide. When once dredged it is stated that the channel remains permanent. Accidents in the channel are few. The superintending engineer, in his Report of July, 1908, indicates the magnitude of the work done by comparisons with the Suez and Panama Canals, the figures standing as in table.

—	Length.	Minimum depth.	Minimum breadth.	Estimated excavation.
	miles.	ft.	ft.	cubic yards.
Suez Canal	100	29½	100 (bottom)	—
Panama Canal	49	41	200 (minimum) 500 (maximum)	80,000,000
St. Lawrence Channel	220*	30	450 (minimum) 1000 (maximum)	70,000,000

* Length of channel requiring improvement demands dredging and excavation over a length of about 70 miles.

In 1844 the largest vessels navigating the St. Lawrence to Montreal were of 500 tons; now the Virginian and Victorian, of the Allan Line (12,000 tons), and the Laurentic and Megantic, of the White Star Line (15,000 tons), proceed to that port, and have made the passage from Quebec in less than ten hours. Ordinarily this passage occupies eleven to twelve hours, the return passage being made in nine to ten hours.

In the execution of these great works a specially designed dredging plant, including several types, has been employed, and works about seven months in the year, and the rock dredging and blasting in the section below Quebec has involved great difficulty. The total amount of rock to be removed amounted to 1,700,000 cubic yards, extending over nearly three miles, and the whole bottom was covered with huge boulders, some of which were 30 to 40 tons in weight. These great masses had to be lifted before blasting and dredging was done. During the fiscal year 1907 8 the expenditure on dredging plant and dredging was nearly £132,000, and 4,832,000 cubic yards of material were removed. At the close of that year 56 millions of cubic yards out of the estimated total of 70 millions had been dredged; the length completed to 30ft. minimum depth was 59 miles out of 70 miles. These facts indicate the advanced condition of the undertaking, and the prospect of its completion at an early date.

In order to secure the safe and continuous navigation of this channel by night as well as by day, under all conditions of weather, during the season when the river is open, every precaution and aid which engineering skill and invention can provide has been laid under contribution. A marine signal service with telephonic equipment has been provided; submarine bells have been established for use in foggy weather; a complete system of buoys and lighting has been installed; the channel is periodically examined and swept to ensure that there are no obstructions; the question of prolongation of the season for navigation by the use of ice-breakers is being studied. The harbour of Montreal has been greatly improved in accommodation and equipment, and the aggregate tonnage, as well as average size of sea-going vessels, using the port have been much increased. In 1898, 868 such vessels aggregating 1,584,000 tons arrived at Montreal; in 1907, 742 vessels aggregating 1,926,000 tons arrived. Of the latter, 522 vessels aggregating 1,525,000 tons were British. At the St. Charles Docks and Wharves, Quebec, in the season of 1907, 235 vessels of 1,009,000 tons were entered inwards, and 67 vessels of 249,000 tons outwards, the first outward steamer leaving on April 7th, and the first ocean steamer arriving on April 26th. The last arrival from the sea was on December 9th, and the ice formed in the tidal basin on December 12th.

Still further improvements of the St. Lawrence navigation are now proposed, and the work was commenced in 1907. It is intended to increase the depth of the channel to a minimum of 35ft. from the sea to Montreal, and the superintending engineer reported in 1908 that with certain moderate additions to the dredging and steam plant this work could be completed in six seasons. The widths and curves of the existing channel will not require any important changes, as they were designed from the first for the largest classes of steamships. When this increased depth has been obtained Montreal as a port will have an approach channel comparing favourably with that of other ports available for transatlantic traffic. At Southampton the existing depth at low water in the approach channel is about 32ft., and it is proposed to obtain 34ft. At Liverpool the minimum depth at low water over the bar and in the approach channel in the Mersey is about 28ft. The Ambrose Channel leading to New York is to have 40ft. depth at low water when the works are completed. Ample depth of water is of the first importance in the economical working of the largest and swiftest ships, and the Canadian Government has been well-advised in deciding to carry out the great scheme above described.

WATER-POWER.

Canada has unrivalled resources in water-power, and its extent and possible utilisation have been made the subject of investigation by engineers for many years past. One of the most important memoirs on the subject was presented to the Royal Society of Canada in his presidential address of 1899 by Mr. Keefer, C.M.G. In recent times many other engineers have studied the subject and carried out important works. Exact knowledge of the total power represented by the waterfalls and rapids of the Dominion is not available, nor can any close estimate be made of the power which may be employed hereafter in factories, mills, or industrial processes, because profitable employment obviously depends upon commercial considerations, which must be governed largely by the localities in which water-power may be found, and the cost of works and of transmission of energy to places where it can be utilised. It has been estimated that on the line from Lake Superior through the chain of lakes and rivers leading to Niagara and thence through the St. Lawrence to the sea eleven millions horse-power may be developed.* Mr. Langelier has estimated that in the Province of Quebec the water-power aggregates more than eighteen millions horse-power; other provinces all possess large resources of the same kind as yet untouched. The most striking example of the utilisation of water-power is that on the Niagara River, which the writer had the good fortune to visit in 1904, during his Presidency of the Institution of Civil Engineers; the works on the Canadian side were then in full progress, and at a stage which enabled one to realise completely their great difficulty and immense scale. The three companies whose works are near the Falls on the Canadian side have provided for a total ultimate development of over 400,000 horse-power, and a fourth establishment lower down the river, intended chiefly for the use of Hamilton, is to develop 40,000 horse-power. In the construction of the works, in the electric generating plant, the arrangements for transmitting power over long distances, and other features of importance, remarkable engineering skill and daring have been displayed. American capital and enterprise have had much to do with these undertakings, as they have with many other important Canadian enterprises; but it may be hoped that British capital will keep its lead and be freely employed in the development and utilisation of all the resources of the Dominion, including that magnificent asset its water-power. The applications of water-power are already very numerous, including not merely the creation of electrical energy and its use for lighting and power in towns and factories situated at considerable distances from the Falls, but for manufactures and industrial processes carried on near the Falls. Amongst these manufactures, that of aluminium and carbide of calcium may be mentioned, while paper and pulp mills and saw mills constitute important industries. Great advances have been made in the transmission of electrical power over long distances, and very high pressures are being used. Electric traction on railways and tramways also derives its power from the same sources, and is being rapidly developed. In 1901 there were 553 miles of electric railways, and in 1907 815 miles.

(To be continued.)

IT is stated in the *Industrial World* that the Pittsburgh Department of Public Works has prepared plans for a reinforced concrete bridge in that city. The structure will be 630ft. long, with a roadway of 50ft., and 10ft. sidewalks. The main span will be 300ft., and will stand 115ft. above the boulevard.

THE IRON, COAL, AND GENERAL TRADES OF BIRMINGHAM, WOLVERHAMPTON, AND OTHER DISTRICTS.

(From our own Correspondent.)

Pig Iron Revival.

THE revival in the pig iron trade of this district continues, and most producers of raw material are now in a strong position, and refuse to enter into forward commitments except on terms considerably better than those current for prompt deliveries. Prices of all brands are firm, and on 'Change to-day (Thursday) in Birmingham the expectations noted last week that the improvement will develop into a good autumn trade were repeated. Consumers of raw material have been covering, in view of the possibility of a further advance in prices, and to-day some further good orders were placed at enhanced rates. Prices were fully 6d. per ton dearer on the week, and in some cases an increase of 1s. 6d. was named, but in these latter instances the figures quoted may be taken rather as an indication of the strength of makers' position than as an actual business figure. Derbyshire forge iron was quoted 50s. per ton; Northampton forge iron, 47s.; Lincolnshire, 51s.; South Staffordshire part-mine iron, 49s. 6d. to 50s.; and common forge iron, 46s. 6d. North Staffordshire iron was worth about 50s. There was some stiffening of quotations for Staffordshire all-mine and cold-blast qualities, but no actual change is at present announced on the former figures of 80s. to 81s. for best all-mine and 110s. cold-blast. As the market closed to-day some brands of both Staffordshire and Midland pigs were withdrawn. It is not at all unlikely that prior to the October quarterly meetings all-mine iron will be put up—at least, if the revival holds.

Manufactured Iron Outlook.

Finished ironmasters attempted to-day in Birmingham to get some advance on rolled iron to compensate for the dearer situation in raw material, but they were successful in only few instances. Should the returning confidence in the pig market be continued, however, manufactured iron consumers here must soon have to concede better values, particularly now that Scotch and Cleveland prices have advanced 5s. to 7s. 6d. per ton. Unmarked bars were £5 17s. 6d. to £6, second grade marked bars £7, and best ditto £8 per ton. A fair number of inquiries have come to hand recently in connection with the renewal of bar contracts, but sales for early delivery have not expanded to any large extent. Hoop iron is still £6 15s., and rivet iron £6 15s. to £7.

Galvanised and Black Sheet Trade.

Black sheets for galvanising and merchant purposes show little improvement, and makers are pressing for orders at £7 2s. 6d. for 24 w.g. sheets, though £7 5s. is still maintained as a nominal quotation. Sheets of 20 w.g. are £7 and £7 2s. 6d., and 27 and 28 w.g. £7 15s. to £7 17s. 6d. Galvanised sheets continue the subject of severe internal competition amongst the makers, associated and non-associated. The Welsh and other coast firms are carrying off the bulk of the orders; £10 10s. to £11 and £11 5s. are regarded as the general quotations of the market for doubles f.o.b. Liverpool or equal-distance outports. Large London exporters in particular, however, declare that they will not give £11, and they call it an "absurd" price in the present severe price-cutting situation. The present position of the industry is a most unenviable one, and no one can tell how the war of competition will end.

Tube Strip Prices.

The long depression has been very trying to makers of gas strip, and the slackness of trade lends colour to some of the statements which are frequently made in connection with the Gas Tube Strip Association. It has been suggested that though an official minimum has been in existence, members have devised means of evading it, while in other quarters it has been asserted that no hard-and-fast minimum was arranged. It is now once again reported that a reduction of 5s. has been declared, making the price £6 per ton, less 2½ per cent., and it is also said that for a considerable time past members of the Association have been accepting business at £6, less 2½ per cent. These statements have been officially denied. Unassociated makers, however, have been selling at less than £6 per ton for a long time, and the general belief of the market now is that the combination firms have also been authorised to do so. The great trouble in this trade is, of course, Belgian competition and the fear that is entertained of its renewed outbreak. So long as this trouble threatens native prices are certain to be easy and open to manipulation by buyers. Wisely enough, the Staffordshire makers are determined to keep out the Belgians at any cost.

Steel Trade.

Crude steel is firm at the prices lately stated. There is rather more activity as regards sections, but values remain unchanged. Bessemer sheet bars are £4 12s. 6d. for Bessemer to £4 15s. for Siemens. The advance of 5s. per ton this week in steel plates in the West of Scotland and on the North-East Coast is received with much satisfaction by local steel makers, who conclude that by lessening the severity of Scotch and Cleveland competition the advance will strengthen Midland prices. Staffordshire mild steel bars are quoted £6 7s. 6d. to £6 17s. 6d., angles £5 10s. to £5 15s., girder plates £5 15s. to £5 17s. 6d., and boiler plates £7.

NOTES FROM LANCASHIRE.

(From our own Correspondent.)

MANCHESTER, Thursday.

Sharp Advance in Pig Iron.

THE predictions of the past few weeks with regard to pig iron have been more than verified by the advances of the past few days. Up to Friday they seemed to be confined mainly to warrants, but under the influence of strong American advices, something like a "boom" has set in, not only in this centre, but throughout the country generally. This is not confined to one brand of iron, but all classes have participated, and a good trade during the autumn seems now to be assured. There was a good attendance on the Iron Exchange on Tuesday, and the under current was admittedly strong. Prices advanced rapidly, Middlesbrough and hematite taking the lead. Lincolnshire on Friday was officially advanced 6d. per ton, but merchants held out for 1s., and even 1s. 6d. was freely talked of. Derbyshire and Staffordshire followed suit, although, perhaps, not to the same extent. On the month the following advances may be noted:—Lincolnshire, 2s. 6d.; Staffordshire, 2s. to 2s. 6d.; Derbyshire, 1s.; Middlesbrough, 2s. to 2s. 6d. Scotch: Gartsherrie, 1s. 9d.; Glengarnock, 1s. 6d.; Eglinton, 1s. to 1s. 6d.; Dalmellington, 1s. to 1s. 6d.; West Coast hematite, 2s. 6d.; East Coast ditto, 1s. 6d. to 2s. 6d. per ton. Forge iron appears to have been in better inquiry, and closes about 2s. to 2s. 6d. per ton higher on the month.

Finished Iron and Steel.

There is no change to note in the first named, although in steel and steel products the feeling is strong. The Scottish advance, however, has not been followed here, although it is stated there is an upward movement in marine boiler plates.

Copper, Sheet Lead, and Tin.

Tough ingots higher, but manufactured unchanged.

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* The *Times Financial Supplement*, April 2nd, 1906, contains a valuable article on this subject, from which many of the above figures are taken.

Sheet lead: Easier. Tin: English ingots again dearer by about £2 per ton.

Quotations.

Lincolnshire, No. 3 foundry, quoted 54s. 6d. to 55s.; Staffordshire, 53s. 6d. to 54s.; Derbyshire, 53s. 6d. to 54s.; Middlesbrough, open brands, 60s. to 90s. 4d. Scotch: Gartsherrie, 60s. 6d. to 60s. 9d.; Glengarnock, 60s. 6d.; Eglinton, 59s. to 59s. 6d.; Dalmellington, 58s. 6d. to 59s., delivered Manchester. West Coast hematite, 61s.; East Coast ditto, 57s. 6d., to 58s. 6d. both f.o.t. Delivered Heysham: Gartsherrie, 58s. 6d. to 58s. 9d.; Glengarnock, 58s. 6d.; Eglinton, 57s. to 57s. 6d.; Dalmellington, 56s. 6d. to 57s. Delivered Preston: Gartsherrie, 59s. 6d. to 59s. 9d.; Glengarnock, 59s. 6d.; Eglinton, 58s. to 58s. 6d.; Dalmellington, 57s. 6d. to 58s. Finished iron: Bars, £6 10s.; hoops, £7 12s. 6d.; sheets, £7 15s. to £8. Steel: Bars, £6 2s. 6d. to £6 5s.; Lancashire hoops, £7 5s.; Staffordshire ditto, £6 17s. 6d. to £7; sheets, £7 17s. 6d. to £8; boiler plates, £7 2s. 6d.; plates for tank, girder, and bridge work, £6 5s.; English billets, £4 12s. 6d. to £4 15s.; foreign ditto, £4 10s. to £4 12s. 6d.; cold-drawn steel, £9 5s. to £9 10s. Copper: Sheets, £72; tough ingot, £63; best selected, £63 per ton. Copper tubes, 8½d.; brass tubes, 6⅞d.; condenser, 7⅞d.; rolled brass, 6¼d.; brass wire, 6½d.; brass turning rods, 6½d.; yellow metal, 6d. per lb. Sheet lead, £16 15s. per ton. English tin ingots, £135 10s. per ton.

The Lancashire Coal Trade.

There was a better attendance on the Coal Exchange than usual, but owing to the open weather, and the Lancashire holidays, actual business continued dull. There is no change to report in either demand or official quotations.

Barrow-in-Furness, Thursday.

Hematites.

The improvement in the hematite pig iron trade referred to last week has been further demonstrated, as not only has the demand from several sources increased, but buyers have been making inquiries for fuller deliveries at forward dates, a good indication of their idea that before many weeks are over there will be a bigger trade done at fuller prices. Indeed, prices which began to move last week have shown a further upward tendency this week, and now makers are quoting 61s. to 62s. for mixed Bessemer numbers net f.o.b., and warrant sellers are asking 59s. 9d. net cash, buyers 59s. 6d. There is much more business in the hands of makers, and they are preparing to put additional furnaces in blast. Two furnaces at the Solway Works, belonging to the new Cumberland combination, are to be lighted at once, and it is probable that other furnaces in the Furness district will shortly be put into operation. A better business is being done in special hematite iron, and makers are now quoting up to 63s. for this high graded metal. Several of the makers of iron have taken up the work of making special hematites according to specifications supplied. Only the best of raw material is used for this purpose, and it is believed that, in future, those using this class of iron for purposes in which the most reliable article is essential will prefer to specify what they want now that they know they can get it. Ferro-manganese is selling better, and there is a good trade in spiegeleisen. Iron ore is in better inquiry, and the best classes are most sought after. Prices range from 11s. to 17s. 6d. for ordinary and best net at mines.

Steel.

There are much better prospects in the steel trade, and the rail mills are better employed than they have been of late, and orders are coming in more freely. There is also the prospect of a revival in the demand for steel shipbuilding material. Prices are somewhat higher, in harmony with the advance in the price of iron.

Shipbuilding and Engineering.

Shipbuilders are quoting for some new work which is now in the market, as they are anxious to get orders to keep their works going during the winter months. Prospects for next spring are satisfactory. Engineers are short of orders in the marine department.

Shipping and Coal.

More activity is shown in the shipping trade. The exports of iron and steel last week from West Coast ports were 15,297 tons—7728 tons of iron and 7569 tons of steel—as compared with 8930 tons in the corresponding week of last year, an increase of 6367 tons. The aggregate of exports to date this year has reached 390,129 tons, compared with 320,620 tons in the corresponding period of last year, an increase of 69,509 tons. Coal and coke are firmer and in rather better sale.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

The Coal Trade.

As to demand, the coal trade at the present time is very active, but, unfortunately, the difficulties arising from "Feasts," the Eight Hours Act, and pit boys are affecting adversely the working at the collieries. There is considerable unrest as to the results of the working of the Act in particular, the men not earning what they think is sufficient money and the new arrangements necessarily causing some friction. Barnsley is the "head-centre" of the "Feast" institution, and the holidays extended from last Saturday to Tuesday night, in some instances a little longer. Advantage is now taken of this holiday time more largely than used to be the case for going to the seaside, the different railway companies encouraging the colliers' exodus by liberal inducements in the way of travelling facilities.

House and Steam Coal Firm.

Though the absence of householders at the seaside and other resorts naturally tells upon the call for coal, business continues steady, and stocking orders are freely forthcoming, mainly for the higher grade qualities. Rather less is being done with London merchants, deliveries on contract account showing some shrinkage, due, no doubt, to the holiday influence. Qoutations are maintained for best Barnsley at 11s. 6d. to 13s. per ton at pit; secondary descriptions from 10s. to 11s. per ton at pit. Steam coal is as actively inquired for as ever, the briskness in shipments being expected to continue to the end of the season. For the last week or two the weight forwarded from Hull has not been equal to that for the corresponding week of last year; but this has been largely due to the lessened quantity sent to Sweden during the industrial trouble there. Now that this is settling down, the return will, no doubt, soon begin to show different results. The last issued, however—for the week ending 17th August—shows the coal exports from Hull to have been 68 196 tons, compared with 85,698 tons for the similar week of 1908. Cronstadt again resumes first place in the list with 11,022 tons, Rotterdam coming second with 7999 tons, and Hamburg third with 6586 tons.

Small Coal and Coke.

The better qualities of small coal keep in good demand, and values are fully maintained. In coke the hardening tendencies noted last week are still evident, and values are firmly maintained at the advanced quotations then given, best washed coke making from 11s. to 11s. 6d. per ton, unwashed 10s. 6d. to 11s. per ton.

Iron—Derbyshire again Advanced.

Producers of pig iron are asking higher prices than have been ruling for some weeks back. This is rather in consequence of a more hopeful feeling in trade than owing to actual demand, though there has been increased buying for local purposes, more especially in hematite, of late. Supplies wanted for forward delivery can only be obtained at an advance of 1s. to 2s. a ton. For Lincolnshire the official quotations remain, but prices are stiffening, and makers are not disposed to sell freely even at present quotations, believing that before long, as trade improves, better values will be obtainable. Lincolnshire, No. 3 foundry, 50s. 6d. per ton; No. 4 foundry, 49s. 6d. per ton; No. 4 forge, 49s. 6d. per ton; No. 5 forge, mottled and white, 49s. 6d. per ton; basic, 50s. 6d. per ton net, delivered in Sheffield and Rotherham. Derbyshire irons are advanced another shilling a ton, No. 3 foundry being now 51s. per ton, and No. 4 forge 50s. per ton net, delivered in Sheffield and Rotherham.

Bars, Hoops, and Sheets.

Quotations unaltered. Bars, £6 10s. per ton; hoops, £7 10s. per ton; sheets, £8 10s. per ton.

The Heavy Industries.

There is nothing fresh to report in the steel trade, which continues languid for all markets, at home and abroad. Engineering establishments are still inadequately employed, and will remain in that condition until there is greater activity on the part of railway companies and shipowners. A hopeful sign in the latter direction is the report that more vessels are being employed. The strike in Sweden is practically over, and its effects have not been felt much, except by several firms who are large users of Swedish iron, and even these, having considerable stocks, were only temporarily inconvenienced. During the past few days paragraphs have appeared in the papers with respect to large orders from the British and other Governments given, or to be given, to the Coventry Ordnance Works, Limited. These would be very welcome, both at Coventry and at Sheffield, where the firms of John Brown and Co. and Cammell, Laird and Co. are much interested as the principal proprietors. The work would, no doubt, be of a heavy character, and provide a considerable amount of employment to the Sheffield works in the early stages. The order recently placed in Darlington for 500 40-ton all-steel bogie freight wagons for Argentina is of considerable importance to this district in these times of small orders and simple replacements, and, it is anticipated, will add materially to the requirements of several makers of axles, tires, and springs.

Colliery Development in South Yorkshire.

Sinking operations are to be begun, within about a month's time, at a new colliery at Thorne Moore, three miles from Thorne. It is expected that the famous Barnsley bed of coal will be found to be 9ft. thick, and of rich quality; but it will not be reached until at a depth of 920 yards. Messrs. Pease and Co. are the owners, and Messrs. J. Eaton and Son are the sinkers. Messrs. Eaton sank the new pit at Bentley, nearer to Doncaster, where the Barnsley bed was reached at a depth of 623 yards. The two shafts for the new Thorne colliery will each be 22ft. in diameter inside the walling. It is estimated that when coal is reached, and operations are in full swing, there will be work for between 3000 and 4000 employés, and that an output of 4000 tons a day will be obtained.

Derwent Valley Waterworks.

Mr. O. B. Steward, clerk to the Derwent Valley Water Board, has issued a report showing the progress of the works. The period covered is the three months from March to June. At the Bole Hill quarries 271 men are employed, and up to the 10th of June 1,071,712 tons of stone had been obtained. At Howden reservoir 443 men are engaged, and on the Derwent dam 332. The work at both these places is proceeding satisfactorily. The Howden dam will be 1080ft. long, and the reservoir 1¼ miles in length, its capacity being 1886 million gallons. The Derwent dam will be 1110ft. long, and the reservoir 1¾ miles long; its capacity 2000 million gallons. All the other works are making satisfactory progress. The population of Birchinlee is 949. With regard to the afforestation of the catchment area, the 32 acres authorised by the Board have been completed, and the engineer has been authorised to proceed with the planting of a further area not exceeding 50 acres. The total number of workmen engaged on June 10th was 2025, and of these 1088 were in the direct employ of the Board. The cost of the works to June has been £2,434,619 9s. 11d.

NORTH OF ENGLAND.

(*From our own Correspondent.*)

Cleveland Pig Iron.

Quite a little "boom" has sprung up this week in the iron and steel industries of this district; buying in several branches has been brisk, and advances in prices the order of the day. The tone was altogether optimistic, and buyers have been much keener to operate than the sellers. The former wanted to purchase for delivery a long time ahead, but sellers did not want to commit themselves too heavily in the face of a rising market, the rise being due as much to an increase in legitimate trade as to an influx of speculation. Evidence is accumulating of the improvement in trade, and there appears to be a general upward movement, it being as noticeable in the finished as in the pig iron branches. A large business has been done during the last few days, and the price of Cleveland warrants touched a higher figure than has been known since last October—51s. 4½d. cash buyers, that being 1s. 3d. advance in a week, 2s. advance since the present month commenced, and 5s. 4½d. rise from the minimum of the current year, that being reported about the middle of March. It is said that the outside public have come in to speculate in warrants, and on Wednesday some of the operators were endeavouring to take their profits, which action rather weakened the price; in fact, at the close of the day buyers would give only 50s. 11d. cash. Makers of Cleveland pig iron have improved their position considerably this week, and have sold No. 3 somewhat freely up to 51s. 3d. per ton for early delivery, but Wednesday's quotation was at 51s. for prompt and 51s. 9d. for delivery up to the end of the year. No. 1 has risen to 53s. 6d., No. 4 foundry to 49s. 9d., and No. 4 forge to 49s. 6d. per ton, all for prompt delivery.

Hematite Pig Iron.

Producers of East Coast hematite pig iron have waited long for a revival of their trade, and have had a very bad time during the last two years, but now a genuine and general improvement has come with a rush, demand having become very active all at once, and a substantial rise in prices has at last to be recorded. In the main the welcome change has been brought about by the improving condition of the shipbuilding industry. Consumers and merchants have arrived at the conclusion that the time to buy has come, and that if they wait they will have to pay higher prices. Very good orders have therefore been distributed, and more could have been secured if the makers had seen their way to sell freely ahead, but they do not want to commit themselves too heavily in face of a rising market. At the close of last week mixed numbers of East Coast hematite iron could readily be got at 55s. 6d. per ton for early delivery, that being 6d. per ton above the price that had ruled for weeks, but now fully 57s. 6d. must be paid; indeed, it is regularly given, and 57s. 9d. and 58s. has been forthcoming for prompt delivery, while 60s. is asked for the first quarter of next year. This is a sharp rise, and yet quotations are still relatively cheaper than those of Cleveland pig iron. Makers of hematite pig iron are this week in high spirits, and certainly their position is considerably better than it was; indeed, some ironmasters are able to choose their customers. No. 1 for early delivery is at 58s., and No. 4 forge at 57s. The sellers of foreign ore have lost no time in advancing quotations, and do not give the iron producer much opportunity of securing profits. Ore has long been too dear compared with the prices realisable for pig iron. This week the price of Rubio ore has been advanced from 16s. 3d. to 17s. per ton by most merchants, and some are asking 17s. 6d. per ton c.i.f. Tees. Likewise the sellers of coke have run up their prices, and quotations indeed are somewhat erratic. Some are asking 17s. per ton delivered Middlesbrough furnaces, but the general price is 16s. per ton, an advance this month of fully 6d. per ton, and this with the rise in ore absorbs almost all the extra that is being obtained for hematite pig iron.

Stocks of Pig Iron.

If statistics had their usual influence on the market the prices would be dropping instead of rising, for it must be acknowledged that the figures of the stocks are very bad indeed. But apparently holders just now ignore the rapid increase in stocks, as the quantity now held will not be excessive if trade improves to the extent now promised. Connal's stock of Cleveland pig iron on the 25th was 280,265 tons—an increase this month of 21,094 tons. The stock consisted of 268,625 tons of No. 3, 8770 tons of No. 4 foundry, and 2870 tons of other iron not deliverable as standard.

Exports of Pig Iron.

Fair shipments of pig iron from the Cleveland district can be reported, and prospects of their increasing are good, for the autumn export demand will shortly have to be satisfied. The worst is that there is so little wanted by Germany this year, though this is not surprising when one takes into account the wretched condition of trade in that country. The exports up to the 25th were 89,912 tons, compared with 70,811 tons last month, 77,805 tons in August last year, and 109,268 tons in August, 1907, all to the 25th.

Manufactured Iron and Steel.

A decided improvement in business is manifesting itself in the finished branches of the iron and steel industries, and this is one of the most encouraging features of the trade, emphasising, as it does, the fact that there is a real revival in trade, and not a spurt only brought about chiefly by speculative operations. Prices have long been stationary, but this week there are substantial advances to be reported, chiefly as a result of the improvement in shipbuilding. Iron and steel plates, iron angles, and iron bars have all been advanced 5s. per ton—the first advances for at least two years, and there is every reason to believe that the upward movement will continue. Steel ship plates are now up to £6, steel boiler plates to £7, iron ship plates to £6 5s., iron ship angles to £7, common iron bars to £7, best iron bars to £7 7s. 6d., and best best iron bars to £7 15s. per ton, all less 2½ per cent. f.o.t. The daily papers have made a good deal of capital recently about the importation of German steel ship plates into the Wear, but evidently the North of England manufacturers attach little importance to this or prices would not have been raised within the last few days. The fact is the quantity imported is small. The prices paid could hardly pay the exporters. It is not at all likely that a competition will spring up in this district between German and British plates, and the producers of the latter are not disquieted. Steel ship angles have not yet been advanced, but can still be bought at £5 7s. 6d. per ton, and packing iron and steel at £5 5s., while steel stanchions are kept at £6 15s., all less 2½ per cent. Early advances, however, are expected in these as well as in ship rivets, and, indeed, all other shipbuilding materials that have not been raised in value this week. Steel bars are quoted at £6, steel hoops at £6 5s., and steel strip at £6 2s. 6d., all less 2½ per cent., while steel joists are at £5 7s. 6d., less 2½ per cent. Heavy steel rails are certainly in brisker request, and prospects are encouraging; they can generally be bought at £5 5s. net f.o.b. Galvanised and corrugated iron or steel sheets are selling well at the recently reduced price—£10 10s., less 4 per cent. for 24 gauge in bundles f.o.b.

Shipbuilding.

There can be no question that there is a brighter outlook for those engaged in shipbuilding, and the conditions are certainly more satisfactory than they have been for the past two years. The Government orders, present and prospective, have no doubt had a good effect upon the shipbuilding industry, and general shipowners are being tempted to distribute orders more freely, so that the number of empty berths at the yards is steadily being lessened. Orders for tramp steamers, as well as liners, are beginning to come in, as it will be necessary to increase quotations for new steamers. As a rule, there is greater confidence all round, and those who would get their needs supplied at anything near the bottom in prices have to lose no more time in giving out their orders. The inquiry for a new Cunarder has tended to strengthon the shipbuilding industry in this district. There are many indications of improvement in shipbuilding, and it is expected that in the coming winter depression will be much less felt than it was a year ago. Not only is there more new work, but the repairing yards are once more busy, and the marine engine works are more fully employed.

Engineering, &c.

Trade is showing improvement at the engineering shops, and at works where departments had to be closed for lack of orders they have been re-opened. The Blake Boiler, Wagon and Engineering Company, Limited, Darlington, which during the past twelve months has supplied 325 wagons for the Buenos Aires and Western Railway Company, in Argentina, has secured an order from the same company for a still larger number. The wagons are to carry 40 tons, and will be built for the 5ft. 6in. gauge. There is more being done in locomotive work, also in points and crossings, and more regular work than for a long time is afforded at establishments producing these. Sir W. G. Armstrong, Whitworth and Co. have applied to the Newcastle Corporation for a much larger site at Walker for shipbuilding purposes than they originally asked for. The company desires to make such alterations that there will be sufficient space for the building of a Dreadnought, and for the accommodation of the largest vessels afloat. The new shipbuilding yard at Southbank, near Middlesbrough, which is being laid out by Smith's Dock Company, Limited, will be brought into use towards the end of the present year, and the site of the present yard at North Shields will be utilised for a graving dock. At Southbank there will be accommodation for the simultaneous construction of the hulls of twelve steam trawlers.

Coal and Coke.

It is curious to note that while best steam coals continue to decline in price, best gas coals are firm, and whereas the former were not long ago realising 13s. per ton f.o.b., they can now be bought at 10s. 9d., but best gas coals have been maintained at 11s. to 11s. 6d. for a long time. It is very unusual to see best steam coal below best gas coal in price. The trade in the latter is, however, steady and legitimate, while that in steam coal has lately been inflated by reason of the Welsh and Scotch labour difficulties, and these having been settled amicably prices have come down with a run. Coke is very stiff in price, and supply is hardly equal to demand. Some sellers have advanced their quotations for furnace coke to 17s. per ton, delivered at Middlesbrough, or equal thereto, but generally 16s. will be accepted. The Executive Committee of the Durham Miners' Association have issued a circular to their members protesting against the practice of ceasing work without giving notice to the masters. Pits were stopped, and the men's agents knew nothing until they saw the fact announced in the papers. No opportunity was given to remedy any grievance, though no trade organisation possessed such complete machinery for settling disputes as theirs. Messrs. Doxford and Sons have patented what they term a "Belt Conveyor Discharge," and have this week at their yard at Sunderland given a demonstration of its working. It has been fitted to the steamer Pallion. The new machinery elevates the coal from the holds by means of running belts, and discharges on to either side of the ship into barges or on to the quay. We refer in detail to this vessel in another column. The Warrenby Relief Fund, which was opened in 1895, after the boiler explosion at the Redcar Ironworks, when a dozen men were killed, has now been closed. In addition to assisting the widows directly, the fund, which reached £2300, was used to help the children until they attained fourteen years of age.

NOTES FROM SCOTLAND.

(*From our own Correspondent.*)

The Revival in Trade.

ADDITIONAL evidence has been furnished since last report of the revival in trade. It would seem that the upward movement in the values of raw iron, which at the first was admittedly of a speculative nature, is now being accelerated by reports as to the placing of contracts for which large supplies of iron will be required. How far the upward trend of prices may go it is impossible to forecast. Many industries in which iron is employed are experiencing an improvement in business, and the demand for the raw material is accordingly becoming more general and widespread. The bullish feeling in the markets has been gathering force, but makers of iron and steel are apparently anxious that its influence should be restrained, so that prices may not be rushed in such a manner as to check the outcome of orders. Fortunately stocks of iron are not so heavy as they have sometimes been in times of boom, and warrants in circulation are also limited; so that if the speculative market is pushed too rapidly the "bears" are likely to come in for their share of the business.

Pig Iron Market.

The Glasgow warrant market has been active since last report, and an increasing amount of iron has changed hands, the prices reaching a higher point, despite occasional fluctuations. Business has been done in Cleveland warrants from 50s. 7d. to 51s. 4d. cash, 50s. 11½d. to 51s. 7d. one month, and 51s. 3½d. to 52s. three months. Transactions are also recorded at 50s. 11½d. to 51s. for delivery in twenty-two days, 51s. twenty-seven days, 51s. 4d. eleven days, 51s. 5d. eighteen days, and 51s. 9d. for 15th October. The amount of iron turned over in the last few days has been greater than for a long time past. The upward movement in Cleveland iron has been attended by an advance in other classes of warrants. Scotch warrants have risen from 56s. 9d. to 58s. 3d., receding subsequently to 57s. 3d., but the stock is so low, and warrants so few, that transactions involving delivery of iron are all but impossible. Standard foundry pig iron has advanced from 49s. 3d. to 50s. 3d. per ton.

Hematite Ore and Pigs.

The imports of hematite ore into the Clyde are increasing as might have been expected owing to the anticipation that larger quantities of it will be required. The quantity received for the year to date is about 100,000 tons greater than in the same period of last year, and the past week's imports consist of eighteen large steamboat cargoes, three of which came from England and the rest from abroad. There has been more life in hematite warrants in the last few days than for a long period, and as the quantity in circulation is comparatively limited, prices have sharply increased. Business has been done in our market in Cumberland warrants 58s. 9d. cash, 59s. for delivery in November, and 60s. 2d. and 60s. 3d. for delivery in twenty-seven days. There has also been a material rise in Scotch hematite, which is now quoted by merchants at 60s. for delivery at the West of Scotland steelworks. This latter figure marks an advance of 3s. 6d. per ton from the lowest point touched this year.

Scotch Makers' Pig Iron.

The position of the Scotch makers is becoming stronger. The inquiry for both G.M.B. and special brands has been active and general, both for local and English consumption as well as for shipment. Two additional furnaces have been lighted since last report to produce ordinary iron, one at Gartsherrie and the other at Ardeer, and the number now in blast in Scotland is 82, compared with 80 last week, and 75 at this time last year. There are now 39 furnaces producing ordinary, 38 hematite, and 5 basic pig iron. Some of the makers have this week intimated a further advance of 1s. per ton in prices. The f.a.s. prices at Glasgow at the time of writing are, for Govan and Monkland Nos. 1, 58s.; Nos. 3, 56s.; Carnbroe, No. 1, 59s. 6d.; No. 3, 56s. 6d.; Clyde, No. 1, 62s.; No. 3, 57s.; Gartsherrie, Langloan, and Calder, Nos. 1, 62s. 6d.; Nos. 3, 57s. 6d.; Summerlee, No. 1, 63s. 6d.; No. 3, 58s. 6d.; Coltness, No. 1, 88s.; No. 3, 58s. 6d.; Eglinton, at Ardrossan or Troon, No. 1, 58s.; No. 3, 56s.; Glengarnock, at Ardrossan, No. 1, 63s. 6d.; No. 3, 58s. 6d.; Dalmellington, at Ayr, No. 1, 60s. 6d.; No. 3, 55s. 6d.; Shotts, at Leith, No. 1, 62s. 6d.; No. 3, 53s. 6d.; Carron, at Grangemouth, No. 1, 64s. 6d.; No. 3, 57s. 6d. per ton.

Pig Iron Shipments.

The shipments of pig iron from Scottish ports in the past week amounted to 4774 tons, comparing with 5462 in the corresponding week of last year. There were despatched to Canada 525 tons, South America 180, India 185, Australia 795, France 250, Germany 140, Holland 260, Russia 10, Belgium 45, China and Japan 27, other countries 255, the coastwise shipments being 2102 tons, against 2887 in the same week of 1908. The arrivals at Grangemouth of pig iron from Cleveland and district were 9415 tons, being 579 tons less than in the corresponding week of last year.

Finished Iron and Steel.

Orders have been coming to hand more freely, especially in the steel trade, and the inquiries seem to point to a considerable expansion in demand. The rise in the prices of pig iron led the makers of malleable iron to advance their prices 7s. 6d. per ton. The steel makers have had several meetings discussing prices, but the general feeling has been that the matter at this stage requires to be dealt with cautiously. There can be no doubt that the tendency of prices is upwards, and it is reported that, as a rule, the steel makers are quoting present rates only against prompt specifications. This policy will enable them to put their machinery into fuller operation. The impression increases that there are orders in reserve for a very respectable quantity of steel material both for shipbuilding and other purposes. The export trade also promises well, and there is a large amount of this kind of business in hand, merchants and shippers pressing for early delivery. Some steelmakers have in prospect good lines of shipbuilding material. There is a good demand for tubes for a variety of purposes. Plain and galvanised sheets are also in demand. Ironfounders in some instances find business better than for a considerable time past, general and miscellaneous castings being more plentiful, while there is more life in the domestic branch of the foundry trade.

Engineering and Shipbuilding.

The outlook in the engineering trade is more encouraging, and business is coming forward more freely. The marine branch has fair prospects, with a good business in progress. The Caledonian Railway has placed with a Glasgow firm orders for nineteen renewal bridges, which will provide employment during a lengthened period and absorb a large amount of material. A large order for railway plant has also been secured by a Glasgow company for the Argentine Republic. Some fair shipbuilding orders have been received, and it is understood that there are others of importance in prospect.

The Coal Trade.

The coal markets are generally quiet, but shipments have been heavier than usual, and the current business for export is good, especially on the East Coast. Home consumers are purchasing only for present requirements, and prices for all kinds of coal are practically unchanged.

WALES AND ADJOINING COUNTIES.

(*From our own Correspondent.*)

State of the Coal Trade.

COLLIERIES are now getting into fuller work as the holiday season wanes, and it is satisfactory to note that there is a fair maintenance of prices. Many believed that prices would advance quietly into the 18s. net, but the older attendants on 'Change, who have been somewhat disappointed that house coals have not declined more during the hot season, are satisfied if prices can be retained about present rates until the autumnal season is more advanced. It will be seen that prices have only moved slightly. There has been a better attendance this week, and a little more animation, but on 'Change chief interest is being directed to the contest in the Committee Courts, where the issue will have a most important effect on business. Best steam and seconds are in strong demand, and while Monday brought about substantial dealings—considering that it was the first day of the week—Tuesday was still more animated, and dry coals were again in strong demand. The latest quotations were as follows:—Best large steam, 17s. 9d. to 18s.; best seconds, 16s. 3d. to 17s. 3d.; ordinary seconds, 15s. 6d. to 15s. 9d.; best drys, 16s. 6d. to 17s.; ordinary drys, 14s. to 14s. 6d.; best washed nuts, 14s. to 15s.; seconds, 13s. to 13s. 6d.; best washed peas, 12s. 6d. to 13s.; seconds, 11s. to 12s.; very best small steam, 9s. to 9s. 6d.; best ordinaries, 7s. 3d. to 8s. 3d.; inferior sorts, 6s. 6d. to 6s. 9d.; best Monmouthshire black vein, 15s. 9d. to 16s.; ordinary Western Valleys, 15s. 3d. to 15s. 6d.; best Eastern Valleys, 13s. 9d. to 14s. 3d.; seconds, 13s. to 13s. 3d. Bituminous coal: Very best households, 16s. 6d. to 17s.; best ordinaries, 14s. 6d. to 15s. 6d.; No. 3 Rhondda, 17s. 3d. to 17s. 6d.; brush, 13s. 6d. to 13s. 9d.; small, 10s. 6d. to 11s.; No. 2 Rhondda, 12s. to 12s. 6d; through, 9s. 6d. to 10s.; small, 8s. to 8s. 3d. Patent fuel, 15s. 6d. to 17s. 6d. Coke: Special foundry, 24s. 6d. to 27s. 6d.; ordinary foundry, 19s. to 22s.; furnace, 17s. to 18s. Pitwood, 20s. 6d to 21s. Public interest has been diverted to the results of using the best Welsh steam coal on leading steamers, where some striking figures are shown. This has been the case with the Cunard liner Lusitania, which arrived at New York at 9.55 p.m. on August 12th in 4 days 16 h. 40 min., thus lowering her time record by 2 h. and 55 min. The average speed was for 2890 miles 25.65 knots. The last 247 miles figured at the rate of 25.77 knots.

Last Week's Coal Trade.

Those who watch keenly the changes of the trade say that it is not the higher-priced coals which show the earliest indications of change. These for some time will exhibit firmness when the inferior coals are beginning to waver. For some weeks the inferior coals, fairly good in quality but inferior as regards the best steam or bituminous, have been in better demand. Last week a better supply enabled coalowners to sell more freely, and to accept also a slight reduction in price. In several instances there were deductions of 3d. from the past quotations. Dry coals remained stiff and rather scarce. The coal prospects are against the likelihood this time of an ascent in price from 18s. This figure was obtainable last week, and in some quarters 18s. 3d. was asked, but the tendency is downwards, and one prominent reason is to be seen in the fact that bookings for September are not at all largely placed. Buyers are waiting to see reduced quotations.

Newport Coal.

Newport has again given evidence of its healthy condition and steady increase in coal development by having shipped 92,449 tons of coal in the course of last week. The large new collieries now in progress, the great dock equipment, and the future of the Rhymney Valley are all significant. What the Rhondda has been, the Rhymney Valley promises to emulate, if not surpass. This is the site of the new Rhondda, and the only point of contest between authorities is whether its best coals will rival those of which the 4ft. Merthyr is one of the finest examples. The late Richard Fothergill, who was one of the successful advocates in the House for the selection of steam coals for the Admiralty, used to describe it as the finest in the earth, opening like a cauliflower. Newport steam coal is now in strong demand. The only falling off has been in placing forward, which has not been so urgently done during the last week or two. Latest prices:—Lower figures are being accepted for second quality Eastern Valleys. Best Newport black vein, 15s. 6d. to 15s. 9d.; Western Valleys, 15s. to 15s. 6d.; Eastern Valleys, 13s. 6d. to 14s.; other kinds, 12s. 9d. to 13s.; best smalls, 8s. to 8s. 3d.; seconds, 7s. 3d. to 7s. 6d.; inferiors, 6s. 9d. to 7s.; best house coal, 15s. to 15s. 3d.; seconds, 14s. to 14s. 3d.; patent fuel, 15s. 3d. to 15s. 6d. Coke: Foundry, 18s. 6d. to 19s. 6d.; furnace, 17s. to 17s. 6d. Pitwood, ex ship, 20s. to 20s. 6d. Steam coals are beginning to droop. A noticeable circumstance last week connected with the smaller port was that Port Talbot cleared in two cargoes 7400 tons coal to Bordeaux.

Swansea Coal.

The port, which is recovering from holiday influence, showed last week a gratifying increase. Close upon 90,000 tons of coal were despatched. The collieries are now working with greater regularity, and there is a strong impression prevailing that the season of winter coals now at hand will be a brisk one. From the margin of the Neath valleys to Pembrokeshire the famous seams of anthracite now in steady development are well placed for the increasing demand which is obtained every season. Strength and firmness were shown when the market opened this week, and best large Swansea was in good demand. Red vein not in good form, and a reduction appears to be setting in; machine coals scarce; rubbly culm firm. Lowest prices:—Anthracite coal, large hand picked, 24s. to 25s. net; seconds, net, 21s. 6d. to 22s. 6d.; big vein, large, 19s. 6d. to 21s., less 2½; red vein, 12s. to 12s. 6d., less 2½; machine-made cobbles, 23s. 6d. to 24s. net; Paris nuts, 25s. to 25s. 6d. net; French nuts, 25s. to 26s. net; German nuts same; beans, 17s. 6d. to 18s. net; machine-made large peas, 11s. 6d. to 12s. 6d. net; fine peas, 10s. to 11s. net; rubbly culm, 5s. 6d. to 6s., less 2½; duff, 3s. to 3s. 3d. net. Steam coal:—Best large, 17s. to 17s. 6d., less 2½; seconds, 14s. to 15s., less 2½; bunkers, 10s. to 10s. 9d., less 2½; small, 8s. to 10s., less 2½. Bituminous coal: No. 3 Rhondda, 18s. to 18s. 6d., less 2½; through, 15s. to 15s. 6d., less 2½; small, 10s. 3d. to 10s. 9d., less 2½. Patent fuel, 13s. 9d. to 14s., less 2½.

Shipping "Combine."

The progress of the ship era, as regards the coal ports of Wales, is on the eve, to all appearances, of receiving a striking addition. When the era opened the coal fleet was limited to sailing vessels trading to Bristol and London, and all of small dimensions. From the thirties these have increased in size, and with the advent of steam power have received an intruder, as old sailors consider, which has gradually displaced sailing vessels by steamers, some of large dimensions. Leading coalowners, such as Radford, now have large fleets, chiefly steamers. One, Messrs. Tatem and Co., have now fifteen large steamers, and it is proposed to amalgamate these and form one large undertaking. The capital is to be £330,000 in £1 shares. The lowest value of any vessel of the fleet is set at 42 per cent. of the original, while the Lady Lewis, which is only two years old, is credited with 2 per cent.

Iron and Steel.

There are significant rumours of changes in the iron and steel trades of the district, but it will be wise to discountenance them for a time. At the first glance they appear to be improbable, but the trade is evidently entering upon a course so distinct from that pursued by the founders that it is not safe to deny the possibility of alterations which may be forced by the turn of affairs, or for economical reasons. At one time the existence of ironstone in a district determined the site of the furnace. Now Welsh ironstone only comes in as a very small accessory; the position on the coast has followed that of Rubio ore. The substitution of hot for cold is the chief consideration. The importation of pig iron from Spain blast was not a more vital change than that of increased production. Dowlais, for example, is being laid out for a very great increase, so large as to make it imperative to have a corresponding increase in demand. Trade continues in a very unsatisfactory state. Up to a late period, while the principal works remained in a weak state, Dowlais displayed a great deal of vitality. A smart business was being done in rails for the Colonies, and the development employed a number of men. Of late there is less being done in reconstruction, and the operatives are being reduced. A large number of mechanics and others are under notice, and at the steel works the regular time is now getting to be four days per week; foundry and locomotive shops are being similarly treated. The stoppage of important work and the issue of notices suggests some radical changes, and now that Cyfarthfa works are practically stopped, the outlook becomes serious. Dumping continues, and appears to be steadily increasing. Imports this week small. In the Swansea Valley the make of pig continues satisfactory. Metal Exchange quotations:—Hematite mixed numbers, 59s. 10½d. cash and month; Middlesbrough, 51s. 4d. cash, 51s. 7d. month; Scotch, 57s. 3d. cash and month; Welsh hematite, 62s. 6d. to 63s. 6d., delivered; East Coast hematite 62s. to 62s. 6d., c.i.f.; steel bars, Siemens, £4 10s.; Bessemer, £4 8s. 9d. to £4 10s. Other quotations: Block tin, £137 17s. 6d. cash, and £139 2s. 6d. three months; copper, £59 17s 6d. cash, and £60 16s. 3d. three months; lead, £13; spelter, £22 2s.; silver, 23½d. per ounce. According to a telegraphic dispatch received as we go to press the prices of rails, bars, and ore were slightly advanced, while the prospects generally in Wales and the Midlands assumed a brighter aspect.

Tin-plate.

The harbour returns, Swansea, last week were as follows:—Received from works 84,186 boxes; shipped during the week, 90,964 boxes; stock remaining, 130,257 boxes. The important event of the week was the annual meeting of the Swansea Metal Exchange, Col. Wright in the chair. The review by the chairman was received with great interest, and as a reliable commentary on trade, and replete with subject matter for discussion, will be widely read. In moving the adoption of the report, the chairman congratulated the attendance that the make of tin-plate, black plate, and galvanised sheets had not suffered so much in Wales as elsewhere. Last year when he addressed them the tide of trade showed a decline. The tin-plates exported in 1907 amounted to 406,328 tons, and in 1908 to 402,869 tons, a decrease of 3459 tons. Black plates in 1907 totalled 71,531 tons, in 1908 to 61,068 tons, a decrease of 10,463 tons. Galvanised sheets exported in 1907 were 467,889, in 1908 to 390,124, a decrease of 77,765 tons, or 6 per cent. The chairman, after showing the loss sustained by these items to the iron and steel industry, went on to comment upon the increased dumping. Up to 1907 the imports to which he specially alluded were shown as a total under the heading of foreign steel, and included blooms, billets, slabs, steel and tin-plate bars. In 1907 we imported 327,201 tons of these classes. In 1908 the classes were divided under three headings, viz:—Ingots, 21,147 tons; blooms, billets, and slabs, 409,206 tons; steel and tin-plate bars, 130,187 tons, making a total of 560,540 tons, which gave an increase of 233,339. This, the chairman showed, if the manufactures could have been confined to Wales, would, roughly stated, have kept five blast furnaces, two steel works, and two collieries fully employed. Concluding a long and able survey of conditions and prospects, the chairman deduced a valuable moral, showing that foreign rivalry emphasised the necessity for the retention and improvement of trade relations and freedom from labour troubles, and maintaining the excellence of make and manufacture. Latest prices: Ordinary tin-plates, Bessemer primes, 12s. 1½d. to 12s. 3d.; Siemens primes, 12s. 1½d. to 12s. 3d.; ternes, 21s. 3d. to 21s. 6d.; c.a. roofing sheets, £8 7s. 6d. to £8 10s.; big sheets for galvanising, £8 10s. per ton; finished black plate, £9 10s. per ton; galvanised sheets, 24 g., £10 5s. to £11 nominal.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

MR. VINCENT S. ALLPRESS asks us to state that in future all letters and correspondence, &c., should be addressed to him either at 39, Victoria-street, Westminster, or to Southwick, Sussex.

THE British Griffin Chilled Iron and Steel Company, Limited, asks us to state that the recent fire at 139, Cannon-street, will in no way affect its business, but that on and after Wednesday, the 1st September, its London address will be 81, Cannon-street, E.C.

MR. T. R. WILTON, B.A., informs us that he has commenced practice at 18, Westminster Chambers, 1, Crosshall-street, Liverpool, as a civil engineer. Mr. Wilton was for many years an assistant to Mr. A. G. Lyster, M. Inst. C.E., Engineer in Chief to the Mersey Docks and Harbour Board.

THE Hon. Alexander Murray, M. Inst. C.E., Colonial Engineer and Surveyor-General to the Government of the Straits Settlements, is retiring on pension, after a period of no less than thirty-eight years' service in the Eastern Colonies. He has held his present appointment since January, 1898, when he left the Ceylon Public Works Department, where he had risen to be Assistant Director of Public Works. During the decade in which he has been head of the Straits Settlements Public Works many important works have been put through in the three Settlements of Singapore, Penang, and Malacca, while in the last year or two Labuan has been added to the original Settlements. During this time the expenditure of the Colony on public works has been trebled and the staff doubled.

INSTITUTION OF MINING ELECTRICAL ENGINEERS.—A Council Meeting of the Institution of Mining Electrical Engineers was held at the Royal Victoria Hotel, Sheffield, on Saturday, the 21st inst. A report was presented by the Hon. Secretary, Mr. J. G. Williams, 3, Moresby Parks, Whitehaven, showing that the membership had reached 300, with a prospective immediate increase to 400 by the addition of candidates who had not yet been formally elected. The Draft Memorandum and Articles of Association were submitted and provisionally approved. It was resolved to create a Diploma Class of Membership, to which candidates could only obtain admission by examination, after having had an approved term of practical experience in charge of electrical plant in mines. It was further arranged that entrance fees should be payable by members of all classes who join after the incorporation of the Institution,

NOTES FROM GERMANY, FRANCE, BELGIUM, &c.

(*From our own Correspondent.*)

Rheinland-Westphalia.

IN spite of a slightly better employment that can be noticed in some departments, quotations leave much to be desired, and the competing mills have even succeeded in further reducing the prices for bars. At a recent meeting of the Steel Convention it was stated that the amount of orders booked at present is 300,000 t. higher than at this time last year. Inland demand in semi-finished steel was stated to have slightly improved, exports remaining limited. Present quotations are to be maintained during the next quarter. In the beginning of the present month the orders booked for sectional iron were 75,000 t. higher than in August, 1908, while deliveries during the first seven months of this year were 174,000 t. higher than in the corresponding period last year.

The Silesian Iron Market.

A greater activity in the building line has caused inland demand for girders and sectional iron to rise, and five to six weeks are the terms of delivery now generally asked, against two to three weeks in last month. Rates have not shown any forward movement; offers of West German firms are plentiful, prices rarely exceeding M. 91 p.t., free Rhenish-Westphalian works, while merchant iron from the Saar is being sold at M. 88 p.t. at works, and this has forced the Silesian ironworks to maintain their low rates; export to any but the nearest countries is quite out of the question. Of the plate market much the same is reported, employment showing an improvement, while quotations remain unremunerative. Official quotations of the Düsseldorf 'Change from August 6th are as under:—Raw spathose ore, M. 10.90; roasted ditto, M. 15.50; Nassau red iron ore, M. 11.50 per ton net at mines. Spiegeleisen, 10 to 12 per cent. grade, M. 60 to M. 63; white forge pig, M. 55 to M. 58; iron for steel making, M. 54 to M. 56; German Bessemer, M. 56 to M. 58; basic, free place of consumption, M. 48 to M. 50; Luxemburg forge pig, free Luxemburg, M. 43 to M. 45; Luxemburg foundry pig, No. 3 M. 45 to M. 46; German foundry pig, No. 1, M. 54 to M. 56; No. 3, M. 53 to M. 55; German hematite, M. 55 to M. 57; common bars in basic, M. 95 to M. 100; iron bars, M. 122.50 to M. 125; hoops, M. 120 to M. 122 50; steel plates, M. 104 to M. 110; boiler plates, M. 114 to M. 120; sheets, M. 117.50 to M. 125, all per ton, free at works.

Austria-Hungary.

There was a little more life felt in the bar and girder department, German imports being less, but there was not much business done generally, a languid tendency prevailing in most branches. In pit coal, as well as in brown coal, a satisfactory business has been transacted, and there will be more life presently, the sugar mills now coming forward with more orders.

Iron and Steel in France.

Makers of semi-finished steel have been doing a fairly remunerative business of late; buyers have come forward more freely with their contracts, and the export trade shows an improvement of 40 to 50 per cent. against previous months. The rolling mills and constructional shops purchase freely, French railway companies having placed numerous orders for locomotives and wagons, and the rail works are well occupied. A contract of 20,000 t. rails was recently placed with some of the leading firms. The mills of Pont à Mousson are doing a good export trade, having secured 16,000 t. pipes for Mexico, and also for Cairo. For merchant iron 155f. to 160f. p.t. is generally paid in the North, which means an advance of 5f. p.t. against previous months; in the Haute-Marne and Centre 165f. to 170f. p.t. are given, and in the Loire 180f. p.t. Girders are in improving request at 190f. p.t. Heavy plates, being in rising demand, have realised 5f. p.t. more than in last quarter. In the Haute-Marne 3 mm. plates are quoted 190f. to 195f. p.t.; in the East and North 165f. to 170f. p.t. are usually given. On the French coal market good trade is reported, especially in engine fuel.

Fair Activity in Belgium.

There is no change in the character of the trade in iron and steel; purchases have rather increased in volume, as more work is coming forward in the manufactured iron department. Some mills have been able to raise bars to £4 10s. f.o.b. Antwerp, while those in less active occupation quote £4 9s. per ton. Plates and sheets generally meet with better request. A somewhat fluctuating tendency was felt on the pig iron market, foundry pig varying between 65f. and 66f. p.t., while forge pig iron only realises 65f. p.t. Compared with last year, output in pig iron shows an improvement; of 44 existing blast furnaces 36 only are in blow, with a daily output of 4800 t. Production in July was 148,110 t., against 102,890 t. in the year before, and during the first seven months of this year 887,390 t. were produced, against 681,270 t. during the same period last year. On the Belgian coal market a steady and remunerative trade is being done.

AMERICAN NOTES.

(*From our own Correspondent.*)

NEW YORK, August 15th.

CHANGES of conditions come suddenly in the United States. The collapse of railway building two years ago and the cutting down of expenses in every conceivable manner left the great iron and steel industry with 40 per cent. of its trade practically cut off. Many influences have united to keep the railroad companies out of the market until recently. The last department in the steel industry to improve is the steel rail industry. Within a very short time orders have begun to flow in. Western mills are deriving the first benefits. The Illinois steel mills and the great Gary plant have now more orders for rails than they can complete by the close of the year by upwards of 100,000 tons. Overflow orders are being sent east. The cause of this sudden burst was the action of three large railway systems in ordering equipment amounting in value to 23,000,000 dols. Thousands of buyers of securities are again buying, and quotations for railway and industrial stocks show a steady upward tendency. Large orders for steel are arriving at eastern plants, and the possibility of not obtaining deliveries in time to suit is leading to a rush of orders by some large buyers. During the month of June the orders for cars amounted to 7600, for July 25,000, and thus far in August 30,000. The strike at the works of the Pressed Steel Car Company, near Pittsburgh, continues.

In structural steel the demand is again large, and orders for early delivery cannot be taken care of. The plate mills by this time are all full of work, and a large amount of business is in sight for the autumn months. The furnace interests are rejoicing over the complete transformation of their business. Prices are quietly moving upwards, especially in steel-making iron. An additional source of activity is found in the shipyards along the Atlantic Coast. The rapid development in the Southern States, especially in the cotton and mineral belts, has stimulated commercial relations. The result is a demand for shipping facilities. All the yards are now running to full capacity. Among recent rail orders are 20,000 tons by the Baltimore and Ohio Road, 10,000 tons by the Chicago and Great Western, and 5000 tons by Burlington. The Pennsylvania Company has added to its recent order cars which will cost three million dollars. Greater activity prevails in copper. During July the Copper Producers' Association report an increase in deliveries of 32,000,000 pounds. Arrivals of tin this month 10,000 tons in round figures.

BRITISH PATENT SPECIFICATIONS.

When an invention is communicated from abroad the name and address of the Communicator is printed in italics.

When the abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent-office Sale Branch, 25, Southampton-buildings, Chancery-lane, London, W.C., at 8d. each.

The first date given is the date of application; the second date at the end of the abridgment is the date of the advertisement of the acceptance of the complete specification.

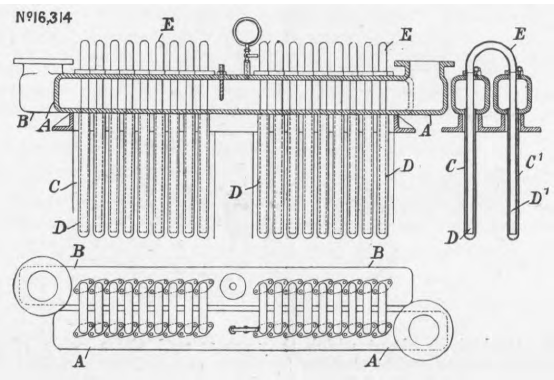
Any person may on any of the grounds mentioned in the Acts, within two months of the date given at the end of the abridgment, give notice at the Patent-office of opposition to the grant of a Patent.

STEAM GENERATORS.

16,314. August 1st, 1908.—IMPROVEMENTS IN APPARATUS FOR SUPERHEATING STEAM, Andrew Bolton, of 49, Deansgate, Manchester, and Thomas Carter Beeley, of Hyde Junction Ironworks, Hyde, both in the County of Lancaster.

Two separate boxes as A and B are provided placed parallel to each other, one box being for the inlet and the other box for the outlet of the steam, each box having one or more rows of tubes $C\,C^1$ depending therefrom; the upper ends of these tubes are open, and are expanded in the bottom of the separate boxes, and the bottom ends of the tubes are closed. Tubes $D\,D^1$ of lesser diameter are placed within and extending respectively nearly to the bottom of the closed ended tubes; the bottom ends of these inserted tubes are open, and the upper end of each of the inserted tubes D on the inlet side or box is connected to the upper end of a corresponding tube D^1 on the outlet side or box B by a semicircular tube E. By these means the steam entering the inlet box A will pass down the set of tubes C whose bottom ends are closed, ascend the tubes D inserted therein, pass through the semicircular connecting tubes E, pass down the inserted tubes D^1 connected therewith, ascend the closed ended tubes C^1 in which they are inserted, and enter the other or outlet box, passing from thence to the outlet pipes. There are seven illustrations.—*August 4th*, 1909.

Nº16,314

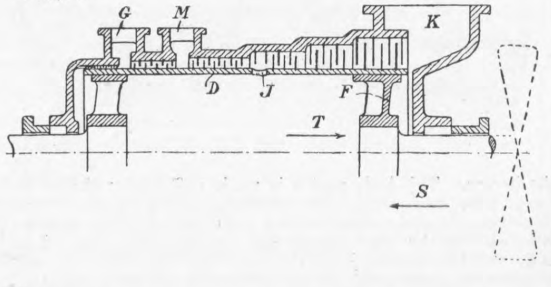


TURBINES.

19,744. September 19th, 1908.—IMPROVEMENTS IN AND RELATING TO BALANCING MEANS FOR STEAM TURBINES, *Carl Roth, of* 9, *Anna Scrarse Zehendorf, near Berlin.*

Steam enters by the pipe G and passes through the blades below it. At a point J any suitable connection is made to the interior of the drum. For instance, an opening is provided in the drum D to admit steam to the inside of the drum, and from the opening J the blading on the drum and casing is continued to the exhaust K. At a convenient distance between the steam inlet G and the opening J, the inlet M from the overload valve is arranged. The drum is of constant diameter throughout its length, and no end balancing faces are provided on which there is a resultant pressure. The shaft is continued outside the casing towards the right, and carries the propeller. The direction of the thrust on the propeller is that shown by the arrow S, while the direction of the pressure on the turbine blades and also on the closed disc F is that of the arrow T. When the end pressure on the propeller shaft varies, the load on the turbine also varies, and in consequence the pressure of steam passing through the opening J alters. Thus if the end pressure of the propeller shaft increases and the overload valve is opened so that steam passes through the opening M, the pressure of steam passing through the opening J in the turbine drum is increased, and in consequence the resultant end pressure on the closed disc F is also increased. In this way automatic control of the end pressure is secured. There are two other modifications.—*August 4th*, 1909.

Nº19,744

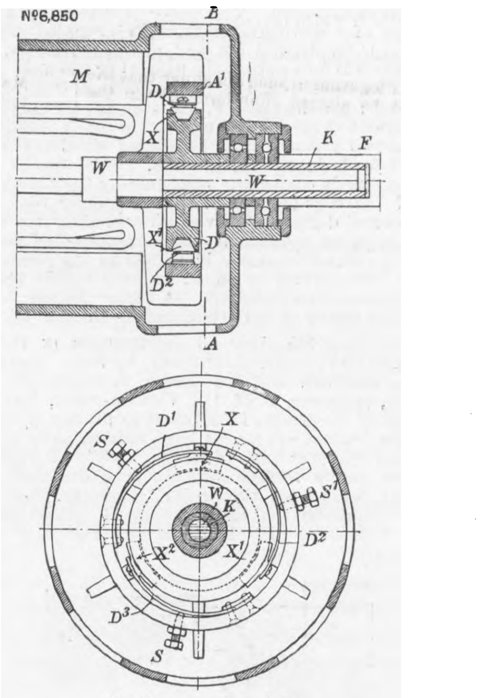


TRANSMISSION OF POWER.

6850. March 22nd, 1909.—IMPROVEMENTS IN FRICTION COUPLINGS ADAPTED FOR USE WITH ELECTRO-MOTORS FOR DRIVING MACHINE TOOLS AND THE LIKE, *La Société Anonyme Electricité Electro-mécanique, of* 34, *Rue du Bosquet, Brussels, Belgium.*

This invention has for its object to avoid the overload and the consequent premature disabling of electric motors, and to this end an improved adjustable friction coupling, of the kind provided with friction driving blocks carried by spring arms adjusted by screws, is employed. On the shaft W of the electro-motor M one member A^1 of the coupling is secured. A sleeve K turning freely on the shaft W carries at one end the second member D of the coupling, the other end of the said sleeve having secured thereon the tool carrier F or the like, which may, for example, carry a drill or boring tool. The outer surface of the member D is provided with a V-shaped groove into which friction blocks $X\,X^1\,X^2$, carried by springs $D^1\,D^2\,D^3$ attached to the member A^1 are pressed by means of the screws *s s s*. The power transmitted from the motor to the tool thus depends upon the frictional resistance of the blocks $D^1\,D^2\,D^3$, which latter may be regulated proportionally to the power. When the load becomes too heavy and tends to overload the motor, the friction blocks $D^1\,D^2\,D^3$, being adjusted by the screws to the overload point of the motor, will slip, thus preventing any overloading of the motor and breaking of the drill or other tool.—*August 4th*, 1909.

Nº6,850



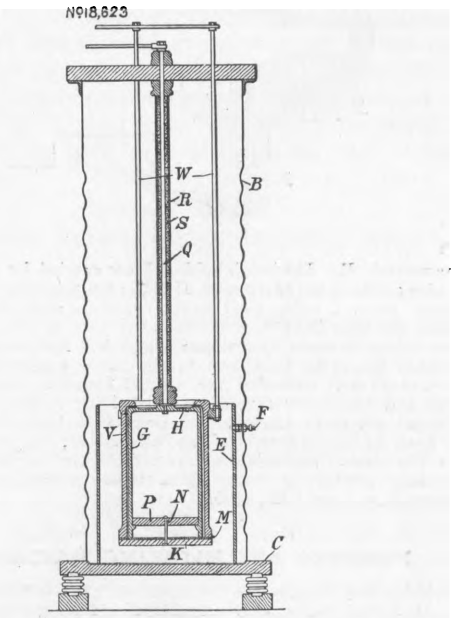
Section on line A.B.

SWITCH GEAR.

18,623. September 4th, 1908.—IMPROVEMENTS IN ELECTRIC STARTING SWITCHES USING LIQUID RESISTANCE, the Sandycroft Foundry Company, Limited, engineers, and Thomas Murthwaite Dutton, both of Sandycroft, Chester.

The liquid is contained in a tall metal cylinder B, which is corrugated to assist in the dissipation of heat. The container is mounted upon a base C, which has supports of porcelain. Within this cylinder there is provided a cylindrical electrode E, which may be of wrought iron, and which is joined to a connecting nut F. The inner electrode G is also cylindrical, and is preferably of cast iron. The casting is closed at the upper end, which, however, is protected by a layer H of enamel or other suitable insulating material. At the lower end the mouth of the cylinder is closed by a plate of wood or the like K, between which and the edge of the cylinder G a tight joint is made by an india-rubber or other packing M. The plate K is pressed against the mouth of the cylinder by a bolt N passing through it and through a crosspiece P resting against projections in the interior of the cylinder. This inner electrode, with its bottom cover, is supported in the vessel by means of the conductor Q, through which the current passes. This conductor is surrounded with an iron tube R filled with bitumen or the like S. Porcelain insulators are preferably interposed at the top and bottom of this tube. With cylindrical electrodes the insulating screen V also takes the form of a cylinder, which, however, is open at both ends. This cylinder is supported by a number of rods W, by means of which it may be raised or lowered in the liquid. The screen may be made of porcelain or other insulating material, or of enamelled iron or the like.—*August 4th*, 1909.

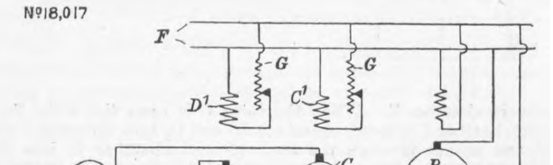
Nº18,623



DYNAMOS AND MOTORS.

18,017. August 27th, 1908.—IMPROVEMENTS IN OR RELATING TO THE REGULATION OF ELECTRIC MOTORS, Siemens Brothers' Dynamo Works, Limited, of York Mansion, York-street, Westminster.

Nº18,017

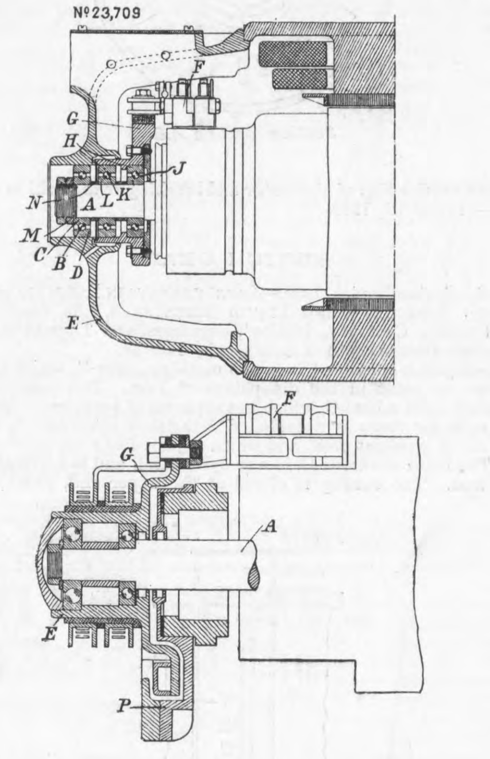


This invention has reference to improved arrangements either for regulating the speed of direct and single or polyphase commutator motors with separate or shunt excitation, or for improving the power factor in the case of alternating current motors. The object of the invention is to maintain a high electrical efficiency under all conditions of load and speed. A indicates the motor whose field and armature voltage are to be altered as described in the complete specification. This motor is driven by a combined set consisting of a driving motor B which is coupled mechanically to a dynamo C for driving the first mentioned motor, and to a second dynamo D for exciting the field A^1 of the first mentioned motor A. The fields C^1 and D^1 of the dynamos C and D are separately excited from the mains F, and each has a voltage regulator G. The regulators are coupled together in such a manner that the fields of the two dynamos must be altered simultaneously in the manner set forth in the specification. This can be done, for example, by merely connecting mechanically together the sliding contacts of the regulators G in such a manner that they each move to an equal degree, and by suitably grading the resistances to give the required variation in the currents of D^1 and C^1. If, however, the resistances cannot be graded in the manner desired the sliding contacts may be geared together so that the required relative movements are obtained. A vector diagram is given for explaining the theory of the arrangement.—*August 4th*, 1909.

23,709. November 5th, 1909.—IMPROVEMENTS IN BRUSH GEAR FOR DYNAMO-ELECTRIC MACHINERY, by Peter Logan Raeburn Fraser, engineer, and the Tudor Accumulator Company, Limited, engineers, all of 119, Victoria-street, London, S.W.

The object of the present invention is to provide a construction in which the brushes are moved over with certainty immediately the rotation changes its direction, while during running there is no undue friction on the armature shaft. In the arrangement shown in the upper engraving, the armature shaft A is supported on ball bearings B, placed between an inner race C fixed to the shaft and an outer race D on the framework E. The brush holders F are carried by a frame G to which are fixed the outer races H of the ball bearings J and K, the inner races L being fixed to the armature shaft A. The inner races are kept in position between the nuts M and a shoulder on the armature shaft by distance pieces N. According to another form of the invention shown in the lower engraving the armature shaft A is extended for a short distance through its bearings and the inner race of a ball bearing is fixed on the shaft beyond the main bearing. The frame G carrying the brushes F is fixed to the outer race of the ball bearing, and can turn freely on the shaft. Suitable stops are provided on the frame P of the machine, preventing the rotation of the brushes too far in either direction.—*August 4th*, 1909.

Nº23,709

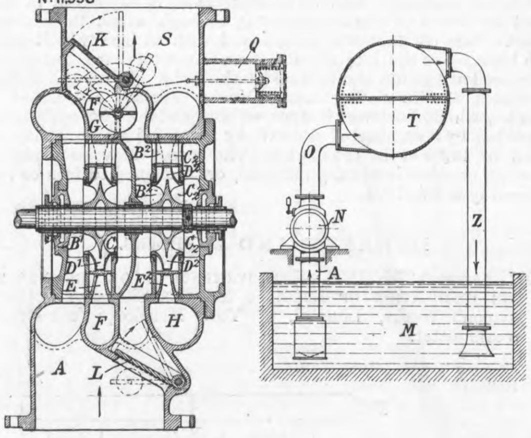


PUMPING AND BLOWING MACHINERY.

11,558. May 15th, 1909.—IMPROVEMENTS IN CENTRIFUGAL PUMPS, *Gebrüder Sulzer, of Winterthur and Ludwigshafen a-R, in the Empire of Germany.*

This invention relates to a multiple coupled centrifugal pump in which the coupled pumps may operate in series for producing a suitably high pressure, or in parallel for pumping a suitably large quantity. The water flows from the suction pipe A through the chambers B^1 C_1, the first disc D^1, and the duct E into the first delivery chamber F. When the valve G is open the water flows from chamber F through chambers B^2 and C_2 into the second disc D^2, and thence through the duct E^2 and chamber H into the delivery pipe S. Since the pressure in the pipe S is in excess of that in chamber F, the valve K remains closed; so also does the valve L, for the pressure in chamber B^2 exceeds that in pipe A. When the pump discs D^1 and D^2 are to operate in parallel, the valve G is closed, so that the first disc delivers water directly into pipe S, and the second sucks water directly from pipe A. In the right-hand engraving the water circulates from the reservoir M through pipe A, pump N, pipe O, condenser T, and pipe Z. For moving the valve G a device Q is used, which consists of a piston, subject on the one hand to the pressure in pipe O, and on the other hand to a spring, such that when the pressure in O falls below a predetermined value the valve G is shut. The spring is so adjusted that the valve G is automatically shut as soon as the pipe Z becomes full of water, and therefore acts to assist the lift of the pump, diminishing the pressure in pipe O.—*August 4th*, 1909.

Nº11,558

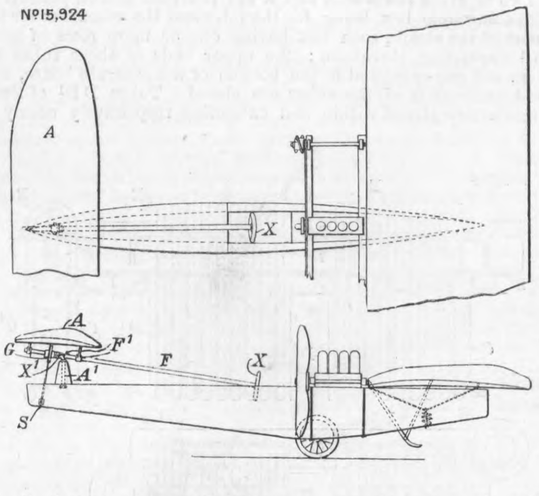


AERONAUTICS.

15,924. July 27th, 1908. — IMPROVEMENTS IN AERONAUTICAL MACHINES, Thomas Wigston Kingslake Clarke, of St. Catherine's, Mapa-road, Surbiton.

For steering the machine, either or both of the supporting surfaces, but preferably the leading one, is mounted on a central pivot A^1, and is provided with a lever F, furnished with a steering wheel X, and mounted in a bearing which is pivoted at F^1. By raising or lowering the lever the plane of the supporting surface may be canted to an angle oblique to the main axis of the machine. The lever is, moreover, mounted in bearings X^1, to work as a spindle, and is furnished with a drum or drums G, to which cords are attached, or about which they are wound, these cords, after passing around guide sheaves S, being respectively attached to the outer extremities of the supporting surfaces, or alternatively to the frame, so that upon turning the spindle F and its drum or drums, either one extremity or the other of the supporting surface A is depressed, according to the direction in which the spindle is rotated. By these means the angular position of the supporting surface A, even when rigid in character, may, by the manipulation of a single steering wheel, be set obliquely to the plane of flight, or may be tilted laterally about its transverse axis. It may also, if deemed desirable, be pivoted about its vertical axis A^1 at right angles thereto.—*August 4th*, 1909.

Nº15,924

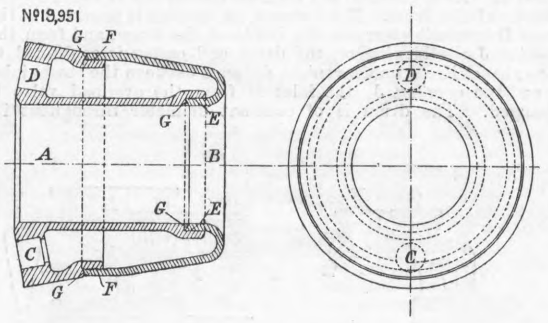


MISCELLANEOUS.

19,951. September 23rd, 1908.—IMPROVEMENTS IN THE MANUFACTURE OF TUYERES FOR BLAST FURNACES, William Haigh Benson, Woodlands, Ashgate-road, Chesterfield.

The present invention has for its object to reduce to a minimum the cost of maintenance of blast furnace tuyeres. The tuyere is made as usual in two parts, respectively A and B. The body part A, which is made of cast copper, is provided with an inlet C and an outlet D, allowing the cooling water to flow freely through the tuyere. This body part A is made sufficiently strong to last for an indefinite period. The renewable nose B is made of wrought drawn copper and screwed in the body part A. The inside joint E which is in the blast passage has a sliding joint bevelled at the end, and the outside joint F is bevelled and screwed, suitable recesses being provided for the purpose in the body part A. This method of connecting the two parts has been found the most convenient for changing the noses rapidly.—*August 4th*, 1909.

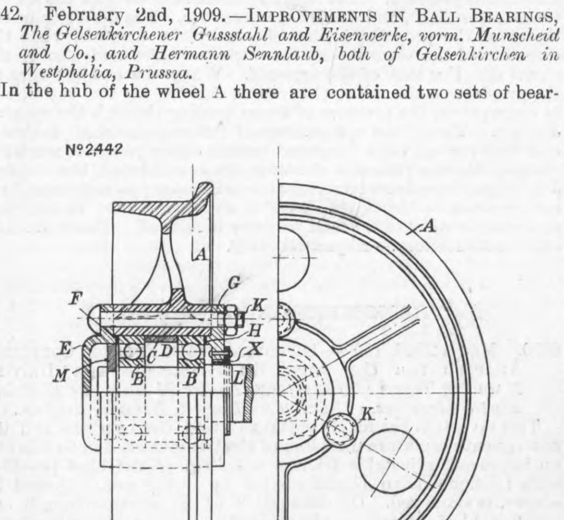
Nº19,951



2442. February 2nd, 1909.—IMPROVEMENTS IN BALL BEARINGS, *The Gelsenkirchener Gussstahl and Eisenwerke, vorm. Munscheid and Co., and Hermann Sennlaub, both of Gelsenkirchen in Westphalia, Prussia.*

In the hub of the wheel A there are contained two sets of bearing rings B, each consisting of an outer and an inner ring provided with ball-races for the balls, which by mechanical means are pressed between the rings so as to form with them a complete structure, the displacement of these bearing rings being prevented by means of the distance ring C, the interior D of which serves as a receptacle for lubricating material. The axle L with its bearing and distance rings are secured in position in the hub by means of a ring or flange G and a cover E, which are clamped together by screw bolts K passing through the hub, whilst longitudinal displacement of the whole of the axle L is prevented by a transversely divided ring M that is lodged within the cap E, and engages with a peripheral groove in the axle L. The cover E is provided with a washer F, and the flange G with a felt ring H; whilst to the flange G there is riveted a leather packing X which prevents the escape of the lubricating material and the entry of dust. Upon drawing together the flanges G and C by means of the screw-bolts K the entire device is firmly clamped together and is kept in position on the shaft L by the divided ring M.—*August 4th*, 1909.

Nº2442



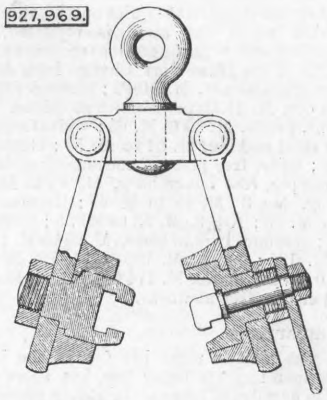
SELECTED AMERICAN PATENTS.

From the United States Patent-office Official Gazette.

927,969. ROPE PULLEY MADE IN TWO PARTS, *J. F. Henry, Boulogne-sur-Mer, France.—Filed December 7th*, 1908.

This is a patent for a pulley which can be opened as shown to release a rope, and so save time in overhauling it. There is only one claim.

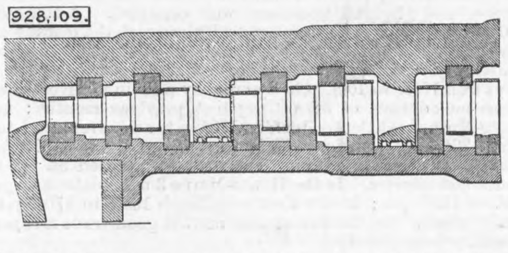
927,969.



928,109. ELASTIC FLUID TURBINE, *C. G. Curtis, New York, N.Y., assignor, by mesne assignments, to General Electric Company, a Corporation of New York.—Filed November 1st*, 1907.

This is a species of covering patent, with ten claims. The second gives a good idea of the nature of the patent. A turbine having a shell and a drum, there being a passage for working fluid between the shell and drum, rows of fixed and moving buckets within the passage, with large clearances between the relatively moving surfaces and a diaphragm dividing the passage into stages of different pressures, there being one row at least of fixed and a plurality of rows of moving buckets in each stage, the said diaphragm having a central opening in which the drum rotates.

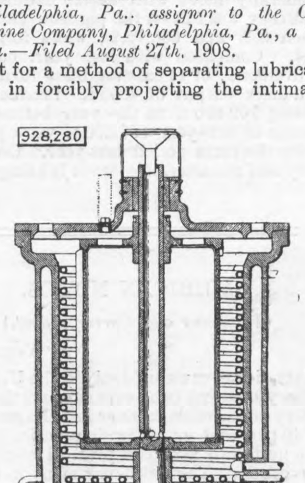
928,109.



928,280. PROCESS OF SEPARATING WATER FROM OIL, *J. W. Pittock, Philadelphia, Pa., assignor to the Oil and Waste Saving Machine Company, Philadelphia, Pa., a Corporation of Pennsylvania.—Filed August 27th*, 1908.

This is a patent for a method of separating lubricating oil from water, consisting in forcibly projecting the intimately mixed oil and water as a spray against a surface heated to a temperature sufficient to evaporate the water but insufficient to decompose the oil, whereby the water is vaporised and the oil remains in a liquid state. There are five claims.

928,280



CONTRACTS.—Hudswell, Clarke and Co., Limited, of Leeds, have just received an order for six locomotive boilers from the Rhymney Railway Company, South Wales.—The contract for pumping plants for the Alexandra Dock, Newport, has just been let. The pumping plant proper will consist of two main pumps coupled direct to two triple-expansion steam engines, two separate 500 kilowatts generating sets being installed for lighting and power purposes. The pumps will be capable, when working simultaneously, of pumping 50,000,000 gallons of water from the river Usk into the dock extension in a period of five hours, the average quantity of water delivered during this period by one pump being 80 000 gallons per minute. The same pumps will be used for emptying the graving dock, which will be built at a future date. In this case the pumps will work against a total head of 42ft., and will each deliver an average quantity of 100,000 gallons per minute. The main contractors for the whole of the scheme are Cole, Marchent and Morley, Limited, of Bradford, while the pumps are being built to the designs of Jens Orten-Boving and Co., by Willans and Robinson, of Rugby.

AUGUST.

On the evening of Saturday, July 14th, a disastrous outbreak of fire occurred on board the Cunard liner Lucania while lying at her berth in the Liverpool docks. The fire, which is believed to have commenced in the saloon galley, soon spread into the forward parts of the vessel, and when the Liverpool fire brigade arrived at the quay, it was found that the entire woodwork in the first-class saloon and elsewhere was rapidly being consumed. It was soon seen that the efforts of the brigade, which was employing two motor fire engines, in addition to taking water from the mains and from four fire tenders, would be unable to overcome the outbreak. Accordingly, it was determined to sink the vessel by admitting the water of the dock into her. But difficulties were encountered when this came to be carried out, as the ship took a lurch towards the quay, damaging her funnels by striking some cranes, and imperilling firemen who were on her at the time. The services of tugs were then employed to restore her to an upright position, and to hold her there until she settled. This she finally did, and sank in about 30ft. of water. After raging for about sixteen hours the fire was thus ultimately extinguished. Great damage was done, but this would certainly have been considerably more had not the engine-room bulkhead prevented the flames from reaching the afterpart of the ship.

It will be remembered that when the Chancellor of the Exchequer presented his Budget in the end of April he made certain promises as to schemes for road improvement, for which he proposed to raise money by taxes laid upon motor cars and petrol. The Government have now laid before the House of Commons a Bill designed to secure this object. It is called the Development and Road Improvement Bill, and is divisible into two sections. The first gives the Treasury power to devote for five years, half a million pounds per year for improvements connected with, agriculture, fisheries, the construction of canals, harbours, tramways, and so on. The money in this case will be drawn from the consolidated funds. The second part of the Bill directs the employment of the money raised from motor car taxation alluded to above. It contemplates the creation of a Road Board, whose function will be (*a*) to construct and maintain new roads; (*b*) to make advances to highway authorities towards the construction of new roads or the improvement of existing roads which appear to the Board to be required for facilitating motor traffic. The roads built under these terms are to be reserved wholly for motor traffic, and a toll may be imposed on any other traffic desiring to use them. There will, it is understood, be no speed limit, but the other clauses of the Motor Car Act of 1903 will be enforced. Powers will be given for the compulsory acquisition of land, and the Board will have the right to secure on each side a width of 220 yards from the centre of the road. The amount of money available in the first year was estimated by Mr. Lloyd George at £600,000, but it will, of course, increase as the number of motors augments.

Several interesting events connected with the lighting and marking of the coasts of the United Kingdom have to be noted in the month of August. On August 12th a submarine bell was put into service at the Nab Lightship in the approaches to Portsmouth, and the experimental submarine bell fitted to a buoy at the Bullock Patch in neighbouring waters at the end of June is said to have given satisfactory results. The submarine bell at the head of the Mail Pier in Holyhead harbour, which was also established at the end of June, is worked by hand when the arrival of steamships is expected during foggy weather, and official announcement is now made that the bell to be placed on the sea bed in deep water off the North Stack, near Holyhead, will be in operation on and after October 14th next. This signal, which we have already referred to in these columns, will be operated from the shore. Notice has also been given that on and after the same date the Kish Bank light vessel, between Holyhead and Kingston, will sound a submarine bell during foggy weather. There will shortly be twelve light vessels in home waters, equipped with submarine bells, in addition to buoy and shore stations. The unwatched gas-lighted boat, which we described and illustrated in our last issue, is to be permanently moored in the Lune Deep in Morecambe Bay. This vessel is fitted for the reception of a submarine bell to be actuated by the motion of the vessel, but the bell has not yet been provided, and no official announcement respecting it has been made. The construction of the Lune Deep boat marks a new departure on the part of the Trinity House, although numerous similar unattended gas-lighted vessels have been in use for several years in Scotland, France, and at Calcutta and Bombay. The Lune Deep differs, however, from earlier examples of the same class in that it is provided with a flashing light with revolving optic instead of a fixed optic with occulting gas burner. The old revolving light at the South Stack lighthouse is now being replaced by a more powerful flashing light which will be lighted in October next, and early in August the occulting light on Bardsey Island, off the Carnarvonshire coast, was replaced by a white flashing light giving five short flashes in quick succession every 15 seconds. At the same time the use of the Cardigan Bay light-vessel was discontinued.

The Welsh Railway Bills, which were considered by Lord Camperdown's Committee in May last, and in due course of time passed the House of Lords, have been before Sir G. Doughty's Committee in the House of Commons during July and August. No less than twenty-six days were occupied in considering the Taff Vale Bill in the Commons, and on August 26th the Committee came to the conclusion that the preamble was not proved so far as it related to the purchase of the Cardiff Railway Company. The purchase clauses formed by far the most important part of the Bill, providing for the transfer of the Cardiff Railway, whose capital stands at £6,333,300, in exchange for a payment of £5,083,300 in Taff Vale Railway Stock. The principal petitioners against the Bill were the Barry Railway Company, the Alexandra (Newport) Docks and Railway Company, and Lord Plymouth. On the other hand, the Bill was supported by the Great Western Railway Company, Lord Bute—who is the principal shareholder in the Cardiff Railway Company—the Cardiff Corporation, and the Rhymney Railway Company. In view of the Committee's decision the promoters decided not to proceed with the other Bill for the Amalgamation of the Rhymney Railway Company with the Taff Vale Railway Company, and it was accordingly abandoned. The decision of the Commons Committee against the fusion of the companies' interests has come somewhat as a surprise, especially after the successful passage of both Bills through the Lords. All classes of Cardiff, Taff Vale, and Rhymney Railway shares fell considerably on the announcement of the Committee's decision, the Cardiff Preferred dropping 6 points to 86. On the other hand, there was a corresponding rise in Barry Railway stock. It is not unlikely that a fresh attempt to bring about the amalgamation of the three South Wales companies will be made next session.

The Brazilian Government have placed the contract for the floating dock intended for the accommodation of the new battleships of the Dreadnought type in the hands of Vickers, Sons and Maxim, Limited, of Barrow-in-Furness. Eight tenders were submitted to the Government, those sent in by the three British firms competing being based on designs prepared by Messrs. Clark and Standfield. The dock is designed for the reception of battleships of the Minas Geraes class, and will be of the "bolted-sectional" self-docking type. The pontoon will be divided into three sections, having a total length of 550ft. 6in., with a clear width at entrance of 100ft. Battleships drawing up to 36ft. and displacing 22,000 tons undamaged will be lifted by the dock. The contract includes an elaborate installation of boilers, engines, cranes, electric lighting, and pumping machinery. An interesting feature is the provision of a cooking plant for 750 men for use when the galley arrangements of the docked ship are not available. The dock is to be delivered at Rio de Janeiro within eleven months from the commencement of the work, which allows the short time of about nine months for construction. The work will be watched with considerable interest in this country, in view of the decision of the Admiralty to construct two similar docks for British Dreadnoughts. The new dock will be the largest ever constructed in this country, and, in fact, in any part of the world outside Germany, where there are two—one completed and one being built—of still larger capacity. The Bermuda Dock, the largest floating dock yet built in this country, has a lifting capacity of 16,500 tons. The cost of the dock will be £182,700 complete, which works out at under £8 10s. per ton of lifting capacity, or about £7 10s. per ton on the value of the work in this country, exclusive of cost of towage to Rio.

The passing of the London County Council General Powers Bill is now assured, and the measure marks an important step in the history of building construction in this country. Engineers are not primarily concerned in many of the details of the Bill, but the clauses which deal with steel frame construction and reinforced concrete buildings affect them to a considerable extent, although, naturally, architects and builders are interested in a still greater degree. Hitherto, not only in London, but throughout the country generally, except in the case of buildings such as those erected by railway companies and authorities exempt from local control, the adoption of steel frame construction in any form did not relieve the building owner from the necessity of erecting walls of the thickness specified in the London Building Act of 1894 or the numerous local by-laws. The absurdity of encasing steel-framed structures adequately stable in themselves with stone or brickwork of unnecessary thickness has long been recognised, and the County Council Bill is the rather tardy outcome of the deliberations of the Building Act Committee of the Council. Clauses are provided which will enable a builder, if he so desires, to obtain exemption from certain of the requirements of the old Act if he satisfies the district surveyor that the design of the proposed building warrants such exemption. The Bill was met by considerable opposition from professional bodies and others, including the Institution of Civil Engineers, not on account of the general principles of the measure, but in reference to details of administration, especially as to the proposed control of the Council over internal construction and on the question of appeal. Objections were also raised to the stereotyping by Act of Parliament of rules relating to methods of construction, which are always in a state of development and change. In the end the Committee on the Bill admitted the right of appeal, and upheld the principle of Parliamentary sanction to the proposed regulations. Incidentally the Act will give powers to the County Council to make regulations in respect of structures of reinforced concrete.

There has been considerable talk in Germany from time to time about establishing regular airship communication between various places. It is, of course, extremely doubtful whether regular aërial communication by means of balloon airships will ever be possible. But the idea of organising more or less regular aërial pleasure trips with Zeppelin airships has now assumed a tangible shape. During the latter part of the month a large number of circulars signed by influential persons was distributed, inviting persons to partake in the formation of a company whose object it shall be to maintain airships at Frankfort-on-Main for pleasure cruises up and down the Rhine, round the Taunus mountains and the Odenwald, and for trips to Cologne, Baden-Baden, Stuttgart, Nuremberg, and other towns. The present plans are to build a station with a large round shed having doors on all sides, and to commence with two Zeppelin airships. If the experience gained with these is encouraging, the airship traffic will be gradually extended, and other stations will be built at Munich, Cologne, Düsseldorf, Baden-Baden, and Strassburg. Later on other lines are to be established to Leipzig, Berlin, Hamburg, Kiel, Lübeck, &c. The question of the prospective profits of the concern is dealt with in the above-mentioned circular. To begin with a capital of three million marks will be required. Half a million will be provided by the Zeppelin Airship Building Company. It is estimated that the annual expenses will be 892,000 marks, the takings 1,050,000 marks, and the profit about 5 per cent. This calculation is based on the assumption that 150 trips of six hours, with twenty passengers, will be made by each ship annually, the fare being 175 marks.

The Irrigation Congress held in the United States in August was to some extent international, since about twenty foreign countries were represented by delegates. The work of the Congress, however, relates only to the development of irrigation in the United States, and its character is commercial rather than technical. The assemblage—which meets annually—was composed of officers of the General and State Governments, mayors, and city officials, business men as individuals or representatives of commercial bodies—such as boards of trade and chambers of commerce—engineers, farmers, and representatives of land organisations. This rather heterogeneous body listens to addresses which are largely of a political tendency, and adopts resolutions requesting the General Government to aid the cause of irrigation in various ways more or less practicable. The Government is committed to a policy of applying irrigation to its lands in the arid region, and is engaged in very extensive work of this kind. The Congress, however, lessened its own importance by demands of a most unreasonable character, especially those asking for the issue of bonds for enormous amounts for work not even planned or investigated. In this respect its action resembles that of the advocates of inland navigation. It is the popular thing now-a-days in America to demand that the Government shall endorse policies and undertake projects of various kinds—irrigation, drainage, public roads, and inland waterways—and shall, as a preliminary, provide vast sums of money to be spent under the direction of various bodies, which may be well meaning and enthusiastic, but which are certainly unfit to be trusted with the expenditures of public funds or the selection of works upon which they are to be expended. One feature of the Congress was the reiterated assertion that certain interests are absorbing lands and water rights where water power is available, and that a huge hydro-electric trust is in process of secret formation. It was urged that the Government should resume control over resources available for hydro-electric development.

Since the formation of the new French Cabinet, and the appointment of Admiral Boué de Lapeyrère as Minister of Marine, the organisation of the navy has undergone an entire change. While the Minister is following the programme of his predecessor so far as concerns the simplifying of the naval administration, he has modified the strategical disposition of the fleet, and instead of continuing the present division of the fleet into Nord and Mediterranean squadrons, there will be two squadrons, denominated first and second squadrons, each consisting of six battleships, twelve destroyers, four armoured cruisers, and one first-class cruiser. All of these vessels will be maintained with their full complement of hands. Each squadron will have attached to it one battleship and one first-class cruiser as reserves. An important reform has also been carried out with a view to facilitating the control of naval expenditure, and it is, indeed, generally recognised that since Admiral Boué de Lapeyrère has taken up his duties as Minister he has been responsible for a good deal of valuable work in increasing the efficiency of the navy.

WITH a view to studying the various systems of street lighting as carried on abroad, a deputation of the Corporation of the City of London has been making a tour through certain of the chief continental cities, and a report giving the conclusions arrived at as the result of these visits has recently been issued. It is recommended that wherever possible streets should be lighted by means of centrally-hung lamps with lowering gear. This is considered particularly important in the City of London, where the number of obstructions upon the footways in the form of lamp-posts, bins, letter-boxes, &c., is so large. Open spaces, it is maintained, should be lighted by means of lamps upon standards, fitted with lowering gear. High-pressure incandescent gas lamps, with inverted burners, are recommended as the illuminant, but where gas is impracticable, and the use of electricity is necessary, open arc and flame arc lamps are advocated. It is suggested, however, that before any drastic alterations are made in the general lighting of the City, the Streets Committee should be authorised to arrange for further experiments in the City thoroughfares. In most of the cities visited centrally-suspended lamps with lowering gear were found. At Munich as many as three lamps are hung in a row. In Berlin, Vienna, Brussels, and other cities, the practice prevails of using electricity from lighting-up time till midnight, and then using gas, but Berlin proposes to discard electricity altogether for street lighting, and is spending a very large sum on an improved gas system.

THE first aeronautical meeting has now been brought to a most successful termination. That the events at Rheims last week indicate the commencement of a fresh period in the history of man's conquest of natural forces no one can doubt who has followed with attention the series of surprising results which has been almost daily added to during the past few months. To the world at large the importance of these events lies not so much in the fact that one man completed a given distance in a few seconds less than another, as in the manner in which new difficulties and conditions of flight were met and surmounted. Thus we find that one aeronaut, in face of a high wind and a threatening storm, flew a distance closely approaching a hundred miles, while another, carrying two passengers, attained a speed of thirty-five miles an hour. But perhaps the most striking feature in this connection is the freedom from accidents which has so characterised the assembly. The early days of this form of aeronautics were overshadowed, and the progress of the art consequently retarded, by the fatal termination of so many experiments. During last week the mishaps were confined mostly to easily repaired breakages caused by careless handling, while the personal injuries to the pilots of the various machines were without exception of a minor kind. Throughout the meeting was carefully organised, and the committee of management deserves every credit for the care bestowed in connection with the comfort and safety not only of those taking part in the contests, but also of the large body of spectators who gathered from all parts to participate in the events of the week.

ON Wednesday, August 18th, an accident occurred at the village of Oliginate, a township of 2000 inhabitants on the left bank of the Adda River, a few miles south of Lecco, Lombardy, which is worth recording because of the striking demonstration it affords of the necessity of every precaution being used in high-tension installations. Like many other Italian villages in the mountainous regions, Oliginate is provided with electric power at a cheap rate from a neighbouring water-power station, the current in this case being supplied at 3000 volts by means of an overhead line from a power station at Lecco. It seems that during a heavy thunderstorm some high-tension transmission wires broke, and in falling came into contact with low-pressure distributors, with the result that the wiring in all the houses and cottages was immediately raised to a pressure of 3000 volts. In numerous instances the wiring and switches in the buildings started to fuse and burn up with disastrous results. The wiring, which was apparently of the surface type, fell about the rooms, and owing to this and the attempts which were made to use the switches, a dozen persons were killed outright and about thirty received severe shocks and burns. All the lamps were, of course, extinguished, and there was quite a panic in the village. A point about the catastrophe worthy of note is that the casualties occurred almost exclusively in the houses of the poorer classes, where the wiring was apparently crude as compared with that of the better class villas. In those few parts of our own country where high-tension transmission lines are in use elaborate precautions are taken to protect the public from danger. But in some parts of the Continent and America such things as guard nets appear to be considered altogether unnecessary, and it is somewhat surprising that calamities of this kind are not more frequent.

THE problem of carrying out public works in a city without unduly hindering traffic is evidently proving too much for M. Pontich, who presides over the thoroughfares in Paris. When it was first decided to construct the Metropolitan Railway it was understood that the road surface was to remain intact, and at first the public had little reason to complain, but during the past year or two the contractors have become increasingly bold in their encroachments upon the roads, until now Paris presents a spectacle that has probably never been seen in any other city except after an earthquake. It is scarcely possible to travel in any part of Paris without meeting huge timber structures and other impediments, and the present state of the city has become such a scandal that the public are clamouring loudly for the removal of these hoardings. So far as concerns the Metropolitan, the obstruction may be in many cases a disagreeable necessity, but there is no excuse for the continual pulling up of the streets. As soon as a section of the underground railway is completed the road is re-laid, only to be pulled up again a month afterwards for the water or gas mains, and after being further re-laid the electrical companies resume operations. The loss incurred to the municipal funds by this unnecessary pulling up of the streets must be enormous. This is given simply as an illustration of the singular want of continuity in the public services in Paris. In order to put an end to this state of things, it is proposed to create a central department which will constitute a sort of connection between the different services, so that when any particular work has to be carried out it can be so arranged that each will do its part with the least inconvenience to the public. Paris is suffering so much from a want of understanding between the various companies that a co-ordination of these services has become indispensable.

THE decision of the Cunard Company to make Fishguard a port of call for all their steamers eastward bound from New York must be a matter of considerable satisfaction to the directors of the Great Western Railway Company, who have expended, and are still spending, huge sums of money in the formation and further improvement of their new harbour for ocean-going steamers at Fishguard. It is said that Brunel, when planning the route for the South Wales section of the Great Western Railway over fifty years ago, concluded that Fishguard Bay formed the most desirable point for the western terminus of the line, but engineering difficulties supervened which, for the time, proved insurmountable, and Milford Haven was selected as the railway terminal. The costly harbour which the Great Western Railway Company opened in 1906 was constructed with the immediate object of improving the company's connections with the south and east of Ireland, but undoubtedly the directors had in view possibilities with reference to Transatlantic traffic which have at length been realised. The Mauretania inaugurated the new service on the part of the Cunard Company by calling at Fishguard on Monday the 30th August, and will be followed by the Caronia, Campania, and other vessels of the fleet. She established a new record across the Atlantic, and on her arrival was met by a special Great Western train, which took passengers to London. The passage to Daunt's Rock occupied 4 days, 14 hours and 27 minutes, or nearly three hours less than the previous record. Fishguard was reached at 1.12, and a special mail train leaving at 2.11 reached Paddington at 6.40, whilst two passenger trains leaving later arrived respectively at 7.30 and 7.56. There is a possibility that the new arrangement will be extended in the future to include calls at Fishguard on the outward voyage. The railway company proposes to run special express trains carrying mails and passengers to London, and also continental passengers direct to Dover. The Booth liners homeward bound from Brazil and Lisbon already call at Fishguard, and the s.s. Anselm, which reached that port at 9.24 a.m. on the 20th August, left again at 9.43 a.m., having landed passengers who reached London by special train at 2.50 p.m., the railway journey having been performed in $4\frac{3}{4}$ hours.

THE DEVELOPMENT OF THE INDUSTRIES OF FINLAND.*

FINLAND is a land of forest and lake. Forestry has been for centuries, and still is, its main economic support. The spinning and weaving industries were started by a Scotchman at the beginning of last century; but all the rapid factory development of the country has taken place in the last thirty or forty years, and most of it in the latter half of that period; moreover, the still most important part of it uses timber as its raw material.

Including the lakes, the country has an area of 373,600 square kilometres, and a population of a little over 3 millions, or only about 9 per square kilometre of dry land; indeed, in the northern half of the country the population is only 1.9 per square kilometre. In 1810 it was just over 1 million, and in 1880 just over 2 millions. Only 15 per cent. inhabit towns; and, while there are some 10,000 villages, there are only forty "towns" in the whole country. In the towns 70 per cent. of the population is of Finnish and $28\frac{1}{2}$ per cent. of Swedish race, while in the rural districts these proportions are 89 per cent. and $10\frac{1}{2}$ per cent. The Russian population numbers only 1 per cent. in the towns, and almost nothing elsewhere, so that the total percentage of Russians is only $\frac{1}{5}$ per cent. Of the whole population over 98 per cent. is Lutheran, so that the Russian or "Greek" Orthodox Church hardly exists except in the form of a few buildings in the cities. Of the whole area of the land less than 5 per cent. is agricultural and less than 4 per cent. meadow land, the two together being only $8\frac{1}{2}$ per cent. and all the rest being either forest or wild moor.

In agriculture, from 1880 to 1906 the production of rye remained nearly constant at about 4 million hectolitre (1 hectolitre = 22 gallons = $2\frac{3}{4}$ bushels); as did also barley at about 2 million hectolitre, while oats increased from 3 to 7 millions, potatoes from 3 to 7 millions, and beets and other roots from $\frac{1}{4}$ to 2 millions. The production of wheat in the same interval increased from 40 to 53 thousand hectolitres, and a mixture of wheat and rye —called "blandsäd"—from 80 to 150 thousand. The flour product of this mixture makes a light brown bread, much in favour in the country. In this same period of a quarter century the growing of buckwheat was increased from 5 to 30 thousand hectolitres in 1895, but has since fallen off again to 3 thousand; while peas and beans have fluctuated uncertainly between 70 and 170 thousand. The culture of flax and hemp has fallen off seriously during this time—from 1500 to 1000 tons of flax, and from 1000—in 1889—to 350 tons of hemp.

The number of horses and oxen have increased about 20 per cent., and the cows and calves by over 50 per cent., in the last 40 years, and the reindeer are $3\frac{1}{2}$ times as many; while sheep and pigs have been kept stationary, and goats have decreased from 25,000 to 5000.

Thus farming in general has made only moderate and somewhat slow progress, except in the production of milk and butter. The milk and butter are excellent and cheap; and larger quantities are used per inhabitant than in any other European country the writer is acquainted with. The exports of butter rose from £200 in 1865 to £400 in in 1875; it remained stationary for the next ten years, and then increased to £1200 in 1905 and to £1500 in 1907. It may be interesting to note that while in 1901 Britain took 61 per cent. of Finland's butter export, she took 91 per cent. of it in 1907. Most of it is sold here as Danish.

One reason of the slow advance in agriculture—which, indeed, is slow in every European country—lies in the extensive areas covered roughly with granite and other rock, with granite sand, and with peat bog; while a second is the wretchedly poor quality of the natural manure available. Only quite recently has the use of artificial manure begun to extend. Many of the forest lands cleared by timber felling have a deep and rich leaf-mould supersoil, and with suitable enterprising treatment there is no reason why they should not yield large and valuable harvests. For the most part they lie barren at present. The market prices of the various grains have shown only very moderate fluctuations and no general upward or downward tendency during the last thirty-five years. Again, the development of dairy farming for export of butter, cheese, and eggs would certainly be profitable. The price of butter has risen in the above period from 15f. to 23f. per 10 kg., that is per $\frac{1}{100}$th ton. Agricultural labourers' wages have risen in the same time from 1.20 to an average of 2.72 and a maximum of 3.25f. per day.

The rivers and lakes abound in salmon and other fish; but the river fishery industry has not been very fortunate. From 1877 to 1906 the quantity of salmon taken has decreased from 444 to 240 tons; that of white fish from 976 to 433 tons; while the catch of herrings has remained nearly constant at about 10,000 tons, and that of smelt has varied irregularly between 2000 and 4000 tons. The seal fishing rose from 4800 seals in 1877 to 10,300 in 1887, and has fallen again to 4900 in 1906.

The only other industry which does not flourish exceedingly is mining. There is little metal to mine. There has been a little gold washing at one place, Ivalojoki. It reached its maximum of 125 lb. of refined gold from 7700 cubic metres of gravel washed in 1871, and has dwindled irregularly since then to almost zero now. Iron is obtained from some of the lakes, from which a maximum of 75,000 tons were obtained in 1897; but this also has dwindled to 39,000 tons in 1905. Iron mines produced a maximum of 30,700 tons in 1900, but the output has decreased to little over 9000 in 1905. Including mining, all the metal industries yielded £2,600,000 in 1906, and £2,460,000 in 1907.

The total industries of the country have, however, shown a most remarkable development during the past quarter century, as seen in Fig. 1. Their total values were in:—

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* This article will be followed by two others upon the railways and their electrification and upon the waterways and waterfalls of Finland.

Year	1884.	1885.	1890.	1895.	1900.	1905.	1906.	1907.
Million £	4.4	4.7	6.7	7.54	13.58	15.70	17.58	20.55

In this development the Viborg district has latterly taken the lead, showing no less than 30 per cent. increase in the one year 1906-7, while the Helsingfors district, which produces a third greater quantity, comes second with 26½ per cent. increase in the same year.

For 1906 and 1907 the following shows the values in eleven great groups of industry:—

Production in £10,000 in	1906.	1907.
Metal industries, including mining	2·60	2·46
Quarrying and stone cutting...	·53	·61
Building trades...	32	172
Timber trades	433	461
Paper and allied manufactures	179	224
Spinning and weaving mills ...	221	251
Foodstuffs ...	367	404
Clothing	52	58
Leather goods	73	85
Chemical manufactures ...	49	51
Printing, engraving, &c.	36	41

Of the 20½ million pounds worth produced in 1907, the towns produced 12½ and the rural districts 8. In this year there were over 74,000 workmen employed in the towns and over 61,000 outside them. Of the former over 18,000 belonged to the building trades, nearly 10,000 in connection with food stuffs, and another 10,000 in textile industries. In the country districts 23,000 were employed in the timber trades and 12,000 in the paper industries. In the towns less than 9 per cent. of the workers were under eighteen years of age, and in the country less than 8 per cent. Of all these workers only 23½ per cent. were women. This last fact has particular social interest in view of the other fact, that in these last few years the banks and other offices have been flooded with women clerks of all grades up to the highest, many of them with university education, in proportions running from three to six women to one man, and the further fact that in Finland women obtained the political franchise four years ago.

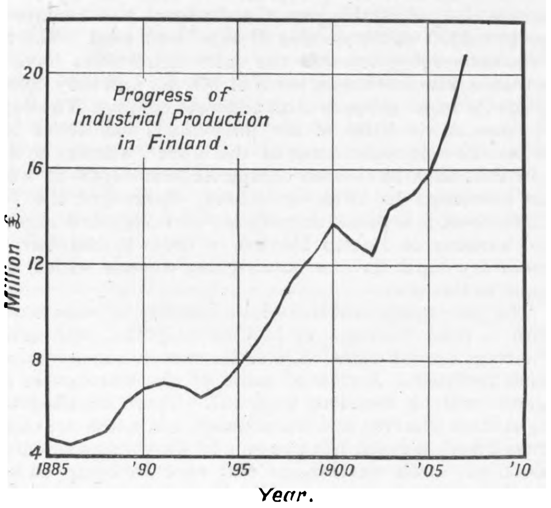

Fig. 1

An important measure of the character and vigour of industry is the extent to which mechanical power is used therein. Fig. 2 illustrates this. In Finland there were in use 1243 steam engines of 60,000 total horse-power in 1906, and 1362 of 69,600 horse-power in 1907; 91 internal combustion engines of 830 horse-power in 1906 and 123 of 1200 horse-power in 1907; 726 water wheels and turbines of 73,300 horse-power in 1906 and 753 of 89,300 horse-power in 1807; 300 electric motors of 1300 horse-power in 1906 and 530 of 2800 horse-power in 1907.

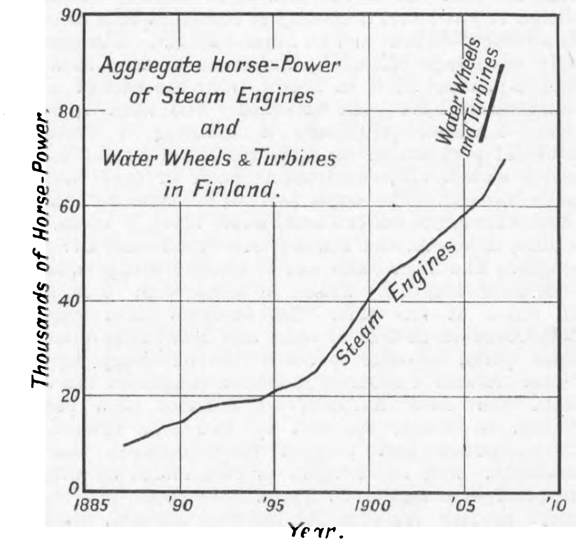

Fig. 2

Of the 69,600 steam horse-power in use in 1907, no less than 23,500 were used for wood working and 14,700 in the textile factories; 8500 horse-power only in the metal industries; 7200 in paper mills; and under 4000 in electric generating stations. Of the 1907 water-wheel 89,300 horse-power, as much as 66,700 were employed in paper mills; 6300 in chemical works; 4200 in the textile industries; and 3900 in the timber trade.

It may be noted that not only does water power take the lead of steam power, but its use also increases in a slightly faster rate. Of this water power, no less than 67,000 horse-power is consumed in the paper industries, which use only 7000 steam horse-power. On the other hand, the timber trade uses 23,600 steam horse-power and only 4000 water horse-power, this in consequence of the waste of the saw-mills being burnt under the boilers. The textile industries employ 14,650 steam horse-power and 4200 water horse-power. Electric motors are used in the chemical and food-stuff factories, in the timber and paper works, in the printing shops, and also for cranes in the building trade.

The figures already given show how largely the timber trade bulks in the prosperity of Finland. Its progress is shown in Fig. 3. Nearly 91 per cent. of the land is still wild forest or bog and morass. The felling and exportation of timber has increased enormously in recent years. In 1870 less than a half million cubic metres of sawn timber of 2 m. length and over were exported per year; in 1880 about one million cubic metres; 1.8 million in 1895; 2.4 million in 1900; 2¾ million in 1905; 3 million in 1906; and 2.8 million in 1907. In 1906 the value of this export was £5,750,000, inclusive of worked wood, such as doors, sashes, &c. The forest land belonging to the State has, since 1883, decreased from 14¾ to less than 12 million hectares; but their timber produce has increased from under ½ a million to over 1 million logs, and in small billets for firewood from 74 to nearly 400 thousand cubic metres; while the total State revenue from these forest lands has increased from 1 to 7 million francs—that is, from £40,000 to £280,000. From 1886 to 1906 the number of water-driven saw-mills has increased from 139 to 160, and that of steam-driven saw-mills from 106 to 429, while the number of workpeople employed at them has risen from 7370 to 23,770. Their production has increased from 1 to 3¼ million cubic metres, and the money value thereof from 23.4 to 96 million francs (£3,840,000) in 1906, and to 101.4 million francs in 1907. Wood is the raw material of the Finnish paper factories and of several chemical works. It is evident that this timber trade is a vast and rapidly-growing industry, and that the wealth of the nation depends in a large proportion upon it. Fears have been entertained of its too rapid extension, and new laws have been passed by the Diet to enforce reasonable re-afforestation. Some of the large companies engaged in this trade have been unscrupulous in their neglect of this national and patriotic duty; but others, such as Hackman and Co., and the much younger Tornato Company, of which Eugene Wolff is managing director and the largest shareholder, have done a great deal in this direction, both by way of scientific investigation and by way of very extensive planting. The carpentry trades represented a production of £271,000 in 1907, and the turneries of reels and bobbins a production valued at £150,000.

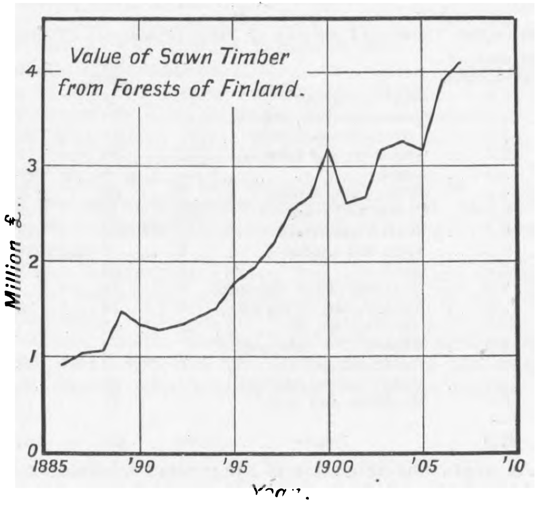

Fig. 3

In point of magnitude the production of food ranks next in order. The flour mills produced £560,000, and the sugar factories £1,200,000 in 1907. The produce of the breweries in the same year was valued at £350,000, and that of the tobacco factories at £830,000. The production of brandy has fallen from £964,000 in 1906 to £875,000 in 1907, a decrease due partly to growing temperance in the habits of the people and partly to increase of the tax on spirits.

The textile industry is the longest established great manufacture, but its progress has also been most remarkable. The total money value of the cotton stuffs produced has been in

Per year.	1885	1895	1905	1906	1907
£10,000 ×	39	65	102	127	133

In 1907 woollen goods accounted for £820,000, and linen for £162,000; while knitted goods yielded £110,000, the total for this year being 2½ million pounds. This manufacture is very much concentrated in the Tavastehus district, which includes the two towns of Tammerfors and Tavastehus. This district alone produces £1,617,000 out of the above total. Fig. 4 shows graphically the progress of this industry.

The most striking recent progress, however, has been in the creation of the paper trade. Before 1885 this industry hardly existed. The following table shows how it has advanced since then, and Fig. 5 is the same in diagrammatic form.

Year.	1885	1890	1895	1900	1905	1906	1907
Horse-power of Machinery:	7000	14,000	20,000	34,000	52,000	58,000	84,000
Number of Employes:	2000	3000	4000	6350	9000	10,000	13,000
Yearly Value of Product, Unit £10,000:	36	49	66	111	164	168	205
Yearly Value of Exports, Unit £10,000:	32	34	51	70	135	152	170

These figures include finished paper and so much of paper pulp and cellulose as was not converted into paper. In 1885 cellulose formed only 1.2 per cent. of the whole manufacture by weight; in 1906 it had become 24 per cent. of the whole. Owing to local causes its increase has not been so rapid since; but in 1906 and 1907 its production was 57,300 and 63,500 tons, and the quantity now being produced is much larger. In 1907 the total of the three products was 311,700 tons, of which 47 per cent. was pulp, 20½ per cent. cellulose, and 32½ per cent. paper. In this year the total export was 174,050 tons, of which 39 per cent. is pulp, 17½ per cent. cellulose, and 43½ per cent. paper. Including book-binding and other minor dependent trades, the whole of the 1907 paper industries were valued at just under 2¼ million pounds. The writer is informed that Japanese paper is not only manufactured in Finland, which he can vouch for, but is also exported to and sold in Japan.

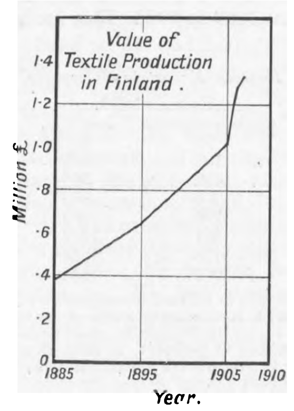

Fig. 4

The above 2¼ million pounds sterling is produced mainly in three districts, as follows:—

District.		
Viborg.	Tavastehus.	Helsingfors.
£1,130,000	£546,000	£301,000

At the Tornato works at Tainionkoski the pulp and the paper are made entirely without the use of chemicals; at the Kankas works, near Willmanstrand, pulp is made by help of sulphide of calcium prepared by burning lime in air with sulphur crystals imported from Sicily, and is afterwards bleached with chloride of calcium; at the newly erected and very modernly designed "Pulp" works in the same district sulphate of soda alone is used; and at a recently erected works north of Elisenvaara a new purely mechanical process is employed for making pulp. At Kotka the cellulose works, "Cellulosa," which went out of operation two years ago, is this year (1909) being again started into activity under new management.

The only other industry that calls for special mention is building. The years 1906 and 1907 exhibited a quite extraordinary development in large tenement and office building, and Helsingfors and Viborg vied with each other in their architectural ambitions. In this one year the activity of this trade increased in the proportion of 5½ to 1. This involved a tremendous stimulus to brick manufacture, but nearly all the face work is done in granite. Native opinion is divided as to the merits of what is called the "new style of architecture," but among foreign visitors there is little hesitation in pronouncing it depressingly inartistic in its heaviness and criminally uneconomic in its wastefulness of a splendid material. The new Finnish architects have yet to learn to distinguish between massiveness and shapeless bigness, and to learn that it does not add dignity to make a thing ten times too strong for its duty. They have a superabundance of magnificent and beautiful material in their various qualities of granite. They would do well to visit Aberdeen and to see there in the new University buildings how wonderful and exquisite grace can be combined with admirable simplicity and strength, the whole evolved from grey granite. We cannot find that any granite is exported from Finland, and the statistics of the quarries and stone-cutting yards suggest that no more is produced than is needed for home consumption. The whole country is filled with granite of fine quality. There is here a mine of wealth almost equalling that of the forests. Why should not the granite be quarried and exported? The

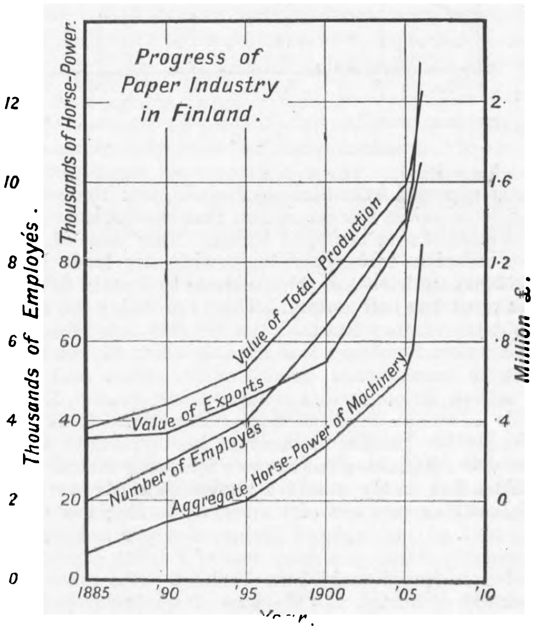

Fig. 5

Finns have too much granite and too little money. If they will only start the enterprise they can exchange the two in foreign lands. The writer is informed that some Finnish granite sneaks into England under the pretence of being Norwegian. There is no need for such pretence, if only the Norwegian stone merchants will allow it to go under its real name.

The following are four tables in which we have set forth a condensed *résumé* of the exports and imports, showing the increase from 1903 to 1906. This increase is shown in diagram, Fig. 6:—

Finnish Exports and Imports.

Unit £10,000.

Year.	Annual exports.	Imports.	Ratio.
1860	91	173	1·90
*1869	196	305	1·56
1880	492	555	1·13
1890	370	562	1·52
1900	790	1083	1·37
1905	991	1073	1·08
1906	1126	1256	1·12
1907	1069	1516	1·42

* The figures from 1870 to 1873 are incomparable with the others owing to the commerce with Russia being omitted from them. The other figures include that across the Finnish-Russian frontier. In 1860 this was 56 per cent. of the whole, 41 per cent. in 1880, 29 per cent. in 1900, and 27 per cent. in 1907. It amounted to £510,000 in 1860, to £2,290,000 in 1900, and to £2,900,000 in 1907.

Proportions of Commerce with Russia, Great Britain, and with Germany to whole Commerce.

Year.	% Russia.		% Germany.		% Great Britain.	
	Exports.	Imports.	Exports.	Imports.	Exports.	Imports.
1901	40·5	29·6	8·5	31·5	28·1	11·9
1903	25·0	38·4	9·5	36·4	30·1	10·1
1905	27·4	35·4	10·7	37·8	30·3	10·8
1906	29·5	30·6	10·4	39·4	30·5	11·5
1907	27·1	29·4	11·5	40·4	31·5	12·0

This table shows how Germany gives much to, but takes little from, Finland in goods; while, reversely, Britain takes much from her, but sends little back, the balance being paid mainly in drafts, which are probably sent to Germany, and sent by Germany back to England.

It would, of course, be much more profitable to Britain if she paid for what she takes from Finland directly in goods exported from here to Finland, and that she does not do so raises a presumption that she neglects a profitable market that lies open to her. This want of balance also occasions serious loss in the shipping trade between the two countries, the ships coming to Britain fully laden and returning half empty. This is probably the origin of the extraordinary fact that the freights from England to Helsingfors for steam coal are only about 4s. per ton, and that, in consequence, good English steam coal can be bought in Helsingfors at cheaper prices than in London.

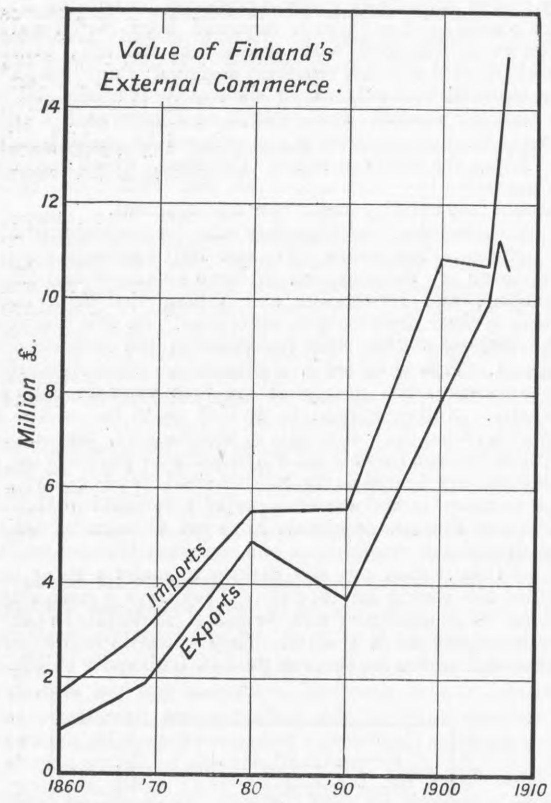

Fig. 6

To show in what particular directions it might be possible for Britain to increase her exports to Finland, the writer has compiled the two following tables.

The first of these tables shows that 51½ per cent. of Finland's exports are of timber, while England takes 35 per cent. of this exported timber. She does not take much paper pulp, because a good deal of English capital is invested in paper making in Finland. She takes a large quantity of butter. In the way of buying from Finland she could not do much more than she does. In the way of selling to Finland, Russia and Germany send their own grain, meat, vegetables, fruit, tobacco, and seeds there, and England has none to send. These form some three-eighths of Finland's total imports. But there is no reason why Britain should allow herself to be so totally beaten in this market for groceries, leather, cloth, clothing, and, particularly, for machines and tools. These form about one-fourth of the total of Finnish imports. It is to be hoped especially that English engineers should open their eyes to the fact that Finland wishes to buy machinery and tools, and that at present she takes almost her whole supply from Germany and America. In chemicals and "metalwork" England probably does nearly as much as her circumstances permit her to to economically; and in textile materials it is to be observed that she does very well.

1906 *Exports exceeding* 1 *per cent. of Total Exports.—Unit* £10,000.

Per cent. of total exports.		Russia.	Germany.	Britain.
14.9	Butter, meat, game	14	7	119
1.7	Fish	17	—	—
51.3	Timber and woodwork	37	79	196
13.7	Paper and pulp	98	18	21
3 3	Skins, furs, leather	20	—	—
1.1	Minerals	11	—	—
4.6	Metals and metalwork	50	—	—
4.0	Ships and boats	44	—	—
94.6	Total	291	104	336

1906 *Imports exceeding* 1 *per cent. of Total Imports.—Unit* £10,000.

Per cent. of total exports.		Russia.	Germany.	Britain.
2 6	Meat and game	21	4	1
23.3	Grain, biscuits, starch	146	108	3
2 8	Vegetables and fruit	17	11	2
11 4	Groceries and tobacco	39	90	2
1.8	Drinks	—	6	—
4.5	Skins, furs, leather	8	30	1
4.5	Plants and seeds	36	15	—
6.8	Textile materials	10	23	48
2 2	Yarn and thread	8	8	6
5.9	Cloth	19	34	9
2.2	Clothing, hats, bonnets	5	18	1
2.5	Rubber, tar, resin, &c.	16	10	3
3.1	Oils, candles, &c.	22	6	4
6.4	Minerals, chemicals, colours, &c.	6	34	23
7.0	Metals and metalwork	8	29	21
5.9	Machines and tools	2	31	10
92.9	Total	363	457	134

An important indication of the present wholesome condition of Finnish industry is that while the number of limited companies has greatly decreased since 1903, their combined capital has increased from £13,300,000 to over £18,000,000 in 1907, and their reserved funds from £1,150,000 to £2,160,000. There are ten private banks in Finland, whose combined capital accounts have increased from £5,360,000 in 1890 to £25,480,000 in 1907; while those of the State Bank of Finland have increased from £2,100,000 in 1890 to £4,600,000 in 1907. Combining these, the sums are £7,460,000 in 1890 and £30,080,000 in 1907, a fourfold increase in seventeen years. The money in circulation issued by the State Bank and the Föreningens Bank—which has equal public standing—together was, in 1900, £2,850,000 in notes and £744,000 in coin—of which nearly half in gold—and in 1907 £3,800,000 in notes and £1,110,000 in coin—of which 53½ per cent. in gold. In the former year, therefore, the ratio of coin to notes was 26 per cent., while in 1907 this ratio had increased to 29½ per cent., while the total circulation has in seven years increased 13.7 per cent., or 2 per cent. per annum.

The State debt at the end of 1906 was only £5,556,000, and at the end of 1907 it was £5,500,000, all issued at from 3 to 3½ per cent., except a trifling amount issued as far back as 1868. The combined debt of the eleven chief cities and towns of Finland was £1,640,000 in 1906, and £1,618,000 in 1907, these loans being issued at from 3½ to 5 per cent., and the average being at 4½ per cent.

These figures demonstrate a condition of very sound credit and a very hopeful all-round situation. It seems clear that Finland is bound to advance rapidly and successfully in industrial output and enterprise. Although in comparison with other countries the budget of the Government expenditure, namely, 4¼ million pounds, may appear very modest, it is not really small in proportion to the population, being 28s. per head. It may be interesting to conclude with an approximate summary of how this is spent. Nearly half of it is spent so as to bring in a *direct* profit to the State.

	£
Grand Ducal Residences, Diet, Governor-General, Senate and State Secretary	142,000
Courts of Justice	170,000
Civil Administration	468,000
Treasury, Customs, &c.	122,000
Forests, Civil and Military State Residences, Military	102,000
Church, University, Schools, Dumb and Blind Asylums, Science and Art	530,000
Land Survey, Agriculture Department	240,000
Land and Water Ways	1,629,000
Navigation, Technical Schools, Industrial Control, Geological Department	192,000
State Archives and Printing	19,000
General	210,000
Pensions	196,000
Public Debt	250,000
Total	£4,270,000

Against the above expenditure on Land and Water Ways stands the greater income from the same of £1,858,000; while £387,000 is received from State Forests, and £49,000 from Lighthouses.

THE TEHUANTEPEC RAILWAY AND TERMINAL PORTS.

No. II.*

The engineering works undertaken at the two terminal ports of Puerto Mexico (Coatzacoalcos) on the Atlantic Coast, and at Salina Cruz, on the Pacific Coast, was commenced simultaneously. Coatzacoalcos is one of the Gulf ports of Mexico, but previous to the improvements effected it was but little used on account of a natural bar, the port being rendered inaccessible to vessels drawing more than 12ft., the normal depth of the water at low tide seldom exceeding 14ft. The removal of the bar was necessary and was effected partly by dredging, but chiefly by the system carried out with conspicuous success by the late Captain James B. Eads, an American engineer, referred to in connection with the railway concession, who had previously carried out a similar engineering feat at the mouth of the Mississippi River, the system being also reduced to practice with good results at the mouth of the Panucó River, near Tampico, in the State of Tamaulipas, Mexico. The process comprises the construction of two converging jetties, or training walls, extending from the mouth of the river into the sea, confining the current within the limits necessary to secure the scouring-out of the channel across the bar by the action of the river itself. The length of the two jetties at the mouth of the Coatzacoalcos River is about 1300 m. each. The stone used for the construction work was obtained from quarries situated at a place called Medias Aguas, about 97 kiloms. (60⅝ miles) from Puerto Mexico, and was deposited in the sea by 20-ton travelling cranes. To the east jetty from the western side of the river, the stone was carried in a 250-ton barge, worked by an endless chain, and making four trips daily. The east jetty was formerly 1395 m. in length, and the west jetty 1125 m. Since September, 1907, however, the western jetty has been carried 50 m. further out, and the eastern jetty 30 m. The depth of water in the channel between the jetties is 8 m., and up to the month of April of this year the dredgers had removed a further 4000 cubic metres of sand and mud. The two arms converging towards the outer extremities have an entrance width between them of 300 m., and they consist of rubble stone mounds with concrete copings. The depth of water at the sites of the jetty-heads was about 28ft. before the commencement of the works, whereas to-day, now that they have been completed, the depth of water has increased to 10 m., or 32.8ft. A dredger, the José Limantour, is kept continually at work day and night in the harbour of Puerto Mexico, in order to maintain the necessary depth for the ocean-going vessels which now come to this port.

The port equipment includes a number of warehouses, with a total frontage of 1500 m. (4920ft.), with ample wharfage accommodation, electric cranes, conveyors, and other facilities. A view of some of the warehouses and cranes will be found on page 237. There are altogether eight steel wharves and warehouses, while the travelling cranes have a reach from vessels to warehouses or cars of 26.26 m. Both warehouses and cars are equipped with movable roofs, so as to permit of the handling of freight at a single operation, and to permit of the working of cranes between vessels and cars and warehouses. There are eighteen of these cranes, each of which has a lifting capacity of 3 tons; twenty-four capstans; and four conveyors. The electrical equipment by which they are operated has a capacity of 1000 kilowatts.

It will be seen that Puerto Mexico, admirably situated as it is, and with the enormous advantages conferred upon it by the engineering works described, has been converted into one of the most completely-equipped harbours on the Gulf of Mexico, the best anchorage outside being 10 fathoms, while inside the harbour large vessels can be dealt with promptly and safely. The bulk of the tonnage handled is through-traffic, the exports consisting of hides, rubber, tobacco, coffee, mineral ores, hardwoods, and dyewoods, while the imports include agricultural implements, machinery, coal and coke, hardware, cotton, linen and woollen goods, glass, earthenware, and groceries.

In the opinion of most of those who have seen both the Puerto Mexico and Salina Cruz harbour works, the latter offer far more features of interest than the former, the engineering problems having proved much more serious on the Pacific than on the Gulf side. The violent northern winds which sweep across the Isthmus of Tehuantepec beat the surf out to sea, and since there is no natural shelter it was found necessary to construct both an outer, or a refuge, harbour and an inner harbour. The one and only advantage offered by Nature is a steep rock-promontory, about 250ft. in height, from the base of which breakwaters have been extended. The work at Salina Cruz consisted principally in creating a first-class artificial port out of an open roadstead by the means above stated, viz., constructing both an outer and an inner harbour. The outer harbour is formed by massive breakwaters, the eastern breakwater being 1 kilom. (⅝ of a mile) in length, and the western breakwater 647 m. in length. The inner basin was formed by dredgers, and is 1000 m. in length by 222 m. in width, with 10 m. depth of water at low tide. The dredgers have removed 600,000 cubic metres of sand and clay in the outer and inner ports, in order to obtain the necessary depth of 10 m. A wall of concrete monoliths separates the inner from the outer harbour, while there is a passage 30 m. in width, spanned by two steel bridges, for the entrance and exit of ships between the two harbours. The inner basin is surrounded by wharves supplied with numerous tracks and sheds, and all the most modern facilities for handling cargoes, including six new electric cranes on each wharf, of a capacity of 3 tons, and eight capstans with a capacity of 1 ton. At the extremity of the western breakwater, as well as at that of the eastern breakwater, a luminous buoy has been placed to mark the entrance into the port, six mooring buoys being provided in the outer port; while on the eastern side of the inner port the wharves have been paved with concrete. The eastern side of the inner port has now been completed, and is provided with two sheds with steps leading down to water level, bollards, and mooring rings.

As already mentioned, Salina Cruz is the Pacific terminal station of the Tehuantepec Railway, and in the grounds 50,000 square metres have been levelled, 22 miles of terminal track have been laid, and suitable dwellings for the yard workpeople have been erected, with an altogether admirable installation of electric light on all the wharves and sheds. In the town of Salina Cruz, which has been rebuilt entirely by S. Pearson and Son, Limited, on the site of the old town—which was completely destroyed in 1902—some 3000 linear metres of sewer pipes with manholes have been held.

At the north-west corner of the inner basin there has been constructed a dry dock 664ft. long and 80ft. 8in. wide. The depth on sill at high water is 35ft. 7in. The coping, which is on a level with the top of the breakwater, is of Norwegian granite. The dry dock can be emptied in four hours by centrifugal pumps, of which there are two sets, twin-coupled, direct-drive, each with a 325 horse-power motor, and driven at a velocity of 360 revolutions per minute. Theoretically, these pumps empty the basin at the rate of 12,060,000 gallons in four hours; but actual test has given a much greater capacity.

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* No. I. appeared August 27th.

One feature of the Salina Cruz dry dock, which will accommodate the largest ship on the Pacific Ocean, is that it is the only dry dock in the Republic of Mexico, with the exception of a small floating dock at Vera Cruz. That it is destined to become a highly-important factor in the handling of crippled vessels, both in the time of peace and war, there can be no question.

As regards the traffic which is already passing through the port of Salina Cruz, the results are even more encouraging than was anticipated. From the very commencement the freights have proved remarkable; and it speaks much in the favour of the contractors that, coming upon them as it did somewhat unexpectedly, this rush of traffic was handled with consummate skill and enterprise, owing mainly to the far-seeing policy which had secured a perfectly easy working before the first bale of goods was handled. Weeks before a steamer came into dock, the electric cranes, each of 3 tons capacity, and with a radius of 55ft., were ready and waiting to grapple with the cargo.

As already stated, the freight cars on the Tehuantepec route are constructed with movable roofs or hatches, so that the cargo can be lifted out and swung across into the open roofs of the warehouses awaiting it; thus, one handling alone is necessary. The cars are shunted into position through cross-over tracks, or carried over by transporters, and hauled into position by electric capstans. On the quays are six solidly-constructed freight sheds, each with a floor area of 44,100 square feet, and each with a capacity of 10,000 tons of freight. For the marshalling and distribution of the cars more than 22 miles of track are laid down in the yards and sidings at Salina Cruz, while, owing to the powerful arc lights distributed in all parts of the yards and docks, night work is carried on without the slightest inconvenience or interruption.

Swain Sc.
Engineer

WAREHOUSES AT PUERTO MEXICO

The Mexican Government have not been content with constructing, in conjunction with Messrs. S. Pearson and Son, Limited, the Salina Cruz port works for commercial purposes only. They have expended several millions of *pésos* in fortifications, which, when completed, will rank among the most remarkable in North America. It is believed that when finally equipped the port of Salina Cruz will be impregnable. Naturally, the plans and armaments are kept absolutely secret.

The guns for the fortifications are now being constructed in France, and will be largely of the Mondragon type, of which the distinguished Mexican General is the inventor. One of the largest pieces, 24 cm. calibre, will be erected on the Cerro de Vigia, at 70 m. above the level of the sea, and will have a range of 180 deg. The gun will be able to cover the whole bay and all its approaches from the Cerro del Campanario, on the east, as far as the Conejo Point, and Chipegua on the west. A second large gun will be stationed on the Cerro de Buena Vista, at a level of 80 m. above the surface of the sea. On this particular point there has been erected an expensive lighthouse, but the position is deemed so important for the adequate defence of the port, that the lighthouse is now being torn down, and fortifications are being erected upon the site. A gun of 24 cm. calibre will also be placed on Cerro del Monte, and another of 15 cm. on the Lomas del Leon. This piece will fire projectiles of 15 kilos. weight. In all there will be 48 large pieces of ordnance erected for the protection of the port, and although they will be of various designs, dependent upon the position of the gun, they will, as already indicated, be mainly of the Mondragon type. It was hoped that they would be delivered before the end of the present year; but there is now some doubt as to whether this will be the case, and in all probability it will be another twelve or eighteen months before the guns are mounted.

THE RHEIMS AERONAUTICAL MEETING.

No. II.*

The Rheims meeting was continued on Thursday of last week, and the weather conditions during that day were better than had been experienced since the opening of the contests on the previous Sunday. As a result, several fine flights were made. Those of the morning, although made at a time when the wind and other disturbing atmospheric influences were least, were, on the whole, unimportant, although they would but a short time ago have been of the nature of world's records.

Among those taking a share in the flights of the earlier part of the day were Delagrange, Latham, Sommer, Curtiss, and De Rue. Of these, M. Latham accomplished seven laps—about 43½ miles—in 1 h. 1 min. 51⅘ sec., while Curtiss descended at the end of his third round, having flown the 30 kiloms. in 28 min. 59⅗ sec. These were the more noticeable achievements, as the other aeronauts contented themselves with carrying out various trial flights.

In the afternoon a change took place in the weather, the wind turned cold and gusty, and rain clouds appeared in the north. At about 2.20 p.m. M. Latham, in spite of the coming storm, decided to start on a flight for the Grand Prix. For the two following hours his efforts were followed with intense interest, particularly as no other aeronaut attempted to rival him. The wind increased and rain fell, but M. Latham held on his course, and, flying at a height of about 90ft., he made the circuit of the plain fifteen times, descending in the middle of the sixteenth lap and damaging slightly one of the wings of his aeroplane. He had flown for 2 h. 18 min., and in this time had accomplished 154 kiloms.—about 96½ miles. His time was thus about 25 min. less than Paulhan's on the previous day, but, on the other hand, he had covered about fifteen miles more, and it was announced that he accordingly held at that moment first place for the Grand Prix.

Shortly after Latham's descent, Paulhan attempted to recover his lost place, and was rapidly followed by de Lambert, Tissandier, de Rue, Curtiss, and Blériot. With the exception of the Comte de Lambert, all these quickly returned to the ground, although Curtiss accomplished 20 kiloms. before doing so. De Lambert meanwhile continued to fly, and only descended at the end of 116 kiloms. on account of his petrol supply having given out; he had flown for 1 h. 56 min., and as a result of the distance traversed had secured the third position at that time for the Grand Prix. During this time Blériot had started on a trial for the passenger-carrying contest, taking as his companion Auzani. His flight, however, was short, and, losing control of his machine, he descended abruptly, seriously damaging the wings of his machine. Neither he nor his companion, however, was hurt in the accident. This concluded the official flights for the day, but several of the competitors utilised the calm of the evening for carrying out practice flights.

The improvement in the weather continued on Friday, which was productive of a series of excellent flights. Shortly after 10 a.m. Paulhan, Bunau-Varilla, Blériot, Delagrange, and Sommer started, but achieved little of importance, M. Blériot, who finished 40 kiloms., being the most successful. A second attempt by Paulhan ended in disaster, the damage to the machine being of such a nature as to exclude this aeronaut from taking further part in the Grand Prix contest, of which this was the closing day.

At 4 p.m. Sommer, Latham, and Farman started in close succession, and for a time all three held on their courses unrivalled. Sommer stopped at the end of his fourth round, and his place was immediately taken by Leblanc on a Blériot monoplane, followed by Bunau-Varilla on a Voisin biplane. Latham continued flying until the fourth round, and the other aeronauts also had soon to descend, M. Farman alone remaining in the air. Tissandier, about 5.30 p.m., rose on his machine, and for the remaining hours of the day the main interest of the meeting became fixed on his and Farman's performances. Latham and other competitors again rose, but their flights were relatively unimportant. When darkness fell Farman and Tissandier were still flying, and the former remained in the air until 7.45, up to which time he had flown 118 miles in 3¼ hours. Meanwhile Tissandier had descended unnoticed at the end of his 110th kilom.

Farman thus easily won the Grand Prix, for which he receives £2000. He had previously been prevented from taking part in the meeting by delay caused in effecting several alterations which he deemed it necessary to make on his machine. He had replaced his engine by a 50 horse-power Gnome motor of the type used by M. Paulhan on his Voisin biplane. Other alterations included the propeller, which at the last moment he changed for one of wood instead of metal and of increased size.

The weather of Saturday, when the Gordon Bennett Cup Race took place, was very favourable for carrying out flights, there being but little wind, while the atmosphere was warm and clear. In addition to the international race, the 10-kilom. speed contest and the passenger-carrying competition were decided on this day.

Soon after the opening hour, Curtiss, the American aeronaut, set off on the one lap of the Tour de Piste competition, and when he had completed the circuit it was announced that he had beaten M. Blériot's record by about 9 sec. Shortly after this feat he again ascended and flew the two laps required for the Gordon Bennett Cup in 15 min. 50⅗ sec. Mr. Cockburn, the British representative, then rose, but came to earth after going about half-way round the course. As only one attempt was allowed each competitor for the Gordon Bennett Cup, he was obliged to relinquish his chances of securing the trophy.

The first French competitor, M. Lefebvre, on a Wright biplane, then ascended and completed the required distance in 20 min. 47⅗ sec. Nothing further of importance happened until late in the afternoon, when M. Blériot made a good flight in the Gordon Bennett race, doing the 20 kiloms. in 15 min. 56⅕ sec. Thereafter, M. Latham, who had been chosen as the third French representative, did the double circuit in 17 min. 32 sec. Thus, Mr. Curtiss's time remained unbeaten, and the international cup was secured to America by the efforts of her representative.

The passenger-carrying contest was then entered upon, and several competitors prepared to start on the 10-kilom. journey with a companion. Of these competitors, M. Farman, the winner of the Grand Prix, was the most successful, performing the round of the course in 9 min. 52⅘ sec. Next in importance was Lefebvre, who, similarly laden, did the like distance in 11 min. 20⅘ sec. Later on M. Farman, carrying two passengers, involving an additional load of nearly 300 lb., flew round the course in 10 min. 39 sec.

The last event of the day calling for mention was M. Blériot's final flight for the Tour de Piste. At the last moment he succeeded in regaining the first place from Curtiss by flying the single lap in 7 min. 47⅘ sec., and thus he secured the prize of £280 offered in this competition.

The events set down on the programme for Sunday, 29th August, the closing day of the meeting, consisted of the final stages of the Prix de Vitesse, the Tour de Piste, and the passenger-carrying competition, while the altitude contest was also to be competed for on that day. It was, however, only in the Prix de Vitesse and the altitude competitions that notable performances were done, as the records made during the previous days in the two other competitions remained unexcelled. Large crowds assembled to see the last stages of the meeting, and they and the competitors were fortunately favoured with agreeable weather, an absence of wind and brilliant sunshine adding largely to the day's successes.

The early hours were marked by an accident to the Blériot's machine, but although the framework of the aeroplane was completely destroyed by the fire which originated in the bursting of the petrol tank, the aeronaut himself escaped with only slight injury.

In addition to the aeroplane contests a competition had been arranged for dirigible balloons, and on this day two balloons, the Colonel Renard and Zodiac III. competed for the prize of £400 to be given for the best time over 50 kiloms. The Colonel Renard won, taking 1 h. 19 min. 49 sec. for the five laps, while the Zodiac's time for the same distance was 1 h. 25 min. 1 sec.

For the Prix de Vitesse several competitors started on a final effort, but interest was mainly confined to the rivalry between Latham and Curtiss. Their respective times for the 30 kiloms. were 26 min. 32⅖ sec. and 24 min. 15⅖ sec. These figures were afterwards given as 29 min. 11⅗ sec. and 26 min. 40⅕ sec., the additions in each case being by way of penalty for previous improper starts. The prize, therefore, fell again to the American representative, who shortly afterwards made renewed efforts to regain the speed record for the 10 kiloms. from M. Blériot, but failed to do so.

Towards evening the altitude contest began, when Latham, who throughout the meeting had been conspicuous by his flights at altitudes greater than those attained by the others, rose to a height of a little over 500ft., and thereby secured first place. Others taking part in this competition were Farman, Paulhan, and Rougier, whose distances were respectively 350ft., 290ft., and 190ft. It is of interest to note that the height of ascent was in each case determined by means of a self-recording barometer, officially guaranteed by the Paris Observatory. In no case was the descent to the ground from those heights attended with any excessive difficulty or damage, each machine gliding gently down and reaching the earth without shock.

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* No. I. appeared August 27th.

We reproduce in the accompanying table the figures for the more notable flights of the last half of the Rheims meeting, the earlier events having been dealt with in our previous issue.

Speeds and Distances at Rheims.

References:—G.P. = Grand Prix. P.V. = Prix de Vitesse. T.P. = Tour de Piste. G.B. = Gordon Bennett Race. F.P. = Flight with Passengers. A.C. = Altitude Competition. D.C. = Dirigible Competition. Prize winners in italics.

Date.	Competition.	Aeronaut.	Machine.	Distance 10 kiloms. to the lap	Time.	
					m.	s.
Aug. 26	G.P.	Latham	Antoinette	7 laps	61	$51\frac{4}{5}$
,,	,,	Curtiss	Herring-Curtiss	3 laps	28	$59\frac{3}{5}$
,,	,,	Latham	Antoinette	$15\frac{1}{2}$ laps	138	$9\frac{3}{5}$
,,	,,	De Lambert	Wright	11 laps	110	$59\frac{3}{5}$
Aug. 27	,,	*Farman*	Farman	18 laps	184	$56\frac{2}{5}$
,,	,,	Tissandier	Wright	11 laps	—	
Aug. 28	G.B.	*Curtiss*	Herring-Curtiss	2 laps	15	$50\frac{3}{5}$
,,	,,	Lefebvre	Wright	,,	20	$47\frac{3}{5}$
,,	,,	Latham	Antoinette	,,	17	32
,,	,,	Blériot	Blériot	,,	15	$56\frac{1}{5}$
,,	T.P.	*Blériot*	,,	1 lap	7	$47\frac{4}{5}$
,,	,,	Curtiss	Herring-Curtiss	,,	7	$55\frac{2}{5}$
,,	F.P.	*Farman*	Farman	,,	9	$52\frac{4}{5}$
,,	,,	Lefebvre	Wright	,,	11	$20\frac{4}{5}$
,,	,,	Farmau	Farman	,,	10	39
Aug. 29	A.C.	*Latham*	Antoinette	155 m.	—	
,,	,,	Farman	Farman	110 m.	—	
,,	,,	Paulhan	Voisin	90 m.	—	
,,	,,	Rugier	,,	55 m	—	
,,	P.V.	*Curtiss*	Herring-Curtiss	3 laps	26	$40\frac{1}{5}$
,,	,,	Lefebvre	Wright	,,	29	0
,,	,,	Latham	Antoinette	,,	29	$11\frac{2}{5}$
,,	P.A.	*Happferer*	Col. Renard	5 laps	79	49
,,	,,	De Vaulx	Zodiac III.	,,	85	1

NILE BRIDGES.

In The Engineer of January 3rd, 1908, appeared an illustrated notice and some details concerning the combined road and railway bridge for the Soudan Government to cross the Blue Nile at Halfaya-Khartoum. Such progress has since been made on the work by the contractors, the Cleveland Bridge and Engineering Company, Limited, of Darlington, that on April 1st the temporary timber bridge required to carry goods trains over the river was taken possession of by the Soudan Government, and this notwithstanding the fact that during the last Nile flood the staging for several of the main river spans was swept away owing to the river bed having been scoured by the force of the water. Up to the present time the electrically-operated rolling lift span at the northern end of the bridge has been completed, and the steelwork of five of the main 218ft. 6in. river spans has been placed in position and the staging for the same withdrawn. As the Soudan Government railway authorities have for four months past been able to utilise the temporary timber structure for the passage of their goods trains, they have made a definite commencement with the southward extension of their system, and railhead will be eventually established at Sennar, a city of the eastern Soudan on the Blue Nile, 160 miles south-east of Khartoum, which has a population of about 8000. From Sennar it is intended to construct a branch line in the westerly direction, so as to open up the district of Kordofan, which has an area of about 41,000 square miles and a total population of 280,000, but which is separated from Sennar by the White Nile. The river is being crossed a short distance from the village of Goz Abu Guma, 192 miles distant by White Nile from Khartoum. Here the width of waterway at Low Nile is 1500ft., but at the flood season it is about three miles, and consequently some heavy embankment approach works are required. The main bridge will be of nine spans, each of 156ft. length, and one hand-operated swing span of 245ft. 6in. length, giving two openings, each 100ft. clear. The height above High Nile will be 6ft. The piers are of masonry in steel caissons, resting on a foundation of 29ft. by 12ft. sunk by compressed air to depths varying from 30ft. to 50ft. below low water. The strata at Goz Abu Guma consists of red and white clay and sandstone. The bridge, which will have a height above High Nile of 6ft., will have a total width overall of 32ft., and will provide accommodation for one 3ft. 6in. railway track, together with two footpaths, each 7ft. wide, carried on brackets outside the main girders, and designed for light traffic. The branch line from Sennar, whilst it will develop the important gum industry of Kordofan, is, at the outset, intended primarily for strategic purposes. Many months will necessarily elapse before the railway reaches Goz Abu Guma, and the contractors' material and steelwork, &c., which is being shipped from the Tees direct to Port Soudan, thence over the Soudan railway to Khartoum, is being transported by water to Goz Abu Guma. The work there is being carried on by the Cleveland Bridge Company simultaneously with the Blue Nile bridge at Khartoum, and it is expected that the White Nile bridge will be completed within eighteen months from date. The conditions of Khartoum and Goz Abu Guma vary considerably, as, during flood, the White Nile expands very much in width by reason of its low banks, and the water has a speed of only about 2 knots, as against 10 knots on the Blue Nile. The latter is more of a mountain torrent, while the White Nile really acts as a large drainage canal.

FLOODS AT MONTEREY.

The disastrous flood of the Santa Catarina River, which has resulted in the destruction of a great part of Monterey and the loss of something like 2000 lives, is of especial interest to engineers, because the unfortunate city has been remarkable for the energy it has shown in the development of great engineering works. It has not only a very complete electricity supply system, but there have been recently finished schemes for water supply and drainage which are of exceptional importance. In November last we gave a very fully illustrated description of these works, which will be turned to with interest at the present time. Monterey was founded by the Spaniards as long ago as 1560; it is situated on a fertile plain and surrounded on all sides by limestone mountains, rising in places to 6000ft. above the general level. The city itself is 1750ft. above the sea, and has a population of 84,000, but is rapidly developing. Part of the water supply is taken from the Estanzuela River, which is nearly due south of the city, whilst the Santa Catarina, which has caused the present floods, is almost due west, but one of the great distributing reservoirs, holding 10,000,000 gallons, is close to the Santa Catarina, and it is to be feared it must have suffered in some degree. This reservoir is a remarkable circular structure built in concrete, 268ft. in diameter by 30ft. deep, and is entirely covered in. Full details of its construction were given in our issue of November 6th, and will be found well worth study. The reservoir is seated 164ft. above the central part of the city, and it may be that this elevated position has saved it from serious damage. There is a second water supply at San Geronimo, to the west of the city, and this is even more likely to have suffered severely. Further particulars will no doubt reach us in a few days.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

ADDRESS BY PROFESSOR SIR J. J. THOMSON, M.A., LL.D. D.Sc., F.R.S., President.

(*Concluded from page* 213.)

Let us now consider how much ether is carried along by ordinary matter, and what effects this might be expected to produce.

The simplest electrical system we know, an electrified sphere, has attached to it a mass of ether proportional to its potential energy, and such that if the mass were to move with the velocity of light its kinetic energy would equal the electrostatic potential energy of the particle. This result can be extended to any electrified system, and it can be shown that such a system binds a mass of the ether proportional to its potential energy. Thus a part of the mass of any system is proportional to the potential energy of the system.

The question now arises, Does this part of the mass add anything to the weight of the body? If the ether were not subject to gravitational attraction it certainly would not; and even if the ether were ponderable, we might expect that as the mass is swimming in a sea of ether it would not increase the weight of the body to which it is attached. But if it does not, then a body with a large amount of potential energy may have an appreciable amount of its mass in a form which does not increase its weight, and thus the weight of a given mass of it may be less than that of an equal mass of some substance with a smaller amount of potential energy. Thus the weights of equal masses of these substances would be different. Now, experiments with pendulums, as Newton pointed out, enable us to determine with great accuracy the weights of equal masses of different substances. Newton himself made experiments of this kind, and found that the weights of equal masses were the same for all the materials he tried. Bessel, in 1830, made some experiments on this subject which are still the most accurate we possess, and he showed that the weights of equal masses of lead, silver, iron, brass did not differ by as much as one part in 60,000.

The substances tried by Newton and Bessel did not, however, include any of those substances which possess the marvellous power of radio-activity; the discovery of these came much later, and is one of the most striking achievements of modern physics.

These radio-active substances are constantly giving out large quantities of heat, presumably at the expense of their potential energy; thus when these substances reach their final non-radio-active state their potential energy must be less than when they were radio-active. Professor Rutherford's measurements show that the energy emitted by one gramme of radium in the course of its degradation to non-radio-active forms is equal to the kinetic energy of a mass of one-thirteenth of a milligramme moving with the velocity of light.

This energy, according to the rule I have stated, corresponds to a mass of $\frac{1}{13}$ of a milligramme of the ether, and thus a gramme of radium in its radio-active state must have at least $\frac{1}{13}$ of a milligramme more of ether attached to it than when it has been degraded into the non-radio-active forms. Thus, if this ether does not increase the weight of the radium, the ratio of mass to weight for radium would be greater by about one part in 13,000 than for its non-radio-active products.

I attempted several years ago to find the ratio of mass to weight for radium by swinging a little pendulum, the bob of which was made of radium. I had only a small quantity of radium, and was not, therefore, able to attain any great accuracy. I found that the difference, if any, in the ratio of the mass to weight between radium and other substances was not more than one part in 2000. Lately we have been using at the Cavendish Laboratory a pendulum whose bob was filled with uranium oxide. We have got good reasons for supposing that uranium is a parent of radium, so that the great potential energy and large ethereal mass possessed by the radium will be also in the uranium; the experiments are not yet completed. It is, perhaps, expecting almost too much to hope that the radio-active substances may add to the great services they have already done to science by furnishing the first case in which there is some differentiation in the action of gravity.

The mass of ether bound by any system is such that if it were to move with the velocity of light its kinetic energy would be equal to the potential energy of the system. This result suggests a new view of the nature of potential energy. Potential energy is usually regarded as essentially different from kinetic energy. Potential energy depends on the configuration of the system, and can be calculated from it when we have the requisite data; kinetic energy, on the other hand, depends upon the velocity of the system. According to the principle of the conservation of energy the one form can be converted into the other at a fixed rate of exchange, so that when one unit of one kind disappears a unit of the other simultaneously appears.

Now in many cases this rule is all that we require to calculate the behaviour of the system, and the conception of potential energy is of the utmost value in making the knowledge derived from experiment and observation available for mathematical calculation. It must, however, I think, be admitted that from the purely philosophical point of view it is open to serious objection. It violates, for example, the principle of continuity. When a thing changes from a state A to a different state B, the principle of continuity requires that it must pass through a number of states intermediate between A and B, so that the transition is made gradually, and not abruptly. Now, when kinetic energy changes into potential, although there is no discontinuity in the quantity of the energy there is in its quality, for we do not recognise any kind of energy intermediate between that due to the motion and that due to the position of the system, and some portions of energy are supposed to change *per saltum* from the kinetic to the potential form. In the case of the transition of kinetic energy into heat energy in a gas, the discontinuity has disappeared with a fuller knowledge of what the heat energy in a gas is due to. When we were ignorant of the nature of this energy, the transition from kinetic into thermal energy seemed discontinuous; but now we know that this energy is the kinetic energy of the molecules of which the gas is composed, so that there is no change in the type of energy when the kinetic energy of visible motion is transformed into the thermal energy of a gas—it is just the transference of kinetic energy from one body to another.

If we regard potential energy as the kinetic energy of portions of the ether attached to the system, then all energy is kinetic energy, due to the motion of matter or of portions of ether attached to the matter. I showed, many years ago, in my "Applications of Dynamics to Physics and Chemistry," that we could imitate the effects of the potential energy of a system by means of the kinetic energy of invisible systems connected in an appropriate manner with the main system, and that the potential energy of the visible universe may in reality be the kinetic energy of an invisible one connected up with it. We naturally suppose that this invisible universe is the luminiferous ether, that portions of the ether in rapid motion are connected with the visible systems, and that their kinetic energy is the potential energy of the systems.

We may thus regard the ether as a bank in which we may deposit energy and withdraw it at our convenience. The mass of the ether attached to the system will change as the potential energy changes, and thus the mass of a system whose potential energy is changing cannot be constant; the fluctuations in mass under ordinary conditions are, however, so small that they cannot be detected by any means at present at our disposal. Inasmuch as the various forms of potential energy are continually being changed into heat energy, which is the kinetic energy of the molecules of matter, there is a constant tendency for the mass of a system such as the earth or the sun to diminish, and thus as time goes on for the mass of ether gripped by the material universe to become smaller and smaller; the rate at which it would diminish would, however, get slower as time went on, and there is no reason to think that it would ever get below a very large value.

Radiation of light and heat from an incandescent body like the sun involves a constant loss of mass by the body. Each unit of energy radiated carries off its quota of mass, but as the mass ejected from the sun per year is only one part in 20 billionths (1 in 2×10^{13}) of the mass of the sun, and as this diminution in mass is not necessarily accompanied by any decrease in its gravitational attraction, we cannot expect to be able to get any evidence of this effect.

As our knowledge of the properties of light has progressed, we have been driven to recognise that the ether, when transmitting light, possesses properties which, before the introduction of the electro-magnetic theory, would have been thought to be peculiar to an emission theory of light and to be fatal to the theory that light consists of undulations.

Take, for example, the pressure exerted by light. This would follow as a matter of course if we supposed light to be small particles moving with great velocities, for these, if they struck against a body, would manifestly tend to push it forward, while on the undulatory theory there seemed no reason why any effect of this kind should take place.

Indeed, in 1792, this very point was regarded as a test between the theories, and Bennet made experiments to see whether or not he could find any traces of this pressure. We now know that the pressure is there, and if Bennet's instrument had been more sensitive he must have observed it. It is perhaps fortunate that Bennet had not at his command more delicate apparatus. Had he discovered the pressure of light, it would have shaken confidence in the undulatory theory and checked that magnificent work at the beginning of the last century which so greatly increased our knowledge of optics.

As another example, take the question of the distribution of energy in a wave of light. On the emission theory the energy in the light is the kinetic energy of the light particles. Thus the energy of light is made up of distinct units, the unit being the energy of one of the particles.

The idea that the energy has a structure of this kind has lately received a good deal of support. Planck, in a very remarkable series of investigations on the Thermodynamics of Radiation, pointed out that the expressions for the energy and entropy of radiant energy were of such a form as to suggest that the energy of radiation, like that of a gas on the molecular theory, was made up of distinct units, the magnitude of the unit depending on the colour of the light; and on this assumption he was able to calculate the value of the unit, and from this deduce incidentally the value of Avogadro's constant—the number of molecules in a cubic centimetre of gas at standard temperature and pressure.

This result is most interesting and important because if it were a legitimate deduction from the Second Law of Thermodynamics, it would appear that only a particular type of mechanism for the vibrators which give out light and the absorbers which absorb it could be in accordance with that law.

If this were so, then, regarding the universe as a collection of machines all obeying the laws of dynamics, the Second Law of Thermodynamics would only be true for a particular kind of machine.

There seems, however, grave objection to this view, which I may illustrate by the case of the First Law of Thermodynamics, the principle of the Conservation of Energy. This must be true whatever be the nature of the machines which make up the universe, provided they obey the laws of dynamics, any application of the principle of the Conservation of Energy could not discriminate between one type of machine and another.

Now, the Second Law of Thermodynamics, though not a dynamical principle in as strict a sense as the law of the Conservation of Energy, is one that we should expect to hold for a collection of a large number of machines of any type, provided that we could not directly affect the individual machines, but could only observe the average effects produced by an enormous number of them. On this view, the Second Law, as well as the First, should be incapable of saying that the machines were of any particular type: so that investigations founded on thermodynamics, though the expressions they lead to may suggest—cannot, I think, be regarded as proving—the unit structure of light energy.

It would seem as if in the application of thermodynamics to radiation some additional assumption has been implicitly introduced, for these applications lead to definite relations between the energy of the light of any particular wave length and the temperature of the luminous body.

Now a possible way of accounting for the light emitted by hot bodies is to suppose that it arises from the collisions of corpuscles with the molecules of the hot body, but it is only for one particular law of force between corpuscles and the molecules that the distribution of energy would be the same as that deduced by the Second Law of Thermodynamics, so that in this case, as in the other, the results obtained by the application of thermodynamics to radiation would require us to suppose that the Second Law of Thermodynamics is only true for radiation when the radiation is produced by mechanism of a special type.

Quite apart, however, from considerations of thermodynamics, we should expect that the light from a luminous source should in many cases consist of parcels, possessing, at any rate to begin with, a definite amount of energy. Consider, for example, the case of a gas like sodium vapour, emitting light of a definite wave length; we may imagine that this light, consisting of electrical waves, is emitted by systems resembling Leyden jars. The energy originally possessed by such a system will be the electrostatic energy of the charged jar. When the vibrations are started, this energy will be radiated away into space, the radiation forming a complex system, containing, if the jar has no electrical resistance, the energy stored up in the jar.

The amount of this energy will depend on the size of the jar and the quantity of electricity with which it is charged. With regard to the charge, we must remember that we are dealing with systems formed out of single molecules, so that the charge will only consist of one or two natural units of electricity, or, at all events, some small multiple of that unit, while for geometrically similar Leyden jars the energy for a given charge will be proportional to the frequency of the vibration; thus, the energy in the bundle of radiation will be proportional to the frequency of the vibration.

We may picture to ourselves the radiation as consisting of the lines of electric force which, before the vibrations were started, were held bound by the charges on the jar, and which, when the vibrations begin, are thrown into rhythmic undulations, liberated from the jar, and travel through space with the velocity of light.

Now, let us suppose that this system strikes against an uncharged condenser, and gives it a charge of electricity, the charge on the plates of the condenser must be at least one unit of electricity, because fractions of this charge do not exist, and each unit charge will anchor a unit tube of force, which must come from the parcel of radiation falling upon it. Thus a tube in the incident light will be anchored by the condenser, and the parcel formed by this tube will be anchored and withdrawn as a whole from the pencil of light incident on the condenser. If the energy required to charge up the condenser with a unit of electricity is greater than the energy in the incident parcel, the tube will not be anchored, and the light will pass over the condenser and escape from it. These principles that radiation is made up of units, and that it requires a unit possessing a definite amount of energy to excite radiation in a body on which it falls, perhaps receive their best illustration in the remarkable laws governing Secondary Röntgen radiation, recently discovered by Professor Barkla. Professor Barkla has found that each of the different chemical elements, when exposed to Röntgen rays, emit a definite type of secondary radiation whatever may have been the type of primary; thus lead emits one type, copper another, and so on; but these radiations are not excited at all if the primary radiation is of a softer type than the specific radiation emitted by the substance, thus the secondary radiation from lead being harder than that from copper; if copper is exposed to the secondary radiation from lead, the copper will radiate, but lead will not radiate when exposed to copper. Thus, if we suppose that the energy in a unit of hard Röntgen rays is greater that than in one of soft, Barkla's results are strikingly analogous to those which would follow on the unit theory of light.

Though we have, I think, strong reasons for thinking that the energy in the light waves of definite wave length is done up into bundles, and that these bundles, when emitted, all possess the same amount of energy, I do not think there is any reason for supposing that in any casual specimen of light of this wave length, which may subsequent to its emission have been many times refracted or reflected, the bundles possess any definite amount of energy. For consider what must happen when a bundle is incident on a surface such as glass, when part of it is reflected and part transmitted. The bundle is divided into two portions, in each of which the energy is less than the incident bundle, and since these portions diverge and may ultimately be many thousands of miles apart, it would seem meaningless to still regard them as forming one unit. Thus the energy in the bundles of light, after they have suffered partial reflection, will not be the same as in the bundles when they were emitted. The study of the dimensions of these bundles, for example, the angle they subtend at the luminous source, is an interesting subject for investigation; experiments on interference between rays of light emerging in different directions from the luminous source would probably throw light on this point.

I now pass to a very brief consideration of one of the most important and interesting advances ever made in physics, and in which Canada, as the place of the labours of Professors Rutherford and Soddy, has taken a conspicuous part. I mean the discovery and investigation of radio activity. Radio activity was brought to light by the Röntgen rays. One of the many remarkable properties of these rays is to excite phosphorescence in certain substances, including the salts of uranium, when they fall upon them. Since Röntgen rays produce phosphorescence, it occurred to Becquerel to try whether phosphorescence would produce Röntgen rays. He took some uranium salts which had been made to phosphoresce by exposure, not to Röntgen rays but to sunlight, tested them, and found that they gave out rays possessing properties similar to Röntgen rays. Further investigation showed, however, that to get these rays it was not necessary to make the uranium phosphoresce, that the salts were just as active if they had been kept in the dark. It thus appeared that the property was due to the metal and not to the phosphorescence, and that uranium and its compounds possessed the power of giving out rays which, like Röntgen rays, affect a photographic plate, make certain minerals phosphoresce, and make gases through which they pass conductors of electricity.

Niepce de Saint-Victor had observed some years before this discovery that paper soaked in a solution of uranium nitrate affected a photographic plate, but the observation excited but little interest. The ground had not then been prepared, by the discovery of the Röntgen rays, for its reception, and it withered and was soon forgotten.

Shortly after Becquerel's discovery of uranium, Schmidt found that thorium possessed similar properties. Then Monsieur and Madame Curie, after a most difficult and laborious investigation, discovered two new substances, radium and polonium, possessing this property to an enormously greater extent than either thorium or uranium, and this was followed by the discovery of actinium by Debierne. Now the researches of Rutherford and others have led to the discovery of so many new radio-active substances that any attempt at christening seems to have been abandoned, and they are denoted, like policemen, by the letters of the alphabet.

Mr. Campbell has recently found that potassium, though far inferior in this respect to any of the substances I have named, emits an appreciable amount of radiation, the amount depending only on the quantity of potassium, and being the same whatever the source from which the potassium is obtained, or whatever the elements with which it may be in combination.

The radiation emitted by these substances is of three types, known as α, β and γ rays. The α rays have been shown by Rutherford to be positively electrified atoms of helium, moving with speeds which reach up to about one-tenth of the velocity of light. The β rays are negatively electrified corpuscles, moving in some cases with very nearly the velocity of light itself, while the γ rays are unelectrified, and are analogous to the Röntgen rays.

The radio-activity of uranium was shown by Crookes to arise from something mixed with the uranium, and which differed sufficiently in properties from the uranium itself to enable it to be separated by chemical analysis. He took some uranium, and by chemical treatment separated it into two portions, one of which was radio-active and the other not.

Next Becquerel found that if these two portions were kept for several months, the part which was not radio-active to begin with regained radio-activity, while the part which was radio-active to begin with had lost its radio-activity. These effects and many others receive a complete explanation by the theory of radio-active change which we owe to Rutherford and Soddy.

According to this theory, the radio-active elements are not permanent, but are gradually breaking up into elements of lower atomic weight; uranium, for example, is slowly breaking up, one of the products being radium, while radium breaks up into a radio-active gas called radium emanation, the emanation into another radio-active substance, and so on, and that the radiations are a kind of swan's song emitted by the atoms when they pass from one form to another; that, for example, it is when a radium atom breaks up and an atom of the emanation appears that the rays which constitute the radio-activity are produced.

Thus, on this view the atoms of the radio-active elements are not immortal, they perish after a life whose average value ranges from thousands of millions of years in the case of uranium to a second or so in the case of the gaseous emanation from actinium.

When the atoms pass from one state to another they give out large stores of energy, thus their descendants do not inherit the whole of their wealth of stored-up energy, the estate becomes less and less wealthy with each generation; we find, in fact, that the politician, when he imposes death duties, is but imitating a process which has been going on for ages in the case of these radio-active substances.

Many points of interest arise when we consider the rate at which the atoms of radio-active substance disappear. Rutherford has shown that, whatever be the age of these atoms, the percentage of atoms which disappear in one second is always the same; another way of putting it is that the expectation of life of an atom is independent of its age—that an atom of radium one thousand years old is just as likely to live for another thousand years as one just sprung into existence.

Now, this would be the case if the death of the atom were due to something from outside which struck old and young indiscriminately; in a battle, for example, the chance of being shot is the same for old and young; so that we are inclined at first to look to something coming from outside as the cause why an atom of radium, for example, suddenly changes into an atom of the emanation. But here we are met with the difficulty that no changes in the external conditions that we have as yet been able to produce have had any effect on the life of the atom; as far as we know at present, the life of a radium atom is the same at the temperature of a furnace as at that of liquid air—it is not altered by surrounding the radium by thick screens of lead or other dense materials to ward off radiation from outside, and what to my mind is especially significant, it is the same when the radium is in the most concentrated form, when its atoms are exposed to the vigorous bombardment from the rays given off by the neighbouring atoms, as when it is in the most dilute solution, when the rays are absorbed by the water which separates one atom from another. This last result seems to me to make it somewhat improbable that we shall be able to split up the atoms of the non-radio-active elements by exposing them to the radiation from radium; if this radiation is unable to affect the unstable radio-active atoms, it is somewhat unlikely that it will be able to affect the much more stable non-radio-active elements.

The evidence we have at present is against a disturbance coming from outside breaking up of the radio-active atoms, and we must therefore look to some process of decay in the atom itself; but if this is the case, how are we to reconcile it with the fact that the expectation of life of an atom does not diminish as the atom gets older? We can do this if we suppose that the atoms when they are first produced have not all the same strength of constitution, that some are more robust than others, perhaps because they contain more intrinsic energy to begin with, and will therefore have a longer life. Now, if when the atoms are first produced there are some which will live for one year, some for ten, some for a thousand, and so on; and if lives of all durations, from nothing to infinity, are present in such proportion that the number of atoms which will live longer than a certain number of years decrease in a constant proportion for each additional year of life, we can easily prove that the expectation of life of an atom will be the same whatever its age may be. On this view the different atoms of a radio-active substance are not, in all respects, identical.

The energy developed by radio-active substances is exceedingly large, one gramme of radium developing nearly as much energy as would be produced by burning a ton of coal. This energy is mainly in the α particles, the positively charged helium atoms which are emitted when the change in the atom takes place; if this energy were produced by electrical forces it would indicate that the helium atom had moved through a potential difference of about two million volts on its way out of the atom of radium. The source of this energy is a problem of the deepest interest; if it arises from the repulsion of similarly electrified systems exerting forces varying inversely as the square of the distance, then to get the requisite amount of energy the systems, if their charges were comparable with the charge on the α particle, could not when they start be further apart than the radius of a corpuscle, 10^{-13} cm. If we suppose that the particles do not acquire this energy at the explosion, but that before they are shot out of the radium atom they move in circles inside this atom with the speed with which they emerge, the forces required to prevent particles moving with this velocity from flying off at a tangent are so great that finite charges of electricity could only produce them at distances comparable with the radius of a corpuscle.

One method by which the requisite amount of energy could be obtained is suggested by the view to which I have already alluded—that in the atom we have electrified systems of very different types, one small, the other large; the radius of one type is comparable with 10^{-13} cm., that of the other is about 100,000 times greater. The electrostatic potential energy in the smaller bodies is enormously greater than that in the larger ones; if one of these small bodies were to explode and expand to the size of the larger ones, we should have a liberation of energy large enough to endow an α particle with the energy it possesses. Is it possible that the positive units of electricity were, to begin with, quite as small as the negative, but while in the course of ages most of these have passed from the smaller stage to the larger, there are some small ones still lingering in radio-active substances, and it is the explosion of these which liberates the energy set free during radio-active transformation?

The properties of radium have consequences of enormous importance to the geologist as well as to the physicist or chemist. In fact, the discovery of these properties has entirely altered the aspect of one of the most interesting geological problems, that of the age of the earth. Before the discovery of radium it was supposed that the supplies of heat furnished by chemical changes going on in the earth were quite insignificant, and that there was nothing to replace the heat which flows from the hot interior of the earth to the colder crust. Now when the earth first solidified it only possessed a certain amount of capital in the form of heat, and if it is continually spending this capital and not gaining any fresh heat it is evident that the process cannot have been going on for more than a certain number of years, otherwise the earth would be colder than it is. Lord Kelvin in this way estimated the age of the earth to be less than 100 million years. Though the quantity of radium in the earth is an exceedingly small fraction of the mass of the earth, only amounting, according to the determinations of Professors Strutt and Joly, to about five grammes in a cube whose side is 100 miles, yet the amount of heat given out by this small quantity of radium is so great that it is more than enough to replace the heat which flows from the inside to the outside of the earth. This, as Rutherford has pointed out, entirely vitiates the previous method of determining the age of the earth. The fact is that the radium gives out so much heat that we do not quite know what to do with it, for if there was as much radium throughout the interior of the earth as there is in its crust, the temperature of the earth would increase much more rapidly than it does as we descend below the earth's surface. Professor Strutt has shown that if radium behaves in the interior of the earth as it does at the surface, rocks similar to those in the earth's crust cannot extend to a depth of more than 45 miles below the surface.

It is remarkable that Professor Milne from the study of earthquake phenomena had previously come to the conclusion that rocks similar to those at the earth's surface only descend a short distance below the surface; he estimates this distance at about 30 miles, and concludes that a depth greater than this the earth is fairly homogeneous.

Though the discovery of radio-activity has taken away one method of calculating the age of the earth it has supplied another.

The gas helium is given out by radio-active bodies, and since, except in beryls, it is not found in minerals which do not contain radio-active elements, it is probable that all the helium in these minerals has come from these elements. In the case of a mineral containing uranium, the parent of radium in radio-active equilibrium, with radium and its products, helium will be produced at a definite rate. Helium, however, unlike the radio-active elements, is permanent and accumulates in the mineral; hence if we measure the amount of helium in a sample of rock and the amount produced by the sample in one year we can find the length of time the helium has been accumulating, and hence the age of the rock. This method, which is due to Professor Strutt, may lead to determinations not merely of the average age of the crust of the earth, but of the ages of particular rocks and the date at which the various strata were deposited; he has, for example, shown in this way that a specimen of the mineral thorianite must be more than 240 million years old.

The physiological and medical properties of the rays emitted by radium is a field of research in which enough has already been done to justify the hope that it may lead to considerable alleviation of human suffering. It seems quite definitely established that for some diseases, notably rodent ulcer, treatment with these rays has produced remarkable cures; it is imperative, lest we should be passing over a means of saving life and health, that the subject should be investigated in a much more systematic and extensive manner than there has yet been either time or material for. Radium is, however, so costly that few hospitals could afford to undertake pioneering work of this kind; fortunately, however, through the generosity of Sir Ernest Cassel and Lord Iveagh, a Radium Institute, under the patronage of his Majesty the King, has been founded in London for the study of the medical properties of radium, and for the treatment of patients suffering from diseases for which radium is beneficial.

The new discoveries made in physics in the last few years, and the ideas and potentialities suggested by them, have had an effect upon the workers in that subject akin to that produced in literature by the Renaissance. Enthusiasm has been quickened, and there is a hopeful, youthful, perhaps exuberant, spirit abroad which leads men to make with confidence experiments which would have been thought fantastic twenty years ago. It has quite dispelled the pessimistic feeling, not uncommon at that time, that all the interesting things had been discovered, and all that was left was to alter a decimal or two in some physical constant. There never was any justification for this feeling, there never were any signs of an appoach to finality in science. The sum of knowledge is at present, at any rate, a diverging not a converging series. As we conquer peak after peak we see in front of us regions full of interest and beauty, but we do not see our goal, we do not see the horizon; in the distance tower still higher peaks, which will yield to those who ascend them still wider prospects, and deepen the feeling, whose truth is emphasised by every advance in science, that "Great are the Works of the Lord."

The Institution of Mining Engineers.—The twentieth annual general meeting of this Institution is to be held at Newcastle-on-Tyne on September 15th, 16th, and 17th. On Wednesday, September 15th, the members will be received by the Lord Mayor of Newcastle-on-Tyne, and by the president and members of Council of the North of England Institute of Mining and Mechanical Engineers. Thereafter the annual meeting will be held in the halls of the latter institute, and several papers will be read and discussed. In the evening the members dine in the King's Hall of Armstrong College. For Thursday and Friday arrangements have been made to enable the members to inspect several local works and places of interest. Among these will be the Harton Coal Company's pits, the sinking of the Newbiggin Colliery, and the recent excavations on the Roman site at Corbridge.

A New 33-knot Torpedo Boat Destroyer.—The new 33-knot Destroyer, H.M.S. Nubian, which completed her official speed trials about six weeks ago, was inspected at the works of the builders, Messrs. John I. Thornycroft and Co., Limited, of Woolston, Southampton, and finally handed over to the Admiralty after the usual acceptance trial on Saturday last, August 28th. The vessel proceeded to Portsmouth Dockyard, and will take up service with the North Sea Flotilla. H.M.S. Nubian is the first of the five vessels of this class (given out by the Admiralty at the end of February, 1908) to be delivered, being completed considerably in advance of her sister vessels, and handed over approximately two months before the expiry of the contract date. The names of the other vessels of this group are as follows:—H.M.ships Crusada (builders, J. S. White and Co., Limited); Zulu (Hawthorn, Leslie and Co., Limited); Maori (William Denny and Brothers); Viking (Palmer's Shipbuilding and Iron Company, Limited).

The New Steamship for the Cunard Line.—The information which has been published in the daily newspapers and several other journals relative to the new vessel which the Cunard Steamship Company, Limited, has decided to add to its fleet is misleading and inaccurate. It is the fact that, from amongst about a dozen tenders submitted, contracts for the hull and machinery were last Friday awarded to Swan, Hunter and Wigham Richardson, Limited, and the Wallsend Slipway and Engineering Company, Limited, respectively, but the precise dimensions of the vessel have not yet been determined, neither has a decision been come to as to whether turbine machinery or a combination of turbine and reciprocating engines shall be used. The statement published by a shipping journal on Wednesday that the new Cunarder is "to be propelled by a combination of reciprocating and turbine engines, or by turbines alone, in which case her speed may reach as high as 30 knots," need not be taken too seriously. The new vessel is intended for the Liverpool and Boston service, and will not be called upon, as has been stated, to act as a "relief" to either the Mauretania or Lusitania. In all probability she will be an improved Ivernia type, which vessel, it will be remembered, was built by C. S. Swan and Hunter, Limited, some nine years ago, and which has a length over all of 600ft.; a depth, moulded, to upper deck, 41ft. 6in.; a depth, moulded, to shelter deck, 49ft. 6in.; a gross tonnage of 15,512 tons; and an indicated horse-power of 12,000.

Disadvantages of Gas Making in a Colliery Centre.—The annual meeting of the Barnsley Gas Company was held on the 26th ult. Mr. E. G. Lancaster, J.P., in moving the adoption of the report, compared the balance-sheet with that for last year. The company had spent £206 more on certain items connected with the manufacture of gas, and had spent £416 less on other items, giving a total saving of £210. In the distribution department there was a total excess, compared with last year, of £1035, of which £597 was accounted for by repairs and maintenance. Rates and taxes were also £106 more than last year. Bank interest also showed an increase of £103. Altogether the expenditure had been £620 more than last year. On the other side, the company had sold gas to the value of £676 more; but residuals had produced £175 less, and sundries £103 less. The total receipts had increased by £398, leaving the finances £222 worse than last year. This, continued Mr. Lancaster, could be explained in a moment. They had often heard the statement made that Barnsley, being in the centre of a coalfield, should make gas more cheaply than anybody else. It was for the very reason that they were in a colliery district that they could not maintain their maximum dividends. As they were aware, a large proportion of the coal had been taken from underneath Barnsley, and to the east the ground was in a constant giving. Between Barnsley and Ardsley the company's men were constantly at work repairing and renewing mains and stopping breakages, while the leakage had been excessive. It got so bad that they had to see whether some different kind of pipe could not be introduced, and they thought they had found a plan, by laying steel pipes, which would bend where iron would break. So far the results had been satisfactory. The growing demand for slot meters had also thrown a good deal of expense upon the company. In the bulk of new property they were fixing slot meters, and this was an expense which would continue for the next two or three years. The motion for the adoption of the report was agreed to.

THE FRENCH ARMOURED CRUISER ERNEST RENAN.

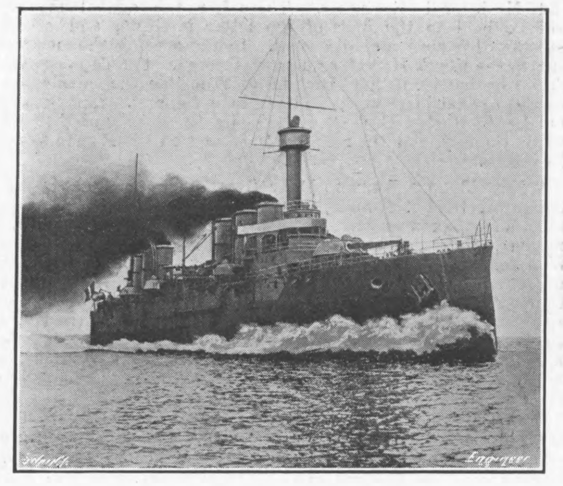
The armoured cruiser Ernest Renan is the largest vessel of her type in the French navy, and the largest cruiser ever launched on the European Continent. She formed part of the 1900 programme, and was ordered from Les Chantiers de l'Atlantique in August, 1903; but as her drawings were frequently altered, from one cause or another—partly by reason of lessons learnt from the Russo-Japanese war—her completion was retarded, and she did not actually join the fleet until last year. She is a remarkable vessel in more ways than one, and we feel sure that a brief account of her will be of interest to our readers.

To begin with, she has the following characteristics:—

Length at the water-line, fully loaded	157 m. =	say, 515ft.
Width at the water-line, fully loaded	21.36 m. =	,, 70ft.
Maximum draught, aft	8.18 m. =	,, 26ft. 10in.
Assumed horse-power	36,000	
Displacement with normal load	13,644 tons.	

The hull is built of mild steel throughout. There is no metallic keel, its place being taken by a false keel of teak, and on each side there are two bilge keels, which are all about half the length of the vessel. The stem is of forged steel, and the stern post of cast steel. Below the lower protective deck the vessel is divided into numerous main water-tight compartments, which are in their turn separated into further smaller compartments. The double bottom, except at the extremities of the vessel, is worked up to the lower protective deck. On each side of the central keelson are eight longitudinal keelsons, to help to ensure the longitudinal rigidity of the hull. Below the water-line there are double garboard strakes and two strakes clincher riveted. The thickness of the hull varies from 18 mm. below the water-line to 10 mm. above it.

Like all the larger vessels included in the 1900 programme, the Ernest Renan is protected by a cellular space, forming an armoured caisson, which is limited as to height by the upper protective deck, and as to depth by the lower protective deck, its sides being formed by the armoured belt. The lower protective deck is in the centre line of the vessel, a little above the line of flotation, while at the sides it forms a junction with the lower edge of the first strake. The upper protective deck, which may also be called the splinter deck, is horizontal, and runs from end to end at the height of the upper edge of the armoured belt.



THE ERNEST RENAN

The side armour belt is worked from the stem to aft of the rudder. The fineness of the lines at this point did not admit of its being taken any further. So as to protect the remaining part from projectiles, a transverse armoured bulkhead has been provided. The armoured belt has the following depths:—

	Forward.	Aft and amidships.
Total depth ...	6.60 m., say 21ft. 8in. ...	3.7 m., say 12ft. 2in.
Depth above water-line ...	5.20 m., say 17ft. 1in. ...	2.30 m., say 7ft. 7in.
Depth below water-line ...	1.40 m., say 4ft. 7in. ...	1.40 m., say 4ft. 7in.

The thicknesses are as follows:—

	Amidships.	Forward and aft.
Main strake	170 mm., say 6.7in. ...	100 mm., say 4in.
2nd strake	130 mm., say 5.1in. ...	90 mm., ,, 3.5in
3rd ,, ...	— — ...	56 mm., ,, 2.2in (Forward only)

All the armour rests against a backing of teak 20 mm. thick and double plating.

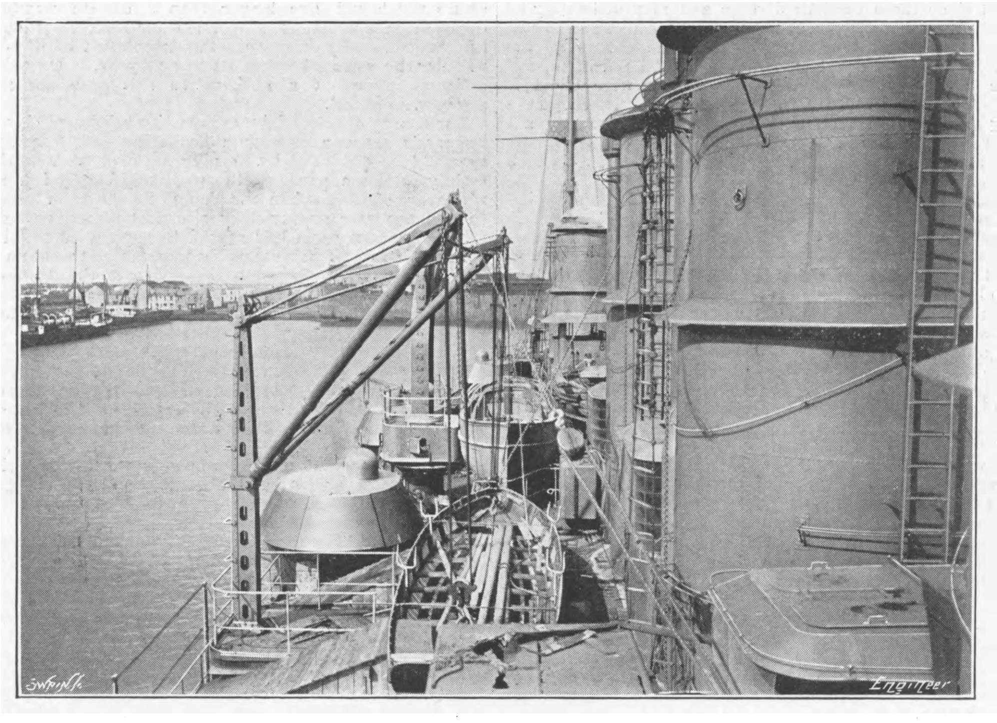
In vessels protected with an armoured belt, that which distinguishes French ships from those of other nations is the light armour which starts from the stem and ends at the forward casemates. In the Ernest Renan this armouring is 37 m. long, from the stem aft, and 56 mm.—2.2in—thick. The French constructors claim for it that it gives a protection forward which is by no means to be despised.

The lower protective deck is 45 mm.—1.8in.—thick where it is flat, and 66 mm.—2.6in.—thick where it slopes. The deck plating has an average thickness of 34 mm.—1.4in. The upper protective deck, or the splinter deck, has only a thickness of from 20 mm. to 34 mm.—$\frac{4}{5}$ths to 1.4in. The space enclosed between the two protective decks and the armoured belt is divided into numerous compartments of the water-tight type, which include—from the starboard side to the centre, for example—an armoured passage-way, two series of bunkers, magazines, and, finally, a central passage-way with transverse splinter plates. Fore and aft of the casemates are athwartships armoured bulkheads, which start from the casemates and reach to the main turrets of the 194 mm. guns. These bulkheads are intended to protect the between-decks from being raked by projectiles fired end on at the vessel. They are 120 mm. thick.

This type of cruiser, unlike similar vessels of other navies, has only one conning tower. It is placed on the lower bridge forward. It has a maximum thickness of armour of 200 mm.—say, $7\frac{7}{8}$in.—and its shield is nearly 6in. thick. The top plates are 2.2in. thick, and the floor 1.6in. There is an armoured passage way, the plating of which is nearly 6in. thick, joining the conning tower with the lower protective deck. This contains the speaking tubes, pipes, and electric wires, and serves as a protection for all the controlling apparatus, &c.

There are forty-two water-tube boilers of the Niclausse type, divided into two groups, each having three funnels. The total grate area is 2680 square feet, and the total heating surface is 84,590 square feet. The full working steam pressure is 299 lb. on the square inch, and it was specified that the forced draught pressure in ordinary working must never exceed that due to 15 mm. of water. There are in all 14,526 boiler tubes, each having a length of 7ft. 6in. The lower tubes have an interior diameter of $2\frac{13}{16}$in., and the upper tubes of $3\frac{1}{16}$in. The funnels vary in height from the grate level from 75ft. 6in. to 91ft. 11in., and they have the following dimensions:—(2) 13ft. 11in. by 27ft. 11in.; (2) 19ft. 3in. by 38ft. 7in.; and (2) 25ft. 11in. by 46ft. Liquid fuel apparatus has been installed, but it is far inferior in its action to that employed in the British Navy; indeed, in this direction—although it was France who made the very first experiments with liquid fuel, the first trials dating from the reign of Napoleon III., when they took place on one of his yachts—there is room for considerable improvement. It is not only ourselves who are backward in developing inventions. On this point we may perhaps be permitted to quote, in the original, from our source of information:—"Une fois de plus l'étranger a su mettre à point une invention française, que son pays d'origine a laissée facilement tomber dans un certain oubli."

The ashes are ordinarily discharged by electrically-worked ash hoists, though when at anchor in roads or when in harbour the work is done by hand. The electric ash hoists apparently do their work rapidly, and have given great satisfaction.



LOOKING AFT FROM UPPER NAVIGATING BRIDGE

According to the contract, the following consumptions of coal were specified:—

10 hours' trial at full power (36,000 I.H.P.)	0.850 kilos. per I.H.P.
Per square metre of grate area	120 to 125 kilos.
(These with a forced draught pressure of from 12 to 15 mm.)	
24 hours' trial normal load and free draught	0.650 to 0.750 kilos. per I.H.P.
Per square metre of grate area	75 kilos.
(Under these conditions 21,600 I.H P. should be developed.)	
Low speed trial	0.600 to 0.700 kilos. per I.H.P.

In the first two cases all the boilers had to be at work. We shall have occasion later on to show how these conditions were fulfilled.

There are three sets of four-cylinder triple-expansion engines. Each set is contained in a separate water-tight compartment. The diameters of the cylinders are as follows:—

High pressure	1180 mm. =	say 46.5in.
Medium pressure ...	1730 mm. =	say 68 0in.
Low pressure	1980 mm. =	say 78.0in.

The common stroke is 1050 mm., say $42\frac{1}{8}$in. The number of revolutions with the engines working at full power is about 136 per minute.

The engines are a fine piece of work, and the finish and arrangement certainly reflect great credit on Les Chantiers de l'Atlantique in which they were built. In their simple construction these engines resemble, though somewhat faintly, those of the large liners. Lubrication is effected with oil supplied under pressure, the pressure being regulated by the rate of movement of the engines. Each engine is arranged in the following manner:—Counting from forward aft there is first of all one of the low-pressure cylinders, then the high-pressure, then the intermediate-pressure, and lastly the second low-pressure cylinder. Each engine has two independent condensers placed in a water-tight compartment. These compartments are in each case abaft the engines, and they contain, in addition to the condensers, the air and circulating pumps, &c. The ventilation of the engine-room and of these compartments is brought about by means of fans.

The engines themselves are furnished with "the latest improvements," with which the French marine authorities intend to provide all their ships. Apparently these "improvements" involve complications, and do not meet with universal approval, for it is said of them that though they are very agreeable in times of peace, and during ordinary operations, when it is easy to put right anything that may go wrong, they are a source of danger when on active service. It is feared that the failure to act of one these "too numerous auxiliary appliances" might cripple one of the main engines at a critical moment, and cause irremediable disaster. It is argued by the critics of these appliances that the simpler an apparatus is the better and more regularly it works, and they go on to remark that it would be much better to revert to the "saner custom" of carrying out everything by hand which could possibly be so done. "The fairy electricity," they continue, "might lose some of her charms, but there would be more certainty of an order being properly carried out; there would, perhaps, be less mathematical precision, but there would be less chance of things going badly wrong." These criticisms, we may mention, come rather from the constructor than from the navigator. Of course, there is much to be said in favour of simplicity, but there will be few who will agree with the sweeping criticisms above quoted. Still, we understand that there is a growing tendency in the French marine to the multiplication of complications, and this cannot certainly be all for good.

The normal bunker capacity of the Ernest Renan is 1354 tons of coal. By using every available space as much as 2300 tons could be stowed away, in addition to the oil fuel. The radii of action at 10 knots would be 7500 and 12,000 miles respectively, and at full power 1026 miles and 1630 miles respectively.

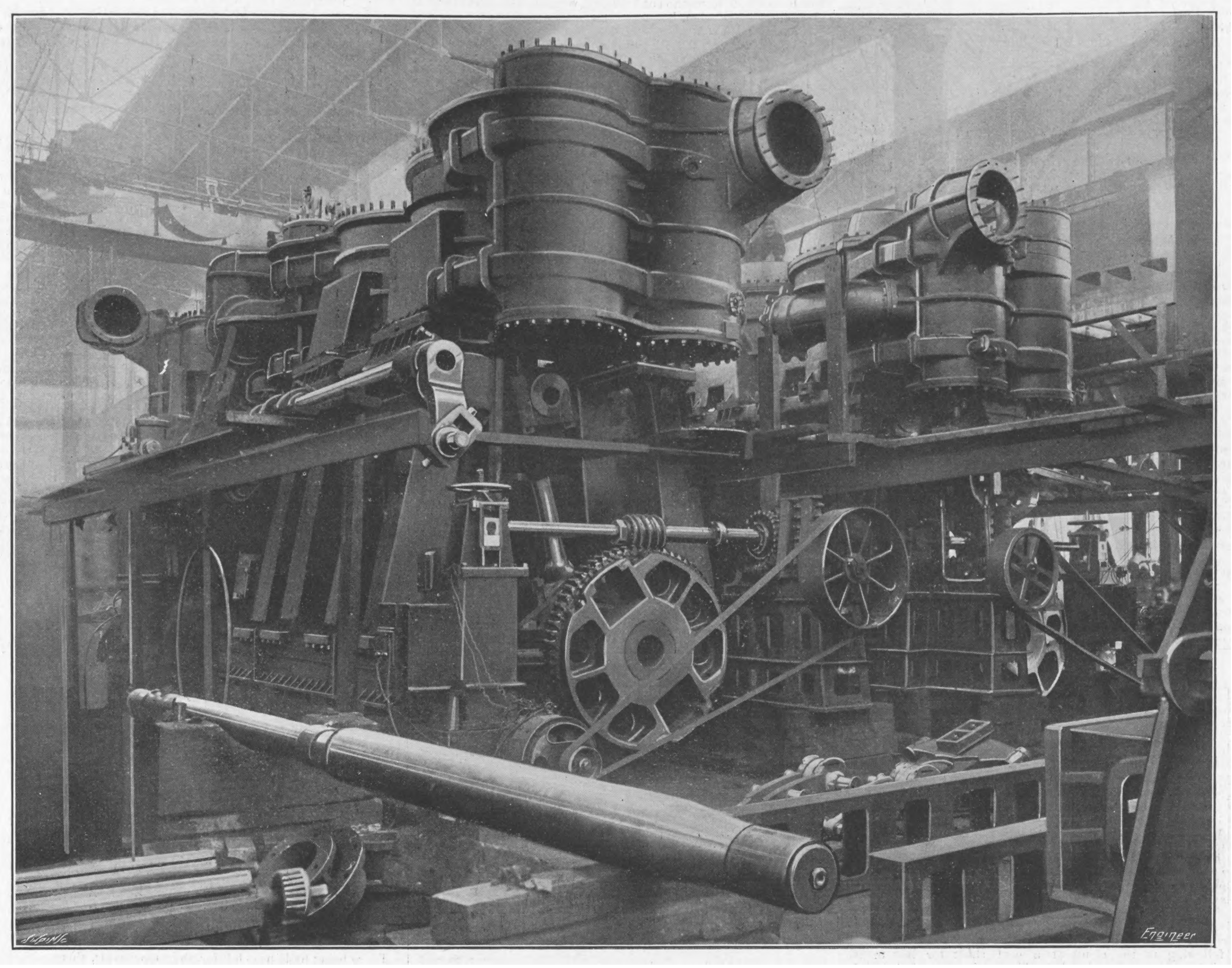
Electricity plays an extensive part on board. By it are actuated all the turrets, ammunition hoists, the three motors for the steering apparatus, the boat winches, and the ventilating arrangements for all parts of the vessel under the protective deck—except the fans for the forced draught air pressure which are steam driven. In addition the plant provides current for lighting and for the projectors, of which there are six. These latter are 0.6 m. in diameter, and work at 75 ampères, with control from a distance. There are four generators placed in two water-tight compartments, one on the starboard and one on the port side. These dynamos, which are driven by reciprocating engines, work at 120 volts, and are each capable of giving 1200 ampères. In each of the compartments just mentioned there is an ammonia refrigerating machine, these being used for cooling the air in the shell-rooms of the 164 mm. guns, which are situated next to the boiler-rooms.

For providing distilled water for the use of the *personnel* there is an apparatus which is capable of producing 150,000 litres, say, 33,000 gallons, of pure water per twenty-four hours.

Below the lower protective deck and near the tiller there are two other water-tight compartments. That on the port side contains the motors which work the rudder, as well as steam stand-by gear for the same purpose. That on the starboard side contains the hand-worked steering gear, which, by the way, needs eight men to operate it. Each compartment is provided with a loud-speaking telephone, an ordinary telephone, speaking tubes, and electric indicators, showing the angle to be given to the rudder, these working on the luminous principle. It is claimed that this arrangement, by reason of its simplicity and sheltered position, gives the greatest possible guarantee of safety for the working of the rudder.

The armament consists of four 194 mm., say 7.6in. guns, placed in two turrets, arranged axially fore and aft; twelve 164 mm., say 6.5in. guns, arranged as follows:—Eight in turrets placed on the spar deck, four on each side, and four placed in four casemates situated two forward and two aft. The smaller armament comprises twenty-eight 47 mm. guns. There are also four 1-pounder guns. Two 18in. torpedo tubes are arranged forward.

THE FRENCH CRUISER ERNEST RENAN—THE STARBOARD AND CENTRAL ENGINES



The thicknesses of the protecting armour of the 7.6in. guns are as follows:—

Stationary Parts.	
From the lower to the upper protective deck ...	1.3in.
From the upper protective deck to the gun or spar deck	4 9 ,,
Other parts	4 9 ,,
Moving Parts.	
Vertical plates	7.9in.
Top plates	2.2 ,,
Splinter plates	4.8 ,,

And of the 6.5in. gun turrets:—

Stationary Parts.	
Tube ring protecting the passages between the two protective decks	1.2in.
Tube ring protecting the passages between the gun and spar deck	3.2 ,,
Tube from upper protective deck to the gun deck	4.9 ,,
Fixed portion of the turret	4.9 ,,
Splinter floor plates	1.6 ,,
Moving Parts.	
Vertical walls	5.5in.
Roof plates	1.5 ,,
Splinter plates	4 7 ,,

As already explained, the armour plating of the casemates has been prolonged forward so as to form an athwartships bulkhead. This bulkhead has a thickness of 4.7in., and is connected to the main turret. The thickness of the various portions of the casemates is as follows:—

Outside plating	4.7in.
Inside plating	2 9in.
Movable shield	3.9in.
Top and floor plates	⅘in.

The Ernest Renan can concentrate either forward or aft the fire of the following weapons:—Two 7.6in. guns and six 6.5in. guns. On either broadside it can concentrate the fire of the following:—Four 7.6in. guns and six 6.5in. guns.

It may be added that all the magazines of the 6.5in. and 47 mm.—say 1.85in.—guns are provided with refrigerating arrangements to prevent the temperature rising above a certain figure, with the idea of preventing the recurrence of accidents similar to those on the Jena.

There are two steam cranes, each with a capacity of from 12 to 15 tons. They are placed one on either side of the ship, and can pick up from or deposit weights on the centre line of the vessel. There are also two 5-ton cranes. The Ernest Renan is the first vessel not to be fitted with a military mast. The mizen mast is only used for the range-finder. The spar deck is much encumbered, as will be realised on examining engravings shown on pages 240 and 244. But this remark does not apply to other parts of the ship. Indeed, it is rare to find a French vessel with deck and 'tween decks so free from obstruction.

The officers' quarters are well arranged. The employment of wood has been much reduced as compared with other French cruisers. The beds are of metal, as is also the bulk of the furniture. The division walls are also of metal sprinkled with cork powder, over which is a covering of canvas cloth. In the cabins of the superior officers the walls are covered with embossed linoleum. The cabins of the junior officers are very like those of the superior officers, saving that the furniture is painted instead of being French polished.

The Ernest Renan came through her official trials in a most creditable manner, as will be gathered from the table above.

Trials of the French Cruiser Ernest Renan.

	No. of boilers at work.	Grate area (sq. m.)	I H.P.	Coal per I.H.P. hour (kilos.)	Coal per sq. m. of grate (kilos.)	Mean speed (knots).	Revolutions per minute.
Consumption Trial.							
Actual figures	6	35·56	3,335	0·658	56·69	8·58	73·8
Contract figures	—	—	3,250	0·700	—	—	—
Twenty-four Hours' Consumption Trial with Natural Draught.							
Actual figures	42	248·94	23,138	0·692	65·39	21·23	119·0
Contract figures	42	248·94	None stipulated	0·700	—	—	—
Ten Hours' Full Power Trial with Forced Draught.							
Actual figures	42	248·94	37,100	0·777	118·60	24·44	136·5
Contract figures	42	248·94	36,000	None stipulated	125·0	23·00	136·0
Air pressure in stokeholds 14 mm.							
Three Hours' Full Power Trial with only Three-fourths of Boilers at Work.							
Actual figures	30	177·81	36,132	0·944	180·18	23·37	135·0
Contract figures	32	189·66	36,000	None stipulated	—	23·00	136·0
Air pressure in stokeholds 23 mm.							

These figures speak for themselves. It will be observed that a speed of nearly 1½ knots in excess of the contract figures was obtained.

We are enabled to give on page 244 four interesting views of this vessel. The first of these is a bow view; the next view shows how curiously the vessel is cut away under water aft. Of the two other views one is taken from the bow looking aft. Unfortunately, the photograph from which the engraving is made was taken on washing day, and some parts are obscured, but the new shape of main turret will be observed. In the final view, which is taken from aft of the navigating bridge looking forward some of the obstructions to which we have referred will be observed. On this page we also give an engraving showing two of the cruiser's engines—the starboard and the central—under erection in the shops. The view is taken from the after end. The large worm wheel seen in each engine is for the steam barring gear. In the engraving the wheels are being temporarily revolved by an electric motor or belting. On board ship they are actuated by a powerful compound engine. A small view is also given of the cruiser undergoing her full-power trial, and still another view looking aft from the upper navigating bridge. The French are justifiably proud of this vessel, which they say is the finest ever built in France, and the speediest ever built on the Continent. She certainly is a great credit to her builders, who had to work under considerable difficulties.

LETTERS TO THE EDITOR.

(We do not hold ourselves responsible for the opinions of our correspondents.)

BRITISH LOCOMOTIVE PRACTICE OF TO-DAY.

Sir,—I have with great interest read the article by "Fireman" in your issue of August 20th on simple *v.* compound. Mr. Chas. W. Dauncey has rightly pointed out that the experiment in question can by no means be accepted as conclusive. For tests of this kind to be of any scientific value—that is, for the formation of reliable data—much greater accuracy would be required in measuring the fuel than was obtained by "Fireman," also the two engines should be identical. It is not fair to either compound or simple if any difference exists as regards steaming powers, adhesion, size of driving wheels, weight, &c., as is the case with the experiment in question. The compound has 2·84 square feet of grate area; the simple has only 25 square feet—quite enough difference in itself to make considerable economy for the compound, as it allows of slower and, consequently, more perfect combustion. The pressures are 220 lb. per square inch for the compound and 180 lb. per square inch for the simple. The driving wheels for the compound are 7ft. in diameter, as compared with 6ft. 9in. for the simple. The larger the driving wheels the better the facilities for expansion. In fact, taking the two engines into consideration for a scientific experiment, nothing could be more unfair to the simple engine. Of course, I by no means doubt any figures in "Fireman's" article, as so far as he went the experiments were very creditable indeed; but science allows of no rule-of-thumb, and demands absolute accuracy before she can judge. The coal must be weighed, not measured by so many "baskets;" the tenders swept out so as to enable absolute accuracy; the water measured by a meter to test evaporative efficiency; the load behind tender carefully measured and speed taken from a reliable indicator.

"Fireman" asks, "Can any simple engine improve on 0.092 lb. per ton-mile fuel consumption?" My answer is, Yes. Twenty-four years ago Mr. Wm Stroudley's Gladstone class were doing 0.081 lb. per ton-mile. I give particulars of a test made by Mr. Stroudley himself. These tests were carried out to find how much power was required to haul a train over the Brighton Railway; also the fuel consumptions. The train was the 8.45 a.m. from Brighton to London Bridge; number of carriages, 24; total weight of engine and train 347 tons, of which the engine and tender weighed 66 tons 1 cwt.; average speed 43.3 per hour, over a difficult road; pounds per train mile, fuel consumption, 28.27 lb.; strong head wind (N.W.); quality of coal moderately good; rails very slippery owing to presence of dead leaves; the train was fitted with electric light; the distance from Brighton to London is 50½ miles. This gives a consumption of practically 0.081 lb. per ton-mile. This was in 1885. There can be absolutely no doubt as to these figures, as they were most accurately obtained. The tenders were swept out for every test. In vol. lxxxi. of the Minutes of the "Proceedings" of the Institution of Civil Engineers can be found a most comprehensive paper by Mr. Stroudley, which is probably one of the most accurate papers ever published on experiments with the locomotive engine. The following is the result of a coal sheet for last month of a railway running into London. The engine was a 0-4-4 tank, with 18½in. cylinders by 26in. stroke; grate, 20.368 square feet in area; heating surface, 1200 square feet, or thereabouts; safety valves set to blow off at 165 lb. per square inch. The fuel consumption for the month of the engine in question was 29.2 lb. per train mile. The engine boiler was fed with cold water, not—as with the Gladstone—with hot feed. The weight of engine, 50 tons; distance of journey, about 26 miles, starting and stopping sometimes as many as ten times in that short distance. The time allowed is, the smallest, 1 h. 8 min.; load usually about 180 tons. The road is a difficult one, and the 29.2 lb. per train mile includes lighting up; this in ton-miles gives approximately .126 lb. I don't think a compound would show any advantage here, especially as the steam pressure is only 160 lb. per square inch when working.

Now comes the part which I know many of your readers will doubt, but I can honestly assure them that it is true. It is possible with these well-designed engines to work along the level at 35 to 40 miles per hour on a 10 per cent. to 12 per cent. cut-off with a train of eight bogie coaches. The reason that a cut-off so early as stated can be so successfully worked is, no doubt, due to the extreme geometrical accuracy observed when designing the valve gear. In the engines not fitted with steam reversing gear a great many drivers carry a wedge or suitable sized bolt to interpose between trigger catch and notch in the quadrant, to get the small cut-off, the first notch giving 20 per cent. cut-off. The compound under these conditions can show very little advantage, and, in my opinion, none. Mr. Stroudley commenced the practice of high expansion as a standard to all types of engines, and on many provided for a 12 per cent. cut-off. A very able Scotch engineer has developed the work which Mr. Stroudley begun nearly thirty-six years ago, and his engines are performing work daily that has rarely been equalled anywhere else.

The field for superheating is large, and the results obtained on many railways has been so very encouraging that a large number of engines are now at work, and I have no doubt that the results when compiled will show considerable economy in favour of superheat, as it enables a lower boiler pressure to be used.

West Norwood, August 28th. Henry W. Dearberg.

Sir,—In last week's issue of The Engineer there appears a letter from Mr. A. Hockley combating the conclusions arrived at in my former letter on this subject. As Mr. Hockley closes by mentioning his inability to give other reasons than those I suggested, his letter would, perhaps, hardly call for reply but for some inaccuracies which it contains. It is, perhaps, permissible to explain these as founded on a perusal of certain somewhat sensational publications purporting to deal with railways, and in which what is termed the Romance of the Rail is liberally evolved by the exercise of not infertile imaginations. This accounts for the mention of 400-ton trains on the Great Western Railway. A more laborious method of obtaining train loads—but one whose trouble is amply repaid by the instruction it affords—is actually to note down the tare weights of the composing vehicles as legibly shown on East Coast Joint, North-Eastern, Great Western, Midland, &c., stock.

Mr. Hockley states that "Great Western locomotives have to surmount gradients far more severe than are to be met with on any other line in this country over which express trains are run," and immediately after refers to those "short bits of 1 in 42 and 1 in 40." The London and South-Western line between Exeter and Plymouth contains appreciably more severe and longer gradients than occur on the Great Western route, and yet some trains which run on it are regarded as "express."

Mr. Hockley proceeds to criticise my statement that "average loads on the Great Northern are heavier and average speeds no less," and by way of getting at these averages he selects nine trains on the Great Western and three on the Great Northern—twelve in all. This method of averaging has undoubted advantages in ease of computation, but the result cannot be regarded as satisfactory, and if Mr. Hockley will devote a little more time to the matter he will see that the locomotive work of a railway is not solely concerned with running a dozen or so of crack trains. In his next paragraph Mr. Hockley ably lays stress on the diversity of passenger types, to which reference was made in my letter; but it may be pointed out with regard to re-boilering that it was the practice of removing modern boilers to install others of similar dimensions, and differing only in trivial detail, to which I referred as very expensive. The remark that boilers are now standard has little weight. They have been standard, for a short time, so frequently since 1899. It should also be noted that the Great Western was the only one of some twenty-three "principal lines" which was seriously hit by what Mr. Hockley terms the "De Glehn boom," which existed rather amongst the publications referred to than amongst engineers. I am glad that Mr. Hockley shares my surprise at the conversion of goods engines to the 3901 class.

Comparison with other lines can only be usefully made if complete, and then lessons can be learnt by comparing the Great Western with almost any other railway. It does not, however, follow that if certain other companies have to some extent made similar mistakes that these are therefore desirable. For the sake of brevity and clearness comparison was made in my letter with one line only, the Great Northern, throughout, and the comparison was as thorough as possible.

Mr. Hockley's statement that the Great Northern standard "Atlantics" are a "gradual development" of 990 is literally true. The development is so gradual that but one stage has yet been reached—the standard type—of which 251 (1903) was the first, and 1451 (1908) is at present the last, being the immediate successors of the 990 class.

Another slight error much repeated lately is that the Midland are building compounds. The last compound—modern No. 1044—was built in 1906, since when the only express engines turned out are the 999 class of 4-4-0 simple with Deeley valve gear.

Mr. Hockley appears to have scarcely grasped the position. It is not a question whether or not a particular type of express engine should be employed, such matters are mere details into which space forbade me to enter. The locomotive practice of a line is concerned with not only express, but local and suburban passenger, goods, and even coal trains, and the fact which seemed to me to need explanation was that the locomotive repair costs on one railway were 62 per cent. higher than on another line whose engines were engaged in more arduous work.

By the courtesy of Mr. Price-Williams I have been able to study the figures given in his paper recently presented to the Institution of Civil Engineers, and dealing with the years 1897-1906. Since 1901 the Great Western expenditure has been higher than that of every other line, while, to extend the same comparison as before, that of the Great Northern has been continuously near the other end of the scale. Moreover, there was a very striking advance in the Great Western figures in the years 1899-1900, which has since been maintained. Perhaps the simplest way is to give the difference in cost for repairs and renewals per locomotive per annum on the Great Western and Great Northern lines. Omitting decimals this has varied as follows:—

Excess Cost per Locomotive per annum for Repairs and Renewals on G.W.R. compared with G.N.R.

Year.	£	Year.	£
1897	69	1902	125
1898	71	1903	137
1899	102	1904	124
1900	127	1905	120
1901	134	1906	133

These figures seem to locate fairly clearly the date of the present excessive rate of expenditure. L. A. F.

August 30th.

MARINE PROPULSION.

Sir,—May I be allowed, in the first place, to correct a misprint in the eighth line of the last paragraph of my letter in the issue of August 20th? The words "when the powder impinges on the gun" should be "when the shot impinges on the gun." The case in question, to put it in other words, is that of a shot being fired from one gun at another gun of equal weight. The velocity imparted to the second gun by the impact of the shot would very nearly equal the velocity of recoil of the first gun from which the shot is fired. Mr. Preidel inferred from this, in his letter of July 26th, that the energy expended in producing the original recoil in the first gun must be equal to the energy expended on the shot, as the energy of the shot produces an equal velocity in the second gun. But my argument, in which the misprint occurred, is that when the shot impinges on the second gun, only a part of its energy is expended in giving motion to that gun, the greater part of the energy of the shot is dissipated in the form of heat, which shows that the energy of the shot is much greater than that of the gun from which it is fired.

Referring now to the question to which I asked if you could obtain a reply from Sir George Greenhill, viz., when a gun is fired, is the amount of work in foot-pounds, which is done on the shot by the explosion, necessarily equal to the amount of work in foot-pounds which is done on the gun? Sir George Greenhill's reply is "No." He also gives other illustrations showing that the work of action is not necessarily equal to the work of reaction, which is my contention.

May I be allowed to point out now that this discussion on marine propulsion arose, so far as Mr. Preidel and I are concerned, by my pointing out to the writer of the first letter on the subject in your issue of March 12th—who endeavoured to show that slip does not represent loss—his mistake in assuming that the work of action is necessarily equal to the work of reaction; my letter appeared in your issue of March 26th. Mr. Preidel then wrote affirming that the work of action and reaction *are* necessarily equal; and this has been the point of the discussion. Sir George Greenhill's verdict confirms my contention; and he corroborates the views expressed in my first letter as regards slip representing loss.

Mr. Preidel asked you to obtain a verdict, and I see in his letter in the current issue that he does not now accept it!

Referring to this letter, the only quotation of the many which Mr. Preidel gives which is to the point is the first quotation from Hertz; and this is absolutely incorrect. The other quotations refer to other matters with which we have nothing to do. Mr. Preidel is right in saying that he is in company with Sir William Anderson, Dr. Aveling, and, apparently, Professor Hertz; but he certainly is *not* in company with Clerk Maxwell and Newton. The first three fall into an error seemingly because they do not think twice before making an apparently correct, though wrong, statement. They would, I firmly believe, have seen it was wrong if the ghost of a hint had been given them; but Mr. Preidel cannot see it is wrong even when it is proved mathematically to be so; for I so proved it to be wrong in my letter of April 27th, and your correspondents Mr. Henry Barnes, "A. R.," "F. R. S.," and Mr. John Ramsay, as well as Sir George Greenhill, have also done so since then. T. S. C.

August 28th.

Sir,—All Mr. Preidel's difficulties will be solved if he will bear in mind that the two forces action and reaction, although quite equal in amount, move over different spaces, and it has been agreed that a force moving over a space represents work; and that the quantity of work is measured by the space.

August 30th. Fuse.

[We do not think this discussion can be pursued further with advantage and it must now close.—Ed. The E.]

EXPERIMENTS WITH A GLASS CARBURETTER.

Sir—Mr. Bickford's invitation of August 20th to carburetter makers to publish the results of their investigations will, I am afraid, not meet with much response. However willing they might be to explain their ideas, they could not, owing to business considerations, afford to give away points which they have perhaps sought for years. One thing is certain; the deeper the search, the greater the obstacles, and the more a man discovers, the less to him appears his knowledge in comparison with what remains to be found out. My questions were meant seriously, and were all on matters which must be investigated before coming to any conclusions at all, and, as such, should hardly be termed "conundrums."

In reply to the question "What effect on the temperature of the mixture in the induction pipe is produced by raising the temperature of the incoming air?" I would point out that the intention of heating the air supply is not for the purpose of affecting the induction pipe temperature, but rather for providing the heat necessary for vaporisation of the petrol, and for prevention of condensation of moisture in the induction pipe. Fulfilment of these functions will absorb most of the apparent added heat, so that the induction pipe will resume the temperature of the outside air, or nearly so, although if the heat of the induction pipe falls much below 60 deg. Fah. condensation may begin, especially when much humidity exists. An argument sometimes used against the principle of heating the ingoing air is that the volume is raised; but this is simply a question of compression space.

In speaking of compression it should be remembered that an autocar engine is, for the greater part of its time, throttled; that is, compression is cut down, more or less, and also that while so cut down piston speed varies immensely, being at one time ten times as fast as at another, yet, under all conditions, power must be evolved. Surely it cannot be said that a fixed proportion of mixture is correct for all these variations—one minute a high compression, and the next almost a non-compression engine. As regards the letters of Mr. Knight and "D. B." as to whether an engine fires after petrol is cut off, I should explain that my remarks applied to a carburetter in which the petrol was really vaporised and kept so. It cannot be denied that a bad carburetter, or one not properly adjusted, will allow of the engine firing after the petrol injection ceases. "D. B.'s" valve being quite tight, where did the necessary air come from? Did the engine fire on petrol only? Walter Gillett.

London, August 26th.

LONG LOCOMOTIVE BOILER BARRELS.

Sir,—The saying that "necessity is the mother of invention" is clearly applicable to the 50ft. long boiler of the new Mallet locomotive for the Southern Pacific Railway, shown on page 223 of your issue of August 27th, and the draughtsman who was confronted by the difficulty of finding thermal use for the immense length of barrel necessary for spanning so many axles, is to be congratulated upon his solution of the problem.

The point naturally arises as to how long a locomotive boiler barrel would have to be made in order to embrace a further series of questionable economies—what indeed, is the limit of ingenuity on the part of a draughtsman in vertically dividing up the surplus length to find justification for the same beyond that called for by the locomotive design?

Having regard for recent discussions upon the economical length of the locomotive boiler tube, one could commence by cutting off the useless last 5ft. of the tubes in the boiler under notice, so as to increase the space available for sections of naturally diminishing temperatures suited to a variety of purposes.

Allowing, then, boiler tubes of 16ft. in length, we might allow—

For the combustion chamber	4ft. 0in.
For the feed-water heater	4ft. 6in.
For a sand drier	2ft. 3in.
For a food-warming compartment	2ft. 0in.
For a clothes-drying compartment	2ft. 0in.

There being little heat left for the superheater, this space could be utilised for other purposes; in fact, one may expect with still more immense locomotives of the Mallet system, that by the time the gases laboriously reach the smoke-box, the temperature may be a minus quantity, thus enabling the last section to serve as a refrigerator for preserving perishable articles of food for use in the dining car on a long journey. Antiplea.

August 31st.

The Institution of Civil Engineers: Association of Yorkshire Students.—On Thursday, September 9th, a visit will be paid to the Leighton Reservoir, in course of construction for the Corporation of Leeds at Masham, by the kind permission of Mr. C. G. Henzell, M. Inst. C E., the engineer for the scheme. The party will leave Leeds (N.E.) at 10.52 a.m., and Harrogate 11.32 a.m. Members wishing to take part in the visit are requested to signify their intention of doing so not later than Monday morning, September 6th, to A. C. Swales, Hon. Sec.

The Iron and Steel Institute.—The autumn meeting of the Iron and Steel Institute will be held in London on the five days commencing Monday, September 27th, and ending on Friday, October 1st. A series of eleven papers has been arranged and an attractive list of visits proposed. The meetings for the reading of papers and discussion thereon will take place at the Institution of Civil Engineers, Great George-street, Westminster. Among the papers offered are:—"Comparative Tests of Cast Iron," by E. Adamson, Sheffield; "The Corrosion of Iron," by J. N. Friend, Ph.D, Darlington; "The Refining of Steel by Electricity," by E. J. Ljungberg, Falun, Sweden; and "The Maintenance and Renewal of Permanent Way," by R. Price-Williams, London. The visits arranged will include an inspection of Woolwich Arsenal, the National Physical Laboratories, Siemens Bros. and Co, Limited, Woolwich, and the Doulton Potteries at Lambeth, while a reception by the Lord Mayor and Lady Mayoress will be given to the members and ladies accompanying them at the Mansion House on Thursday, September 30th. On Friday, October 1st, a special train will leave Victoria to convey the members to Portsmouth, where the dockyard and other naval establishments will be inspected.

New Scottish Docks.—Tenders have been invited by the Leith Harbour and Docks Commissions for the construction of a new graving dock which will be entered from the Imperial Dock. The work is to be carried out under powers obtained by the Leith Dock Act of 1908, which authorised the Commissioners to borrow a sum of £140,000 for the construction of the dock. The graving dock will be 550ft. long, with an entrance 75ft. in width, and having a depth over the sill of about 25ft. The largest existing graving dock at Leith is the Prince of Wales Dock, built as long ago as 1862. This dock is 382ft. in length on blocks 68ft. 6in. wide at entrance, and has a depth of 23ft. on sill at high water. The Imperial Dock, from which the new graving dock will be entered, has a water area of 19 acres and was completed in 1902. The new dock has been designed by Mr. Peter White, the engineer to the Commissioners. It is also announced that the Burntisland Harbour Commissioners and the North British Railway Company have leased a plot of land to the Hudson Consolidated Company of London for the purpose of constructing a graving dock 660ft. in length, with an entrance 65ft. wide and 24ft. deep over sill. The site is of about 8 acres extent, and at the old harbour. Burntisland is on the north shore of the Firth of Forth, and a rapidly growing port having excellent railway connections.

RAILWAY MATTERS.

The South Indian Railway Company has decided, it is reported, to establish shops at Trichinopoly for dealing with the entire locomotive, carriage, and wagon stock of the broad gauge. This project includes the laying of a third rail.

A copy of a decree appears in the *Diario Official*, Brazil, for July 14th, approving plans prepared by the Companhia Paulista de Vias Ferreas e Fluviaes for the construction of a railway from Pederneiras to Bauru, a distance of 24 miles, at a cost of about £895,000.

The New York, New Haven, and Hartford Railway Company is about to make tests of the comparative performance of electric and steam locomotives in freight service. To this end two freight locomotives have been ordered. One of these is to be equipped with side rods, and the other will be of the geared type.

It is announced that the Middle District Railway Office of Japan has decided to dispense with steam engines on the Hachioji-Kafu line, and to use electric locomotives. Fifteen motor carriages have been ordered from the Osaka Railway Carriage Company. The change is expected to effect a saving of over an hour on the journey.

An additional advantage claimed for electric welding of rails is the reduction of corrugation of the surface by traffic and the resultant noisy running of the carriages. Electric railway authorities in Berlin, Hamburg, and Bremen claim that the welding of a strip of soft iron to the rail surface not only prevents corrugation, but reduces the noise due to corrugations already made.

The construction of the bridge across the Teetas River in connection with the Akhaura-Bhairab Bazar extension of the Assam-Bengal Railway has been much impeded by heavy floods, and a recent report states that it cannot be completed till the next working season. The Akhaura-Ashuganj section, 19 miles in length, will probably be ready for opening to public traffic next January.

The success of the mono-rail system for carrying freight and passengers is largely a question of finding a satisfactory type of carriage, and experiments are now being made in connection therewith on short lengths of roads in India. The mono-rail system is believed to possess great value, because of its simplicity and cheapness of construction, for military purposes on mountain roads.

The question of the conveyance of a substantial portion of the mails and parcels by the Kalka-Simla Railway is now under the consideration of the Indian Government. The arrangements contemplated provide for a petrol railway motor van, to be ordered from England by the Railway Board for experimental purposes. If the experiments prove satisfactory, arrangements for carrying these mails will be further considered.

A consular report on the Detroit district says that it is believed that trains will be running by October next through the international tunnel which is being constructed by the Michigan Central Railroad. The trains will be hauled by electric locomotives using direct current, and the tunnel will be lighted electrically. The electrification of the St. Clair tunnel was completed by the Grand Trunk Railway and formally opened in November last. Single-phase alternating current is used, and the tunnel is brilliantly lighted by incandescent electric lamps.

According to the report of H.M. Consul at Helsingfors on the trade of Finland in 1908, a sum of about £380,000 has been provided for new railways. It is proposed to build a line through Vichtis to Högfors, forming a continuation of the projected line from Sockenbacka, near Helsingfors, to Nurmijärvi, north-west of Helsingfors. So far the project has reached the preparatory stage only, there being many difficulties in the way. The Finnish Senate have decided that a railway shall be built from Seinäjoki Station to Kristinestad and Kaskö, but the course of the line is not fixed yet. The line would begin at Seinäjoki, and run along the Kyrö River to the village of Perälä, where it would fork off into two branches.

In a recent issue of the *Elektrotechnische Zeitschrift* a writer criticises the present "fast train" policy of the Berlin suburban authorities; this consists, says the *Electrician*, in building lines on which fast trains can be run only underground. The writer demands such a tariff for these railways that it shall be possible for them to withstand the competition of other traffic undertakings, such as tramways and omnibus, and states that underground construction should be confined to the crowded parts of the town where surface lines are impossible. He supports this argument by referring to the unsatisfactory results obtained on the London underground railways. The extensions of the Berlin railways underground will load the undertakers with debts which the receipts will not justify.

The *Railway Times* publishes the official returns of the fifty-four principal railways in the United Kingdom for the week ended August 15th. These returns show total receipts amounting to £2,410,937, being £46,702 less than for the corresponding week last year, while the mileage was 21,438, or 68 more than for the corresponding week. The receipts were at the rate of £112 9s. 2d. per mile of line open, a decrease of £2 10s. 10d. a mile as compared with last year. Thirty-six of the returns distinguish between the receipts from passenger and goods traffic, and these show a decrease of £13,148 (or 16s. 8d. per mile) in the passenger receipts, and a decrease of £32,856 (or £1 14s. 7d. per mile) in the receipts from goods traffic. The aggregate decrease on the thirty-six railways for six weeks in the passenger receipts has been £82,320, while the aggregate increase in the goods receipts was £71,540. The aggregate receipts of the fifty-four railways for six weeks (July 4th to August 15th) amounted to £14,535,355, a decrease of £16,714 on the corresponding period of last year.

Some months ago an application made by Americans for a concession to enable them to build railways in Armenia and Kurdistan was laid before the Turkish Parliament. For military reasons the consideration of the application was postponed. The proposed statute in connection with this scheme has now been sent up to the Chamber, but the end of the session is so near that it cannot be discussed. According to its terms the Americans are to construct the line connecting Siwas-Karput-Diarbekir-Bitlis-Van, which is about 1250 miles long, and some branch lines without any guarantees from the Government. In return for this the holders of the concession are to be given the right to exploit the mines in the territory 20 kms. on either side of the line. It may be mentioned that these lines touch some of the points that were at first included in the Bagdad railway, and which were subsequently left out. There is another railway project besides the above that is being considered by the Works Ministry. This refers to lines from Trapezunt on the Black Sea to Erzerium in Armenia. An Anglo-French group is endeavouring to secure the powers for the construction of this line. It is about 155 miles long, and in connection with the above-mentioned railways it is very important, not only from a military, but also from an economic point of view, as it follows the route of an important commercial road from the Black Sea to Persia. It is well known that when the concession for the Bagdad railway was granted, the Russians succeeded in drawing up an agreement with Turkey to the effect that no railways should be constructed in the regions bordering on the Black Sea without their consent. If the above projects, especially the latter one, are to be carried out, Turkey will have to find some way of cancelling this agreement.

NOTES AND MEMORANDA.

Metallic chromium, states the *Brass World*, is now a commercial article, and can readily be obtained with a high degree of purity and at a reasonable price. As far as is known, it has not yet become a constituent of the non-ferrous alloys, although it has long been used in making very hard and tough steels.

The annual prize of 5000 dollars instituted by King Leopold of Belgium in 1874 will, for the year 1911, be awarded for the best work in French, Flemish, English, German, Italian, Spanish, or Portuguese on "The Progress of Aërial Navigation, and the most effective Means for its Encouragement." The works submitted for competition must reach the Belgian Minister for Science and Art before March 1st, 1911.

A review was recently given in *Stahl und Eisen* of the present position of the various processes for the recovery of nitrogen from the atmosphere. The only requirement for the success of the artificial production, says the writer, is power at the lowest possible rate. An account will also be found here of the electric processes for the production of calcium cyanamide by the plan proposed by Caro and Frank of passing pure nitrogen over highly heated calcium carbide.

The transfusion of particles of different kinds of metals through the agency of electrical current has been held by some to take place just the same as in the case of electrolytes. To prove or disprove this contention an experiment has been recently carried out on a system composed of aluminium and copper, through which an electrical current was passed continuously for one year. After the two parts were separated it was found that neither metal contained any particles or traces of the other.

A new system of telegraphing half-tone photographs has been introduced, and is at present in operation between London and Manchester. It is claimed that a half-tone photograph containing seventy-five or more lines to the inch can be wired very rapidly, while the transmitted picture is received direct, without the intervention of photography, upon a plain sheet of specially sensitised paper, the sensitiveness being electro-chemical, not photographic. It is stated that a photograph nearly whole-plate size can be transmitted in less than ten minutes.

A short time ago the Baltimore and Ohio Railroad laid down 17 rails treated with titanium alloy. The rails were placed on both the high and low side of a 9 deg. curve, which is in almost constant use under heavy traffic. These have been tested, and the company reports that all the titanium rails are in excellent condition, and when sufficiently worn down on one side may be turned and used again. The standard Bessemer rails put in service at the same time and place, are now worn out and are to be removed. The loss by wear, it is stated, from the Bessemer rails in pounds per yard was 294 per cent. greater than from the titanium rails.

Negotiations were recently concluded whereby a European syndicate takes control of the sixteen best gem mines in Ceylon. These mines up to the present have been under the management of natives and have a romantic fame running back through many centuries. Moonstones, cat's eyes, rubies, and sapphires are among the stones found in the island. The ruby, however, cannot compare with the rich deep-coloured stones found in Burma, but the sapphire, it is stated, is found there in shades of colour unknown in other parts of the world. In the olden days the native artificers cut the star sapphires in a peculiar fashion. But the secret of their art has been forgotten. There are, at present, it is reported, no fewer than 3366 gem mines in the island.

The principal object of a recently designed clock is to show at a glance, says the *Journal* of the Royal Society of Arts, the time all over the world. In front of it a disc is mounted, which revolves with the earth once in 24 hours, having the hours 1 p.m. till 12 midnight, and 1 a m. till 12 noon, painted on its outside edge, the hours being divided into intervals of five minutes each. In the same plane as the disc is a fixed dial, with a circular aperture to accommodate the disc. The dial has Greenwich painted on the top, the names of the other places being arranged at such distances from Greenwich that at any moment the corresponding time for any part of the world is shown. The clock is set by turning the disc, so that the time at any place abroad at a given time in London, or other place, can easily be read off.

In a paper read before the fifth annual meeting of the Illinois Gas Association, the author said that he considered clean coal tar pitch, free from water acids or soluble mineral matter, as the most efficient type of covering for the prevention of soil and electrolytic corrosion of iron pipes. Such a pitch, he states, should be as hard as it is possible to make it without being brittle at ordinary temperatures, and should not crack when struck a hard blow. The pipes to be coated should be smooth, free from moisture, rust and loose scale or any foreign matter. Projections on the surface should be filed down before coating. The clean pipe should be left in a melted bath of pitch until the metal and dip are of the same temperature, which should be just sufficient to melt the pitch to a uniform liquid condition. The pipe, when removed, should have a smooth, uniform, black, glossy coating, $\frac{1}{32}$in. thick and free from lumps, bubbles or foreign matter.

Some particulars of the Duke of the Abruzzi's recent expedition in the Himalayas have been published. From start to finish there was not a single accident, the members of the party enjoyed an entire freedom from illness, and altogether the expedition was most successful. Seventy days were spent on the glaciers, sixty-five of them at an altitude of over 16,000ft. The attempt to climb to the summit of Mount Godwin Austen failed, on account of the exceedingly difficult nature of the ground, and the unfavourable climatic conditions, but the explorers succeeded in reaching a height of 19,000ft. before turning back. The party then made an attempt to reach the top of the Bride Peak, and on this peak the record altitude of 24,600ft was attained. The summit was not very far away, but the weather made farther progress impossible. Many panoramic maps were made, and the expedition secured interesting scientific collections and numerous photographs.

An electrolytic hydrogen plant has been erected by the United States Army Signal Corps, at Fort Omaha, in Nebraska, in connection with a large new balloon house which has been established there for experiments with dirigible and other balloons. According to the *Electrical World*, a 200-kilowatt motor generator, taking current from an electric light and power company in the neighbourhood, has been erected. This converts the alternating supply to continuous current at from 66 to 110 volts. The hydrogen is generated by electrolysis in cast iron cells containing caustic potash electrolyte. There are 30 of these cast iron electrolytic cells, all connected in series. The voltage required varies according to the temperature of the cells, hence the wide range of voltage for which the generator is designed. The operating voltage when the cells are warmed up is 85 volts for the 30 cells, or 2.8 volts per cell. The cells are rated at 1500 ampères. The output of hydrogen at 1500 ampères is about 23 cubic feet of gas per hour, or 690 cubic feet for the 30 cells. Both of the electrodes are of iron. The iron case of the cell forms the negative electrode from which the hydrogen is obtained. The positive electrode, which gives off oxygen, is in the shape of an iron cylinder in the cell. Hydrogen gas, which collects above the negative electrode, is taken to a 50,000-cubic feet gasholder.

MISCELLANEA.

A consular report on the Chicago district states that at the new steel works at Gary, Indiana, the gases from sixteen blast furnaces, each of which has a capacity of 450 tons a day, will be utilised for the generation of electric power. Gas engines have been worked successfully in this manner in steel works at South Chicago.

A large portion of the cliff to the north of Carr Naze at Filey, involving, it is said, many thousands of tons of earth, slid bodily into the sea last Saturday afternoon. The coastline at this point stands well over 300ft. above sea level. The fall, it is believed, is due to the very heavy rains of the past few months. Other points show indications that similar falls are probable.

Steps are being taken with a view to establishing wireless stations along the South African Coast. The Natal Government are negotiating with the Imperial Government on the subject, and it is proposed to erect a station on the Bluff at Durban. The idea is to form a line of wireless stations between Delagoa Bay and Cape Colony, and a similar line of stations on the west coast.

Winnipeg, where the British Association is now meeting, had a population in 1870 of 215, and was a frontier trading post of the Hudson's Bay Company. This year, according to figures recently published, the population is over 150,000. It has an area of 18,990 acres, 29 miles of street railways, 316 acres of park playgrounds, and five theatres. In 1900 there were 16 schools, with a school population of 7500, while in 1907 there were 28 schools, with 18,940 scholars.

An influential committee has been formed at Chamonix for the purpose of constructing a wireless station on the summit of Mont Blanc. The idea of the proposed installation is to provide means for summoning aid for alpinists in danger on Mont Blanc and neighbouring peaks, and also to connect the Alpine districts of France, Italy, and Switzerland. It is understood, says *Electrical Engineering*, that there has already been a generous response to an invitation for subscriptions for this purpose.

In Norway and Sweden remarkable progress is reported to have been made in the commercial operation of electric furnaces. Arrangements have now been completed in connection with the Tröllhatan water-power works for the installation of three electric furnaces for the production of pig iron. Each furnace, it is stated, will be capable of producing 7500 tons of iron per annum. The cost of production is calculated to be £2 16s. 8d. per ton, and the capital necessary for an annual output at 15,000 tons is about £33,000.

In accordance with the resolutions of the last International Congress of Mining and Metallurgy, Applied Mechanics, and Practical Geology held at Liége in 1905, it has been arranged that the next Congress shall meet at Düsseldorf during the last week of June, 1910, under the auspices of the Rhenish-Westphalian Mining Industry. An influential Committee of Organisation has been formed, which is charged with the making of the arrangements for the reading and discussion of papers, visits to places of technical interest, and social entertainments.

Matters in connection with the establishment of an explosives factory at Crombie, on the north shore of the Forth, to the west of the Rosyth naval base, have for some time been in abeyance, but certain negotiations have been completed, and it is understood that work will be commenced immediately. The Admiralty have acquired, it is stated, about 400 acres, and of this about 40 acres will be utilised solely for the erection of the above buildings. It has been estimated that the works will cost at least a quarter of a million, while employment is likely to be given to four or five hundred persons.

The Postmaster-General has stated in some parliamentary papers that the capital cost of the Post-office wireless telegraph station at Bolt Head has been about £2000, and its annual cost, including allowances for interest and depreciation, is estimated at about £750. The work of the station hitherto has been chiefly experimental, and in connection with the arrangements for giving effect to the International Radiotelegraphic Convention. A considerable number of ships report their position to Bolt Head in passing, but happily no messages have had to be received from ships in distress.

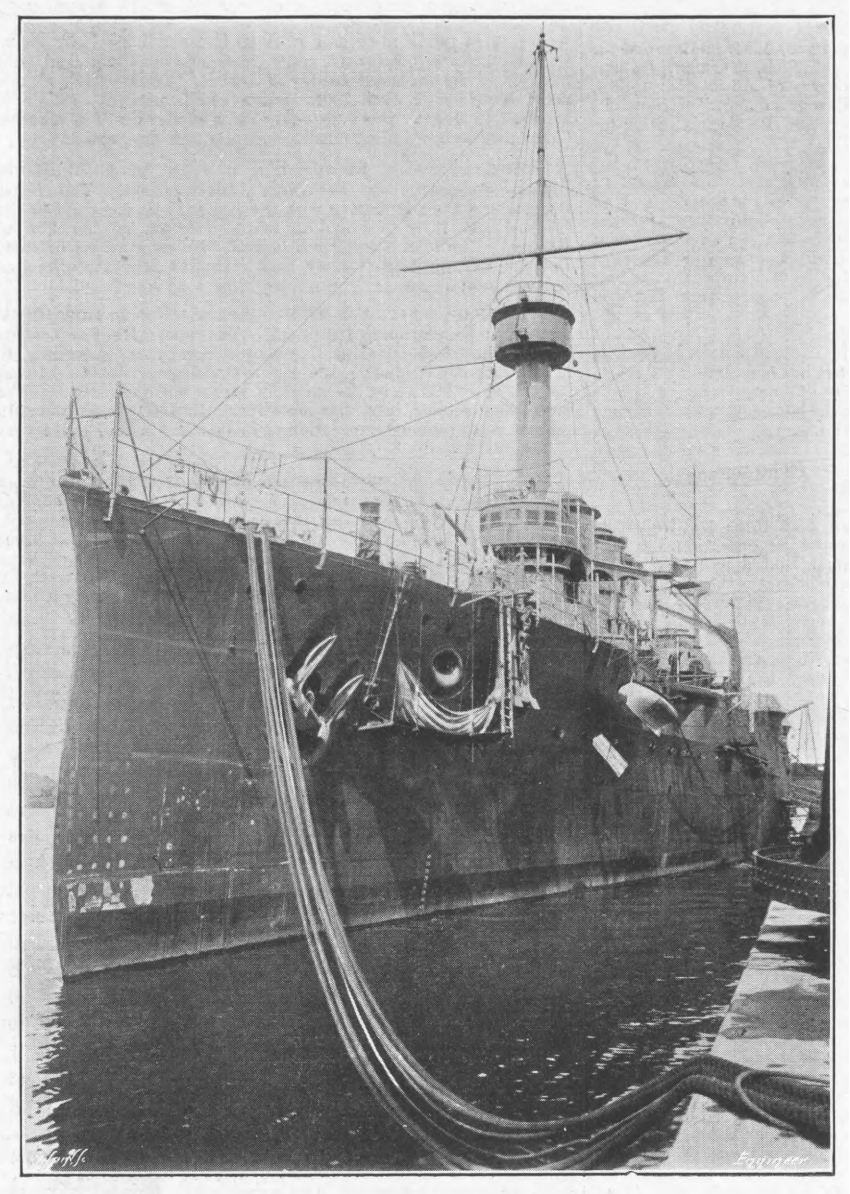
The Transvaal is engaged in carrying out extensions and improvements to its telephone and telegraph services. It is intended to connect up every town not yet served, and main trunk lines are to be carried to every point where the railway lines cross the border. It is proposed to extend the lines to the coastal ports and to Bulawayo. It is regarded as certain that the Union Government will find telephonic communication between Cape Town and Pretoria absolutely essential under the proposed arrangement by which Parliament will meet at a place so far removed from the administrative centre. The scheme contemplates connections with farmhouses and the establishment of call offices at convenient centres in rural districts. It is estimated, according to the *Natal Mercury*, that the coast extensions definitely undertaken will cost £250,000.

The annual statistics with regard to the taxes known as the "contributions directes" have just been published in France; they include some interesting figures which deal with the increased employment of industrial motor vehicles in that country. Several tables are presented in the section dealing with the French motor industry, and they summarise the totals of all classes of motor vehicles that have been registered for the past ten years. Those figures dealing specifically with commercial motor vehicles are instructive. In 1899, 234 "voitures automobiles industrielles" were registered in France; in 1900, there were 543; in 1902, 1849; in 1903, 3062; in 1904, 4588; in 1905, 6532; in 1906, 8904; in 1907, 11,685; and, in 1908, no fewer than 15,334. In the last three years there has therefore been an increase of 8802 vehicles. It is also interesting to note that in the same period there was only an increase of 7241 pleasure cars. These totals, of course, only refer to vehicles in use in France and taxable there on that account. Exports are not included, and no allowance is made for new machines which have taken the place of those duly consigned to the scrap heap.

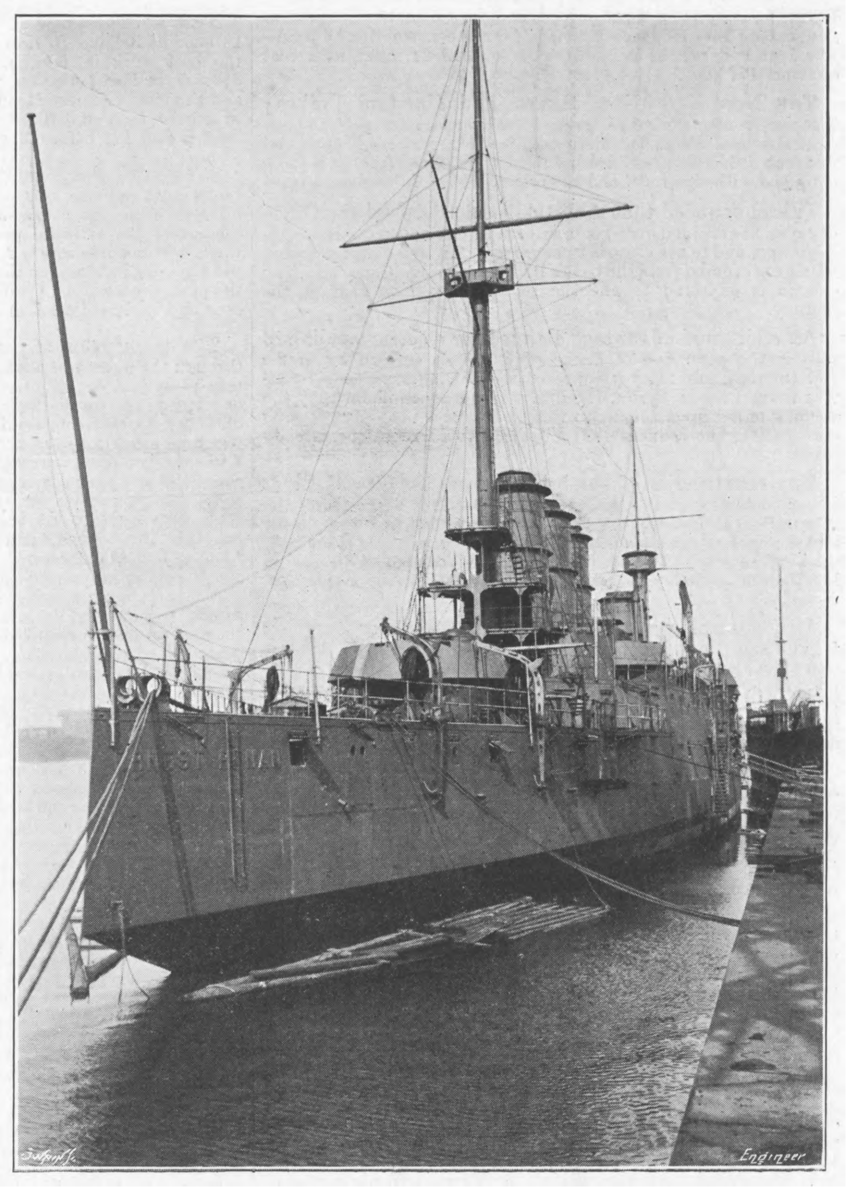
A Blue-book was recently issued giving particulars of the navigation and shipping of the United Kingdom for 1908. During the past twelve months 70,654 vessels, of a total tonnage of 65,977,139, entered and cleared with cargoes and ballast at ports in the United Kingdom from and to foreign countries and British Possessions. Of this number 36,447 were British vessels of a tonnage of 38,980,184, compared with 38,821 and a tonnage of 40,892,824 during 1907. Whereas the British vessels had declined during the year, the foreign vessels cleared had grown from 34,011, with a tonnage of 26,137,983, in 1907 to 34,207 and a tonnage of 26,996,955 last year. There were at the close of last year 38,608 steam and sailing vessels, with a total tonnage of 13,263,354, on the British registers, compared with 38,342 vessels, with a tonnage of 13,183,335, for the previous twelve months. Of the crews of 14,692 British vessels, 196,834 were British sailors, 34,735 foreigners, and 44,152 Lascars. The number of British seamen was in 1907, 194,848. During 1908, 804 sailing and steam vessels were built in the United Kingdom, of which 431 were for foreigners. The total number of British vessels lost was 250, with a tonnage of about 150,000. The number of fishing boats registered was 25,757 as against 26,125 in 1907, and the number of men and boys required to work the same 105,922 and 107,076 respectively.

THE FRENCH CRUISER ERNEST RENAN

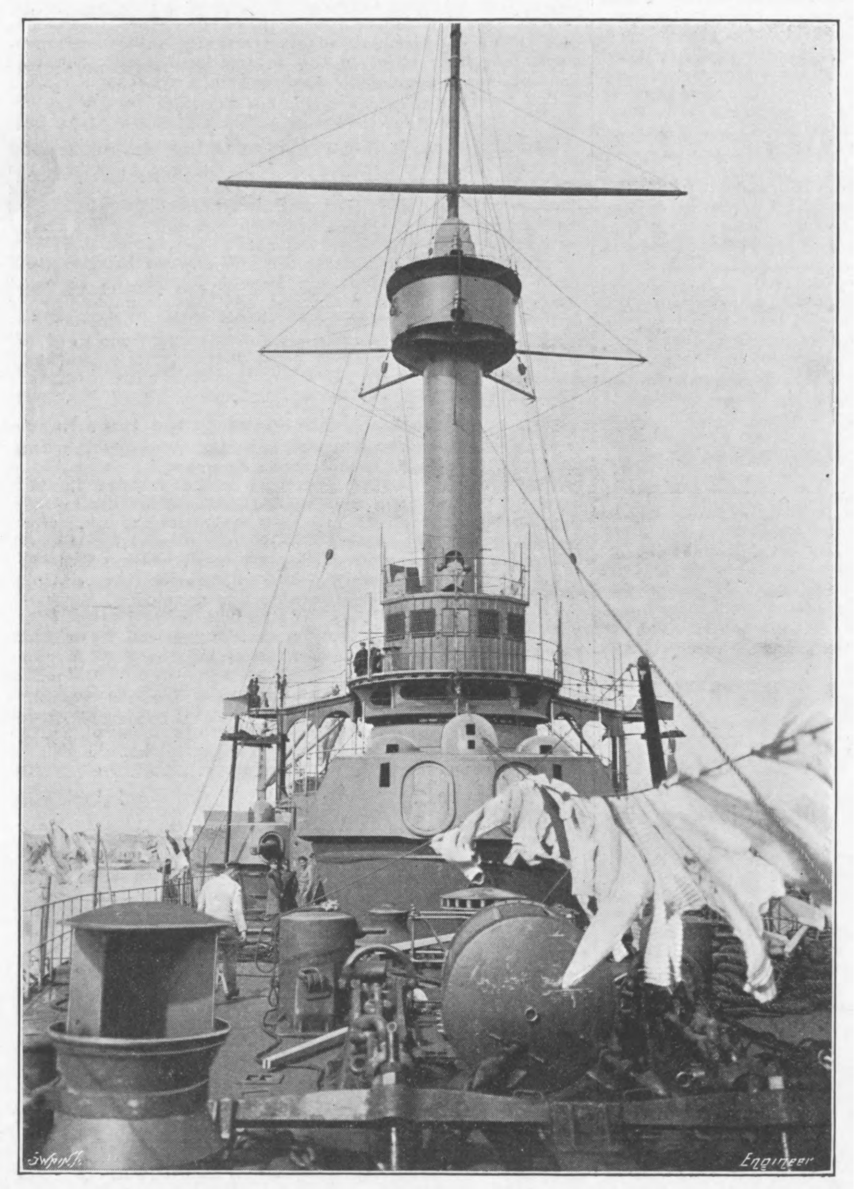
(For description see page 240)



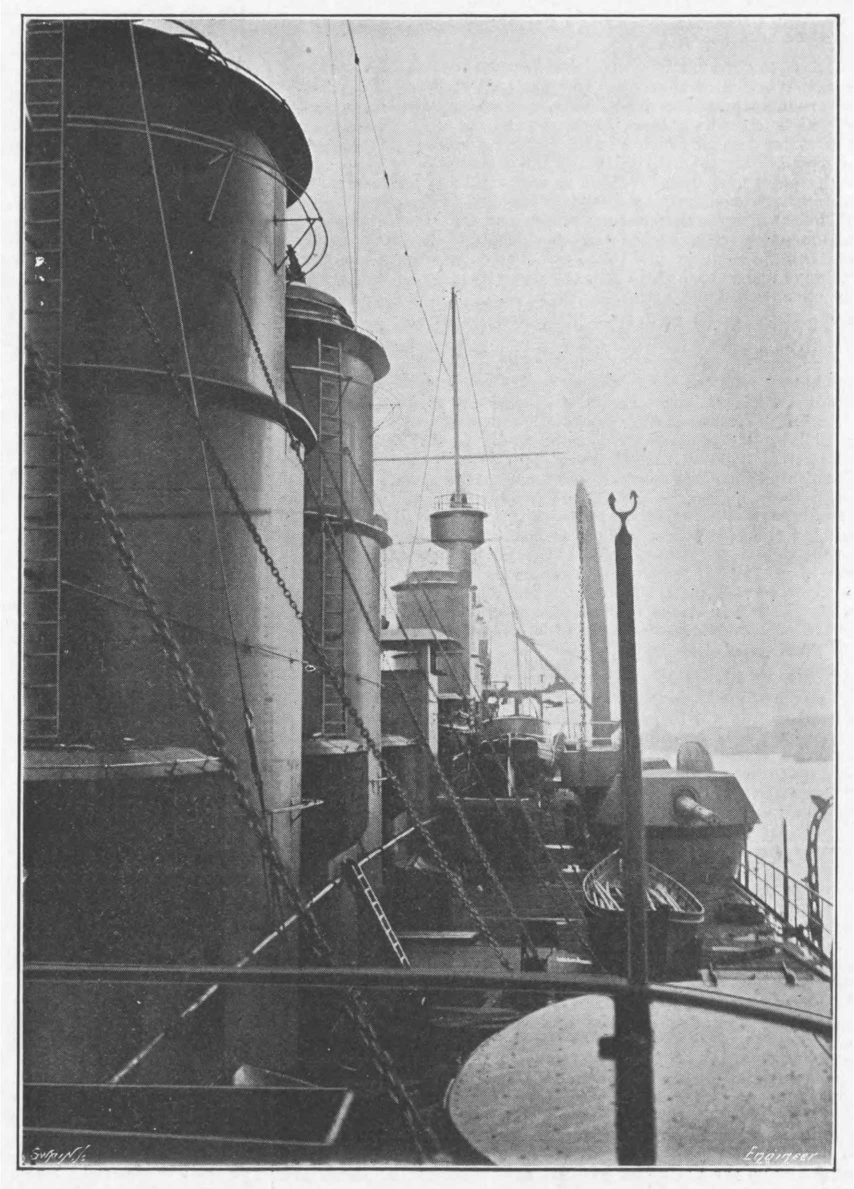
BOW VIEW



STERN VIEW



THE FORWARD TURRET



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H.M.S. VANGUARD.

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TO CORRESPONDENTS.

☞ *In order to avoid trouble and confusion we find it necessary to inform correspondents that letters of inquiry addressed to the public, and intended for insertion in this column, must in all cases be accompanied by a large envelope legibly directed by the writer to himself, and stamped, in order that answers received by us may be forwarded to their destination. No notice can be taken of communications which do not comply with these instructions.*

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REPLIES.

E. S. (Ponder's End).—We can only suggest that you should try Professor Weighton's air gauge. It can be obtained from the Edwards Air Pump Syndicate.

INQUIRIES.

WIRE-DRAWING.

Sir,—Can any of your readers refer me to any publication in which the mathematics of wire-drawing are given? I want particularly to know the power required to reduce from one diameter to another at a given speed when the E of the material is known. M. P.

August 31st.

MEETINGS NEXT WEEK.

The Railway Club.—Thursday, September 9th. Visit Messrs. Stableford and Co.'s Engineering Works, Coalville. Leave London, St. Pancras, 12 noon, and Leicester (Midland) at 2.48 p.m. for Coalville.

Institute of Marine Engineers.—Saturday, September 4th, at 3.30 p.m. Visit to Imperial International Exhibition, Shepherd's Bush. Papers (Congress Hall): "The Extended Uses of Electricity on Board Ship;" "The Treatment of Marine Boilers on Long Voyages."

THE ENGINEER.

SEPTEMBER 3, 1909.

The Scrap Heap.

THERE is a familiar story of an illustrious engineer who, when visiting some mechanical engineering works, was asked what he would like to see first. His reply was, "the scrap heap;" and the story goes on to add that he found so much of interest there that he never saw the shops at all. There is also a story less well known, perhaps, of another engineer who, emulating his great predecessor, asked an American engine builder the same favour. "Pray, pardon us," was the reply, "we keep the secret of our success to ourselves." Both stories illustrate admirably the fact that mechanical engineering has been thrashed out by step-by-step progress. Failures have taught men what to avoid, and the scrap heap is nothing but the living and speaking note-book of experiments. Every broken or futile part is a post labelled danger, and the multiplication of such posts on both sides of the road buoy out a passage along which the engineer may travel safely. It has often been suggested that some of our learned societies should persuade the authors of papers to give histories of failures instead of successes. Rarely, indeed, do we get anything of the kind, and if it were not for the reports of the chief engineers of insurance companies and official returns, we should all be left in the dark as to the causes of failures. Amongst the former the report of the chief engineer to the British Engine, Boiler, and Electrical Insurance Company is one of those most eagerly read, and it is its appearance that has suggested these remarks.

Mr. Longridge provides us annually, first with a general review of the accidents of recent years, and then with details of a number of cases selected from the accidents of the last twelve months. It may be taken, we imagine, with safety, that his records represent in miniature the whole country, and it will be fair to assume that the percentages of failures he gives are fair percentages for the machinery generally of the United Kingdom. Now, in 1907, of all steam engines insured 1 in 11.7 suffered some accident, and of all gas engines 1 in 11.1. In 1908 the proportion had risen respectively to 1 in 9.4 and 1 in 9.1. Mr. Longridge neither offers any explanation of this increase as a whole nor of the remarkable fact that both types of engine have advanced by almost equal amounts. It may be purely a coincidence, but it is sufficiently curious to be worthy of observation. When we turn to the details of breakdowns we find also some curious facts. For example, in steam, gas and oil engines the valve gear is the part most liable to failure; but whereas the percentage of such failures in steam engines has risen from 28 in 1907 to 34.8, in internal combustion engines it has fallen from 43.3 to 31.3. These percentages are based on the total number of breakdowns, and as we do not know the numbers, it is difficult to say whether the proportion is fortuitous or not. Mr. Longridge, however, remarks, "The continually increasing percentage of breakdowns of steam engines, due to breakage of valves and valve gear, from 23.3 per cent. in 1906 to 28 per cent. in 1907 and to 34.8 per cent. in 1908, suggests that some improvement in designing and manufacturing these parts is desirable. Perhaps more strength, and certainly more care in fitting and screwing nuts, screws, pins and cotters, would reduce the figure." This observation, reflects, we fancy, rather on the user than on the maker, for we find on the examination of the few cases that are given in detail that the failure of new, or even fairly new engines, is comparatively rare. It is generally an engine some years old, frequently many years, that fails, owing to the cumulative failure—if we may so call it—of some part, or the negligence of the attendant. The increase in one case, and the decrease in the other, of the percentage of failures in valve gear must naturally affect the proportion which the failure of other parts bears to the whole. Amongst steam engines nearly everything else has decreased by a small amount, and some by large amounts, but here any definite deduction is impossible, because in some cases the decrease is obviously due to the fact that the part that used to fail is disappearing altogether. For example, failures of spur gearing showed an average of 14.8 for the twenty years preceding 1907, and in 1908 it had fallen to 8.1, largely, as Mr. Longridge remarks, because spur gearing is rapidly disappearing from engine-rooms of textile mills and factories. A similar remark can, of course, be made of the various parts of beam engines, which are being gradually replaced by modern types. Gas engines, of course, are all more or less modern, and since the same argument cannot be applied, the comparative figures are of more value, and it is a little disconcerting to find that the four principal parts have all shown percentages of failure greater than for last year. Failures of cylinders and cylinder ends have risen from 13.5 to 19.4, or 2.8 above the general average; of pistons from 2.7 to 4.8, but in this case the reduction on the average is great; of connecting-rods and their bolts the rise is from 8.1 to 10.8, and of failures of main shafts the increase is from 4.7 to 9.1. This, again, is a long way above the average, which is only 5 per cent., and would indicate that further attention to this part, which has always presented difficulties, is required. Mr. Longridge, in view of certain tests on crank webs, urges the desirability of employing built-up cranks whenever possible; and there is really no valid objection to that plan being adopted, since the processes of manufacture have been so perfected that the building up of a crank presents but little difficulty. We shall on another occasion refer in more detail to one or two of the principal engine breakdowns, and in particular to a remarkable failure of a shaft to which the report devotes a good deal of space.

We turn now to electrical machinery, and notice that here also the number of breakdowns has increased. Amongst dynamos there has been an increase in the number of failures of no less than 13 per cent. over last year, amongst motors of 8.2 per cent., and among starters and controllers 18.2 per cent., the overall increase being no less than 10.7 per cent. greater than in 1907. At first sight one might be disposed to regard this as indicating that electrical engineers were slow to learn the lesson of the scrap heap, but Mr. Longridge has attempted a classification of the causes of failure, and we observe with satisfaction that they indicate that if there is not a marked improvement in construction, there is at least no retrogression. In 1907, 21 per cent. of the failures of dynamos were ascribed to bad workmanship and design; last year only 20 per cent. of the failures were attributed to this cause. In 1907, 18 per cent. of motor failures were due to the makers; in 1908 only 11 per cent.; but for the breakdown of starters and controllers the makers' responsibility has risen from 8 per cent. to 9 per cent. Dirt and neglect are held to be the cause of something over one quarter of the failures of dynamos and motors, and age and deterioration account for nearly as much. Hence, we find that half the accidents are due to causes directly preventable by the user, an amount which is 10 per cent. higher than amongst steam engines, and 13 per cent. higher than amongst internal combustion engines. In all cases the percentage is higher than it ought to be, and the need which we have so often urged of employing properly trained persons to look after machinery, is enforced by a consideration of the figures. When we turn to Mr. Longridge's review of boiler failures during the year—none of the boilers insured by the company have failed—we find the same convincing fact that it is the user of the boiler who in the majority of cases is responsible for the accident. Of fourteen boiler explosions on which formal investigations were held in 1908 by the Commissioners, penalties were inflicted in eight cases. It is clear that many breakdowns of all sorts of machinery could therefore be prevented if only proper care and attention were used. To prevent accidents altogether is humanly impossible, but it should be possible to add very materially to the number which must be included under the head unascertained causes. At the present time the makers are battling with two opponents. They have, on one hand, the so-called "mysterious" failures of material, and, on the other hand, the crass folly of many users. They are overcoming one by diligent research and experiment, and the others by a heartbreaking effort to make things fool-proof. That the latter might be materially facilitated by the collaboration of the user is not a matter about which there can be dispute.

Motor Car Wheels.

THE great rise which is announced in the price of india-rubber tires—20 per cent.—directs attention once more to the various and conflicting problems presented by the wheels of motor cars. We are told, it is true, that the present rise in price is due not to scarcity of raw material, but what is euphemistically termed "a manipulation of the market." The result is the same in so far as the owners of motor cars are concerned. But a temporary rise will not supply that stimulus to invention, or, rather, to the prosecution of research, which a permanent advance in price would give. None the less is it worth considering whether or not further inquiry might leave the world less dependent than it is on india-rubber. We have used the word research advisedly. We have only to look at the Patent-office journals of this and other countries to learn that there is no lack of inventors and inventions. So far as can be learned, however, it appears that next to nothing has been done in the way of testing any of these inventions which are distinctly novel. At all events, the expenditure must be very small, or the facts have been kept very secret. We are not now speaking of substitutes for india-rubber, the production of which has been made the subject of much chemical research, but about substitutes for the normal pneumatic tire, the more or less rapid destruction of which represents at once annoyance, danger, and heavy expenditure.

It will save time if we say here at once that we do not propose in what follows to consider what is known as the elastic wheel; that has been very fully dealt with in our columns. Our purpose is to consider briefly why it is that india-rubber is regarded as the only material from which a tire can be made. It might, indeed, be supposed that if there were no india-rubber trees the modern motor car would have no existence. In what way then does india-rubber satisfy certain conditions in a fashion and with a thoroughness that leaves it without a rival? The reply usually given to the question is simply that it is elastic; but a very little thought would show that that does not answer the question, because the tire of a motor car is not elastic. We use the word "elastic" in its familiar not in its precise scientific sense. The air inside it is, and so is the internal tube. But the tire proper—the thing that costs much money and wears out rapidly—is a combination of canvas and india-rubber, which is flexible, but not elastic, as everyone who has had to take off and replace even a small motor car tire knows by bitter experience. This outer tire is a casing provided to protect and sustain the elastic inner tube. That, beyond question, must be of india-rubber. But its cost is comparatively trifling. If it were not for friction between it and the outer "tube," or tire proper, it would last indefinitely, if spared punctures. The first pneumatic tires were, we believe, fitted to a tricycle. They were really simple india-rubber tubes, and had no canvas in their composition. They were very large—about 3in. in diameter when inflated. A short experience sufficed to demonstrate at once the beauty of the pneumatic system of supporting vehicles, and the utter unfitness of the unprotected elastic tube for use on a road. Then came a multitude of patents; and so the modern tire is apparently a survival of the fittest. It is probable, however, that the initial success attained with india-rubber convinced the motor world that nothing but rubber could be used, and so far turned attention away from methods of construction that did not involve its use.

As we have said, the canvas and india-rubber outer tube is flexible but practically inelastic. It is not intended to stretch, and will not do so. If it could it would not be able to sustain the pressure inside it of 40 lb. to 80 lb. on the square inch. It possesses the great advantage that it can be moulded. Thus the edges can be thickened to take the side grooves provided in the wheel rim to retain it in its place. Furthermore, it possesses a quality most inadequately defined by the work "toughness," that is the rubber does. When the outer coat of rubber is worn away and leaves the canvas bare, the tire is practically done for. The hemp will not stand the abrading action of the road. This is particularly true of driving tires. In searching for substitutes we find at once that nothing can be combined with canvas to any good purpose but rubber; we reject canvas, and try, let us say, leather. In so far as being adapted to road work, leather answers very well. It is constantly used, indeed, to protect tires, and when studded with steel rivets is said to prevent side-slip. But it would not be possible to fix leather outer tubes on wheels of the normal type. The leather must be converted into a complete tube, and this construction presents almost insurmountable mechanical difficulties with regard to the putting in and getting out of the inner tube. There is, besides, the fact that leather absorbs water, and becomes very limp and helpless. When it dries again it lacks flexibility. It is one thing to put a belt round a rubber tire, and quite another to make a leather tire. All these objections apply to raw hide, which has been proposed. We may at once abandon the theory that nothing will give so much adhesion as india-rubber. Canvas or leather will hold much better when roads are greasy; anything will hold when they are dry. Nor is the power of resisting puncture, and cutting, and abrasions peculiar to rubber; leather and hide are just as good, if not better.

A careful consideration of the whole question leads to the conclusion that the use of rubber and canvas tires is necessary, not because nothing so good can be found to make contact with road surfaces, but because no other material lends itself to a method of construction which has given satisfaction. If the pneumatic system is to be retained, then we must have an elastic, air-tight tube. For this nothing can be suggested as a material but india-rubber. This tube does not represent any considerable outlay. The casing in which it is placed must be fairly easily removable from the wheel and from this inner tube. No satisfactory attempt has been made as yet to meet this constructive difficulty. Leather, as we have seen, cannot be moulded. "Lips" and thickened edges and such like are impossible. Such materials as gutta-percha and its congeners are totally useless, for well-understood reasons. It may be taken as proved, we think, that no good can be gained by the mere invention of a substitute for india-rubber. What is required is a new wheel as a whole—a wheel whose construction will be compatible with the retention of the inner inflated elastic tube. That costs very little—it lasts fairly well. A radical improvement in motor car wheels will be one in the outer tires. In what direction that is to be sought it is not easy to see. It is quite easy to see, however, that nothing can be achieved without the expenditure of much time and money on that kind of research which is represented by constantly making experiments. No doubt success would bring a substantial pecuniary reward. It seems to be certain, however, that for some time to come the owners of motor cars will remain at the mercy of those who bull and bear the rubber markets of the world.

Compulsory Working of Patents.

THE first year's experience of the compulsory working clause of the Patents and Designs Act, 1907, clearly proves the absolute lack of foundation for the apprehensions which were entertained in various countries, particularly in Germany and the United States, that Section 27 of the Act would be enforced in a drastic manner that would be disastrous to the foreign owners of patents granted in the United Kingdom. The reason why such fears were specially manifested in these two countries is to be found in the circumstance that their subjects have hitherto obtained the majority of the British patents issued every year to foreigners domiciled throughout the world. Owing to the exceptional facilities for securing protection for inventions in the United Kingdom, this country has been made the happy hunting-ground of foreign patentees, and the percentage of patents granted to other than British subjects has been much higher than in either Germany or the United States, although less than in Austria-Hungary, Switzerland or Russia; but the latter three countries are not strictly comparable with the former three leading manufacturing nations. If the large number of British patents sealed in favour of the subjects of other countries in the past has been the means of contributing towards an increase in the revenue of the Patent-office, it has, on the other hand, tended to retard progress and development in the United Kingdom, in consequence of the non-working of many of the patents and the withholding of facilities from British firms to do so. But this state of affairs is undergoing a remarkable change in consequence of the compulsory working clause in the Act of 1907, and from the constant offers of patents for disposal or for working on royalty, it would seem as if foreign patentees have for months past been fully conscious that they must no longer withhold their inventions from makers or consumers in this country.

The number of patents revoked in the past twelve months—and this is of special interest to the United States and Germany—has been ten, but as two out of four appeals made to the High Court were successful, the actual removal of patents in the first complete year since the compulsory working clause came into operation has only been eight. When it is taken into consideration that the number of patents granted annually to foreigners amounts to several thousands, it will be obvious that the elimination of only eight represents merely an insignificant fraction of the whole number, and this should finally dispel, if it has not already dissipated, the apprehensions exhibited in certain countries as to the method of administering the compulsory working clause in the United Kingdom. The passing of the Patent and Designs Act, 1907, led some time ago to the report of contemplated retaliation on the part of the United States, whose patent law contains no provision for compulsory working. Already alarmed by the clause in the English Act, and anxious to obviate similar action on the part of the United States, the German Government hastened to negotiate a reciprocal patent treaty with that country, and this was concluded a few months ago, as was mentioned in this journal on April 23rd. Although the treaty was welcomed by the German newspapers and was suggested as a basis for the conclusion of a similar arrangement with France, it has not required many months to convince such an important association as the Verein Deutscher Maschinenbau Anstalten that the agreement is defective, at least as far as the machinery trades are concerned, and should not be repeated in the case of any other countries. The Association, in the course of a petition which has just been addressed to the Imperial Home-office in favour of an international regulation of the problem, points out that the treaty with the United States provides that compulsory working in one of the treaty States by the subjects of another treaty State shall only be applied to the extent of the limitation which the latter imposes upon its own subjects. As there is no compulsory working clause in the United States as compared with the existence of such a clause in Germany, the effect of the new treaty has been to place American subjects who own Teutonic patents in a more favourable position than the Germans themselves, as by the agreement compulsory working is not necessary in order to maintain the German patent so long as the United States patent law contains no provision for compulsory working.

It is quite conceivable that under the patent treaty in question it would be possible for American manufacturers to obtain a number of patents in Germany and not be under the obligation to work them. The Verein Deutscher Maschinenbau Anstalten submits that this advantage constitutes a great danger to German industry, as it will hamper work and the possibility of development. In particular, the danger threatens the machinery industry, which has not only to meet severe American competition in the form of importation of complete machines, but in the case of special machines constructed in Germany it is possible to protect small constructive details by means of patents. It thus turns out that the so-called reciprocal treaty, at all events in the case of the machinery trades, may prove to be largely of a one-sided character unless the United States reform the patent law by introducing the necessity for compulsory working. As the case stands at present Americans are able to obtain patents in both countries and prevent the Germans from using them, and although the situation is not quite so unfavourable as the Association would appear to think from the terms of the petition, there is no doubt that the Americans have gained the best of the bargain. It is now feared that other countries which have no system of compulsory working may also proceed to adopt the method, and it is therefore suggested that the German Government should endeavour to bring about an international agreement in respect of compulsory working, so that the conditions of its application may be modified. It is, of course, impossible to predict what changes, if any, may take place in the working of patents in different countries in future years, but there is no doubt that satisfaction in the United Kingdom is general in so far as the first year's working of the new Act is concerned; whilst, at the same time, very few foreign patentees can complain of having lost their patents in consequence of non-compliance with the section relating to compulsory working in the United Kingdom.

Motor Roads.

In fulfilment of a promise which he made in his Budget speech on the last day of April, Mr. Lloyd George has now brought in a Bill which should satisfy the most exacting motorist, and from one point of view at least give satisfaction to the householder who has groaned under the intolerable burdens of dust, smell, and noise on the public highways. The proposal is to employ the money derived from the taxation of motor cars and the additional impost on petrol used by motorists for the construction of roads which will be the sole property of the motor car. On these roads the "scorcher" may have his fill of speed, and he will miss only the excitement which the possibility of the police trap now adds to the legitimate enjoyments of motoring. He will presumably be subject to the common law of manslaughter if he kills another motorist; but as the ordinary pedestrian may be—the Act is still vague on the point—a trespasser on the motor road, it is not certain that the motorist who slays him will be any more guilty than the engine driver who runs over a trespasser on the railway. From these motor roads all other traffic will be excluded, unless it is prepared to pay such a toll as the Road Board may see fit to impose. Not unnaturally, perhaps, the owners of the King's Highway are asking if they may not be allowed to reciprocate by laying a toll upon motorists who use the common roads, for the use of which few of them now pay an adequate share, and in the future will probably pay less. They, moreover, are to be given an advantage which, we believe, is wholly unprecedented. The Bill proposed to confer upon the Road Board the power not only of purchasing land wide enough for the construction of reasonable roads at the present value of the land, and without consideration of the inconvenience and loss it may cause to the present owners, but it may acquire a strip of land some two hundred yards broad on each side of the new road, and it may develop this land for its own benefit, such profit as it makes by the lease or sale of sites being devoted to the further extension of the motor road system of the United Kingdom. In view of the fact that at the present time the majority of motorists outside the great cities use their cars for pleasure purposes only, it is open to discussion if it is equitable to give them the power of cutting the country up into play grounds. If it is fair to give one sport this advantage, it is surely fair to give it to another; and we can imagine that football, cricket, and tennis clubs may ask for powers to acquire land wherever they please at its present agricultural value, with a width of 220 yards from the centre on each side for development purposes. The Bill has yet to be discussed, and we imagine there will be more than one view about its propriety. We may add that the sum at the disposal of the Road Board in the first year is estimated at £600,000.

THE AEROPLANES AT RHEIMS.

(By our own Correspondent.)

No. I.

To say that the aeroplane meeting at Rheims has established a science of aeronautics would not be exaggerating the importance of this remarkable gathering. The experiments carried out previously had allowed of ideas being formed of the conditions that should be fulfilled by the successful aeroplane, but as results were obtained in so many different ways, it was impossible to form anything like a settled opinion upon the best form of machine and the system to be adopted for its propulsion. Isolated experiments gave one the impression that the machine was essentially unstable except in calm weather, that the pilots themselves had to possess exceptional skill, and that even when they obtained complete mastery over the machine they only made their flights when the conditions were specially favourable. The performances of Paulhan and Latham, and the sensational flight across the Channel by Blériot, gave increased confidence in the possibilities of the aeroplane, but still it was doubtful whether the aeroplane could fly in any weather, which was obviously essential to the success of a meeting like that at Rheims. It was a bold venture, but it was successful, because the rivalry of aeroplane pilots induced them to take more risks than they had hitherto dared, and judging from the comparative immunity from accidents, these risks were less serious than they had supposed.

Perhaps the most remarkable thing about the meeting was the similarity of results obtained by machines of entirely different forms. This is all the more promising for the future of aviation, because it shows that the problem of mechanical flight is not narrowed down to any particular solution. As there are different forms, so it may be assumed that they may each be developed to fulfil special conditions, whether for speed or for carrying capacity. An encouraging thing is the simplicity of the whole principle. Science has attempted to explain the forces at work in lifting a plane, but most of the work has been done by men of no scientific attainments, who have experimented until they have obtained results that satisfied them. It is on account of this continual experiment that so many successful forms of aeroplanes have been evolved. In many cases the final results have been in direct opposition to what might have been supposed to constitute the principles of an aeroplane. At first it might be supposed that the larger the sustaining surface the greater would be the carrying capacity of the machine. As a matter of fact, the question of surface is closely bound up with air resistance and propulsive effort. As the result of experiment aeroplanes are designed to fly with a pressure of 20 to 23 kilos. per square metre—that is to say, this pressure is exerted under the planes when travelling at 35 to 40 miles an hour. The problem lies in obtaining this result with the lowest motive power. This calculation provides for a good margin of load, since most of the aeroplanes can take up passengers, and Farman even carried two passengers at the Rheims meeting.

The principles of aeroplane construction can best be dealt with by describing the features of different machines. In most of the earlier apparatus it was hoped to secure an automatic stability by the employment of cellular planes, thereby following the traditions of Hargreave, Chanute, and other experimenters. In France the only firm who have retained this principle are Voisin Frères. As will be seen from the illustration published last week, the Voisin apparatus is composed of two horizontal planes connected by vertical planes, and from the centre, at right angles to the main planes, extends a skeleton frame terminating in a rectangular cell. The planes have a sustaining surface of 50 square metres, and the total weight of the machine with fuel is 560 kilos. The half a dozen machines competing at Rheims had engines developing from 50 to 55 horse-power. A two-blade propeller with a diameter of 2 m., making about 1100 revolutions per minute, is used. A certain stability is obtained by employing long and narrow planes; this is common to all biplanes, and in the Voisin machine further steadiness is secured by the rear cell, which is an essential feature of this type of aeroplane. The rear cell serves to balance the main planes carrying the load, and allows of its turning, for no machine possessing automatic stability has yet been built without a "tail." It has now to be seen whether this stability is absolute, and whether it has not been obtained at too great a cost. When the load has been adjusted properly to balance the machine—and this has to be done with extreme care on all aeroplanes—the Voisin apparatus appears to have perfect stability in calm weather. There has always been some doubt as to whether it was equally reliable in moderate winds, and it is difficult even now to come to any definite conclusion, despite the flying of Paulhan on one day when a very stiff breeze was blowing. On that occasion the machine rocked and swerved in a way that did not convey an impression of security. It would have been interesting to know whether a less skilful pilot than Paulhan would have kept the machine in the air under these conditions. Until it is proved that the Voisin apparatus can be safely handled in squalls of wind, it is impossible to assert that it has an absolute automatic stability; but as it possesses this quality to at least a limited extent, it is one of the easiest machines to drive, and pilots are often able to fly after an apprenticeship of only a week or two. The drawback of the Voisin machine lies in its lack of speed, due to high skin friction. It is among the heaviest apparatus and employs the most powerful engines, from which it will be seen that the old theory of weight and power being conducive to speed does not necessarily hold good. There are many other factors that determine the speed of aeroplanes.

An evolution from the Voisin type of apparatus is observable in the machines built by Farman, who at first made his reputation as a pilot of Voisin aeroplanes. Farman has suppressed all the vertical planes, but otherwise the general lines of the Voisin apparatus are preserved. He has abandoned the idea of automatic stability, and controls his apparatus by an "aileron" or controlling plane. He has thus effected a compromise between the Voisin and the Wright—that is to say, he combines some of the steadiness of the French cellular apparatus with the facility of control obtainable with the aid of "ailerons." The result is a machine much faster and more flexible than the cellular aeroplane. Having only 40 square metres of sustaining surface, the extra speed certainly gives it at least as much sustaining capacity as the Voisin. Farman was able to carry sufficient petrol to allow of his winning the long distance championship by flying 112 miles in 3 h. 4 min. 56 sec., and when obliged to stop through darkness setting in he still had sufficient petrol in the tank for half an hour's flight. It was objected at Rheims that Farman's performances were not so much a demonstration of flying as of skimming over the ground, as he rarely rose to a higher elevation than seven or eight feet; but this proved the stability of his machine, and it is doubtful whether any other machine except the Voisin would have dared to fly so low. After the first novelty had worn off, the public were only interested in machines flying high in the air. Farman showed what he could do in the altitude competition when he flew to a height of 110 m., only being beaten by a monoplane.

A third type of aeroplane is represented by the Wright and Curtiss machines, which are constructed on much the same lines. As further opportunities are given of comparing the Wright type of apparatus with the French aeroplanes, one is forcibly struck with the completeness of the American machine. This will be more observable when we go into the question of engines and propellers. The design of the Wright apparatus is well known. Having a sustaining surface of 50 square metres, the two planes, connected by vertical hickory struts, are bent at the ends for lateral control, and longitudinal stability is obtained partly by the balancing of the frame, and more particularly by manipulating a horizontal plane in front. The stability of the apparatus is dependent entirely upon the pilot. To control such a machine necessarily entails considerable practice, but when the pilot has acquired the requisite skill he seems capable of doing anything with the machine. Lefebvre amused the public by performing acrobatic feats in the air on one of the lighter Wright machines, and occasionally took a flight across country. No doubt a constant handling of this machine becomes second-nature, but it would appear highly dangerous in the hands of a man liable to lose his head.

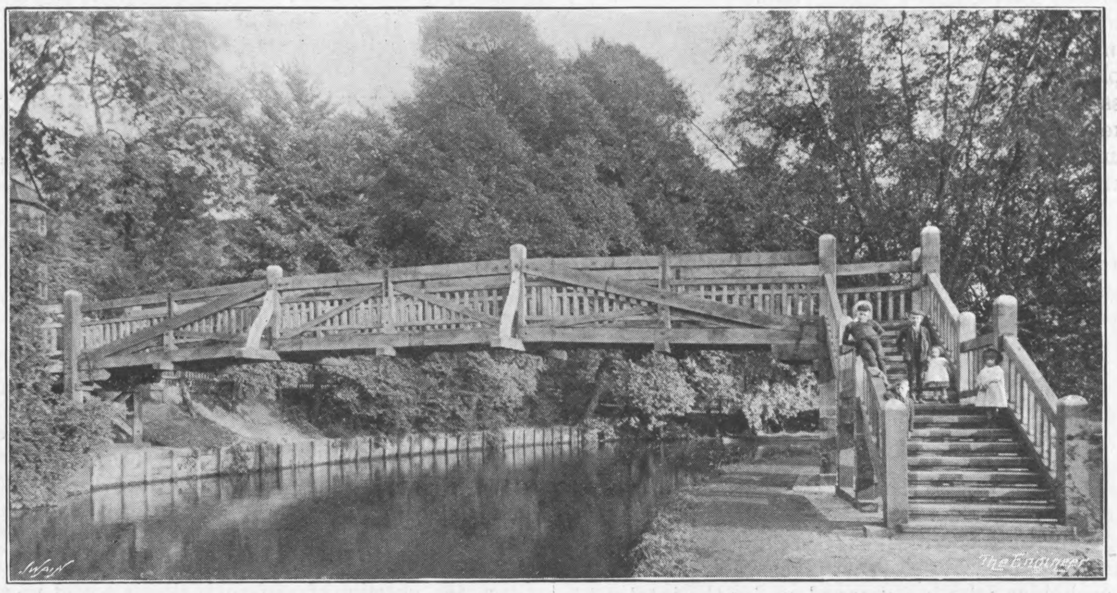
The Glenn Curtiss machine is in the same class as the Wright, of which it is a modification, the principal difference being that the machine is controlled by an "aileron" instead of by bending the sustaining planes. From the front and back of the apparatus extends a long triangular frame, the one at the rear carrying the vertical rudder, and the one in front a combination of horizontal and vertical planes pivoted on the apex of the frame. The rising and falling movements are controlled by a wheel and worm gear, while lateral stability is obtained by the displacement of the pilot's seat. The stabilisator planes in front are connected with the sliding seat by wires, so that when the machine inclines one way and the pilot instinctively inclines in the other direction, the displacement of the seat pulls the stabilisator plane round. To this extent, therefore, the Curtiss apparatus has more automatic stability than the Wright, since it obeys an instinctive movement on the part of the pilot. Another difference between the two types of machine is that a single high-speed propeller is keyed on the crank shaft of the 25 horse-power four-cylinder engine. Again, it starts on wheels by its own power, so that as regards the application of power and the system of starting, it possesses some of the features of the French biplanes. Having a sustaining surface of only 24 square metres, its weight is about 400 lb. It was thus by far the smallest and lightest machine competing at the Rheims meeting. Mr. Curtiss did not make many flights for the reason that, like many of the other aviators, he frequently found it necessary to tune up his apparatus, and he did not fly except when he was absolutely sure of his machine. On most occasions the machine flew with great steadiness, but in competing for the Gordon Bennett Cup it behaved in a very peculiar manner, dipping and rising in a way that seemed to onlookers to threaten destruction at any moment. At the time of the flight the air was heavy and hazy, and Mr. Curtiss affirmed that the atmosphere was "boiling"—that is to say, the machine was continually passing through gyratory currents which threatened to bring it to the ground. He could only escape accident by manipulating his controlling planes all the time. Mr. Curtiss attributes his high speed to this "boiling" of the air, which increased the reaction behind the propeller, and avoided what would be equivalent to cavitation in marine propellers. Unfortunately, as competitors were able to choose their own time for making flights, there was no opportunity of seeing other aeroplanes performing under the same conditions. It would have been interesting to see if aeroplanes of the Voisin and Farman types would more easily preserve their stability. Aeroplane pilots affirm that close to the ground the atmosphere is always more or less agitated, and it is therefore easier to fly at an altitude than lower down; but as we have stated, Farman rarely rose to a height of more than 8ft. or so, while the Wright machines and the monoplanes always flew high. Curtiss secured the Gordon Bennett Cup by covering the 20 kiloms. (12½ miles) in 15 min. 50 sec., beating Blériot with an engine of twice the power by 6 seconds. He also won the competition over 30 kiloms. (18.6 miles), which he covered in 23 min. 29 sec., or 1 min. 49 sec. faster than Latham on his Antoinette monoplane. The Curtiss machine was only beaten for speed on one occasion by the narrow margin of two seconds over a lap. The lightest and lowest powered machine, therefore, proved itself the fastest in the competition.

Although the biplane demonstrated, for the time being, its superiority as regards speed, carrying capacity, and distance covered, it was yet singular to note that the monoplane enjoyed the greater popular success. In the first place, this is accounted for by the fact that the monoplane is regarded as an essentially French machine, and, again, its flights were certainly more impressive than those of the biplanes. So far as the principle of flight is concerned, it matters little whether the machine is built with one, two, or more planes. Until MM. Blériot and Levavasseur proved the stability of the single plane, it had always been supposed that the greater the number of superposed planes the steadier would be the machine, and if experimenters finally adopted the biplane it was because a large number of planes augmented the resistance to a considerable extent. The present type of French monoplane is an evolution of the Langley experimental apparatus, and it was only after lengthy trials and the construction of a number of machines that the tandem system of planes was dropped in favour of the single plane with a long body terminating in an arrangement of small vertical and horizontal planes for steering and control. As the sustaining surface in relation to the speed is a fixed factor, it matters little whether this surface should cover one plane or two, so long as other conditions are the same. So far as could be judged from the performances at Rheims, there appeared to be little to choose between the stability of the monoplanes and biplanes. This, however, appears to be largely a question of skill of pilots, for, as we have said, the monoplanes require to be handled by men who have had a long experience, while biplanes of the automatic or semi-automatic type can be driven by any men with sufficient nerve after a short apprenticeship. It would therefore appear that the only advantage which can be claimed for the monoplane is the possibility of its travelling at much higher speeds, owing to the absence of struts and stays and other impediments offering resistance. At the Rheims meeting the monoplanes travelled faster than the biplanes, with the exception of the Curtiss machine, and as this biplane travelled faster with much lower power, the alleged superiority of the monoplane as regards speed is still a matter of doubt. Nevertheless, it may be assumed that with a better utilisation of power the monoplane will show greater speed, and may be built with a smaller sustaining surface.

The apparatus meeting with the greatest popular success was the Antoinette monoplane piloted by Latham. The Antoinette is probably the only successful machine which has been directly designed in accordance with certain well defined principles without the original type being materially changed as the result of successive experiments. M. Levavasseur argued that by making his planes slightly V-shaped, and placing the centre of gravity as much as possible below the meta-centre when loaded, he would obtain suitable stability. In Latham's machine the sustaining surface is about 50 square metres, and the weight when flying is 520 kilos. The eight-cylinder engine develops 50 horse-power and drives a high-speed propeller in front keyed to the crank shaft. The body is a light skeleton structure of square section, tapering to the rear, where it carries cruciform planes which are necessary for stability. The whole is covered with a rubber solution, and varnished to a high degree of polish with a view to reducing skin friction. Latham invariably flew at a certain height, and his machine certainly made a greater impression than any other competing. It flew as straight as an arrow, without any perceptible rolling or pitching motion, and it looked, indeed, like a gigantic bird soaring in a perfectly straight line. This particular machine was not seen in flight when there was any high wind blowing; but on one day, when there were squalls of wind and rain, Latham went out with a new type of Antoinette monoplane, in which the two planes are inclined in opposite directions by some such mechanism as is employed for reversible propellers. By manipulating his planes in this way Latham was able to exercise complete control over his machine in high winds, and although very little was seen of this new apparatus, it was sufficient to prove that the monoplane is capable of great development. As regards the flattened V shape of planes, it is doubtful whether this can have any great influence upon lateral stability when flying in a straight line, although it would probably render the machine steadier if blown sideways out of its course. One cause of stability in the monoplane is the lowering of the centre of gravity, but the chief factor is the influence of the stabilisator planes at the rear end of the body. The fastest time officially made by Latham was 30 kiloms. (18.6 miles) in 25 min. 18 sec., and he obtained second prize in the long-distance trial with 154 kiloms. 500 m. (96 miles). He also secured the prize in the high flying test, when he reached an altitude of 155 m.

The Blériot monoplane differs somewhat from the Antoinette, notably in having a very much smaller sustaining surface, although the total weight is about the same. Probably no one has experimented with so many different types of machines as M. Blériot, who, starting with monoplanes, made a short incursion in the domain of biplanes, and then returned to the single plane apparatus of a much smaller type. The one usually driven at Rheims had a sustaining surface of 22 m., and was propelled by an engine developing 50 horse-power. A smaller machine, having a surface of 14 m. and a 25 horse-power engine, was piloted by Delagrange, who did very little at the meeting on account probably of insufficient experience with this type of apparatus. The Blériot planes are slightly curved at the rear, as is the case with the Curtiss, whereby more lifting force is obtained, although at the cost of much higher resistance, and had Mr. Curtiss not shown such a high turn of speed it might be supposed that the resistance due to curvature was responsible for the failure of M. Blériot to attain much higher speeds than he did. Failing to beat the Curtiss machine in point of speed, M. Blériot finally cut off a strip from the back edge of his plane, thereby reducing the curvature and the sustaining area, and succeeded in beating the record for the 10 kiloms. around the trial grounds in 7 min. 47 sec., or about 2 sec. better than Curtiss. On the last day M. Blériot was attempting to improve upon his performances, and was flying at a height of about 100ft., when the machine suddenly stopped with a shock, as if it had encountered an obstacle, and, turning over, fell straight to the ground. The petrol caught fire, but M. Blériot was fortunately able to get clear of his machine, and roll over the ground until he extinguished the burning spirit which had flowed over his clothes. As the apparatus is completely burnt, it is impossible to say what caused this accident, but M. Blériot himself believes that the chain broke. It will be remembered that a somewhat similar accident happened to Orville Wright in America last year, when a passenger lost his life and Orville Wright himself was badly injured.

WOODEN BRIDGE OVER THE WEY



A NEW FOOTBRIDGE OVER THE RIVER WEY.

On Wednesday, August 25th, the Mayor of Guildford opened a new footbridge over the river Wey. The bridge, which is shown in the accompanying illustration, has been erected by public subscription at a cost of nearly £400. It has been modelled after the design of Palladio's bridge over the river Cismone between Italy and Germany. The clear span over the river and to the towing path is 63ft. 6in., the overall length being 78ft. The clear width is 5ft. As shown in the illustration, the west end is approached by a staircase, so as to leave a headway of 9ft. to the towing path, and at the east end the bridge lands the pedestrian on the Shalford-road level.

The bridge is constructed entirely of English oak, framed together and secured with wrought iron straps and bolts. At each end it is supported on four 12in. by 12in. oak posts, braced together on sole pieces resting on cement-concrete foundations. The dimensions of the tie beams, each of wbich is in three lengths, are 12in. by 9in., and the same applies to the principal braces, queen posts, and straining beams. The cross beams carrying the floor are 9in. by 9in. The work was carried out by R. Wood and Son, of Guildford, to the designs of the architects, Clemence and Moon, also of Guildford. The consulting engineers were Henry Adams and Son, of 60, Queen Victoria-street, E.C.

A LARGE TURBINE LATHE.

The large turbine lathe illustrated by the accompanying engravings and sketch was constructed by Joshua Buckton and Co., Limited, of Leeds, for the marine engine works of

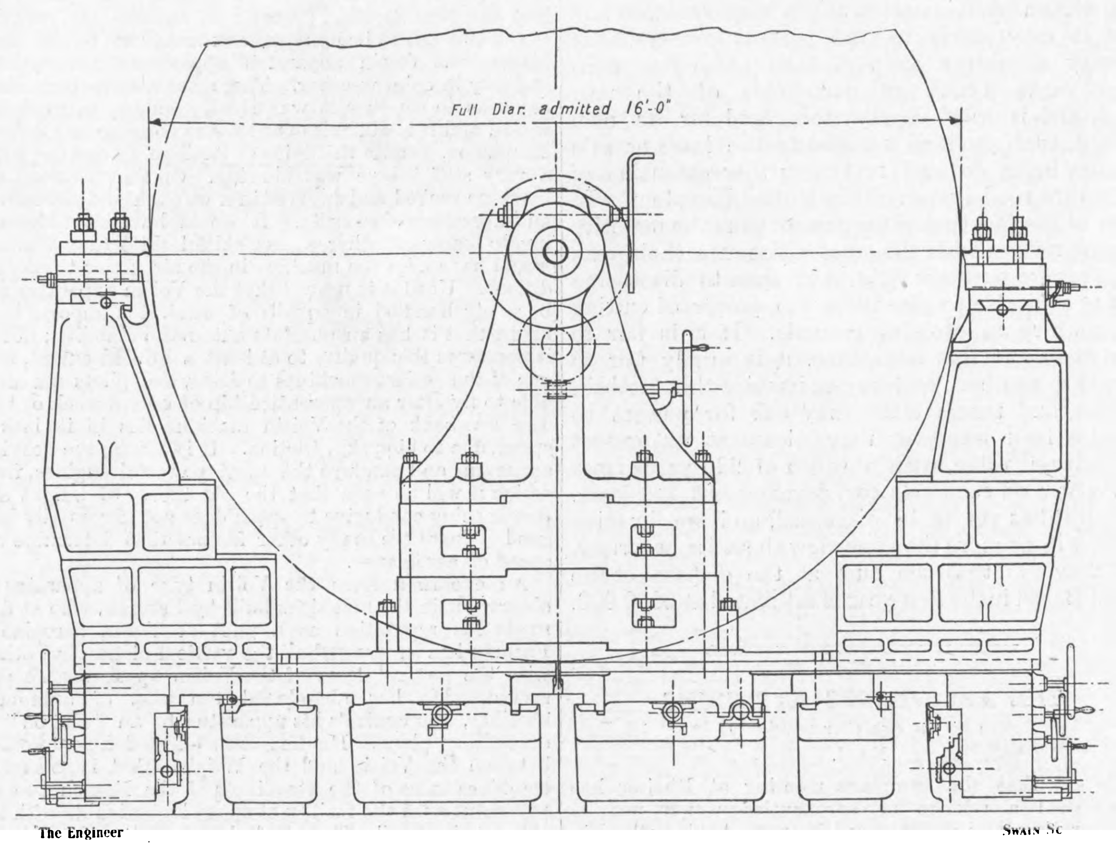


Fig. 1

Ansaldo, Armstrong and Co., of Genoa. Its maximum height of centres is 104in.; when the packing blocks seen in Fig. 1 are removed the height of centres is 69in., or one set of packing blocks only may be used, giving an intermediate height of 87in. It will admit work up to 50ft. long between centres, and when at its maximum height will swing work with a diameter of 17ft. 4in. over the bed, and of 16ft. clear diameter over the saddles, such diameters being required for turning large turbine rotors. At its lower limit of 69in. height of centres it is convenient for the ordinary work of a heavy marine shop, and for dealing with crank and propeller shafts.

It is driven by a direct geared electric motor of 80 horse-power, the speed of which can be varied over a range of 3 to 1, and which drives through double, treble, or quadruple gear, the final drive being into an internal ring of teeth on the back of the face plate. All the changes of gear are effected by interlocking handles conveniently situated on the front of the headstock; with this arrangement the nicest gradations of speed can be attained throughout the whole range.

The bed, which is 15ft. wide by 2ft 3in. deep, is of five-shear section, each of the shears being of box-section girder form, braced together at close intervals by wide box-section transverse bars. The bed carries independent saddles at the front and back, either two or four, as the case may be, the lathe illustrated by the photograph being fitted with two. They are fitted with compound rests, self-acting for sliding and surfacing, and a front saddle is also fitted for screw cutting over the whole length. The feed motions of each saddle can be stopped, started, varied, or reversed independently of each other, and all these motions are controlled upon the saddles themselves, the changes of feed being effected by the controlling handles without the removal or changing of any gearing.

The loose headstock base is wide enough to embrace the three central shears of the bed, and both it and the saddles can be rapidly travelled to and fro on the bed by an independent motor of 10 horse-power. The loose headstock spindle is fitted with improved wedge and screw-locking motion, and has quick and slow adjustment.

All the gearing throughout the lathe is machine cut, the teeth being of the special involute form adopted by the makers for gear drives of this character, these giving perfectly smooth and silent running at high speeds. The lathe is, of course, designed for use with high-speed steel and to work up to an overload on the motor of 25 per cent. The weight of one of these lathes with four rests, and fitted with a pair of stays to suit the exigencies of the work, is 225 tons.

Although this lathe is of exceptional character from the point of view of the size of work admitted over its whole length, it is not as powerful as some of the heavy gun lathes built by the firm, which utilise upwards of 100 horse-power.

LARGE TURBINE LATHE

JOSHUA BUCKTON AND CO., LIMITED, LEEDS, ENGINEERS

(For description see page 248)

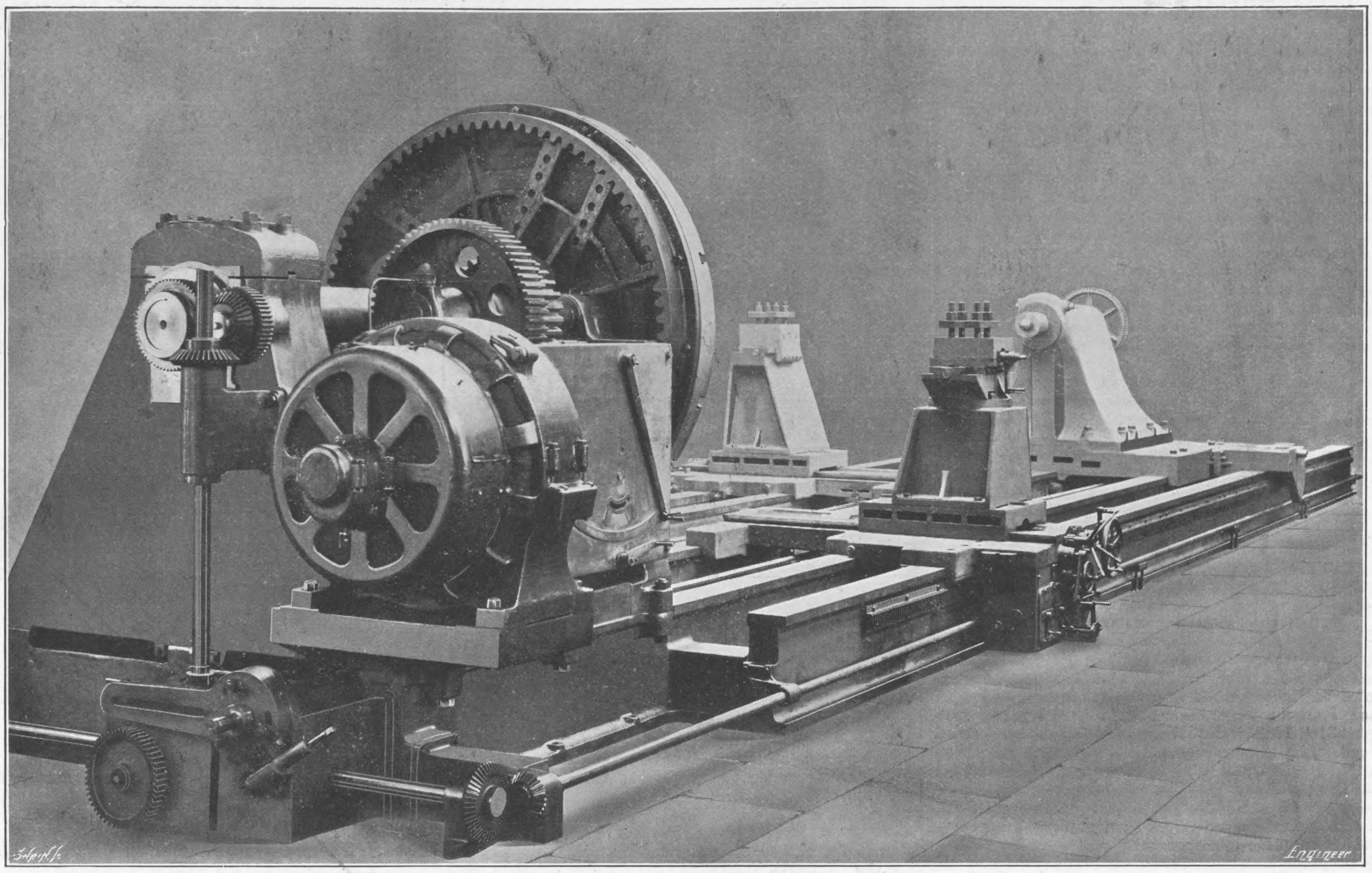


Fig. 2—PACKING BLOCKS REMOVED

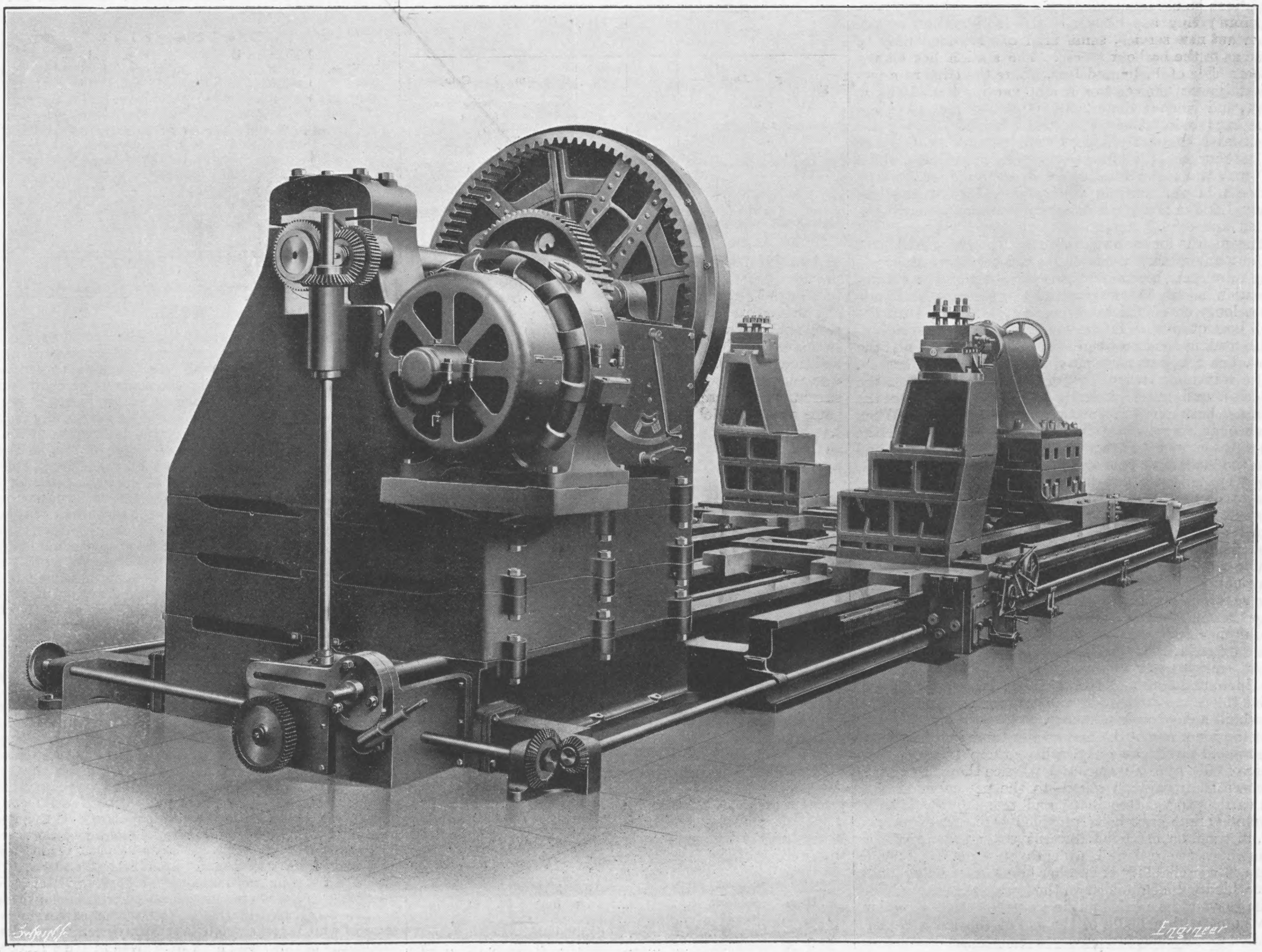
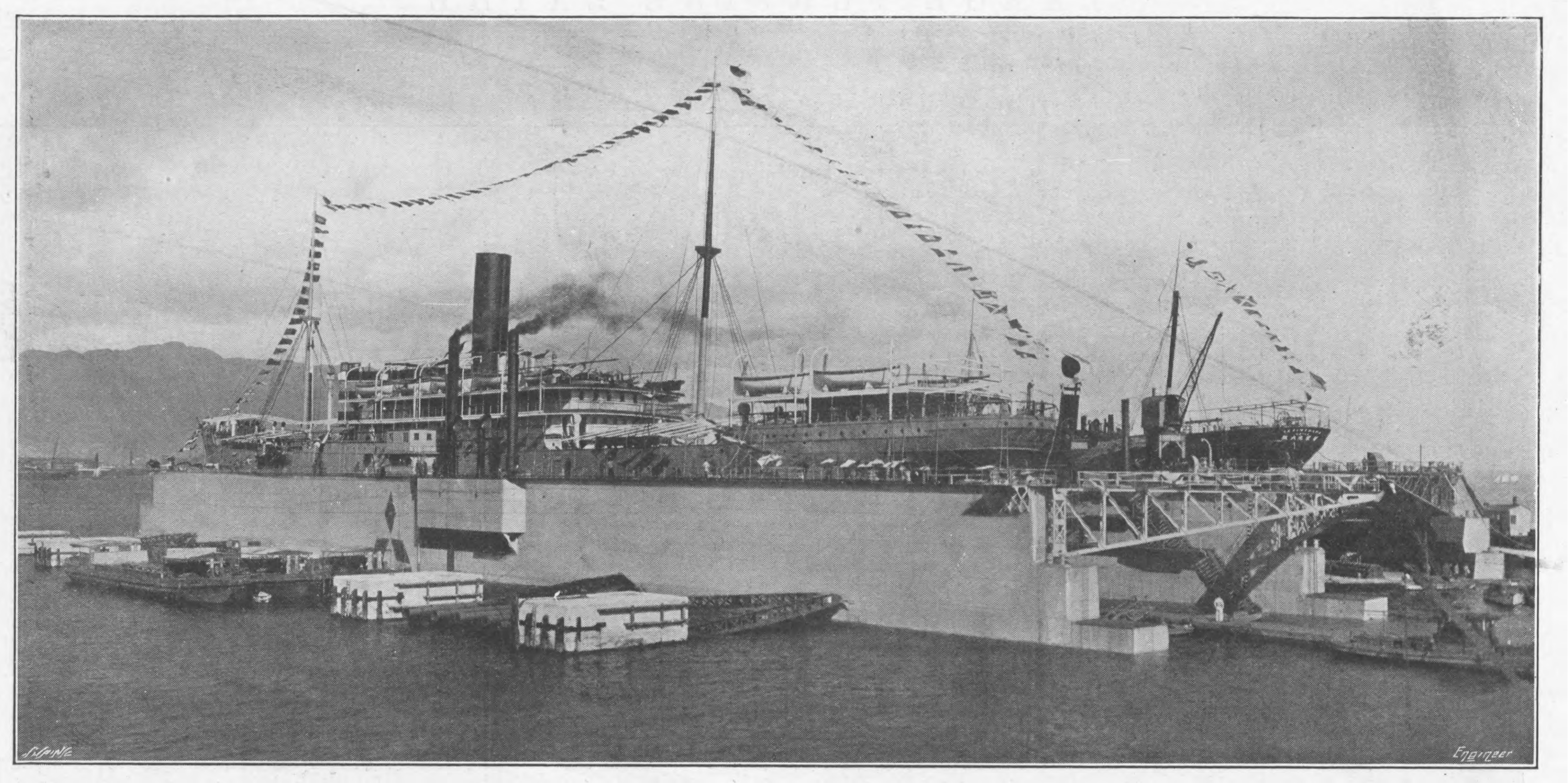


Fig. 3—BLOCKS IN PLACE

FLOATING DOCK AT KOBE, JAPAN



FISHGUARD AS A PORT OF CALL.

Monday last was the third anniversary of the opening of the new route to Ireland *viâ* Fishguard and Rosslare. The works in connection with the construction of Fishguard Harbour were described in The Engineer for August 31st, 1906, and we then observed that there was a "possibility of the scheme developing into something greater than this, and that is, as a port of call for the Atlantic mails."

In April, 1908, the Booth Line steamers from South America commenced to call at Fishguard, and now, after some delay—more apparent than real—this anticipated larger scheme became realised on Monday last by the Mauretania calling there on her homeward journey, and she will be followed by each east-bound Cunard liner—the slower boats leaving New York on Saturdays as well as the faster leaving on Wednesdays—unless the weather conditions be unfavourable.

Before giving any details of the inauguration of this important new service, some brief observations may be made as to the harbour works. The station lies on the western side of Fishguard Bay, where the cliffs rose precipitately from the sea to a height varying from 100ft. to 200ft., and whence about 2,000,000 tons of rock have had to be excavated. The large stones helped to build the breakwater, the medium sized were put into the sides of the harbour, and the filling of the quay and sidings, whilst the small was made into ballast or concrete for the 5000 concrete blocks used in the quay wall. At the end nearer London is the siding accommodation for carriages, loaded and empty goods, coal and cattle wagons. The arrangements for landing and dealing with cattle are, from an engineering point of view, most interesting, and were fully described in our previous notice. The accommodation is for 650 wagons. The passenger station is 800ft. long, of the island type, and is parallel with the Irish boat quay wall, 1103ft. long. There are two sidings and a loading dock between the station platform and the quay, but traversers are provided to bridge the spaces. These traversers, when out of use, are kept under the platform, and are electrically drawn forward into the opening between the platform and raised. When coaches or wagons are in these siding roads and the traversers cannot be used, passengers gain access to and from the boats by a subway. The depth of water is 20ft. at low spring tides, and 33ft. 6in. at high water. Nine electric cranes have been provided on the quay, two capable of lifting 3 tons, and the remainder of lifting 30 cwt. each. To the west of the station are the cattle pens, and at the north end is the accommodation for coaling vessels direct from a wagon raised by a 21-ton electrical crane. Still further north is the electric power-station, and between the passenger station and this point there is a space whereby the quay could be extended for another 200ft. From the power-station the breakwater extends in a direction south-east by east. It is 2000ft. long, 300ft. wide at the base, 60ft. wide at the top, 90ft. high, and 30ft. above high water. Since our previous notice the concrete parapet wall therein referred to has been built along the breakwater.

At the inner end of the breakwater there has now been constructed an ocean quay, where there is a depth of water of 30ft. at low water, and whence there are paths—separated from each other—to the passenger station and cattle pens. One 3-ton and one 30 cwt. electric travelling crane have been provided here. These works will, in time, be extended towards the outer end of the breakwater, where there is a depth of from 40ft. to 43ft. There is a probability of another breakwater being built later which will commence on the foreshore in the middle of the bay and be carried out in a north-easterly direction to a point within 500ft. of the end of the existing pier, and this would make an enclosed deep-water harbour of 150 acres, in which vessels of any size could be berthed, and would render the use of tenders unnecessary except in bad weather.

In anticipation of the service opened last Monday, the telegraph office accommodation was increased, and additional traversers were provided to fill temporarily the opening between the two goods platforms, and thereby give plenty of landing room for passengers and baggage. Three additional tenders were sent to Fishguard from Plymouth. The allotment of space for Customs examination was satisfactory, and guide posts to the telegraph office, bookstall, Customs-office, money exchange, &c., were provided. Each passenger had a seat allocated to him on the train, and large placards appeared on the carriages indicating the number of seats each contained.

There were many things that contributed to make the inaugural service a success. The Mauretania's log is as follows:—

Date.	Distance.	Latitude.	Longitude.	Winds, &c.
		N.	W.	
Wednesday, Aug. 25th	—	—	—	10.08 a.m. Left Company's pier
,, ,,	—	—	—	Noon. Ambrose Channel Lightship abeam
Thursday, Aug. 26th	590	41.48	61.07	S.W. to W.N.W.
Friday, ,, 27th	580	45.25	48.43	W. to S.E.
Saturday, ,, 28th	584	49.03	35.25	E.S.E. to N.E.
Sunday, ,, 29th	578	51.07	20.44	N.E.
	475	To Daunt's Rock Lightship		Monday, Aug. 30th—Arrived Daunt's Rock Lightship, 7.27 a.m.
From Ambrose Lightship to Daunt's Rock Lightship	2807			Length of passage: 4 days 14 hours 27 minutes Average speed: 25·41

and on this passage she excelled her own record. Her previous best trip was three weeks ago, when she crossed in 4 days 17 h. 20 min. By leaving New York at 10 a.m. she arrived at a very convenient hour on this side, one result of which was that the continental mails were able to leave London by the ordinary 9 p.m. train. In addition the weather was fine, although a disturbed sea was running outside the breakwater. Finally, whilst the surroundings were new, the routine was very much the same as that which the Great Western Railway Company has been for a long time past accustomed to at Plymouth, so that passengers and mails were transhipped with what appeared to many marvellous celerity.

The Mauretania left Queenstown at 8.10 a.m., and came to anchor off Fishguard breakwater at 1.12 p.m. The tender for the mails was first alongside, and the first bag was transhipped at 1.28. As the bags were counted they were placed in large hampers, so as to be quickly unloaded, and as soon as the mails were all aboard the tender it left for the Ocean Quay. Here a special train was in waiting, which left Fishguard at 2.11½ p.m., calling at Cardiff, where a van with mails for South Wales and the North and West of England was detached, and arrived at Paddington at 6.40 The passengers were transferred to a second tender and the baggage to a third, both of which came alongside the Irish boat quay. Two special trains with these left at 2.53 and 3.3 respectively, each calling at Cardiff, where a vehicle was detached from the baggage train and arriving at Paddington at 7.30 and 7.56 respectively. The engines on each of the three trains were changed at Cardiff, and the quick way in which this and the detaching of the vehicles was done reflected the greatest credit on all concerned.

By the courtesy of Mr. F. G. Wright, chief assistant to the locomotive engineer, we are enabled to give below the running of the three trains:—

Mail Train.

	Fishguard Harbour ...	dep.	2.11½		
71¾ m.	Landore	pass	3.31	54.1	m. p. h.
116¼ m.	Cardiff	arr.	4.19	55.6	,,
	Cardiff	dep.	4 21½		
184¼ m.	Swindon	pass	5.32	57.8	,,
261½ m.	Paddington	arr.	6.40	67.8	,,

Fishguard to Cardiff—Engine 3381 Maine, 4-4-0 class.
Weight of engine and tender, 96 t. 9 c.
,, train, 73 t. 8 c.
Cardiff to Paddington—Engine 4023 King George, 4-6-0 class.
Weight of engine and tender, 115 t. 12c.
,, train, 55 t. 5 c.

First Passenger Train.

	Fishguard Harbour ...	dep.	2.53		
71¾ m.	Landore	pass	4.14	53.1	m. p. h.
116¼ m.	Cardiff	arr.	5.4	53.4	,,
	Cardiff	dep.	5.8		
181¼ m.	Swindon	pass	6.21	55.8	,,
261½ m.	Paddington	arr.	7 30	67.1	,,

Fishguard to Cardiff { Engine 3402 Halifax, 4-4-0 class, 95 t. 6 c. weight. Engine 4108 Gardenia, 4-4-0 class, 93 t. 6 c. weight.
Cardiff to Paddington—Engine 4021 King Edward, 4-6-0 class, 115 t. 12 c. weight.
Weight of train throughout, 273 t. 18 c. weight.

Second Passenger Train.

	Fishguard Harbour ...	dep.	3.3		
116¼ m.	Cardiff	arr.	5.23	49.8	m. p. h.
	Cardiff	dep.	5.26		
184¼ m.	Swindon	pass	6.43	53.1	,,
261½ m.	Paddington	arr.	7.56	63.5	,,

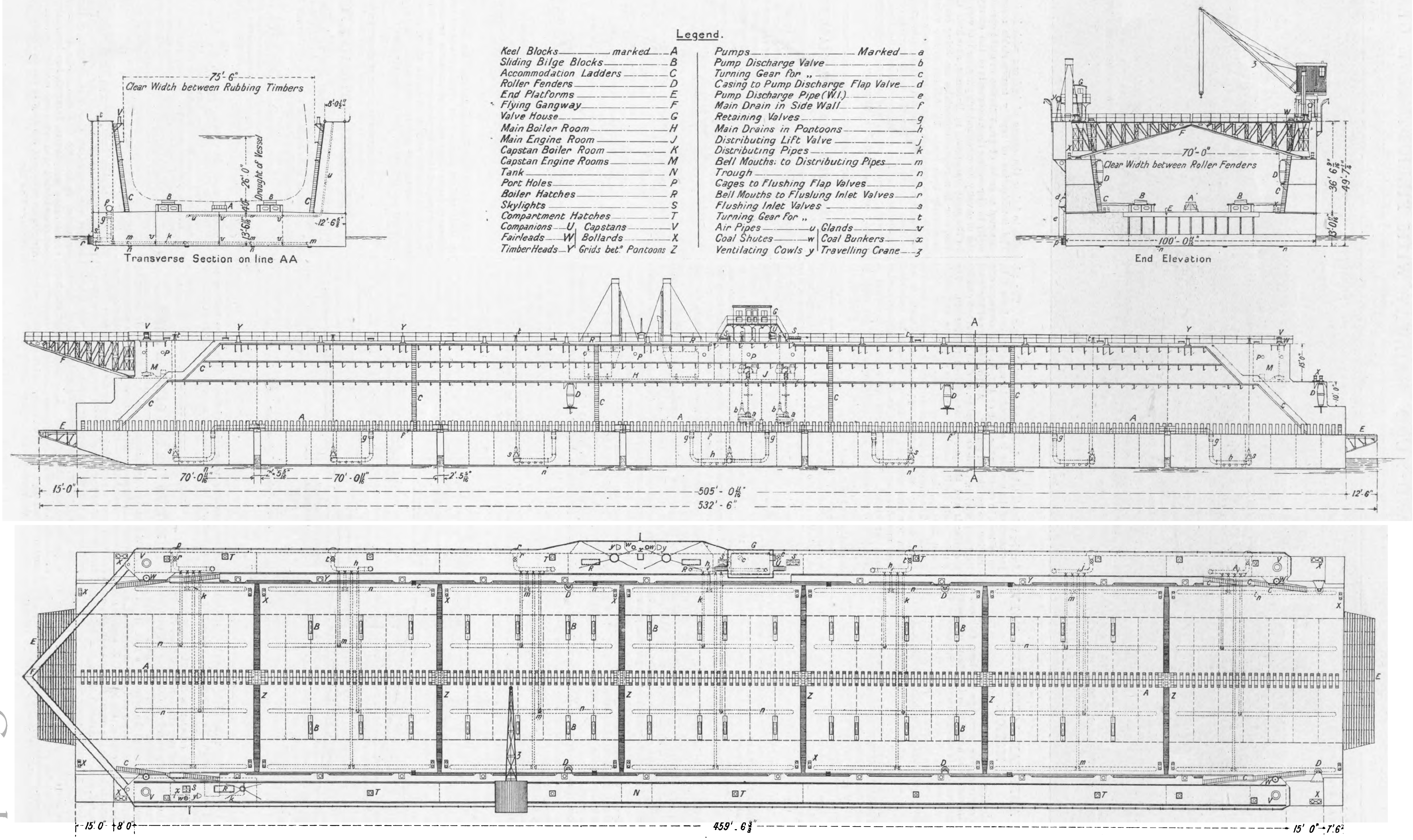
Fishguard to Cardiff—Engine 4116 Mignonette, 4-4-0 class, 93 t. 6 c. weight.
Engine 4111 Anemone, 4-4-0 class, 93 t. 6 c. weight.
Train, 298 t. 13 c. weight.
Cardiff to Paddington—Engine 4022 King William, 4-6-0 class, 115 t. 12 c. weight. Train, 281 t. 7 c. weight.

12,000-TON PONTOON FLOATING DOCK FOR KOBE.

THE Mitsu Bishi Company has recently had a second floating dock built for use at its dockyard and engine works at Kobe, Japan, and it is shown in the accompanying drawings. This dock has a length over the pontoons of 505ft., and the working floor is extended at each end by means of two light platforms, these making the total length of the dock floor 532ft. 6in. The clear width of the dock between the roller fenders is 70ft., but this is somewhat increased at the keel block level so as to enable each of the seven identical pontoons, which are 70ft. long, after being unbolted from the underside of the walls of the dock and drawn out, to be docked on the remainder of the dock when requiring repainting or repairing. The pumping power, generated by two large boilers, is capable of enabling the dock to lift a 12,000-ton ship in four hours, and the following are the maximum dimensions of vessels which can be accommodated in this dock:—Length, 580ft.; breadth, 66ft.; and draught, 26ft. The mooring arrangement of the dock is somewhat novel, as it is effected by four ferro-concrete caissons, to which the starboard wall of the dock is connected by means of four articulated booms, as may be seen above. The No. 1 floating dock at the Mitsu Bishi Dockyard and Engine Works was constructed at the company's Nagasaki works, and from its opening in August, 1905, up to the end of April of the present year, about 300 vessels, aggregating 700,000 tons gross, were taken into it; whilst for the first four months since its opening in December last, 26 vessels, aggregating 90,620 gross tonnage, have been taken into the second dock, illustrated on page 251. Both these docks are of the sectional pontoon self-docking type, built from the designs of Messrs. Clark and Standfield, of Westminster, and, as evincing the steadily growing popularity of the floating type of dry dock in Japan, it may be mentioned that a third dock is now being built by the Kawasaki Dockyard Company, of Kobe, from Clark and Standfield's designs, which, although not primarily intended for docking vessels, will be used for laying down the large ferro-concrete monoliths which are now being used in the Kobe Harbour extension works, some of which blocks weigh over 2200 tons. Some detailed particulars of this latter dock were given in THE ENGINEER of January 29th last.

12,000-TON PONTOON FLOATING DOCK FOR KOBE

(For description see page 250)


75'-6"
Clear Width between Rubbing Timbers
8'-0½"
Draught of Vessel
26'-0"
4'-0"
13'-6 11/16"
12'-6⅝"
70'-0"
Clear Width between Roller Fenders
36'-6 9/16"
49'-7¼"
13'-0 11/16"
100'-0 11/16"
70'-0 11/16"
2'-5 5/16"
505'-0 11/16"
532'-6"
15'-0"
12'-6"
15'-0"
10'-0"
459'-6⅜"
15'0"
8'0"
15'0"
7'6"

Transverse Section on line AA

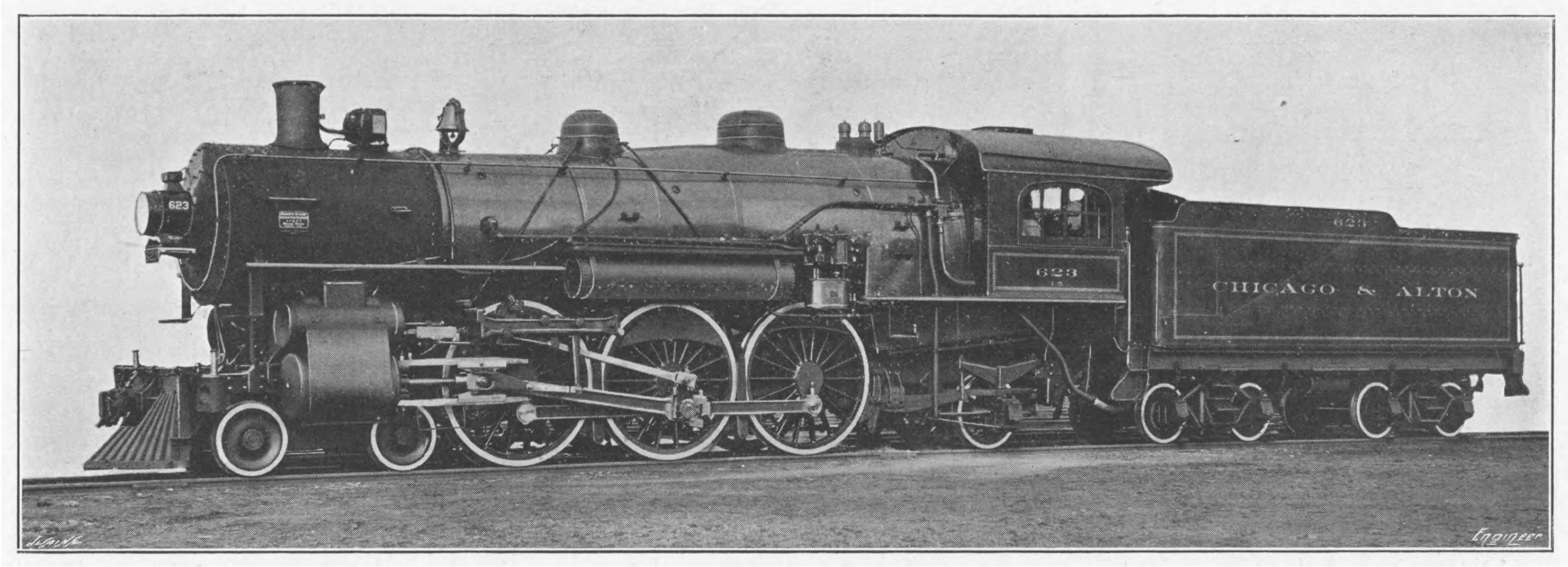
End Elevation

Legend.

Keel Blocks —— marked	A	Pumps —— Marked	a
Sliding Bilge Blocks	B	Pump Discharge Valve	b
Accommodation Ladders	C	Turning Gear for „	c
Roller Fenders	D	Casing to Pump Discharge Flap Valve	d
End Platforms	E	Pump Discharge Pipe (W.I.)	e
Flying Gangway	F	Main Drain in Side Wall	f
Valve House	G	Retaining Valves	g
Main Boiler Room	H	Main Drains in Pontoons	h
Main Engine Room	J	Distributing Lift Valve	j
Capstan Boiler Room	K	Distributing Pipes	k
Capstan Engine Rooms	M	Bell Mouths to Distributing Pipes	m
Tank	N	Trough	n
Port Holes	P	Cages to Flushing Flap Valves	p
Boiler Hatches	R	Bell Mouths to Flushing Inlet Valves	r
Skylights	S	Flushing Inlet Valves	s
Compartment Hatches	T	Turning Gear for „	t
Companions	U	Air Pipes	u
Capstans	V	Glands	v
Fairleads	W	Coal Shutes	w
Bollards	X	Coal Bunkers	x
Timber Heads	Y	Ventilating Cowls	y
Grids betn Pontoons	Z	Travelling Crane	z

"THE ENGINEER" SWAIN SC.

LOCOMOTIVE OF THE CHICAGO AND ALTON RAILWAY WITH PILLIOD VALVE GEAR



A NEW AMERICAN LOCOMOTIVE VALVE MOTION.

THE introduction of the Walschaerts valve gear on American locomotives a few years ago has been followed by a very extensive use, as in addition to its steam efficiency it effects a material saving in weight over the Stephenson link motion. This advantage increases with the size of the engine, so that the saving reaches an important sum on the large and heavy engines which are characteristic of American main line service. The successful use of this one-valve motion has led to experiments with others, a few of which are in use to a limited extent. At the present time several railways are trying the Pilliod motion, which has the peculiarity of avoiding all loose or sliding parts—such as links and link blocks—the several parts having positive pin connections.

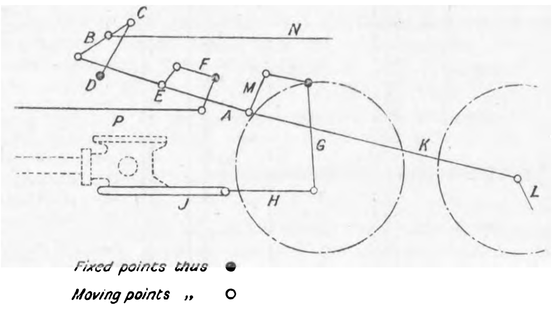


Fig. 1

Fig. 1 shows a diagrammatic sketch of the new valve motion, while Fig. 2 gives a more detailed view. In Fig. 3 the valve gear is seen applied to a locomotive of the Chicago and Alton Railway.

It will be seen that, as with the Walschaerts valve gear, the motion is derived partly from a return crank on the main crank pin and partly from the crosshead. Referring to Fig. 1, the excentric rod K is connected at one end to the return crank L and at the other to a link M, which is suspended from the horizontal arm of a bell-crank lever G. The lower end of the latter is joined by a link H to an extension J rigidly fixed to the crosshead. A rod A is connected at one end to the excentric rod and at the other to a link B. The point of suspension C of the upper end of B is not fixed, but can be varied at will by means of the lever C D and bar N, which is in connection with the reversing handle in the cab. P is the valve rod, and is connected through a bell-crank lever F and a link to a point E on the rod A.

The combined motions of the return crank and the crosshead thus give an elliptical motion to the end of bar A. The other end of this bar moves in a circular segment, being hung from the point C. Thus the point E, whence the motion for the valve is taken, describes a distorted ellipse. The adjustment of the motion is effected by rocking the lever C D, so as to raise or lower the end of bar A, and consequently shifting the position of point E. All the pins are of hardened steel and work in hardened bushes, and all parts are outside the wheels and the power transmission mechanism. The moving parts are the same for any class of engine, and weigh about 1000 lb., the total weight of the motion being about 3000 lb. The throw of the excentric crank or return crank is 6½in. for any valve travel up to 6½in. There is no strain on the reversing lever, which can be unlatched and moved in any condition, with the regulator either open or closed. This motion is expected to effect a saving of 5 per cent. in fuel, an increase of 5 per cent. in tractive power, and a saving of 25 per cent. in expense for maintenance and repairs.

The Pilliod valve motion, it is further claimed, maintains a uniform lead, and gives a large port opening at all points of cut-off. Only 5 per cent of the travel of the piston is required for full port opening. The cut-off is uniform. Any cut-off from 75 to 85 per cent. can be had at full gear by lengthening the quadrant; this allows the reversing lever to be put farther over, lowering the point C of the motion, and thus increasing the valve travel and the cut-off at full stroke. The motion has a late release, and at quarter stroke it releases at 85 per cent.; that is, on a 24in. stroke with 6in. cut-off the exhaust port opens when the piston has travelled 20¾in. With the Walschaerts motion under the same conditions the exhaust port opens after 15in., or about 65 per cent. of the stroke.

The compression is late and balanced, and excessive compression in the short cut-off is eliminated. There is a reduced back pressure due to the quick and complete release, and the lower terminal pressures permit the use of a larger blast nozzle. There is an entire absence of pre-admission. The motion is said to be especially adapted to high speeds, producing an efficiency equal to that of valve motions employing two to four valves. It increases the pulling power or tractive effort, for the reason that the movement of the valve produces a higher effective pressure and more uniform pressure upon the piston. This valve motion is manufactured by the Pilliod Company, of Chicago, U.S.A.

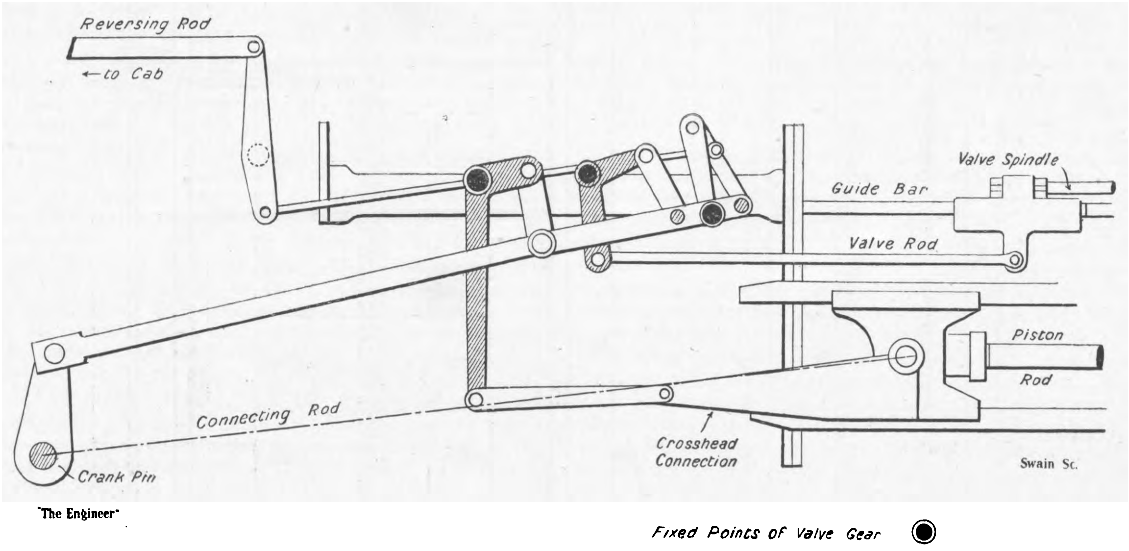


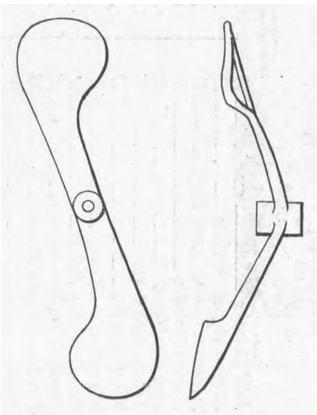
Fig 2

MOTORS FOR THE GERMAN ARMY.

NEW uses for the automobile seem constantly to occur to the Austro-Hungarian military authorities. The latest is an automobile search-light—the Daimler factory having just delivered two cars specially designed for this purpose. They consist of a 24 horse-power motor car and a wagon with the search-light and 80 horse-power motor. When the search-light is in operation, the automobile motor will be coupled to the wagon with the dynamo. It is claimed that this new search-light will have a far greater illuminating capacity in elevation than any heretofore in use, and that it will be possible to follow the course of balloons with its intense rays. The introduction of rapidly transportable search-lights is expected to prove of great service in night operations, especially in discovering the movements of the enemy when the use of cavalry for reconnoitring purposes is of very little value. In the great manœuvres in Bohemia, at which the German Emperor is a guest, automobiles are being employed more extensively than ever. In addition to the volunteer automobile corps established in Vienna, there is now a similar organisation in Buda Pesth, and both are strongly represented in these manœuvres. For the rapid carrying of orders and dispatches, and for scouting purposes also, these volunteer motorists, among whom are several motor cyclists, have already demonstrated their efficiency.

SCREW PROPELLERS OF SMALL BOATS.

A CORRESPONDENT, writing from a town in West Siberia concerning oil engines and the engines of motor boats sent out there, says:—"Another curious thing they do here with respect to these engines and boats is they remove the beautifully finished and balanced bronze propellers sent with motors, and hack out of ¼in. to $\frac{3}{16}$in. iron or steel plate two and three-blade propellers something like sketch; the result is their motors slow off in speed, but their boats go considerably faster than with the scientific propeller, this in spite of the fact that the plate propellers are all corners and irregularities as the cold chisel leaves them, even the edges not filed to a feather edge in some cases. The explanation I have not yet arrived at, but the fact remains."



THE BRAZILIAN FLOATING DOCK.

THE following are the tenders received by the Brazilian Government for the construction of the 22,000-ton floating dock which is to be built for the use of the new battleships Minas Geraes and San Paulo:—

Name of tenderer.	Time required for building and delivery at Rio de Janeiro. Months.	Amount of tender (including towage). £
Cammell, Laird and Co., Limited, Birkenhead	12½	182,500
Vickers, Sons and Maxim, Limited, Barrow-in-Furness (with Sir William Armstrong and Co., Limited, and others)	11	182,700
Swan, Hunter and Wigham Richardson, Limited, Newcastle-on-Tyne	12 14	212,500 204,500
Compagnie des Forges et Chantiers de la Méditerranée (La Sayne), Toulon	18-20	262,436
Blohm and Voss, Hamburg	12-15 (time for delivery at Hamburg)	307,000
Maryland Steel Company, Baltimore, U.S.A.	12	371,000

Two other tenders from German firms were delivered in London. These tenders had not been received when the other tenders were opened at Rio. The amounts of these tenders are stated to be over £200,000. The tender of Messrs. Vickers, Sons and Maxim, Limited, has been accepted. We understand that the accepted tender includes a sum of £16,000 for towage of the dock to Rio de Janeiro.

THE BRITISH ASSOCIATION: SECTION G—ENGINEERING.

Address by Sir W. H. WHITE, K.C.B., Sc.D., LL.D., F.R.S., President of the Section.

(*Concluded from page* 228.)

Over-sea Trade and Transport.

It was remarked at the outset that a great truth is embodied in the old toast of "Ships, Colonies, and Commerce," and the efficient and economical transport of passengers, produce, and manufactured goods between the dominions beyond the seas and the Mother Country is essential both for the development of colonial resources and for the continued prosperity of the United Kingdom. The British mercantile marine commands the larger portion of the carrying trade of the world; its earnings constitute a valuable item in the national income; it forms one of the strongest bonds of union between the various parts of the Empire. This general statement may be illustrated by reference to the over-sea trade of Canada and to the shipping engaged therein.

The total value of the imports and exports of the Dominion in 1898 was close upon 61 millions sterling; in 1908 it exceeded 130 millions sterling, having more than doubled within ten years. During the year ending March 31st, 1908, the vessels which were entered at Canadian ports (inwards from the sea) carrying cargoes were classified as follows in the official returns:—

Ships.	Tons register.	Freight carried.		Crews.
		Tons weight.	Tons measurement.	
British (2603)	4,539,256	1,306,822	254,373	165,078
Canadian (2803)	718,490	202,939	1,449,054	44,594
Foreign (2878	1,758,549	887,154	36,618	86,293
Totals (8284)	7,016,295	2,396,915	1,740,045	295,965

The corresponding figures for ships entered outwards for sea-carrying cargoes were:—

Ships.	Tons register.	Freight carried.		Crews.
		Tons weight.	Tons measurement.	
British (2533)	4,258,960	2,706,334	714,085	136,614
Canadian (3557)	1,041,053	616,248	291,480	45,658
Foreign (4132)	2,211,605	1,454,787	538,499	88,093
Totals (10,222)	7,511,618	4,777,369	1,544,064	270,365

Taking the combined over-sea traffic inwards and outwards, it employed 18,506 ships of 14,528,000 tons, whose cargoes aggregated 7,174,000 tons deadweight and 3,284,000 measurement tons, the crews exceeding 576,000 officers and men.

Of the 2603 British ships entered inwards there came from Great Britain 852 ships of 3,392,000 tons, carrying as cargoes over 860,000 tons deadweight and 153,600 tons measurement; while there came from British Colonies 399 ships of nearly 381,000 tons, carrying cargoes of 236,000 tons deadweight and 44,000 tons measurement. Of the 2533 British ships entered outwards there proceeded to Great Britain 732 ships of 2,529,000 tons, carrying cargoes of 1,635,000 tons deadweight and 509,000 tons measurement; while there sailed for British Colonies 648 ships of nearly 400,000 tons, carrying cargoes of 259,000 tons deadweight and 76,500 tons measurement.

It will be seen, therefore, that the British ships entered inwards carried more than 54 per cent. of the total deadweight cargoes and 14½ per cent. of the measurement goods, while foreign ships carried about 37 per cent. of the deadweight and rather more than 2 per cent. of the measurement goods. British ships entered outwards carried more than 56 per cent. of the total deadweight, and more than 46 per cent. of the measurement; whereas foreign ships carried only about 30 per cent. of the deadweight, and not quite 35 per cent. of the measurement.

The trade from and to ports in the British Empire amounted to 45 per cent. of the grand total deadweight freight; and ships carrying the British flag—excluding Canadian vessels—carried about 56 per cent. of the grand total deadweight, and nearly 30 per cent. of the measurement goods. Including Canadian vessels, the British Empire can claim possession of 67½ per cent. of the total deadweight trade, and 82½ per cent. of the measurement goods. The average tonnage per ship for the British was about 1700 tons; for the Canadian vessels less than 300 tons; for the foreign ships a little more than 900 tons.

It may be interesting to add a few figures showing the magnitude of the coasting trade of the Dominion. In 1908 there arrived and departed 104,527 steamers aggregating nearly 42,857,000 tons, and 50,710 sailing ships aggregating 7,673,000 tons. The sailing ships included nearly 50,200 small schooners, sloops, barges, canal boats, &c., averaging about 150 tons each. The grand totals for the coasting trade were 155,237 ships of 50,530,000 tons, and of these 151,873 ships of 47,356,000 tons were classed as British in the official returns. It will be obvious that great importance must attach to every detail of the business involved in carrying on a shipping trade of the magnitude indicated by the foregoing figures, and still more is this the case in regard to the immensely greater transactions of British shipping considered as a whole. No pains must be spared in promoting economy or improving procedure, and even minute savings on particular items must be secured, since their aggregate effect may be of vast amount.

Since the introduction of iron for the structures of ships and of steam as the propelling power marvellous economies have been effected in the cost of over-sea transport. The chief causes contributing to this result have been (1) improvements in steam machinery, leading to great reductions in coal consumption, (2) considerable enlargement in the dimensions of ships, and (3) the supersession of iron by steel for structures and machinery. It is unnecessary, and would be impossible on this occasion, to deal in any detail with these matters, which have been illustrated repeatedly by many writers, including the speaker. On the other hand, it would be improper to leave altogether without illustration the remarkably low cost of sea transport under existing conditions, since it has great influence on the commerce of the British Empire and of the world.

Rates of freight, of course, vary greatly as the conditions of trade and the stress of competition change. At the present time these conditions remain unfavourable, although it may be hoped that there are signs of improvement, after long and severe depression. It will be preferable, therefore, to give facts for more normal circumstances, such as prevailed five or six years ago. Coal was then carried from the Tyne to London (315 miles) for 3s. 3d. a ton; to Genoa (2388 miles) for 5s. a ton; to Bombay (6358 miles) for 8s. 6d. a ton, including Suez Canal dues. The corresponding rates of freight were .111, .025, and .016 of a penny per ton-mile.

Grain was brought across the Atlantic for 9d. per quarter in large cargo steamers, whereas in former times, when it was carried in small vessels the charge was 9s. 6d. Goods were carried 6400 miles eastward *via* the Suez Canal in tramp steamers at an inclusive charge of 25s. to 30s. a ton, the freight rate averaging about .05 of a penny per ton-mile. It was estimated at that time that the average railway rate per ton-mile in Great Britain for cost of transport and delivery of goods was about thirty times as great; but the moderate distances travelled, local and national taxation, high terminal charges, and the immense outlay involved in the construction, equipment, and maintenance of railways account for much of the great difference in cost of transport. The ocean furnishes a free highway for the commerce of the world.

Economy of fuel consumption has played a great part in the reduction of working expenses in steamships. Fifty years ago from 4 lb. to 5 lb. of coal per indicated horse-power represented good practice in marine engineering for screw steamships. At present, with quadruple-expansion engines high steam pressures, and more efficient reciprocating engines, from 1¼ lb. to 1½ lb. is common practice, and better results are claimed in some cases. A cargo steamer of the tramp type, carrying 6500 tons deadweight, can cover about 265 knots in twenty-four hours in fair weather for a coal consumption of 27 tons per day, representing an expenditure on fuel of £20 to £25. A larger vessel carrying about 12,000 tons deadweight, driven by engines of similar type, would consume about 45 tons in covering the same distance at the same speed. This increased economy in fuel per ton-mile is the result of an increase in dimensions from 365ft. length, 47ft. breadth, and 24½ft. draught of water to a length of 470ft., a breadth of 56ft., and a draught of 27½ft. The first cost of cargo steamers is small in relation to their carrying capacity and possible earnings; varying, of course, with the current demand for new steamships. In the present depressed condition of shipping, about £5 10s. per ton deadweight is named as a current rate; in busy times the price may be 40 to 45 per cent. higher; even then it is small in proportion to earning power. Working expenses are kept down also by the use of efficient appliances for rapidly shipping or discharging cargoes, and so shortening the stay of ships in port. As an example a case may be mentioned when a ship of 12,000 tons deadweight and 800,000 cubic feet measurement capacity had her full cargo discharged at an average rate of 300 tons an hour. a fresh cargo put on boad at the rate of 250 tons an hour, and 1600 tons of coal shipped between 7 a.m. on Monday and noon on the following Friday—that is, in 101 hours. In another case a cargo weighing 11,000 tons was discharged in 66 hours. "Quick dispatch" in dealing with cargo is now universally recognised as essential, and it has been asserted that a saving of one day in discharging or loading a tramp steamer when she finds full employment may involve an expense equal to 1 per cent. on her first cost.

The "intermediate" type of steamer—in which large carrying capacity is combined with provision for a considerable number of passengers and moderate speed—is of comparatively recent date, but it has been developed rapidly and is subject to the universal laws to which all classes of shipping conform. Increase of size is adopted in order to favour economy in working and greater earning power, while increase in speed is made in some cases. Vessels like the Adriatic or Baltic of the White Star Line, the Carmania and Caronia of the Cunard Line, and the George Washington of the Hamburg-American Line illustrate this statement, while its latest and greatest examples are found in the two steamers now building for the White Star Line by Messrs. Harland and Wolff, which are said to be of 45,000 tons, to be intended to steam 20 to 21 knots, to provide accommodation for a great number of passengers, and to have large capacity for cargoes. In mail and passenger steamers of the highest speed increase in dimensions is devoted chiefly to provision for more powerful propelling apparatus, and for a correspondingly large quantity of fuel, and the cargo-carrying capacity is relatively small, but the law of increase in size and cost is obeyed, and will be followed up to the limit which may be fixed by the vast outlay necessary in order to provide suitable harbours and dock accommodation with an adequate depth of water, or by commercial considerations, and the possibility of securing a suitable return on the large capital expenditure. Growth in dimensions of ships will not be determined by the naval architect and marine engineer finding it impossible to go further, for there are even now in view possibilities of further progress if the shipowner so desires. Invention and improvement have not reached their ultimate limits.

The wonderful progress made during the last seventy years is well illustrated by the history of shipping trading between Canada and Great Britain, and it may be of interest to recall a few of the principal facts. For a long period trade and communications were carried on by wood-built sailing ships, many of the finest being Canadian built; but at a very early period Canadians had under consideration the use of steamships. One of the first steamers to cross the Atlantic was the Royal William paddle steamer, built near Quebec in 1831. She was 160ft. long, 44ft. broad, of 363 tons burden, sailed from Quebec on August 5th, 1833, and reached Gravesend on September 16th, a passage of more than forty days. in the course of which sail-power was largely used. Cabot, in 1497, crossed in the good ship Matthew, of 200 tons burden, which was probably from 90ft. to 100ft. in length; so that three centuries of progress had not made very great changes in size of ships employed. Wood was still the material of construction, and sails were still used as a motive power, although the steam engine was installed. In 1839 it was a Canadian, Samuel Cunard, who secured—in association with two British shipowners, Burns and McIver—the contract for a monthly Transatlantic service from Liverpool to Halifax and Boston. The four steamers built were wood hulled, driven by paddle wheels, had good sail-power, and were of the following dimensions:—207ft. long, 34½ft. broad, 1150 tons burden, and about eight knots speed. A rapid passage to Boston then occupied about fourteen days.

Another Canadian enterprise, the Allan Line, started about 56 years ago. The first steamer built for the company was appropriately named the Canadian. At the time of her construction she ranked among the most important mercantile steamers in existence, and was quite up to date. Her dimensions were:—Length, 278ft.; breadth, 34ft.; burden, 1873 tons. She had inverted direct-acting engines, driving a screw propeller, and a full sail equipment

The Transatlantic service to New York, as was natural, rapidly surpassed that to Canadian ports, but the latter has been continuously improved, and its development has been marked by many notable events. For example, the Allan Line was amongst the first to use steel instead of iron for hulls, and in their two largest steamers now in service, dating from 1903, they were the first to adopt steam turbines for ocean-going ships, although their lead of the Cunard Company was not long. The Virginian and Victorian are 520ft. long, 60ft. broad, of 10,750 tons, and their maximum speed is 18 knots. The Canadian Pacific Railway authorities added shipowning to their great land enterprises at an early period in their career by building for the Pacific service in 1891 three important steamers, each 456ft. long, 51ft. broad, of 5950 tons, and 17 knots speed. These vessels continue on service, and have done splendid work as a link in the "all-red" route. Since this step was taken the Canadian Pacific Railway has become possessed of a large fleet of Atlantic steamships, and quite recently has placed on the service from Liverpool to Quebec passenger steamships nearly 550ft. in length, 66ft. in breadth, of 14,200 tons, with a maximum speed of 20 knots.

The latest addition to the Canadian service has been made by the White Star Line in the form of two steamers, the Laurentic and Megantic, of 15,000 tons, 550ft. long, about 67ft. broad, and 17 knots speed. In the Laurentic an interesting experiment has been made, Messrs. Harland and Wolff having introduced a combination of reciprocating engines and a low-pressure turbine. This system was patented as long ago as 1894 by Mr. Charles Parsons, to whom the invention of the modern steam turbine and its application to marine propulsion are due. Mr. Parsons foresaw that while the turbine system would prove superior to reciprocating engines in ships of high speed, and with a high rate of revolution, there would be a possibility of getting better results by combining reciprocating engines with low-pressure turbines in ships of comparatively slow speed, where a low rate of revolution for the screw propellers was necessary to efficient propulsion. His main object, as set forth fifteen years ago, was "to increase the power obtainable by the expansion of the steam beyond the limits possible with reciprocating engines, and subsequent investigations led Mr. Parsons to the conclusion that it would be possible to secure an economy of 15 to 20 per cent. by using the combination system as compared with that obtainable with efficient types of reciprocating engines. Many alternative arrangements have been designed for combining reciprocating engines with low-pressure turbines; that now under trial associates twin-screw reciprocating engines, in which the expansion of the steam is carried down to a pressure of 9 lb. to 10 lb. per square inch when working at a maximum power, and then completed to the condenser pressure in a turbine. Triple screws are employed, the central screw—driven by the turbine—running at a higher rate of revolution than the side screws, which are driven by the reciprocating engines. The Laurentic has been but a short time on service, and few particulars are available of her performances as compared with those of her sister ship, fitted with reciprocating engines. It has, however, been reported that the results have proved so satisfactory that the combination system will probably be adopted in the two large White Star steamers of 45,000 tons now building at Belfast. This favourable view is fully confirmed by the performances of the Otaki, built by Messrs. Denny, of Dumbarton, for the New Zealand Shipping Company, and completed last year. That firm, as is well known, have taken a leading part in the application of the Parsons type of steam turbine to the propulsion of mercantile and passenger steamers, and they possess exceptional experience as well as special facilities for the analysis of the results of trials of steamships, having been the first private firm to establish an experimental tank for testing models of ships and propellers on the model of that designed by Mr. W. Froude and adopted by the Admiralty. Messrs. Denny have generously placed at the disposal of their fellow-shipbuilders the principal results obtained on the official trials and earliest voyages of the Otaki, and have compared them with similar results obtained in sister ships fitted with reciprocating engines.* The Otaki is the first completed ship fitted with the combination system and subjected to trial on service, and as the successful application of that system to cargo steamers and steamers of the intermediate type would result in a considerable economy in the cost of oversea transport, it may be of interest to give some details of her recorded performance. She is 465ft. long, about 60ft. broad, and of 7420 tons (gross). Her deadweight capability is about 9900 tons on a draught of 27ft. 6in., and the corresponding displacement (total weight) is 16,500. The vessel was designed for a continuous sea speed of 12 knots when fully laden, and the contract provided for a trial speed of 14 knots with 5000 tons of deadweight on board. The trials were accordingly made at a displacement of about 11,700 tons. Her installation of boilers is identical with that of her sister ship, the reciprocating-engined twin-screw steamer Orari, which is 4ft. 6in. shorter than the Otaki, but generally of the same form. On the measured mile the Otaki obtained a speed of 15 knots, while the Orari reached 14.6 knots. In order to drive the Orari at 15 knots about 12 per cent. more horse-power would have been required, and this is a practical measure of the superiority of the combination system over the reciprocating twin-screw arrangement in the Orari. The total water consumption per hour of the Otaki at 15 knots was 6 per cent. less than that of the Orari at 14.6 knots. If the Otaki also ran at 14.6 knots, the water consumption would have been 17 per cent. less than that of the Orari at the same speed. On the voyage from Liverpool to New Zealand the Otaki averaged about 11 knots, which would have required on the measured mile only about 40 per cent. of the power developed when running 14.6 knots. With the ship laden more deeply, the average development of power on the voyage was about one-half the maximum developed on the measured mile, and this was disadvantageous to economy in the combination. Even in these unfavourable conditions, the Otaki realised an economy in coal consumption of 8 per cent. on the voyage from Liverpool to New Zealand and back, as compared with her reciprocating-engined sister ship. This represents a saving of about 500 tons of coal. Ordinarily, the ship would leave England with sufficient coal on board for the outward passage, so that 250 tons less coal need be carried, and a corresponding addition could be made to cargo and freight-earning. Probably, as experience is gained, the actual economy will prove greater than that realised on the maiden voyage; but, even as matters stand, there is a substantial gain, and a prospect of the extended application of the steam turbine to vessels of moderate and low speed. In view of results already obtained, the New Zealand Shipping Company have decided to apply the combination system to another vessel just ordered from Messrs. Denny.

In designing turbine machinery for vessels of moderate or low speed there must necessarily be conflicting claims. For maximum efficiency in steam turbines a high rate of revolution is necessary, whereas at moderate or low speeds it is antagonistic to propeller efficiency to run at this high rate of revolution. Engineers are at present much occupied with the study of arrangements by means of which these conflicting claims may be harmonised and greater total efficiency of propulsion obtained. Having regard to the enormous capital invested in cargo steamers of moderate speed, and the importance attaching to their economic working as influencing the cost of oversea transport, it will be obvious that it is most desirable to find an arrangement in which the high speed of the rotor may be reduced by means of some form of gearing or its equivalent, so as to enable the screw shaft and its propeller to be run at a speed which will secure maximum propeller efficiency. Many proposals have been made, including mechanical gearing and hydraulic or electric apparatus for transforming the rate of motion. Some of these are actually undergoing experimental trials, and are said to have given very promising results. One of the most important trials is that undertaken by the Parsons Marine Steam Turbine Company, which has purchased a typical tramp steamer, and is carrying out on her a series of trials in order first to ascertain accurately what are the actual conditions of steam and coal consumption with the present reciprocating engines, and then to ascertain the corresponding facts when those engines have been removed and a steam turbine with its associated gearing has been fitted. It is interesting to note in passing that in the earliest days of screw propulsion with slow-running engines it was found necessary to adopt gearing in order to increase the rate of revolution of the propellers, whereas at present interest is centred in the converse operation. Furthermore, if any system of gearing-down proves successful it may be anticipated that its application will be extended to swift turbine-driven steamships, since it would enable good propulsive efficiency to be secured in association with rapidly running turbines of smaller size and less weight than have been employed hitherto.

The Marine Steam Turbine.

The rapid development of the marine steam turbine during the last seven years constitutes one of the romances of engineering, and the magnitude of the work done and the revolution initiated by Mr. Charles Parsons will be more justly appreciated hereafter than it can be at present. In some quarters there is a tendency to deal critically with details and to disregard broader views of the situation as it stands to-day. In May, 1909, there were 273 vessels built and under construction in which steam turbines of the Parsons type are employed, the total horse-power being more than three and a-half millions. In the Royal Navy every new warship, from the torpedo boat up to the largest battleships and armoured cruisers, is fitted with turbine engines, and the performances of vessels which have been tested on service have been completely satisfactory, in many instances surpassing all records for powers developed and speeds attained. In the war fleets of the world this example is being imitated, although in some cases it was at first criticised or condemned. In the mercantile marine as a whole, while the new system has not made equal advance, many notable examples can be found of what can be accomplished by its adoption. It is now admitted that steam turbines enable higher speeds to be attained in vessels of given dimensions, and in steamers built for cross-channel and special services, where high speed is essential and coal consumption relatively unimportant, turbines have already ousted reciprocating engines. For oversea service and long voyages an impression has existed that the coal consumption of turbine-engined ships would considerably exceed that of ships driven by triple or quadruple-expansion reciprocating engines. Critics have dwelt on the reticence in regard to actual rates of coal consumption practised by owners of turbine steamships. Naturally, there are other reasons for reticence than those which would arise if the coal consumption were excessive, but pioneers in the use of turbine machinery may reasonably claim the right of non-publication of results of trials in the making of which they have incurred large expenditure and taken considerable risks if they think that silence is beneficial to their business interests. Even if it were true that in the earliest applications of the new system economic results had not been obtained equal to those realised in reciprocating engines, which have been gradually improved during half a century, that circumstance should not be regarded as a bar to acceptance of a type of engine that admittedly possesses very great advantages in other ways, but should be regarded as an incentive to improvements that would secure greater economy of coal. The evidence available, however, does not confirm the adverse view, and those familiar with the facts do not admit its truth. One example may be cited as it affects the Canadian service. In June, 1907, it was authoritatively stated that in the Allan liner Virginian the reports which had been circulated respecting the excessive coal consumption were unfounded, that the vessel was making passages at speeds of $17\frac{1}{2}$ to $17\frac{3}{4}$ knots, as against the 17 knots estimated, and the rate of coal consumption was really about 1.4 lb. per indicated horse-power which would have been required to attain this speed if the vessel had been fitted with reciprocating engines. This result compares well with the consumption in ordinary passenger steamers running at high speeds in proportion to their dimensions, although in large cargo steamers and vessels of the intermediate type, working under much easier conditions and at very low speeds in proportion to dimensions, lower rates of consumption may be obained. With these latter vessels the fair comparison is the combination system and not the pure turbine type which is adapted for high speeds.

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*See a paper by Engineer Commander Wisnom, R.N., in the "Proceedings" of the Institution of Engineers and Shipbuilders in Scotland for 1909.

The crowning triumph of the marine steam turbine up to the present time is to be found in the great Cunard steamships Lusitania and Mauretania. The passages made this year by the latter ship since she was refitted have been marvellously regular, and the 25 knots average across the Atlantic, which was the maximum contemplated in the agreement between the Government and the Cunard Company, has been continuously exceeded. As one intimately concerned with the design of the Mauretania, who has had large experience in ship design, has made a life-long study of the laws of steamship performance, and had the honour of serving on the committee which recommended the employment of turbines in these great ships, the writer ventures to assert that equal results could not possibly have been obtained with reciprocating engines in vessels of the same form and dimensions. Contrary opinions have been expressed, but they have been either based upon incorrect data or have omitted consideration of the fact that in vessels of such great engine power it was necessary to have time to perfect the organisation of the staff in order to secure uniform conditions of stoking and steam production, and to bring the "human element" into a condition which would ensure the highest degree of efficiency in working the propelling apparatus. This necessity for time and training has been illustrated again and again in the case of new types of Transatlantic steamers, including some which held the record for speed prior to the appearance of the Cunarders. In the Lusitania and Mauretania the engine power is fully 60 per cent. greater than that of their swiftest predecessors, yet no similar allowance appears to have been thought necessary by some critics, who assumed that performances on the earlier voyages represented the maximum capabilities of the vessels. Subsequent events have shown this view to be fallacious, and have justified the recommendation of the Turbine Committee and the action of the Cunard directors. Allegations made in regard to excessive coal consumption have also been disproved by experience, and in this respect the anticipations of the Committee and of Mr. Parsons have been fully realised.

The marvellous regularity maintained by the Mauretania on a long sequence of consecutive Transatlantic passages—made under varying and, in many cases, very adverse conditions of wind, weather, and sea—illustrates once more, and on an unprecedented scale, the influence which large dimensions have upon the power of maintaining speed at sea. Starting from the eastward passage, beginning on February 3rd last, and taking twelve passages (westward and eastward) which followed, the average speed for the thirteen passages, approaching 40,000 sea miles in length, has been $25\frac{1}{2}$ knots; the lowest average speed in the series has been 25.2 knots, the highest average speed 25.88 knots. Many of the winter passages in this series were made in winter weather against strong winds and high seas, which would have considerably reduced the speed of her predecessors, but had small influence on the Mauretania. In many instances delays have been caused by fogs.

On seven consecutive passages made since the beginning of last May the average speed of the Mauretania in covering about 20,000 sea miles has been 25.68 knots, the minimum speed for the passage having been 25.62 knots and the maximum 25.88 knots. On her contract trials the Mauretania maintained an average speed of 26.04 knots for a distance somewhat exceeding 1200 knots, the steaming time being rather less than forty-eight hours. On the passage, when she averaged 25.88 knots, she ran 1215 knots from noon on June 17th to noon on June 19th (about forty-six hours), at an average speed of 26.23 knots, and by noon on the 20th had covered 1817 knots at an average speed of 26.18 knots for sixty-nine hours. The ship has, therefore, surpassed on service her performance on the contract trial.

In view of the foregoing facts and of others of a similar nature, it is reasonable to assume that as experience is enlarged and information is accumulated in regard to forms of propellers likely to prove most efficient in association with quick-running turbines, sensibly improved performances will be obtained. At present, in comparisons made between the efficiency of reciprocating-engined ships and turbine-engined ships, the former have the great advantage attaching to long use and extended experiment; but this is not a permanent advantage, and it may be expected that good as the position is to which the marine steam turbine has attained in the brief period it has been in practical use, that position will be gradually improved. Whether or not other forms of propelling apparatus in their turn will surpass the steam turbine it would be unwise to predict. Internal combustion engines are regarded in some quarters as dangerous and probably successful rivals to steam turbines in the near future. Within certain limits of size, internal combustion engines no doubt answer admirably, but as dimensions and individual power of the engines are increased, the difficulties to be overcome also rapidly increase, and the fact is fully recognised by those having the best knowledge of those types of prime movers. On the whole, therefore, it seems probable that the turbine will not soon be displaced, whatever may happen eventually.

An Imperial Navy.

Three centuries ago a great English seaman and coloniser wrote these words:—

> "Whomsoever commands the sea commands the trade;
> Whomsoever commands the trade of the world commands the riches of the world, and, consequently, the world itself."

In these words Sir Walter Raleigh clearly expressed the doctrine of "sea power," which in recent times has been emphasised by Admiral Mahan, of the United States navy, and other writers. Twenty years ago, when the movement began, which has been followed by an unprecedented series of shipbuilding programmes, great additions to the *personnel* of the Royal Navy, and large expenditure on improvements of existing naval bases and the creation of others at important strategical points, the same truth was expressed in a report made by three distinguished admirals, one of whom, Admiral of the Fleet Sir Frederick Richards, subsequently became First Naval Lord of the Admiralty, and did much to give effect to the policy he had joined in recommending. One passage in this report may be quoted:—"No other nation has any such interest in the maintenance of an undoubted superiority at sea as has England, whose seaboard is her frontier." "England ranks amongst the great Powers of the world by virtue of the naval position she has acquired in the past, and which has never been seriously challenged since the close of the last great war. The defeat of her Navy means to her the loss of India and her Colonies, and of her place amongst the nations."

The "maintenance of an undoubted superiority at sea" in existing circumstances, and in face of foreign competition, is no easy task, and it is good to know that the dominions beyond the seas are ready to take a share of the heavy burden of empire. In what way effect can best be given to this fundamental idea it is not easy to decide. It is necessarily a matter in which the views of all concerned must be considered, and a policy determined on which shall command hearty support from all portions of the Empire. It may be presumed that the arrangement of such a policy has been the chief object of this year's Defence Conference. The decision which may be reached, and the action taken, must exercise momentous influence upon the destiny of the Empire. Universal approval has been given to the arrangement for that Conference, and this is a happy augury of its ultimate success in framing a satisfactory scheme for the construction and maintenance of an Imperial Navy. Many valuable suggestions have been made by British and colonial authorities as to the great lines on which such a scheme should be drawn, but this is not the place to enter upon a discussion of the subject. It may be permitted, however, as a sequence to the preceding remarks on oversea transport, to remark that the protection of trade routes between the Mother Country and the dominions beyond the seas constitutes an essential duty, in the performance of which duty, especially in portions of trade routes adjacent to the Colonies, naval forces maintained by the Colonies may render valuable service. Such a policy in no way infringes the fundamental condition that supremacy at sea ultimately depends upon battle fleets, while it recognises the fact, which past struggles have demonstrated, that behind and beyond the work of battle fleets lies the need for adequate protection of commerce and communications. Moreover, it leaves colonial Governments unfettered in making arrangements for the execution of that portion of the general scheme of defence which they may undertake, and there can be no inconvenience or loss from such independent action, provided the scheme of Imperial defence has been considered as a whole, and an understanding reached in regard to the distribution of the work. At present the Mother Country alone possesses experience and means of manufacturing warships and armaments, so that gradual developments, requiring time and experience, will be necessary before the Colonies can become self-supporting in these respects, should they desire to do so. On the side of *personnel* and its training also the Royal Navy must be the great school for all parts of the Empire. Finally, the full utilisation of Imperial defensive forces demands the existence of a complete understanding and the pre-arrangement of a common plan of campaign. In order to meet this essential condition there must be an Imperial staff.

The burden of naval defence has hitherto been borne almost entirely by the Mother Country. What the weight has been is hardly realised until the figures for expenditure are examined. As indications of what is involved in creating and maintaining a modern navy of the first class, it may be mentioned that in the ten financial years of the present century (including the current year, 1909-10) the total expenditure on the Royal Navy amounts to 328 millions sterling. From 1885 to 1902, during the period the writer occupied the position of Director of Naval Construction and Assistant Controller of the Navy, the total outlay on the 245 ships, for the designs of which he was responsible, amounted to about 100 millions sterling. The stress of foreign competition, and the growth in dimensions and cost of warships, is leading to still greater expenditure on the Navy, and it is good to know that Canada, Australia, New Zealand, and South Africa are ready and willing to bear their share of the inevitable burden.

All branches of engineering have been, and will be, drawn upon freely in the execution of this great task. Mining and metallurgy assist by the production of materials of construction; mechanical and electrical engineers contribute machines and appliances required in shipyards and engine factories, as well as guns, gun-mountings, and mechanical apparatus of all kinds required in modern warships in order to supplement and economise manual power; marine engineers design and construct the propelling apparatus, and constantly endeavour to reduce the proportion of weight and space to power developed; naval architects design and build the ships; constructional engineers are occupied in the provision of docks, harbours, and bases adapted to the requirements of the fleet; and other branches of engineering play important, if less prominent parts. The progress of invention and discovery is increasing, rapid changes occur unceasingly, the outlay is enormous, the task is never ending, but its performance is essential to the continued well-being of the Empire, and it must and will be performed.

AUSTRALIAN NOTES.

(*From our own Correspondent.*)

A LECTURE was recently delivered by Mr. Henry Temple before the South Australian Chamber of Manufactures at Adelaide on "The National and Economic Phases of Iron and Steel in Australia." In the course of his address he pointed out that so far there had been nothing but failures. Some time ago Dr. John Storer, the well-known metallurgist, with other experts, visited Lithgow, New South Wales, to investigate the situation of the industry at that centre, and came to the conclusion that there was no hope of the industry becoming a lucrative undertaking, the principal disadvantages being stated as follows:—

(1) The ore was too high in percentage of gangue;

(2) That it contained too much combined and free moisture;

(3) It was in the wrong geographical position, and too far away from a suitable fuel;

(4) The local fuel was low in calorific value and high in percentage of ash; and

(5) The ore, when converted, contained too high a percentage of phosphorus and sulphur.

Even with a bonus of 12s. per ton, there was no possibility of the industry ever becoming remunerative at Lithgow. In the general controversy that has taken place over this lecture the Minister for Works (New South Wales) has had the subject under consideration, and, in emphatically refuting the opinions expressed by Mr. Temple, has furnished the following particulars:—

(1 and 2) In determining on a field from which to obtain ore for treatment, two important factors have to be considered—viz., what the net product of metallic iron per ton of ore smelted will be, and whether the nature of the gangue is such as to permit of its being readily and economically treated in the blast furnace. The character of Australasian ores was very closely investigated by P. C. Gilchrist and E. Riley, and their reports were published in the "Proceedings" of the Iron and Steel Institute for 1886.

In an action brought before the High Court of the Commonwealth of Australia, it has been decided that the Excise Tariff Act, or "New Protection," as it is generally known by, is *ultra vires*.

The cases in question were the appeals in The Commonwealth *v.* Barger and The Commonwealth *v.* M'Kay. Defendants had sought from the President of the Court of Conciliation and Arbitration exemption from payment of Excise duty under the Excise Act, 1906, on certain classes of agricultural machinery. One of the conditions under which it is provided that exemption may be granted is that the manufacturer must pay a fair and reasonable rate of wage. It was decided by the lower Court that the wages paid by defendants to certain classes of their employés were not fair and reasonable, and certificates of exemption were refused.

CATALOGUES.

DICK, KERR AND CO., Limited, Abchurch-yard, Cannon-street, E.C.—An excellent catalogue describing crane motors and controllers has reached us.

BAYLISS, JONES AND BAYLISS, Limited, Wolverhampton.—Some literature has reached us from this company which deals with "Helicoid" lock nuts. A full description of this lock nut is given. Also illustrations and prices for various sizes.

JAMES C. KAY AND CO., Limited, Phœnix Foundry, Bury, Lancashire.—This is an illustrated catalogue of friction clutches, wheels, belt and rope pulleys, fly-wheels, &c. Prices and other particulars of interest to buyers are included.

THE HARKER PATENT FIRE EXTINGUISHER AND FUMIGATOR COMPANY, Limited. London Manager: James A. Smith, 47, Leadenhall-street, London, E.C.—We have received a pamphlet having reference to the Harker patented fire extinguisher and fumigator.

C. WINN AND CO., St. Thomas-street Works, Granville-street, Birmingham.—Lists Nos. D 55 and D 56 have reached us. The former has reference to gun-metal steam stop valves, whilst List D 56 deals with Winn's "G.W." automatic force-feed lubricator for all classes of steam engines, gas engines, oil engines and pumps. Both lists give prices, dimensions, and other particulars of interest to buyers.

THE BIRMINGHAM SMALL ARMS COMPANY, Limited, Sparkbrook, Birmingham.—This is a catalogue of engineers' small tools, such as twist drills, cutters, reamers, &c. Although a small catalogue, it contains much which is useful to those responsible for the purchase of small tools. The tables of code words, prices, and dimensions, together with the index, enable the user quickly to arrive at any specific information.

CAMPBELLS AND HUNTER, Limited, Dolphin Foundry, Saynor-road, Leeds.—This is a circular illustrating and describing a horizontal drilling, tapping, and staying machine for marine boilers. The machines are made in various sizes, the largest being capable of dealing with boilers up to 20ft. in diameter. They are for drilling and tapping the stay holes in boiler backs through both shell and combustion chamber plates and screwing the stays into position, also for tapping the stay tube holes through both plates at once and screwing the tubes into position.

W. A. STEVENS, Limited, Victoria Works, St. Peter-street, Maidstone.—We have received a new catalogue dealing with the "Hallford-Stevens" petrol-electric and electric omnibuses and commercial vehicles. We have also received a reprint from *Electrical Engineering* describing a system of battery charging by which the batteries of electric omnibuses can be charged from the electric mains with a small loss of efficiency. It also deals with Stevens' system of regenerative boosters for automatically maintaining constant voltage at the ends of three-wire feeders of varying lengths.

SIEMENS BROTHERS, Caxton House, Westminster, S.W.—A copy of this company's new pamphlet, R. S. 7, which has reference to the Siemens battery signal machine, has reached us. This machine has been introduced to overcome the difficulties attending working signals by mechanical means, where such signals are at a great distance from the levers working them, and also for operating signals automatically by track circuit or other means. A special feature of the machine is that only a small primary battery is used to lower the heaviest signal to the clear position. The pamphlet fully describes the system, and there are some good illustrations.

THE UNION ELECTRIC COMPANY, Park-street, Southwark, S.E.—We have received from this company list No. 6020, section 4, which is devoted to Fortiter direct-current motor-starting switches. It gives a general description of the Fortiter system and deals with starters with no volt and overload releases and air-cooled resistances, starters with no-volt release and overload release and oil-cooled resistances, starters combined with field regulating switches, starters fitted with reversing switches, Foolproof starters with independent levers, slow-motion starters, starters for remote control and various other types. Tables of prices, dimensions, and weights are given.

THE ALBANY ENGINEERING COMPANY, Ossory-road, Old Kent-road, London, S.E.—Some price lists, bound together in a neat cover, have been sent to us. They have reference to the "Albany" water-sealed rotary pump, the company's improved pattern electrically-driven pump, rotary pumps for marine work, breweries, fire engines, generating stations, ammonia solution, chemical works, hot liquor, &c. Another list deals with the "Albany" latest pump for golf greens, general garden, and irrigation purposes, &c., whilst others describe and illustrate the "Albany" high-lift centrifugal pump, the "Albany" motor car circulating pump, and "Blizzard" propellers for exhausting and ventilating.

SIEMENS BROTHERS' DYNAMO WORKS, Limited, Caxton House, Westminster, S.W.—This is an excellent pamphlet dealing with mine and surface electric locomotives. All classes of electric locomotives are considered, including those supplied with continuous current from an overhead line or accumulators and those supplied with three-phase or single-phase current from an overhead line. The first part deals with mine locomotives, whilst the second part has reference to goods and mineral railways, and particulars are given of locomotives for outputs up to 640 horse-power and for three-phase current or continuous current up to a pressure of 2000 volts. Illustrations and data of locomotives supplied to and under construction for the Consett Iron Company, Limited, are given. Locomotives are dealt with suitable for speeds up to 130 miles per hour for branch and main lines, for continuous current supplied by accumulators or from an overhead line, or with single-phase or three-phase current from an overhead line.

NEGRETTI AND ZAMBRA, 38, Holborn Viaduct, E.C.—A quantity of literature has been sent to us by this firm. There are lists having reference to nautical instruments of all kinds, microscopes, microscopical apparatus and stereoscopes, prism binoculars, electrical recording anemometers, self-recording rain gauges, electrical recording rain gauges, the Bourdon-Rabut patented stress indicator, and E. Bourdon's Manet-Rabut indicator. The object of this latter instrument is to measure the variations in length of the bars forming part of any structure which are subject to tensile or compressive stress. Another list, which appeals more particularly to engineers, is one which deals with the acrometer, for giving a direct reading of the maximum values attained by the pressure in the cylinders of various kinds of engines, also for showing other pressures above and below the pressure of the atmosphere. Other lists to hand have reference to an electrical wind vane, and the micro-barograph, which is an apparatus designed to magnify and record the minor and sudden fluctuations of the atmosphere,

THE IRON, COAL, AND GENERAL TRADES OF BIRMINGHAM, WOLVERHAMPTON, AND OTHER DISTRICTS.

(*From our own Correspondent.*)

Iron Market Improvement.

The best feature of the iron market improvement which is now so conspicuous in the Midlands is an extension of the revival to the manufactured iron branches. Hitherto confined to pig iron, the upward movement is now beginning to be distinctly felt in rolled iron and steel. This is all the more a matter of importance, since it has been to the mill and forge products of the district that the ironmasters have been longest looking for support to the higher prices and larger call for pigs. Stimulated by the advances in the West of Scotland and the Cleveland district and Lancashire, the Staffordshire finished ironmasters are now attempting to secure more money, and although buyers are not yet responding with much readiness, there is no question that, as raw materials become dearer, the manufactured ironmakers will be successful.

Advance in Finished Iron Prices.

Some of the Shropshire makers are already asking 5s. per ton more for bars, and are refusing to accept less than £6 5s., while North Staffordshire makers report a better demand and stronger prices, on the basis of £6 10s. for "crown" bars f.o.b. South Staffordshire common bars are up 2s. 6d. on the minimum, and have now become £5 17s. 6d. to £6. There is much talk that at the October quarterly meetings, if not before, Staffordshire marked bars will probably advance 10s. per ton, which would bring the figure up to £8 10s. At present marked bars are £8, and second grade marked bars £7.

Galvanised Sheets 10s. per Ton Dearer.

Black sheets are still at £7 2s. 6d. to £7 5s. for doubles; but galvanised corrugated sheets, which have recently been the matter of such severe internal competition between the late associated and non-associated makers, are understood to be rising from the late extreme minimum, the result of a larger enhanced demand which has appeared for shipment. Leading galvanisers are scarcely able to supply their customers fast enough. Instead of business being recorded at £10 5s. and £10 10s.—prices which ensued upon the break up of the association—sales are now being made at £10 15s. and £11, and some firms decline to sell at less than £11 5s. per ton, thus showing an advance of 10s. per ton.

Raw Iron Conditions.

The revival in raw iron is well maintained, and current markets are the best of the year. Producers are now becoming very confident, and there are more buyers than sellers, the former being more anxious to do business than the latter, which is an evidence in itself of the strong position which makers are taking up. Sellers believe that there will be further advances, hence their refusal to overburden their contract books at the furnaces at current figures. Both Staffordshire and Midland brands are 6d. to 1s. dearer on the week, making an aggregate 2s. 6d. advance in the past three weeks. As may be imagined, the change is very welcome, and all the blast furnaces are now booked up to the end of the year. Not for two years have prospects looked so promising as at present, and it may be stated without hesitation that business is improving week by week. Northampton forge iron is 47s. as a minimum, while superior brands are 48s., and occasionally even 49s. per ton. Derbyshire forge iron is this week 49s. to 50s.; Lincolnshire, 51s.; and North Staffordshire, 50s. to 51s. Best South Staffordshire all-mine iron is 80s. to 82s., and cold air qualities £5 10s. Hematite is quoted 71s., delivered to works in this district.

Steel Advanced 2s. 6d. to 5s. per Ton.

The steel trade is looking better, both for raw and manufactured sorts, and prices all round are higher, raw steel by 2s. 6d. per ton and manufactured steel by 2s. 6d. to 5s. per ton. In the latter case the increase is not altogether due to the Scotch or Cleveland or Lancashire advances. Since these were announced there has naturally been something of a rush on the part of local customers to make purchases, and some good orders have been secured, but apart from this there has been an expansion of business. Engineering angles are quoted at £5 12s. 6d., which is a rise of 2s. 6d., and tees and channels for engineering purposes are dearer in the same proportion. Joists have not yet been altered, but it is understood that this is only a question of a few days. Raw steel bars are also 2s. 6d. to 5s. dearer, the minimum for Bessemer qualities now being £4 15s. and Siemens 2s. 6d. extra. Reports from South Wales are much more encouraging, both as regards steel and tin-plates. Current steel prices in Staffordshire may now be fairly regarded as follows:—Bessemer sheet bars, £4 15s.; Siemens, £4 17s. 6d.; engineering angles, £5 12s. 6d. to £5 15s.; girder plates, £5 15s. to £5 17s. 6d.; boiler plates, £7; joists, £5 10s. to £5 15s.; and mild bars for engineering and similar purposes, £6 7s. 6d. to £6 17s. 6d.

NOTES FROM LANCASHIRE.

(*From our own Correspondent.*)

Manchester, Thursday.

Pig Iron still Firm.

The Iron Exchange was not so well attended as usual. There were not so many buyers present from the out districts, especially Oldham, where the "wakes" are in full swing, and all the works closed. Notwithstanding this, the tone was very strong, and, in spite of a lull in the market for Cleveland iron, there was a recovery which made buyers all the more anxious to cover their requirements in this particular department. If anything, prices were in sellers' favour, but there was no disposition to grant concessions to induce business. It was reported that Lincolnshire makers are fairly well sold for the ensuing twelve months, and on the authority of one of the largest makers of Derbyshire iron, it is also certain that they are not booking orders in quantity for some months to come. Staffordshire showed little or no change on the week. Hematite continues to advance, and both East and West Coast are higher. Forge iron remains steady and in sellers' favour.

Finished Iron and Steel.

Although the advances in the North have not been generally followed on spot, there is generally an upward movement, especially in boiler plates. Billets are also firm.

Copper, Tin, and Sheet Lead.

There is little movement in manufactured stuff, and sellers are disposed to accept slightly under official rates to induce business. Tin: English ingots have advanced, and are in fair request at about £3 per ton more. Sheet lead on the easy side.

Quotations.

Lincolnshire, No. 3 foundry, quoted 54s. 6d. to 55s.; Staffordshire, 53s. 6d. to 54s.; Derbyshire, 54s.; Middlesbrough, open brands, 60s. 4d. Scotch: Gartsherrie, 61s. 6d. to 62s.; Glengarnock, 61s.; Eglinton, 59s. 6d.; Dalmellington, 60s., delivered Manchester. West Coast hematite, 61s. 6d.; East Coast ditto 60s. 6d., both f.o.t. Delivered Heysham: Gartsherrie, 59s. 6d. to 60s.; Glengarnock, 59s.; Eglinton, 57s. 6d.; Dalmellington, 58s. Delivered Preston: Gartsherrie, 60s. 6d. to 61s.; Glengarnock, 60s.; Eglinton, 58s. 6d.; Dalmellington, 59s. Finished iron: Bars, £6 10s.; hoops, £7 12s. 6d.; sheets, £7 15s. to £8. Steel: Bars, £6 2s. 6d. to £6 5s.; Lancashire hoops, £7 5s.; Staffordshire ditto, £6 17s. 6d. to £7; sheets, £7 17s. 6d. to £8; boiler plates, £7 7s. 6d.; plates for tank, girder, and bridge work, £6 5s.; English billets, £4 12s. 6d. to £4 15s.; foreign ditto, £4 10s. to £4 12s. 6d.; cold-drawn steel, £9 10s. to £9 15s. Copper: Sheets, £72; tough ingot, £63; best selected, £63 per ton. Copper tubes, 8½d.; brass tubes, 6⅞d. to 7⅛d.; condenser, 7⅞d.; rolled brass, 6¼d.; brass wire, 6½d.; brass turning rods, 6½d.; yellow metal, 6d. per lb. Sheet lead, £16 15s. per ton. English tin ingots, £136 10s. to £137 per ton.

The Lancashire Coal Trade.

The attendance on the Coal Exchange, although fairly good, was not large. There was little or nothing done in slack and steam coal, but buyers of domestic fuel are keen in covering forward requirements. On shipping account there is a better feeling reported. Quotations remain unofficially unchanged.

Barrow-in-Furness, Thursday.

Hematites.

The hematite market remains firm, and there is a full maintenance of the improvement which set in a few weeks ago, and which was a matter more of steady growth than of rapid rush. Makers are confident that better things will follow, and that before long, because users are beginning to inquire for terms of delivery of larger parcels of metal than they have been using for some time past, and they are more anxious than they have been to make arrangements for large forward consignments of metal. This can only be done at fuller values, for makers are even now having to pay increased prices for raw material. They are well booked forward, and are beginning to increase their output of metal. One of the furnaces at the Solway Works at Maryport has been lighted this week, and another is almost ready for lighting. At other works in the district there is a movement in the same direction. There are now twenty-seven furnaces in blast in the district. Prices are steady at 61s. 6d. for mixed Bessemer numbers net f.o.b.; warrant sellers at 60s. net cash, 61s. at a month, buyers 3d. to 6d. less. Stocks remain low. There is still 14,510 tons of iron in warrant stores. Special hematites are selling better, and ferro-manganese is also in good request. Iron ore is dearer at 12s. for good ordinary, 14s. 6d. for medium, and 18s. for best classes net at mines. Foreign ores have also advanced about 1s. 6d. per ton. There is a good demand for forward delivery.

Steel.

There is a fairly steady demand for railway classes of steel, and the three large works in this district are all kept fairly well employed in this department, but new business is not coming to hand with as much freedom as is desired, although prospects are much better than they have been. Prices have advanced, and prospective buyers are anxious in some cases to place business before further increases are made. Merchant steel is quiet. There is a better demand for steel plates, and now that Scotch makers have ceased to book orders, there is some prospect of the plate mills at Barrow being re-started, and particularly so as some large orders for plates are coming into the market on local account. There is not much being done in steel foundries.

Shipbuilding and Engineering.

No new shipbuilding orders are reported, but it is expected that builders will be fairly busy on the Brazil and Aberdeen floating docks to be built at Barrow this winter. Local engineers have received orders from the Admiralty for the armament of the new Dreadnought to be laid down at Portsmouth on the 1st of April, and it is intimated they will get the orders for the armament for two of the four Dreadnoughts to be laid down by private builders on the 1st of April next.

Shipping and Coal.

The shipments of iron and steel from West Coast ports last week amounted to 6270 tons—iron, 2640 tons; and steel, 3630 tons—as against 8431 tons for the corresponding period of last year, a decrease of 2161 tons. For the year to date the shipments aggregate at 396,399 tons, against 329,051 tons for the corresponding period of last year, an increase of 67,348 tons. Coal and coke are slightly dearer, and in increased consumption.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

The Coal Trade.

The position in the coal trade is very much as reported last week, but, if anything, the demand is more acute as the shipping season draws near to its termination. At the time of writing several collieries in the district are shut down entirely, owing to local differences consequent on the Eight Hours Act. These will no doubt be smoothed out in time, but meanwhile the spell of better prices which has been prevalent for a few weeks past has not been taken advantage of in consequence of the very imperfect working of all pits in the district. Most of the local "feasts" are over, but their cessation has not much improved the situation. The railway companies are also somewhat feeling the pinch of short supplies.

House Coal Active.

House coal continues firm for all markets, owing to the near approach of cold weather and the shortage referred to. The return of householders from holidays has led to an increased trade on stocking account. The principal business is in the better grades, best Barnsley fetching from 11s. 6d. to 13s. per ton, secondary descriptions from 10s. to 11s. per ton. A very good trade is reported with the Eastern Counties markets, and the demand from country stations is also more active. Without question, should the present shortage of output continue, an advance is inevitable. The usual time for making the increase is October, but possibly this date may be anticipated, except, of course, in the case of contracts which will be worked out at the contracted rates.

Small Coal.

Small coal continues in excellent request in the better qualities. The Lancashire cotton and Yorkshire woollen mills are ordering freely, the demand from the textile districts being quite equal to the output, the price ranging from 4s. 6d. to 5s. 6d. per ton. The Lancashire mills, like the Scotch mills, take a week of holidays at a definite period of the year, and a similar practice has been thought of from time to time in the Sheffield works, but no agreement has ever been come to, owing to the greater variety of employment and manufacture. These holiday weeks, however, do not greatly affect the demand, as they are known in advance and provided for.

Coke.

Business firm, and the stiffening in values continues. For best washed coke 11s. to 11s. 6d. per ton is readily obtained, unwashed making from 10s. 6d. to 11s. per ton.

Iron: Another Advance in Derbyshire.

The situation in regard to hematites, West and East Coast, continues as noted in our last report, with the freer buying for local purposes maintained. For forward delivery, sellers require advances of from 1s. to 2s. per ton. The usual fortnightly meeting of the Lincolnshire Ironmasters' Association is due to be held on the 3rd inst. At the time of writing the official quotations remain as given last week, viz.:—Lincolnshire, No. 3 foundry, 50s. 6d. per ton; No. 4 foundry, 49s. 6d. per ton; No. 4 forge, 49s. 6d. per ton; No. 5 forge, mottled and white, 49s. 6d. per ton; basic, 50s. 6d. per ton, all net, delivered in Sheffield and Rotherham. Derbyshire pig iron has again advanced—this time 6d. per ton—No. 3 foundry being now 51s. 6d. per ton, and No. 4 forge 50s. 6d. per ton net, delivered in Sheffield and Rotherham. Derbyshire makers are not pressing sales in pig iron, owing to the uncertainty about coal through the operation of the Eight Hours Act, which is estimated to be lessening the output by 9 per cent. In South Yorkshire we have heard the lessening thus caused put at 10 per cent. In North Lincolnshire and South Yorkshire iron is smelted with coke; in Derbyshire largely with coal. As it takes practically two tons of coal to a ton of pig iron, the lessened output is a matter of much importance.

Bars, Hoops, and Sheets.

We cannot hear of any material improvement in finished iron. The South Yorkshire Bar Iron Association will be holding their monthly meeting on the 6th inst. Meanwhile quotations are as given in last report, viz.:—Bars, £6 10s. per ton; hoops, £7 10s. per ton; sheets, £8 10s. per ton.

The Heavy Industries.

There are more frequent inquiries for shipping, but these are not materialising very fast in orders. The outlook is more hopeful, inasmuch as increased shipping appears to be going into the water, and owners on this account are more disposed to build for replacement. Steel for engineering and allied trades is still in poor demand. Very little new work seems to be going, and not much is being expended in replacements. There is still, however, a hopeful feeling in this direction also. Some of the large firms with special lines are fairly busy, but generally trade is languid. In railway material, as well as in the naval and military departments, there is nothing fresh to add to what was outlined last week.

NORTH OF ENGLAND.

(*From our own Correspondent.*)

Cleveland Pig Iron.

The pig iron market has been firm and steady this week, and the improvement has been maintained, but there is not the excitement that was reported last week. Prices have continued to move upward, though not so sharply and, perhaps, wildly as they did last week, and there is every reason to believe that a sound, healthy business will be done during the remainder of the year. Certainly the outlook is more favourable for ironmasters and their position is encouraging, for during the last few weeks they have booked good orders. That the general opinion is that the prices will continue to rise may be known from the fact that outsiders are beginning to operate in Cleveland warrants, and further than this the market prices of the shares of most iron and steel companies have substantially risen, especially during the last few days. Warrants change hands freely, and the prices are now higher than they have been at any time since early last October. The news from the United States tends to strengthen our markets a good deal, for there is no doubt of a genuine revival there, and traders are discussing how soon it will be before the Americans begin to take Cleveland pig iron as they did in 1906 and 1907. The present difference in prices would almost allow of Cleveland firms competing successfully with American iron at the foundries in the Eastern States. This week buyers have offered as much as 51s. 6½d. cash for Cleveland warrants, and the price of prompt deliveries of No. 3 Cleveland G.M.B. pig iron has been raised to 51s. 6d. per ton, while No. 1 has gone up to 53s. 9d.; No. 4 foundry to 50s.; No. 4 forge to 49s. 9d.; mottled to 49s. 3d.; and white to 49s., all for prompt delivery, and the quantity of iron for sale for early delivery is not large, except in the case of No. 3, which is the most generally made.

Hematite Pig Iron.

The revival in business in this branch of the iron and steel industries is very pronounced, and more activity in buying is reported than for at least two years. Consumers have during the past two or three weeks purchased freely, and this has led to quotations being advanced somewhat rapidly, after they had been stationary for months. The rise in August was 3s. 6d. per ton, brought about not by speculation, but by a genuine improvement in the demand from consumers, who, indeed, expect further substantial advances in prices to be made. Producers are asking considerably more for forward than for prompt delivery, and some have closed their books against further orders for early execution, and refuse to quote. Mixed numbers have this week been put up to 58s. 6d. per ton for early f.o.b. delivery, and 60s. has been asked and paid for delivery up to the end of the year, while 62s. 6d. is the rate for delivery over the first half of next year. Such a strong upward movement as this has brought consumers forward in considerable numbers, as there are no speculative operations in warrants to check the rise, seeing that there are no hematite warrants in this district, none of this description of pig iron having been lodged in the public stores for many years. The ore merchants are losing no time in advancing their quotations in sympathy with the rise in pig iron, and they ask 17s. to 18s. per ton for Rubio ore delivered c.i.f. Middlesbrough at an early date, while for next year's delivery they will not quote at all, as the Spanish mineowners have not yet made up their minds what they will demand for ore in 1910. The price of coke has also been raised, and 16s. 6d. per ton delivered at Middlesbrough is now asked for furnace coke, but there are plenty who will not sell under 17s., and are not particular at that, seeing that they can sell the to better advantage as coal than as coke.

Stocks of Pig Iron.

Though trade is undoubtedly better, the stock of Cleveland pig iron in Connal's public stores is increasing more rapidly than ever. Last month the increase was no less than 29,331 tons—over 1100 tons per working day, and on only two days in the month had a decrease to be reported. On some days the increase was very large, *e.g.*, on 16th it was 2524 tons, and on 23rd 2400 tons. During the last ten days of the month the increase averaged over 1500 tons per day. But these unfavourable statistics do not detrimentally affect the market, as there are counteracting influences. The total stock held at August 31st was 288,502 tons, whereas a year ago it was under 60,000 tons. The stock consisted of 273,304 tons of No. 3, 12,178 tons of No. 4 foundry, and 3020 tons of iron not deliverable as standard. No other description of pig iron is now held in Connal's stores.

August Shipments of Pig Iron.

The increase in the exports of pig iron from the Cleveland district in August affords evidence of improved trade, and has served to help forward the feeling of confidence that is springing up. The total quantity shipped was 115,684 tons—the best for over a twelvemonth, with the exception of that of April last, when 123,387 tons were delivered by sea. The average of August over the past ten years—104,501 tons—was exceeded by 11,183 tons, or 10½ per cent. The July, 1909, return was exceeded by 14 per cent., and that of August last year by 18½ per cent., while a better August return has only been reported in 1896, 1906, and 1907; but as compared with the best August—that of 1907—when 146,730 tons were shipped, there is a falling off equal to 22 per cent., while compared with the best month on record—April, 1907—the figure of last month was 61,943 tons, or 35 per cent. less. Deliveries have increased to Italy, France, Belgium, Canada, Scotland, and Wales; but poor deliveries are reported to

Germany, which for years was Cleveland's best customer, taking as much as 62,000 tons in a month, whereas last month the quantity was only 11,207 tons, against 23,482 tons in August last year, and 36,876 tons in August, 1907. To Canada 12,455 tons of pig iron were despatched last month from the Tees, and to Italy 15,486 tons, the latter being the largest delivery to any oversea market, and only in three previous months has that quantity been exceeded. The increasing trade with Wales is a very satisfactory feature. The total exports for this year so far have reached 794,358 tons, compared with 923,119 tons in the corresponding period of last year, and 1,229,254 tons in the first eight months of 1907; they were the poorest since 1905. To Germany only 100,405 tons have been sent, against 333,726 tons in the first eight months of 1907. Business with Germany is the great "let down" at the present time.

Manufactured Iron and Steel.

What is giving the greatest satisfaction is the general revival which is showing itself in the leading branches of the manufactured iron and steel industries. This is apparent from the increased demand, the fuller employment at the works, and the advances of prices. The outlook is much more favourable than it has been at any time within the last two years, and more particularly is this noticeable in the rail, plate, and steel departments. The exports of manufactured iron and steel from the Tees last month afford indications of the better state of affairs, for they reached 55,261 tons, against 49,543 tons in August, 1908. The eight months' deliveries were up to 430,776 tons, against 404,180 tons in the corresponding period of last year. The chief deliveries were to South America (chiefly Argentina), India, Japan, and Australia. The advances in price announced last week have been well maintained, and have not checked the demand, so that further advances in quotations may reasonably be expected. Heavy steel rails are at £5 5s. net f.o.b., and nearly all the manufacturers' order-books are well filled. Steel ship plates are at £6, steel ship angles at £5 7s. 6d., and iron ship angles at £7, while steel bars are at £6 and iron bars at £7, all less 2½ per cent. f.o.t. Galvanised and corrugated steel sheets have been advanced to £11 per ton, less 4 per cent. for early f.o.b. delivery of 24 gauge in bundles. Black sheets are also put up to £7 10s., less 2½ per cent. f.o.t. An order for 10,000 tons of rails and sleepers for South Australia has within the last few days been secured in this district.

Shipbuilding and Engineering.

The outlook for shipbuilders is more satisfactory than it has been for several years, and orders are being booked at a good rate. Better freights are obtainable in several trades, and the prospects are more encouraging for the autumn trade. The number of laid up vessels is steadily decreasing, and on the Tyne only fifty-three are now idle, or little more than a third of the number reported in the early part of the year. These features give heart to the shipowners, and they are giving out contracts now not only for liners, but also for tramp steamers, trawlers, &c. The allotment of the orders for the new Cunarder to Messrs. Swan, Hunter and Wigham Richardson, Wallsend, is very satisfactory. They have already built three Cunarders, the latest being the Mauretania. The same firm has secured an order for a liner intended for the Italian emigrant traffic with Canada. The armament business is very active, and is likely to be so over the next two or three years. Sir W. G. Armstrong, Whitworth and Co., Elswick, have been awarded the contract for the armament of the cruiser to be built at Devonport. It is also expected that they will be called upon to build one of the new Dreadnoughts which the Admiralty have undertaken to order.

Coal and Coke.

The steam coal trade is quiet, but less so than it was last week, and it is likely to become brisker over the autumn. Consumers who had to pay 13s. or 14s. per ton f.o.b. for best steam coal in July can now get it at 11s. 3d. to 11s. 6d., but it has been sold within the last ten days at as low a figure as 10s. 6d. Gas coals of all kinds are in good request, best realising 11s. 3d., and seconds 10s. 3d. f.o.b. The collieries producing gas coals are all well occupied. Bunker coals are in somewhat better request at 9s. 6d. per ton f.o.b. Tyne Dock. The demand for coking coal is brisker, and the price obtainable for it is such that it will pay the collieries to sell it as coal instead of converting it into coke, though the latter has gone up, and now furnace coke has been advanced to 16s. 6d. per ton delivered at Middlesbrough.

NOTES FROM SCOTLAND.

(*From our own Correspondent.*)

General Condition of Trade.

THERE is ample indication of a general improvement in trade, but the movement towards a better state of things is rather steady than rapid. In Glasgow there is a gradual diminution of unemployment. This is proved by a census just taken, the result of which is announced this week, and which shows that there are rather over 21,000 men and boys out of work. It is not so long ago—some time in the spring of this year—that the Distress Committee set down the number of the unemployed at something approaching 40,000. The census was taken from house to house in the most systematic way, and of the 21,000 out of work, 1380 belong to building trades, and 4271 to the metal and engineering branches. Improvement in the building industry may be slow, as the erection of dwelling houses has of late been rather overdone; but there is a good prospect of engineers and metal workers now idle being gradually drafted into the ranks of the employed. The census did not embrace certain large outside industrial centres, but there is evidence that in those districts trade has been improving.

The Pig Iron Market.

As was to be expected, there have been fluctuations in the prices of warrants, but reactions in price have quickly been followed by improvement. This week a large business has been done both for immediate and future delivery. Cleveland warrants have sold from 51s. 2½d. to 50s. 11½d. and up to 51s. 7d. cash, 51s. 1d. to 51s. 8d. one month, and 51s. 8½d. to 52s. 1½d. three months. Business has also been done at 51s. 6d. for delivery in eight days, 51s. 3½d. to 51s. 4½d. twenty-five days, 51s. 5½d. twenty-nine days, and 51s. 9½d. for 25th November. There has again been a demand for Cumberland hematite warrants, which have sold from 60s. up to 60s. 10½d. for delivery in one month. Scotch warrants have been nominally 57s. 3d. to 57s. 4½d., and standard foundry iron 50s. to 50s. 4½d. per ton.

Scotch Makers' Iron.

The makers of Scotch pig iron are doing a large business in ordinary and special brands, and prices are in some instances higher than last week. At Glasgow, f.a.s., Monkland, No. 1, is quoted 58s.; No. 3, 56s.; Carnbroe, No. 1, 60s.; No. 3, 57s.; Clyde, No. 1, 62s.; No. 3, 57s.; Gartsherrie and Calder, Nos. 1, 62s. 6d.; Nos. 3, 57s. 6d.; Langloan, No. 1, 63s.; No. 3, 58s.; Summerlee, No. 1, 63s. 6d.; No. 3, 58s. 6d.; Coltness, No. 1, 88s.; No. 3, 58s. 6d.; Eglinton, at Ardrossan or Troon, No. 1, 57s. 6d.; No. 3, 55s. 6d.; Glengarnock, at Ardrossan, No. 1, 63s.; No. 3, 59s.; Dalmellington, at Ayr, No. 1, 60s. 6d.; No. 3, 55s. 6d.; Shotts, at Glasgow or Leith, No. 1, 62s. 6d.; No. 3, 57s. 6d.; Carron, at Grangemouth, No. 1, 64s. 6d.; No. 3, 58s. There are 82 furnaces in blast in Scotland, compared with 75 at this time last year, and of the total 39 are making ordinary, 38 hematite, and 5 basic iron. It is anticipated that the current output will be maintained, and perhaps even increased, for orders have been placed with makers during the last few weeks for a very large amount of pig iron. The demand for Scotch hematite pig iron has been increasing with the improvement in the steel trade, and makers have this week further increased their prices, the quotation now being 51s. to 51s. 6d. for delivery at the West of Scotland steel works. The current output of hematite pig iron is only at the rate of about 350 tons per week more than at this time last year, so that it may be expected that considerable inroads will soon be made on the private stocks of makers.

Pig Iron Shipments.

The pig iron shipments at Scottish ports in the past week amounted to 6861 tons, compared with 8480 in the corresponding week of 1908. The large shipment of 1450 tons was made to Australia, to the United States 750 tons, Canada 350, India 327, France 20, Germany 305, Russia 100, Belgium 151, China and Japan 186, other countries 281, the coastwise shipments being 2941 tons, against 4491 in the corresponding week of last year. The arrivals at Grangemouth of pig iron from Cleveland and district were 8019 tons, being 2941 tons less than in the corresponding week.

Finished Iron and Steel.

While the amount of business promising appears to be important, there has only been a moderate amount of work placed at the increased prices Not a few firms are, however, well supplied with work for early delivery, which was accepted before the rise in price came into force. The further upward movement in the value of hematite renders steel business at current prices somewhat difficult. Inquiries for structural material for the home market are quiet, and for export business there is keen competition.

Engineering and Shipbuilding.

There is good employment in some of the engineering branches, such as the construction of sugar-making machinery, the makers of which are very busy, with a prospect of important orders coming forward as soon as these can be undertaken. Locomotive engineers have been slack, but orders just placed for South Africa, India, and the Argentine Republic will serve to mitigate the present depression. Marine engineers are getting their works gradually filled, and important additions to present contracts are expected. The eight months' output of new shipping on the Clyde is practically the same as it was in the same period of last year, but the very considerable increase in cargo steamers recently launched would seem to be an evidence of expansion in the shipping trade.

The Coal Trade.

Heavy shipments of coal have been taking place alongside of a feeling of depression in the coal market. Current inquiries have not been such as was expected, but coalmasters appear to anticipate with confidence an expansion of business during the remainder of the season. Coal prices f.o.b. at Glasgow are for ell, 9s. 3d. to 9s. 6d.; splint, 9s. 6d. to 10s.; steam, 9s. 9d. to 10s. per ton.

WALES AND ADJOINING COUNTIES.

(*From our own Correspondent.*)

Last Week's Coal Trade.

THE somewhat stationary character of the coal trade—lacking any marked change one way or the other—is accepted by the trade as fairly satisfactory. Each week of late has witnessed an increased output, and prices only varied about 3d. per ton. One marked feature last week was the scarcity of dry coals, which remained at top figures. Steam smalls, and also bituminous, had a downward tendency. There were large shipments to foreign destinations. Very little change has been shown in house coal, for which, in the past week, there was only a sluggish demand, though Swansea and Newport shipped largely.

Present State of the Coal Trade.

The Cardiff market opened this week with more animation, and it was the comment of authorities that business was coming up to the expectations of coalowners. On Tuesday over 80,000 tons were despatched from Cardiff, and reports came freely to hand of increased output. The demand for best steam and seconds remains strong, and these coals are scarce. Best small, for bunkering, is also scarce. House coal and Rhondda coals steady.

Latest Coal Prices, Cardiff.

Best large steam, 17s. 9d. to 18s.—in one or two cases 18s. 3d. has been quoted; best seconds, 16s. 3d. to 17s. 3d.; ordinary seconds, 15s. 6d. to 15s. 9d.; best drys, 16s. 6d. to 17s.; ordinary drys, 14s. to 14s. 3d.; best washed nuts, 14s. to 15s.; seconds, 13s. to 13s. 6d.; best washed peas, 12s. 6d. to 13s.; seconds, 11s. to 12s.; very best small steam, 8s. 9d. to 9s.; best ordinaries, 7s. to 8s.; inferiors, 6s. 3d. to 6s. 6d.; very best Monmouthshire black vein, 15s. 6d. to 15s. 9d.; ordinary Western Valleys, 14s. 9d. to 15s.; best Eastern Valleys, 13s. 3d. to 13s. 6d.; seconds, 12s. 9d. to 13s. Bituminous coal: Very best households, 16s. 6d. to 17s.; best households, 16s. 6d. to 17s.; best ordinaries, 14s. 6d. to 16s. 6d.; No. 3 Rhondda, large, 17s. 3d. to 17s. 6d.; brush, 13s. 6d. to 13s. 9d.; smalls, 10s. 6d. to 11s.; No. 2 Rhondda, 11s. 9d. to 12s.; through, 9s. 6d. to 9s. 9d.; smalls, 7s. 9d. to 8s. 3d. Patent fuel, 15s. 6d. to 17s. Coke: Special foundry, 24s. 6d. to 27s. 6d.; foundry, 19s. 6d. to 22s.; furnace, 17s. 6d. to 18s. Pitwood, 19s. to 19s. 6d.

Newport Coal.

Last week the coal shipment was again large, and any week may total 100,000 tons, as many expect. The total last week was 96,289 tons. This week prices were not quite so firm, and small sellers were giving slight concessions. In house coal the prevalence of cold winds aided in keeping prices unchanged. Latest figures were as follows:—Best black vein, 15s. 3d. to 15s. 6d.; Western Valleys, 14s. 6d. to 14s. 9d.; Eastern Valleys, 13s. to 13s. 3d.; other sorts, 12s. 3d. to 12s. 6d.; best smalls, 7s. 6d. to 7s. 9d.; seconds, 7s. to 7s. 3d.; inferiors, 6s. 6d. to 6s. 9d. Bituminous coal:—Best house coal, 15s. to 15s. 3d.; seconds, 14s. to 14s. 3d.; patent fuel, 15s. to 15s. 6d. Coke: Foundry, 18s. 6d. to 19s.; furnace, 17s. to 17s. 6d. Pitwood, ex ship, 19s. to 19s. 6d.

Swansea Coal.

Little or no alteration in business. It is noticeable that if a slight easiness in prices occurs one day, the next it disappears, and so on, one day following another. For prompt delivery, at present the tendency is to an abatement of price, but so small that prospects remain hopeful for a permanency of good business. Red coal better, and larger output and shipments. Latest prices:—Best anthracite coal, large hand picked, 24s. to 25s. net; second, malting, 21s. 6d. to 22s. 6d. net; big vein, large, 18s. 6d. to 20s. 6d., less 2½; red vein, 12s. to 12s. 6d., less 2½; machine cobbles, 23s. 6d. to 24s. net; Paris nuts, 25s. to 26s. 6d. net; French nuts, 25s. to 26s.; German nuts, 25s. to 26s. net; beans, 17s. 6d. to 18s. net; machine-made large peas, 11s. 6d. to 12s. 6d. net; fine peas, 10s. to 11s. net; rubbly culm, 5s. to 5s. 6d., less 2½; duff, 3s. to 3s. 3d. net. Steam coal, 17s. to 17s. 6d. less 2½, for best; seconds, 14s. to 15s., less 2½ per cent.; bunkers, 9s. 6d. to 10s. 6d., less 2½; small, 8s. to 10s., less 2½. Bituminous: No. 3 Rhondda, 18s. to 18s. 9d., less 2½; through, 15s. to 15s. 6d., less 2½; small, 10s. to 10s. 6d., less 2½. Patent fuel, 13s. 6d. to 14s., less 2½.

Colliery Inspection for Wales.

In Mr. Gray's annual report for 1908 he states that in 1901 the total number of persons employed was 20,221, and the output was 20,675,940 tons of coal. Since that time there had been an increase of 1048 in men and of 4,096,953 in tons of coal. The quantity of mineral produced per person employed showed a decrease when compared with the production of previous years, and was lower than in any year since the district was formed.

Iron and Steel.

At the last meeting of the Newport Metal Exchange prices were advanced in rails, bars, and ores. There is also a slight improvement in the aspect of things at Dowlais. But there last week only a turn and a half workers were employed, and the Bessemer was worked down on Friday. The best production was in tin bars, which were worked in substantial quantities. In angle iron and billets there was not much done. Large dumpings continue, 721 tons steel came to Newport from Bruges in one cargo; 1350 tons in another. On the 31st 1300 tons steel came from Antwerp to Newport, Mon., and 970 tons bars from Rotterdam. About the average quantity of iron ore has been received, principally at Newport, by Ebbw Vale, which had one large consignment of 3800 tons from Bilbao, and 2800 tons from Port Vendres. Guest has also been importing from Bilbao and Hornello. At Swansea Metal Exchange the following were the last issued:—Pig iron: Hematite mixed numbers, 60s. 7½d. cash and month; Middlesbrough, 51s. 5d. cash, 51s. 8d. month; Scotch, 57s. 4½d. cash and month; Welsh hematite, 63s. 6d. to 64s. d.d.; East Coast hematite 62s. 6d. to 63s. 6d. c.i.f. Steel bars: Siemens, £4 10s.; Bessemer, £4 10s. Rubio ore, 16s. 3d. to 16s. 9d., on basis of 50 per cent. iron. Other quotations: Copper: £59 15s. cash, and £60 13s. 9d. three months; lead, £13 12s. 3d.; spelter, £22 10s.; silver, per oz., 23⅞d.

Tin-Plate.

The Swansea Harbour report last week showed that a good volume of trade continues to be done. The works turned out 97,421 boxes, 90,363 boxes were shipped, and 137,314 remain in stock. I note that among the loadings now going on there are substantial cargoes for Batoum, Rotterdam, Petersburg, and Hamburg. The prosperous condition of trade continues; five days' work was registered last week. At the adjacent spelter factories it was a case of full time, and the same condition was to be noted at the copper works and the Mannesmann and Mond works. Latest prices, tin-plates: Ordinary plates:—Bessemers, 12s. 1½d. to 12s. 3d.; Siemens, 12s. 1½d. to 12s. 3d.; ternes, 21s. 6d.; c.a. roofing sheets, £8 7s. 6d. to £8 10s.; big sheets for galvanising, £8 10s.; finished black plate, £8 10s.; galvanised sheets, 24 g., £10 5s. to £11 per ton. Block tin, £140 cash; £140 17s. 6d. three months.

LAUNCHES AND TRIAL TRIPS.

Meltonian, steel screw steamer; built by Harland and Wolff, Limited; to the order of the Wilsons and Furness Line, Limited; dimensions, 413ft. by 52ft. by 30ft. 6in.; to carry 6300 tons; engines, quadruple-expansion, constructed by the builders; trial trip, August 17th.

Florinda, steel screw steamer; built by Swan, Hunter and Wigham Richardson; to the order of the Linea de Vapores Serra, of Bilbao, Spain; dimensions, 290ft. by 42ft.; to carry 3250 tons; engines, triple-expansion, constructed by the builders; launch, August 17th.

Tortona, twin screw steamer; built by Swan, Hunter and Wigham Richardson, Limited; to the order of the Cairn Line of Steamships, Limited; dimensions, 464ft. by 54ft. 2½in. by 40ft.; engines, triple-expansion, 25¼in., 41in., 68in. by 48in. stroke; constructed by Palmer's Shipbuilding and Iron Company, Limited, of Jarrow; launch, August 18th.

Mataram, steel screw steamer; built by the Clyde Shipbuilding and Engineering Company, Limited; to the order of Burns, Philp and Co., Limited; dimensions, 331ft. by 43ft. by 24ft. 9in.; to carry 4200 tons; engines, triple-expansion, 24in., 40in., 60in. by 42in. stroke; launch, August 18th.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

We are informed that the A.B.C. Coupler, Limited, has appointed Mr. Cecil Watson, A.M. Inst. C.E., to the position of engineer and manager of the company.

We have been asked to state that Mr. H. Ellison Walker, Cardiff, for seventeen years representative of Messrs. Crossley Brothers, Limited, has been appointed agent for South Wales and West of England for Messrs. John Cameron, Limited, makers of pumps, shipbuilders' tools, gas engines, and suction plants; also, for Bristol Channel ports, for the United Collieries, Limited, Glasgow, fire bricks.

We are informed that the Daimler Company has opened a depôt in Paris under the title Société Francaise de la Daimler, at 5, Rue Rude, Paris, with the sole selling rights of the "New Daimler" in France. This depôt is under the management of Monsieur Girardot, and carries a full complement of spares and accessories likely to be required by Daimler owners in that country.

Contracts.—We learn that Messrs. Ashmore, Benson, Pease and Co., Limited, of Stockton-on-Tees, have been awarded a contract for the supply, delivery, and erection in Calcutta of riveted steel mains, 6ft. and 5ft. internal diameter, for the water supply of that city. The total length of the main lines will be about 4¼ miles, and where necessary will be carried by riveted lattice girder bridges with watertrough bottoms over canals and railways. The work has to be completed within two years from receipt of instructions to commence.—We have been advised that the contract for a large water-purifying plant for H.M. Dockyard North, Devonport, has been placed in the hands of the Harris Patent Feed Water Filter, Limited, of London and Newcastle-on-Tyne. The contract includes all structural ironwork for supporting the plant above the boilers in the boiler-house, and all pipes and valves conveying the water to and from the apparatus. The plant is arranged to treat 7000 gallons of condensed steam per hour, removing every trace of oil therefrom.—We are informed by Clarke, Chapman and Co., Limited, that they have recently received some large orders for their "Woodeson Patent" water-tube boiler. Among these are three large boilers for Bury Corporation, one for the Admiralty, four for the new coke oven plant for Messrs. Strakers and Love, making the sixth repeat order from this firm, and several others for home and foreign power stations and elsewhere, many of these being repeat orders.—We are advised by Samuelson and Co., Limited, Banbury, that they have received an order from the Buenos Ayres and Pacific Railway Company, Limited, for 30 additional smiths' hearths, together with one of their electrically-driven "Acme" blowers, for the railway workshops at Alianza, which Samuelson and Co., Limited, previously fitted up with 24 hearths with one of their "Acme" blowers to be shipped to a large number of hearths. They have also an order for Bahia Blanca for a new shop of the same company.

NOTES FROM GERMANY, FRANCE, BELGIUM, &c.

(*From our own Correspondent.*)

Rheinland-Westphalia.

Iron and steel show little life, orders having increased only in some especially favoured branches since last month, and the tone of the market generally remains languid. A recent report from Cologne states pig iron to have been reduced M. 2 and M. 3 p.t. since the beginning of August. This is due to strong competition, and the opinion prevails that the prices for pig iron have not yet touched bottom. A reduction in the prices for iron ore has now been taken into consideration. The German Wire Rod Convention reports employment for the fourth quarter to be satisfactory, and list rates will consequently remain unaltered for the present. In finished iron and in hardware a fluctuating business is done, and the trade on foreign account has been weakening perceptibly.

Silesia.

All the principal branches of the manufactured iron industry report a fair amount of fresh work for immediate delivery to be coming in, while but few forward contracts are being placed, dealers as well as consumers awaiting the further development of the market before they purchase largely. Producers, too, begin to show more reserve as regards taking in orders at the present low rates, for the outlook in some branches has improved of late. The harvest accounts are favourable, and more life was shown in the building line during this and last week.

The Coal Market in Germany.

Rhenish-Westphalian coalowners report a moderate trade, while the coal and coke industry in Silesia has been showing a good deal of animation. Winter quotations for most sorts of coal will be slightly higher than present rates. The coke trade has improved a little since last month.

Firmness in Austria-Hungary.

During the last few weeks activity at the shops and factories has slightly increased, and the Alpine Company and the Prague Iron Industry have no longer to restrict their working hours. Foreign competition is not nearly so keen as before, and inland makers therefore can maintain prices firmly without fearing the loss of orders. The Convention of Machine Factories, which was formed about a year and a-half ago, has now been dissolved, as the arrangement was not successful. Coal has continued in regular demand, and the inquiry for gas coal is stronger than previously; coke shows a rising tendency.

The French Iron Market.

Trade in iron and steel is progressing favourably. Although prices could not be firmly maintained in every instance, there is more demand generally, and a healthy tone was perceptible in the inland business. Coal in the northern districts meets with good request, purchases being regular, though not extensive. House coal is quiet at the former rates. Owing to the increasing number of briquette works, both in France and in Belgium, producers find it difficult to dispose of their wares, and quotations, consequently, are weak.

Iron and Steel in Belgium.

It speaks well for the activity of the Belgian iron industry that production in pig iron, during the first six months of this year shows a rise against the corresponding period last year, being 739,500 t., while import was 229,200 t., the total consumption in pig iron thus amounting to 968,700 t., against 780,400 t. in the same period last year. A steady business is being done in manufactured iron and steel, but animation is wanting in most branches. Export sales in semi-finished steel are effected at 95f. to 100f. p.t.; in scrap iron a poor business only is being carried on, at 60f. to 62f. p.t.; rails meet with good demand for foreign consumption. A rising inland demand in the girder trade makes up to some extent for a sluggish foreign trade. A fairly satisfactory business is done in bars, £4 9s. being quoted. Plates show some improvement and the export rate of £5 1s. is paid without questioning. Deliveries in dry sorts of coal increase, brick kilns and cokeries buying freely. Briquettes remain neglected. The output of coal in Belgium during the first six months of this year was 12,559,745 t., or 253,905 t. less than last year; 8,167,915 t. fall to Hennegau; 3,175,210 t. to the Liège district; and 1,417,220 t. to the Namur district.

AMERICAN NOTES.

(*From our own Correspondent.*)

New York, August 23rd.

Steel rail orders for the past two weeks foot up 160,000 tons. Many lines will delay the placing of orders, as no advance in rails is looked for. A large amount of business has been done in structural steel, because of the increasing probabilities of a further advance. The Carnegie Steel Company advanced its quotation last week from 1.30 to 1.35, whereupon several independent companies advanced to 1.40 for steel bars. This will probably be followed by an advance in plates and shapes. Present prices: 1.40-1.45, against 1.60 a year ago. An exceptional demand is being maintained for sheets and tin-plates, and the efforts of buyers to place orders for next year's delivery are not successful, as manufacturers are asking 3.55 dols. for 1910 deliveries, against 3.40, present price. The car shortage scare of 1907 promises to be repeated this year, notwithstanding that all the car plants, except at McKees Rocks, are working night and day. All the trunk lines have their orders in. All the idle blast furnaces in the Pittsburgh district will soon be in blast. The Carnegie Company is operating all its open-hearth capacity at the Duquesne plant. Southern furnace capacity is all sold up for two to three months. The Inter-State Commerce Commission will make exhaustive tests on block signals on railroads for automatically controlling the speed and stoppage of trains. One device is known as the mechanical type, and has been installed on the Chicago, Burlington, and Quincy Road; the other is known as the intermittent contact rail, and is in operation in Southern California. The Government has just ordered the building of two additional battleships, which will be built at Philadelphia. The Chicago and North-Western Company has just contracted for the delivery of 8000 freight cars, 125 all-steel passenger cars, and 125 freight and passenger locomotives; contract price, 16,000,000 dols. The passenger locomotives will be built to haul fourteen Pullmans, at a speed of 60 miles an hour, and will weigh 116 tons each. The freight locomotives are to be delivered before December, and the passenger locomotives not later than the end of January. On Saturday last the Atchison, Topeka, and Santa Fé Company contracted for the delivery of 130,000 tons steel rails, at a contract price of 3,600,000 dols., for use in Texas and California, and for renewals. Exports of copper so far this month, 12,750 tons, as compared with 26,600 tons corresponding time last month; present price, 12 92½

In a recent communication to the Royal Society of Edinburgh, Dr. Dawson Turner describes the results of introducing a solid dielectric between the electrodes of an induction coil when these have been placed at such a distance apart that a spark will not pass easily. Mica, sulphur, glass, ebonite, &c., will facilitate the sparking if placed near or against the positive pole, but will not have this effect if placed against the negative pole.

BRITISH PATENT SPECIFICATIONS.

When an invention is communicated from abroad the name and address of the Communicator is printed in italics.

When the abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent-office Sale Branch, 25, Southampton-buildings, Chancery-lane, London, W.C., at 8d. each.

The first date given is the date of application; the second date at the end of the abridgment is the date of the advertisement of the acceptance of the complete specification.

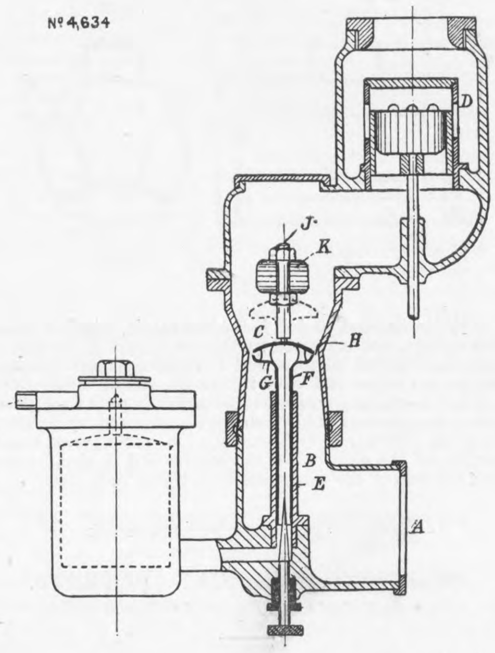
Any person may on any of the grounds mentioned in the Acts, within two months of the date given at the end of the abridgment, give notice at the Patent-office of opposition to the grant of a Patent.

INTERNAL COMBUSTION ENGINES.

4634. February 25th, 1909.—Improvements in Automatic Carburetters for Internal Combustion Engines, *Henri Pieper, Liège Belgium.*

The admission of the air takes place through the opening A. The air drawn in by the motor passes first through the chamber B, then through the cone C, and arrives at the throttle valve D. Passing up the middle of the chamber B is a vertical tube E through which the fuel passes, and which communicates by a passage with the float chamber. The vertical tube E is fixed to the foot of the chamber B and contains another vertical tube F capable of freely sliding and forming as tight a joint as possible. At the upper end of the tube F is a disc G having double walls, and of which the interior space communicates with the tube F and also with a circular slot H facing the cone C. At the lower part of the chamber B is a needle screw which passes into the interior of tube F, and which serves for setting the apparatus. Above the disc G a screwed rod J carries a weight, consisting of lead discs K. Under the effect of the suction of the engine the disc G rises until the force exerted by the current of air drawn in balances the weight K. When this occurs the force exerted beneath the disc is equal to the weight K, and the carburetter thus works at constant pressure. There is a position of equilibrium corresponding to all supplies of mixture, for in proportion as the disc G is lifted in the cone C, the size of the passage increases, but equilibrium only take places when the predetermined suction is obtained.—*August 11th*, 1909.

Nº 4,634

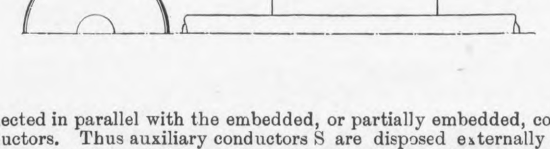


DYNAMOS AND MOTORS.

11,822. May 19th, 1909.—Improvements in and relating to Dynamo Electric Machinery, The Honourable Charles Algernon Parsons, C.B., and Alexander Henry Law, Heaton Works, Newcastle-on-Tyne.

This invention relates to the armatures of dynamo electric machinery. It is also applicable to stationary parts of alternators or any electrical winding in which it is desirable to reduce the self-induction as much as possible and which has to be secured strongly against mechanical or electrical forces. The invention consists in the use of auxiliary conductors in the air gap connected in parallel with the embedded, or partially embedded, conductors. Thus auxiliary conductors S are disposed externally to the slots and coupled in parallel with the embedded conductors. These auxiliary conductors having very little self-induction act in a similar manner to the kicking coil of a field magnet coil breaking switch and allow the current in the conductor to be stopped and reversed without a large and sudden inductive rise of voltage in the coil causing sparking. The auxiliary coil S is preferably laminated, and may be connected in parallel with the ordinary windings at points external to the magnetic field only or at any number of intermediate points.—*August 11th*, 1909.

Nº 11,822 ⁰⁹

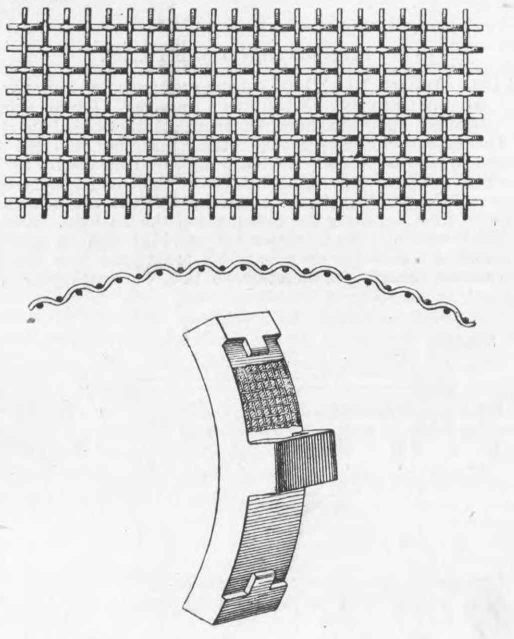


LOCOMOTIVES.

28,344. December 29th, 1908.—Improvements in Brake Shoes, *European Brake Shoe Company, West Orange, N.J., U.S.A.*

To strengthen the shoe, and in order to prevent the sections of a cracked shoe from entirely separating and falling upon the track, and thereby derailing the train, the body, which is preferably made of cast iron, is reinforced by a strip of wire mesh or netting. The width of this strip is slightly less than the width of the shoe in which it is to be embedded, and its length slightly less than the curvilinear length of the shoe. At their points of intersection the longitudinal and transverse strands of the netting are firmly secured against movement in any suitable manner, such as by subjecting it to pressure while cold, thereby forming interlocking depressions in the surfaces of the wires at their points of intersection. Otherwise the netting may be first heated, and then subjected to pressure so as to weld the strands together, or, again, the strands may be rigidly secured by means of solder.—*August 11th*, 1909.

Nº 28,344



TRANSMISSION AND POWER.

26,017. December 2nd, 1908.—Improvements in or relating to Flexible Shafting, *Daniel Schoening, Bergedorf, Germany.*

The invention relates to flexible shafting consisting of a number of separate members, and its object is to provide a light, cheap and efficient shafting of this type. Accordingly the shafting is composed of tubular members having inwardly projecting claws and slots, the style and manner in which these engage being clearly shown in the figures. Further facility for bending is provided by a chamfered edge formed at each end of the members. The modified form of construction shown in Figs. 3 to 5 requires only a single type of member having a large portion with front teeth and a reduced portion in which are formed holes and ending with a chamfered edge.—*August 11th*, 1909.

Nº 26,017

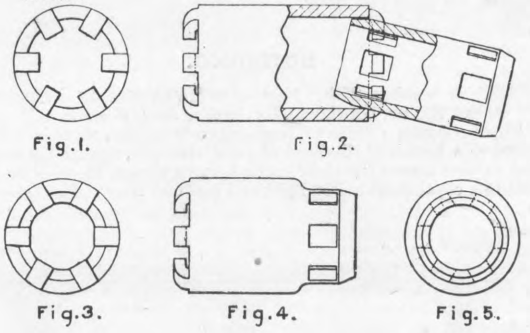


Fig. 1. Fig. 2.

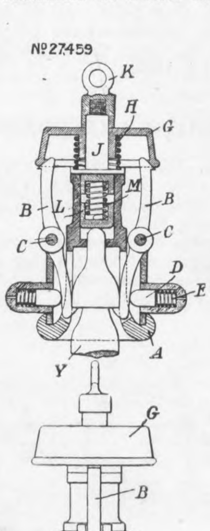
Fig. 3. Fig. 4. Fig. 5.

MEASURING AND TESTING APPARATUS.

27,459. December 17th, 1908.—Method and Apparatus for Fastening the Indicator Cords to, and Unfastening them from, the Rods of Indicators on Steam Engines, Explosion Motors and the like, *Lodewgk Benedit van Boven, Amsterdam, Holland.*

This invention has reference to an apparatus for fastening the cords to the rods of indicators on steam engines and the like. The apparatus is composed of a bell A, to which are linked two levers B, pivoted at C, and provided at their ends with hooks as shown, the lower hooks engaging beneath the conical knob of the indicator-rod Y, as soon as they are pressed against it by the springs E and plungers D. The upper hooks grip frictionally against the conical edges of the crown G as soon as a light pressure on the crown removes the upward resistance of a spring H. The crown G is fitted with a boss which surrounds a bolt J connected with the shank K. In the upper part of the bell A is arranged a slidable socket L in which a spring M is held in place

Nº 27459



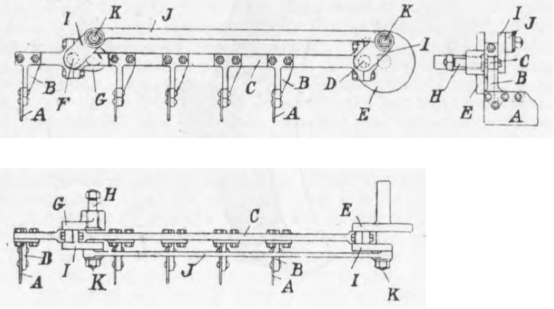
by a screwed cap connected with the bolt J. The spring M exercises a pressure on the indicator-rod Y so that the coupling of this rod with the apparatus can be broken as soon as the lower hooks cease to grip under the knob of the rod. The indicator cord is fastened to the eyelet piece K.—*August* 11*th*, 1909.

MINES AND METALS.

23,140. October 30th, 1908.—IMPROVEMENTS IN AND RELATING TO COAL-CUTTING MACHINES, Anderson, Boyes and Co., Limited, and Alexander Anderson, Motherwell, Lanarkshire.

This invention relates to coal-cutting machines, and has for its object to provide in such machines improved means for removing the cuttings from the neighbourhood of the cutting tools, so as to prevent the cuttings from re-entering the cut made in the coal seam or from impeding the movement of the machine. According to the invention, such machines are provided with an attachment comprising a shovel or shovels, which are dipped into the *débris*, the motion changing in direction, so that the cuttings are moved backwards along the floor, the shovels afterwards rising, and making the return stroke at a higher level, the shovel or shovels being operated simultaneously with the cutters, and, if desired, driven from the same motor as the cutters. As shown, the shovels A are carried on arms B, depending from a connecting-rod C, having one end connected to a crank pin D on a driving disc E, and the other end connected to the crank pin F of a crank G centred on a fixed stud H, the crank pins being preferably connected to one another as by means of arms I, one secured to each pin, and secured to a link J by means of studs K, which serve as crank pins disposed at the same radius as the crank pins F and D, the link J thus constituting an auxiliary connecting-rod co-operating with the connecting-rod C to assist in carrying the crank G past the dead centres.—*August* 11*th*, 1909.

Nº23,140

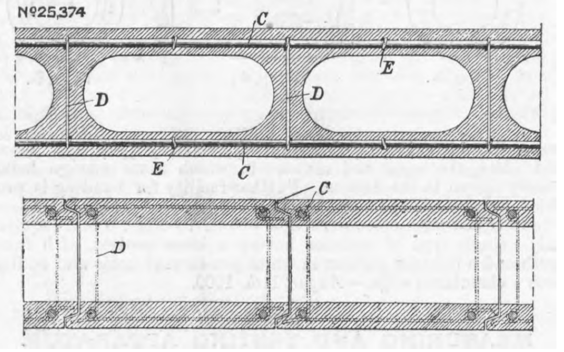


BUILDING.

25,374. November 25th, 1908.—IMPROVEMENTS IN FERRO-CONCRETE BEAMS, *Guillaume Du Jardin, Huy, Belgium.*

This invention relates to ferro-concrete beams, its object being to provide beams of this kind of great strength, though very light, and to give means for their mutual engagement, in order to constitute a continuous hollow light and resilient floor. The beam has a rectangular cross-sectional shape, and is provided with hollows which are crosswise directed with reference to its longitudinal section. Embedded in the upper and lower parts of the concrete beam are parallel iron rods C arranged in pairs, and connected by binding wires D. Besides the wire connection D, which forms a rectangle, there is a second wire connection E to tie together the rods of the upper and lower pairs. At its longitudinal edges the beam is provided with depressions and projections such that the projections of one beam engage the depressions of the neighbouring beam.—*August* 11*th*, 1909.

Nº25,374

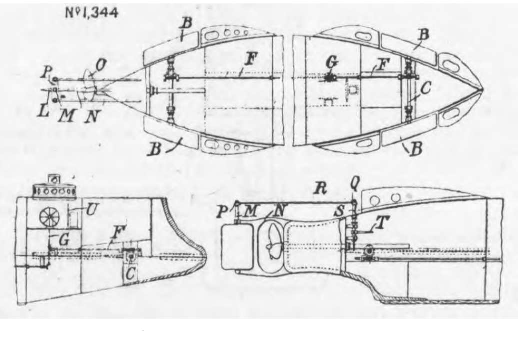


SHIPS AND BOATS.

1344. January 19th, 1909.—IMPROVEMENTS IN AND CONNECTED WITH RUDDERS FOR SUBMARINE VESSELS, Albert James Kemp and Frederick William Randall, Southsea, and Francis Archibald Primrose, Folkestone.

This invention relates to submarine vessels and particularly to the steering mechanism, comprising a pair of diving rudders and a stern rudder for steering the vessel in a horizontal plane. It is to provide means for protecting the steering mechanism from floating or fixed obstacles, and also means whereby the steering mechanism may be controlled from the conning tower. The invention consists in providing one or more fins adjacent to each rudder, each fin tapering off towards the end remote from the rudder, and projecting laterally beyond it and provided with lightening holes. In carrying out the invention, the vessel is provided with two pairs of rudders B, equidistant from the centre of buoyancy when the vessel is wholly submerged, and mounted on horizontal shafts C. These shafts are provided with worm wheels engaging with worms carried by shafts F, which are geared to a vertical shaft G through bevel pinions. The shaft G is adapted to be rotated in either direction by a steering wheel in any usual manner. The horizontal steering of the vessel is effected by a rudder L mounted on a shaft M arranged in a bracket N, which surrounds the propeller O. The shaft M is provided with a yoke P linked to a similar yoke Q by means of rods R. The yoke Q is mounted upon a shaft S passing into the interior of the vessel and fitted with a lever T, which may be operated by any usual mechanism from a steering wheel U in the conning tower.—*August* 11*th*, 1909.

Nº1,344



14,920. June 26th, 1909.—IMPROVEMENTS IN OR RELATING TO SUBMARINE BOATS, *Fried. Krupp Aktiengesellschaft Germaniawerft, Kiel-Gaarden, Germany.*

This invention relates to receptacles which are arranged in the interior of submarine boats, and are intended for the reception of compressed air. Two methods of carrying out the invention are described. The first is shown in Figs. 1 and 2, where A is the hull of the submarine, and B is the receptacle, which is biconvex in cross section, and is formed by the use of part of the hull A, by building in a vaulted division wall C running longitudinally, and two similarly vaulted end walls D. In the second form—shown in Figs. 3 and 4—there are provided, in addition to the receptacle B, two other receptacles G H, which are also formed by parts of the hull, and by building in division walls J K. and vaulted ends E F. A portion of the walls of the receptacles G H is also formed by parts of the wall of the receptacle B.—*August* 11*th*, 1909.

Nº14,920

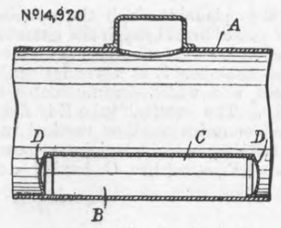


Fig. 1.

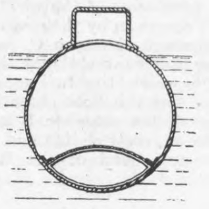


Fig. 2.

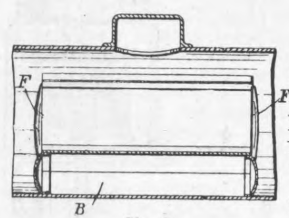


Fig. 3.

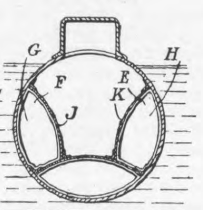


Fig. 4.

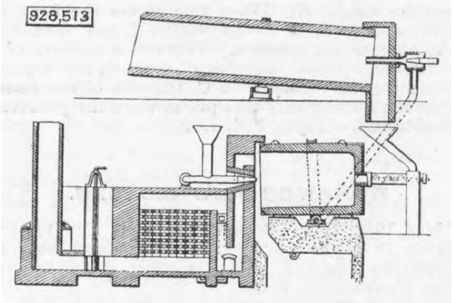
SELECTED AMERICAN PATENTS.

From the United States Patent-office Official Gazette.

928,513. PROCESS OF AND APPARATUS FOR BURNING CEMENT, *B. E. Eldred, Bronxville, N.Y., assignor to the Eldred and Palmer Company, New York, N.Y., a Corporation of New York* —*Filed April* 30*th*, 1908.—*Renewed April* 8*th*, 1909.

This patent is for a clinker-making plant for producing calcined material at or near the clinkering temperature, a rotary clinkering kiln having a closed upper end, means for introducing the calcined material into the upper end, feeding a jet of powdered coal into the lower end, a pair of regenerators having flues opening into the lower end on either side of the coal jet, and means for alternately passing waste gases from the kiln through each of these regenerators to exit, and air through the other regenerators, and so into the kiln. There are fifteen claims.

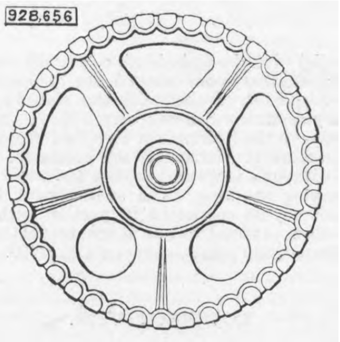
928,513



928,656. CLUTCH, *C. P. Hollister, Pittsfield, Mass., assignor to Stilson Motor Car Company, Pittsfield, Mass., a Corporation of Massachussetts.—Filed December* 7*th*, 1908.

This is a motor car clutch. The wheel is made with partially cylindrical grooves, in which are placed corks put in endways. These can be renewed without trouble at pleasure. There are five claims.

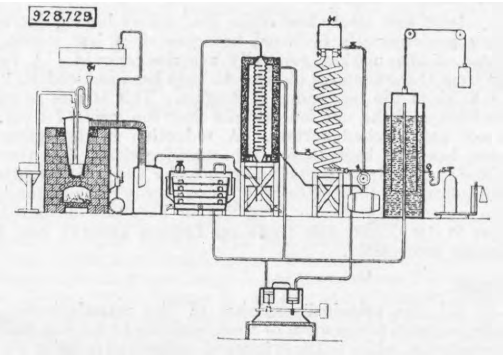
928,656



928,729. LIQUID GAS SUITABLE FOR ILLUMINATING AND HEATING PURPOSES AND METHOD OF MAKING SAID GAS, *L. Wolf, Boston, Mass.—Filed October* 1*st*, 1908.

This patent is interesting as being one of the first of its kind. The invention consists in producing gas by the distillation of hydrocarbon, such as mineral oil, cooling the distillation gases to approximately – 25 deg. Cent., thereby to liquefy all those constituents which comprise the easily vaporisable liquid hydrocarbons, separating the liquid thus obtained from the remaining constituents, and forcing all the remaining constituents into a chamber filled with gasolene under a pressure of approximately 1500 lb. There are four claims.

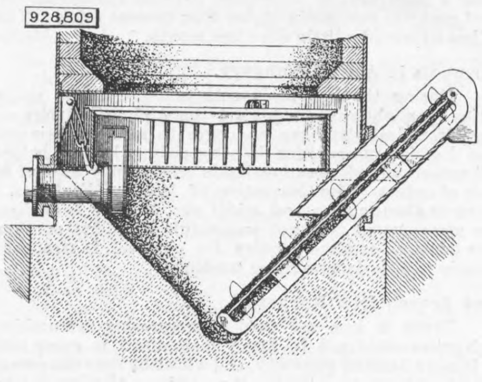
928,729



928,809. GRATE FOR GAS PRODUCERS AND MEANS FOR REMOVING ASHES THEREFROM, *H. F. Smith, Lexington, Ohio.—Filed October* 10*th*, 1908.

This invention consists in the combination with a grate for supporting the bed of fuel in the producer, means for supporting the grate, a liquid seal in the ashpit extending around the supporting frame of the grate; a removable shoot extends through the side of the producer with a liquid seal, and a removable conveyor extending through the shoot into the ashpit serves to remove the ashes from the pit.

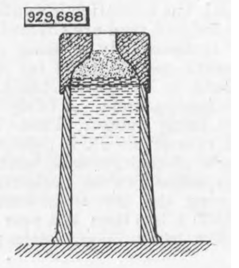
928,809



929,688. PROCESS OF CASTING METAL INGOTS, *J. F. Monnot, New York, N.Y., assignor to Monnot Metallurgical Company, New York, N.Y., a Corporation of New York.—Filed September* 6*th*, 1907.

In the art of casting metals, the process of making homogeneous ingots which consists in casting molten metal into an ingot mould down through a wiping layer of fused alkali silicate. There are twelve claims.

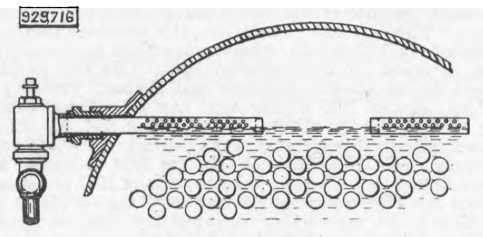
929,688



929,716. MEANS FOR INTRODUCING FEED-WATER INTO STEAM BOILERS, *C. W. Seddon, Proctor, Minn., assignor of one-half to J. E. Chisholm, Oelwein, Iowa.—Filed March* 6*th*, 1908.

The inventor discharges the feed-water into the steam space, the perforations being all in the upper half of the internal feed pipe. This can be withdrawn with the clack valve by unscrewing the gland as shown. There is only one claim.

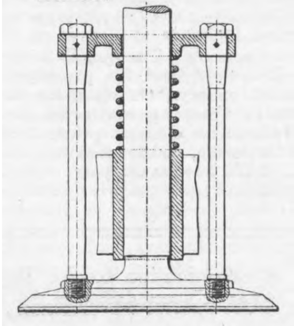
929,716



929,886. MEANS FOR MOUNTING VALVES IN ENGINE CYLINDERS, *L. G. Sabathé, Paris, France, assignor to the Société des Moteurs Sabathé, Saint-Etienne, Loire, France, a Corporation of France.* —*Filed June* 10*th*, 1908.

The drawing almost explains itself. The valve is fitted with a crosshead secured to it by two vertical rods. The valve stem is surrounded by a spring resting on the guide as shown. There are five claims.

929,886



THE TEHUANTEPEC RAILWAY AND TERMINAL PORTS.

No. III.*

Having given some description of the construction of the Tehuantepec National Railroad and the two terminal ports, Salina Cruz and Puerto Mexico, it may be interesting to consider the relations of this enterprise, both present and prospective, with the Panama Canal. To some extent such relations must, of course, be conjectural; but sufficient is known of both enterprises for a fairly accurate idea of their respective spheres and futures to be formed. It is an acknowledged fact that the Tehuantepec Railway will shorten the traffic route for the Atlantic coast and for Europe by over 1200 miles; while it will also shorten the New Orleans route by 850 miles. On the other hand, it cannot be disguised that it is only probably for the next few years, and until the Panama Canal is open, that the Tehuantepec will be enjoying such a rush of traffic as at present exists, and that this will desert it in some degree when the Panama route is finished. Naturally a good deal will depend upon the respective rates in force by the two routes; and it is quite clear that unless the managements come to an understanding, which is not at all unlikely, since "rings" and "trusts" are the order of the day, a severe competition will exist until one or other of the undertakings hauls down its colours.

It has been stated on frequent occasions that in building the Panama Canal, the United States Government were actuated by strategical and commercial rather than by financial considerations, and that they were quite prepared to operate the Canal for some years at a heavy loss. The Tehuantepec Railway is in no such strong position financially; for, while it undoubtedly has abundant working capital, and is at present enjoying the full fruits of its enterprise, it is very questionable whether it could successfully withstand for any length of time a rate war such as is threatened. For this reason alone there seems to be little doubt that when the Panama Canal is open and ready for business, the rates in force on the Tehuantepec Railroad will have to be revised and adjusted.

It may be pointed out that the rates through all canals are on gross tonnage. Either Colon (Aspinall) or Panama will have to be a distributing point for vessels up and down the west coast of South America. It will not be economical for a vessel to leave New York, for instance, for the Panama Canal, pass through it, and then proceed down the west coast. More profitable will it be to take to Colon cargo which will fill the ship to the maximum capacity, and bring back a cargo in the reverse direction. A large part of this freight will have to be transferred into vessels of smaller tonnage in order to save canal tolls, and the result will probably be that a considerable proportion of package stuff will go across the Isthmus by rail, or will be taken through the canal on lighters, which will overcome the burden imposed on large steamers passing through the Canal and returning empty, or going through about half-filled.

This consideration, and many others, will bear upon the rate question; and by the result will the prospects and the future of the Tehuantepec route be controlled. Even, however, when the Panama Canal is open there must still remain a heavy traffic for the Tehuantepec Railway, which will secure a large proportion of freight for the west coasts of Mexico and South and Central America, unless, indeed, the Panama rates should be reduced below a profit-earning point, and equally desirable facilities for handling the traffic, or the privilege of breaking bulk and distributing from terminals at both termini, should not be assured. In any case, the vessels for the Orient and Australia would pass through the Panama Canal. It will take years, moreover, to develop practical methods of handling the Panama Canal business. A large number of smaller ships will have to distribute the cargoes of the large ships; the railway will handle very likely one-half of the freight that will cross the Isthmus, if that route is to compete with the Tehuantepec and the Suez Canal; and the rates will necessarily have to be very low if greatly to affect transcontinental rates in Mexico. If these rates are not made low enough to reduce greatly such transcontinental charges, then the Tehuantepec Railroad and the Suez Canal will continue to enjoy the greater part of the traffic.

Up till recently, the charges made for transportation across the Isthmus of Panama have given cause for much complaint, and in spite of the high rates prevalent the gross earnings for 1908 were only 2.48 dols. gold per ton of 2000 lb., or 40 cubic feet, and this included the heavy quantities of material handled for the Canal Commission. The through traffic amounted only to 35 per cent. of the whole. Latterly greater attention has been paid to the management of the Panama Railroad, to which considerable additions in the way of rolling stock have also been made, and the whole line has now been put into a greater state of efficiency.

There can be no question that the Tehuantepec route has been well organised, the facilities afforded to both steamship and railway companies having met with the emphatic approval of shippers. Cargoes are accepted at through rates and on through bills of lading between many Mediterranean ports, such as Trieste, Fiume, Patras, Palermo, Naples, &c., for all ports on the Pacific between British Columbia and Valparaiso; while the same facilities are in force for the ports of Antwerp, Hamburg, Havre, Barcelona, Bordeaux, Lisbon, London, Marseilles, Stockholm, Southampton, Manchester, Liverpool, and Rotterdam.

It must be remembered that the Gulf of Mexico is one of the most important commercial centres of the world, that Galveston and New Orleans are now, next to New York, the most important ports in the States for tonnage; that, canal or no canal, there will always be a very important tonnage from New York, also from Europe, to the Gulf of Mexico, proceeding there with the sole object of handling the traffic destined for, and originating at, Mexican and United States ports in the Gulf of Mexico. Thus Puerto Mexico is assured of a permanent heavy tonnage at its doors, and, in consequence, of adequate steamship connections on the Atlantic.

It is true that the character of the traffic of the Tehuantepec Railroad will probably change on the opening of the Canal. It is certain, by that date, owing to the rapid extension of railroad development from the Isthmus of Tehuantepec through Guatemala and even Salvador, linking up Puerto Mexico with an important territory in Central America, that considerable tonnage from this district will always be assured to the Tehuantepec Railroad, as such tonnage must naturally find its way to the splendid terminals of the Tehuantepec Railroad, both on the Atlantic and the Pacific, and to the steamship connections from such ports to all parts.

Then, again, the mineral resources of the State of Oaxaca, in Mexico, have not yet been tapped, and from the information now to hand it would appear that some few years hence the Tehuantepec Railroad will be called upon to handle an enormous mineral traffic—principally iron ore—a traffic which is not so attractive to the Tehuantepec Railroad to-day.

One of the earliest, as well as one of the most important, contracts made by the Tehuantepec Railroad was with the American-Hawaiian Steamship Company, which called for a minimum of 250,000 tons of Hawaiian sugar annually—a figure which has already been considerably increased in the short time that the route has been open. European traffic commenced about October last, and since that date the railroad has successfully handled nearly 25,000 tons of coffee, as well as carrying a large volume of dried fruit from the Pacific coast to both New York and Europe; while the total traffic handled by the railroad last year amounted to the considerable figure of 650 000 tons—a result, however, which will be exceeded this year.

As an evidence of the interest which the South American States are taking in the Tehuantepec route, it may be said that Peru has already announced that in the future its Consuls in the United States will urge all American exporters to utilise the Tehuantepec route, while similar steps will be undertaken by the authorities in Peru with regard to freight for the United States.

No fewer than thirteen steamers a month now leave Europe for Puerto Mexico, and with the exception of the fortnightly passenger steamers of the Hamburg-Amerika Line, all these steamers make Puerto Mexico their first Mexican port of call, whereas formerly they all proceeded first to Vera Cruz, then to Tampico, and lastly to Puerto Mexico. Eight steamship lines in all are giving services from Europe to Puerto Mexico, and of these, four lines are British—viz., the Harrison Line, the Leyland Line, the Royal Mail Steam Packet Company, and the Cuban Line. The remaining four lines are:—The Hamburg-Amerika, of Hamburg; the Cie. Générale Transatlantique, of Paris; the Cia. Trasatlantica, of Barcelona; and the Norway-Mexico Gulf Line, of Christiania. In addition to these, the American-Hawaiian Line maintains a weekly service of freight steamers of 8500 tons between New York and Puerto Mexico; there is a fortnightly service by the Wolvin Line between Texas City and Puerto Mexico, and three or four steamers a month of the Mexican Navigation Company, giving regular connections with all Mexican ports on the Gulf.

On the Pacific, the Tehuantepec Railroad's terminal port of Salina Cruz is served by seven lines—namely, the American-Hawaiian, giving three sailings a month to San Francisco, Puget Sound, Portland, and the Hawaiian Islands; the Kosmos Line, two sailings a month to all ports as far south as Valparaiso, and as far north as Puget Sound; the Compañia Naviera del Pacifico, with sailings every ten days to all Mexican ports; the Jebsen Line, with monthly sailings to all ports between Corinto, in Central America, and British Columbia; the Canadian-Mexican Pacific Line, with monthly sailings to Victoria and Vancouver; the Pacific Mail, monthly passenger service to all Central American and Mexican ports and San Francisco. In addition, there is a service to Hong Kong and the Orient by the Mexican Oriental Steamship Line, and by the Tokyo Kisen Kaisha.

Another more or less important factor in the development of the Tehuantepec Railroad is that the Salvador Railway Company has made arrangements to establish a weekly steamship service of its own between Acajutla, the terminal of the Salvador Railway, and Salina Cruz. As Acajutla is only thirty-six hours' steam from Salina Cruz, the weekly service of steamers, proceeding direct from Acajutla to Salina Cruz without any intermediate calls, must result in giving Salvadoreans such a service as they have never had in the past. It will enable them to reach Mexico City, the Mecca of all Central Americans, in less than four days.

If the steamship arrangements entered into by the Tehuantepec route are encouraging, others which may be entered into in some of the great United States railway lines are hardly less so. Among these may be mentioned as probable the Vanderbilt System, which includes the New York Central and Hudson River Railroad, the West Shore, the Boston and Albany, the Rutland, the Michigan-Central, the Lake Shore and Michigan-Southern, the Chicago-Cleveland, the Cincinatti and St. Louis, the Lake Erie and Western, the Chicago-Indianapolis, and the Southern, with their numerous connections and spurs. The various railroads comprised in this group take an enormous tonnage from the commercial centres of the United States, such as New England, New York, Pennsylvania, Ohio, Indiana, Illinois, and Michigan; and it would probably be no exaggeration to say that, from first to last, these lines handle 75 per cent. of the manufactured products of the United States. From this section of the North American Republic is shipped an immense tonnage across the continent for consumption in the Western and Pacific Coast States, as well as in the Prairie and Cereal States of the north-west and middle-west. Of this 75 per cent., one-third, at least, might at no very distant date easily pass over the Tehuantepec route, more especially when it is considered that, while it takes from three weeks to five months for freight to go from New York to San Francisco by rail, shipments are being regularly made by way of the Isthmus of Tehuantepec in less than thirty days. It would appear that if the New York Central System adopt the Tehuantepec route it may well lead to a complete transformation in trans-continental traffic, and would confer upon the Tehuantepec Railway an enviable distinction by making it the greatest highway of transportation that the world has ever seen. That the pioneers of the undertaking are not blind to its great future is clear from the fact that they have considered the advisability of not only doubling but of quadrupling the lines across the Isthmus, and this in full consideration of what the Panama Canal may mean for them when it is once open. Even should the Canal prove as successful as its most ardent advocates profess to believe, however, the Tehuantepec Railroad will, as we have pointed out, still secure as much traffic as it can conveniently handle. By the time that the Canal is completed, freight business will have increased so enormously and contracts will have been made so far ahead, that the route first to be opened will have little to fear.

Attached is a complete table showing the distances of the various routes at present existing.

Route from	Total distance.	Excess over Tehuantepec route.
New York to Hong-Kong *viâ*:—		
Cape Horn	20,379	8,777
Cape of Good Hope	16,945	5,343
Suez Canal	13,596	1,994
Panama Railroad	12,953	1,351
Isthmus of Tehuantepec	11,602	—
New York to Yokohama *viâ*:—		
Cape Horn	19,802	9,796
Cape of Good Hope	18,085	8,079
Suez Canal	15,527	5,531
Panama Railroad	11,256	1,250
Isthmus of Tehuantepec	10,006	—
New York to Auckland, New Zealand, *via*:—		
Suez Canal	16,871	7,447
Cape of Good Hope	16,719	7,295
Cape Horn	13,890	4,466
Panama Railroad	10,305	881
Isthmus of Tehuantepec	9,424	—
New York to Melbourne *viâ*:—		
Cape Horn	15,215	4,150
Suez Canal	15,171	4,106
Cape of Good Hope	15,019	3,954
Isthmus of Tehuantepec	11,065	—
New York to Honolulu *viâ*:—		
Cape Horn	15,826	9,163
Panama Railroad	7,939	1,276
Isthmus of Tehuantepec	6,663	—
New York to San Francisco *viâ*:—		
Cape Horn	15,687	10,797
Panama Railroad	6,063	1,173
Isthmus of Tehuantepec	4,890	—
Liverpool to Hong-Kong *viâ*:—		
Cape Horn	20,606	5,353
Panama Railroad	16,471	1,218
Cape of Good Hope	15,722	469
Isthmus of Tehuantepec	15,253	—
Liverpool to Yokohama *viâ*:—		
Cape Horn	19,400	5,945
Cape of Good Hope	17,653	4,198
Panama Railroad	14,540	1,085
Isthmus of Tehuantepec	13,455	—
Liverpool to Auckland, New Zealand, *via*:—		
Cape of Good Hope	16,221	3,412
Suez Canal	14,645	1,836
Cape Horn	13,897	1,088
Panama Railroad	13,312	503
Isthmus of Tehuantepec	12,809	—
Liverpool to San Francisco *via*:—		
Cape Horn	16,552	8,276
Panama Railroad	8,885	609
Isthmus of Tehuantepec	8,276	—
New Orleans to Hong-Kong *via*:—		
Cape Horn	20,804	10,531
Cape of Good Hope	17,845	7,572
Suez Canal	15,108	4,835
Panama Railroad	12,308	2,035
Isthmus of Tehuantepec	10,273	—
New Orleans to Yokohama *via*:—		
Cape Horn	20,227	11,590
Cape of Good Hope	18,625	9,988
Suez Canal	17,039	8,402
Panama Railroad	10,611	1,974
Isthmus of Tehuantepec	8,637	—
New Orleans to Auckland, New Zealand, *via*:—		
Suez Canal	18,381	10,286
Cape of Good Hope	17,259	9,164
Cape Horn	14,314	6,219
Panama Railroad	9,659	1,564
Isthmus of Tehuantepec	8,095	—
New Orleans to Melbourne *via*:—		
Suez Canal	16,683	6,947
Cape Horn	15,640	5,904
Cape of Good Hope	15,560	5,824
Panama Railroad	11,181	1,445
Isthmus of Tehuantepec	9,736	—
New Orleans to Honolulu *via*:—		
Cape Horn	16,251	10,917
Panama Railroad	7,294	1,960
Isthmus of Tehuantepec	5,334	—
New Orleans to San Francisco *via*:—		
Cape Horn	16,112	12,551
Panama Railroad	5,418	1,857
Isthmus of Tehuantepec	3,561	—

It will be observed that in all the foregoing the Tehuantepec route offers an advantage.

BOULTON AND THE SOHO WORKS.

Through the courtesy of Mr. Courtney Darlington, who for many years assisted his father, whose death occurred quite recently, in the management of the Soho Works, we are able to put before our readers a number of illustrations of old tools which have a particular interest at the present time, owing to the fact that we have but just passed the anniversary of Matthew Boulton's death. The pictures are reproductions of photographs taken before the works were acquired by W. and T. Avery, Limited, and they may be regarded as supplemental to the series of draw

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* No. II. appeared September 3rd.

OLD TOOLS AT THE SOHO WORKS, BIRMINGHAM

(For description see page 259)

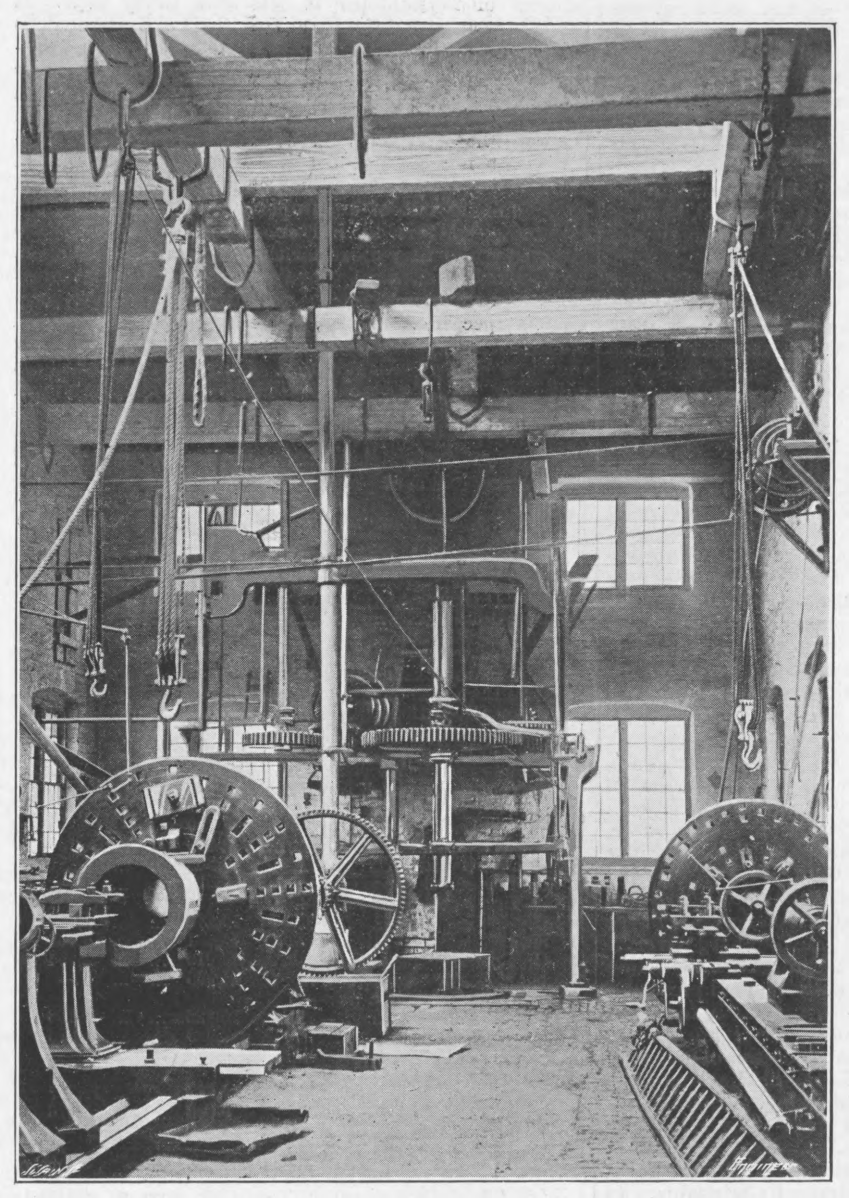


Fig. 1—VERTICAL BORING MACHINE

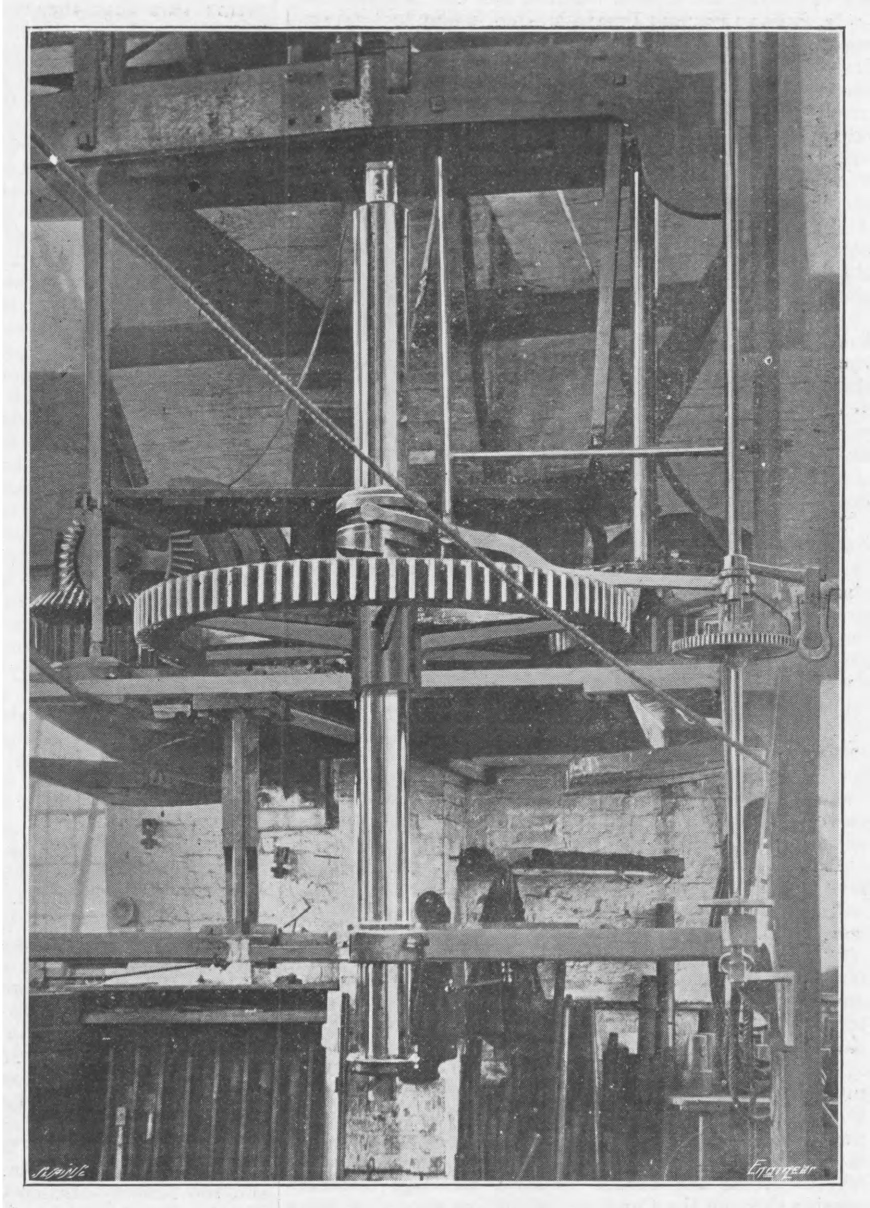


Fig. 2—VERTICAL BORING MACHINE

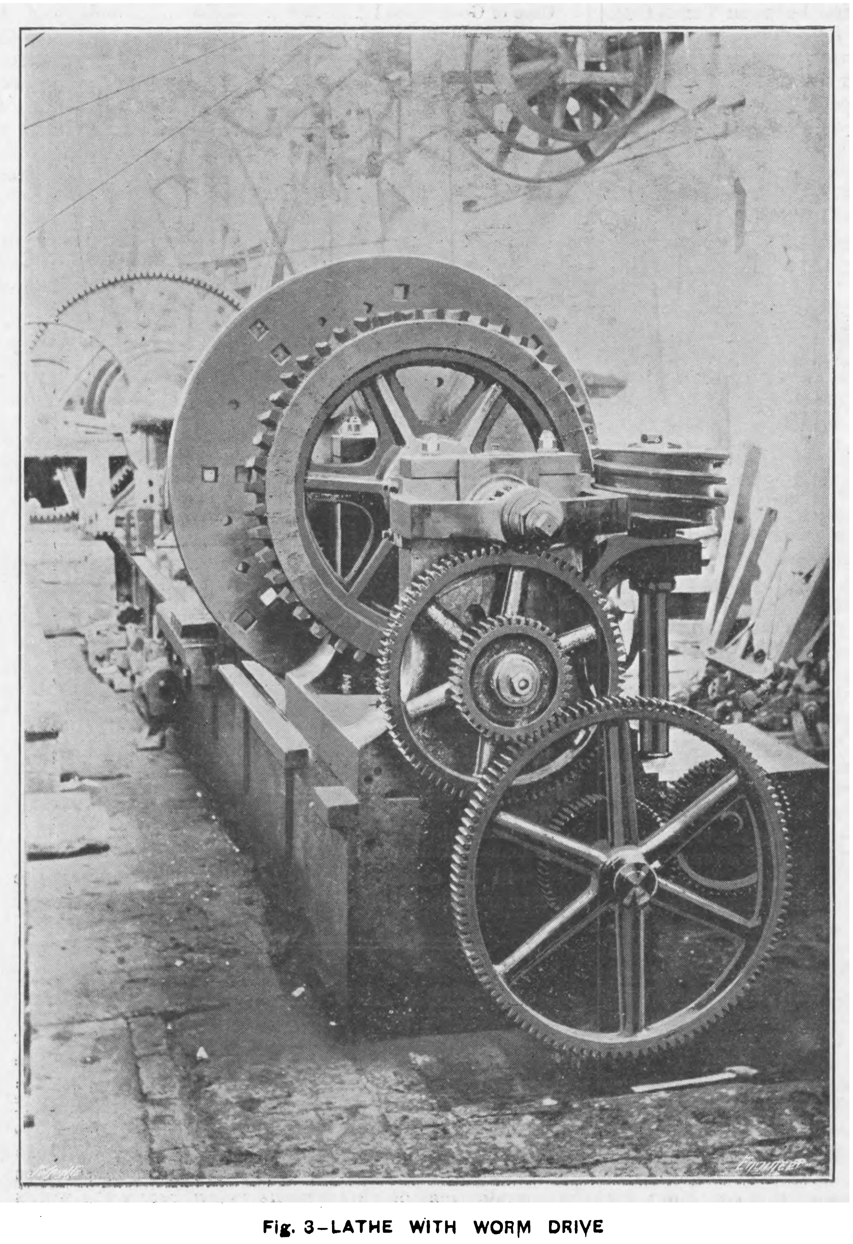


Fig. 3—LATHE WITH WORM DRIVE

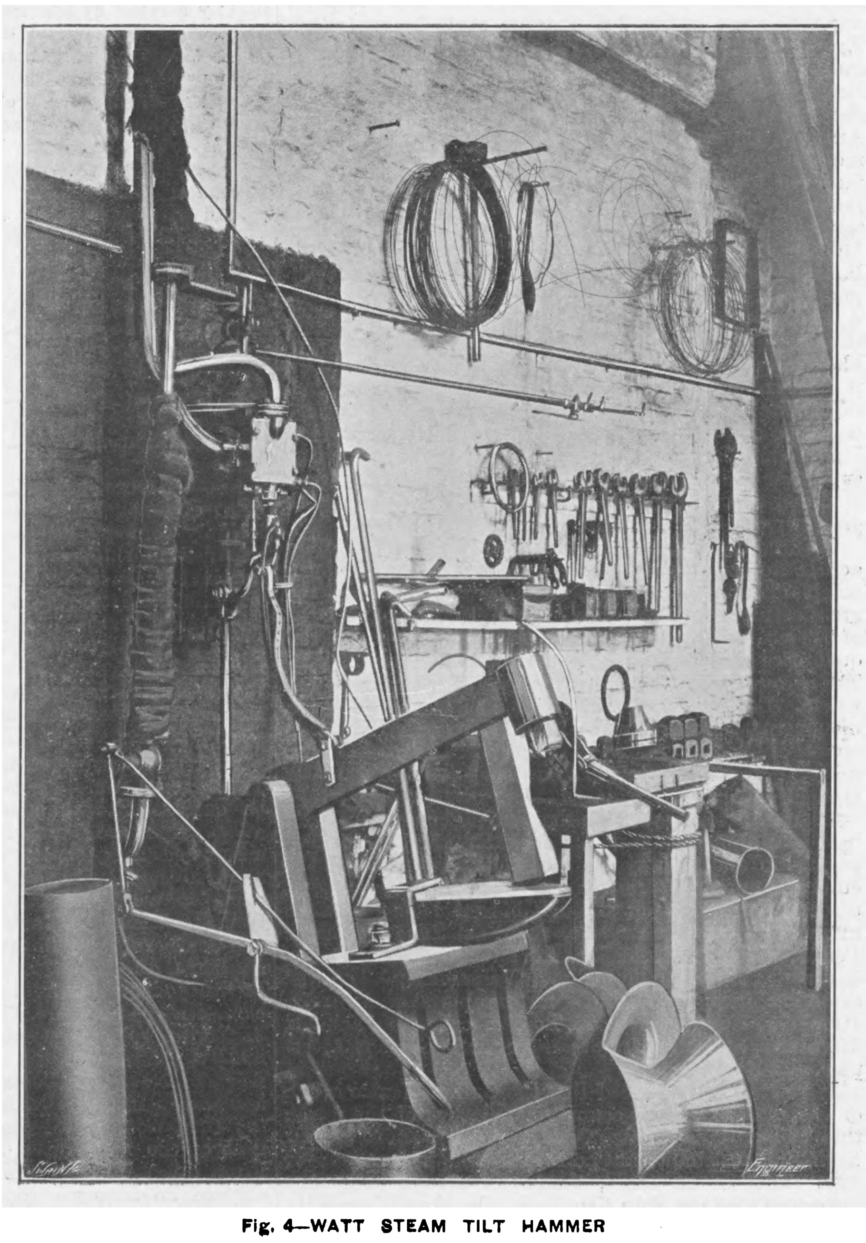


Fig. 4—WATT STEAM TILT HAMMER

MURDOCH'S GAS PLANT AT SOHO

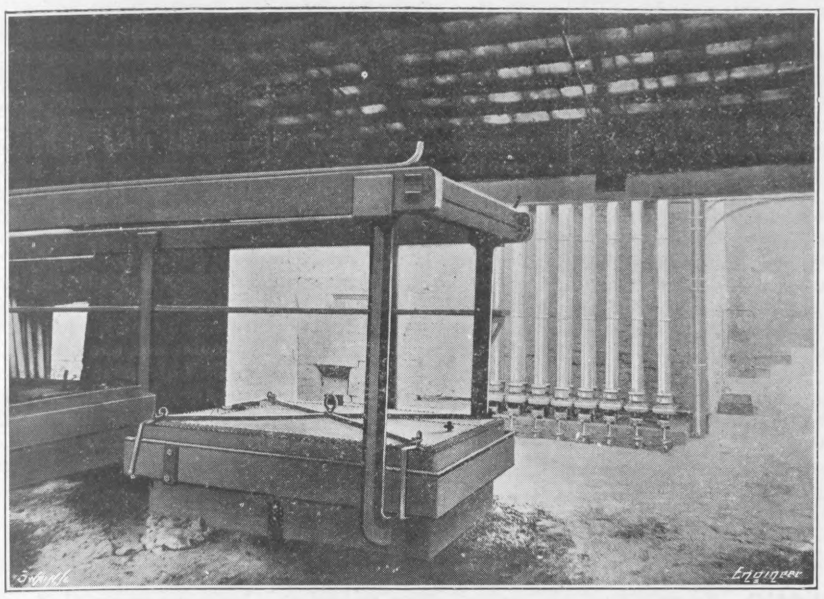


Fig. 5

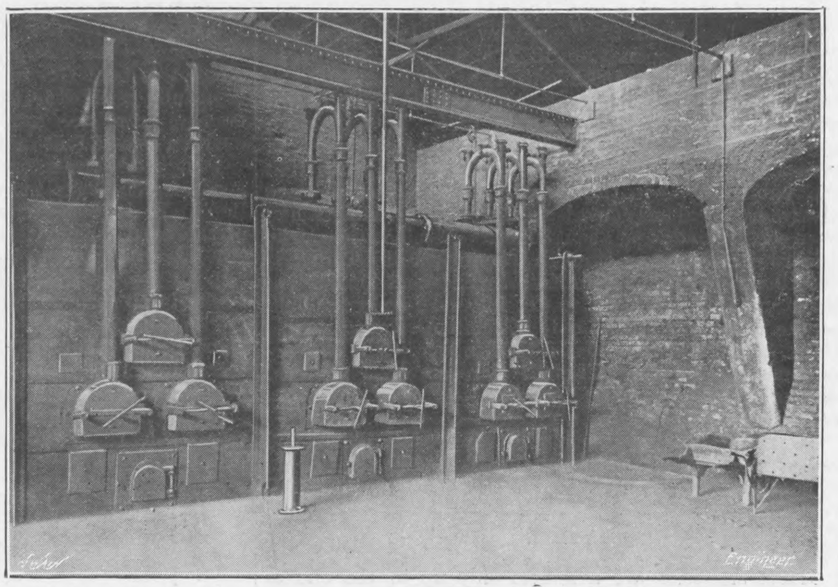


Fig. 6

ings which we gave in the eightieth volume of THE ENGINEER. Mr. Darlington has supplied us with what notes he can about the machines, and these in a few cases we have been able to supplement from other sources; but the early records of most of the tools have, we regret to say, been lost. It is greatly to be deplored that the history of machine tools has not been preserved, for in it might be found the whole story of the rise and progress of mechanical engneering. What the struggle of the early engineers were, when nearly everything had to be done by skill of hand, we, who have scores of different machines, can only faintly conceive. To all of us it would have been of the very greatest interest if records of the stages by which those tools were developed had been preserved. We hope that if anyone who may read this article is able to add anything to our knowledge of the machines shown, or to recall anything of the methods of building engines in the days of Watt and his predecessors, he will not hesitate to give us the benefit of his knowledge.

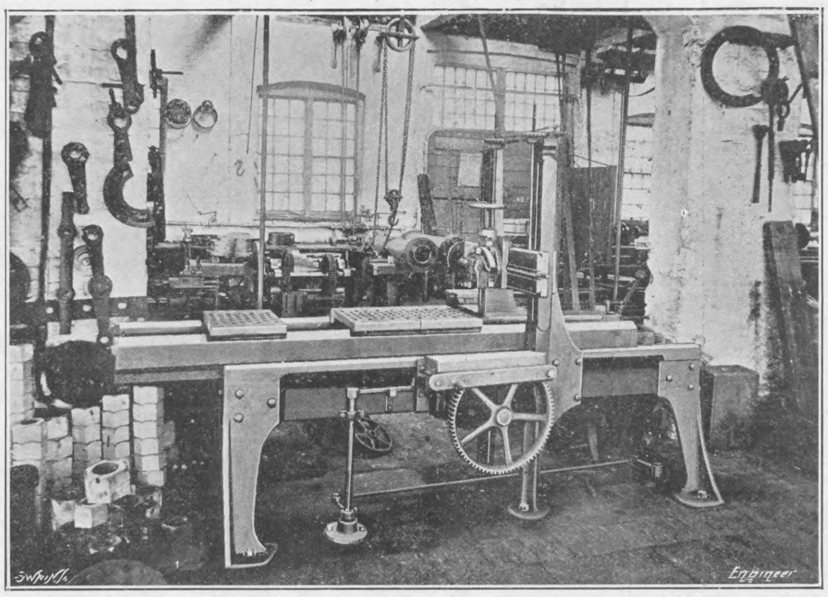


Fig. 7—LIGHT PLANING MACHINE WITH LOOSE TABLES

Boring was one of the most difficult operations the early engine builders had to face. When Watt started making engines boring machines were of the crudest construction. The boring head was a cast iron disc fixed on the end of a long bar, which was revolved by a waterwheel or by horses. In the periphery of the disc the tools were wedged. The cylinder to be machined was firmly chained to a wagon which ran on a smooth road in front of the machine. Tackle was provided for pulling this wagon along; that was the only feed gear. The heavy boring head sagged down and cut more at the bottom than the top, and there was nothing whatever to ensure that the cylinder was straight. It was rarely cylindrical, and we find Watt on one occasion rejoicing that one cylinder he had produced was nowhere more than $\frac{3}{8}$in. from true circularity. Later on, in 1775, Wilkinson, of Bersham, invented a boring machine with a stout and strong bar that went right through the cylinder and along which the boring head was fed. With this a 72in. cylinder was bored for Watt so well that it was "not further from absolute truth than the thickness of a thin sixpence in the worst parts." This was a horizontal machine, but many engineers recognised the advantages of boring vertically, and there were several machines so arranged at Soho. One of these is shown in Figs. 1 and 2. According to modern ideas, the scantling of the machine is, it will be seen, very light. The boring bar ran freely in bearings and in the wheel, but was splined along its upper half and keyed to the upper half of the saw tooth clutch, which is seen clearly in the engraving. A long rack, just visible in Fig. 1, projected vertically from the top of the bar, and with it a small pinion engaged. The pinion was on a cross shaft, which had a worm wheel keyed to the other end, and by revolving the corresponding worm the feed was effected. The drive was taken from a cone pulley right up under the beams to another cone on the right of the machine. The shaft of the second cone bore a small bevel pinion gearing with a large wheel on a vertical shaft. Just below the bevel wheel was a pinion gearing with the big driving wheel, thus giving rotation to the bar.

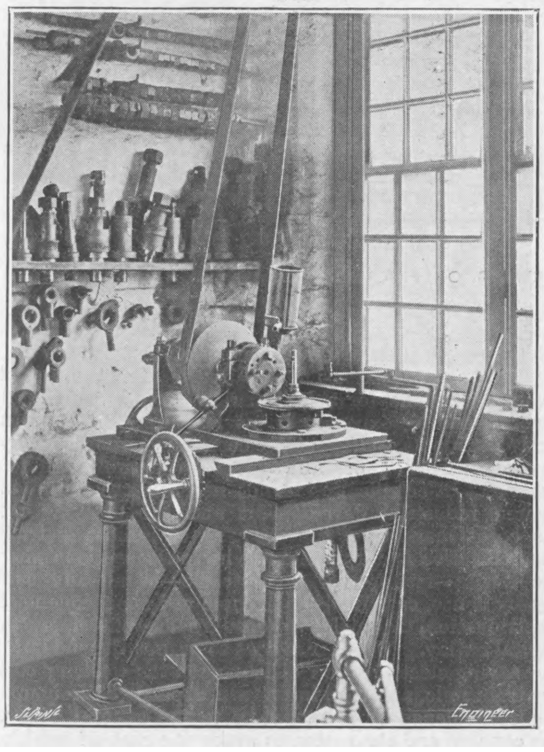


Fig. 8—NUT FACING MACHINE

Fitted into the same housing was a smaller drilling and boring machine driven in a similar manner. It can be distinguished to the left of the big machine. The machines in the foreground of Fig. 1 were comparatively new when the photograph was taken, and were built, like all tools, and even travelling cranes, at the Soho Works, by Boulton and Watt themselves. As an example of a Soho lathe we give Fig. 3. It is of interest chiefly for the worm drive at the near end; the worm wheel, it will be observed, hardly comes into line with modern requirements. Fig. 8, on this page, is interesting because it is an early example of a type of machine invented by Nasmyth. It will be recalled that the inventor of the steam hammer obtained his first job when he came to London in the private laboratory of Mr. Maudslay, and that there he was employed in making those elaborate and beautiful models of marine engines which engineers know so well. Part of his work was to file up hexagon nuts, and this work proving difficult and tedious, he devised a milling device which was fitted to a lathe for performing it. Subsequently, this lathe developed into a complete and independent machine. which was the ancestor of all modern nut milling machines, and possibly of all milling machines, and was very similar to the tool here illustrated.

Amongst his many other inventions Watt produced a steam tilt hammer some years before Nasmyth designed the type of hammer that bears his name. Soho held at one time a great reputation for coppersmith work, and it was with the Watt hammer illustrated in Fig. 4 it was done. Even up to the end this steam tilt was employed on the production of copper expansion joints.

As an example of another early machine built at Soho, we reproduce, Fig. 7, a photograph of a light planing machine. A curious feature about it is the table. It was apparently provided with two inverted vee slides, upon which small plates provided with holes for holding-down bolts were fitted.

From tools we turn to one or two other interesting antiquities. Fig. 9 shows one of the oscillating cylinders for the 2000 horse-power engines of the s.s. Ulster, of the City of Dublin Steam Packet Company. It was made to replace one that had been cast in 1859. Its internal diameter was 96in., and it weighed approximately 30 tons. The stroke of the engine was 72in. The production of such a cylinder would be regarded as a remarkably fine piece of engineering even now, and this was a copy of one made nearly fifty years ago. It is interesting to recall that the Ulster was provided with a superheater, which, after trial, was discarded.

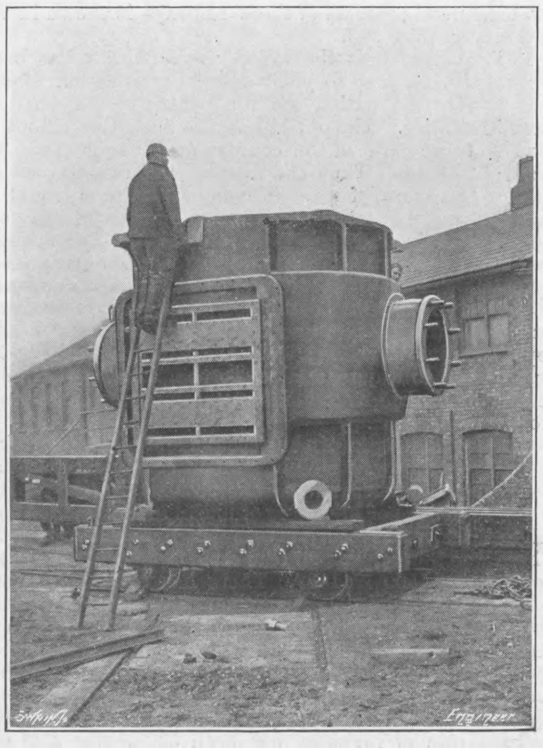


Fig. 9—OSCILLATING CYLINDER OF S.S. ULSTER

Finally, we give two illustrations of the Murdoch gas plant at Soho. This plant was used until the old works changed hands, and in Murdoch's own time it had lighted the underground shops or caverns in which he did much of his mechanical work.

THE FINNISH RAILWAYS AND THEIR ELECTRIFICATION.*

Some 93 per cent. of the railways in Finland belong to and are worked by the State. Only 287 kiloms. are owned by private companies, while the total length of the State railways, including service lines, is about 4500 kiloms. The first line from St. Petersburg to Helsingfors and Tavastehus was opened in 1862, and is 522 kiloms. in length. A short line, 153 kiloms. in length, to Hangö was built and opened by a private company in 1873; but it was bought up by the State in 1875. This promptitude, and the fact that all the great extensions of recent years have been made by the State, prove that the public rights in the ways of communication have always been jealously guarded. By 1883 1520 kiloms. had been constructed; and about 3000 kiloms. since then. The line from Helsingfors through Tammerfors to Tornea is 830 kiloms. long; that from Kotka to Kajana is 492 kiloms.; that from Viborg to Joensuu 311 kiloms. The great bulk of the lines are single, only 177 kiloms. being double track. They are constructed to 5ft. gauge. The country is generally flat, the rail-gradient reaching 25 per 1000 only at one place, and 20 per 1000 at three places; only 54½ kiloms. length have a gradient above 15.

The total cost of these lines has been about 350 million marks = £14,000,000, that is £3100 per kilom., or nearly £5000 per mile, including service lines, or £7200 per mile excluding service lines. At the end of 1907 the public debt on account of railways stood at only £5,500,000, or only £1220 per kilom. of line.

Exact statistics are available only up to the end of 1907, and since then an important branch, 82 kiloms. long, from Elisenvaara to Nyslott, has been opened, while another twice as long from Joensuu to Nurmes may be finished next year. Another branch about 100 kiloms. long is being built in the extreme north from Kemi to Ravaniemi. Herewith is a specially prepared map showing both the railways and the waterways in Finland. The waterways will be referred to in a subsequent article. The lines are served by about 500 locomotives, 1000 passenger coaches, and 13,000 goods wagons, the average capacity of the coaches being 33 seats and of the wagons 9 tons.

In 1907 there were run 8½ million passenger train-kiloms. and 4½ million goods train-kiloms.; 12 million passengers were carried, or about 170,000 per kilom. length of line, each passenger travelling an average distance of 43½ kiloms. This means 520 million passenger-kiloms.; and the average fare was 3¼ centimes per passenger-kilom., the total passenger receipts being 16¾ million francs, or £670,000, which equals £350 per mile of line—excluding service lines.

In the same year 3½ million tons of goods were carried, or 140,000 tons per kilometre of line, each ton being carried an average distance of 122 kiloms. The receipts from goods traffic were 22½ million francs. This means £470 per mile of line. Thus the combined receipts from passengers and goods and other odd sources were 40 million francs, or £830 per mile of line in operation. On the other hand, the total costs of operation amounted to 33½ million francs. This means £700 per mile, or a little over 84 per cent. of the receipts. Of these costs 7¼ per cent. went in central management, 25½ per cent. in supervision and maintenance, 32¾ per cent. in traffic expenses, and 34½ per cent, in locomotive costs and materials.

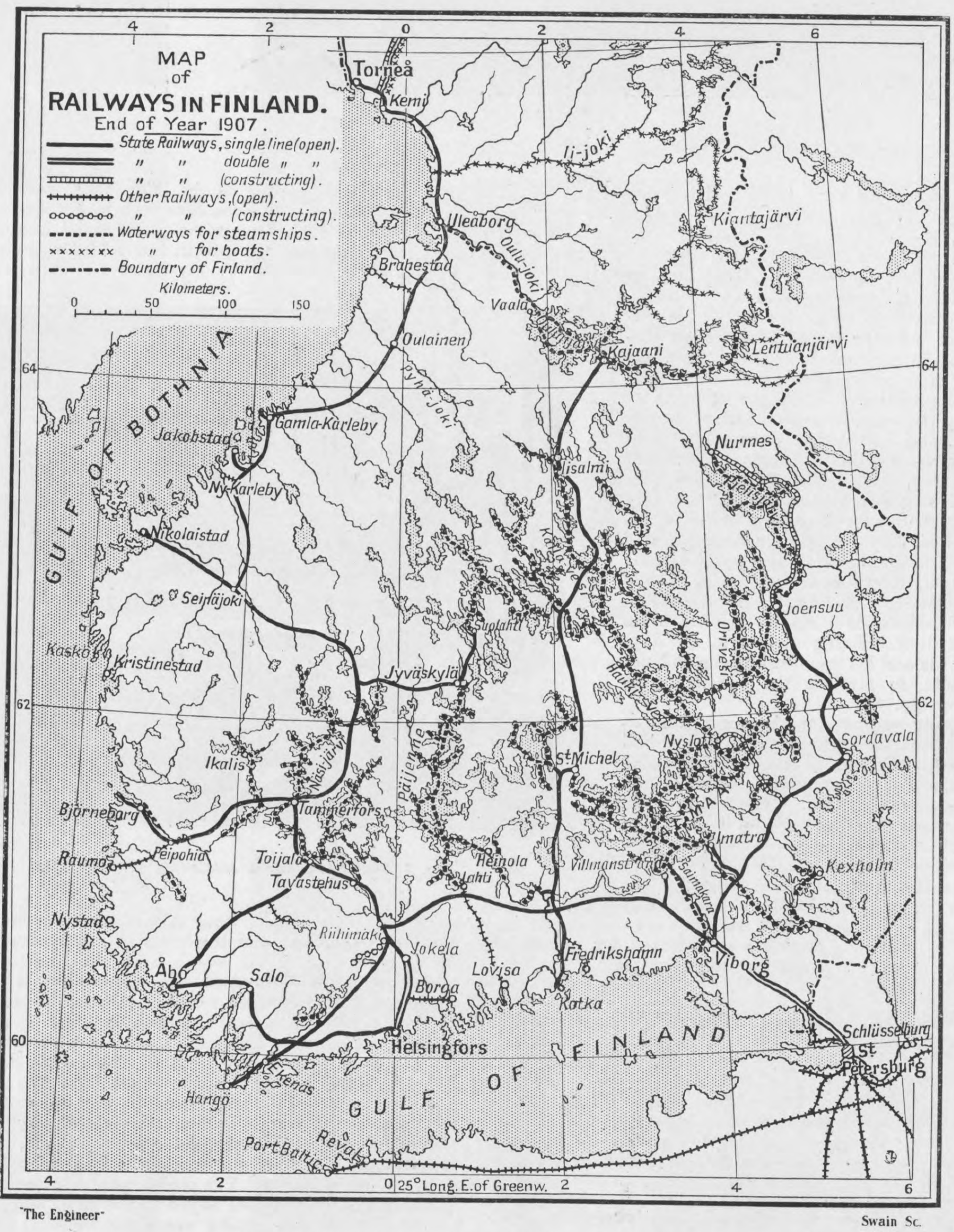
The net excess of receipts over costs, excluding interest on first cost, being 6⅛ million francs, yield 1¾ per cent. on the capital outlay.

The number of servants, both regular and day labourers, on the railways is 14,630, which works out at 7.7 per mile of line. Of these 6150 are day labourers, and the total cost in salaries and wages is 22.4 million francs, or an annual average of 1530f. = £61 per worker. A State pension and accident insurance bureau for the railway servants is in operation.

The general progress of these railways is shown in the diagram on page 262.

It is evident that the railway expenditure has been regulated so as just to yield a low amortisation rental, and to give the nation the full benefit of the possible traffic facilities. The object has also been throughout to develop those parts of the country most handicapped by natural features. Thus the interest upon capital outlay yielded by excess of receipts over costs varies from 3.7 per cent. on the Petersburg-Helsingfors-Tavastehus section, and close on 3 per cent. on the Abo-Tammerfors and Viborg-Imatra sections, down to 0.45 on the Abo-Karis-Helsingfors line along the coast, which was opened as late at 1899, and is still not greatly used in consequence of the competition of the very comfortable and rapid coasting steamers; while the two lines running far northwards to Kajana and to Tornea, as also the more recent line to Björneborg, in the extreme west, yield only from ½ to $\frac{6}{10}$ per cent.

The developments of the receipts and of the operating costs have followed closely similar curves, and in the early years suffered severe fluctuations. After rapidly rising to 9300f. per kilometre of line in 1874-6, the receipts fell to 7100f., and then again rose steadily to 9300f. in 1882. There was then, again, a great rapid falling off, the lowest point being 5500 in 1887. There has been a constant advance since that date; but the recovery was slow until 1895, when only 6800f. was reached. In 1900 the sum of 10,500f. was attained; and during the subsequent period of five years of world-wide depression there was no further increase. Since 1905 the rise has again been rapid—at the rate of 1300f., or £52 per annum. Since 1895 the average rate of increase has been 520f., over £20 per kilometre per year. Since 1896 the annual rate of increase of costs has been 590f., so that while the net receipts remained at 3000f per kilometre from 1896 99—a little higher only than the average for the previous twenty years—it has fallen to 2000f. in the last few years.



"The Engineer" Swain Sc.

THE RAILWAYS AND WATERWAYS OF FINLAND

The total receipts have risen from under 7 million francs in 1876 and 8.4 millions in 1887 to 39.6 millions in 1907. This great increase in total income has followed upon a bold policy of extension of length of line. This remained stationary from 1876 to 1882. With the exception of short pauses it has since then been rapidly developed. The average rate of extension has been over this period exactly 100 kiloms. per year. Thus the trust in the capacity of the country for industrial and general development on which this bold Government policy has been based has been fully justified by the financial results. Over the last twenty years the total income has increased at the average rate of 1.56 million francs (£62,400) per year.

It is also satisfactory to note that the passenger and goods traffics have increased in precisely equal proportions. In 1876 the passenger traffic yielded 44 per cent. of the total receipts; in 1906 it yielded 43½ per cent. An interesting fact is that while the goods traffic remains fairly constant throughout the year, the passenger traffic is 50 per cent. greater in summer than in winter.

The receipts per kilometre of line are very unequally distributed. They are 33,600f. per year on the Helsingfors-Petersburg section; 14,600f. on the Abo-Tammerfors section; over 9000f. on the Hangö, Vasa, and Imatra branches; and much less on the other lines. It is regrettable that the official statistics do not give the separate figures for the different portions of the Helsingfors-Petersburg line, because the traffic throughout a long middle length upon it is, in a great ratio, less dense than that between Petersburg and Viborg, and that between Helsingfors and Rihimäki. Probably between Petersburg and Viborg the receipts are over £3000 per kilometre of length. Again on the line stretching from Kotka on the coast northwards to Kajana, the traffic on the short southern section from Kotka to Kouvola is much denser than that north of this limit; but the official statistics do not differentiate between the two sections. On the whole length of 526 kiloms. the receipts are only 5600f. per year per kilometre.

Projects of Railway Electrification.

In 1907 official estimates were very thoroughly worked out for the capital and working costs of electrification of the more important lines. The chief engineer of the State Railway Administration has very kindly given the present writer complete details, not only of the results of these estimates, but also of the bases on which they rest, and the manner in which the calculations have been made, including sample diagrams of the actual graphic and arithmetic calculations for the most difficult portions of the main Petersburg-Helsingfors line. A close examination of these, assisted by lengthy explanations generously given by the staff, convinces one that they are completely trustworthy, erring in detail only in the rightly prudent direction of making here and there over-liberal allowances for doubtful items in cost of construction. The general order for this work, emanating, no doubt, from the Senate, erred seriously, however, in the opinion of the present writer, in directing that the estimates should cover far too great a proportion of the whole system. The above given statistics illustrate the immense variation of the density of the traffic, and it does not seem to have been sufficiently recognised (1) that it requires, under all possible local conditions, a considerable traffic-density to justify the initial capital outlay upon electrification, and (2) that when a long line carries heavy traffic through short lengths at either end, but very light traffic over its middle length, it may be bad policy to electrify the whole length, but very good policy to electrify the two short end lengths. This preliminary remark is necessary in order to enable a true comprehension of the following figures to be arrived at. The estimates show a profit upon each of the four alternative big schemes investigated. But the profit would be many times greater if the schemes were more rationally restricted to those sections where electrification is economically justified. The policy of the general industrial development of the country as a whole by a great extension of railways into remote parts where the traffic for a long period of years can hardly cover operating expenses is, at least in Finland, a perfectly justifiable and profitable economic national policy; but electrification of railways is an entirely different question. Electrification is not necessary to obtain the desired industrial development and the bringing into the coast markets of the products of remote districts. Electrification is only justifiable in those sections where the traffic—mainly passenger traffic—is already sufficiently dense, or is likely to become so in consequence of electrification, to yield a substantial profit upon the capital outlay. Whether it does so or not depends upon the saving electrification effects upon the working costs per train mile, and this, in its turn, depends entirely upon the traffic density. It cannot be to the general good of the country and the nation to make the cost of working the remote lines greater per train mile than they are at present. It necessarily promotes the general good to make the working cost per train mile less than it now is upon the already busy sections, and upon those sections where a speedy great development is fairly certain.

The maximum weight of the trains varies largely on the various lines. It is 300 and 570 tons respectively for passenger and goods trains on the Petersburg-Helsingfors line. The lowest passenger train weight is 190 tons on the Hangö line, and the lowest goods train weight 200 tons on the Suolahti branch. The maximum number of trains in motion simultaneously is thirty-eight on the Petersburg-Helsingfors line, and the minimum is four upon the above-named branch. The maximum horse-power calculated to be required at the turbine shaft of a central electric-power generating station had, for the year 1906, the extreme limit on the Petersburg-Helsingfors line, 36,800 horse-power, and a "normal" value of 28,400, while the "probable" normal for 1910 is 32,600. The yearly mean for this line would be 8900 horse-power. These figures are obtained from complete calculations based on weights, gradients, curves, &c. &c., at each point along the whole line, the true average being obtainable only by making the calculations throughout the whole length.

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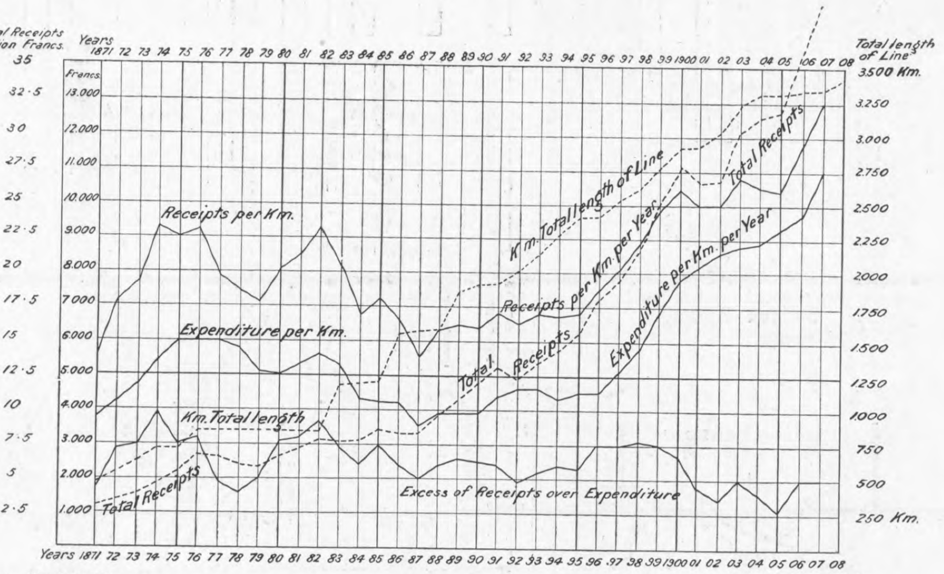
* See the "Development of the Industries of Finland," The Engineer, September 3rd, 1909.

For the lines connecting Viborg-Imatra-Elisenvaara-Nyslott-Joensuu the extreme maximum for 1906 was 14,700; the probable normal maximum for 1910 was 11,600, and the yearly mean 1750 horse-power. On the much longer line from Kotka to Kajana the similar figures were 15,000, 12,300, and 1760 horse-power. The estimates for electrification cover nine other lines besides the above. The whole of the twelve are grouped officially into four districts. For these the following are the totals yielded by the electrification estimates:—

	Maximum No. of simultaneous trains.	Extreme H.P., 1906.	Probable normal maximum H.P., 1910.	Annual mean H.P.
Wuoksen-Kymmene, or Eastern	64	60,000	52,000	12,500
Kumo, or South-Western	28	25,000	22,000	4,680
Seinäjoki, or Western...	14	12,000	10,000	1,680
Ulea, or North-Western	17	13,000	11,000	1,280
Totals		110,000	95,000	20,140

It is further estimated that in 1916 there will be a further increase of about 20 per cent. The present writer thinks this estimate much too low, and the diagrams of development prove it to be so if very unfavourable conditions be not gratuitously assumed. Confining attention to the portions of less sparse traffic, the statistics show a reasonable anticipation of between 30 and 40 per cent. in six years' time, without any allowance being made for stimulation due to electrification. If allowance be made for this, an increase of 50 per cent. is well within the limits of sober and moderate expectation.



PROGRESS OF THE RAILWAYS OF FINLAND

The data for construction costs have been taken from the Swedish electrified railways, these being, in general economic condition, the most nearly similar to the Finnish railways. For the power lines about double the copper cross-section used in Sweden has been assumed, because of the longer transmission distances; and for this reason iron trellis masts have been estimated for the transmission, the contact line being mostly upon timber poles. In these two items the costs are placed much higher than in Sweden; and, in passing, it may be pointed out that this excess in the estimates would entirely disappear if a more rationally restricted area of electrification were adopted. The price of copper is assumed at £100 per ton. As the cost of the bare copper is, in this estimate, $48\frac{1}{2}$ per cent. of the whole cost of power and contact transmission, a reduction of 35 to 40 per cent. in the price of copper would lower the whole by between 15 and 20 per cent.

The detailed estimates are made out only for the line between Petersburg and Helsingfors and that between Viborg and Antrea, these having a total length of track 482 kiloms., or 890 kiloms. of single line, inclusive of sidings.

The power transmission is single-phase at 40,000 volts and 25 periodicity; and the locomotive motors are single-phase at 12,000 volts. The transformer stations are placed apart an average distance of about 40 kiloms. The total number of these stations is fourteen, most of them with three transformers in each, while each of the two nearest Petersburg has four; each transformer has a maximum capacity of 1500 kilovolt-ampères. Most of the power line runs alongside the track, and where it lies at a distance from the railway it consists of two lines supported on independent rows of masts. Exclusive of copper, this system makes the power and contact lines together double as costly as in Sweden for single track railway and 1.6 times as costly for double-track lines. The standard contact line is given 65 sq. mm. section for main line and 50 sq. mm. for sidings. From 20 to 25 per cent. increase of speed over the present schedules has been reckoned on. This increase may perhaps be as much as is practicable without re-formation of the roads as at present laid; but it is not so much as is desirable. Of the various rates allowed for depreciation and upkeep, it will be sufficient to mention 8 per cent. for central station (water-turbine) machinery; 6 per cent. for transformers; $1\frac{7}{10}$ per cent. for buildings; $2\frac{1}{2}$ per cent. for contact line; and $\frac{7}{10}$ per cent. for power transmission line.

In reckoning the cost of the electric locomotives allowance is made for the value of the displaced steam locomotives; 136 of the former are assumed to do the work of 170 of the latter, on the ground that the former require less frequent laying-by and less time in the repair shops on each visit thereto. Again, fifteen steam locomotives are retained as a reserve. On this basis, the displaced locomotives being kept in service on other portions of the State Railways where the traffic is developing rapidly, the new cost of electric locomotives is found to be £96,000, and on this 3 per cent., or £2880, is allowed yearly for amortisation.

The savings in operating expenses are calculated under the head of (1) fuel, inclusive of 3 per cent. on two years' storage of (wood) fuel; (2) materials for locomotive oiling, cleaning, and lighting; (3) locomotive repairs; (4) locomotive wages; (5) workshop wages; (6) material for pumping and warming shops; (7) train lighting and warming, a not inconsiderable item in Finland; (8) saving on six small existing railway electricity central generating stations. These savings total to £101,300 per year.

The new expenditure is then calculated for power developed at the waterfalls of Wallinkoski, on the river Wuoksen, the river which discharges the whole of the water from the enormous Lake Saima, and which yields a minimum flow of 410 cubic metres per second, with a fall of about $10\frac{1}{2}$ metres. For this scheme the bare copper at £100 per ton costs 9,150,000f.; the total cost of the transmission and contact lines, 18,874,000f.; that of the transformer stations, 2,200,000f.; and the central station buildings and machinery, 5,550,000f. This latter works out at only £5 3s. per horse-power at the turbine shaft. The minimum steady horse-power yielded at the turbine shaft by this fall is 43,000, and the price asked by the proprietors of the land and water rights has to be added to the above. The total of the new yearly expenditure, including all that has been mentioned above, comes to £54,790. Subtracting this from the already cited total savings, a net yearly saving of £46,530 is effected. The horse-power required on the railway for this scheme is calculated as 35,000.

But the report states that electrification would bring about such an increase of traffic on the sections near Petersburg that within a very short period 15,000 horse-power would be used on the first 19 kiloms. of line outside Petersburg alone. As this stretch is supposed under the above described scheme to be fed from one transformer station of 6000 kilovolt-ampère capacity, it is apparent that, so far as these districts of dense traffic are concerned, the estimates fell far short of the actual probabilities.

Similar calculations have been made for the use of the Imatra Waterfalls further up this same river. Here the buildings and machinery of the central station are estimated to cost 11,500,000f., or double the cost at Wallinkoski, the hydraulic works being extremely expensive, and the horse-power actually in the water being 70,000. The peculiarity of this estimate is that nothing is charged against the acquisition of the water and land rights, the reason being that these are already State property. The remark may be interpolated that this seems a bad reason for placing the value at zero. In spite of this advantage, this scheme yields a materially less profitable financial result than the first one. It is otherwise unnecessary to consider it in detail, because both the State supreme authorities and unanimous public opinion have decided against the damming of the Imatra Falls, which is the great show public garden of the north, attracting weekly throughout the summer many thousands of tourists from all the countries of mid and north Europe, as well as from Britain and America. The same remark applies to the third scheme worked out by the State Railway engineers, which consists in the partial damming of these same Imatra Falls. Their fourth scheme consists in the utilisation of three falls, namely, Wallinkoski along with Anjala and Mankala, two waterfalls on the Kymmene River, which runs into the sea at Kotka. Here again Anjala is State property, and no charge is made for the acquisition of the rights. Mankala is private property, and difficult to acquire. The two together yield a horse-power 1200 less than is required for the scheme, so that this scheme necessitates the accumulation of energy in one or other form. It works out to a rate of profit about two-thirds that given by the other schemes, and for this and other reasons, explained in the engineers' report, it is not recommended.

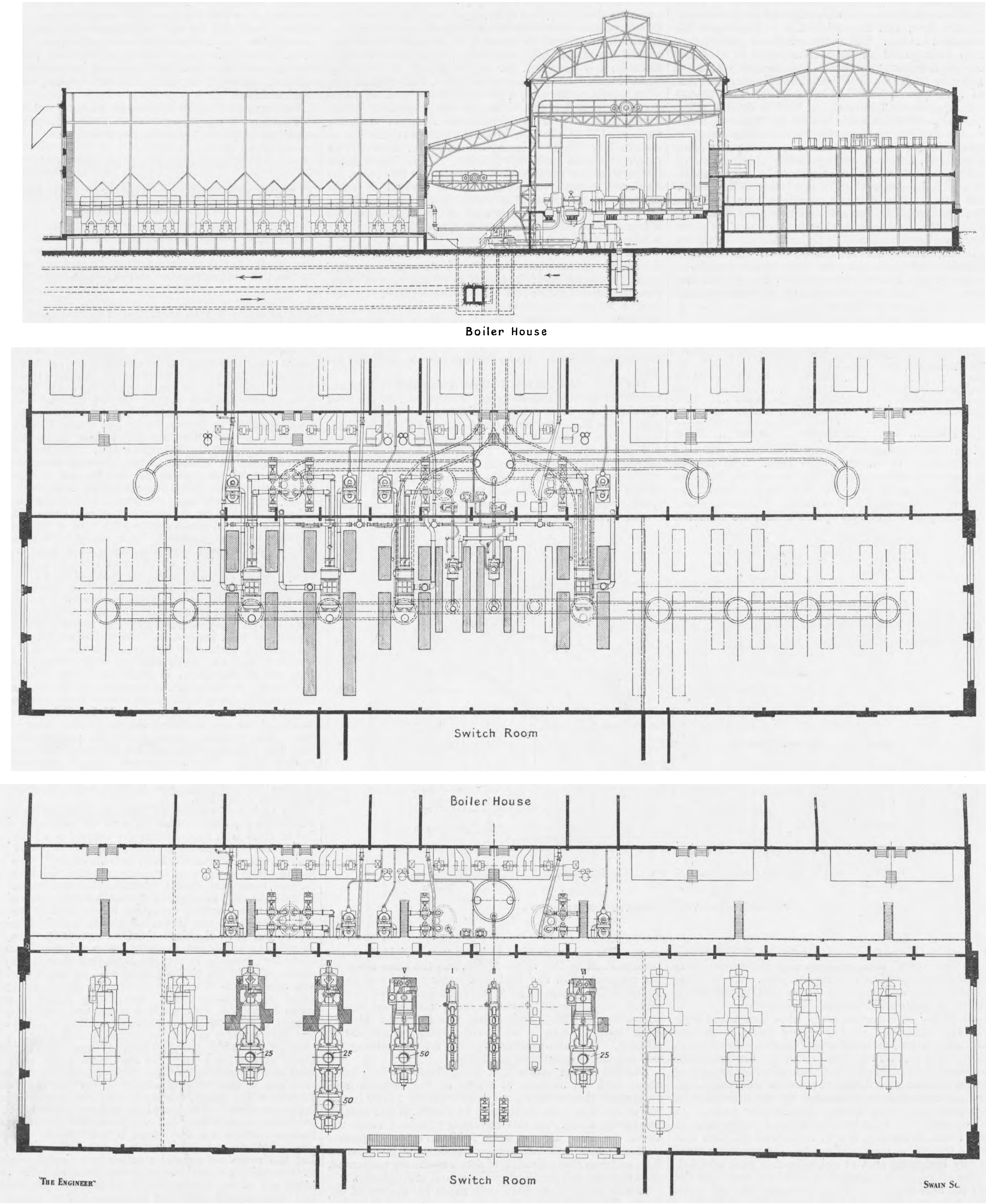
The engineers' report finishes by pointing out that the Petersburg-Viborg section of the Finnish State Railway is the most ripe for profitable electrification.

A NEW ELECTRICAL GENERATING STATION AT BUENOS AYRES.

SOME time ago the German Transatlantic Electricity Company, of Berlin, which either owns or leases all the stations for supplying electric current for power and lighting purposes in the city of Buenos Ayres, decided to concentrate its plant in one large central station, which is now in course of construction on an arm of the Dock Sud, situated outside the boundaries of the city of Buenos Ayres. This new station is to be equipped with machinery of approximately 110,000 horse-power capacity, and will be one of the largest electrical generating stations in the world. Some idea of its size will be gathered by reference to the illustrations. When completed it will contain ten turbo-alternator sets, each of 11,000 horse-power, of which five are at present in hand—three at the works of Franco-Tosi, at Legnano, and two at the Mannheim works of Brown, Boveri and Co. The top illustration on page 267 shows the first of these large turbo-alternator sets, which was despatched by Brown, Boveri and Co. to Buenos Ayres in November last, whilst the others show the finished and unfinished parts of the turbo-alternator. The steam turbine is constructed for a normal output of 11,000 horse-power at a speed of 750 revolutions per minute, and is capable of giving an output of 14,200 horse-power for at least two hours under normal conditions, the steam pressure at the stop valve being 180 lb. per square inch, and the superheat 572 deg. Fah. The normal steam consumption with a load of 7500 kilowatts has been guaranteed not to exceed 6.3 kilogrammes (13.9 lb.) per kilowatt-hour, the cooling water being supplied at 60 deg. Fah. There are two generators, each having an output of 750 kilowatts, at 12,000 volts and cos ϕ .9, coupled in tandem, one having a periodicity of 25 cycles and the other a periodicity of 50 cycles per second. An exciter, coupled to the end of the alternator shaft, with an output of 110 kilowatts at a pressure of 220 volts, provides the exciting current for both generators. The surface condenser, which has a cooling surface of 1300 square metres (13,993 square feet) will be able, when supplied with sufficient cooling water at 60 deg. Fah., to condense 50,000 kilogrammes (110,200 lb.) of steam, giving a vacuum of 28.5in., whilst a vacuum of 27.2in. will be maintained when the condenser is supplied with the cooling water at 77 deg. Fah. The total weight of the set, including the condensing plant, is 475 tons. The turbines, which are of the parallel-flow type, have two cylinders—high and low-pressure—with a bearing between them. This arrangement, we are informed, has been adopted with a view to obtaining the highest economy in steam consumption, and to allow a greater number of blade rows to be fitted.

The high temperatures are confined to the comparatively small high-pressure cylinder, so that the expansion effects due to these high temperatures are reduced to a minimum. The double-beat controlling valve is operated by means of oil under pressure instead of steam, as is customary. The oil is supplied from the general lubrication system, the advantage claimed being that, should lubrication fail, the turbine will be automatically stopped. A fly-ball governor operates the relay on the controlling valve, and is connected to the same vertical shaft as one of the oil pumps, and is driven by helical gear from the shaft. On the same shaft there is an emergency governor set to act if the speed should increase above the normal by 15 per cent., and thus close the double-seated valve in the ordinary manner. On the other side—and symmetrical with this shaft—is a second oil pump, driven by the same helical wheel. This second oil pump works in parallel with the first pump, and supplies oil for general lubrication at a pressure of 22 lb. per square inch. The turbine rotor consists of forged steel drums, into the extremities of which the shaft ends are shrunk and locked by means of bayonet keys. The steel hubs which carry the shaft ends are provided with heating channels on the steam inlet end, so that uniform heating of the rotor is obtained. To balance the thrust, dummy pistons with labyrinth packing are provided. The one which balances the thrust of the low-pressure expansion, and which, in the earlier type of Parsons turbines was very large, is built on the low-pressure end of the rotor, in accordance with Fullagar's patent. The two rotors are coupled together by a flexible coupling, an intermediate thrust bearing being provided. The alternators are of the Brown, Boveri turbo-type with rotating field magnet and stationary armature. They are of the enclosed type with induced draught ventilation. The laminations of the stator are sub-divided by means of a large number of air ducts, as is customary in such machines, thus presenting large cooling surfaces to the air. The entire core with its spacers is held together by press plates at each end of the machine, the windings being secured in the slots by means of wedges. The ends of the windings projecting out from the armature housing are fastened by insulated supports in such a manner that no displacement, either due to mechanical or electrical causes, is possible. The circular steel plates forming the field magnet cores are also separated from one another by distance pieces to allow free ventilation between them, and are provided with slots to receive the windings. The coils are of copper strip wound on formers, and are so arranged in the slots of the field magnets that the pressure due to centrifugal force cannot cause deformation. The coils are secured in the slots by means of metallic wedges so that movement is impossible. The ends of the windings projecting over the core of the field magnet are protected and held in position by caps of a non-magnetic metal of considerable strength and all the windings are ventilated. The two alternators are mounted on separate bed-plates fitted and screwed together. The ventilation is carried out on Brown, Boveri and Company's system, cold air entering at both ends of the

ELECTRICAL GENERATING STATION AT BUENOS AYRES



machine through two openings in the bed-plate provided for this purpose, and the air is then blown, by means of two fans situated at the ends of the rotor, through the channels provided in the rotor field magnet wheels and through the stator, after which it goes out by an opening on the top of the machine casing. By means of this system of ventilation all parts of the machines are maintained at a uniform temperature, and equal expansion is obtained. It is said to be impossible for the machines to get out of balance. The alternators are capable of carrying an overload of 25 per cent. for half an hour, and the temperature rise after ten hours' continuous running is guaranteed not to exceed 45 deg. Cent. to 50 deg. Cent. on any part of the machine above that of the surrounding atmosphere. The weight of one of these generators complete, but exclusive of bed-plate or bearings, is 73.4 tons, the stator alone weighing 48.1 tons and the rotor 25.3 tons. Six sets are being built in the works of the A.G. Brown, Boveri and Co. at Baden and Mannheim for the central station, Buenos Ayres. Four sets will each consist of a three-phase generator, with a normal output of 7500 kilowatts—maximum 9000 kilowatts—coupled to a turbine, whilst two sets have two separate generators of the same output.

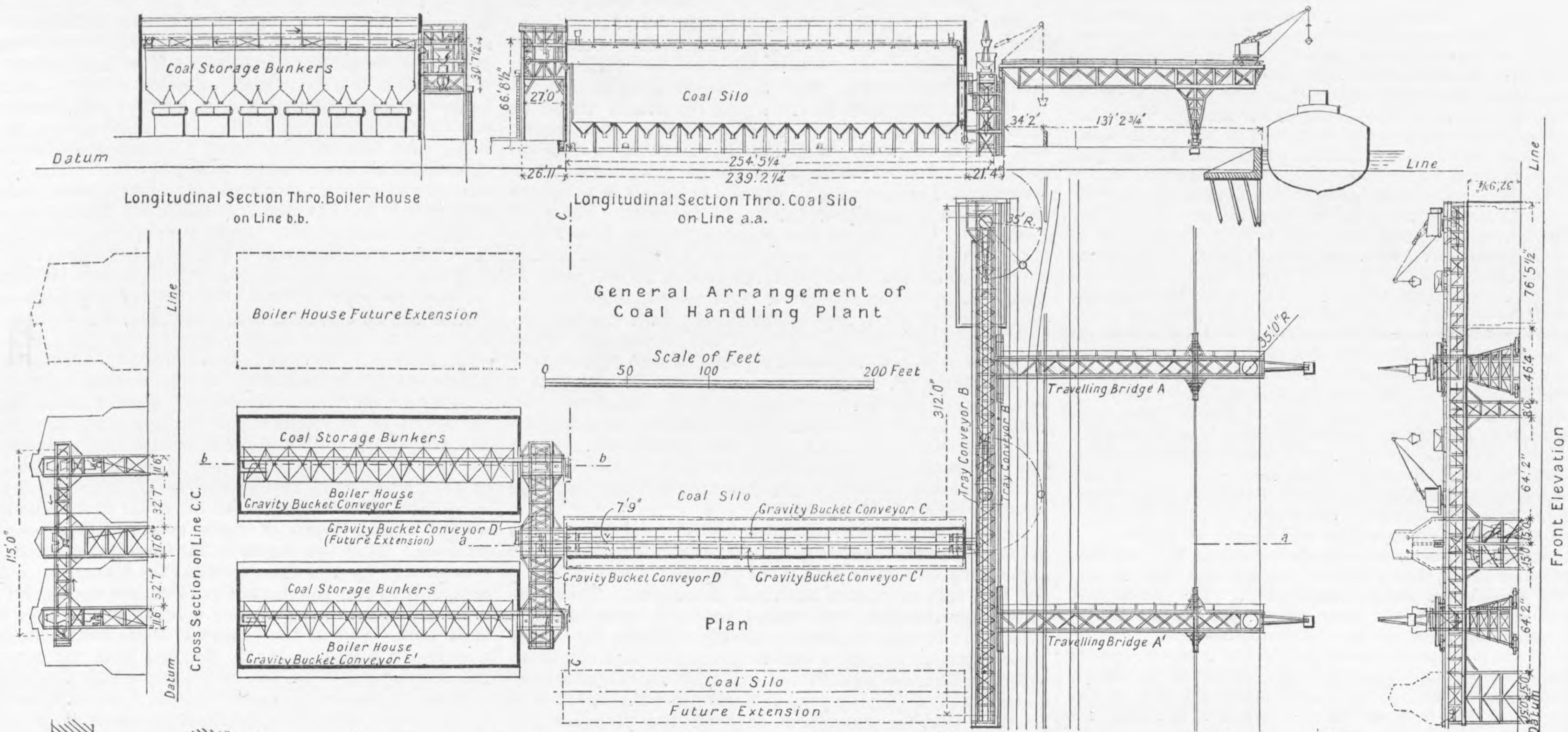
Each of the five bays of the boiler-house will contain twelve Babcock and Wilcox marine type boilers. These bays are at right angles to the dock, and are fitted with overhead bunkers.

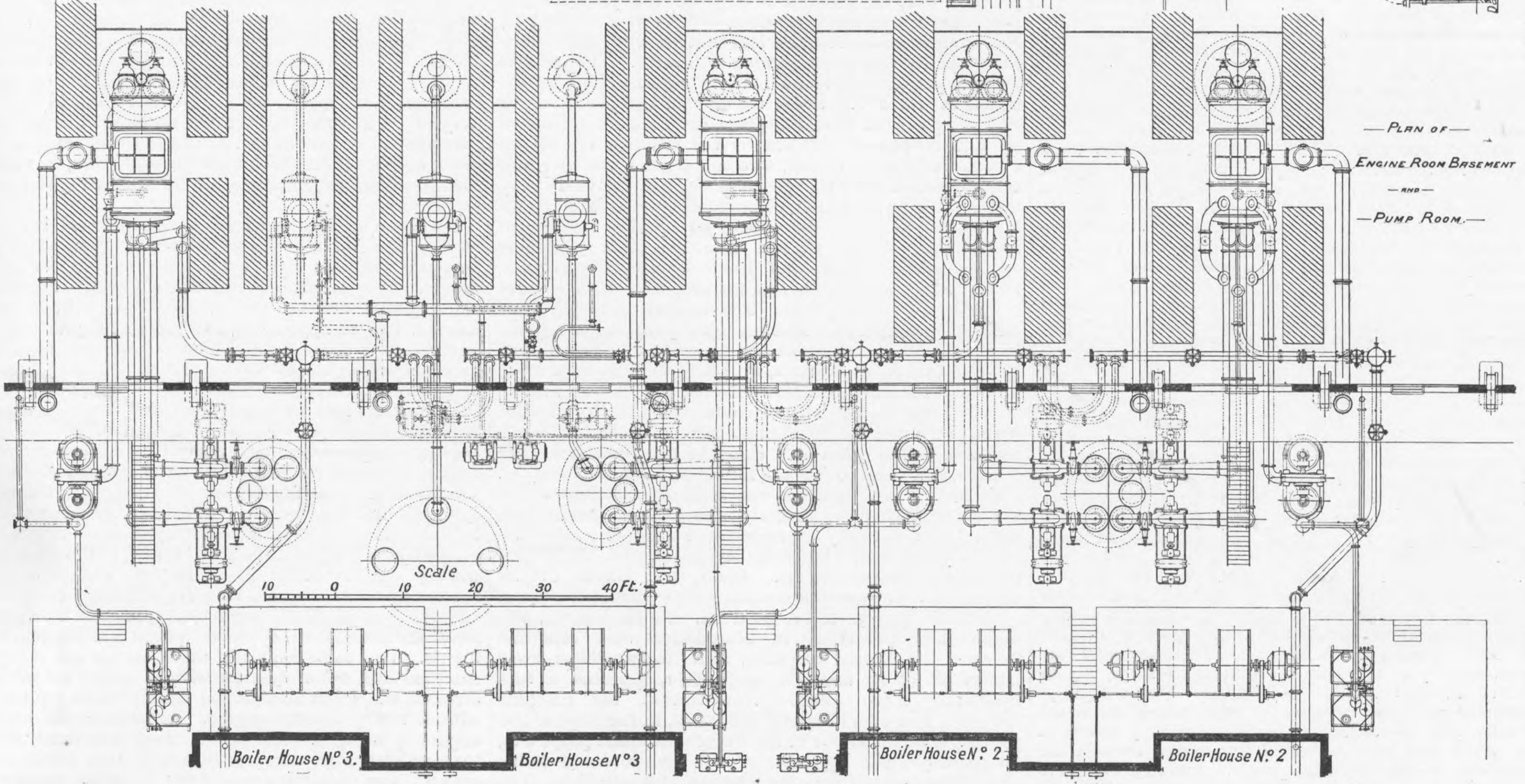
The coaling plant has been designed to utilise "run-of-mine" Welsh coal from the colliery, carried by ocean-going steamers, and to deliver it either into storage silos or direct into bunkers in the boiler-house. The coal in its passage from the steamer will be broken to a suitable size for use in connection with automatic stokers and simultaneously automatically weighed. The coal will be brought to the station for the time being by means of railway wagons, and unloaded by jib cranes placed on the bridge carrying conveyors B and B^1—see page 265—which run parallel to the railway track. When the river is sufficiently dredged to permit of ocean-going colliers being brought alongside the quay, travelling bridges will be constructed upon which the jib cranes will be placed, and the travelling bridges fitted each with one of Babcock and Wilcox tipping tray conveyors capable of handling large pieces of coal. As the bridges may be moved along the quay side the position of the cranes will easily be adjusted to suit the hatches of the colliers. At the outset, however, there will be two travelling 4½-ton jib cranes. These cranes, with a radius of 35ft. and capable of hoisting the maximum load at a speed of 100ft. per minute, will be placed on the structural steelwork, on which will be installed the tipping tray conveyors B and B^1 above referred to. The cranes will be of the Babcock and Wilcox single motor type fitted with the "Crypto" gear, by means of which the motor operating the crane runs continuously, and is started by means of a single switch, no controller being required, and the power of the motor is transmitted to various motions of the crane by means of epicyclic gear. Each crane, when in full working order, will handle 50 tons of coal per hour, the coal being discharged by the crane into a combined travelling hopper and single-roll coal breaker, and all pieces of coal will be reduced to a maximum size of 8in.

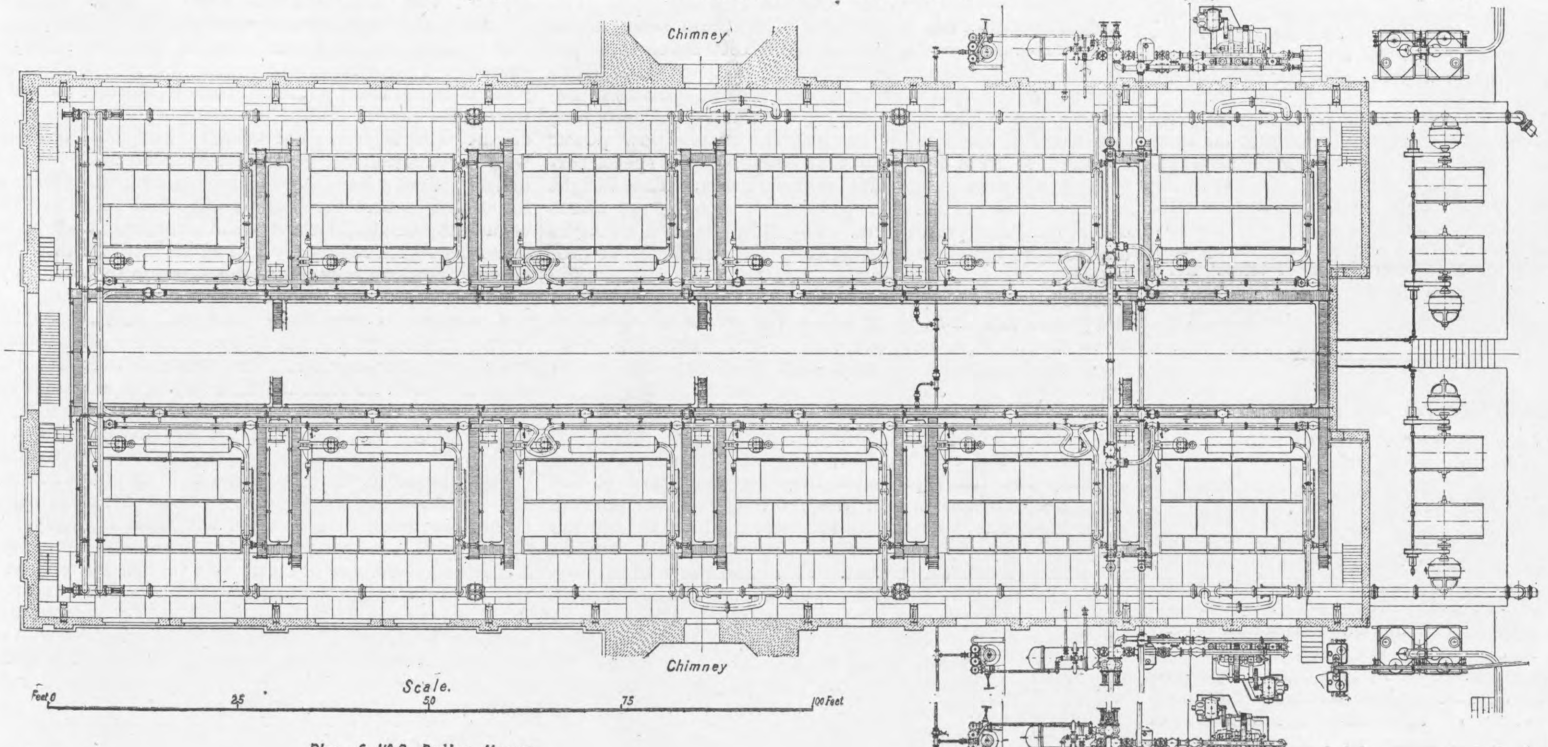
From the coal breaker the coal will pass into two of the tipping

ELECTRICAL GENERATING STATION AT BUENOS AYRES

For description see page 263)


Coal Storage Bunkers
30'7¼"
66'8½"
27'0"
Coal Silo
34'2"
131'2¾"
Datum
Line
26'11"
254'5¼"
239'2¼"
21'4"
Longitudinal Section Thro. Boiler House on Line b.b.
Longitudinal Section Thro. Coal Silo on Line a.a.
General Arrangement of Coal Handling Plant
Scale of Feet
0 50 100 200 Feet
Boiler House Future Extension
Line
Datum
Cross Section on Line C.C.
115'0"
Coal Storage Bunkers
Boiler House
Gravity Bucket Conveyor E
Gravity Bucket Conveyor D' (Future Extension)
Coal Silo
7'9"
Gravity Bucket Conveyor C
Gravity Bucket Conveyor D
Gravity Bucket Conveyor C'
Plan
Coal Storage Bunkers
Boiler House
Gravity Bucket Conveyor E'
Coal Silo
Future Extension
Tray Conveyor B
Tray Conveyor B'
312'0"
35'0"R
Travelling Bridge A
Travelling Bridge A'
76'5½"
64'2"
64'2"
Front Elevation


Plan of Engine Room Basement and Pump Room.
Scale
10 0 10 20 30 40 Ft.
Boiler House No. 3.
Boiler House No. 3
Boiler House No. 2
Boiler House No. 2


Chimney
Chimney
Scale.
Feet 0 25 50 75 100 Feet

Plan of No. 3 Boiler House.

"The Engineer" Swain Sc.

tray conveyors, B and B^1, each of which is capable of handling a maximum of 100 tons of coal per hour. These conveyors will deliver the coal into breakers which are placed in the towers situated at each end of the silos, the coal having to be broken to suitable dimensions for burning on mechanical stokers. In its descent to the next pair of conveyors the coal is automatically weighed and registered, and, after passing the weighing machine, it is delivered by means of special rotary fillers into either one or two of the gravity bucket conveyors—C and C^1, page 265—each of which is capable of handling 100 tons of coal per hour. These conveyors are designed either to deliver the coal into the silos, or, if it is desired to feed direct from the collier into the boiler-house bunkers, to discharge into conveyors D and D^1, which are carried on steel structures across the end of the boiler-house. After having been weighed, the coal passes from the conveyors D and D^1 into the boiler-house to conveyors E and E_1, each of which has a capacity of 50 tons per hour. Should it be desired to take the coal from the silo into either of the boiler-houses, delivery is effected from the bottom of the silo by means of special valves delivering the material to travelling fillers, which are placed below the silo, and charge the buckets of the 100-ton conveyors C and C^1. The coal is then elevated and carried along the top of the silos and delivered into conveyors D and D^1 as before. The delivery of the coal from the silos would be at the rate of 50 tons per hour.

The plant has been designed to work automatically with the minimum amount of attention, and is capable of indefinite expansion, as the conveyors D^1 and B and B^1 may be so extended as to take in any number of units, that is, silos and conveyors. The whole of the coal handling plant, including the gantry cranes, conveyors, coal breakers, &c., is being manufactured at the Renfrew Works of Babcock and Wilcox, Limited, whilst the electrical equipment is being furnished by the Allgemeine Elektricitäts-Gesellschaft, of Berlin.

The turbine house extends across the end of the five bays of the boiler-house, with a special intermediate bay to contain the whole of the pumping machinery. The switchboard room is being built on the other side of the turbine house. All the main buildings will be of steel and concrete.

One of the principal difficulties which had to be surmounted in connection with this plant was the question of the supply of condensing water. It had been estimated that if the supply were drawn from and then returned to the dock the temperature of the water would be unduly raised, and a design has been adopted by which the condensing water will be drawn from the dock and carried by means of an underground tunnel, beneath the dock, and discharged into the river Plata, a distance of about one mile.

Between each boiler-house and in the centre are placed the chimneys, six in number. There will be thirty Babcock and Wilcox water-tube marine boilers, constructed for a working pressure of 190 lb. per square inch, and each capable of evaporating normally 24,600 lb. of water per hour and at a maximum of 30,800 lb. per hour. Each of the boilers will have a Babcock and Wilcox superheater constructed to provide a maximum temperature of steam of 625 deg. Fah., the tubes being of weldless steel and connected at both ends by expanded joints to wrought steel cross-boxes. Each boiler and superheater will be enclosed in casings composed of wrought steel plates fitted with fire refractory material and provided with outer air casings. There is an arrangement to facilitate the removal of soot from the tubes and to provide for the thorough inspection of all tubes and fittings. The waste gases from the boilers are taken through Green's economisers, of special construction, arranged on a floor above the boilers. The pump-house has a 10-ton overhead electrically-driven crane, and in the turbine house there will be a 30-ton overhead electric crane. The piping installation has also been supplied by Babcock and Wilcox, and practically the whole system consists of steel piping, the steam and feed being solid drawn, and the water and exhaust being riveted. The steam from each set of six boilers is taken to a 14in. main at the rear of the boilers. The two mains in each boiler-house are connected at one end by cross-over mains. The other ends of the mains pass across the pump room into steam separators situated in the engine-room basement before passing to the turbines. These separators are all connected by a 14in. main, so that, if necessary, any set of boilers can supply steam to any turbine. The feed pumps are situated in rooms between the boiler-houses above the hot wells, and the boilers can either be fed by means of water which has been heated in its passage through the economisers, or direct from the pumps. Arrangements have been made whereby the amount of water passed into any boiler can be measured. The steam consumption of each turbine can also be determined, as the air pump discharge is taken through Schilde water meters before it enters the hot well.

An arrangement has been made with the Buenos Ayres Great Southern Railway Company to dredge the branch of the Dock Sud, so as to permit of ocean colliers coming alongside the Electrical Company's wharf, and in order to facilitate the unloading of the machinery from the steamers a floating pontoon, equipped with sheer legs, has been supplied by Babcock and Wilcox, Limited, and by this means weights up to a maximum of 60 tons are being lifted out of ships' holds and placed either in barges alongside or carried upon the sheer legs of the pontoon.

THE AEROPLANES AT RHEIMS.

(By our own Correspondent.)

No. II.*

The meeting at Rheims having demonstrated that it is comparatively easy to fly, and that this may be done by machines presenting considerable variations in form, the problem now to be solved is the selection of the most suitable types and the laying down of principles which will allow of their being steadily improved. Experiments have so far been carried out on the "trial and error" plan, and good results have been obtained without experimenters knowing exactly how it is done. But now a Société d'Etudes de Locomotion Aérienne has been formed with a view of advancing the science of aeronautics. It has a laboratory in Paris, comprising, among other things, an ingenious apparatus, very similar to that employed by Stanton, Maxim, and others, designed by M. Rateau for determining the value of planes and propellers. This consists of a helicoidal ventilator having a diameter of 1.20 m., driven by a petrol engine of 25 horse-power. This ventilator is placed at one end of a box 1.60 m. square, which at the other end terminates in a truncated cone, in the aperture of which is placed a trellis of wood. As the air is forced through the trellis rotation and eddies are taken out of it and it issues as a steady blast on the planes to be tested. The velocity of the air at the aperture is measured by a Pitot tube connected with a water manometer. It can be varied with great accuracy from zero up to 40 m. per second. In front of the aperture is a wooden frame made as light as possible, and in order to reduce the inertia the weight is partly supported by floats in cylindrical recipients. On the frame are fixed uprights carrying two plates drilled with a number of holes to permit of the plane to be tested being adjusted at any inclination. The effort exerted by the air on the plane in raising the frame is measured by weights on a balance supported at the bottom, while the horizontal movement of the plane is measured by a long balanced lever attached parallel to the frame. A good deal of interesting data has already been obtained with the aid of this apparatus, which promises to advance considerably the science of aeroplane construction. It has, for instance, been shown that a thin plane is less efficient than one made up of two surfaces over a light framework, the lower surface being flat and the upper surface curved. The tests, however, have not been carried out long enough to allow of any definite conclusions being arrived at concerning the most suitable forms to be given to planes.

The problem of the sustaining surface and forms to be given to planes is working out its own solution, but the same thing cannot be said of the propeller, which is giving rise to a vast amount of academic discussion. There are some experimenters who affirm that the aeroplane will eventually be able to glide by simply utilising the forces of the wind, in the same way as the condor and albatross. Whether this will be achieved or not, it cannot affect the necessity of employing propellers for swift flight, and it is probable that for some time to come the propeller will constitute the principal agent in the progress of aviation. The trouble arises from the fact that no one knows how the propeller acts when turning in the air. The various theories put forward found little to support them in the trials at Rheims. Some builders of aeroplanes argue that the propeller should displace the greatest volume of air and be pushed forward by the reaction of the air current it creates; others, who constitute a much smaller class, contend that the propeller should cleave its way through the air, and that, theoretically, the velocity of the air behind the propeller should be equal to its forward movement. Thus, in one case, we have propellers running at high speeds and driven by powerful engines, and in others larger slow-running propellers with engines of about half the power. The results obtained with different propellers at Rheims were puzzling, to say the least. In his former machines, as well as the one piloted by Delagrange at Rheims, M. Blériot employed a small propeller running at about 1400 revolutions per minute keyed direct on the engine shaft. In the No. 22, with which he beat the 10 kiloms. record, he had a larger propeller geared down by a chain to 500 revolutions per minute, the engine developing about 50 horse-power. The speed of the machine was materially increased, but the monoplane was distinctly slower than the Curtiss, while M. Blériot only succeeded in beating one record by carefully tuning up his engine and getting the maximum power possible out of it. Again, Mr. Glenn Curtiss arrived in France with a biplane which attracted general admiration, except for the propeller. To the French, who make their propellers in accordance with scientific formulæ, the Curtiss propeller, with its two flat narrow blades set at an angle to each other, appeared to be a hopelessly crude affair. Nevertheless, his machine showed a fine turn of speed, and when, in the hope of improving it he fitted one of the French scientific propellers, his speed dropped appreciably. He then returned to his own propeller and won the Gordon Bennett Cup. The Curtiss propeller has a diameter of 6ft., and being keyed on to the engine shaft, runs at about 1300 revolutions per minute. The engine develops 25 horse-power. Until recently the Wright machines were looked upon as representing the highest efficiency yet attained in aeroplane construction, principally on account of the low power required to drive them; but at Rheims their speed performances were somewhat disappointing. The Wright machine has two large propellers turning at about 450 revolutions per minute. The difficulty in arriving at any correct conclusions regarding the efficiency of propellers is due to the necessity of taking so many outside factors into account, such as the form and dimensions of the planes and the way in which the power is applied to drive them. It is, however, fairly certain that the small high-speed propeller as at present made has the lowest efficiency of all. Judging from the results obtained with the engines, the waste of power must be enormous. Such propellers are employed chiefly on monoplanes, where, on account of the construction, they are placed in front. Possibly the front propeller may be conducive to the remarkable steadiness of the monoplane; but, on the other hand, the body lies in the stream of air behind the propeller, whereby there would appear to be a certain reaction against the thrust. This was particularly the case with the Antoinette as well as the earlier Blériot machines, but in the latest Blériot the propeller is driven by a chain at the point above the body, although against the plane. It would seem that, in order to utilise the force to the best advantage on monoplanes, the propeller should be placed somewhere underneath the rear of the plane; practically, however, this is out of the question, because the propeller must not be placed in a position where it is liable to be damaged when alighting. The position of the propeller has, therefore, to be determined largely by a question of convenience, although when the most suitable form and position are ascertained, builders will be able to design their aeroplanes in accordance with these new conditions. So far as can be judged from a necessarily imperfect comparison between machines and propellers offering so much diversity, the propeller should cleave through the air instead of churning it up like a ventilator fan. The two narrow flat blades of the Curtiss propeller, set at an angle to each other, seem to offer the highest efficiency yet attained. It is to be hoped that Professor Rateau's new apparatus will throw some light upon the propeller design, otherwise the problem will be discussed indefinitely until it is possible to carry out experiments with different propellers on aeroplanes of the same type and dimensions and flying under exactly the same conditions. Another thing that has entirely upset preconceived ideas is the threatened abandonment of twin propellers. The Wrights have always affirmed that twin propellers were necessary to stability, and yet nothing could be steadier than the machines running with single propellers. Whether one or two are used is merely a question of efficiency.

While a considerable amount of experimental work will have to be carried out before any really satisfactory results can be obtained with propellers, it is obvious that the question of motive power is merely one of mechanical improvement. With an increase in the efficiency of propellers the power employed can be diminished for a given speed, and therefore smaller and more reliable engines can be employed in the future for light aeroplanes, except, of course, for those built to attain exceptionally high speeds. As we have explained, the waste of power on the majority of aeroplanes necessitated the use of engines of something like 50 horse-power, and in order to diminish their weight special types of light engines have been constructed. That the engine is far from being satisfactory was proved by the time spent at the Rheims meeting in getting it to run satisfactorily. For one successful flight each day there were probably a dozen preliminary flights or failures. One of the causes of these continual engine troubles, it was said, lay in the fact that the aeroplane flies at varying altitudes, with the result that the gas mixture is not always constant, and Farman knew what he was doing when he made his flights close to the ground, whereby the gas mixture was always constant. In view of the very moderate elevations generally attained, it is difficult to believe that this cause can have been very potent. A motor car ascending a hill has to meet similar barometric changes. It was to be remarked that the majority of aviators had brought down their selection of carburetters to two makes, and as they were still far from being absolutely reliable for aeroplane engines, it is certain that considerable attention will have to be given to the carburetter.

So far as engines themselves are concerned, it is noteworthy that all the machines which accomplished the best performances were fitted with engines of special design. This is entirely opposed to previous experience, since special engines for aviation have always proved more or less disappointing, and the best flights have frequently been done with engines of the ordinary type, modified and lightened for the purpose. In this class may be placed the Glenn Curtiss engine, which, however, has been made especially light, but the engines used by Blériot, Latham, and Farman were all of special types. Farman's biplane was fitted with a Gnome so-called rotary engine, in which the five cylinders rotate round the axis. The Gnome is a beautifully built engine with ribbed cylinders machined out of nickel steel, whereby extreme lightness is obtained, and contrary to what might have been expected, showed itself to be one of the most trustworthy engines competing. As the ribbed cylinders revolve at a high speed, they are efficiently cooled, and, not being required to carry water, Farman was able to have an abundant supply of petrol for long-distance flights. It is to be remarked that Farman had entered a machine with a four-cylinder vertical engine for the long-distance trials, but he obtained permission to replace this with a rotary Gnome engine. At present the aviation engine is being worked out in three directions, that is to say, with high compressions and high lineal piston speeds; low compressions with a large number of cylinders and high angular velocities; and rotary engines. The Gnome engine, which is not of the true rotary type, since the cylinders rotate round the axis by the aid of pistons and cranks, is the only one in the last-named class which has proved at all successful. The multi-cylinder engine, with high angular velocity, has the advantage of weight reduction per horse-power, and engines with high lineal piston speeds are more economical, which is an important feature for aeroplanes. The solution will rest with aeroplane builders who will select the lightest motors consistent with regularity and economy, and as scores of engine firms are now preparing aviation motors, they will probably have plenty of choice in the early future.

A serious inconvenience with all the machines competing at Rheims was the absence of the clutch between the engine and propeller. The chief reason for this is, that there has been no clutch sufficiently light and trustworthy for transmitting high powers, and as lightness is of so much importance, aeroplane makers have preferred to do without a clutch wherever possible. For starting the engine, therefore, the propeller has to be pulled round, and the machine begins at once to skim along the ground unless held back by men until the pilot is ready. This, of course, is a risky method of starting, and the pilot has not the convenience of being able to run his engine and test it preparatory to starting, which is the reason why there are so many failures to fly. The construction of clutches, however, is making the same progress as in other branches of aeroplane manufacture, and metallic clutches are now being introduced, light, powerful and reliable enough to be fitted to aeroplanes.

In dealing with the design and construction of aeroplanes at Rheims we have not referred to the all important question of providing means for rising from the ground without being obliged to run on skates or wheels over a specially selected surface for a considerable distance before there is sufficient pressure under the planes to lift

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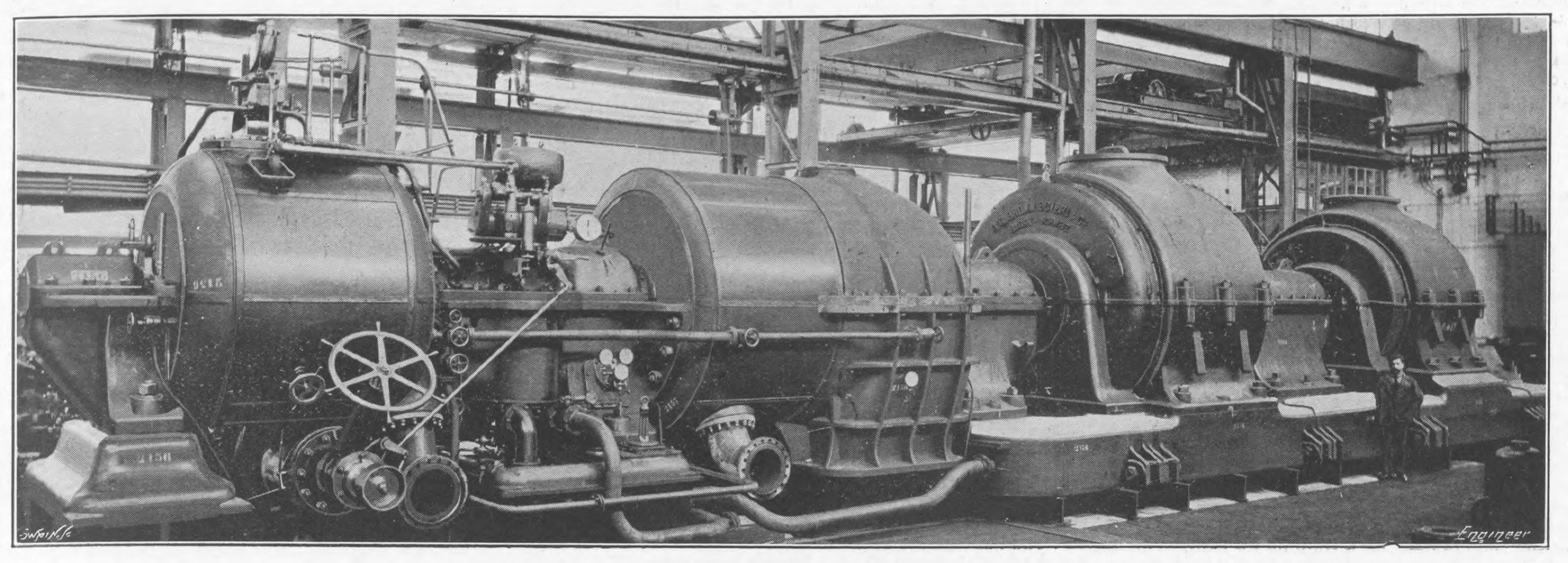
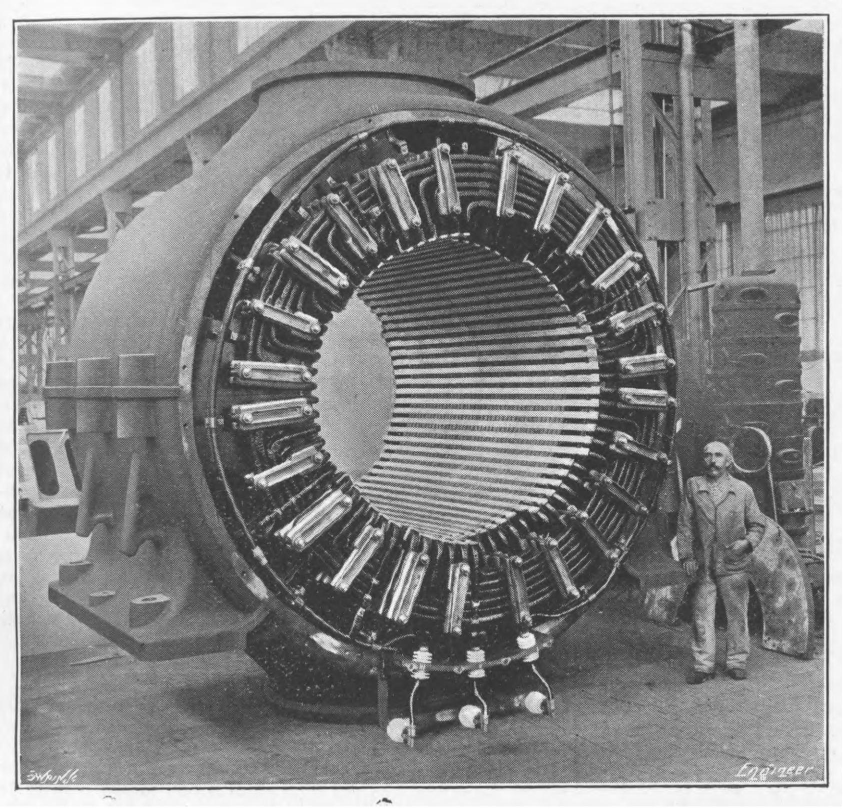
* No. I. appeared September 3rd.

ELECTRICAL GENERATING STATION AT BUENOS AYRES

(For description see page 263)



11,000-H.P. TURBO ALTERNATOR



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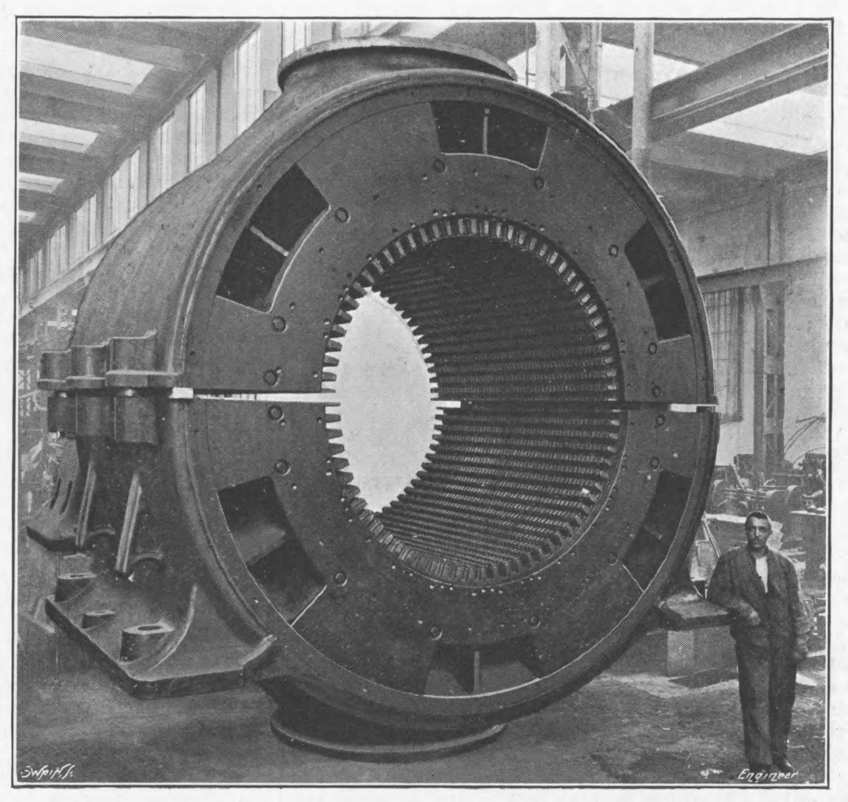
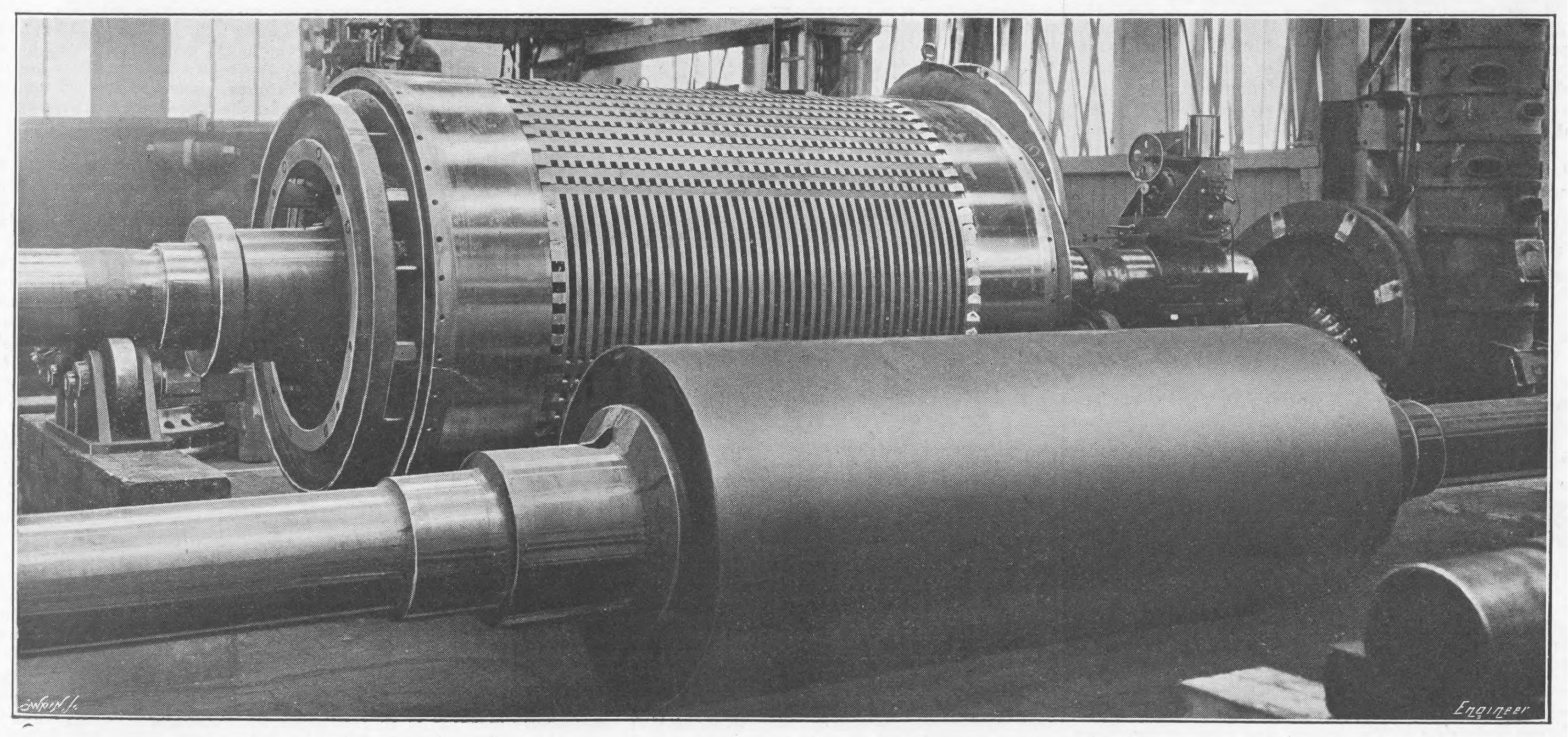


COMPLETE STATOR



ROTOR AND ROTOR SHAFT

the machine in the air. It is, however, a moot point whether the present types of aeroplanes will ever be able to rise straight from the ground by a suitable arrangement of propellers or by other means, or whether the striving after a machine combining the advantages of the helicopter and the ordinary aeroplane will not result in the evolution of an entirely different kind of apparatus. In the present state of the art, which is still very young, despite the remarkable progress made during the past few weeks, it is impossible to venture anything more than mere suppositions as to the form the flying machine will take in the early future.

SHOP MANAGEMENT AT THE WORCESTER POLYTECHNIC INSTITUTE.

By WILLIAM BIRD, Professor of Mechanical Engineering, Director of the Washburn Shops.

The American technical school of the past has been asked to do too much, but it has nevertheless been very successful, and has had a marked influence on education in general. It has been required to give its students a general training more or less in harmony with that given by the regular college, and, in addition to this, some engineering work of a professional nature; while at the same time the students have had more or less practice to develop skill in drawing and shop practice. The college now teaches the sciences and laboratory system, the high school has taken up manual training, mechanical drawing, and the elementary sciences, and the trade school deals with the shop practice as a training for skill. This leaves the field clear for the technical school to develop into a strictly professional engineering school.

The modification of the course in shop practice to meet the new conditions of the engineering school is an important question, and this article is an account of how this problem is being worked out at the Worcester Polytechnic Institute in Worcester, Mass.

In the first place, the object of the work in shop practice in the course in Mechanical Engineering is to teach the young engineers how to manufacture, and by this term manufacture is meant a combination of two things—construction and management. Under construction he is taught something of what can be done and how it should be done, no great importance, however, being placed on ability or skill in the actual performance of an operation. The work in construction is divided into four parts, and the student learns in a general way the possibilities and limitations in pattern making, foundry, forge, and machine shop practice. The course in Mechanical Engineering requires four years of thirty-two weeks each, with about fifty-five hours' work per week in recitation, lecture, laboratory, and study, with eight hours each week devoted to shop practice. This shop practice time is given up to construction for the first three years and to shop management in the fourth year.

When it comes to shop management, most of the engineering schools resort to the lecture system. The services of outside parties, who have had successful business careers, are often secured, and the student has an opportunity of hearing how things are done. The problem, however, has been how to establish the laboratory system and have a place in connection with the school where manufacturing was actually going on. Worcester has been the first to do this, and for a number of years has had in the Washburn Shops a regular manufacturing plant. The general impression seems to be that this means simply that some commercial use is made of the students' work, while in reality it means that several well-organised shop departments are carried on throughout the year by competent foremen, each with his own set of journeymen, entirely independent of the students and their instructors. Whatever of the students' work passes inspection is turned over to a commercial department, and the instruction department is credited with the same. It may be of interest to some to know that these credits amount to less than 10 per cent. of the cost of instruction.

The line of argument here presented, if carefully followed, can lead to but one conclusion. First, the shop as a part of the school is carried on for educational purposes. Second, the student, after reaching the point of efficiency in any given operation, does not learn very much. Third, the shops do not secure financial gain until after the student has reached the efficiency point. Conclusion: There can be no profit in selling what the students make. If, however, a line of goods is manufactured by a regular commercial department, it is possible to sell these goods at a profit, and at the same time furnish an incentive to the student to do good work, for he sees that the piece he is working on may become a part of some machine which is being constructed by the shops. The shop work at Worcester differs from that given at other schools, principally in the fact that the students work in the same shops as the journeymen, and the element of time is constantly brought to their attention.

In the first half of the fourth or senior year the student takes up the subject of jigs and fixtures, the fixing of piecework prices and the making up of operation cards. In the second half he connects all of his previous shop training with the office work. Here the commercial department plays a part which is unique at Worcester. All of the records of the previous year's business from which the books were made up are given out, and a complete review made of the office work. The class is divided into twelve groups, one for each month. From the cash slips each group makes up a cash book for its month, from the original orders and dates of shipments a day book for each month is made, and from the invoices a journal or record of purchases of each month is made. These books must check up with the office records before being posted. The ledger is divided into twelve parts, each group having a few letters and one or two shop accounts. The correct balance for each section of the ledger is obtained from the office, and the students are required to go over their work until they get the same result. This work gives them a very good conception of accounting, and no graduate need in the future be dependent upon a bookkeeper, for he knows enough about the books to look things up for himself.

Having made up a complete set of books, the work of analysing the various accounts is taken up. The time cards as handed in by the journeymen are gone over and the pay roll and distribution sheet made out. These time cards are also used to study the cost of each operation in the construction of each piece, which is required for the different machines which are manufactured by the shops. This gives them the necessary data for comparing the shop costs of different lots, and for making an inventory at any time with the parts in various degrees of completion. They are also able to work out a statement as to what equipment would be required to manufacture a given number of machines within a stated time. The overhead charge or shop burden is worked out, and its relation to productive labour compared with previous years. The various expenses in the foundry are tabulated, and the proper allowance which the foundry department should be given for the several sets of castings required for the different machines is figured out and checked up with the prices actually allowed.

The cost of equipment is next considered and the proper allowances for depreciation made. Each group is given a shop department to work on, and a report is made up after the students have measured up the belting, shafting, pulleys, &c., and looked up the records of each machine. Their results are then compared with the office records. The next step is to consider plant appraisal, and here the work is similar to the equipment valuation.

The important point in all of this work is that in addition to lectures and class-room work the students at Worcester are brought into actual contact with the commercial world. They do book-keeping, they ship goods, they carry on correspondence, they handle actual time cards.

The course in shop practice is laid out in such a way as to harmonise with the other studies. The work in machine design must agree with the possibilities of machine construction, the charging of the cupola with the lecture on foundry practice. The power required for the machine tools, as shown by laboratory tests, gives the data for the design of the power plant as taught in the course in Steam Engineering.

Other institutions may have preceded Worcester in the establishment of a course in shop management, but Worcester is the first, and at present is the only, engineering school which carries on a manufacturing plant in which the student has an opportunity for laboratory practice in shop management.

The Washburn Shops form a commercial establishment selling its goods in the open market in competition with other manufacturing concerns. It has selling agents for its drill grinders and sensitive drills in all countries where manufacturing is carried on. Its aim is to make the best machines of their kind, and to make use of all the latest developments in science and experimental work in the design of new machines. The student who has had his engineering shop practice in an establishment of this character finds the start in life at commencement a comparatively easy step.

The article printed above was most courteously written by Professor Bird, in reply to our request for information about the novel form of training engineering students at the Worcester Polytechnic Institute. Since its receipt we have had an extremely interesting correspondence with Professor Bird, and his letters add so much to our knowledge of the system he is developing and the principles at the base of it, that we, with his permission, give the following abstracts from them.—[Ed. The E.]

With regard to the actual shop work of our students, I would say that we have a regular course, consisting of exercises in standard shop operations. Our men, of course, do not become expert machinists, but do learn enough to hold their own when working during the summer recess in outside shops, as a number are obliged to do to earn their way. Of course, we are not training our men for this work. Our object is to teach the possibilities of the different operations With this training, it is possible for them to take up the more advanced work in which they study the cost of an operation; for example, the comparative cost of a machine part finished in lathe, or roughed out in lathe and ground, the cost finished in planer, and corresponding cost milled. The object in the accounting is to give them an idea of book-keeping, so that they can study the shop costs and analyse the reports of different lots of the same machines, and see what the possibilities are of further reductions.

We are continually asked to recommend men, and with the invariable request that a man who has had experience is wanted. What we are trying to do is to give our men something as near to shop experience as it is possible to do, and at the same time give them an opportunity to continue their studies under instructors who are capable of giving them information which the students find they lack when they run up against shop problems.

We agree with you that a great deal of shop instruction as given in most schools might better be left out, and our problem has been so to improve our shop instruction to make it equivalent in value to regular engineering studies, such as steam, gas, electrical, and hydraulic engineering.

We have had some success in our work, and while we depend largely on good raw material, we have turned out a number of men within the last two or three years who have become office managers, and have gone right by men from other schools. Some have gone into shops and reduced the cost of manufacturing and saved the amount of their salaries several times over the first year.

Of course, there are other men we have to graduate because they pass the requirements, but who never amount to much, and if you can suggest some study to introduce in our course that will brace these men up we would be under lasting obligations to you. We are not training machinists, not cost clerks, but teaching our men how to make the best use of material, machines, and machinist on the one hand, and what to have the cost clerks do on the other hand to make information valuable and available.

Our great claim in this work is that in the Washburn Shops we have a real shop, and consequently the students are in a commercial atmosphere and come pretty near having real shop experience.

Of course, the scheme is more or less of an experiment, and we are continually changing the work to meet the new features as they appear. We are alone in a way, as we have no other school to go to for advice based on experience.

I agree with you and Sir Robert Hadfield that personality counts for more than training. The students themselves appreciate this point also, for most of them expect us to deal out this personality the same as we do equations in thermodynamics. We have a better chance than most schools to develop a man along certain lines in our Washburn Shops, as the conditions are very different from those prevailing in the ordinary college shops.

There are, however, two very serious difficulties. One is the influence of the "college professor," for, of course, we have them here, and they want to have things done just the same as they are done in other colleges. The other difficulty is the age of the students. Coming as they do from our high schools, they are still boys, and they take their studies as so much medicine to be swallowed, and the instructor, under the same delusion, first decides on what is a good average dose, and then gives them all the same quantity and quality. Now, if we could have the right kind of men rather than all kinds of boys, it would be easier for us, for they would come to us knowing what they wanted. Their individuality would be more pronounced, and all of their studies would be purely professional and not simply for training. The problem is what to do with the boy in the twilight zone. If we let him develop into a man in the shops, he loses his mental grip, and finds it very hard to resume his studies. If we let the development take place in the college, we generally find that he has not developed into the right kind of a man.

Now, our present idea is to combine a college course for culture and mental training, a shop course for work and observation, and a professional course for useful information and ability. The Bible says that we should train up a boy in the way he should go, and we have always emphasised "the way." Our idea is to put the emphasis on "he." That is, there are many ways, and each one should take the way best fitted for his personality. The objection to this scheme is that every student will require a special course, and we propose to answer this by offering a course which is different from all other courses, and assume that it will only attract such students as are naturally interested along these lines.

Now, if all of our engineering schools would take up special "ways" instead of all trying to be "the way," a young man would have a chance to choose *his* way.

DEVELOPMENT OF MODERN GOLD DREDGERS.

Power dredgers for gold recovery in alluvial fields have been largely developed through experience with various types in New Zealand, and examples, based generally on the best known of these types, have been produced in considerable numbers by Lobnitz and Co., Limited, Renfrew, for a wide variety of destination and employment. Siberia, Burma, Straits Settlements, Bolivia, Peru, Ashanti, British Guiana, French Guiana, Senegambia, Ankobar, Tierra del Fuego, and the Offin River are some of the diverse places on the world's surface where dredgers by this firm have been put to work.

Although it is generally recognised that every gold dredger, to ensure success, should be designed to suit the particular conditions for which it is intended, it is yet true that dredgers fitted with shaking screens and similar devices have, for most conditions, been superseded by craft having a sluice box, or a revolving screen and elevator, as main features. In turn these features are now being set aside—in the experience of Lobnitz and Co. at least—by the "propulsion screen" which they are fitting to most of their productions of this class. The first gold dredger fitted with this device was completed in March this year for use in Peru, to the design of Messrs. Inder and Henderson, consulting engineers, London. Three dredgers in which the propulsion screen is a feature have been completed and despatched this year—one, the first, that mentioned above, to the order of the Inambari Gold Dredging Concessions, Limited, Peru; one to the Syndicat Mana, French Guiana; and one to the Compagnies des Mines de Senegambie, Paris, and the Guiana Gold Company, Limited, London, has just placed an order with Lobnitz and Co., Limited, to fit their third dredger with a propulsion screen. By adopting the propulsive screen the usual revolving screen and elevator. which are costly to repair, are entirely dispensed with, and the gravel is much more simply and effectively treated, and is discharged as high as required behind the dredger. The pictures on page 270 are from photographs of dredgers fitted with the screen as erected in Lobnitz and Co.'s works.

The special feature under notice is best seen in the top view, where the screen and the rigid shelf which supports it in its traverse are seen projecting over and beyond the hull of the dredger. The screen is mounted, as may be seen from our illustration, on small wheels or castors, and receives its propulsive motion through a rod connecting it with a suitable moving part of the dredging machinery without the use of any intermediary gear wheels. By means of an ingenious arrangement of cranks and rods associated with the castors, and tied to both shelf and screen, the motion imparted to the latter is of an unequal character, being accelerated on the outward and retarded on the return stroke. This unequal reciprocating motion, of course, gives the dredged material the momentum necessary for the proper rate of traverse along the screen. The latter thus acts like a riddle in separating the gravel, the fine material being caught on gold-saving tables as usual, and the coarse material discharged at the end of the screen. The gravel while being separated is continuously visible and accessible, thus providing for very convenient and effective treatment. The form of the screen enables the perforated plates to be quite flat, and very easily changed or replaced. By changing a few perforated plates in the screen the dredger fitted with it can be very quickly adapted to meet any variation in the ground. It is quite suitable for either river or paddock dredging. Heavy boulders can pass over the screen without injuring it, and there is no elevator to suffer damage. There is no necessity to stop working and lift boulders out of the buckets, as they can be safely, and without any undue wear of the machinery, passed over the top tumbler along with the finer gravel.

To make dredgers adaptable to any spoil the builders arrange this patented screen with the incline adjustable, as also the steel gold tables and the tail-races to suit varying material. To render re-erection abroad as simple as possible the steel hull and the framing and machinery of each dredger are erected complete in the builders' works and run under steam before dismantling for shipment begins. The regular size of gold dredger with propulsion screen suitable for running night and day requires a crew of two men per shift—say, six in all in the twenty-four hours—and this machine will lift and properly treat per day as much gravel as 1000 men, with hand rocker and washing arrangement, are capable of. It is almost needless to add that in addition to the large amount of spoil treated with economy one great advantage of this type of machine is that the buckets can be lowered below water to reach bed-rock, where the heaviest and richest gold is oftenest found, and which, as a rule, is quite unattainable by ordinary hand recovery and washing.

RAILWAY MATTERS.

Representatives of the American steam railways and a number of Government officials have joined in a co-operative plan to conduct an inquiry into the physical properties and methods of manufacture of steel rails to ascertain what can be done to improve the rails now purchased.

The Mazoe Railway, Rhodesia, will probably leave the Aryshire line at about 13 miles from Salisbury, cross the Gwebi River to the west of Salisbury-Mazoe Road, then passing to the east of Goroto's Kraal, will run down the Umvodzi River to the foot of the hills between Belfort Homestead and the Jumbo Mine.

According to the *Electrical Review*, a Swedish engineer, Herr Quistgaard, is the author of a project for the construction of an electrical railway under the Sound, to connect the town of Malmo with Copenhagen. The projected line would be 236 kiloms. long, 16 kiloms. of which would be in a tunnel under the sea.

The construction of the Dunfermline and district tramways is being pushed forward rapidly, and the towns to be tapped in the meantime from Dunfermline include Lochgelly, Cowdenbeath, and Kelty, while in the near future it is expected that the line will run from Dunfermline to the naval base, and that there will be forty or fifty miles of tramways.

According to a contemporary, electric traction is to be adopted for the main line sections, Lauban—Görlitz, Görlitz—Kohlfurt, Kohlfurt—Lauban, and Lauban—Marklissa, in Silesia, the work of equipment to be completed by May, 1910. Electric power is to be taken from the Queis-talsperre Works, near Marklissa. Four coaches, each with a seating capacity for 130 passengers, are to be run on each section at frequent intervals.

To reduce fires in the Arkansas national forest the United States Forest Service has made an agreement with the Kansas City Southern Railway whereby the latter will clear its right of way. The railway will remove inflammable material for 50ft. on each side of the track and burn over an additional 100ft. where necessary, the Forest Service to supervise the work and supply the tools. A telephone system for the use of the Forest Service will be built along the right of way.

A line is under survey from Khanai, on the Sind-Pishin section of the North-Western Railway, to Hindubagh, 45 miles long, with two branches to the chrome mines, which are becoming an important source of industry in Baluchistan. The line will open up the Zhob Valley, besides affording an outlet for the chrome area, the output of which has been steadily increasing, though its development hitherto has been much hampered by the lack of railway facilities for bringing the products to the market.

It is reported that the British Columbia Electric Railway Company and the City of Victoria have come to an agreement whereby the city agrees not to erect a power plant in competition with that of the company without offering to purchase the company's plant at a price to be fixed by arbitration. The company on its part agrees to reduce the cost of electric light to the citizens and to erect a power plant at Indian River, some 50 miles from Victoria, at an expense of about £300,000. The new arrangement is similar to that existing in Vancouver, and must be ratified by the ratepayers before coming into force. According to reports, the Canadian Pacific Railway is investigating a scheme for electrifying the Columbia and Western branch of the system. The West Kootenay Power Company is indicated as likely to supply energy to the sections in the neighbourhood, which deal with a heavy mineral traffic to local copper smelters.

An article by an "Austrian Engineer," in a recent number of the *Electric Railway Journal*, gives some details relating to electric railway conditions in Austria. The first single-phase railway in the world, the Stubaitalbahn, was built in the Tyrol, and the absence of coal and the large amount of water-power have given great impetus to the construction of electric railways. Recent statistics indicate that there are about 5,500,000 horse-power available in the water-power of Austria, or 187 horse-power for each 1000 inhabitants. This amount is surpassed only in Switzerland, where there are 454 horse-power for each 1000 inhabitants. The figures showing the percentage of utilised to available power are, in Switzerland, 25 per cent.; Germany, 20 per cent.; France, 18 per cent.; Italy, 14 per cent.; and Austria only 9 per cent. A commission appointed by the Government is now systematically studying the subject of utilising all the available water-power for electric traction.

Construction work on the new section of the Cape to Cairo Railway has already commenced, says the *South African Railway Magazine*, and 2000 tons of rails are being shipped weekly. The railhead is still at Broken Hill, 375 miles north of the Victoria Falls, where it has been for the past year, pending the completion of negotiations as to the construction of the extension northward. From its present terminus, the line will run due north as far as the Congo border, and beyond there will strike north-west along the copper belt and past the various mines. It is hoped that the new section will be completed this year, and that copper from the mines at Bwana Macuhwa, near the frontier, will be transported over the Rhodesian system before a year has elapsed. When the boundary is reached there will be about 2200 connected miles of railway from Capetown to the Congo. As to the further extension of the Cape to Cairo line, it is probable that extensions will be made northwards in the Congo territory.

According to the *Electrical World*, the consulting engineer for the electrification work of the Great Northern Railway tunnel through the Cascade Mountains, U.S A., has concluded exhaustive tests of the electrified section, which is now in successful operation, heavy freight trains being hauled a distance of about four miles from the yard at one end of the tunnel to the yard at the other portal. Four three-phase locomotives are at present in use, each of which weighs 115 tons; and the recent tests show that they are fully capable of performing more work than required by the specifications. When very heavy freight trains are hauled through the tunnel three of the locomotives are used. In addition to the trains a heavy steam locomotive is at present pushed through in order to take the train at the end of the electric zone. So far as the brief operation of this short stretch of electric road has shown, it is an entire success. Upon the ultimate success of this piece of track depends the electrification of about sixty miles of the Great Northern through the entire Cascade Range.

His Majesty's Legation in Brazil reports that at the end of the year 1908 that country possessed 18,628 kiloms. (about 11,570 miles) of railway open. Over 8000 kiloms. (nearly 5000 miles) of this extent of line are the property of the Federal Government, 4000 kiloms. have been constructed under the terms of various concessions, generally for sixty years, and will eventually revert to the Federal Government, while the remaining 6000 kiloms. represent railways owned by the States of the Union. Over 1000 kiloms. of line were opened to traffic in 1908, a record in Brazil. Most of the larger systems have been formed by the amalgamation of a number of smaller lines, and include varieties of ownership and tenure. The large systems tend to increase and become important corporations; they are, as a rule, centred in one State—the Federal Government having only lately introduced a constructive policy of inter-connections—and they follow each other along the Atlantic coast from north to south, the lines running roughly east and west and converging at a particular port. Railway administration and construction are in the hands of the Federal Ministry of Communications and Public Works.

NOTES AND MEMORANDA.

The tiresome vibratory effect so often seen when bioscope or kinematograph pictures are thrown on the screen is not due to the passage of the film itself across the front of the lantern, but to the shutter which cuts off the light at rapidly repeated intervals during the motion of the film. By simply increasing the frequency of interposition of this shutter from 14 to 56 times per second, that is by using a motor working at four times the usual speed, this painful vibratory sensation is completely suppressed.

A process has recently been patented by two Italian gentlemen for rendering calcium cyanamide inoffensive. At present this product has several serious drawbacks owing principally to its causticity, and the ammonia and hydrocyanic ethers which it gives off. The process in question proposes to add sulphuric acid, diluted with its weight in water to the cyanamide; after introducing the cyanamide in small quantities to the liquid, the whole should remain slightly acid. After an intimate mixture, the product is dried at 40-50 deg. Cent., and then pulverised.

A thoroughly modern installation of aluminium lightning arresters has been recently put into use to protect the transmission system of a generating station on the Hoosic River, N.Y. From this station 12,000 kilowatts at 32,000 volts are transmitted to works at a distance of 21 miles. The transmission lines are in duplicate, and are supported on specially constructed steel towers fitted with the link type of suspension insulator. A ⅜in. stranded steel cable earthed at each tower is supported above the transmission wires as additional protection against atmospheric discharges.

On board ship the benefits accruing from forced draught, states the *Vulcan*, are more pronounced than on land. The height of the funnel of a steamer is restricted, and natural draught comparable with land practice can only be obtained with a high temperature. With mechanical draught the intensity of the fire is independent of chimney temperature, and the heat of the waste gases may be used to heat the feed-water or the supply of air to the furnace. Artificial draught is independent of atmospheric temperature, which not infrequently causes inconvenience on board ship in tropical climates if the draught depends on the chimney.

According to the *Electric Journal*, the following method for drilling slate and marble has been found to give excellent results:—Use ordinary twist drills for holes 1½in. or less in diameter, giving the lip plenty of clearance; above this size, wing cutters will give better results. Keep tool thoroughly wet with water while cutting, and keep clean to avoid jamming. A speed of 400 revolutions per minute for ⅝in. or less and 200 revolutions per minute above ⅝in. will be found satisfactory. Feed by hand and be careful when nearly through, as the material is apt to break off in large pieces; for this reason a machine feed is not desirable.

The first bituminous coal mined in the United States, states the United States Geological Survey, was taken from what is usually termed the Richmond Basin, a small area in the south-eastern portion of Virginia, near the city of Richmond. This basin is situated on the eastern margin of the Piedmont Plateau, 13 miles above tide water, on James River. It lies in Goochland, Henrico, Powhatan, and Chesterfield counties. The coal beds are much distorted, and the coal is of rather low grade when compared with that from other districts with which it has to come into competition. The occurrence of coal was known in the Richmond Basin as early as 1700, and in 1789 shipments were made to some of the Northern States. In 1822 the production amounted to 48,215 gross tons. At present what little coal is produced in this field is for local consumption only.

A writer in the *Foundry* points out that blowholes, fissures, and shrinkages in castings are frequently due to the manner in which the metal is melted in the crucible, rather than to bad sand, occluded air, and disturbances in pouring. The remedy he proposes is to sub-divide the charge into small units, so as to obtain a uniform metal of constant chemical composition. The charge of coke should merely cover the layers of pig iron, thus economising fuel; and the charge is preferably made ready in a sheet-iron cylinder of the same diameter as the crucible, and provided with a removable cover at the bottom. This cylinder is lowered into the crucible, and enables the layers of coke and pig to be deposited in the exact situations they should occupy. The operation of charging is thereby simplified, and the exact weight of the charge can also be determined.

The possibility of gas engine silencers causing an explosion probably does not suggest itself to owners of gas engines, but the risk is one that cannot be ignored, and several failures of this kind have been experienced. Failure of this kind in connection with a 1000 horse-power gas engine, recorded in the annual report of the Inspector of Factories, which led to fatal consequences, may be noted by those interested as a warning of the possibilities that exist in this direction. It should be remembered that unconsumed gas may at any time be discharged into the silencer through misfires, and that the hot gases of the next discharge may ignite them, causing an explosion which the outlet pipe cannot release in time to prevent a dangerous pressure. It would thus seem that safety lies only in making the silencer strong enough to stand the explosion, or in providing relief valves which will act quickly enough to prevent accident.

A series of tests on the absolute efficiency of light production of the common incandescent lamps was made in 1908 at the University of Vermont, under direction of Prof. W. H. Freedman. These are reported in the *Vermont Engineer*. A method of finding the ratio of light radiation to the total was adapted, using a thermopile and galvanometer. One face of the thermopile was carefully protected from temperature changes, and the other was exposed to the lamp under test. The galvanometer was in series with the thermopile alone. A double screen of heat insulating material was placed between the lamp and thermopile, but the screen contained openings which could be opened and closed by slides from a distance. A glass cell, carrying water, was used between the lamp and screen to cut off the non-luminous rays when desired. The first kick of the galvanometer, on opening the screen, was taken as proportional to the radiation received by the thermopile. The ratio of kicks under exposure to luminous and to total radiation was taken as the radiant efficiency of the lamp under study. No correction was made for the absorption or reflection of luminous rays by the glass cell.

Attention is drawn by J. F. van Lonkhuyzen in the *Elektrotechnische* to a simple source of error in electric instruments which is frequently overlooked, though quite understood. It is the static charge of the cover-glass of the instrument. The longer the pointer, the nearer it is to the glass, the drier the atmosphere, and the feebler the directive force of the instrument, the greater will be this error. By drawing a piece of soft leather across the glass of a galvanometer Lonkhuyzen produced deflections up to 5 per cent. In a dry warm room instruments went wrong by as much as 20 per cent. when touched with the dry hand. These deflections are not lasting, but it may be an hour before the pointer indicates correctly again. When making comparisons with mirror instruments the error may become pronounced, because the glass is cleaned to wipe off the dust. Particular care has to be exercised in this respect in the workshop, especially with suspended instruments. There is, fortunately, an easy preventive—breathing upon the glass. Faulty indications may also result when the instrument is joined to the secondary of an insulated transformer. The secondary may have a static charge sufficient to upset the instrument.

MISCELLANEA.

Arrangements for the reopening of Blackfriars Bridge by the Lord Mayor on Tuesday, 14th inst., are being completed with all speed by the Bridge House Estates Committee of the Corporation, which has the entire control of the City bridges.

There is now nearing completion a 6ft. steel main, which is being built to supplement the masonry conduit which carries the Brooklyn water supply from Nassau County. It is 23 miles in length, and will cost over £500,000. The present masonry conduit has a daily capacity of 120,000,000 gallons. The daily consumption of Brooklyn and Queens is 142,000,000 gallons, part of which is drawn from local artesian wells. The new steel main will have a capacity daily of 55,000,000 gallons.

Numerous occurrences of graphite and graphite-bearing rocks have, says the *Bulletin* of the Imperial Institute, been reported recently from African Colonies, and in many cases specimens have been forwarded for report to the Institute. The mineral usually occurs in the ancient crystalline rocks, either as a constituent of the rock itself or in veins. In the former case the material is of no commercial value till it has been separated by washing or other mechanical means.

A consular report dealing with the trade and commerce of Port Said and Suez states that both Suez town as well as Port Tewfik are now lighted throughout by electricity, supplied by the Electricity and Ice Supply Company. About 4000 lamps are in use in dwelling-houses and public buildings, and 250 in the lighting of the public roads. The wires are partly aërial and partly underground. This company also manufactures ice. Its plant for this purpose consists of two machines, capable of an output of 5500 tons per annum.

The United States Consul-General at Stockholm, in a recent report, gives some details respecting an industry about to be established in Sweden. He says that in Halmstad Mr. Pontas Holmström is about to start a spinning mill for making yarn out of paper. Such mills already exist in Germany and France. So far, the manufacture of rugs and carpets seems to be the best practical use of this new paper yarn. It is stated that people in Sweden, especially in the province of Ostergötland, are already making carpets with paper welt. Narrow rolls of paper tape are used, but this, of course, is not spun.

During the seven months ending July 31st Great Britain exported iron and steel and manufactures thereof to the value of 21¾ millions; other metals, 4¾ millions; cutlery, hardware, &c., nearly three millions; machinery, 16½ millions; and ships, nearly 3¾ millions. Our exports of iron and steel and manufactures thereof for July amounted to £3,474,876; of other metals, to £741,853; of cutlery, hardware, &c., to £505,198; of machinery, to £2,635,878; and of ships, to £402,982. The total British exports for July amounted to £35,487,240. The total value of exports from the United Kingdom during the seven months ending July 31st was £212,421,590.

On Saturday, September 4th, the Trinity steamer Triton completed the laying of a submarine bell near the South Stack, Holyhead, connected with the signal station by a cable a mile and a-quarter long, which will convey the electric current to ring the bell. On the cross-Channel steamers of the London and North-Western Railway Company and City of Dublin Steam Packet Company have been placed sound-receiving apparatus, and through a telephonic installation the sound of the constantly ringing bell can be heard through the water, and according to the strength and direction of the sound will the position of the vessel and its proximity to a dangerous coast be ascertained. Experiments with the system show that it is far more reliable than the gun-signalling, which depends on sound and flash for its usefulness. The steamers running from Holyhead are the first cross-Channel vessels to be so fitted.

In the House of Commons, recently, Mr. John Wilson asked the Secretary of State for the Home Department whether he had noted the prominence given by Prof. Redmayne, Chief Inspector of Mines, and Mr. R. D. Bain, Inspector of Mines in Durham, in their report on the West Stanley explosion, to the dangers arising from the use of electricity in mines, and to the statement in the report that, on the assumption that the explosion did originate in the Busty seam, they were of the opinion that electricity was a more likely first cause than any of the alternatives already discussed; whether he was aware that all the evidence given at the inquest by mining experts and other witnesses went to show that the explosion originated in the Busty seam; and whether, having regard to this evidence as to the Busty seam, and the statement of the inspectors making the report as to electricity being the most probable cause, he would arrange a commission of inquiry into the danger involved in the use of electricity in mining operations. In reply, the Home Secretary signified his intention of appointing a new committee to consider the rules relating to the use of electricity in mines.

According to a contemporary, the cruiser Indefatigable, which was laid down at Devonport Dockyard on February 23rd, will be launched on Thursday, October 28th, but it is not yet known by whom the ceremony will be performed. The battleship Neptune will be launched at Portsmouth on September 30th, the Duchess of Albany performing the ceremony; and the cruiser Blanche will be put afloat at Pembroke Dock on October 27th. The Neptune was the only battleship provided for in the 1908-9 Estimates, and was laid down on January 19th last. She is a vessel of 20,250 tons, but her main armament remains the same as in the 17,900-ton Dreadnought—ten 12in.—and her anti-torpedo battery will comprise twenty 4in. quick-firers. She should be completed by January, 1911, and by that date Great Britain will possess a homogeneous fleet of eight Dreadnought battleships, all having the same speed and the same main armament. The Indefatigable, in general details, follows the Invincibles—that is to say, she will have the same armament of eight 12in. guns and the same designed speed of 25 knots. By a lengthening of the ship, however, a much more satisfactory arrangement of the two middle turrets will be made. She will be completed for sea early in 1911. The Blanche belongs to the 1909-10 programme, was laid down on April 12th last, and is an improved Boadicea, carrying an armament of ten 4in. guns, and designed for 25 knots.

Certain details which have become known of the cruiser—a super-Invincible—to be laid down on the slip at Devonport Dockyard, from which the cruiser Indefatigable will be launched in October, leave no doubt that the vessel will be a marked improvement in all essentials on her immediate predecessor. She will possess greater speed, approaching 30 knots, with an increased displacement and a length of about 600ft., and will thus permit of more powerful propelling machinery, stronger armament, both gun and torpedo, the latter being the new type of 21in. long-range weapons, and the former consisting either of eight 13.5in. or an increased number of the latest type of 12in. weapons, together with an improved anti-torpedo armament. The new vessel will have only one mast, of an improved design, with greater shell-resisting power, and so placed in relation to the funnels as to permit of a re-grouping of the armament with an improvement in fire distribution. Increased armour protection will be another feature of the new vessel. Plans and estimates have been prepared for lengthening the building slip by about 80ft. The new vessel has not yet received her name, but it is believed the Admiralty intend to revive the once-famous frigate names, of which the Arethusa is a type, and that there will eventually be a group of four of these powerful single-mast cruiser-battleships, provision for the others being made in the Estimates for 1910–11.

PROPULSION SCREEN GOLD DREDGER FOR PERU

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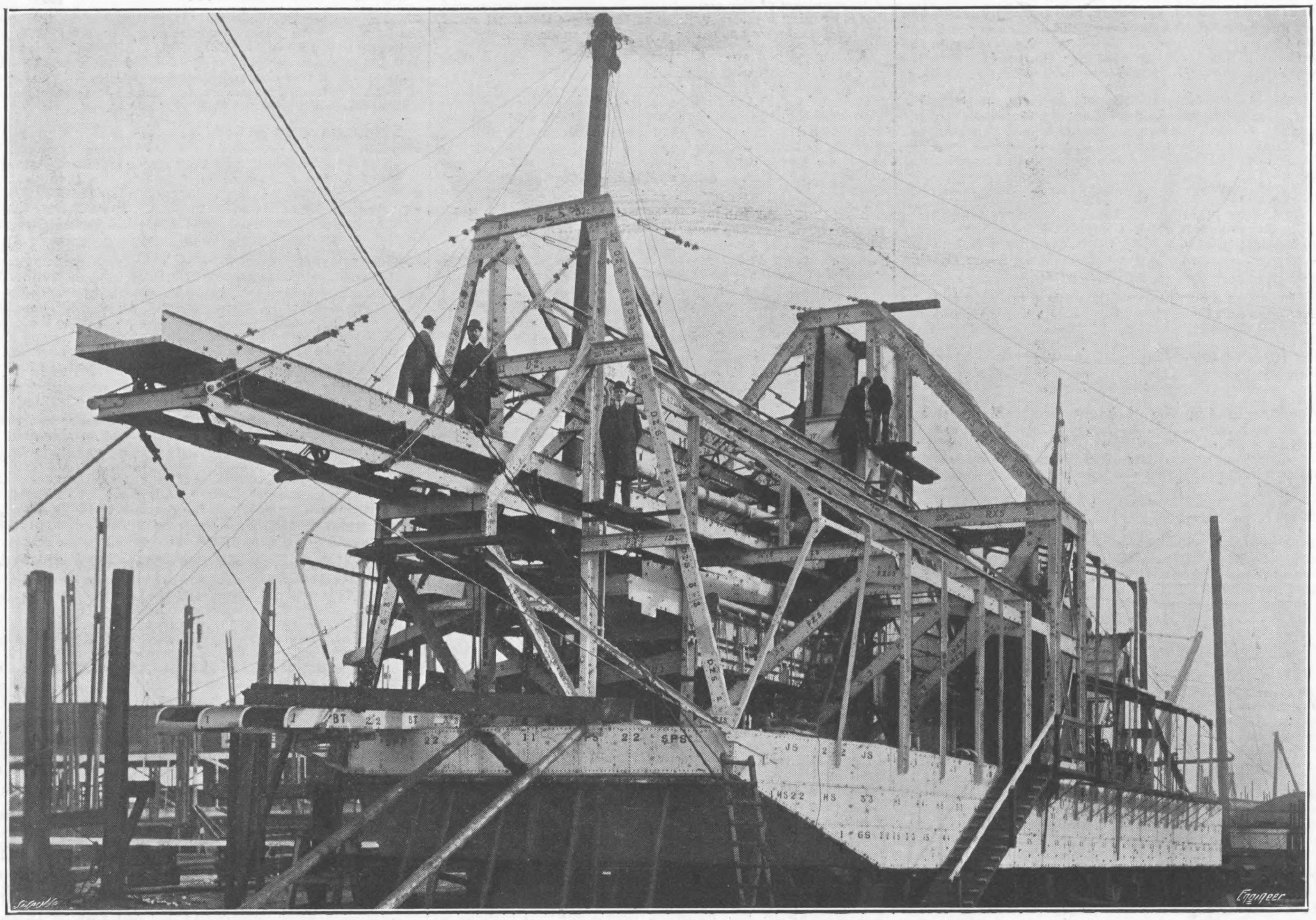
(For description see page 268)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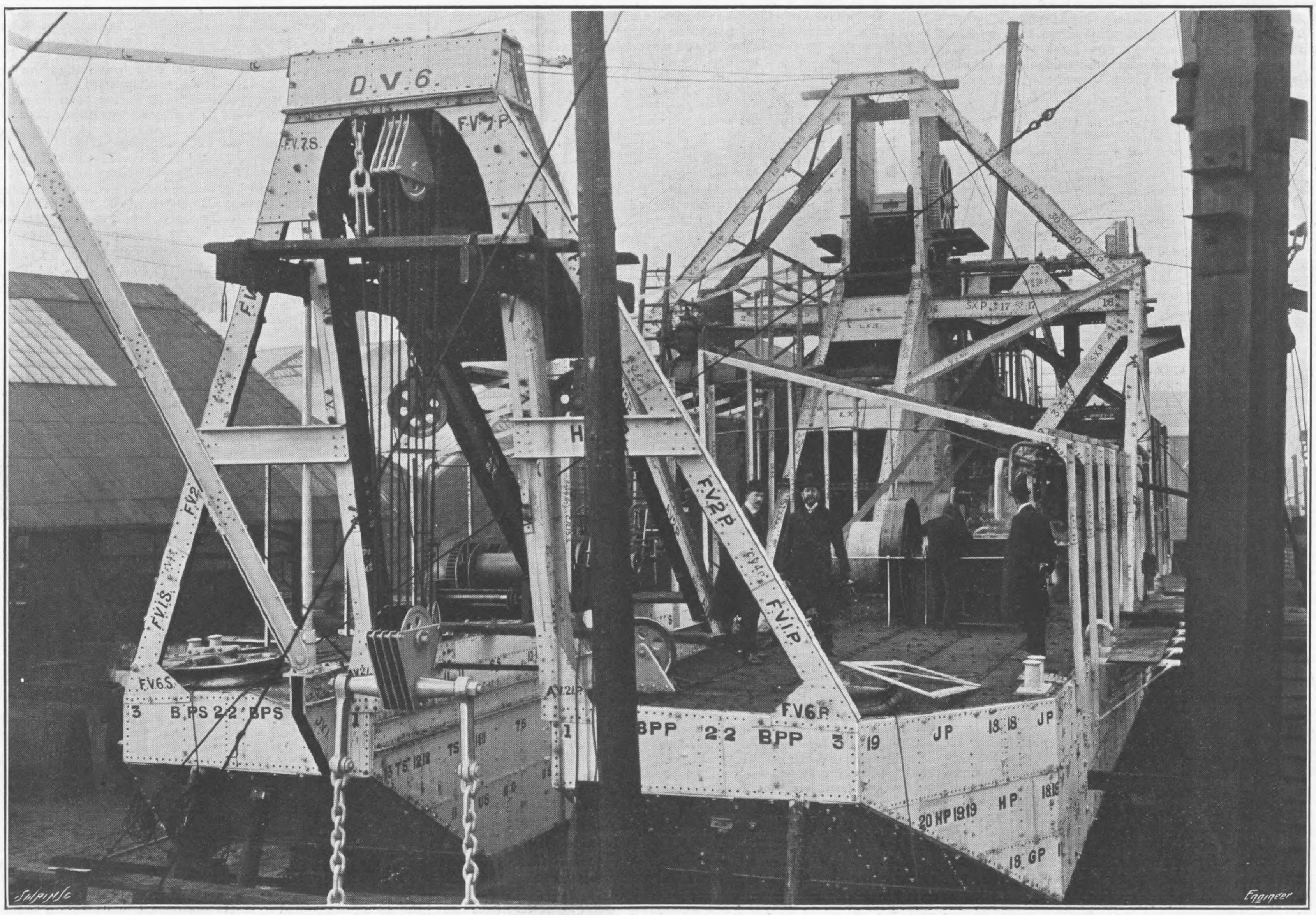
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TO CORRESPONDENTS.

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REPLIES.

E. D. (Finchley).—It is hard enough for regularly trained engineers to get work, and we fear you would have little chance by adopting the plan you suggest.

DRAINAGE.—With such scanty particulars it is impossible to answer your question. Personally we should incline to the electrical arrangement. The pump is called the Rees Roturbo, and is made by the Rees Roturbo Manufacturing Company, Limited, of Wolverhampton. We strongly advise you to obtain the opinion of a good engineer who has examined the site; there may be unanticipated difficulties.

MEETINGS NEXT WEEK.

MANCHESTER ASSOCIATION OF ENGINEERS.—Saturday, September 11th, at 7 p.m. Quarterly meeting.

THE INSTITUTION OF MINING ENGINEERS.—September 15th, 16th, and 17th, at Newcastle-upon-Tyne. 20th annual general meeting.

THE ENGINEER.

SEPTEMBER 10, 1909.

The British Association and Gaseous Explosions.

ABOUT this time last year we drew the attention of our readers to the very important and useful work of the Gaseous Explosions Committee appointed by the Engineering Section of the British Association for the investigation of gaseous explosions, with special reference to temperature. At that time the Committee had just issued their first report, and we now have before us their second publication. The practical importance of this work is due to the rapid progress made with the development of the internal combustion engine, and to the growing need for enlightenment as to the lines upon which further improvement is possible. As we pointed out on the previous occasion, there is much uncertainty, to put it no more strongly, as to the fundamental properties of the gases used in the gas engine, viz., carbon dioxide, steam, carbon monoxide, oxygen, and nitrogen. This lack of knowledge has severely handicapped all who have attempted to make dependable calculations as to heat flow and thermal efficiency. Until a few years ago almost all authorities based their calculations upon the assumed constancy of specific heats. They took it for granted that the number of heat units required to raise one pound of any gas through one degree was just the same, no matter whether the gas was quite cool or extremely hot—even white hot. We now know that this is untrue, and that many more heat units are required as the gas gets hotter; but we do not know exactly the amount of the increase, although, thanks to the work of the British Association, we probably can obtain estimates within 5 per cent. of the mark. This leads to the somewhat curious situation that at the present moment practically every book written on the subject is out of date so far as thermodynamics and efficiency calculations are concerned. Here, evidently, is room for constructive work; but until the investigations of this Committee have been carried several steps further there is no sufficiently sure foundation upon which to build, or at any rate upon which to base numerical calculations. The present report of the Committee contains much that is of interest, much that is important; but it is plain that there is still a great deal to be achieved. The *personnel* of the Committee is a strong one. Among the members are: Drs. Glazebrook and Harker, Professors Bone, Callendar, Coker, Dixon and Petavel, whilst the energetic secretaries are Mr. Dugald Clerk and Professor Hopkinson.

During the session 1908-9 the work of the Committee consisted partly of new investigations, and partly of study and critical discussions of English and continental work already published. In particular, special investigations were made by individual members, who presented notes upon them at the various committee meetings. The subjects so chosen were:—"The Analyses of Exhaust Gases from the Petrol Engine," by W. Watson; "Some Experiments on Chemical Equilibrium in Gaseous Explosive Mixtures," by Dugald Clerk; "Deville's Experiments on the Dissociation of Gases," by J. A. Harker; "On Radiation in a Gaseous Explosion," by B. Hopkinson; "The Alternate Compression and Expansion of Dry Air in an Engine Cylinder," by Dugald Clerk; "Direct Measurement of the Temperature of the Working Fluid in a Gas Engine Cylinder," by W. E. Dalby; and "The Temperatures Reached in the Compression of Air," by B. Hopkinson.

No new high temperature experiments on specific heat were available for discussion, but the Committee investigated very carefully the lower end of the scale and revised Regnault's well-known observations on air at temperatures of from 100 deg. Cent. downwards. Their conclusion is that there is now little doubt that these figures are too low, and that the more modern work of Swann, both on air and carbon dioxide, is more reliable, and may, in fact, be adopted as correct.

The next part of the report is concerned with the accuracy of Mr. Dugald Clerk's experiments upon specific heat. At the time when these experiments were first made we gave our reasons for not admitting without question the conclusions arrived at, and this caution was amply justified by the action of the Committee, who, in their first report, stated that the figures were apparently too high—possibly even as much as 10 per cent. too high. This matter has been further considered by the Committee, and they still consider that the figures should be reduced, and that 3 per cent. perhaps represents the amount of the error. This conclusion seems to be admitted in the very interesting summary of the Committee's work which Mr. Dugald Clerk read at the Winnipeg meeting; but what is really needed is further experiment, and this, we are glad to learn, is being undertaken. If, as Mr. Clerk seems to anticipate, it should prove possible to carry his experiments up to 3000 deg. Cent., a great step in advance will have been gained. On reading the first issued report we felt bound to draw attention to the unexpected suggestion made by Professor Hopkinson in his criticism of Mr. Clerk's figures, that at a certain part of the expansion stroke the gas, although at a far higher mean temperature than the walls, might have been receiving heat from those walls. It is interesting to find that this point has now been experimentally investigated by Mr. Clerk, who found himself unable to detect any effect of the kind; and although the Committee endeavour to illustrate the means by which such an effect could be produced, we feel that it would be wiser to say no more about such a phenomenon until someone has shown that it has a real physical existence.

An important part of the report is devoted to Dr. Watson's very complete experiments with petrol engines. This experimenter reaches one conclusion which is worth careful study, viz., that even when the combustion in the petrol engine is apparently perfect, there being some excess of oxygen and no carbon monoxide nor hydrogen in the exhaust, the ratio of hydrogen to carbon in the exhaust gases is considerably greater than in the petrol used, showing, it is considered, that even in this case there must be some incomplete combustion. Upon this, Professor Bone, one of the distinguished chemists, who has been good enough to give so much time to a matter which, after all, affects chiefly engineers and not chemists, makes certain comments which seem to indicate that upon some parts, at any rate, of the Committee's report, a "minority report" could have been written. He says:—"I am not in the least surprised that Dr. Watson has obtained evidence of some disappearance of carbon (as a soluble product) in his experiments; indeed, I should have been rather surprised if he had not obtained such evidence. Some years ago, working on the combustion of dense hydrocarbons in a Diesel engine, I found a considerable 'disappearance' of both carbon and hydrogen, which was at once explained when the water condensed from the exhaust gases was found to give a very strong aldehydic reaction." Here again we must wait for more experimental work to be undertaken before certainty can be reached. The investigation would be one in which the assistance of a chemist would be essential, and it is to be hoped that such experimental skill will be available, and that any conclusions reached will be such as will command the assent of the chemist, the physicist and the engineer equally. The report contains also some indicator diagrams obtained simultaneously with Hopkinson and Crosby indicators, which show some interesting discrepancies, and it concludes with a reference to the work that has been done on the dissociation of carbon dioxide, in connection with which it is satisfactory to read that the National Physical Laboratory has decided to investigate this phenomenon, particularly at the higher temperatures. We hope that the difficulties of the work will not be so great as to prevent trustworthy results being obtained.

We have already referred to the note read by Mr. Dugald Clerk before the Winnipeg meeting. In addition to describing the work of the Gaseous Explosions Committee, he offers some important observations on the thermal efficiency of modern internal combustion engines. He shows that existing engines have achieved as much as 88 per cent. of what is theoretically possible for the cycle upon which most gas engines work. This means, of course, that the cycle of operations will have to be altered if there is to be as much progress made in the decade 1909-1919 as there has been in the last ten years. The more efficient our engines become, the less is the amount of heat passing to the cooling water, but the proportion of heat carried away by the exhaust gases steadily increases with the rise of compression ratio and the corresponding rise in efficiency. The heat of the exhaust gases requires, therefore, to be used in some way. This can, perhaps, be done best by compounding, although if there is anything in analogy with steam engine practice, a combination of reciprocating engines and turbines might be found useful. On the other hand, since, unfortunately, one cannot condense to a liquid the exhaust products of a gas engine as one can those of a steam engine, the greater part of the attractiveness of this proposal disappears.

Finally, we commend to those of our readers who are concerned with the internal combustion engine the perusal of this very important report, and of Mr. Dugald Clerk's commentary upon it. We hope that the continued co-operation of so distinguished a body of men will advance very materially the future progress of this important branch of engineering work.

Crank Shaft Failures.

LAST week we dealt with some of the facts and figures contained in Mr. Longridge's annual report. We by no means exhausted the subject. Far more might be said, indeed, than it is possible to say within the limits available in our pages. Few questions are more important to the steam user than the reason why his engine breaks down, and no man living has tried harder than Mr. Longridge to supply the answer. If he has not invariably succeeded, the reason is simply that very much remains to be learned as to the behaviour of metals —and in particular of that metal known as steel— under varied and long-continued stresses. Several examples of this ignorance or partial knowledge may be found in the report before us. It is well to remember that the general results of an inquiry into the particulars of a breakdown may usually be classified under different heads. We have in most cases a fact and a consequence about which there is no doubt of any kind. Thus, if a piston-rod breaks and the end is knocked out of a cylinder, we need not trouble ourselves about the strength of the cast iron; we confine our attention to the piston-rod, and about that, its strength, and its characteristics we need carry out no speculative inquiry if we know that the smash was the result of heavy priming. The inquiry is pushed another step further back, and we want to know why the boiler primed. But there remain always in the records of such an insurance company as that to which Mr. Longridge is the engineer-in-chief, particulars of failures, the explanation of which is not perceptible at a glance, and may, indeed, not be discovered at all in so far as the ultimate or first cause is concerned.

We have an example of this in the cracking of the crank shaft of a pair of horizontal tandem triple-expansion engines of considerable power. We have referred to this case in our last impression. Various changes had been made. The engine was originally compound, but the crank shaft of Whitworth's fluid compressed steel had not been changed, and was certainly sixteen years old; it may have been twenty-six years. It was about 16ft. 7½in. long, with an overhung crank at each end; the journal which cracked was 2ft. 3in. long and 13¾in. diameter. It was properly filleted at each end. The shaft was carefully examined in 1905 and found quite free from defects. It was again examined in October, 1908. The inspector reported a number of fine marks like scratches principally in a circumferential direction, and "as clean as if cut with a knife." One in particular, 7in. from the fly-wheel end of the neck, was 18in. long. As the marks were so fine and clear it was thought that, if cracks, they could not be very deep, and as the shaft was not heavily stressed it was allowed to go on running. A few days later, however, the engines had to be stopped, as exuded oil was seen on the surface of the bearing, and the long circumferential crack was found to have extended more or less continuously nearly round the neck. The shaft had made in the course of its life about 218 millions of revolutions. The stress did not exceed 5300 lb. per square inch. The shaft was taken out and broken under a tup. It gave way across the crack. Very fine circumferential cracks besides the original crack were found, and we are told that "many years ago the company directed attention to the probability of even the finest scratches on steel under stress developing into cracks, and the shaft now under discussion is an admirable illustration of the process."

We need not ask why this shaft failed. That was because cracks were developed in it. The real point is, why the shaft, after making millions of revolutions, should have developed the minute hair-like "scratch?" We may say here, that "scratch" appears to be a misapplied term. There is obviously a close analogy between glass and steel. Now glass cannot be "cut" by scratching it. The stories of panes cut out of windows with diamond rings are quite untrue. Glass can only be severed by a natural splinter of diamond or bort, which makes a hair-like split or true crack in the glass, and so starts cleavage. We have before now called attention to the desirability of carrying out an inquiry into the imperfectly mastered phenomena of the cutting of glass, and its analogy with the fracture of very heavy masses of steel in which cleavage has been started. It is quite possible that if the shaft had been put in the lathe in time, and the "scratch" cut out, it would have remained good for years. Turning now to the report in search of explanations, we fail to find anything that can be regarded as conclusive. As to the quality of the steel, chemical analysis showed that it was excellent. The microscope detected nothing but that certain arrangements of pearlite and sulphide areas suggested the possibility of ultimate brittleness. It is possible that this "condition has been brought about not so much by over-heating as by prolonged heating at a temperature that would not affect the properties unless long continued. It does not suggest the appearance of burnt iron in the ordinary sense." This helps not at all. Mr. Longridge tells us that during its early life the neck had given a good deal of trouble by heating, but none at all during recent years. It is impossible to believe that the shaft could have worked for long periods at a temperature sufficiently high to modify the structure of the steel; and, even if we grant that it had, why did it hold out subsequently for several years? The problem is further complicated by the fact that the journal at the other end of the shaft, which was more heavily stressed, had worked for years with several irregular diagonal cracks in it.

It is by no means easy to draw any practical lesson of value from the case, save perhaps one— the desirability of frequently examining all those parts of a machine the breakage of which would be followed by disastrous consequences. In the case under consideration no expense had been spared to obtain a shaft of the best possible material. The design was in no way open to criticism. It is accepted as a fact that if a journal heats it is liable to crack; but no cracking followed heating in this case. We fall back on the old theory of fatigue; but the tests to which the steel was submitted show no evidence of this; the steel was weak, but very tough. The elongation in 2in. lengths was 40 and 41 per cent. and the reduction in area 60 and 60.6 per cent. If it is conceded that hair cracks will extend, then the key of the mystery lies in the explanation of how the cracks came into existence. They are apparently, in their way, akin to "notches" made for impact tests; but we think the analogy is more apparent than real. The true analogy is between the cleft made by a diamond in glass and these minute fissures in steel concerning the immediate cause of which so little is known. One more point deserves consideration. Differences of opinion as to the importance of cracks and "scratches" continually arise, particularly with the Board of Trade and Lloyd's, between inspectors and superintending engineers. These last have very strong objections to the condemnation of costly crank shafts because of almost microscopic "scratches." The usual test of their importance is that if the shaft is wiped dry and rotated in its bearings oil will ooze out if they are true cracks. We can call to mind, however, a case in which a 20in. intermediate shaft of a paddle wheel mail steamer was rejected because of a minute hair crack. The rejected shaft was put in a lathe, and the bearings skimmed over. It was found that the so-called crack was really a scratch. Events of this kind—and they are not rare—heavily handicap the inspector, and strengthen the arguments of shipowners and steam users against the rejection of shafts. The hair-crack deserves more investigation than it has yet received. It is, however, above all things essential that it should be dealt with by wholly unprejudiced men who have no individual theories about the effect of notching. Is the failure of a journal due to the crack? or is the crack the first manifestation of molecular changes which must result ultimately in the breakage of the shaft? These and many other questions are ripe for consideration, investigation and discussion. May we suggest that Mr. Longridge is the right man to deal with the subject?

Improving Trade.

THE outlook in the iron and steel trades in general has become more favourable in the past two or three months, and there are fairly sound reasons for believing that the period of unsatisfactory business is being superseded by returning prosperity in these branches and in the shipbuilding industry. Two years of economic depression, which have affected most parts of the commercial world to a more or less extent, have caused such a large amount of injury that an improvement will be welcome in all quarters. As the downward movement commenced in the United States, and as that country holds the leading position in the production of pig iron and steel, it is only natural for us to glance across the Atlantic for any indications which may react favourably upon the commercial circumstances in the United Kingdom. In this connection, Judge E. H. Gary, the chairman of the United States Steel Corporation, is reported to have recently expressed the opinion that trade conditions in Great Britain are more or less dependent upon those which prevail in America. He added—and his observations were made before the Sheffield Chamber of Commerce—that a decided advance in trade has taken place in the United States during the past few months, particularly in the iron and steel branches, and he therefore thought that England, and especially Sheffield, had good reason to be hopeful with regard to the immediate future. A revival in the iron and steel trades in the United States, of which the chairman could possibly have given statistical information, is the natural consequence of a general improvement in the domestic trades and commerce in that country, seeing that the exports of iron and steel, having reached approximately 1,200,000 tons per annum, fluctuate around this quantity, and do not have any material influence upon the total production of pig iron and steel in that part of the world. Indeed, the domestic market is so enormous that, whatever the future may bring forth, no disposition has been manifested in the past few years to force the export trade, or this would have been attempted in the two financial years which ended last June; but preference has been given to the policy of keeping plant idle until required.

The general improvement in the home market in the United States has become accentuated since the conclusion of the new tariff, and it has resulted in an increase in the prices of pig iron and of manufactured iron and steel. Apart from other circumstances, the railway companies have exercised a very considerable influence upon the iron and steel trades both directly and indirectly. Financial considerations for a period of over a year and a-half compelled the railways to be extremely reserved in the placing of orders for railway material, locomotives, and other rolling stock; but the traffic and gross revenue in the present year have again expanded to such an extent that it has been found impossible further to delay contracts for renewals or new lines, and it is stated that enormous orders have been given out for engines and rolling stock since January last. How these and other orders have favourably affected the production of pig iron is shown by the fact that the output in the first six months of 1909 was 4,000,000 tons larger than in the corresponding period in 1908, and 2,000,000 tons greater than in the second half of 1908, whilst the output in July was not far short of the largest registered production in any month down to the present time. On the other hand, if the British iron and steel trades may expect to benefit from a recovery in the American home market, they should also derive advantage from a substantial improvement in the domestic market of Germany. A favourable change of this kind has, however, not yet taken place. The degree of employment has certainly become greater in recent months, and the production of pig iron in Germany, including

Luxemburg, increased by 280,000 tons in the first seven months as contrasted with the equivalent period in 1908; but until a week ago the prices of pig iron and of manufactured iron and steel were at a very low level except in the case of those products which are maintained by syndicates. The quotations for pig iron were then slightly raised, and endeavours are also being made to secure higher rates for bars and plates.

It is impossible to say definitely whether the improvement in the United States has as yet contributed towards the recovering tendency in the United Kingdom, but a continuance of the upward movement in the former would eventually be of advantage to the latter country, as has been shown by the experience gained in previous cycles of prosperity. So far, however, it is reasonable to ascribe the favourable change taking place in our iron and steel trades to the general improvement which is manifesting itself, and particularly in the case of the shipbuilding industry. A number of orders for new ships have been placed in the past few months, and the output of the Clyde shipyards in August was the highest for any month this year, whilst the total for the eight months is practically identical with that in the corresponding period in 1908. The orders for warships also play a prominent part in the improved activity of some of the shipyards, and those in prospect in the next twelve months should tend further to improve the position of affairs. We thus have a tolerably fair basis for a continuation of the present upward movement, which has already been reflected in the iron and steel trades by an advance in the prices of various products. It would, however, be possible to regard the future with greater confidence if a material improvement were to take place in the inland requirements of Germany, as that would tend to relieve the pressure of competition from that quarter in Great Britain and foreign markets. The imports of iron and steel into Germany in the first seven months of the current year experienced a decrease, whereas the exports increased, and on the balance the trade returns indicate a gain of 155,000 tons as compared with the equivalent period in 1908. On the other hand, the imports into the United Kingdom have increased, whereas the exports have diminished in the same months in the two years respectively. The position of Germany is then the only shadow on the brightening aspect of trade. Were it removed we might be entirely confident that the long expected cycle of good trade had come round again.

Motor Roads.

In view of the welcome that several of the leading political papers had extended to the Improvements Bill, it was with some hesitation that we ventured last week to criticise the measure. But since its first appearance a change of feeling appears to have occurred, and we notice on all sides a tendency to moderate the original transports. In its purely political aspects the Bill is now adversely criticised, particularly with regard to its first part, on grounds into which we are not called to enter. But criticism does not stop there, for the second part, the part which provides for the expenditure of half a million per year upon the development and construction of motor car roads, has been received with little cordiality even by motorists. After a long discussion on Friday last, the General Committee of the Royal Automobile Club—surely the most representative body of motorists in the kingdom—adopted a resolution expressing the hope that the attention of the Road Board might be directed to the improvement of existing roads rather than to the construction of the proposed new motor highways, upon which no speed limits were to be enforced, and from which ordinary traffic might be excluded. This resolution amounts practically to a polite refusal of Mr. Lloyd George's proffered gift. The fact is that special roads would suit the motorists not at all. The country is already cut up by roads in every conceivable direction where a road can be of any value, and if new highways were constructed they would generally have to extend through country uninteresting in itself, and would either lead nowhere or to towns of small importance. On the other hand, no one will deny that many of our roads might be widened with advantage, whilst the road surface on nearly all might be improved; here and there, also, short supplementary roads might be constructed, but without the 220 yards of property on either side. It is in such directions as these that the motorist who has not an insane desire to possess the whole country would prefer to see the money which the new taxes force him to subscribe spent.

THE RAILWAY POSITION.

In an editorial in The Engineer for January 8th last, when dealing with the railway outlook for 1909, we remarked that very stirring times were apparently in store for British railways. A great part of the year has now passed, and a study of the question and review of the situation may be opportune.

The Great Northern, Great Central, Great Eastern Working Union Bill has been withdrawn under circumstances that were fully noticed in our issue of April 30th, and all that need be said in relation to that subject is that the companies incorporated in the Bill clauses that had been agreed to by the Board of Trade and which made excellent concessions for the protection of traders and servants. But still the second reading was only carried by a small majority, and when the composition of the Committee to which it was referred was enlarged and the area to be covered by their inquiry widened—the whole cost of which would have had to be borne by the companies—the climax was reached, and so the Bill was withdrawn, and we are not likely to hear more of the matter during the present Parliament.

The withdrawal of the Bill had one unfortunate result in that it removed an opportunity of Parliament considering for the first time since 1872 the whole question of railway amalgamations, agreements, pooling, &c. That some investigation is desirable is generally admitted, and we are disposed to think that the companies and the Board of Trade would welcome it—the former because it would clear the air, and the latter as relieving it from an embarassing position in that it has to administer the law in relation to railway agreements as to pooling, &c., as it stands, and this is unpalatable to many supporters of the present Government. It was, therefore, a natural sequel that a Departmental Committee should be appointed, and an announcement to that effect was made by Mr. Churchill on June 14th. The Committee are to "consider and report as soon as practicable what changes, if any, are expedient in the law relating to agreements among railway companies and what, if any, general provisions ought to be embodied for the purpose of safeguarding the various interests affected, in future Acts of Parliament authorising railway amalgamations or working unions." The Committee included four members of the House of Commons:—Mr. Russell Rea, who is to act as chairman; Lord Robert Cecil, Sir Maurice Levy, and Mr. G. H. Roberts; two members of the House of Lords:—Lord Hamilton of Dalzell and Lord Newton; and Mr. J. S. Beale, Mr. Alexander Siemens, Mr. Ernest Moon, and Mr. W. Temple Franks. The composition of the Committee was soon assailed, and Mr. Churchill frankly admitted that it was not intended to be representative of all the interests in the country involved, but that his aim had been to secure a thoroughly fair and competent body, authoritative rather than representative in character, and small enough in numbers to facilitate rapid and practical work upon the important questions which are included in the reference. Answering a further inquiry in the House on July 8th as to why there was no representative of the workpeople on the Committee, Mr. Churchill said that he had met this by the appointment of a member of the Independent Labour Party—Mr. Roberts; and in reply to a supplementary question as to an inadequate representation of traders, the right hon. gentleman said that he was prepared to put a trader on the Committee in the event of a vacancy occurring. Since then Lord Robert Cecil has withdrawn and Mr. William Russell, C.B., a barrister and coalowner, has been appointed. It has been more than once alleged that inclusive of Mr. Beale, Mr. Moon, and Mr. Temple Franks in the Committee, it is too favourable to railway interests. It should, however, be pointed out that the companies have only one direct representative—Mr. Beale—who is a director of the Midland Railway. Mr. Moon is a member of the Parliamentary Bar, and the son of the late chairman of the London and North-Western Railway, and may probably therefore be regarded as another. Mr. Temple Franks was the secretary to the Railway Companies Association, and is, as a consequence, suspect, but he is now the Comptroller of Patents, and an officer of the Board of Trade. As a consequence his is an admirable appointment, because his former relations to the railways have given him an excellent acquaintance with the subject under review, whilst his present office secures for him an independent and unbiased position. But even were railway interests unduly guarded, it must be remembered that it is they that are at stake.

Questions have often been asked in the House as to whether railway companies should not, by law, submit their agreements between each other to the Board of Trade. The statutes on this point were fully explained in our issues of November 6th and December 18th last, and we then showed that there was no such necessity, and this Mr. Churchill has admitted. He, however, subsequently—on May 6th—announced that the London and North-Western and Midland Companies had unofficially supplied him with a copy of their agreement, and had consented, as an act of grace, to its being laid on the table. But there seemed some delay in this being done, and the reason became apparent when it was announced on June 7th that these two companies had brought the Lancashire and Yorkshire Company into their circle, and this tri-partite agreement was made public on June 21st. That this would be the course that events would take we ourselves felt satisfied, and in our issue of November 6th last we said that the situation was interesting to the watcher of events. The Lancashire and Yorkshire Company does not compete with the North-Western and Midland, but the circumstances were peculiar for other reasons. Since the Midland Company, in 1889, exercised its running powers over the Lancashire and Yorkshire line, it and the North-Western have been strong competitors for the very valuable traffic to and from the territory served by the Lancashire and Yorkshire, and the last named company has not failed to take advantage of the rivalry to play off one company against the other, but the North-Western—Lancashire and Yorkshire agreement of 1906 almost put the Midland out into the cold entirely, as the combination was too strong for it as far as passenger service was concerned. Now the agreement a year ago between the larger companies put the Midland on the same level as its neighbour, and so created an absurd position which took the turn we anticipated, and resulted in a tri-partite agreement, which cannot be determined without ten years' notice, and as such notice is not to be given before December 31st, 1998, it means that it is to last for at least 100 years. Those who have agitated for the agreement to be laid on the table will not find anything in it that can be unfavourably criticised. It has only thirteen clauses, which may, however, be amplified when the formal agreement referred to in the last clause as "to carry out these heads" is entered into. Suffice for us to notice that Clause 4 agrees that each of the three companies shall afford to the others all due and reasonable facilities for interchange of all traffic, whether divisible under the agreement or not, so as to give the public the benefit of the best route, and Clause 5 recites that arrangements are to be made as soon as possible with a view to securing the most economical methods of working, combined with the best facilities to the public. One result of the agreement is the through service between Bradford (Lancashire and Yorkshire) and Sheffield (Midland). No doubt, too, Midland engines will now work their own trains, excursion and ordinary, through from Leicester, Nottingham, and Sheffield to Blackpool and back instead of only to and from Manchester. We shall also possibly see the Irish cross-Channel sailings during the winter being *viâ* Fleetwood and Heysham alternately like the Great Western and London and South-Western for the Channel Islands. A possible sequel to these agreements is that the North-Western saved £236,254 in working expenses during the past half-year and the Midland saved £167,224.

The reference to the Great Western and London and South-Western companies reminds us that there was some very candid speaking by the chairman of the former company at their half-yearly meeting. It arose out of an observation by Sir Charles Scotter at the South-Western meeting that they were prepared to enter into an agreement with the Great Western, and approached the latter company years ago on the subject, but for some reason or other the directors of the Great Western thought the time was not opportune for entering into any further combination. Viscount Churchill, at the Great Western meeting, departed from precedents, as he admitted and told the shareholders freely what had been done. How fully he revealed the transactions between the two companies may be judged from the fact that the remarks on this subject occupied three-quarters of a column in the *Times*, and they would appear to show that the absence of closer relations between the companies is more due to the authorities at Waterloo than those at Paddington.

The Bills for the merging of the Rhymney and Cardiff Railways into the Taff Vale successfully passed the Committee and other stages in the House of Lords, but were nearly rejected on second reading in the House of Commons—the ostensible reason for this being that any amalgamation proposals should stand over until the Committee on Railway Agreements had reported. To the surprise of a good many people the absorption of the Rhymney Railway was subsequently approved in Committee, but the Cardiff proposals were rejected, and the Bills were therefore withdrawn altogether last month.

We dealt with the report of the Board of Trade Railway Conference in our issue of June 18th, and therein remarked that the outstanding feature was the triumph of the railway case. We intimated that there were features in the report that we would like to refer to later in detail, and this is probably an opportune moment to do so. Suggestions have been made by traders that the proceedings before the Railway and Canal Commission were costly, and the procedure framed too much upon formal judicial lines. The railway representatives on the Conference were therefore willing to agree to some modification of the procedure, and suggested that many cases might be dealt with by the Registrar, who, if desired, might receive the assistance of assessors. Various other points in dispute were settled. The conditions under which goods are carried at owners' risk rates are to be extended. At present these lower rates relieve the companies of all liability except for wilful misconduct, or it may not be for a lower rate, but for the acceptance unpacked of goods liable to breakage, damage or pilferage. The railway companies' representatives were not only willing to increase their liabilities herein, but at the request of the Conference they consulted the companies generally, and ascertained that, with a view to settling this controversy and avoiding legislation, they were willing to embody these suggestions in their present consignment notes, subject to any drafting amendments that might be found necessary by counsel. To avoid all future disputes as to the facilities that should be given by the companies to traders who own private sidings, or for whom private sidings were to be constructed, and the rates to be charged for traffic consigned to or from such sidings, a committee of the Conference drafted a model private siding agreement which the Conference accepted, and which is embodied in the report, and they further recommended that the modified arrangements as to disputes being dealt with by the Registrar to the Railway and Canal Commission shall apply to the settlement of disputes as to private sidings. The same committee had under consideration the question of detention of private owners' trucks in transit, and efforts were made to arrive at an agreement between the representatives of the traders and of the companies as to a scale of payments to be made by the companies as demurrage. These negotiations were futile at the time, but the report says that the representatives of the railways have agreed to meet the traders again in order that a settlement may be arrived at. One of the subjects considered by the

Conference was Working Agreements, Combinations, and Amalgamations of Railways, and this was referred to another committee, and this we will mention after dealing with the two remaining points. These latter are, first, the acquisition and holding of land. The whole Conference would appear to have dealt with this. After mentioning that the paid-up capital of the companies amounts to £56,000 per mile of open line, the report says that it was generally felt by all the members of the Conference that simplification and cheapening of the procedure could not fail to be beneficial generally. For powers for the acquisition of land wider authority should be given to the Board of Trade to grant certificates for compulsory powers as under the Railways Construction Facilities Act, 1864, and the Light Railways Act, 1896. For assessing compensation the Conference recommended provisions similar to those in the Light Railways Act, 1896, and the Small Holdings Act, 1907. It may be added that the Conference recommended that the principle of betterment should be recognised in assessing compensation. The second remaining point is that the Conference proposed that an Advisory Committee on Railway Matters, which the Board of Trade might consult on such matters as they might think fit to refer to it, be constituted.

Reverting now to the Committee on Working Agreements, &c., it may be observed that their conclusions do not carry the matter far, probably because the subject is too big or the views of the members were too diverse. Anyway, the Committee report that "in their opinion various circumstances have combined to make it desirable to conclude their present sittings." They had before them various memoranda which are printed as an Appendix, and from them some new thought on this subject may be gathered. Mr. Sam Fay, for instance, reminds us that Sir Rowland Hill said as to the rating of railways:—"While in common with the owners of other public vehicles railway companies are taxed by the State, their lines, unlike the old roads, are heavily rated by every parish they traverse; so that in some rural districts a railway company, though perhaps, on the one hand, relieving the parish of much pauperism by giving profitable employment to the peasantry, and, on the other hand, lightening the pressure on the rates by increasing the value of the property on which they are levied, is yet made to pay, in a direct form, half the parochial expenditure." Mr. Fay also makes a point of which little notice has been taken in this country, but which in America has led to the railway supply men forming a Railway Business Association, whose purpose is to resist anti-railroad legislation. Mr. Fay says: "It is not generally recognised how much home industries depend upon railway purchases. The annual value of material and stores of all descriptions bought by British railways on revenue account may be put down at £26,000,000 sterling, or equal to the value of nearly three months' total exports from the United Kingdom to British Possessions." Mr. Kaye Butterworth, of the North-Eastern, gives us an admirable thought when he says of the benefits of agreements:—"By freeing the officers of the two companies from the necessity of spending their time in scheming how to secure traffic for their own line, it would enable them to throw their best efforts into what, under an ideal system, would seem to be the proper channel for the efforts of the brain-workers on a railway, viz., on the operating side, devising how best to combine economy and efficiency of working, or, in other words, how to give to the public the greatest facilities at the least cost and, on the commercial side, trying to create and foster new industries, and, generally, to develop to the fullest extent the resources of the district which the company exists to serve." The late Mr. Robert Millar said that fewer goods trains might be run, which would lead to less occupancy of the line and easier regulations of the hours of duty. Mr. Guy Granet concludes his memorandum by the following suggestive observation:—"Whether more extensive benefits might not be attained by a more complete and systematic elimination of competition, short of State purchase, by a scientific grouping of railways, constitutes an alluring field for speculation and inquiry. Apart, however, from the inherent difficulties in connection with any attempt at defining the limits of the proposed groups, I do not see how such a result could be achieved without direct Government action and, as a necessary concomitant, direct Government financial assistance and control. After reading the minutes of the meeting between the Chancellor of the Exchequer and the President of the Board of Trade and the representatives of the Railway Association, it is clear, however, not only that such an inquiry is outside the scope of this Conference, but that the Board of Trade are not prepared to indicate the possession of any opinion on the subject." Investigations were conducted on behalf of the Conference by Mr. Reyntiens, barrister-at-law, and Mr. C. H. Pearson, of the Great Central Railway, as to the methods employed by continental railways. They have visited Germany and Austria-Hungary, but only their conclusions as to German railways are completed, and these are included. They deserve greater attention than we can afford space for at this moment, and therefore we defer our consideration of them for the present.

Another point of interest is the report of the Departmental Committee on Railway Accounts. The main feature of this was the rejection of the suggestion as to the adoption of ton mileage figures, and this we noticed in an editorial in the issue of June 25th, but we might here observe that in our forecast last January as to the outlook for 1909 we observed that it was unlikely that ton-mileage would be recommended.

The Viceregal Commission on Irish Railways completed taking evidence last February, but have not yet reported. It is stated that the Commission are divided as to their conclusions, but it would seem that those members who do not go so far as to recommend State purchase will advocate the absorption of the smaller companies by the larger, and this, we suggest, portends "districting"—a course we advocated when the Commission was proposed. In Mr. John Redmond's speech at Arklow on July 11th, about which there has been so much controversy, he said that under the Development Bill "money would also be available which could be used to facilitate the purchase and amalgamation of Irish railways under an Irish local authority."

Lastly, it may be observed that at the Trade Union Congress on September 4th it was stated that Mr. Churchill informed a deputation on the previous Monday that if the Government ran its course they would be prepared to bring in a Bill on railway management, railway facilities, and so on.

In conclusion, we would say that we believe that the happier relations that now exist between railway companies—not only amongst those to whom we have referred in particular, and amongst whom we might have included the Scotch companies, but railways as a whole—will increase and develop, and lead to better times for the proprietors, and, as a consequence, for the servants. The public have nothing to fear either. As yet they have never lost anything by amalgamations, and in the quotations we have made from the tri-partite agreement it will be observed that one of the essentials is that the public is to be given the benefit of the best route. There may be fewer trains, but what is the loss of this when a passenger has a choice of two or three routes? And there may be decelerations, but what are three or four minutes extra in a journey of 200, 300, or 400 miles? But it is in the goods and mineral traffic that the main economies are being, and will be, effected, and these the general public are not cognisant of, nor are they likely to be affected thereby. How much further the co-operative principle will extend one cannot say, but our railways are managed by "very able men"—to quote Mr. Mond—who know their business, and who recognise their strength and their weakness, and who, whilst they may differ with their neighbours, know that their differences may be adjusted. What is possible of the North-Western and Midland, the Great Northern and Great Central, and of the Scotch companies, is possible of all and everywhere. It is all a question of agreeing as to proportions. Without doubt much is being done of which we shall hear in due time. But a committee having been appointed to consider the question of railway agreements, whose labours may be followed by legislation, makes it probable that we shall now hear sooner than later. We trust so.

LITERATURE.

SHORT NOTICES.

Drawings for Medium-sized Repetition Work. By R. D. Spinney. London: E. and F. N. Spon, Limited. 3s. 6d. net.—Draughtsmen generally will find this book of great assistance to them in carrying out the host of little duties which fall to them to execute. The title of the volume is, perhaps, a trifle misleading, as it will be found to contain much that is more applicable to general drawing-office work rather than what is purely confined to the design of repetition work. The author has brought together many hints of a nature such as can only be learned, without the aid of some such work as the present, by a long experience of the draughtsman's art. He has, however, avoided almost completely the natural tendency which such a book has to assume a disconnected and scrappy nature, and the division of the work into chapters, dealing separately with such subjects as standard lists of parts, tolerances, dimensioning and reference indexes, renders it compact and interesting, and assists in the classification of the subjects with which the author deals. The standardisation of methods and the suppression of the idiosyncrasies of the individual draughtsman must help towards the efficiency of both the drawing-office and the workshops, and towards these ends the present book will be found full of practical advice. While not agreeing altogether with some of the recommendations made, we do not doubt that many drawing-offices would find that the adoption of some such system as is here outlined would assist largely in the rapidity of output and help to avoid confusion on the part of the workmen when working to the drawings.

The Metallurgy of the Common Metals. By A. Humboldt Sexton and J. S. G. Primrose. Manchester: The Scientific Publishing Company. 7s. 6d. net.—The authors of this work have collected from many sources accounts of the treatment of the ores of the more important non-ferrous metals. They intend the work to serve as an introduction to larger and more specialised treatises, and have confined their energies to giving as accurate and concise information regarding the various metallurgical processes as is obtainable. The first nine chapters are devoted to an account of copper smelting and refining, then follow four each on the treatment of tin and zinc. The next twelve chapters contain a discussion of the processes in use for the recovery of lead from its ores, attention being paid to the recovery of silver in the lead by the Pattinson and Parkes processes. Antimony, aluminium, and nickel are dealt with in the remaining five chapters, while in the appendices will be found data connected with the subject, which should prove of use to those who may be engaged in the study or practical operation of the processes described in the book. The volume is illustrated throughout by numerous diagrams and tables, which are uniformly well executed, while the printing, unlike that of so many books on this subject, leaves nothing to be desired.

Descriptive Geometry. By Victor. T. Wilson. New York: John Wiley and Sons. Price 6s. 6d. net.—The subject of descriptive geometry is hardly an attractive one to the ordinary run of engineers, and having but few applications in every-day work, it has become relegated, more or less, to the dark regions of college examinations. As an aid, however, to clear understanding of working drawings and as a corrective after much work in two-dimensional geometry, its utility has long been recognised. The present volume professes to deal with the subject from a mathematical standpoint. In carrying out this scheme, the author has made the usual problems found in most of the text-books on the subject to depend upon a few fundamental theorems. Whether or no such a treatment will be found to add to the lucidity of an already abstruse subject will depend entirely on the ability of the student to reason in the fashion of Euclid. The average student will, we believe, be well advised to leave this book to the later stages of study in this subject and acquire his knowledge at the start from some less pretentious volume. A very thorough treatment is given of the matter dealt with under descriptive geometry, and special emphasis is given to the discussion of curved surfaces. Those wishing to pursue this subject beyond the range of the ordinary class work we confidently advise them to examine this book.

The Theory of Structures. By R. J. Woods, M.Inst. C.E. London: Edward Arnold. Price 10s. 6d. net.—This is a welcome addition to Professor Woods' earlier work on the "Strength and Elasticity of Structural Members." The present volume amplifies the previous one, and includes much that was deemed too advanced for its forerunner. The author here expounds various theories dealing with such subjects as earth pressure, excentric loads, stresses in girders, wind pressure and bracing, arched ribs, and reinforced concrete. The clear style and concise statements, which were marked features of his earlier work, are again in evidence in this volume, and the diagrams and sketches illustrating the text are uniformly good and neatly executed. Many numerical examples are given, and we would in particular call the attention of students and draughtsmen to Chapter XII., where the complete design of a plate-web girder for a 60ft. span is given. Chapter IX. is devoted to continuous girders, and the theorem of three moments, with numerical examples, will be found fully developed here, as well as an extension of this theorem made to embrace the case of concentrated loading.

The Practical Management of Sewage Disposal Works. By W. C. Easdale. London: The Sanitary Publishing Company, Limited. Price 2s. net.—The effective management of sewage disposal works calls for qualities on the part of the man in charge which vary from those acquired during a medical training to those of an engineer. This little book, however, does not pretend to be a treatise on the subjects comprised in this range, but will rather be found to be an outline of the duties of the manager of such works; an outline, however, that contains many helpful hints and remarks. The author first deals with preliminary processes and particularises on grit chambers, tanks, and screens. He then discusses contact beds, filters, and final processes, and ends with a few general remarks on tests and records. As the book is intended, among other uses, to be of value to consulting engineers who may desire to give some general instructions to the man left in charge of their work after its completion, the author has provided some blank pages at the end for the insertion of whatever special remarks the engineers may think necessary.

Engineering Units of Measurement. By John Ramsay, A.M. Inst. C.E. Glasgow: John Smith and Son, Limited, 19, Renfield-street. Price 1s. net.—This little book consists of a collection of the more commonly required definitions and laws introduced into a study of the physical side of engineering principles. It is designed particularly for first-year students, but we believe that many others will find it of use to them in more advanced studies. Without attempting to prove any relations, the author states in clear language the various laws and theorems connected with the subjects of elasticity, hydrostatics, electricity, &c. We only regret that he has not thought it advisable to introduce the subject of dimensions into his treatment of units. This would have been quite suited to the class of student for whom the book is intended, and as an aid in many ways to the clear understanding and reproduction of formulæ its utility cannot be doubted. A useful series of conversion tables and convenient data are added at the end of the book.

Steam Power Plant Piping Systems. By W. L. Morris. New York: McGraw-Hill Book Company. Price 21s. net.—This book contains a very full account of the principles of pipe installation, and covers all the ground from the main steam pipe to the smallest oil drip. The author enters a plea for the contractor for a power station, and urges that the pipe system should be left to him as far as the design of details is concerned. He believes that the duties of the engineer should extend only to an indication of the general scheme of piping, and holds that such work is now as specialised as, say, boiler design. Many excellent illustrations are embodied in the text, and the explanations given are clearly stated. Although representing American practice, we have no doubt that the book will be found helpful to many in this country, whether they be engaged on the design or in the control of steam power installations.

BOOKS RECEIVED.

Exercises in Surveying. By J. C. Tracy. New York: John Wiley and Sons. 4s. 6d. net.

The Solicitors' Patent Practice. By G. F. Emery. London: E. Wilson. 3s. 6d. net.

The Principles of Fitting. Fourth edition. By J. G. Homer. London: Whittaker and Co. 5s. net.

The Iron Age Directory, 1909. New York: David Williams Company. Price 25c.

Proceedings of the Forty-second Annual Convention of the American Institute of Architects.

Transactions of the Manchester Geological and Mining Society. Parts V.-VIII., Vol. xxxi.

Exercise Papers in Elementary Algebra. By E. M. Radford, M.A. London: J. M. Dent and Co. Price 2s.

The British Motor Tourists' A.B.C., 1909-10. London: L. Upcott Gill. Price 1s. cloth, 5s. leather.

The Gas, Petrol and Oil Engine. By D. Clerk. Published by Longmans, Green and Co., 39, Paternoster-row, E.C. 12s. 6d. net.

Molesworth's Metrical Tables. By Sir Guilford L. Molesworth. Fourth edition. London: E. and F. N. Spon, Limited, 57, Haymarket. Price 2s. net.

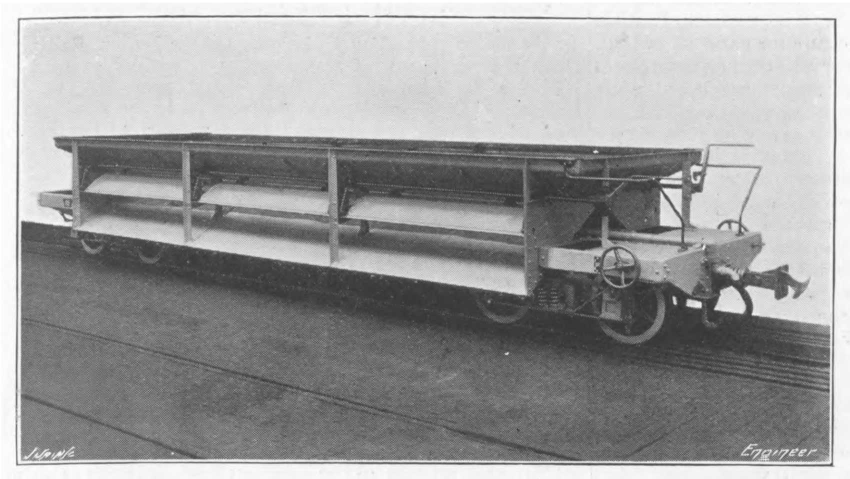
The Elements of Machine Design. Part I. New and enlarged edition. By W. C. Unwin, LL.D., F.R.S. London: Longmans, Green and Co. Price 7s. 6d. net.

Exercises in Physical Chemistry. Dr. W. A. Roth. Authorised translation by A. T. Cameron, M.A., B Sc. London: A Constable and Co., Limited, 10, Orange-street, Leicester-square, W.C. Price 6s. net.

The Construction of the Balance. By Dr. E. Brauer. Third edition. Translated by H. C. Walters, on behalf of the Incorporated Society of Inspectors of Weights and Measures. Watford: Incorporated Society of Inspectors of Weights and Measures. Price 15s. net.

SELF-DISCHARGING STEEL WAGONS FOR BURMA

THE LEEDS FORGE COMPANY, LIMITED, LEEDS, ENGINEERS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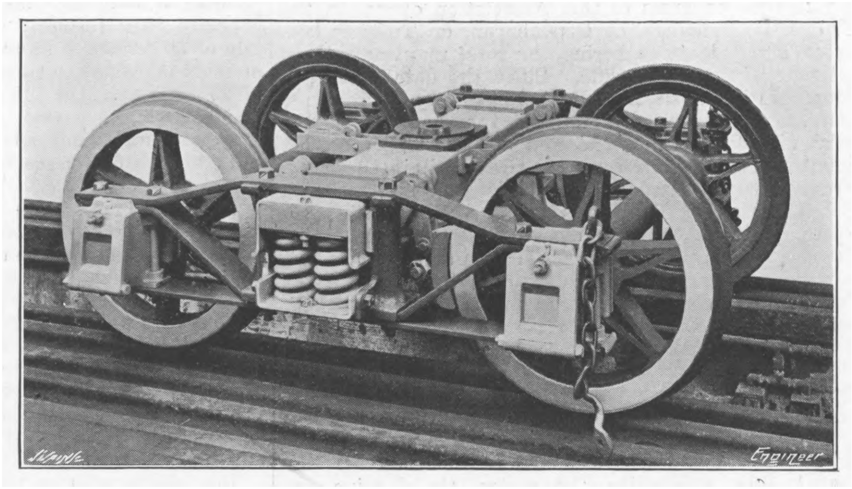
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Engineer

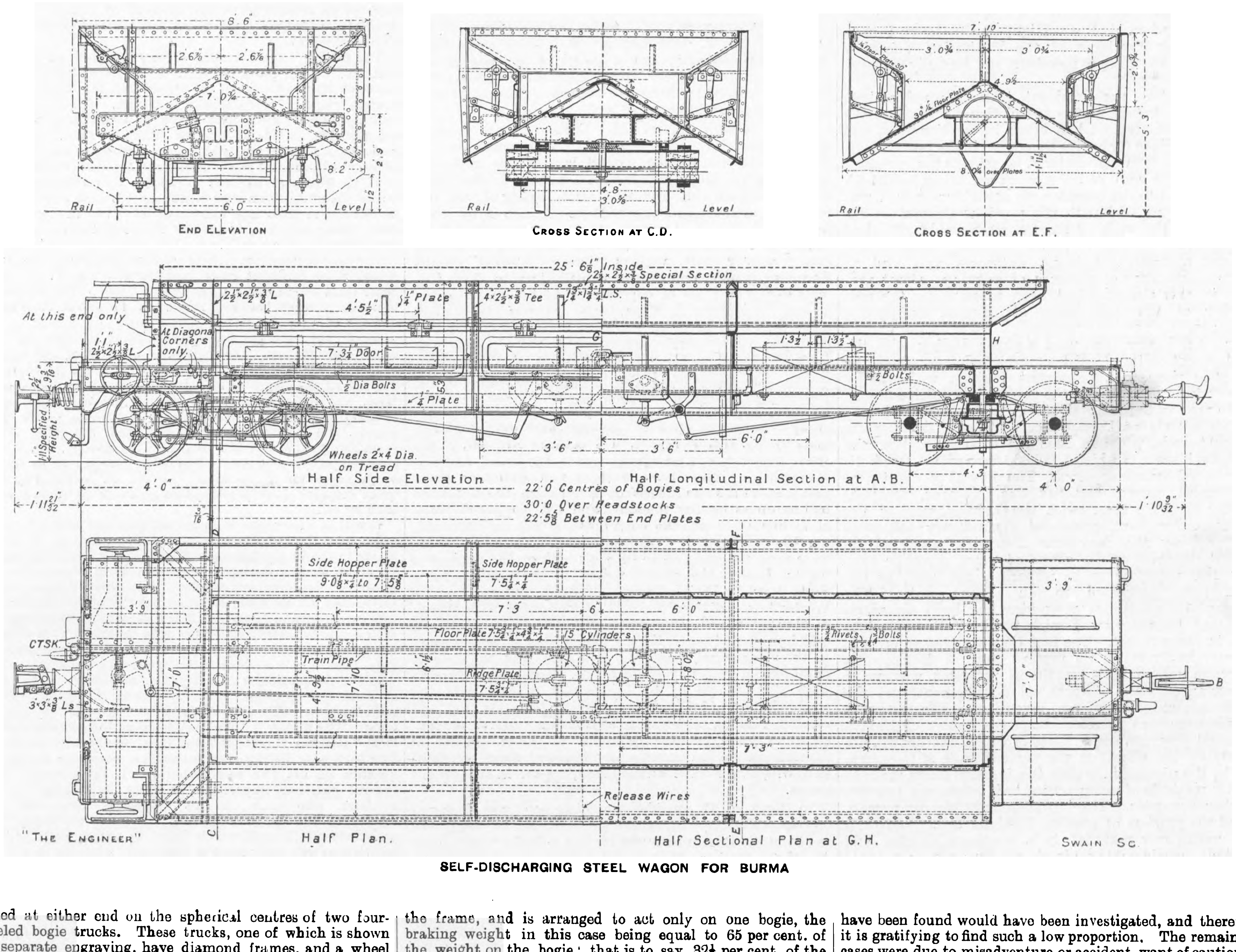
21-TON SELF-DISCHARGING WAGON.

SELF-DISCHARGING wagons of a new type are now being introduced into the service of the Burma Railways Company. They are shown in the accompanying engravings, and are intended for the transport of lead ore, and have been designed for the metre-gauge lines of the company. In conjunction with Messrs. Rendel and Robertson the wagons have been designed and constructed by the Leeds Forge Company, Limited. It will be seen that the body of the wagon, which is constructed throughout of steel, is carried on Fox's patented pressed steel underframes, the latter being carried at either end on the spherical centres of two four-wheeled bogie trucks. These trucks, one of which is shown in a separate engraving, have diamond frames, and a wheel base of 4ft. 3in., the wheels being 2ft. 4in. in diameter.

On each side of the wagon body three door openings measuring 7ft. 3¼in. in length and 1ft. 4 13/16in. in height are provided. The doors for these are of corrugated pressed steel, in accordance with Lane's patent, and are operated from the platform at the end of the wagon through a longitudinal shaft extending the whole length of the side. To avoid any obstruction the lifting links connecting this shaft with the doors have been placed at the ends, and are so arranged as to obviate any necessity for a device for locking the doors. To secure this they are made in the form of a toggle joint, the arrangement of which will be seen from the end views of the wagon. When the doors are closed the two horizontal links are in line, and therefore the outward thrust of the load in the wagon on the doors has no power to open the door. Similarly the arm on the longitudinal shaft and the link connecting this with the two horizontal links are in line vertically when the doors are closed, and hence the vibration and knocking are prevented from moving up the middle joint of the horizontal links, and thus the doors are kept closed. This arrangement, which is patented, at the same time permits the doors to be opened with ease, and during tests carried out by the constructors it was found that one man could readily open all three side doors simultaneously.

The wagons are fitted with the standard buffing gear of the railway company, and are provided with both vacuum and hand brake installations. The former system is operative on all the wheels of both bogies, and is arranged to exert a braking force of 90 per cent. of the total tare weight; the latter is operated from hand wheels placed at one end of the frame, and is arranged to act only on one bogie, the braking weight in this case being equal to 65 per cent. of the weight on the bogie; that is to say, 32½ per cent. of the tare weight. The following are some of the leading dimensions:—

	ft.	in.
Length over buffers	33	10
Length over headstocks	30	0
Length inside	25	6
Width over all	8	1
Width of underframe	7	0
Wheel diameter	2	4
Centres of bogies	22	0
Buffer height (unloaded)	1	11
Centres of journals	4	8
Net capacity	315 cubic feet	
Load	21 tons of lead ore	
Tare	9 tons 1 cwt. 3 qr.	


End Elevation
Cross Section at C.D.
Cross Section at E.F.
Rail
Level
8' 6"
7' 10"
2' 6⅞
7' 0¾
8' 2
6' 0
2' 9
4' 8
3' 0⅞
3' 0¾
4' 9½
5' 3
2' 0⅝
30° Floor Plate
8' 0¼ over Plates
25' 6⅝" Inside
2½×2½×⅜ Special Section
2½×2½×⅜ L
¼" Plate
4×2½×⅜ Tee
1¾×1¾×⅜ L.S.
4' 5½
At this end only
At Diagonal Corners only
7' 3¼ Door
⅝ Dia Bolts
¼ Plate
⅝ Bolts
1' 3½
1' 3½
G
H
Wheels 2' 4 Dia. on Tread
3' 6"
3' 6
6' 0
4' 0"
4' 3
4' 0
1' 11 21/32
1' 10 3/32
Half Side Elevation
Half Longitudinal Section at A.B.
22' 0 Centres of Bogies
30' 0 Over Headstocks
22' 5⅝ Between End Plates
Side Hopper Plate
9' 0⅝×¼ to 7' 5⅝
Side Hopper Plate
7' 5⅝×¼
7' 3
6'
6' 0
3' 9
3' 9
CTSK
Train Pipe
Floor Plate 7' 5⅝×4×¼
¾ Cylinders
Ridge Plate
7' 5⅝
Rivets
Bolts
7' 0
7' 0
7' 3"
3' 3×⅜ Ls
Release Wires
B
"The Engineer"
Half Plan.
Half Sectional Plan at G.H.
Swain Sc.

SELF-DISCHARGING STEEL WAGON FOR BURMA

THE GENERAL REPORT ON RAILWAY ACCIDENTS.

THIS report, which was issued on the 19th ult., was briefly noted in the "Railway Matters" column in our issue of August 27th. It had, however, been anticipated by the "Return of Accidents and Casualties" issued in April last and commented upon in THE ENGINEER of the 30th idem.

The only further information of note given in the later report is that the number of inquiries held into train accidents has fallen from 25 to 22, which is the lowest figure recorded. There were 888 inquiries held by the assistant-inspecting officers or sub-inspectors into casualties to railway servants, but in only 156, or 17·6 per cent., of these did the report show that they were due to what may briefly be termed preventable causes. We may rest assured that all cases where any irregularities on the part of the companies could have been found would have been investigated, and therefore it is gratifying to find such a low proportion. The remaining cases were due to misadventure or accident, want of caution or misconduct on the part of the injured person, or want of caution or breach of rules, &c., on the part of servants other than the person injured.

Many of the reports on the accidents to servants contain "recommendations." There were 362 such reports last year out of 888, or 40.8 per cent., which compare with 45.1 per cent. in 1907, 42.3 per cent. in 1906, 40 per cent. in 1905, and 42.7 per cent. in 1904.

The casualties in coupling and uncoupling are less than in 1907, being 16 killed and 675 injured, as compared with 18 killed and 757 injured. Of these 4 were killed and 249 injured when dealing with screw-coupled vehicles which cannot be coupled and uncoupled with the coupling pole. These figures might be still less—they are lower than in 1907—would the men not step into the "four foot" until the vehicles had come to rest. Instructions to that effect have been issued by some, if not most, of the companies.

INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

No. I.

The fifth congress of this Association opened in the University Buildings, at Copenhagen, on Tuesday last, before a very large gathering, the total number of those attending being about 700. Since the date of the last congress in Brussels, in 1906, there has been a gratifying increase in the membership of the Association, the total membership now exceeding 2000. The following countries are now represented:—Great Britain, Germany, France, Italy, United States, Russia, Denmark, Austria, Belgium, Greece, Holland, Hungary, Norway, Sweden, Spain, Portugal, Roumania, Switzerland, Australia, Canada, Brazil, the Argentine Republic and Japan. The largest membership is to be credited to Germany, the number of German members in May of the present year being 375, the United States coming second with 290, Austria third with 219, France 156, and Denmark with 155. Great Britain has at the present time about 100 representatives, and some 40 of these are attending the present congress. There is a gratifying representation of British institutions, including representatives of the Board of Trade, the War-office, Lloyd's Register, the British Fire Prevention Committee, the Engineering Standards Committee, the National Physical Laboratory, the Concrete Institute, the Iron and Steel Institute, the Institution of Mining and Metallurgy, and the British Weights and Measures Association.

Most of those attending the Congress arrived in Copenhagen on Monday last, and Mr. Alex. Foss, the President, entertained the members of the Council to dinner on Sunday evening, following the Council meeting held on that day. On Monday evening the Council were entertained to dinner at the Palace by the King and Queen of Denmark, a distinguished company being present at this entertainment.

The formal opening of the Congress took place in the Grand Hall of the University, Copenhagen, on Tuesday morning, in presence of the King and Queen and other members of the Royal Family. A distinguished company was present, when his Royal Highness the Crown Prince, the Honorary President of the Institution, offered a welcome to the foreign members, and formally declared the Congress open.

Mr. Alex. Foss, the President, then delivered a short address. On behalf of the Association, he thanked the King for the interest he had taken in the Congress, and the Crown Prince for having taken part in the proceedings. He wished to refer particularly, he said, to the increased interest in the work of the Association taken by British engineers, and to the considerable attendance from Great Britain as compared with the previous Congress. He trusted that the work of the Congress would stimulate international relations, would generally bring about a closer association between engineers, and lead to the standardisation of methods of working. Great progress in this direction had been made since the first meeting of the Association at Munich twenty-five years ago.

Mr. Paul Larsen then read a paper dealing with the development of the Danish cement industry, which, he said, had risen to a prominent position without any support from the State in the shape of protective duties. In the year 1889 the total production in Denmark was 115,000 barrels of Portland cement, and the imports 135,000 barrels, while in 1908 the total production was 1,560,000 barrels, of which 1,110,000 were sold in Denmark and 410,000 barrels exported. The present production of the Danish cement factories was, however, 2,600,000 barrels, or more than twice the consumption of the country. The development of the industry had been hampered by the fact that Denmark possessed no natural resources in the shape of water power or coal. Fuel had therefore to be imported, and was, at the same time, subjected to an import duty. The unfavourable conditions of working had been somewhat mitigated by the new Danish tariff, which came into force in January last. The fact that the Danish cement industry had reached its present state of development under the unfavourable conditions indicated was due to the advanced state of technical development, and the constant introduction of new inventions. The history of the industry was therefore largely a report of Danish technical progress, the advance of which was shown, not merely by the effect on the cement trade of Denmark, but by the manner in which the improvements made in Danish methods of manufacture had influenced practice in other countries. The introduction of the dry process solved the problem of making Portland cement out of a soft, moist, raw material, in a continual process, and effected a considerable saving in working costs compared with the thin slurry process. The modified form of Aalborg kiln of very large capacity, latterly introduced, had been taken up abroad to a great extent, the installations in foreign cement works representing an annual output of over 3,000,000 barrels. Reference should also be made to the wet and dry methods which paved the way to the introduction of the thick slurry method now generally adopted in connection with burning in rotary kilns. Then, following the introduction of sand cement, came the tube mill, which constituted an epoch-making change in methods, the mill possessing great advantages, not only for the manufacture of sand cement, but also for the grinding of Portland cement. This mill, which had a very low figure of power consumption, was now generally adopted for cement manufacture, and had had a great influence on the development of the Portland cement industry all over the world. It was at the present day employed in its different forms in all departments of the cement factory. There were now 1391 tube mills of Danish origin running in foreign factories, and giving an annual output of about 30 million tons.

For the preliminary treatment of the raw material prior to its reduction in the tube mill, the Kominor had been adopted in works with an annual output of 13½ million tons. The introduction of the rotary kiln in a form suitable for the cement industry was due to America, and the improvements introduced in recent years had resulted in a superior fuel economy and a much higher capacity than formerly obtained. The modern Danish kiln of 50 m. length and 2.7 m. diameter gave an output of more than 600 barrels per day, with a coal consumption of 25 per cent. The thick slurry process, combined with fuel saving rotary kilns, was now largely adopted for foreign factories, not only for moist and soft raw materials, but also to a considerable extent where dry raw materials were used. The Danish rotary kiln practice was in operation in foreign works, with an annual capacity of about 14 million barrels. The progress which had been made might be measured by the fact that, as compared with fifteen years ago, the labour in cement factories had been reduced to one-sixth of what it then was, 200 men doing the work which formerly required 1200. It was unlikely that further improvements would bring about any radical change or saving in the Danish thick slurry process. The cement industry in Denmark had attained its present position by purely technical advances, and by that international co-operation which it was the object of the Association to enlist.

The Conference then adjourned until Wednesday. An extensive programme of visits which had been arranged included on Tuesday an inspection of the Carlberg Breweries. Here an opportunity was afforded of gaining some knowledge of the work done in the Carlberg laboratory in the domain of scientific research. The founder laid down the proviso that none of the work carried on which could be of theoretical or practical benefit ought to be kept secret, and among the best known results of research here may be cited the introduction of the pure yeast and the Kjeldahl method of determining nitrogen. The chemical department is directed by Professor Dr. S. P. L. Sorensen, whose investigations on the dissociation of albumen are well known.

On Tuesday night there was a reception of visiting members by the Danish Association of Civil Engineers at the Royal Shooting Club.

The sections A, B, and C, under the presidency of Mr. O. Busse, Mr. T. Grut, and Mr. B. Münter, commenced work on Wednesday, and a report of the papers and proceedings will appear in a subsequent issue. The Congress finishes its sitting to-morrow—Saturday—when the final report will be submitted.

Section A deals with metals; Section B with cements, stones, concretes; and Section C with sundries. In Section A the papers are divided into groups under the heading of metallography, hardness testing, impact tests, testing metals by alternating stresses, testing of cast iron, influence of increased temperature on the mechanical qualities of metals, magnetic and electric properties of materials in connection with their mechanical testing, committees' reports, various reports, internal strains. There were many noteworthy contributors to these subjects in the long list of papers brought before the metal section. Professor E. Heyn, Gross Lichterfelde, brought up a report on progress made in metallography during the three years which elapsed since the Brussels Conference, special steels was the subject of a paper presented by Professor Leon Guillet, and Mr. Walter Rosenhain dealt with his researches at the National Physical Laboratory on slag enclosures in steel. In the group of papers on hardness testing, there were contributions by Mr. Harold Moore, of Woolwich Arsenal, on the Brinel method, and an official report by Dr. P. Ludwik, of Vienna. Professor A. Martens and Professor Heyn also presented some results obtained with the simplified ball hardness testing machine, and Dr. August Gessner, of Vienna, discussed the cone pressure test for determining the hardness of permanent way materials. There were nine papers in all to be dealt with on the subject of impact testing, the official report on the subject being contributed by Dr. H. Charpy. Messrs. Sulzer Bros., of Winterthur, presented a report in connection with experiments they have carried out on the strength properties of cast iron of various sections. The effects of temperature on the mechanical properties of metals was the subject of an official report by Professor M. Reudelloff. Reports were also brought up by committees dealing with the establishment of international specifications for iron and steel, and on the proposals to establish a uniform nomenclature. Some detailed reference to these groups of papers, and the discussion which followed their presentation, will, as we have already said, appear in subsequent issues.

In Section B considerable attention was focussed on papers dealing with reinforced concrete, following the report of the Committee with its five valuable appendices. At the meeting of the Institution of Mechanical Engineers at Liverpool in July last, Prof. Unwin, in a discussion on a paper by Mr. Auden, drew particular attention to the risks attending the present basis of design adopted for reinforced concrete structures, and the records of experience with such buildings, which are being collected by this International Association, are likely to prove a valuable guide for the future.

Under the general heading of progress in methods of testing twelve papers came up for discussion, an official report on the progress made in the methods of testing hydraulic cements by Mr. R. Feret being first on the list. A small but interesting group of papers dealt with cement in sea water, Mr. A. Poulson treating the subject generally, and the use of reinforced concrete where it is exposed to the action of sea water being discussed by Prof. M. Möller.

In Section C the preservation of iron and steel was brought up by Mr. J. Cuickshank Smith, who raised the question in a paper read before the spring meeting of the Iron and Steel Institute, and the Association also had the advantage of learning through the medium of a report presented from Washington of the work done by the American Society for Testing Materials in connection with preservative coatings for iron and steel. The work of these various sections will also receive detailed attention in subsequent issues.

GERMAN RAILWAYS AND THE STATE.

In the report of the Board of Trade Conference on Railways there is a summary of the conclusions arrived at by Mr. Nicholas S. Reyntiens, barrister-at-law, and Mr. C. H. Pearson, of the Great Central Railway, as to the administration of German railways and their relation to the State. These gentlemen visited the Continent at the request of the Conference, and their conclusions as to Austria-Hungarian railways are to follow.

From this report it would appear that during the year 1906 the total passenger receipts on the Prussian State Railways were 509,633,330 marks, from goods 1,235,759,471 marks, other receipts amounted to 122,474,728 marks, giving a total of 1,867,867,529 marks received from all sources, from which 1,169,773,093 marks have to be deducted for expenditure, leaving a profit of 698,094,436 marks, which, on a total capital of 9,500,243,497 marks, is equivalent to 7·48 per cent. During the last eleven years the profit has only twice been less than 7 per cent. The Palatinate Railways of Bavaria became State property from January 1st last. They are 869 kiloms. long and make 5·09 per cent. profit.

The total mileage of the Prussian State Railways is about 35,400 kiloms. This divided into the above-mentioned capital amount means that the cost is 268,365 marks per kilom., roughly £21,500 per mile. This, we may remark, compares with £56,000 per mile for British railways. Natural geographical conditions are, in the main, responsible for this favourable result, but there are other reasons. There are few under or overbridges, level crossings being customary, and on the Nebenbahnen—local or feeder railways—no watchmen are necessary for the crossings. On the Hauptbahnen—trunk lines—the crossings have to be protected by having a watchman, but bridges are not called for unless the cost would be lower than the capitalised cost of watching. Where considerable traffic exists—this is closely watched by the police authorities—if a bridge be required the local authorities are asked to join in the cost, and if a method of division be not amicably agreed upon the question must be referred for arbitration to the Minister of Public Works, as head of the Railway Department, and his decision and apportionment is final.

The height of the platform is very low, and, at the older stations, except those on high or low level, footbridges or subways are not provided, the regulations not requiring footbridges where only two lines of way exist.

State railways are only mulcted in local taxes, and these amounted in 1906 to an average of £46 per mile, but private lines pay a railway tax, graduated according to the profits, in addition to the local rates, and these together amounted, in 1907, to approximately £93 per mile. We may here interpolate the observation that during 1907 British railways paid £4,863,121 in rates and taxes and £348,760 in Government duty, which together, divided by 23,108 miles open for traffic, equals over £225 per mile.

For loose consignments there are Fast Stückgut—piece goods—and Slow Stückgut rates, and for wagon loads there are other rates which come under three heads. The minimum to obtain a wagon load rate is five tons for two of these heads and ten tons for the third. These rates are named in the order of cheapness, the fast stückgut being the dearest. The report observes that "the method of calculating the tariff is a matter which causes some complaint amongst traders." The amounts chargeable for terminals also vary according to class, and these, contrary to British practice, increase in amount according to distance—for a distance of under 10 kiloms. the terminals for a consignment are rated at half those charged for over 100 kiloms. It is strange, too, to read that the parcels post is very frequently resorted to in respect of packages up to 50 kilos. (110 lb.) in weight requiring quick despatch, conveyance by this means being much cheaper than by rail.

It will be instructive to hear that the chief difficulty of all arises from the deviations from and alterations in the tariffs which in the long process of time have come into existence. To effect such a deviation from the tariff is nevertheless a matter of considerable difficulty; in the first instance, application has to be made to the local "Railway Direktion" concerned, setting forth in full the reasons for the request, with complete statistical details as to the effect of the existing tariffs and the necessity for reduction in the charges, not only from the individual standpoint but as affecting the whole of the particular industry in that district. The effect of a change upon particular industries in competition—if such exist—in other parts of the State must also be touched upon. The matter is then considered by the president of the local "Railway Direktion," and if it should only affect his own particular district it is within his power to decide the question on his own responsibility. If the question is of general national importance it must be referred to the Minister, who again, at his discretion, may refer the matter to the General Railway Council. Obviously, this procedure entails considerable delay, as the councils or their committees can only meet at fairly long intervals, and if the Minister, on his own responsibility, does not see his way to grant the reduced rate—and very rarely does he do so—considerable time is involved, instances being known not only of a delay of months but of a year or more. Should it eventually be decided to make an alteration in the rate it can be effected in two ways, either by an alteration in the classification or by the institution of a special kilometric rate, and then the tariff becomes known as an "Ausnahme," or exceptional rate. It is these "Ausnahme Tariffs" which form the chief difficulty of the German tariff, and their importance can be judged from the fact that during the year 1906, of the 283 million tons conveyed by the Prussian State Railways, 64.32 per cent. were at exceptional rates. The objective of these tariffs is declared to be (*a*) the advancement of the internal industrial and agricultural production by the granting of facilities for the supply of raw materials; (*b*) to assist the native products to obtain markets in competition with foreign rivals by granting facilities for export; (*c*) to support the trade of German commercial centres, and more especially the seaports, against foreign competition; and (*d*) to support the inland means of communication, and principally the railways, against foreign competition.

A matter of considerable moment to be remembered when comparing German methods with British is that the rates are for carriage only. Outside firms known as "Spediteurs," which, we assume, correspond with the express companies of America, collect and deliver. Consignments sent at wagon load rates are neither loaded nor unloaded free, and if a crane has to be used a charge is made for it according to the weight. Sheets for loads sent at wagon load rates are charged for according to the number used and the length of the journey. If a firm has sheets of its own no charge is made for returning them, but a terminal charge of 30 pfennig for each waybilled consignment is made. Further fees are extracted from traders for weighing a wagon in case the weight is challenged, for an advice as to the arrival of goods, for counting the number of articles in a wagon, whilst even the consignment notes have to be bought.

One reason for the economical cost of German railways is the limited supply of rolling stock. To secure greater use of the wagons high demurrage charges are made if consignments are not cleared away within a certain period, which is often only six hours.

Lastly, it may be noted that, whilst private sidings are permitted, the conditions of user are very strict. These are given in full in the report. From them we notice that the owner of a private siding is liable to a fine of 100 marks should a wagon supplied to him for loading or unloading be used for some private purpose, such as shifting material from one part of the yard to another, and a similar fine should he fail to report that a wagon has been derailed on his premises, even if no damage be done, and he must pay for any damage done to railway trucks discovered at the time of their removal from the sidings, provided that such damage has not already been discovered and noted by the railway officials.

OBITUARY.

C. G. WARNFORD-LOCK.

Mr. Charles George Warnford-Lock was the son of a mining engineer, and was born in Hampshire on September 9th, 1853. He was educated at Cranleigh, and his first professional engagement was in the sulphur mines of Iceland. He was afterwards engaged in alluvial mining in Hungary, and later on held responsible positions as mine manager in the Black Hills of South Dakota and in New South Wales. It was in the latter country in 1896 that he took charge of the Wentworth Goldfields Proprietary Company's mines. While he was controlling affairs there a prolonged strike took place, and it was owing to his energy and determination that he was able to run the mines during the period of disturbance and bring the strike to a satisfactory issue. Mr. Warnford-Lock also managed mines for the Bulawayo Exploration Company at Gwelo, Rhodesia, and for the Raub Gold Mining Syndicate in the Malay Peninsula. For some time he resided in Sydney, where he practised as a consulting mining engineer.

He was the author of several well-known works on mining and cognate subjects, of which the chief are: "Practical Gold Mining" (1889), "Mining and Ore-dressing Machinery" (1890), "Economic Mining" (1895), "Principles and Practice of Gold Milling" (1901), and "The Miner's Pocket-book," which ran into five editions, the last being published in 1907. In that year he also brought out his last work, "Mining in Malaya for Gold and Tin," the second edition of which has already been issued.

Mr. Warnford-Lock was one of the original members of the Institution of Mining and Metallurgy, and served on its Council and on its various Committees. He, moreover, contributed several papers on mining and metallurgical subjects to the "Transactions" of the Institution, and always maintained a keen interest in its affairs and well-being.

He returned to Malaya in 1908, where he was engaged in inspecting and reporting on properties for various mining companies. An attack of ptomaine poisoning in the autumn of last year seriously impaired his constitution, and he was compelled to take voyages to China and Ceylon to recuperate his health. These were, unfortunately, unavailing, for after eight weeks' severe illness he died at Bandarawella, Ceylon, on July 30th last.

AMERICAN RAILWAY ACCIDENTS.

We now present below our usual figures, derived from the Bulletin of the Inter-state Commerce Commission, as to the number of casualties on American railroads for the three months ending March 31st last. The figures for the corresponding periods of 1907 and 1908 may be found in The Engineer for October 23rd, 1908.

	Passengers.		Trainmen.	
	Killed.	Injured.	Killed.	Injured.
Collisions	31	704	49	407
Derailments	6	721	44	259
Miscellaneous train accidents, including boiler explosions	—	39	13	231
Total train accidents	37	1464	106	897
Coupling or uncoupling	—	—	22	262
Other work about trains	—	—	18	2252
In contact with overhead bridges or structures at side of the track	—	2	13	157
Falling from cars or engines or in getting on or off	28	670	57	1473
Other causes	15	609	41	321
Total other than train accidents	43	1281	151	4465

We have not thought it necessary to quote here the figures for last year. Suffice it to say that the improvements we have before noticed are continued, although, as the report observes, "It covers a period in which considerable recovery of traffic had been accomplished." The record, we notice, would have been better still but for one collision in which 20 persons were killed and 28 injured, owing to the driver misreading his orders. We notice, further, that the "conductor did not take sufficiently prompt measures to stop the train."

According to another report issued by the Inter-state Commerce Commission, there has been during the year ending December last an increase of 1387.6 miles protected by automatic signals, but a decrease of 517.6 miles protected by the block system. This latter is due to the substitution of automatic signals for the block system in many cases. As there are 229951.19 route miles of railway in America—of which 204683.86 miles are single—and only 59548.7 miles are protected by automatic signals or the block system, it will be seen that much remains to be done.

LETTERS TO THE EDITOR.

(*We do not hold ourselves responsible for the opinions of our correspondents.*)

BRITISH LOCOMOTIVE PRACTICE OF TO-DAY.

Sir,—The object I had in view when joining this very interesting discussion was to assist towards solving the problem as to how it becomes practicable for a simple engine to compete favourably against a compound locomotive, whereas in stationary and marine practice it utterly fails to do so. I can assure Mr. Dearberg that I had no thoughts of antagonism when writing my reply; indeed, I welcomed his letter as coming from the pen of one who was thoroughly conversant with British locomotive practice. His letter in the last issue of your esteemed journal is no exception. I have had no British railway experience, and therefore am unable to reply to all the points he puts forward. I will, however, deal with such as appear pertinent to the question at issue.

In the first place, Mr. Dearberg states that under present British conditions the compound is not desirable. I quite fail to understand how conditions can in any way affect the successful working of a steam engine. The apparent failure of compounding as applied to locomotives is attributed by some to the variable conditions of work required from it. Others maintain that it can only show up to advantage when running at a slow speed and with a constant load. The able article which appears in the same issue of your paper now clearly shows that a compound engine can do better work than a simple engine when running at high speed. Yet this same compound engine when working compound would completely fail to do equal work with a simple engine in a test of power on a heavy incline, which leads me to infer, not that compounding is a mistake, but that the system as applied to locomotives is at fault, and that a compound locomotive can and should be designed so that when so working it can not only be equally as flexible as the simple engine, no matter what the condition of work may be, but can do the work more economically, the economy increasing in its favour in ratio as the power is increased. Mr. Dearberg states that Mr. Dean, Mr. Johnson, &c., first used large cylinders, not for power, but to get better expansions only; further on in his letter he refers to the Horwich-built engine, for which greater range of expansion is claimed. What I should like to ask is, what can the object be in seeking for a better range of expansion? So far as I can judge there is absolutely nothing to be gained in economy in steam consumption by increasing the steam expansions in the cylinders of a simple locomotive engine. Mr. Chas. W. Dauncey shows in his letter that the draw-bar pull of a certain engine when running at 20 miles an hour was 4½ tons, while at 53 miles an hour it was nil. If, then, the work falls off in ratio with the expansion, where is the gain? In a former letter I pointed out how I had failed to get any advantage by increasing the number of steam expansions without having arranged to get some gain in power at the same time. Hence my reason for stating that any alteration made to increase the number of expansions only was a misconception on the part of the designer. As Mr. Dearberg explains, all such alterations may only be experimental; they are nevertheless excessively costly, and surely the time has arrived for the locomotive to get past the experimental stage.

Mr. Dearberg bears out my contention that when piloting is resorted to with a view to serious running there is not sufficient power for one engine to do the work—perhaps he has in view the Scottish Highland Railway. Hence my suggestion for the necessity to enhance the capacity of cylinders, so that not only would the engine have the necessary power to impart rapid acceleration to a train, but also work it to time single-handed.

Mr. Dearberg also agrees with me that engines could do better work if fitted with larger cylinders, but only, if—the engine did not slip. This second "if" leads me to suppose that Mr. Dearberg does not quite grasp the importance of my proposed system of compounding or he would see that enlarging the cylinder capacity increases the power of the engine without any tendency to slip the wheels. When a simple engine is working under normal conditions, curiously enough slips can be stopped by increasing the power of the engine, *i.e.*, by increasing the mean effective pressure of steam in the cylinders. For instance, when climbing heavy grades I have frequently had to teach the driver how to surmount a steep part when he had been stalled through slipping. This was accomplished by working the engine with an increased mean effective pressure in the cylinders, thus increasing the power of the engine and allowing a more than usually heavy load to be successfully taken up the grade without any slip taking place. In plain words, slip is caused by the initial steam pressure acting on the pistons being in excess of the required adhesion, so that there is a limit to the capacity of high-pressure cylinders; but I should like to inform Mr. Dearberg that as I do not propose to increase the capacity of the high-pressure cylinders of the compound engines there should, therefore, be no greater tendency for it to slip than the simple engine. It is true that I suggest using a cylinder capacity more than twice that possible with a simple engine, if necessary, so as to considerably enhance the power of the engine. The driver, however, is never able to pass boiler steam to this cylinder. It may be that Mr. Dearberg has had in view the fact that boiler steam is allowed to pass into low-pressure cylinders of existing types of compound engines to enable them to compete with the simple engine, but such is not the case with my proposed system. I hope I have now made matters clear as to the advantage of increasing the cylinder capacity of locomotive engines.

It appears to me unnecessary for Mr. Dearberg to refer to the disagreement of locomotive superintendents, for such is proverbial. The introduction of a standard locomotive would, no doubt, tend to better agreement.

Mr. Dearberg finishes his letter by a reference to various types of locomotives, all of which, no doubt, can do excellent work in their own way. This reminds me of a famous type of locomotive which did excellent work as far back as 1867. It had 6ft. 6in. single wheels and 15in. by 24in. cylinders. For economy in coal consumption per ton-mile I have up to the present day never met engines which can excel this type. It is needless to say that the engines were not only built, but were also designed by a noted firm of British locomotive engine-builders.

In reply to Mr. Chas. W. Dauncey regarding the sluggish running of compound engines, the able article by a "Fireman" which appears on page 185 of your esteemed paper is, in my opinion, a good reply, although an improvement in running could be effected by using a later cut-off in the low-pressure cylinders and from the use of very large steam ports. Regarding excessive back pressure in the high-pressure cylinders, there is no difficulty in designing an engine which will do away with this back pressure.

Argaith, Dumbreck, August 24th. John Riekie.

Sir,—The correspondence on this subject in The Engineer up to date, August 20th, has just come into my hands, and I have read with interest the views of your various correspondents and the facts which they adduce. Mr. Dauncey says that he started the discussion in the hope that the locomotive question would be thoroughly thrashed out. He is evidently an optimist. For my own part I have given up any expectation of seeing these matters settled, and in saying this I refer not only to matters of detail, but to some of the most important problems of locomotive design. That our locomotive practice, both from a technical and from a historical point of view, is the most interesting in the world, to engineers and to outsiders alike, is a statement with which I suppose most of your correspondents will agree. That our engines are, on the whole, as efficient as those of any other State, either on the Continent or in America, is also, I believe, a fact beyond dispute. But, judging from the history of the last forty years of British locomotive design and from the nature of the present-day locomotive stock of the principal railways, I believe that electrification of main lines, or the adoption of some radically different means of transit, will have come before there is anything like a general agreement among our locomotive engineers either on the points raised by your correspondents or on others of importance that could be mentioned.

One of the most important points of locomotive design is the number and position of the cylinders. A few years ago this question appeared to have been settled to the satisfaction of most locomotive engineers of this country, these gentlemen having fixed on the inside position and the employment of the crank axle, though at no time was such practice universal. Now, however, quite a revulsion has taken place, and outside cylinders have become common, even in cases where the general design does not necessitate their use. The employment of three or four cylinders and the question of compounding come under this heading of cylinders, and here again we have an astonishing variety.

Then as to boilers, we have a bewildering assortment. Large or small, long or short, coned or straight, narrow fire-box, or Belpaire, or wide grates, water tubes or none, domed or domeless, which is to be the boiler of the future express engine? He would be a rash man who would predict. Yet these features are not—like corrugated fire-boxes or thermal storage—merely isolated experimental examples, but they are part and parcel of modern practice on various lines. Again, one often hears of the difficulties of the locomotive engineer in getting longer bearing surfaces, and, in fact, the length of main bearings on a good many of our modern express engines would seem ridiculously inadequate to a marine engineer; yet only one British railway has in recent years employed double frames. But years ago, when weights were far smaller, we find double frames the rule.

It would be easy to write a large volume on the discrepancies and anomalies of British locomotive practice. But enough has been said in this direction, and many of your correspondents are better able than I to observe for themselves. It remains to point out one or two conclusions that may be drawn from a careful study of our engines.

(1) There are eras of "fashion" in locomotive design just as there are in the design of garments for the fair sex. What one engineer does another is sure to copy sooner or later, whether it be a small matter, like extended smoke-boxes, or one of more importance, like the design of huge tank engines for suburban works which had a brief epoch in 1903. No doubt it would be more charitable, and possibly more correct, to ascribe these fluctuations to an earnest-seeking after truth. But the desultory manner in which these "experiments" are made does not seem to make for the correctness of the latter explanation.

(2) Just before the control of the locomotive department changes hands, there is often a complete change of the "style" previously in use—that is to say, the shape of the chimney, dome, safety valves, cab, &c., undergo a more or less radical alteration.

(3) If such alterations have not taken place just before the change of locomotive superintendency, they invariably take place when the new engineer is appointed. Often the external appearance of the engines will undergo profound modification—sometimes the colour will be changed, outside cylinders will be adopted or abolished, compounds appear or disappear, and a thousand and one changes in detail take place. It is difficult to believe that the greater efficiency of the new fittings has been experimentally established; it is easier and probably more truthful to ascribe them to the personal taste of the engineer, or to the fashion prevailing on other lines.

I have no wish to condemn our locomotive engineers, for I believe them to be as good as any others in the world; yet it is difficult to see how these frequent reversals of policy, as well as alterations in detail, can be conducive to economical working. Either the old or the new must be wasteful. Thus the locomotive policy of the London and North-Western Railway with regard to the building of compound engines has been completely changed by Mr. Whale from that of his predecessor, the late Mr. F. W. Webb. Not only have no more compounds been built, but in the short space of six years an enormous number of comparatively new engines have been broken up, while others have been radically altered, and even Mr. Webb's last designs have undergone considerable modification, being at the time but four years old. Either, then, Mr. Whale has been shamefully extravagant, which no one with any knowledge of the engines could think for one moment, or else Mr. Webb for upwards of twenty years had been building a type of engine which was mechanically or economically wrong. With all respect to the memory of Mr. Webb, who in other departments of the great railway effected reforms which probably no other man could have done, I am compelled to the latter belief, more especially as the criticisms of "Argus" and others in the "compound" controversy over twenty years ago have never been satisfactorily answered. Mr. Webb, in fact, took no notice of these criticisms. How came it that Mr. Webb for such a long time persisted in a policy in which "the dividends of the shareholders were blown up the chimneys of their engines?" That, I fear, is a question that will never be answered. Mr. Webb must have believed in his own engines. Yet how could he have failed to know of their continual lack of efficiency and to realise that it was no use to save 25 per cent. by compounding if two engines had to be employed to keep time? It is a mystery, and until someone steps forward with accurate and reliable information we may as well give up trying to solve it.

I hope I have said enough to show that at present there is no indication of a solution of the many problems of locomotive design. I admit that the conditions may vary enormously on different railways, or on different parts of the same railway. I admit that allowance must be made for changes necessitated by increase of traffic. But locomotive design cannot be reasoned out from an armchair. There is but one method, that of careful and consistent experiment. So far there are only a few instances of the latter.

Personally, I believe that this diversity of types adds enormously to the fascination of steam locomotives, and I for one should be sorry to see any standard type of express locomotive enforced over one or more of our railways. But were I a shareholder I might think differently. Frank L. Bassett.

Farnham, September 2nd.

Sir,—Mr. Dauncey will remember that in 1897 the late Mr. F. W. Webb constructed a couple of four-cylinder locomotives, one simple and the other compound, which were identical in every respect, with the necessary exception of the low-pressure cylinders of the compound. The boilers were alike in both engines, and were pressed to 175 lb. per square inch. The simple had four 15in. by 24in. cylinders. These dimensions were adopted for the two high-pressure cylinders of the compound; the low-pressure were 19½in. by 24in. The engines were at that time respectively numbered and named 1501 Iron Duke and 1502 Black Prince. Their driving wheels were 7ft. 1in.

Now, I have always understood that the simple, Iron Duke, failed to supply an adequate amount of steam to her cylinders, while, on the other hand, the compound, Black Prince, suffered from back pressure. Manifestly this means that the same sized boiler did not suffice for the simple, but was large enough for the compound, which latter engine could with advantage, of course, have had very much bigger low-pressure cylinders, and so have developed far more power, independently of the elimination of sluggishness. Even if the compound gave no direct economy in coal consumption, it could have thus hauled loads appreciably heavier than those possible with the simple. It will be remembered that Mr. Webb rebuilt the simple engine as a four-cylinder compound and re-named it Jubilee. The low-pressure cylinders were 20½in. by 24in., and the steam pressure was raised to 200 lb. These dimensions were also introduced into the Black Prince. The numbers of the engines then became 1901 and 1902 respectively.

In my opinion the high-pressure cylinders were too large, the low-pressure ones too small.

The Alfred the Great, or enlarged series of these compounds, laboured under the same disadvantage as regards back pressure. This did not make itself manifest in a serious degree until higher average speeds were required from the engines. In order to remove this disability, Mr. Whale, in 1903, fitted No. 1952 Benbow with duplex valve gear, to enable the cut-off in the high-pressure and low-pressure cylinders to be varied independently. A trial trip was then run with the engine. It took place on the 27th September of the same year. The load behind the tender was 372 tons. The time taken to run to Stafford, 24½ miles, was 33½ minutes, the average speed being 44.09 miles per hour. A stop was made at Stafford. Without desiring to make invidious comparisons, but as a matter of scientific interest, I may mention that the Benbow took only half a minute longer to get to Stafford than did the simple engine, No. 513 Precursor, when the latter ran its trial trip on the 27th March, 1904. The Precursor hauled a load only 2¾ tons heavier than that of the compound, and, moreover, ran right through to Rugby, passing Stafford at a speed of 51 miles per hour. As some seconds would be spent by the Benbow in slowing down in order to stop at Stafford, the times taken by the two engines were approximately equal. The loads, too, were virtually the same for both locomotives. The engine weights were:—Benbow, 57 tons 12 cwt., adhesion 37 tons; Precursor, 59 tons 15 cwt., adhesion 38 tons. The tender of the compound weighed 31 tons 12 cwt., and that of the simple 37 tons. The simple had, it is true, a steam pressure of 175 lb., as against the 200 lb. of the compound, but, even so, the work done by the latter engine was, to my mind, suggestive, in that it indicated that the ratio of cylinder volume, high-pressure : low-pressure, was an important factor in the failure or success of compound locomotives. Possibly the Benbow would have done still better work if her low-pressure cylinders had been considerably larger than 20½in.

The late Mr. Rous-Marten quoted an instance in which the Alfred the Great itself (No. 1941), after being provided with the altered valve gear, hauled a load, exclusive of passengers and luggage, of 464 tons, at an average speed of 54 miles per hour. The train was well filled, and the gross weight behind the tender was nearly 490 tons. The run was from Rugby to Willesden, and the time taken for the 77 miles was 85 min. 42 sec.

London, September 4th. F. W. Brewer.

EXPERIMENTS WITH CENTRIFUGAL PUMPS.

Sir,—The article in your issue of August 27th, on "Experiments with Centrifugal Pumps," is a very interesting one. The various curves shown, and results obtained, which must have entailed a great amount of time and work, form a valuable contribution to our knowledge on the subject. Will you grant me, as a purchaser of this class of pump, space for a few remarks?

I venture to think the theoretical portion of the paper, from which the final formulæ (5 and D) are deduced, is incomplete. It does not take into account all the known hydraulic losses, which can be more or less calculated, and leaves too much to be found by experiment. The article deals: (1) With losses due to impact on disc blades at entry to disc; (2) with losses due to impact on guide vanes at exit from disc; (3) frictional losses. These must necessarily be determined by experiment, and two constants are given. (4) With changes in the centrifugal head.

I must confess I do not quite understand what is meant by the term introduced here, but, anyway, two more constants have to be found by experiment. Nor do I quite see how the final equations 5 and D, involving three constants, are arrived at. However, they are the same equations as used by Innes in his book on "Centrifugal Pumps and Turbines."

While the final equation D may be of use in the case of a manufacturer who, by means of numerous tests, is able to fix the value of constants C and K for his particular design of pump, I do not think it would greatly help anyone called upon to design a pump for a specific purpose, and who wished beforehand to draw a curve showing the probable behaviour of the pump at various discharges and constant speed. My reason for this statement is that the constants C and K vary in the article under discussion by as much as 50 per cent. for the same pump.

Any formula should, I think, include all the hydraulic losses, then the hydraulic efficiency can be calculated, and the work left for determination by experiment is reduced to a minimum. The simplest method, I think, is to draw up a sort of balance sheet showing the hydraulic gains and losses from which the hydraulic efficiency can be determined, leaving thus only the frictional losses to be determined by experiment. The gains are:—

1. Head gained at exit from pump disc. Taking the symbols used in your article—

$$= \frac{v^2{}_1 - U^2{}_1 \operatorname{cosec}^2 \rho - U^2{}_1}{2\,g}$$

where the second term is the head lost in producing the backward flow, and the third term the head lost in creating the initial velocity of flow. It is assumed that the flow through the pump disc is constant, or that $U = U_1$.

2. Head gained in the whirlpool or guide blade chamber.

Let V_w be the velocity of the water at exit from pump disc, then the head gained—

$$\frac{V_w{}^2}{2\,g}$$

Note: $V_w{}^2 = (v_1 - U_1 \cot \rho)^2 + U_1{}^2$

These two gains added together give the theoretical head, which may also be expressed by—

$$\frac{2\,v_1\,(v_1 - U_1 \cot \rho)}{2\,g}$$

On the other side we have the losses.

1. Loss at entry to disc due to impact. Let the ratio between the internal radius of disc r_1 and external radius r_2 be denoted by N, then the head lost—

$$= \frac{(N\,v_1 - U_1 \cot \theta)^2}{2\,g}$$

2. Loss due to impact on guide vanes at exit from pump disc—

$$= \frac{(V_w - U_1 \cot \alpha)^2}{2\,g}$$

A simple whirlpool chamber without guide blades is probably quite as good as one with guide blades, and in that case the above loss would not occur. This view is supported by tests recently published of a pump for about 300ft. lift constructed by a leading firm, which had no guide blades and which gave an efficiency of about 80 per cent. loss in the whirlpool chamber.

3. Let R_1 = the external radius of the disc and R_2 external radius of the whirlpool chamber, then the loss—

$$= \frac{\left(\frac{R_1}{R_2}\right)^2 (V_w)^2}{2\,g}$$

4. Loss in volute surrounding whirlpool chamber due to impact of water from whirlpool chamber meeting water flowing in volute.

Velocity of water leaving whirlpool chamber $= \left(\frac{R_1}{R_2}\right) (V_w)$.

Let V_v = velocity of water flowing round volute. Then loss—

$$= \frac{\left\{\left(\frac{R_1}{R_2}\right) (V_w) - V_v\right\}^2}{2\,g}$$

5. Loss due to velocity in discharge pipe (V_d)

$$= \frac{V_d{}^2}{2\,g}$$

The difference between the gains and the losses represent the actual head, and this divided by the theoretical head gives the hydraulic efficiency.

As regards frictional losses, further experiments are no doubt needed, and, as far as I know, there is very little published information on the subject. In pumps of moderate size the power required when the pump is just supporting a static head and there is no delivery appears to be somewhere about 35 per cent. of the power required at the normal duty for which the pump is designed. At normal duty the power required to cover hydraulic and frictional losses appears to be about 25 per cent. of the total power required. As the delivery increases the power required to cover friction appears to increase as $U_1{}^2$, but when the flow greatly exceeds the normal, it would appear to be more nearly between $U_1{}^2$ and $U_1{}^{\frac{5}{2}}$.

Assuming these figures to be approximately correct, the following example may be given:—A pump is required to deliver 3300 gallons per minute—disc velocity 80ft. per second—the velocity of flow 10ft. per second, with suitable interior blade angle—a flat exterior angle, a whirlpool chamber twice the diameter of the disc, and no guide blades.

At normal duty the theoretical head = 100ft.

,, actual ,, = 90.4ft. ($v_1 = 1.05 \sqrt{2\,g\,H}$),

and the hydraulic efficiency = 0 904.

The actual efficiency would probably be about 0.70 per cent.

Therefore the power required $\frac{90.4}{0.7} = 129$.

9.6 horse-power is required to cover hydraulic losses, and 29 horse-power for frictional losses. When merely supporting the static head the power required would probably be about 45 horse-power.

If the velocity of flow be increased to 16ft. we have—

Theoretical head	40ft.
Actual head	24.66ft.
Hydraulic efficiency	0.616

$$\text{Work done} = \frac{24.66 \times 1.6}{40 \times 1.6} = \frac{39.4}{64}$$

$$\text{Frictional losses 29 H.P.} \times (1.6)^2 = 74 \text{ H.P.}$$

$$\text{Actual efficiency} = \frac{39.4}{138} = 0.28$$

Probably the frictional losses would be somewhat higher, viz., between $(1.6)^2$ and $(1.6)^{\frac{5}{2}}$, say from 84 horse-power to 94 horse-power, giving actual efficiencies of from 0.27 to 0.25.

24.6 horse-power would thus be required to cover hydraulic losses, and from 74 horse-power to 94 horse-power to cover frictional losses.

At U_1 = 17ft. the head would be about 10.8ft., the total horse-power from 135 to 158, and the efficiencies 0.14 to 0.11.

U_1 will be a maximum at about 17.6ft., when the head will be nil.

Where a flat exterior blade angle is used it may be noted that the power curve begins to fall after a certain point, and the maximum power required cannot exceed the power at normal duty by more than about 20 to 25 per cent.—a valuable feature when electric motors are used for driving.

In a well-known type of pump recently described in your columns, I believe, speaking from memory, stress was laid on the fact that the power curves fell towards the end. Now this pump discharges from the disc or drum through orifices set at a flat backward angle. It seems to me therefore that the drop at the end of the power curve is due in both classes of pump to the same cause, viz., a flat backward discharge from the disc.

September 6th. F. H. S.

Sir,—Reverting to the issue of August 27th, "Experiments with Centrifugal Pumps," I beg permission to amend the statement on page 208, column 1, as follows:—

Divide (D) throughout by "m," and we have—

$$59.24\,h \text{ (feet)} = v^2{}_1 + 2.079\,v_1 \cdot Q/a - 57.12\,(Q/a)^2{}_1$$

or $$v^2{}_1 + (2.079\,Q/a)\,v_1 - [59.24\,h + 57.12\,(Q/a)^2] = 0,$$

an equation of the general form $a_1\,y^2 + b\,y + c = 0$, whose solution is—

$$y = \frac{-\,b \pm \sqrt{b^2 - 4\,a_1\,c}}{2\,a_1}$$

In our case a_1 is unity.

Assign values to Q/A convenient for plotting. Each of the corresponding values of Q/a gives a value for "b"—which equals $2.079\,Q/a$—and, assuming "h" fixed, a simultaneous value for "c" which equals

$$-\,[59.24\,h + 57.12\,(Q/a)^2].$$

The solution of each equation for "v_1" is only a matter of substituting in the formula given above for "y," which is identical with v_1.

For example, taking h as 24 lb. per square inch, or 55.45ft., and Q/A as 5in. by the Pitot tube, so that $Q/a = 0.9975$ft. per second, we have $v^2{}_1 + 2.07\,v_1 - (3282 + 56.8)$, so that—

$2\,v_1 = -2.07 \pm \sqrt{4.3 + 13355.2}$, $v_1 = 56.715$, or speed = 2207 r.p.m.

And similarly for other values.

It is to be noticed in dealing with constant discharge curves, exactly the same method of calculation applies, but Q/a is the definite fixed value—so that "b" is a constant for each curve—whilst v_1 is calculated for each value assigned to "h."

In dealing with the constant speed curves, the expression (D) is conveniently divided by "K," "b" will be constant for each curve, namely, $-\,(0.03639\,v_1)$, and "c" will be $[1.037\,h - 0.01751\,v^2{}_1]$, whilst Q/a corresponds to y in the formula given above.

The speed in revolutions per minute, namely, . . . *sic.*

Forest Hill, September 4th. J. G. Davis.

EXPERIMENTS WITH A GLASS CARBURETTER.

Sir,—Referring to Mr. Gillett's letter in The Engineer of this week, as he seems to want answers from an amateur to the questions he raises, I will give them to the best of my ability.

My reason for not doing so before he will find, I believe, in the first two paragraphs of his letter of the 10th ult., for, as regards the first of these, where Mr. Gillett says, "Not only does the writer make such assertions, but proves them by experimenting with lamp glasses, tubs, tubes, pieces of metal plate, &c," it seems to me that I might quite logically retort on him, "Not only does he make such assertions, but proves them by the use of verbs, adjectives, paper, and ink." The fact that glass happens to be used in a certain form of lamp chimney does not necessarily render it valueless and absurd if used for some other purpose. If Mr. Gillett objects to the use of lamp chimneys, he should point out why they are unsuitable for the purpose, and not confine himself to seeking to discredit the deductions by merely calling attention to the household and homely names of the constituent parts of the apparatus used. If he does this I have no quarrel with him whatever; but I hardly considered myself called upon to answer the letter in the form in which he left it, hence my reply.

As to the questions, I certainly do believe that what I saw with my lamp chimneys actually does take place, at least, in a very large number of cases. As I said, I have seen petrol entering the induction pipe of an 18 horse-power Siddeley in a solid stream, and the carburetter of this car was of such good quality that the engine would drive the car 45 miles per hour on the level, pull steadily at eight miles per hour with open throttle up an incline of 1 in 17, and take the car 20 miles per one gallon of petrol. If, then, such an unpromising-looking arrangement as regards the flow of petrol is concerned can give such excellent results in practice there is nothing inherently improbable in other carburetters passing liquid petrol into the engine, or nearly so. Again, anyone who has had much to do with petrol engines will recollect cases where leaks into the induction pipe dropped petrol, showing that the petrol in liquid form was there.

If Mr. Gillett wants to settle the point let him attach a good standard carburetter, say one of his own, or a Claudel Hobson, or a White and Poppe, to some sucking device such as an engine by a length of glass induction pipe and supply the air to it heated to the usual extent. I am prepared to take him a sporting bet of a new hat that he finds liquid petrol going through the pipe, except in the one case where the mixture passes through a small hole immediately after leaving the jet, and even in that case I shall not be surprised to see liquid fuel in the pipe.

Mr. Gillett has quite missed the point of my remarks about the small hole. I said a small hole close to the jet, not at some considerable distance from it. Every carburetter has the hole somewhere. When running throttled, very few comply with the conditions I named.

If I can find the time, it is my hope to repeat these experiments, using an old engine for a sucker driven by a large lathe, so as to have the lathe speeds to alter the consumption. I am thinking of making this engine blow air into a barrel full of water under different conditions of pressure and depression, and I believe by this means it will be possible to get a close approximation to the amount of air delivered at different speeds and under the influence of different partial vacua. This point established, we shall know where we are as to the proportions.

I then propose to connect this engine up to as many standard carburetters as I can borrow for the purpose, warm the air to the temperature recommended by the makers, and see what happens. I am expecting a fine exhibition of liquid petrol and shall be very much surprised if I do not get it.

As Mr. Gillett says, it is difficult to get any apparatus to measure the rate of flow of air, but, if it is found that the above method empties my barrel under the same conditions in always the same time, I shall take liberty to assume that when these conditions are repeated the rate of flow will not differ from that noted by an amount sufficient to vitiate results.

As to the question whether constant mixture is advisable I have not the slightest idea. But I do know that when we have a carburetter which can be relied on to give an entirely constant mixture under all conditions it will be the easiest thing in the world to vary the mixture. What one does not want is an instrument which does not know its own mind for two seconds together.

I am given to understand that a weak mixture is not economical, but I have never tried any experiments on this head, not having the apparatus.

In conclusion, I may say that it is my firm belief that the evaporation in the average petrol engine takes place inside the cylinders themselves, and this in itself accounts for the fact that cutting off petrol stops the engine. In any case the deposit of petrol in the pipes would have to be very great indeed to produce a mixture rich enough to fire after the petrol is turned off—for Mr. Gillett must not accuse me of thinking that no evaporation takes place by spraying; I neither said nor thought that, but that by no means all the petrol is so evaporated, and, in fact, very little.

J. S. V. Bickford.

Camborne, September 4th.

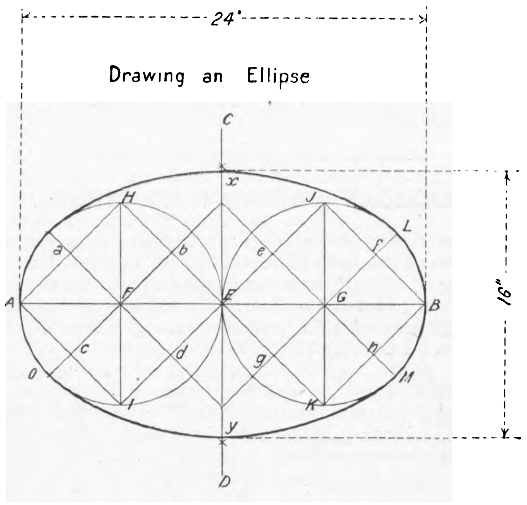
DRAWING AN ELLIPSE.

Sir,—While seeking for a quick and simple method of drawing an ellipse without using ordinates, which, besides being cumbersome, never give an accurately curvilineal contour, I have hit upon the process described below. Given its extreme simplicity and accuracy, my only doubt is whether it is not a re-invention of an already well-known method, but I have never seen anything like it in any treatise or engineering pocket-book. I forward it in case you may think it worth publishing for the benefit of your readers, and I shall be glad to hear whether it is already known to any of them.

Problem: Draw an ellipse whose axes are as 16 *is to* 24.

1. Draw the two axes A B and C D, intersecting at E, making A E and E B, each $= \frac{24}{2}$.

2. Divide A E and E B into two equal parts A F, F E and E G, G B, and, with F and G as centres and A F = G B as radius, describe the circles A H E I and B J E K.



3. Draw H F I and J G K at right angles to A B, and join B J, J E, E K, K B, and also A H, H E, E I, I A, and divide each side of the resulting inscribed squares into two equal parts.

4. Join the centres of opposite sides of the said squares thus: ad, bc, eh, fg, prolonging these four lines until they cut the circumferences of the circles A H E I and B J E K at L, M, N, and O.

5. With each of the latter points L, M, N, and O as centres, and with 16 as radius, describe arcs of circles, intersecting the vertical axes C D at y and x.

6. With y and x as centres, and the same radius (16), describe arcs of circles, which will accurately join the points L M and N O, and the required ellipse will be the result.

Although the demonstration is long, the operation itself is short and very accurate, and can even be abbreviated somewhat. I have given the full construction for clearness' sake.

Huelva, July 28th. P. Merry del Val, C.E.,
General Manager of the Zafra-Huelva Railway.

The use of tar and other dust preventives upon the highway is having a curious sequel. The Thames Conservators have issued a circular to District Councils calling their attention to discharges of an objectionable character from surface-water drains. The Conservators are advised that the increasing use of oily and tarry substances for dust prevention will prove detrimental to the river and subsidiary streams, and they request the Councils to take precautions accordingly. When the circular was read to the Abingdon Rural District Council a member remarked, "The public urge us to prevent the dust nuisance, and now the Thames Conservators threaten to prosecute us if we do it."

INDICATING OF GAS ENGINES.*

By Professor FREDERICK W. BURSTALL, Member, of the University of Birmingham.

IN the report of the Standards Committee on Gas Engines of the Institution of Civil Engineers the opinion † was expressed that the indicating of gas engines was open to very much greater errors than was the case with steam engines, and that they therefore preferred to draw all their conclusions from the studying of the brake horse-power. The matter was considered by the Research Committee of this Institution, and in order to determine what the error amounted to in the indicating of gas engines, it was decided to use two indicators simultaneously, one being the ordinary string type, and the other the optical indicator. The results obtained in the present paper are to be looked upon as purely comparisons of indicators, as it was found that after these experiments had been concluded that the cylinder of the engine was very badly oval, and a very considerable amount of leakage was taking place from the motor cylinder to the differential piston, which vitiates the results as regards efficiencies; but as the indicator diagrams were taken simultaneously, the comparison of the indicator is not affected.

The engine experimented upon had a cylinder 16in. in diameter by 24in. stroke, running at 165 revolutions per minute under full load. It was constructed by the Premier Gas Engine Company, and is fully described in the third report to the Gas Engine Research Committee. ‡

The comparison was undertaken in connection with the C trials in the third report, being about 180 lb. above atmosphere. The only variation in the four tests was the amount of gas admitted, the mean pressure varying from 5½ kg. per cm.^{2} (78 lb. per square inch) up to about 7¼ per cm.^{2} (103 lb. per square inch). The method of driving the two indicators and the branch piece showing the attachment are fully illustrated in Fig. 1. It will be observed that the branch piece is not symmetrical, as it was impossible to fit a symmetrical fitting on to the limited space available on the breach end. The Crosby indicator was on the end of the straight passage, while the optic was at the end of the bent passage. To test the effect of this want of symmetry, simultaneous diagrams were taken with two Crosby indicators, which were then interchanged; but it was not possible to detect any difference between the diagrams on either indicator. Hence it is reasonable to conclude that the actual pressure on each indicator was substantially the same. The length of the passage between the indicators and the motor cylinder was some 15in., and the diameter of the pipe originally ⅜in. This was found to give serious oscillations down the expansion line, even when a comparatively heavy spring was used, namely, 400 lb. per square inch. When the indicator hole was opened up to ½in. in diameter these oscillations disappeared, showing the importance of having wide passages from the cylinder to the indicator when there is any considerable distance for the pressure to pass. The string indicator employed was the well-known Crosby type, selected by the Crosby Company for these tests. In previous experiments a large number of indicators have been tried of the external-spring pattern, but in all cases their inertia is too great, and the waves down the expansion line become so serious as to make it impossible to measure up the diagrams. Before and after each set of trials the indicator was tested for back-lash and friction, and the spring was also calibrated. The back-lash was in all cases negligible, and the friction amounted to less than 1 lb. with a spring having a scale of 400 lb. per square inch.

The optic indicator was one kindly lent by Professor Hopkinson, and is fully described in the "Proceedings" of the Institution.* It was calibrated in the University, and this calibration has been employed in drawing the mean diagram. For both indicators particular attention was directed to the method for driving the indicator barrels, as this is a matter which the author ventures to consider as not receiving sufficient attention. In the string indicator the bell-crank lever, Fig. 1, was driven by a stout steel wire. This lever was controlled by a very heavy spring, in which a compression of 400 lb. produced a contraction of 2in. The barrel of the indicator itself was rotated by a phosphor-bronze stranded wire, and a similar wire was employed on the optic indicator. In neither case was there any measurable back-lash in the driving mechanism. The use of a hemp string in any form is certainly not so desirable as the stranded bronze wires, although the bronze wires do not last, as they fracture very readily.

The mean diagram, Figs. 2, 3, were prepared from the individual diagrams in the same method as has been followed in the second and third reports, namely, not less than twelve diagrams were divided by the method of ordinates, and the heights read by an accurate steel rule. All diagrams were taken with a hard lead pencil on smooth paper, and the width of the line was considerably less than $\frac{1}{200}$in. With care it was possible to read these ordinates with an accuracy of half of 1 per cent. The optic indicator also had very fine lines, and could readily be measured up to the same order of accuracy. The diagrams were plotted on squared paper, and superposed one on the other, so as to exhibit whatever differences there were between the indicators.

Speaking generally, the compression curves are coincident. In C 1 this coincidence is complete within the error of measuring the diagrams, which amounts to about one-tenth of a kilo. per square centimetre. In the C 2 and C 3 there are slight diversions. The maximum pressures practically agree in tests C 3 and C 4; while in C 1 the Crosby gives the higher initial pressure, in C 2 the Hopkinson gives the higher initial pressure. Down the expansion line the two indicators agree for the third of the stroke. After that the Hopkinson gives a persistently higher expansion line, the difference between the two being larger than the probable experimental error of the measurements. The effect of this higher expansion line makes the Hopkinson indicator give about 3 per cent. higher mean pressure than the Crosby. This difference has been carefully considered, and the effects of inertia and friction investigated, but the author is of opinion that neither of these causes are likely to account for such a persistent difference between the two expansion lines.

In the Hopkinson indicator the spring was in the form of a flat bar rigidly fixed at the ends, and loaded in the centre; the central deflection in this beam is a direct measure of the pressure on the piston. During the calibration with dead weights from which the scale of the springs is obtained, the ends of the bar may be assumed to be absolutely fixed, but when the indicator is in use it is possible that there is a slight slip in the bar through the screws which constrain it, which would cause a compression on the lower side of the bar, and thus prevent the pressure falling as rapidly in this indicator as in the string one; and for this reason alone the author is inclined to prefer the results obtained from the string indicator, and also for the reason that were the string indicator persistently low it would make the efficiencies in the third

FIG. 1.—*The two Indicator-Gears fitted to the Premier Engine.*

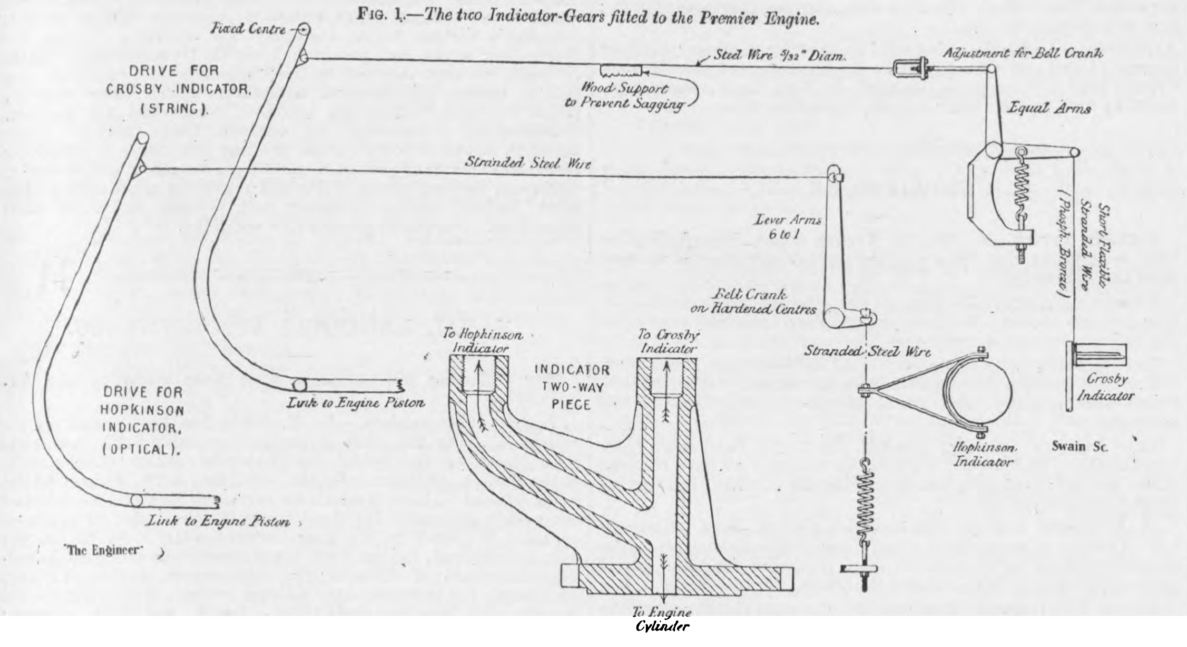


FIG. 2 —*Mean Diagrams.*
Facsimile of Reporter's Drawings. (Reduced about half size.)

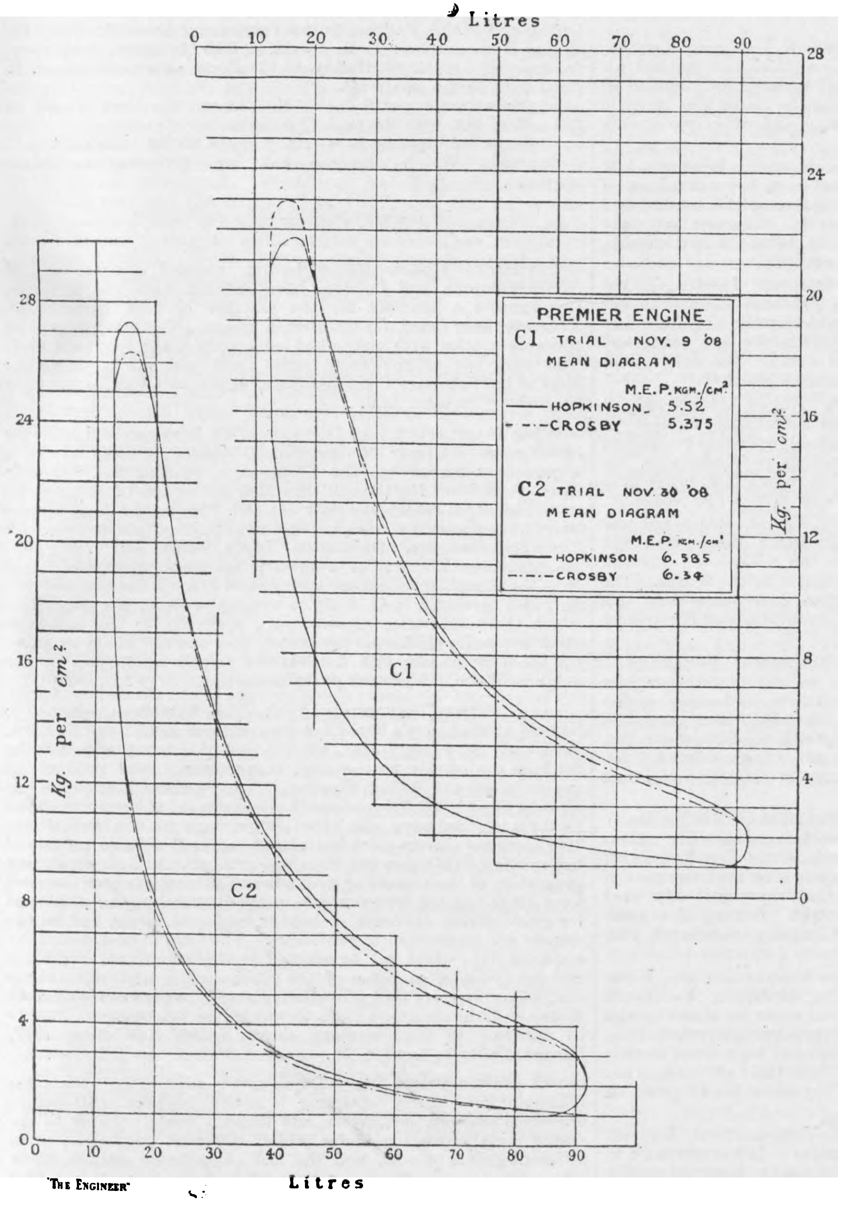
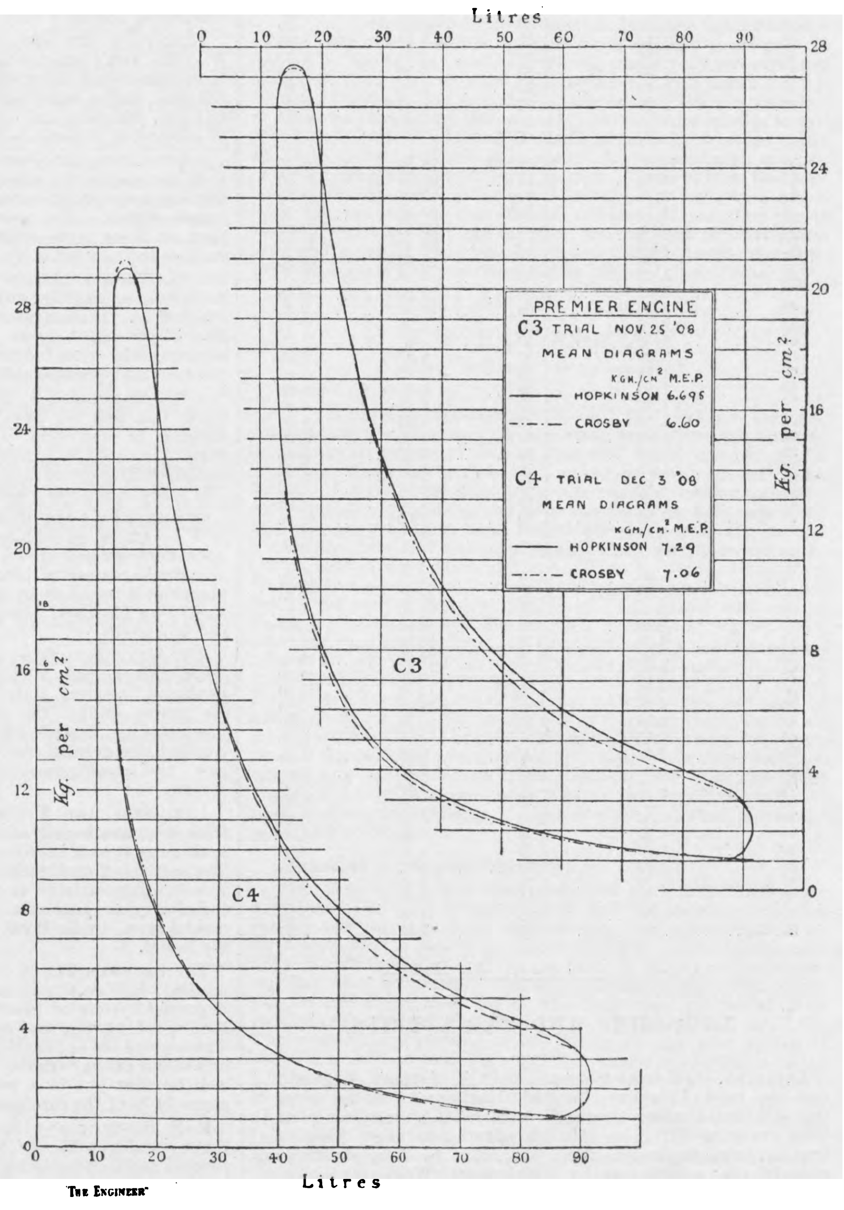


FIG. 3 —*Mean Diagrams.*
Facsimile of Reporter's Drawings. (Reduced about half size.)



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* The Institution of Mechanical Engineers.

† "Proceedings," Institution of Civil Engineers, 1906, vol. clxiii., page 247.

‡ "Proceedings," 1908, Part I., page 5.

* "Proceedings," 1907, Part IV., page 884.

report still higher than they are, which, while not impossible, is certainly not a result to be expected.

The result of these comparisons, while not an absolute proof of the accuracy of either of the indicators, is still strong evidence that both are giving results very close to the truth. The two are entirely dissimilar types, one multiplying the motion of the indicator piston by 6, and the other by about 120, and a very similar multiplication being the case with the rotation of the drum and the mirror. In the optic indicator the inertia is certainly negligible; that the two give results to within 3 per cent. on the mean pressure, and very nearly the same figures for the initial pressure, is good presumptive evidence that when either indicator is used with the precautions which have been described the results so obtained are at least as accurate as any other measurement which can be made in engine testing.

The author expresses the opinion that unless these precautions are taken when obtaining indicator diagrams, the results should only be looked upon as affording a clue to the valve-setting, and giving no reliable figures as to the power developed in the engine cylinder.

APPENDIX.

Trial C 1.

Volume. Litres.	Pressures. Kg. per cm².			
	Compression.		Expansion.	
	Hopkinson.	Crosby.	Hopkinson.	Crosby.
12.75	14.90	14.90	20.30	20.30
14	13.00	13.00	21.30	22.75
15	11.85	11.85	21.55	22.90
16	10.80	10.80	21.70	22.95
19	8.40	8.40	21.05	21.40
20	7.90	7.90	20.30	20.70
25	5.90	5.90	16.40	16.10
30	4.65	4.65	13.17	12.80
35	3.75	3.75	10.85	11.55
40	3.05	3.05	9.15	8.85
45	2.60	2.60	7.85	7.45
50	2.25	2.25	6.85	6.55
55	2.00	2.00	6.05	5.80
60	1.75	1.75	5.42	5.15
65	1.60	1.60	4.87	4.62
70	1.45	1.45	4.40	4.15
75	1.35	1.35	4.00	3.75
80	1.23	1.23	3.65	3.37
85	1.12	1.12	3.24	3.00
87.5	1.10	1.10	3.00	2.80
90	1.05	1.05	2.62	2.40
91	1.02	1.02	2.40	2.40
91.75	1.00	1.00	2.10	2.10

Trial C 2.

12.75	18.50	18.50	26.10	25.10
14	14.50	14.50	27.10	26.20
15	12.80	12.40	27.30	26.30
16	11.60	11.10	27.30	26.30
19	8.90	8.50	25.00	24.90
20	8.30	7.95	24.00	24.00
25	6.10	5.90	18.00	17.65
30	4.75	4.60	14.35	14.05
35	3.80	3.70	11.80	11.50
40	3.15	3.00	9.90	9.60
45	2.67	2.40	8.60	8.20
50	2.30	2.15	7.60	7.20
55	2.00	1.85	6.70	6.35
60	1.80	1.65	6.05	5.65
65	1.60	1.50	5.50	5.10
70	1.40	1.35	5.00	4.60
75	1.20	1.25	4.50	4.20
80	1.20	1.20	4.15	3.85
85	1.10	1.10	3.70	3.50
87.5	1.10	1.10	3.50	3.30
90	1.30	1.30	3.10	3.00
91	1.40	1.40	2.80	2.80
91.75	2.00	2.00	2.20	2.20

Trial C 3.

12.75	18.70	18.70	25.60	25.60
14	14.20	13.10	27.25	27.05
15	12.45	11.60	27.45	27.30
16	11.25	10.70	27.40	27.30
19	8.95	8.50	25.50	25.50
20	8.35	7.90	24.10	24.10
25	6.05	5.80	18.40	18.20
30	4.70	4.45	14.55	14.30
35	3.80	3.60	12.00	9.75
40	3.20	3.00	10.20	9.85
45	2.70	2.55	8.75	8.40
50	2.30	2.20	7.65	7.25
55	2.00	1.90	6.80	6.35
60	1.75	1.70	6.05	5.60
65	1.55	1.50	5.45	5.05
70	1.40	1.30	4.90	4.60
75	1.30	1.20	4.45	4.20
80	1.20	1.10	4.05	3.80
85	1.10	1.10	3.60	3.45
87.5	1.10	1.10	3.40	3.30
90	1.40	1.40	3.00	3.00
91	1.55	1.55	2.65	2.65
91.75	1.80	1.80	2.00	2.00

Trial C 4.

12.75	15.60	15.60	28.50	28.80
14	12.80	13.30	29.25	29.65
15	11.35	11.90	29.30	29.55
16	10.40	10.90	29.10	29.00
19	8.30	8.70	26.00	26.00
20	7.80	8.10	24.70	24.70
25	5.85	5.90	19.00	19.00
30	4.65	4.65	15.10	15.10
35	3.75	3.75	12.50	12.30
40	3.15	3.10	10.50	10.20
45	2.70	2.60	9.10	8.70
50	2.30	2.20	8.00	7.55
55	2.00	1.90	7.10	6.65
60	1.75	1.70	6.30	5.90
65	1.55	1.50	5.60	5.30
70	1.30	1.40	5.10	4.80
75	1.20	1.30	4.60	4.40
80	1.10	1.20	4.20	4.00
85	1.10	1.10	3.80	3.65
87.5	1.10	1.10	3.55	3.45
90	1.35	1.35	3.10	3.10
91	1.60	1.60	2.85	2.85
91.75	2.20	2.20	2.30	2.30

LAUNCHES AND TRIAL TRIPS.

Appenine, steel screw steamer; built by Irvine's Shipbuilding and Dry Docks Company, Limited, Hartlepool; to the order of the Gulf Line, Limited, Greenock and London; dimensions, length 360ft., breadth 51ft., by 25ft. 6in. depth; to carry 6400 tons; engines, triple-expansion, 25in., 40in., 67in. by 45in. stroke, pressure 180 lb.; constructed by Richardsons, Westgarth and Co., Limited; trial trip, August 21st.

Bendew, steel screw steamer; built by Irvine's Shipbuilding and Dry Docks Company; to the order of Furness, Withy and Co., Limited; dimensions, 360ft. by 51ft. by 25ft. 6in.; to carry 6300 tons; engines, triple-expansion, 25in., 40in., 67in. by 45in. stroke, pressure 180 lb.; constructed by Richardsons, Westgarth and Co., Limited; launch, August 30th.

Querida, steel screw steamer; built by Swan, Hunter and Wigham Richardson, Limited; to the order of the Donald Steamship Company, Incorporated, of Bristol and New York; dimensions, 230ft. by 36½ft. beam; to carry 2000 tons; engines, triple-expansion; constructed by the North-Eastern Marine Engineering Company; launch, August 31st.

Vogesen, steel screw steamer; built by Wm. Doxford and Sons, Limited; to the order of Mr. H. Vogemann; dimensions, 350ft. by 51ft. by 25¼ft.; to carry 6450 tons; engines constructed by the builders; launch, August 31st.

Winnebah, steel screw steamer; built by Irvine's Shipbuilding and Dry Docks Company, Limited; to the order of Elder Dempster and Co.; dimensions, 355ft. by 46ft. by 25ft. 3in.; engines, triple-expansion, 25in., 40in., 67in. by 45in. stroke, pressure 180 lb.; constructed by Richardsons, Westgarth and Co.; launch, September 2nd.

Shonga, steel screw steamer; built by Irvine's Shipbuilding and Dry Docks Company; to the order of Elder Dempster and Co.; dimensions, 355ft. by 46ft. by 25ft. 3in.; engines, triple-expansion, 25in., 40in., 67in. by 45in. stroke, pressure 180 lb.; trial trip, September 4th.

Guanabacoa, double-ended steel screw ferry steamer; built by Cammell Laird and Co., Limited; to the order of the Havana Central Railroad Company, Limited, of New York; dimensions, 140ft. by 55ft. by 14ft. 8in.; launch, September 4th.

CATALOGUES.

Gilbert Little and Co., 2, Norfolk-street, Strand, W.C.—This is an interesting little publication having reference to ropeways and cableways.

Eyquem's Patents, 10, Dean-street, Oxford-street, London.—This firm has sent us a list having reference to aeroplane accessories and engines for model aeroplanes.

The Steel Barrel Company, Limited, Uxbridge, Middlesex.—This is a circular having reference to vertical welded boilers, which have recently been added to the manufactures of this company.

Ludw. Loewe and Co., Limited, 30 to 32, Farringdon-road, Clerkenwell, London, E.C.—From this company we have received a new booklet illustrating and describing the Colburn 34in. vertical boring and turning mill.

W. F. Dixon and Co., 60, Percival-street, C.-on-M., Manchester.—Circular of metal-bushed buffalo raw hide silent gears. The circular contains an illustration of a portion of fourteen sets of gears supplied to South African gold mines.

Berlin-Anhaltische Maschinenbau-Actien-Gesellschaft.—We have received from this firm circulars illustrating and giving prices of an elastic stud coupling, which is constructed in various sizes, the largest being capable of transmitting 2300 horse-power.

The British, Irish, and Colonial Department of the Maschinenfabrik Oerlikon, Oswaldestre House, Norfolk-street, Strand, W.C.—Two leaflets have reached us dealing with alternating and continuous-current motors and starters for small outputs.

The Midland Engineering Company, Limited, Birmingham.—From this company we have received a tasteful little pamphlet having reference to "Zylba" patented condensing and cooling plants. The pamphlet is well illustrated and it contains a list of users of "Zylba" cooling towers.

James Hendry, 252, Main-street, Bridgeton, Glasgow.—This is a new illustrated catalogue giving full particulars relating to Hendry's patented laminated leather belting. It is a well got up little publication, containing excellent illustrations, and the descriptive matter is very clear.

J. Taylor and Sons, Limited, Belle Isle, York-road, London, N.—This firm's latest catalogue of petrol engines has reached us. It contains many illustrations of engines suitable for commercial vehicles, motor cars, cabs, motor lifeboats, launches, electric lighting, pumping, &c. Prices, dimensions and other particulars of interest to buyers are included.

Schuchardt and Schutte, 34, Victoria-street, London.—List D 32 has reached us, which illustrates and describes a new form of turning rest, specially adapted for turning locomotive, tender, and wagon wheels. The peculiar combination of former and rack feed on these rests enables forms to be turned automatically, such as are impossible by the ordinary methods.

C. C. Wakefield and Co., 27, Cannon-street, London, E.C.—A catalogue dealing with Wakefield's patented lubricators has reached us. It illustrates and describes mechanical and condensation displacement types adapted for locomotive and stationary engines using saturated and superheated steam. The descriptions are remarkably clear, and the illustrations excellent.

S. N. Brayshaw, 2, Mulberry-street, Hulme, Manchester.—From this firm we have received three useful cards suitable for hanging in the office. One gives decimal equivalents ranging from $\frac{1}{64}$in. to $\frac{63}{64}$in. Another gives millimetre equivalents, the corresponding values in inches being given from 1 mm. to 900 mm. The other card gives a comparison of the Cent. and Fah. scales.

Vickers, Sons and Maxim, Limited, 32, Victoria-street, London S.W.—This is an illustrated pamphlet which deals with the operations connected with the use of the "Vickers" one-lock adjustable reamer as used at the company's Erith Works. The pamphlet is issued as an aid to the practical man when using this tool. We have also received a circular describing and illustrating the tool itself.

The Lilleshall Company, Limited, Oakengates, Shropshire.—From this company we have received a well illustrated pamphlet having reference to a new compound tandem condensing engine for rolling mills. The particular engine which the pamphlet illustrates and describes was supplied to Frederick Brady and Co., Limited, for driving the sheet mills at the Eclipse Works, Glasgow, and constitutes a distinct departure in this type of prime mover.

Lancaster and Tonge, Limited, Pendleton, Manchester.—This firm has issued a leaflet dealing with the Lancaster patent limit rings, which have already been described in The Engineer. The method of construction of these rings is such that the area of the limiting surfaces is so regulated that the rings only wear sufficiently to keep the piston steam-tight. A copy of a testimonial from the Trafford Park Power Company is enclosed with the leaflet.

The Peckham Truck Company, Queen Anne's Chambers, Westminster, S.W.—A well-bound catalogue describing Peckham's improved system of pendulum and radial gears for tramway and high-speed electric and steam railway carriages has reached us. These gears are applicable to goods wagons and high-speed electric and steam railway trucks and carriages, and their advantages are well brought out in a report by Mr. Sayers which is given on pages 14-25 of the catalogue.

E. S. Hindley and Sons, 11, Queen Victoria-street, London, E.C.—Catalogue No. 330 has been sent to us. It has reference to vertical multi-cylinder high-speed gas engines, and contains many excellent illustrations showing engines of various sizes. The construction of the company's patented expanding but jointless cylinder is fully described and illustrated, whilst a concise specification gives the reader a general idea of the construction of the other parts. The engines dealt with are for town, producer, or natural gas.

Geo. Thomas and Co., Parsonage-lane, Deansgate, Manchester.—Catalogue No. 27 E is devoted to tachometers, tachographs, engine counters, &c., constructed according to Dr. Horn's patents. The range illustrated in this book includes everything, from small hand instruments to the sensitive recording tachographs, and also revolution counters, speedometers, &c. The tachometers are dead beat, and independent of the direction of rotation. The book is well illustrated, and gives the prices of the different instruments.

Dean, Smith and Grace, Limited, Worth Valley Tool Works, Keighley.—A copy of this company's new catalogue dealing with high-speed lathes has been forwarded to us. It is an interesting and well compiled publication, and contains many good illustrations of the company's shops and of the lathes and lathe parts which are manufactured therein. The lathes dealt with are suitable for many kinds of service, and the catalogue consequently appeals to a large number of manufacturing engineers. The principal dimensions of every lathe dealt with are given, and there is also a general specification which describes and illustrates the various parts.

Maschinenfabrik Augsberg-Nurnberg—London Office, 219, Caxton House, Westminster, S.W.—An excellent catalogue has reached us. Among other things it gives descriptions of this company's various works, including the Augsburg works, the Nuremberg works, and the branch works, Gustavsburg. Nearly 70 pages are then devoted to the company's chief manufactures, such as boilers, superheaters, automatic stokers, steam engines, steam turbines, Nuremberg producer plants and gas engines, double-acting Nuremberg gas engines, Diesel motors water turbines, complete power plants, printing machines, refrigerating machinery, pumping plants, hydraulic plants, machines for testing materials, vacuum plants, lifting and conveying appliances, rolling stock, railway wagons, tramway cars, bridges and other steel structures. Numerous illustrations are given.

NAVAL ENGINEER APPOINTMENTS.

The following appointments have been made by the Admiralty:—

Engineer Commanders.—A. W. Gibbs has been placed on the retired list, with the rank of engineer captain; P. G. Drake has been placed on the retired list at his own request; T. Shattock, to the Europa, additional, for the Gibraltar; A. W. Turner, to the King Edward VII., additional, for service on staff of Vice-Admiral commanding Second Division, Home Fleet, in lieu of engineer captain; W. Ryan, to the King Edward VII.; F. Barter, to the Vivid, additional, for the Bristol, and to assist on staff of Admiral-Superintendent of District; E. J. Rosevere, to the Victory, additional, for fourteen days' oil fuel course; E. Atwool, to the Vernon and Excellent, additional, for T. and Hyd. courses; E. W. Cudlip, to the Topaze, additional, for torpedo-boat destroyers and torpedo-boat tenders; H. B. Moorshead, to the Arrogant, on re-commissioning.

Engineer Lieutenants:—L. W. Curgenven, to the Orion, additional, for the Foam; G. J. Mathews, to the Blenheim; P. C. W. Howe, to the Admiralty for temporary service in Dockyard Branch; H. W. Grant, to the Assistance; H. J. Rampling, to the Patrol, on completing; A. W. Sutton, to the Sapphire, and for service with torpedo-boat destroyers; C. E. M. Roe, to the Topaze, additional, for the Bat; F. A. Chater, to the Orion, for the Mallard, and C. L. J. Risch, to the Diamond, for the Dove, both reappointed on re-commissioning; W. Dawson, to the Pembroke, for the Scorpion, and H. G. Radford, to the Vivid, for the Foxhound, both additional, and to assist on staff of Admiral-Superintendent of District; C. T. Morgan, to the Mars; G. Bevis and W. H. Outfin, lent to the Victory, for fourteen days' oil fuel course; A. E. Hurst, to the Vernon and Excellent (lent), for T. and Hyd. courses, on termination of oil fuel course; W. H. Outfin and W. H. Pudner, to the Vernon and Excellent (lent), for T. and Hyd. courses; T. M. David, to the Arrogant, temporary, for trooping; H. G. W. Haddy, to the Doris, on completing; J. E. MacLaren, to the Roxburgh.

Engineer Lieutenant R.N.R.—H. Tronson has been placed on the retired list, with the rank of commander.

Engineer Sub-lieutenant.—A. E. Francis, to the Duncan.

Engineer.—W. V. Browne has been promoted to senior engineer.

Contract.—Messrs. Henry Lovatt, Limited, contractors, of Wolverhampton and London, have secured from the Egyptian Government a contract for the erection of new barracks at Abbassia, near Cairo, for the British troops. The material will be concrete blocks, with reinforced concrete for the floors and roof. The work will occupy about three years, and will be on similar lines to the Salisbury Plain barracks, which were very successfully erected by the same firm.

West Hartlepool and District.—We have received from the chief goods manager of the North-Eastern Railway at York a pamphlet issued by the Corporation entitled the "County Borough of West Hartlepool," in which the aspects of this district as an industrial centre are fully set out. From the same source there have previously been issued similar publications dealing with Tyneside, Teesside, Darlington, Blyth, Selby, and York, and manufacturers in search of a new site for their works can obtain from these useful preliminary information to assist them in deciding on which district is most likely to present to them the conditions which their industries require. An appendix to the pamphlet gives the scales of charges for water, gas, and electricity supplied by the Corporation and the various private companies in the neighbourhood. The book contains excellent large scale maps.

Japan-British Exhibition, 1910.—This Exhibition, which is to be held at Shepherd's Bush, London, will commence on May 3rd, 1910, and will remain open till the end of October, and is to be confined exclusively to the arts, manufactures, and products of the Japanese and British Empires. The Parliament of Japan has already voted 1,800,000 yen, and the Government of Formosa and the local prefectures have also voted large sums for the Exhibition. The Japanese Government has already secured a large portion of the existing Exhibition buildings and grounds, and a corresponding proportion of the remaining grounds and palaces has been reserved for a display of the products, &c., of the British Empire. Diplomas for grand prizes, diplomas of honour, and gold, silver, and bronze medals will be granted to exhibitors. They are to be awarded by a special jury, which will be selected by the Japanese Government and the British Committee of the Exhibition. Application forms and the regulations of the Exhibition, as well as terms for outdoor spaces and concessions, will be forwarded to intending exhibitors by applying to the Secretary, Japan-British Exhibition, 1910, Shepherd's Bush, London, W.

The United States Navy Department has ordered the establishment of yearly steaming contests between battleships, armoured cruisers, destroyers, and torpedo boats. Owing to the varied duty, steaming under widely different conditions, with different grades of coal, and the lack of sufficient data to place other vessels of the service on an equal basis for competition, only these classes of vessels will enter into the first competition. Standards for the different classes of vessels have been established from experience gained in the past; and, while certain ships may be favoured in some instances, every effort will be exerted by the department to adopt such measures in improving the machinery where demonstrated to be necessary in order to even conditions. The winning vessels will receive suitable trophies, which will be carried for the following year in some conspicuous place, and the name of the vessel with the year she won it will be inscribed on each trophy. The commanding officers and engineer officers of the winning vessels will receive commendatory letters from the department, copies of which will be filed with their records. Money prizes will be given to the men of the engineers' force of the winning vessels, but no man not actively engaged on his station during one of the full power trials will be entitled to a prize.

THE IRON, COAL, AND GENERAL TRADES OF BIRMINGHAM, WOLVERHAMPTON, AND OTHER DISTRICTS.

(*From our own Correspondent.*)

Trade Revival Progress.

THE progress of the trade revival continues to be very satisfactory. The works are much better engaged than for a long while past, employment is more regular, and the demand is of an encouraging character both on home and foreign account. Values of materials are rising, which feature, if continued, must ultimately lead to better prices for machinery and for other engineering productions.

Advances in Pig Iron.

Sellers are asking more for pig iron. Cold blast pig iron, which has been quoted 110s. for about a year and a-half, is now being quoted 115s., or a rise of 5s. The demand for this description, for chilled roll making and for other purposes where an extra good quality of pig iron is required, is improving. All-mine hot-air descriptions are dearer to the same extent, namely, 5s., forge sorts being now 85s., and foundry 90s. Medium and common descriptions are also dearer than recently, but not to the same extent as best sorts, sellers asking from 6d. to 1s. rise on the week. Quotations are about as follows:—Staffordshire cinder forge, 47s.; part-mine, 50s. 6d. to 51s. 6d.; Northamptons, 49s. to 50s.; and Derbyshires, 50s. to 51s. There is a better demand than recently for North Staffordshire descriptions, sellers asking 51s. 6d. to 52s. 6d. for forge up to 58s. and 59s. for best foundry.

Manufactured Iron Firmer.

In sympathy with the upward movement in pig iron, common bars are being quoted more firmly than of late, and may be said to be about half a crown dearer than a fortnight or three weeks ago. The general quotation is £6, and some makers ask £6 2s. 6d. If this strengthening tendency continues, marked bars will probably soon also be advanced. Some members of the association which governs this important department of the trade are understood to be already in favour of a declared advance, but the majority are inclined to allow the improvement first to become a little stronger and more settled. It will probably not be long, however, before the £8 quotation at which marked bars have remained since the middle of last year will be raised. For North Staffordshire crown bars £6 10s. is asked, with a much better inquiry than recently. Hoop iron is quoted £6 15s.; gas strip, £6 5s. to £6 7s. 6d.; rivet iron, £6 15s. to £7; and slit nail rods, £7. Plain black sheets are quiet, with some of the mills scarcely making half-time, and quotations remain at: singles, £7 to £7 2s. 6d.; doubles, £7 2s. 6d. to £7 5s.; and trebles, £7 15s. to £7 17s. 6d. A very different state of affairs obtains in the galvanised iron trade, where activity prevails. Some of the firms can take no more orders for the present, having booked heavily since the collapse of the Galvanised Iron Trade Association. The general quotation at present is £11 to £11 5s., whilst some makers ask 5s. additional to these figures. Prices are decidedly rising again after the recent "slump."

Increased Galvanised Sheet Exports.

The new Board of Trade returns for the month of August and for the first eight months of the year contain good news for galvanised sheet manufacturers. The increase in the shipment of galvanised sheets for the single month of August has been in quantity from 31,813 tons to 34,298 tons, and in value from £441,347 to £444,341, which is an increase in quantity of 2485 tons, and in value of £2994. With regard to the first eight months of this year, the shipments have reached 305,293, valued at the considerable amount of £4,194,390. This is an increase on last year in quantity of 53,281 tons, and in value of £677,276. The two chief improvements for the eight months are the Argentine Republic from 40,383 tons to 62,644 tons, and Australia from 40,330 tons to 55,341 tons. India shows a slight decrease from 61 918 tons to 59,653 tons. Trade with New Zealand is about the same as a year ago, the new total of 10,793 tons comparing with 10,947 tons last year. Further markets to which increased exports have been sent during the eight months are as follows, in order of quantity shipped:—South Africa, Chili, Canada, Dutch East Indies, Uruguay, Portuguese East Africa, Straits Settlements, Philippine Islands, Ceylon, and "other countries."

Steelworks Extensions.

The steel trade generally is more active. It is announced that steps are being taken for some extensive enlargements of the Earl of Dudley's Round Oak Steelworks. An old portion of the ironworks, erected many years ago, is to be altered for steel making, and is to be equipped with up-to-date machinery and plant. Structural steel is in better demand, and values are rising. Angles are quoted £5 15s. to £5 17s. 6d., which is an advance of 2s. 6d. upon a fortnight ago, and of 5s. upon three weeks ago. Girder plates are also quoted £5 15s. to £5 17s. 6d., boiler plates £7, joists £5 10s. to £5 15s., and mild steel engineering bars £6 7s. 6d. to £6 17s. 6d. There is more movement than of late in semi-finished steel, in which department £4 15s. is asked for Bessemer steel bars, and 2s. 6d. additional for Siemens.

The Engineering Trades.

A large demand, both home and foreign, is experienced for gas and oil engines, particularly the latter. Some of the steam engine building firms have good contracts in hand. India, Egypt, and South Africa are furnishing orders for pumps and for wind engines and other descriptions of economical motors for driving them. The European demand for harvesting machinery has recently been very good. Mining machinery firms are doing better with South Africa than for a long while past. The Russian demand for thrashing machinery and for steam ploughs is improving. In most other descriptions of agricultural machinery for use in Russia, American and German competition is becoming increasingly keen, and that country is also more and more making for itself. This is true of harvesting machinery, winnowers, and flour-milling plant. Midland edge-tool firms are doing better in picks, shovels, and other road-making tools, and are also expecting a busy time next year.

Aerial Engineering.

The interests of aerial engineering are likely to be furthered by the formation of a new club, known as the Midland Aero Club, which has just been founded at a meeting at which Captain Cooke presided, whilst an address was delivered by Mr. W. Ivy Rogers, who has been elected honorary secretary. Mr. Rogers looks forward to the establishment in Birmingham of the manufacture of complete aeroplanes as well as of component parts. Several firms in the district already make component parts, and at least two complete aeroplanes are, it is said, under construction.

Electricity in Mines.

Mr. Arthur Hall, M.E., of Mineaton, who is consulting mining engineer to the Electrical Construction Company, of Bushbury, near Wolverhampton, has been appointed president of the Warwickshire and Staffordshire branch of the recently established Institution of Mining Electrical Engineers, which is forming branches in all the chief mining districts of the kingdom. The hon. sec. of this branch is Mr. Harry Arnott, of Bedworth.

NOTES FROM LANCASHIRE.

(*From our own Correspondent.*)

MANCHESTER, Thursday.

Pig Iron on the Up Grade.

ON the Manchester Iron Exchange on Tuesday the attendance was fairly good. To all outward appearances there was a boom in pig iron, but this was not fully confirmed on inquiry amongst merchants generally. Lincolnshire was officially advanced on Saturday, but this was to a great extent discounted by Friday's higher prices. For Derbyshire and Staffordshire more money also was asked. While there was little change in Scotch brands, hematite remained steady. As a matter of fact, it would seem that pig iron on the spot has been forced up to a somewhat abnormal extent. The result is that merchants who have large engagements are "under-cutting," and the close of the market was somewhat dull. Forge iron has witnessed an advance, but it has had little or no effect on spot.

Finished Iron and Steel.

There is only a moderate business passing in the first named, but in steel some excellent reports were received, especially from Staffordshire. For forward delivery 5s. to 10s. per ton more was being asked for certain classes of steel.

Copper, Lead, Tin.

There was a dull feeling all round, and ingots were a shade lower. Sheets showed little change, but tubes ruled in buyers' favour. Lead: Sheets continue steady. Tin: English ingots were a shade lower.

Quotations.

Lincolnshire, No. 3 foundry, 55s.; Staffordshire, 53s. 6d. to 54s.; Derbyshire, 54s 6d.; Middlesbrough, open brands, 60s. 4d. Scotch: Gartsherrie, 61s. 6d. to 62s.; Glengarnock, 60s. 6d.; Eglinton, 59s. 6d.; Dalmellington, 60s, delivered Manchester. West Coast hematite, 62s. to 62s. 6d.; East Coast ditto, 60s. 6d., both f.o.t. Delivered Heysham: Gartsherrie, 59s. 6d. to 60s.; Glengarnock, 58s. 6d.; Eglinton, 57s. 6d.; Dalmellington, 58s. Delivered Preston: Gartsherrie, 60s. 6d. to 61s.; Glengarnock, 59s. 6d.; Eglinton, 58s. 6d.; Dalmellington, 59s. Finished iron: Bars, £6 10s.; hoops, £7 12s. 6d.; sheets, £7 15s. to £8. Steel: Bars, £6 2s. 6d. to £6 5s.; Lancashire hoops, £7 5s.; Staffordshire ditto, £6 17s. 6d. to £7; sheets, £7 17s. 6d. to £8; boiler plates, £7 7s. 6d.; plates for tank, girder, and bridge work, £6 5s. to £6 7s. 6d.; English billets, £4 12s. 6d. to £4 15s.; foreign ditto, £4 10s. to £4 12s. 6d.; cold-drawn steel, £9 10s. to £9 15s. Copper: Sheets, £72; tough ingot, £62; best selected, £62 per ton. Copper tubes, 8½d.; brass tubes, 6⅞d. to 7⅛d.; condenser, 7⅞d.; rolled brass, 6¼d.; brass wire, 6½d.; brass turning rods, 6½d.; yellow metal, 6d. per lb. Sheet lead, £16 17s. 6d. per ton. English tin ingots, £134 to £134 10s. per ton.

The Lancashire Coal Trade.

There was a fair attendance on the Coal Exchange, but the feeling was generally quiet. It is not yet known whether there will be any advance on the winter prices of house coal, but in the meantime merchants appear anxious to cover forward requirements. So far as can be ascertained they will be able to do so. Steam coal in fair request, and demand on shipping account good. In other respects there is no new feature to note.

BARROW-IN-FURNESS, Thursday.

Hematites.

The strength of the hematite iron market is well maintained, and a fair trade is being done, but it is not yet sufficient to induce smelters to increase further their output of iron. The prospects of the future are, however, good, as there are indications of a probable improvement from a number of sources. Makers are fairly well sold forward, and their delivery engagements are keeping their stocks down. The bulk of iron held in warrant stores and in their own yards is low, and it is considered expedient to keep it so in view of the stronger position they will be in when any marked increase in the demand takes place. Prices are somewhat higher. Mixed Bessemer numbers are at 62s. net f.o.b. Warrant sellers are quoting 60s. 6d. one month, 62s. 3d. three months, and 61s. 3d. seventeen days. There is not much speculative business on paper, but several buyers have been securing deliveries at forward dates with the view of getting deliveries at cheaper prices than will probably rule later on. Several makers are, however, chary of doing much forward business except at substantial advances on current cash prices. There is a fairly good trade in special hematite iron, as the needs of the trade in higher graded metals have shown an improvement of late, and it is probable there will be a much larger trade when once the market for ordinary hematite iron substantially improves. Prices range from 64s. to 66s. for this class of iron. Ferro-manganese does not enjoy a good market at the moment, owing mainly to the recent advance in prices. Eighty per cent. qualities are selling at £8 per ton. A fairly good demand is maintained for charcoal iron. Sales of scrap iron are few, and some large stocks are held in the district. Iron ore is at somewhat higher value. Good average sorts are now selling at 12s. net at mines, medium at 14s 6d., and best sorts at 18s. The price of foreign ore has also advanced from 1s. to 1s. 6d. per ton, and smelters of iron are complaining that the higher price at which iron is being sold to-day is largely absorbed by the increase which has taken place in the price of raw material.

Steel.

There is a fair amount of activity in the steel trade, so far as railway material is concerned, but the market for the latter is not brisk, and makers are being supplied with orders from hand to mouth. Every effort is being made to keep the works going, and hopes are entertained that a better winter will be experienced this year than last. Merchant steel is quiet, and there is nothing being done at the plate mills. It has been expected that the Barrow Steel Company would get the order for the plates required for the two floating docks to be built at Barrow during the winter, but no intimation to that effect has yet been made.

Shipbuilding and Engineering.

The demand for new tonnage is quiet, and competition for the new orders in the market, which are few, is very keen. No new orders have been booked, but some have been tendered for, including important admiralty work for foreign Powers. Engineers are short of orders in the marine shops, and although they are well supplied with business in the gun-mounting departments the shops look short of work.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

Tne Coal Trade.

THE feature of interest in the coal trade continues to be the dearth in available supplies, due to the lessened production, as a result of the working of the Eight Hours Act, reference to which has been made in previous reports, and to the holiday stoppages. This week, owing to the Doncaster races, there is throughout the South Yorkshire coalfield hardly a pit that has not had one day's "play." The shipping season is rapidly drawing to a close, and a much larger quantity could be dealt with at Hull, but the coal is not available. Prices for best hards are very firm at 9s. 3d. to 9s. 9d. per ton, which are about the top prices of the year, and represent a considerable advance on the rates ruling earlier in the year.

House Coal Firm.

The colder weather has tended to increase the demand of house coal, and this, together with the fact that outputs are lower, owing to the causes mentioned above, maintains prices. The demand from London is better, but merchants are still in arrears with their contract quantities. Best Barnsley coal is quoted from 11s. 6d. to 13s. per ton, and secondary sorts from 10s. to 11s. per ton. There is no falling off in the demand for small coal from Lancashire and the West Riding, and prices are steady at 4s. 6d. to 5s. 6d. per ton.

Coke.

There is an improving market for coke. Prices are very firm, owing in part to the reduced supplies of coal available, and also to larger calls from pig iron manufacturers. Best washed coke is strong at 11s. to 11s. 6d. per ton, and unwashed 10s. 6d. to 11s. per ton.

Hull Coal Returns.

The Hull Chamber of Commerce returns relating to the coal trade at the port for August have just been issued. The total quantity received at Hull amounted to 564,736 tons, against 541,120 tons in August last year, an increase of 23,616 tons. For the year to date the tonnage is 3,833,024 tons, against 4,002,752 tons, a decrease of 169,728 tons, due to the decreased consignments earlier in the year. The quantity of coal exported from the port shows a gain on the month of 61,501 tons and 210,486 tons for the past eight months, compared with the corresponding period of last year, the figures being as follows:—August, 1909, 408,282 tons; August, 1908, 346,781 tons; January to August, 1909, 2,108,068 tons; January to August, 1908, 1,897,582 tons. Last month the chief individual exports were:—North Russia, 125,860 tons, against 102,384 tons for August, 1908; Holland, 70,727 tons, against 32,990 tons; Germany, 63,462 tons, against 48,454; Sweden, 29,432, against 58,780 tons; Egypt, 21,123, against 14,690; Denmark, 18,291, against 15,454; France, 18,888, against 22,715; South America, 15,321, against 13,577. The drop in Swedish consignments is due, of course, to the strike in that country. Coastwise shipments totalled 66,945 tons.

Iron: Further Advance in Prices.

At the meeting of the Lincolnshire Ironworkers' Association on the 3rd inst. the official quotations were raised 2s. per ton. Prices are now as follows:—No. 3 foundry, 52s. 6d. per ton; No. 4 foundry, 51s. 6d. per ton; No. 4 forge, 51s. 6d. per ton; No. 5 forge, mottled and white, 51s. 6d. per ton; basic, 52s. 6d. per ton, all net, delivered in Sheffield and Rotherham. The only change in Derbyshire iron is another advance of 6d. per ton in No. 3 foundry, which is now about 52s. per ton; No. 4 forge remaining at 50s. 6d. These prices are also net, delivered Sheffield and Rotherham. Makers are not pressing sales, and business is quiet. There is also less activity in hematites, a lull having followed the heavy buying recently noted, but prices are still maintained and are very firm indeed. Quotations are:—East Coast, 65s. to 67s.; West Coast, 68s. to 70s. net, delivered Sheffield and Rotherham.

Bars, Hoops, and Sheets.

Despite the firmness of the pig iron market there is no improvement to note in finished iron. The South Yorkshire Bar Iron Association decided at their monthly meeting on the 6th inst. to make no alteration in prices, which remain:—Bars, £6 10s. per ton; hoops, £7 10s.; sheets, £8 10s. We understand that it was reported that there had been a great deal of contracting for bar iron, but the specifications are coming forward very slowly. Contracts are being made at current prices as far ahead as six months.

The Heavy Industries.

A more hopeful tone continues in these industries, but order books remain rather lean. This is especially the case in respect to the railway material branch, where work averages not more than from two to four days per week. The Great Central Railway Company has recently contracted for 1000 wagons, but so far as we can gather, the only share of the order coming to this district is 500 sets of wheels. Most of the moderate business doing on home railway account is in regard to replacements, and the orders from abroad are of small extent. Reports from the shipbuilding centres are a little more cheerful, but not much actual work has yet reached this district. Makers of tool steel report very little change in their industry, the demands of the general engineering trades being very small, but manufacturers who cultivate the export trade are doing better business than of late.

NORTH OF ENGLAND.

(*From our own Correspondent.*)

Cleveland Pig Iron.

IT must be reported that there is this week not the same animation in the Cleveland pig iron market as had to be announced during the latter part of August, but that is not unexpected, for consumers could not go on long buying so freely as they were doing. However, producers are in a favourable position, generally well supplied with orders, and they can afford to wait, especially as there are coming in more sanguine reports from abroad, and the finished iron and steel trades at home are beginning to do better, and to need more pig iron. That is a very satisfactory feature, and shows that there is good ground for believing that the period of depression is at an end. Cleveland warrants on Friday last week reached 51s. 7d. cash buyers, the highest price reported since September of last year, but has not maintained that figure, for on Wednesday last 51s. was the quotation. No. 3 Cleveland pig iron for prompt delivery was then at 51s., No. 1 at 53s. 3d., No. 4 foundry at 49s. 6d., No. 4 forge at 49s., and mottled and white at 48s. 6d. But for delivery over the next half year 6d. to 9d. per ton more had to be paid. It is stated that a good many people outside the trade are now speculating in warrants in the expectation of making good profits out of the business, and their operations impart some uncertainty to the market, as they are apt to be very erratic and unsteady. Thus a steady upward movement cannot be looked for.

Expected American Demands.

The reports and telegrams from the United States are now scanned with far greater interest than has been known during the last two years; indeed, they have acquired much importance, for a considerable part of the improvement in the Cleveland market is due to the belief that the condition of affairs in the American iron trade is becoming such that consumers there will before long be under the necessity of obtaining some portion of their requirements from Cleveland, as was the case in 1906 and 1907. The production of pig iron in the States, though now at double the rate which had to be reported last year, is hardly equal to the increased consumption, and prices have gone up so rapidly that it is now possible to deliver Cleveland iron to founders near the Atlantic seaboard of the United States at prices which compare favourably with those ruling for American pig iron. No. 3 Cleveland pig iron could be delivered at Philadelphia or Baltimore at 70s. per ton, duty paid, and the quotation for American iron is 18½ dols. Some likelihood of business being done is apparent from the fact that a considerable number of inquiries from American traders have within the last ten days been received in the Cleveland district, though it cannot be said that as yet any actual orders have been booked. Lower quotations are not likely to be made by sellers in other districts either at home or abroad. Cleveland has a considerable stock of pig iron, so that the wants of consumers could be satisfied without delay. The expectations with respect to America have made the warrant market quite animated, and the opinion that the trend of prices will continue upward is bringing into the market many outsiders who are keen to speculate, and their action is causing the prices of Cleveland pig iron to rise perhaps faster than would be the case if only legitimate buying were being done.

Hematite Pig Iron.

The improvement in the demand for East Coast hematite pig iron is going on steadily, and business in this branch is not influenced by speculation. There are no warrants in this district for speculators to operate with, and the better prices are brought about by a real improvement in trade. The price of mixed numbers East Coast hematite pig iron has been further advanced 6d. per ton this week to 59s. per ton, that being just 4s. rise from the minimum of the year, whereas ordinary Cleveland iron has gone up 5s. 6d. per ton. Hematite iron is still relatively cheaper than Cleveland ordinary iron, but better prices can safely be looked for. The situation is better than it has been for more than two years, and the strong revival in the steel trade is very satisfactory to all who have to supply steel manufacturers with materials, hematite iron makers being among the number. Rubio ore is firm at 17s. per ton, delivered promptly c.i.f. Middlesbrough, a rise of 2s. 3d. on the lowest price of the year. There is just now no business being done for next year, as merchants will not quote, seeing that the Spanish mineowners have not made up their minds what they shall ask for 1910 delivery. But advanced rates are expected. Furnace coke is up to 16s. 9d. per ton delivered equal to Middlesbrough, and 17s. 6d. has been paid for delivery over the first half of next year.

Stock of Cleveland Pig Iron.

In spite of the fact that deliveries have increased the stock of Cleveland pig iron in Connal's public stores continues to increase rapidly, a feature which is anything but satisfactory. On 8th inst. the quantity held was 296,077 tons, an increase for the month of 7575 tons. The stock consisted of 278,543 tons of No. 3; 14,449 tons of No. 4 foundry; and 3085 tons of other iron not deliverable as standard.

Pig Iron Exports.

The shipments of pig iron from the Cleveland district are very fair this month, but to the Continent they are much short of what might be expected at this season of the year, the best business being done with Italy. German traders appear more disposed to export than to import pig iron, for their furnaces are producing considerably more than their own market needs. The total shipments up to the 8th inst. reached 22,977 tons, compared with 26,679 tons last month. 27,902 tons in September, 1908, and 24,192 tons in September, 1907, all to the 8th.

Manufactured Iron and Steel.

Cheerful reports are now given by manufacturers of steel with respect to their business, and certainly they have good reason to believe that they have once more entered upon another period of good trade. The increased demand is not brought about by speculation, but is a sound and healthy improvement, and the advances of prices which have lately been made are firmly adhered to, and are being realised. Steel and iron ship plates are at £6, steel ship angles at £5 7s. 6d., iron ship angles at £7, packing iron and steel at £5 5s., iron ship rivets at £7 10s., steel bars at £6, iron bars at £7. steel hoops at £6 5s., steel strip at £6 2s. 6d., steel sheets at £7 10s., all less 2½ per cent. f.o.t. Galvanised and corrugated steel sheets are at £11, less 4 per cent. f.o.b., for 24 gauge, in bundles, and excellent shipments are reported, particularly to Japan and South America. Prospects of still better prices are good. Heavy steel rails are at £5 5s. net f.o.b., and output and shipments are very satisfactory. This branch has for a long time been the most active of all departments of the iron and steel industries.

Shipbuilding and Engineering.

The improvement in the shipbuilding industry is kept up, and builders have generally advanced their quotations for new vessels. They are finding more employment for their existing steamers, and certainly the outlook is better. The number of vessels laid up in the Tyne has been reduced to 50; that is too many considering that this is the busiest season of the year for shipping, but it is a very great reduction on the number reported in the first half of the year. There is more activity in the engineering industry, and more hands are now being employed than for a long time. The North-Eastern Railway Company is about to build at its Darlington works ten new locomotives of the "Atlantic" type for the East Coast express service. The engines in working order will weigh 72 tons, and the tenders 43½ tons.

Deaths of Well-known Teessiders.

The death is to be recorded at the age of seventy-two years of Mr. Albert Kaufmann, who since 1865 has been connected with the iron trade of Cleveland as a merchant and broker. He was a native of Danzic, and before starting at Middlesbrough was a member of the firm of Eekhout, Kaufmann and Co, of Glasgow. The death took place last week of Mr. John McCrie, who has been secretary of the North-Eastern Steel Company, Middlesbrough, since it was established in 1882. Prior to that, Mr. McCrie was secretary of the Steel Company of Scotland.

Coal and Coke.

The gas coal trade is very active, but the coking coal and bunker branches are decidedly weaker; indeed, prices in the latter have steadily receded since the settlement of the Scotch dispute—a circumstance which is satisfactory to shipowners, who certainly have had to pay for their coals prices quite out of proportion to the rates of freight which were ruling. Now both coking and bunker coals are at 9s. 3d. to 10s. per ton f.o.b.—figures fully 1s. per ton less than were reported a month ago. Next year it is believed that coals will be dearer, because of the increased cost of production due to the application of the Miners' Eight Hours Act. It is calculated that this will augment the cost of working fully 1s. per ton. Best gas coals are at 10s. 9d. to 11s. per ton f.o.b., and seconds at 10s. 3d. Furnace coke is at 16s. 9d. per ton delivered at Middlesbrough works, but 17s. 6d. has been paid for delivery over first half of next year.

NOTES FROM SCOTLAND.

(*From our own Correspondent.*)

The Business Outlook.

A less sanguine view is now taken of the general business outlook. The opinion is still strongly held that we have entered upon a period of expanding trade, but the upward movement in speculative business has sustained a check which may probably have no undesirable consequences. The dividend announcements of two of the principal Scottish railways made this week have caused some disappointment, as they show that scarcely any advantage, to shareholders at least, has been gained from the policy of rigid economy and increased charges that was inaugurated some time ago. There is no reason to doubt, however, that the railways will profit from the general improvement in business that is now gradually taking place.

The Iron Market.

From the record prices paid for warrants towards the end of last week there has been a reaction. There has been a quieter feeling in the market, with a diminished business in warrants. Cleveland iron has sold since last report from 51s. 8d. to 51s. 2d. cash, 51s. 11d. to 51s. 5½d. one month, and 52s. 5½d. to 51s. 11d. three months. Transactions are also noted at 51s. 7½d. and 51s. 5½d. for delivery in seven days, 51s. 10d. for 19th November, and 51s. 11d. for 1st December. Current foreign business in iron has turned out somewhat disappointing so far, not bearing out the anticipations that were freely expressed regarding it in the course of the last few weeks. Neither are the prospects of trade with the United States now spoken of with confidence, the output there having been increased, and being apparently equal to prospective requirements. Speculators in warrants have at the same time been inclined to realise profits. To these circumstances the reaction in the warrant market is attributed.

Scotch Makers' Iron.

The wants of home consumers and shippers having been pretty well met for the present, the demand for Scotch makers' pig iron has now become quieter. Advices from the Continent do not give much hope of substantial quantities of our iron being required there at an early date. Prices of makers' iron were again marked up at the end of last week, when the warrant market was strong. Monkland, f.a s., at Glasgow, No. 1, is quoted 58s. 6d.; No. 3, 56s. 6d.; Carnbroe, No. 1, 59s. 6d.; No. 3, 57s.; Clyde, No. 1, 62s. 6d.; No. 3, 57s. 6d.; Gartsherrie and Calder, Nos. 1, 63s.; Nos. 3, 58s.; Summerlee, No. 1, 63s. 6d.; No. 3, 58s. 6d.; Langloan, No. 1, 64s.; No. 3, 59s.; Coltness, No. 1. 89s. 6d.; No. 3, 59s.; Eglinton, at Ardrossan or Troon, No. 1, 58s.; No. 3, 56s.; Glengarnock, at Ardrossan, No. 1, 63s. 6d.; No. 3, 59s. 6d.; Dalmellington, at Ayr, No. 1, 61s.; No. 3, 56s. Shotts, at Leith, No. 1, 64s. 6d.; No. 3, 58s. per ton. There are 82 furnaces in blast in Scotland, compared with 75 at this time last year; of these 39 are making hematite, 38 ordinary, and 5 basic iron. One furnace has been changed from ordinary iron to hematite at the Eglinton Ironworks.

The Hematite Trade.

The demand for hematite pig iron is now on a comparatively large scale. Makers are understood to have considerable stocks in hand, but it is thought that eventually these will be required as well as the output now taking place. Large arrivals of ore are reaching the Clyde weekly. The price of ore has been firmer, and freights are now on the basis of 4s. 6d. per ton Bilbao to Glasgow. There has again been some demand in our market for Cumberland hematite warrants, which have been purchased from 61s. 4½d. to 62s. 3d. for delivery in three months, and at 60s. 10½d. to 61s. 4½d. one month, and 61s. 3d. for delivery in seventeen days. Scotch hematite has been quoted up to 62s., but business is reported to have been done at 61s. to 61s. 6d. per ton, the last figure being now quoted for delivery at the West of Scotland steel works.

Pig Iron Shipments.

The shipments of pig iron from Scottish ports in the past week were light, amounting to 5744 tons, compared with 6832 in the corresponding week of 1908. There was a comparatively heavy shipment of 1300 tons to Canada; to India, 252; Australia, 195; France, 45; Italy, 150; Germany 255; Holland, 155; China and Japan, 110; other countries, 572; the coastwise shipments being 2710 tons. The arrivals at Grangemouth of pig iron from Cleveland and district were 9784 tons, being 1115 tons more than in the corresponding week of last year.

Finished Iron and Steel.

There is now more regular and fuller employment at the malleable iron and steel works; but the makers are still in a position to give satisfactory delivery, their machinery being only in a few instances fully in use. While work has been coming to hand, there has been a disposition to accommodate buyers in the matter of price as much as possible. The steel makers have again had their quotations under review, and while the upward movement of raw iron would justify a further advance in prices, they decided in the meantime to accept prompt specifications at former figures. Steel angles are quoted £5 10s., ship plates £5 17s. 6d., and boiler plates £6 17s. 6d., all less the usual 5 per cent. discount for cash in one month, Clyde district delivery. It is not considered likely that these prices will be adhered to very long. Indeed, in certain circumstances, a little more money is being quoted.

The Coal Trade.

The coal market has a rather dull feeling on account of the heavy supplies. Shipments from the Clyde have been good, but they have fallen away considerably at some East Coast ports. House coal and coal for manufacturing purposes are in rather fuller demand, but prices are scarcely maintained.

WALES AND ADJOINING COUNTIES.

(*From our own Correspondent.*)

State of the Coal Trade.

This can be briefly described as unsatisfactory. A circular issued by the coalowners on Monday has caused a good deal of comment in trade circles. It has long been understood that the Eight Hours Act was neither approved of by master nor by man, and a conflict was most likely. The old authorities have for some time openly expressed their belief that as the term of the Conciliation Board expires in March, the constant reiteration of the men that a strike was likely at that time suggested that the relations between capital and labour were much strained, and, unfortunately, the representatives of the men did not appear to be inclined to pacific measures. As one of the coalowners argued, power more than pacification would seem to be their object. On Monday matters seemed to be approaching a crisis by the issue of the following circular by the coalowners:—"The Association yesterday at the general meeting fully considered the position which has arisen through the attitude taken by the men in obstructing the introduction of afternoon shifts at the collieries, except on payment of six turns for five afternoon shifts worked, the Association having already passed a resolution that no fresh payment shall be made. It was felt that the position calls for immediate action on behalf of the associated owners by the adoption of one or two alternatives, viz, the giving of notice on October 1st to all the workmen at the associated collieries, to terminate their contracts on October 31st, or the giving of such notices to the workmen at all collieries, where the owners desire to introduce afternoon shifts, and can only attain that object by the payment of six turns for five referred to. Notice will be sent to you in due course of a meeting of the Association to consider these alternative suggestions. The meeting will probably be held on either the 18th or 20th inst. I may add that at yesterday's meeting the opinion was expressed that the former alternative should be adopted, but I give you this early intimation in order that you may consider the question prior to the proposed meeting referred to, when a decision will be arrived at. So that the Association may be placed in a position to calculate what would be the effect of the adoption of the second of the proposed alternatives—if that be decided upon—will you kindly let me know whether your company would desire to give notice to the workmen at your collieries on the 1st of October to terminate their contracts, with a view to endeavouring to secure the afternoon shift.—Signed, W. G. Dalziel, Secretary." The issue of the circular is regarded as forerunning a crisis and perhaps the adoption of the 20th Rule, by which a partial or a general lock-out would be made. Little surprise has been expressed in the trading world of Cardiff at the resolute attitude of coalowners, but some regret that the men's leaders, who have long aimed at power instead of pacification, do not seek to bring about a peaceful understanding instead of "inflaming the passions of the men." In the meanwhile, the effect on trade is anything but satisfactory, and the possibilities of a rupture, and possibly strike, had its effect on the market. Long contracts were not easily adjusted at present figures. The market was steady and prices well sustained.

Latest Quotations, Cardiff.

Best large steam, 17s. 6d. to 18s.; best seconds, 16s. to 16s. 9d.; ordinary seconds, 15s. to 15s. 6d.; best drys, 16s. 6d. to 17s.; ordinary drys, 14s. to 14s. 3d.; best washed nuts, 14s. to 15s.; seconds, 13s. to 13s. 6d.; best washed peas, 12s. 6d. to 13s. 3d.; seconds, 11s. to 12s.; very best small steam, 8s. 6d. to 9s.; best ordinaries, 6s. 9d. to 7s. 9d.; inferior sorts, 6s. 3d. to 6s. 6d.; very best Monmouthshire black vein, 15s. 6d. to 15s. 9d.; ordinary Western Valleys, 14s. 9d. to 15s. 3d.; best Eastern Valleys, 13s. 3d. to 13s. 9d.; seconds, 12s. 9d. to 13s. Bituminous coal: Very best households, 16s. 6d. to 17s. 6d.; best ordinaries, 14s. 6d. to 15s. 6d.; No. 3 Rhondda, large, 17s. 3d. to 17s. 9d.; brush, 13s. 6d. to 13s. 9d.; smalls, 10s. 6d. to 11s.; No. 2 Rhondda, 11s. 3d. to 11s. 9d.; through, 9s. 6d. to 9s. 9d.; smalls, 7s. 9d. to 8s. 3d. Patent fuel, 15s. to 15s. 6d. Coke: Special foundry, 24s. 6d. to 28s.; foundry, 19s. to 22s.; furnace, 17s. 6d. to 18s. Pitwood, 19s. to 19s. 6d.

Newport Coal Prices.

Slightly more vigour is shown, but no advance in prices. Latest:—Best Newport black vein, 15s. 3d. to 15s. 6d.; Western Valleys, 14s. 9d. to 15s.; Eastern Valleys, 13s. 3d. to 13s. 6d.; other sorts, 12s. 6d. to 12s. 9d.; best smalls, 7s. 3d. to 7s. 9d.; seconds, 6s. 9d. to 7s.; other sorts, 6s. 3d. to 6s. 6d. Bituminous coal:—Best house coal, 15s. to 15s. 3d.; seconds, 14s. to 14s. 3d.; patent fuel, 15s. to 15s. 6d. Coke: Foundry, 18s. 6d. to 19s.; furnace, 17s. to 17s. 6d. Pitwood, 19s. to 19s. 6d.

Swansea Coal Trade.

Coal for Italy is having a fair run, but there is not much animation in business. Lower prices prevail with some descriptions. Latest:—Best anthracite, 24s. to 25s. net; seconds, malting large, 21s. 6d. to 22s. 6d. net; big vein, 18s. 6d. to 20s. 6d. net; red vein, 12s. to 12s. 6d., less 2½; machine-made cobbles, 23s. to 24s. net; Paris nuts, 25s. to 25s. 6d. net; French nuts, 25s. to 26s. net; German nuts, 25s. to 26s. net; beans, 17s. 6d. to 18s. net; machine-made large peas, 11s. 6d. to 12s. 6d. net; fine peas, 10s. to 11s. net; rubbly culm, 5s. to 5s. 6d., less 2½; duff, 3s. to 3s. 3d. net. Steam coal, best, 17s. to 17s. 6d.; seconds, 14s. to 15s.; bunkers, 9s. 6d. to 10s. 6d.; small, 8s. to 10s.; No. 3 Rhondda, 18s. to 18s. 9d.; small, 10s. to 10s. 6d.; patent fuel, 13s. 6d. to 14s., all less 2½.

Port Said and Wales.

The important part played by this port in the export of coal from Wales is shown by late returns which yield the fact that fully one-third of the coal sent to Port Said in 1908 was Welsh coal. This is principally used in coaling.

Large Contracts of Coal for 1909.

Among the contracts now being placed or to be arranged shortly are those of the Belgian State Railways. The authorities are inviting tenders for the supply of 120 lots of 5000 tons each of small steam, 5000 tons each of patent fuel, nine lots of 2500 tons of nut coal, three lots of 3500 tons of forge coal, and 500 tons of patent fuel. Delivery to begin in November, and extend into next year. Among important contracts to be decided are the Egyptian State Railways, the Madras, Saragossa, and Alicante Railway, and the White Star Line.

Iron and Steel.

The operations at Dowlais have for some time been regarded as a safe index to the trade in Wales, and when idle mills and furnaces are to be seen there the conclusion that trade is dull in Wales generally is accepted as correct. For some time these indications have prevailed, but last week there were signs of improvement, and on Sunday night lighting up began, and a tolerably good week was occupied with heavy and light steel rails. Fishplates, angle iron, and tin bars were also in evidence, and full time was the rule, much to the satisfaction of the men. Pig iron from Middlesbrough has been a feature in the imports, and one steel cargo from Bruges. That there is an upward movement in iron and steel is shown by an improvement in the coke trade, and one or two consignments have been made of late to foreign destinations. At the metal market the prospects of trade were regarded as more hopeful. Metals generally, and especially iron and steel, look strong, and an altogether higher basis of prices is quite possible next year. Latest prices:—Pig iron: Hematite mixed numbers, per ton, 61s. 4½d. cash and month; Middlesbrough, 51s. 3d. cash, 51s. 6d. one month; Scotch, 57s. 3d. cash and month; Welsh hematite, 63s. 6d. to 64s.; East Coast hematite, 63s. 6d. to 64s.; Siemens steel bars, £4 10s. per ton c.i.f.; Bessemer, same. Iron ore: Best Rubio, 15s. to 15s. 6d.; second class, 14s. to 14s. 6d. Cardiff or Newport as regards iron ore. Other quotations:—Copper, £59 cash, £59 17s. 6d. three months; lead, £13 5s.; spelter, £22 12s. 6d. per ton; silver, 23$\frac{13}{16}$d. per oz.

Tin-plate.

The buoyancy of trade continues in all quarters, and both in operations at the mills and in shipment strenuous work is perceptible. Last week the quantity of tin-plates received from the mills totalled 96,609 boxes; 106,771 boxes were despatched, and in dock warehouses and vans 180 boxes remain in stock. Good loadings are going on this week at Swansea. Latest prices at Metal Exchange:—Ordinary Bessemers, 12s. 1½d. to 12s. 3d.; Siemens the same; ternes 28 by 20, 112 sheets, Siemens, 21s. 6d.; C.A. roofing sheets, £8 7s. 6d. to £8 10s.; big sheets for galvanising, £8 10s. per ton; finished black plates, £9 10s. per ton; galvanised sheets 24 g., £10 5s. to £11 nominal per ton; block tin per ton, £136 12s. 6d. cash; £138 month.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

We have been notified that Mr. John W. Bainbridge has been appointed agent for London and district for Messrs. Wm. Arnott and Co., Coatbridge, N.B., manufacturers of Lancashire and Cornish boilers.

We are advised that the governors of Faraday House have appointed Dr. Alexander Russell, M.A. (Cantab), D.Sc. (Glasgow), M.I.E.E., Principal of that Institution, in succession to Mr. Hugh Erat Harrison, deceased.

We have been advised that Messrs. Alfred Herbert, Limited, Coventry, are opening an office in Berlin, where they will deal with inquiries received from Germany and Austria Hungary, for their machine tools.

We are informed that Mr. J. Bruhn, D.Sc., who was elected director of Det norske Veritas at an extraordinary meeting of the committee of that Institution in June of this year, entered upon the duties of that office on 1st September, 1909. Mr. J. Bruhn's address will in future be: Det norske Veritas, Christiania.

We are advised by Messrs. J. and E. Wright, Universe Works, Birmingham, that they have appointed their Mr. C. Bright to act as joint representative in South Wales with Mr. David Thomas, who has for the past twenty years represented the firm in that district. They also inform us that they are opening branch offices at Royal Chambers, Park-place, Cardiff.

The Board of Trade have recently confirmed the Halesowen Light Railways (Transfer, &c.) Order, 1909, transferring to a company the powers conferred upon the Rural Council of Halesowen by the Halesowen Light Railway Order, 1901, and by the Halesowen Light Railways (Extensions) Order, 1902, and amending those Orders.

NOTES FROM GERMANY, FRANCE, BELGIUM, &c.

(*From our own Correspondent.*)

Moderate Trade in Rheinland-Westphalia.

Though the condition of the iron market is quiet, and very little forward business is done, some establishments can boast of being well occupied, with fair prospects for future employment. On the whole, activity has been regular at the mills and factories, demand being better than prices, which have even become a shade easier in a few branches. Bars are quoted M. 95, in some instances M. 97 50 to M. 100 has been quoted, but producers cannot realise more. Generally, accounts are just a little more favourable as regards the tone of the market, and the slight improvement that was felt in the export trade has not been without influence on prices for foreign sales. The Gas and Water Pipe Convention has raised the quotations 1 per cent. from August 24th. Quotations for wire will remain unchanged during the fourth quarter, being M 127.50 p.t. for drawn wire; M. 142 to M. 145 p.t. for wire nail rods, and M. 157.50 to M. 160 p.t. for wire nails. There are symptoms of improvement in the wire trade. Representatives of the Saar, Luxemburg and Lorraine ironworks at a recent meeting resolved to raise bars that have hitherto been quoted M. 92 p.t. to M. 95 p.t. free Neunkirchen.

Fair Accounts from Silesia.

A pretty good business was reported to be done in raw and finished iron during this week and the last. Bar makers show much firmness in their prices and reserve as regards accepting fresh orders, a slight rise in quotations being contemplated for the first quarter in 1910.

List Rates.

The following are the current list quotations per ton at works:—Raw spathose iron ore, M. 10.90; roasted ditto, M. 15.50; Nassau red iron ore, M. 11.50 per ton at mines; spiegeleisen, 10 to 12 per cent. grade, M. 60 to 63; white forge pig, M. 55 to 58; iron for steel making, M. 54 to 56; German Bessemer, M. 56 to 58; basic, free place of consumption, M. 48 to 50; Luxemburg forge pig, free Luxemburg, M. 43 to 45; Luxemburg foundry pig No. 3, M. 45 to 47; German foundry pig No. 1, M. 54 to 56; No. 3, M. 53 to 55; German hematite, M. 55 to 57; good merchant bars, M. 95 to 100; the same in iron, M. 122.50 to 125; hoops, M. 120 to 122.50; common plates in basic, M. 103 to 110; boiler plates, M. 115 to 120; sheets, M. 118 to 125; steel wire, M. 127.50.

Coal and Coke in Germany.

For engine coal only a limited demand is experienced in the Rhenish-Westphalian district, while house coal meets with very good call. English, Belgian, and French competition has increased rather than otherwise, influencing prices most unfavourably, and there is little hope for improvement in the immediate future. A satisfactory business was done on the Silesian coal market, deliveries on local account being extensive; in coke, too, a fair trade is done.

Austria-Hungary.

Of the iron and steel trade in Austria-Hungary little can be told, except that prices have remained pretty firm, while sales, generally, continue regular, but small. The locomotive shops report themselves well supplied with Government orders up to the end of present year, some having secured work also for the early part of 1910. Nevertheless, they have already been trying to obtain further orders, and there is talk of 80 to 100 locomotives that are to be given out before long. Exports in locomotives have been very limited, quotations for foreign sales being most unsatisfactory, on account of the very keen Belgian competition. The tone of the coal market in Austria-Hungary is fairly strong; coke shows more animation than before, large contracts having been placed.

Firmness Increasing in Belgium.

The improvement that began to be felt a few weeks ago has continued in the principal trades, orders coming to hand pretty freely. Rates show more firmness than previously, because confidence increases slowly. In iron and steel articles employment must be termed satisfactory, and the monthly accounts given by the principal ironworks are more favourable than in last month. Girders continue to meet with good request for inland consumption; export remains very limited. The reverse is the case with rails, foreign demand increasing. Merchant bars remain firm at £4 9s. to £4 11s., both for iron and steel bars. The above is quoted for foreign sales, while for inland orders 120f. and 137.50f. p.t. are quoted for iron bars, and 117.50f. to 130f. p.t. for bars in basic. The coal market is steady, though the business transacted in house coal is less active than was anticipated; also for industrial purposes comparatively little is bought, and the briquette trade leaves very much to be desired.

AMERICAN NOTES.

(*From our own Correspondent.*)

New York, August 31st.

The legitimate demands for steel rails, which run close to three hundred thousand tons per month, including requirements for new enterprises, have fallen far below this average for the past twenty-two months. Within a few months the demands have increased, but they are still far below the average. Only two plants are working to capacity, and their orders cover a few months. Among recent orders are one from the Southern Pacific for 40,000 tons, of which 28,000 tons are to be made by the United States Steel Corporation and 12,000 tons by the Pennsylvania Steel Company. Rail makers think they have reason to believe that the general buying season will soon set in. The remarkable enlargement of capacity during the past year and the assurance of a fixed price relieves railroad people of all anxiety as to getting rails about when they want them. Hence there is no such anticipation of orders as was necessary during most of 1907 and previous years. The tariff agitation has temporarily subsided, to the relief of every manufacturing interest. The coming agitation is the establishment of a monetary or currency system which will ensure steadiness and avert the possibilities of a recurrence of such a panic as overtook the country in 1907, and which is now attributed to defects in our financial system. The most progressive railway system is that known as the Harriman system, covering 65,000 miles of road. Harriman, who has only recently returned from Europe, is unable to take the helm, and the Stock markets are disturbed over all manner of reports affecting the management of his roads. Under his general direction much building is under way and projected. The condition of traffic is fairly revealed in the fact that on May 1st last year there were in round numbers 500,000 idle box cars on American railroads. On August 18th the estimate was 159,424 cars. There are some 40,000 cars now standing for crop moving purposes in the north-west, and thousands are being hurried west. Copper shipments abroad for the first twenty-six days of August amounted to 19,500 tons; for the first twenty-two days of July, 22,600 tons. At present the home demand is moderate. Copper developments are in active progress at various points. Deposits of alleged enormous extent are to be reached by the construction of a railroad along Copper River. Electrical companies are large consumers of copper, but at present are supplied.

BRITISH PATENT SPECIFICATIONS.

When an invention is communicated from abroad the name and address of the Communicator is printed in italics.

When the abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent-office Sale Branch, 25, Southampton-buildings, Chancery-lane, London, W.C., at 8d. each.

The first date given is the date of application; the second date at the end of the abridgment is the date of the advertisement of the acceptance of the complete specification.

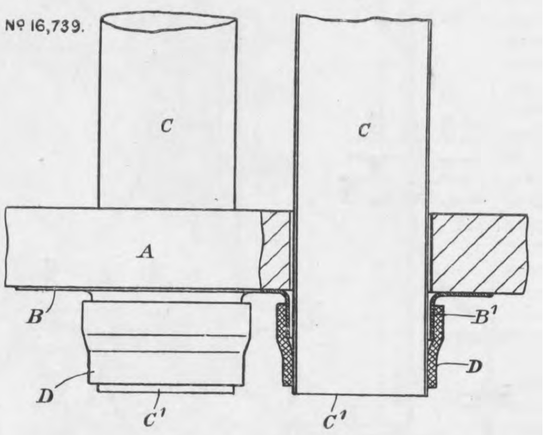
Any person may on any of the grounds mentioned in the Acts, within two months of the date given at the end of the abridgment, give notice at the Patent-office of opposition to the grant of a Patent.

STEAM ENGINES.

16,739. August 8th, 1908.—Improvements in India-rubber Packings for the Tubes of Surface Condensers and similar Tubular Apparatus, *Otto Dresen, of 25, Schützengasse, Reichenberg, Bohemia, Austria.*

A is a portion of a tube-plate of a tubular apparatus, for instance, of a surface condenser. This tube-plate is perfectly flat, that is to say, it has no annular projections cast in one piece with the plate or tube pieces riveted therein. But there are annular projections B¹ formed out of a sheet-metal plate B arranged in front, or at the outside of the plate A. The tubes C project beyond the projections B¹ and pieces D of india-rubber hose fit over the ends C¹ of the tubes C, as well as over the projections B¹, just as they did in the old form previously mentioned. Thus it will be seen that single or separate packings, *i.e.*, pieces of india-rubber hose, are used in connection with a flat or plane tube-plate such as A, the distinction between this invention and that method in which united packings formed by a perforated plate, through which the tube ends pass and used in connection with a flat tube or plate, being obvious.—*August 18th*, 1909.

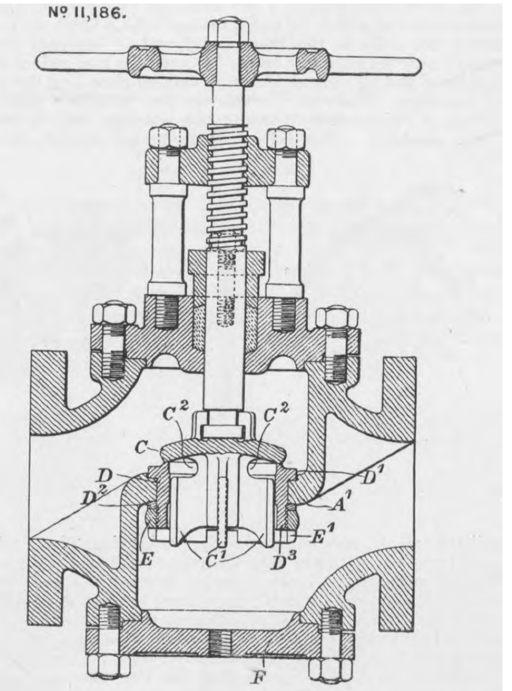
Nº 16,739.



11,186. May 11th, 1909.—Improvements in or relating to Stop Valves, Thomas Joseph Noakes, of Thomas Noakes and Son, Limited, of 4 and 5, Osborne-place, Brick-lane, E.

C represents the valve. D is the seating, which is provided with a flange or collar D¹ and is a tight fit in the socket portion A¹ of the valve body, the joints preferably being faced and touched with an appropriate paint to make a steam-tight joint. D² is a metal washer and E is a ring nut screwing on to the lower end D³ of the valve seating. The nut E is provided with lugs or preferably with an annular extension E¹ having recesses in it by which with an appropriate tool the nut E can be screwed up so as to draw the flange D¹ of the seating firmly down upon the portion A¹ of the valve body. The valve C has wings or vanes C¹ fitting within the seating D, and each vane C¹ is recessed as at C² at its upper end under the valve head, it being found that with this arrangement less scoring action of the steam upon the valve faces is obtained, and a modified swirling motion may be imparted to the steam. To give easy access to the valve and especially to the nut E, the valve body is provided at its lower part with a detachable cover F preferably circular and concentric with the axis of the valve and spindle. By the removal of this cover and the top cover, the valve can be got at and the valve seating removed.—*August 18th*, 1909.

Nº 11,186.

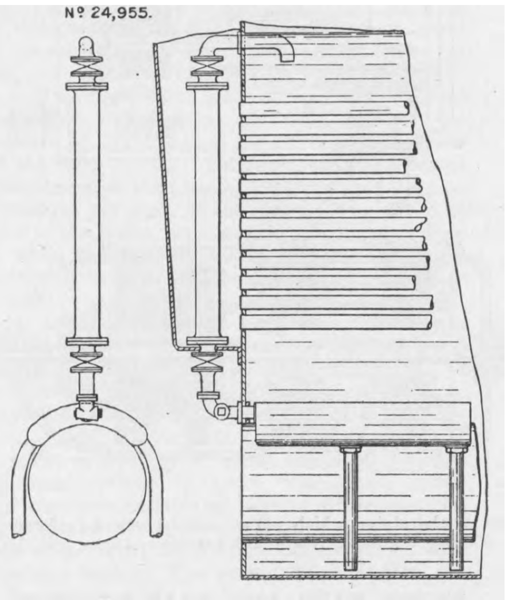


STEAM GENERATORS.

24,955. November 20th, 1908.—An Improved Water-circulating Apparatus for Steam Boilers, Charles Edington, of 61, Rowallan-gardens, Broomhill, Partick, Glasgow.

According to this invention there is arranged a saddle or other shaped chamber or chambers—or a pipe or pipes or the like or a combination of a pipe or pipes and a chamber—which is or are provided with one or more depending open-ended pipes extending down into the cold water space of the boiler. Arranged in the smoke-box of the boiler is a second chamber (or chambers) or a pipe or series of pipes or a combination of chambers and pipes which are connected, on the one hand, by one or more pipes to the saddle chamber or chambers, and, on the other hand, by one or more pipes with the steam or hot water space of the boiler. There are four other drawings.—*August 18th*, 1909.

Nº 24,955.

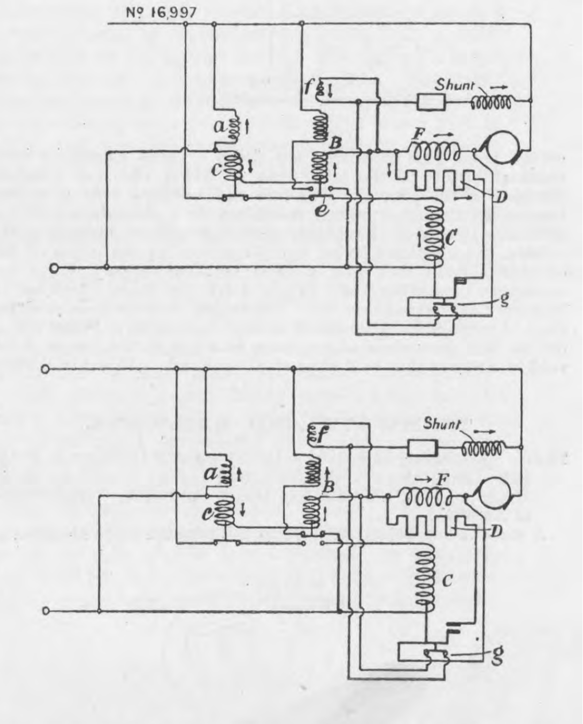


DYNAMOS AND MOTORS.

16,997. August 12th, 1908.—Improvements in and relating to the Control of Dynamo-electric Machines, the British Thomson-Houston Company, Limited, of 83, Cannon-street, London, E.C., and Frederick William Carter, of 223, Clifton-road, Rugby.

This invention relates to the control of dynamo-electric machines, and more particularly to compound wound traction motors, adapted to be run as generators while the vehicle is coasting or reducing its speed so as to return energy to the line. The object is to so arrange the controlling mechanism that when an overload occurs the motor will be provided with a full series field so as to bring down the speed, and also that the shunt field will be opposed by a full series field when the motor begins to act as a dynamo and generate current. During normal operation the position of the relays and contactor is as illustrated in the upper engraving. The contactor operated by the coil C is closed, thus establishing a shunt circuit about the series field F of the motor through the diverter D. If, however, an overload occurs in the circuit the overload relay B will operate and cause the bridging contact *e* to break the circuit of the coil of contactor C as illustrated in the bottom engraving. The contactor therefore opens and breaks the short circuit about the series field, at the same time bridging the contacts *g* and short-circuiting the coil *f*. The direction of the current through the coils is indicated by the arrows. When the motor is acting as a generator the direction of current through the coil *c* is reversed, and this coil assists coil *a* and causes the relay to operate, thereby breaking the circuit through the coil of contactor C and short-circuiting the coil *f*. There are three illustrations.—*August 28th*, 1909.

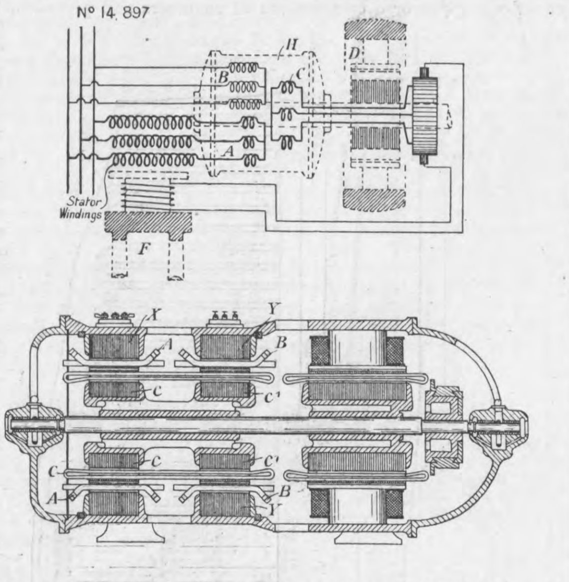
Nº 16,997



14,897. July 14th, 1908.—Improved Method of and Apparatus for Compounding Alternating-current Generators, *Dr. Max Breslauer, of 40, Uhlandstrasse, Berlin.*

The exciter H, D, consists of a part H built and wound after the manner of an asynchronous motor, and of a continuous current machine D; and these are mechanically coupled together, the armature of the latter being also electrically connected to the rotor of the former at suitably situated points. The stator of the asynchronous part is built in two parts; the one, X, being excited through windings A by the current, and the other, Y, through windings B, excited by the voltage of the main generator F. A voltage will be produced in the windings C of the rotor of the asynchronous part proportional to the geometrical sum of the two fields produced respectively by the current and by the voltage. The field produced by the current or that produced by the voltage may be arranged to predominate as may be desired according to the armature reaction of the main generator. Instead of the actual current and voltage, portions of them, which must be nearly proportional and cophasal, can be employed. The rotor of the asynchronous part of the cascade converter may preferably consist also of two parcels of laminations c and c^1 corresponding with

Nº 14. 897



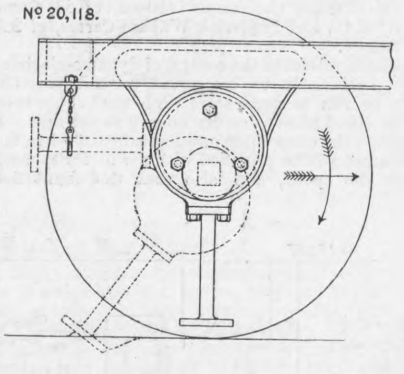
those of the stator, which parcels can be wound preferably with one winding C going through both parcels.—*August 18th*, 1909.

MOTOR CARS AND ROAD TRAFFIC.

20,118. September 25th, 1908.—IMPROVED MEANS FOR PROPELLING MECHANICALLY-OPERATED VEHICLES ON SLIPPERY ROADS, James Golby Barford and John Edward Sharman Perkins, both of Queen-street Ironworks, Peterborough.

The object of this invention is to provide means for propelling mechanically-operated vehicles in situations where, owing to the slippery condition of the road, the coefficient of friction between the wheels and the surface of the road is not sufficiently high to enable them to be propelled in the ordinary manner. The vehicle is ordinarily propelled by the revolution of the main wheels, but on the main axle excentrics are fitted. These excentrics have excentric straps, to the lower side of which rods are attached reaching to the ground. The free end of these rods have feet formed on them to provide suitable points of contact with the ground. In case of the wheels revolving without propelling the vehicle, these feet are forced into the ground by the action of the excentrics until they find a fixed point of support, when the excentrics continuing their action, drive the vehicle forward or backward as the case may be. The length of these rods is either fixed or adjustable by means of cotters or screws. When not in use the feet are suspended by chains attached to the frame of the vehicle, and are thus held clear of the ground.—*August 18th*, 1909.

Nº 20,118.

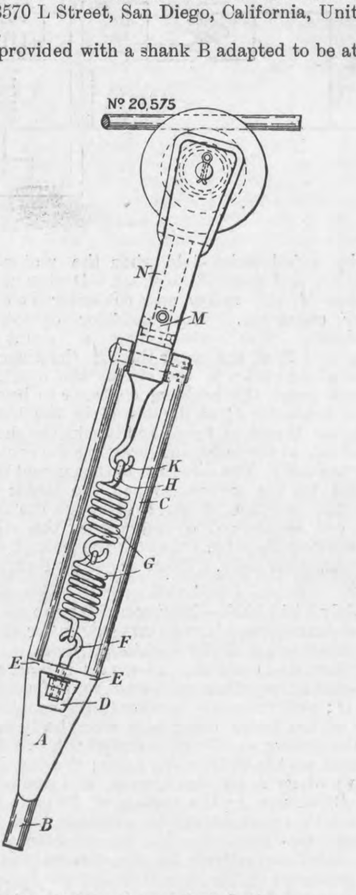


TRAMWAYS AND RAILWAYS.

20,575. September 30 h, 1908.—IMPROVEMENTS IN TROLLEY POLES FOR TRAMS AND LIKE ELECTRICALLY-DRIVEN VEHICLES, Solon Bryan, of 3570 L Street, San Diego, California, United States of America.

A stock A is provided with a shank B adapted to be attached to the trolley pole by means of a socket and set-screw or similar device. The stock is bifurcated to form two parallel arms C, below which is an aperture D which forms a bridge E. A hook F is fitted in the bridge, between the arms, and is adjustably retained in place by nuts within the aperture D. The hook F engages one end of two coiled springs G which are linked together end to end, the remaining end H being engaged by a hook K which is mounted transversely between the ends of the parallel arms on a pivot. This hook projects beyond the arms, in alignment therewith, and has a shank M for attachment to the socket N of the trolley-wheel fitting, or a continuation of the pole when the device is applied intermediate to the ends of the pole as before mentioned. By the employment of two springs linked together, resiliency is increased and, consequently, strong springs can be used. The hook K is kept in alignment with the attachment by the tension of the springs, but can rock upon its pivot when the strain is applied sidewise to the pole. The tension of the springs can be regulated by means of the nuts on the lower hook.—*August 18th*, 1909.

Nº 20,575

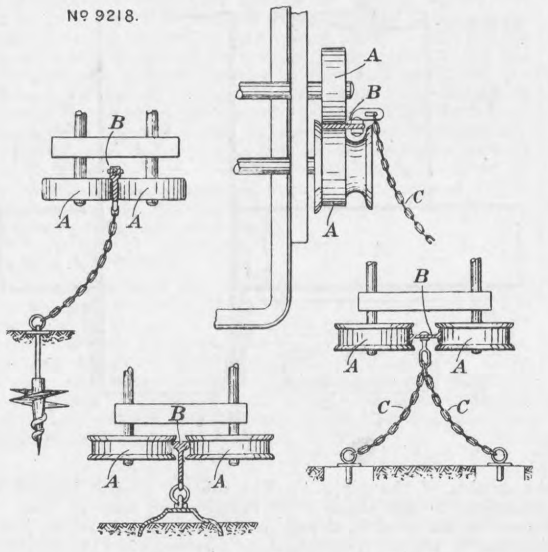


SHIPS AND BOATS.

9218. April 19th, 1909.—IMPROVEMENTS IN SHIPS' TOWING AND PROPELLING SYSTEMS, *Richard Koss, of* 28, *Steinfurter Strasse, Münster* (*Westphalia*), *Germany.*

This invention relates to a ship's towing and propelling system of that class in which ships are guided and propelled by means of rolling apparatus frictionally engaging bars or rails. Modifications of the method of carrying this invention into effect are illustrated in the accompanying engravings, in all of which movable anchoring means, such as ropes, chains, rods and the like, are adapted for fastening the guiding means, whilst affording same the required freedom of motion. The towing devices which are secured to floating vessels are composed of rolling apparatus, which traverse the guiding means with artificial adhesion. In the different forms of construction shown A are driven rollers constituting the rolling apparatus connected to the floating vessel and which draw the metal guiding means B in between them by pressure, such guiding means being connected to the bed of the water way by flexible connections, such as ropes or chains C, or by a rod with eye connection C^1 as in the bottom left-hand engraving, and which affords the required freedom of motion of such guiding means in relation to the bed.—*August 18th*, 1909.

Nº 9218.

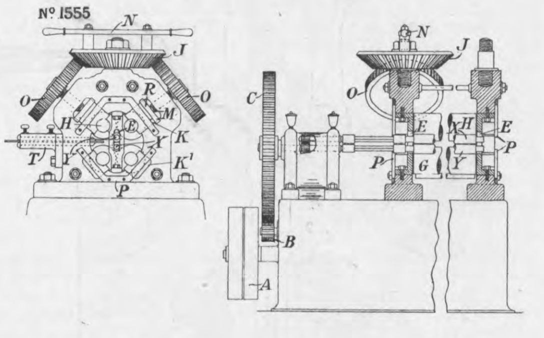


MACHINE TOOLS AND SHOP APPLIANCES.

1555. January 21st, 1909.—IMPROVEMENTS IN ROLLING MILLS, *Edouard Mathey Fils, of Neuville, Switzerland.*

The two working rolls X Y are actuated by means of a pulley A geared with the pinion B, which meshes with a large spur wheel C driving the rolls at the same speed and in opposite directions through gear enclosed in a casing between the two pedestals. The journals of the rolls are mounted in vertical slots E in the frame of the machine. The roll Y rests on two auxiliary rolls G, the journals of which rotate in two bronze bearings fixed in the frame of the machine. The roll Y is supported against two other auxiliary rolls H, held in position by two bearings K and K^1, which can be moved at right angles to the geometrical axis of the auxiliary rolls. The bearings K are made of bronze, and each carries a tempered forge steel plate R which bears against the lower end of a screw-threaded spindle M. The other end of this spindle carries a gear wheel o that engages with a bevel wheel J. On operating the wheel J, by means of the horizontal lever N, the two wheels o are rotated simultaneously, so that the two bearings are always moved in a position that is symmetrical to the vertical plane passing through the geometrical axes of the two working rolls. Guides P prevent the bearings K and K^1 from moving laterally. T is a guide for the work.—*August 18th*, 1909.

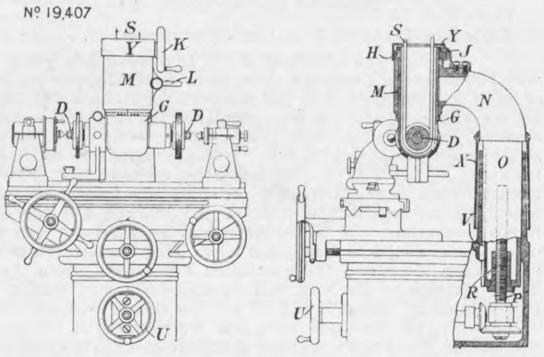
Nº 1555



19,407. September 15th, 1908.—IMPROVEMENTS IN GRINDING MACHINES, *Subo Nikoloff, of* 1025, *Southbridge-street, Worcester, Massachusetls, United States of America.*

The object of this invention is to provide improved means for the adjustment of the grinding wheel. Attached to the upper end of the sleeve G is a worm gear wheel H engaged by a worm J, provided with a hand wheel K, by which the sleeve G is rotated to rotate the grinding wheel shaft D in a horizontal plane about the axis of the sleeve. The bearing M is cut apart and clamped upon the sleeve G by a screw L to hold the sleeve in its adjusted position. The bearing is supported on the end of a curved overhanging extension N of a spindle O, which is capable of a sliding movement in a hollow post by means of a screw P working in a nut R and rotated by mitre gears, shaft and hand wheel U. The spindle O is held from rotation by a key V. A sleeve X attached to the spindle O extends downwardly over the hollow post to prevent the admission to the bearing surface of the spindle O of dirt or grit which may be produced by the adjacent grinding wheels. A plate Y covers the top of the bearing and the worm gear, and has an opening to admit a driving belt S connecting a driving shaft. A rotating movement of the sleeve G by means of the hand wheel K adjusts the axis of the grinding wheel shaft D, relatively to the axis of the work held between the centres, and

Nº 19,407



the twist imparted to the driving belt by any ordinary adjustment is slight, as the axis of the sleeve G passes through the centre of the driven pulley.—*August 18th*, 1909.

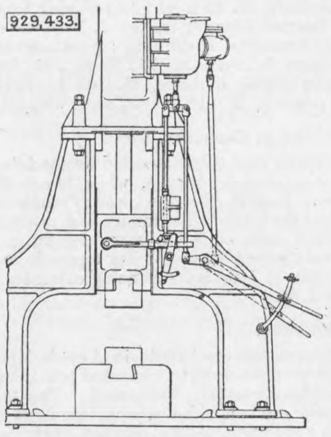
SELECTED AMERICAN PATENTS.

From the United States Patent-office Official Gazette.

929,433. STEAM HAMMER, *T. E. Holmes, Sheffield, England, assignor to Davy Brothers, Limited, Sheffield, England, an Incorporated Company.—Filed June 24th*, 1908.

This is a combination patent for improvement in details. It refers to hammers of the self-acting and manually controlled type with a so-called handling lever pivoted to the top. A floating lever is pivoted at an intermediate point of its length to the slide valve spindle, a guide sleeve for the driving lever is fulcrumed at a stationary point, and connecting-rods couple the opposite ends of the floating lever to the guide sleeve and handling lever respectively, the fulcrum of the guide sleeve can be made at will to coincide axially with the pivot connection between this sleeve and the connecting-rod whereby it is coupled to the floating lever. There are four long claims.

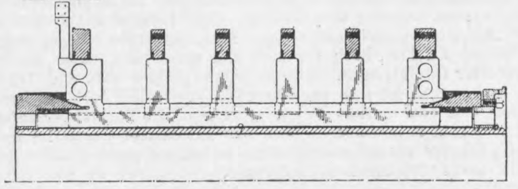
929,433.



931,130. COMMUTATOR FOR DYNAMO-ELECTRIC MACHINES, *B. G. Lamme, Pittsburg, Pa.—Filed October 7th*, 1908.

This patent is for a commutator comprising a bushing or cylinder, a plurality of notched bars or segments disposed on the surface thereof in radial planes to form annular projections and means for establishing ventilating passages longitudinally adjacent to the surface of the bushing and radially between the annular projections. There are five claims.

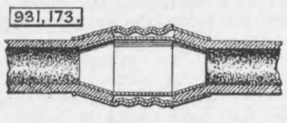
931,130.



931,173. COUPLING, *J. G. Zimmerman, Milwaukee, Wis.—Filed June 25th*, 1906.

This patent relates to a hose coupling, comprising a resilient sheet metal spreader having a cylindrical centre portion with a bore larger than that of the hose to be coupled, and having conical ends integral therewith and forming abutments for the hose ends, and a plurality of pressed sheet metal caps each having a resilient conical portion for holding a hose end against one of the abutments, the caps having cylindrical portions with shallow helical swages of rounded outline pressed therein which interlock to hold said caps in position. There are two claims.

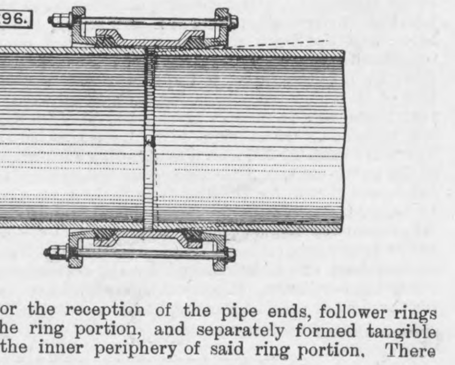
931,173.



931,296. PIPE COUPLING, *W. H. Hammond, Pittsburg, Pa.—Filed July 24th*, 1908.

According to this patent a pipe coupler is employed, comprising a ring portion for the reception of the pipe ends, follower rings coacting with the ring portion, and separately formed tangible lugs welded to the inner periphery of said ring portion. There are three claims.

931,296.



THE WATERWAYS AND WATERFALLS OF FINLAND.*

WHEN one says that between 11 and 12 per cent. of the area of Finland is water surface, this statement conveys no true idea to those not familiar with the actual proportions between land and water in other countries. A glance at the map shows the country to be intersected everywhere and in every direction by great rivers and enormous expanses of lake. These lakes, rivers, and artificial waterways are seen on the map published with the previous article upon the Finnish railways, and here reproduced. The lakes are ramified in the most tortuous and intricate fashion, each system of interconnected lakes being often several hundreds of miles in length. Examination of large scale maps shows that these lakes are thickly strewn all over with innumerable small islands. Both in the lakes and in the rivers the depth of water varies continuously through quite short reaches and through extraordinary ranges of depth. The geological origin of this strange configuration cannot be discussed here. But its practical, industrial, and economic results are very great. The rivers are a series of great, deep, quiet pools alternated with tempestuous torrents sweeping wildly over rugged ridges of granite rock. The navigable channels through the lakes are excessively narrow and tortuous, and in order not to be dangerous require to be staked out all along the routes, the rocky irregularity under water level being as great as that above it. These course-stakes are swept away every year, the ice forming over the whole lake surfaces to thicknesses of from 6ft to 10ft., so that the courses have to be marked out afresh every "spring," which, in Finland, means the month of May. The rapids on the rivers are, fortunately, most of them, navigable for cargo barges and floated timber, although the navigation requires much skill and intimate local knowledge. The Government has done during last century an immense deal to improve these waterways and facilitate navigation (1) by the construction of up-stream towing roads and the clearing of the more dangerous parts of the river channels, and (2) by the building of intercommunication canals.

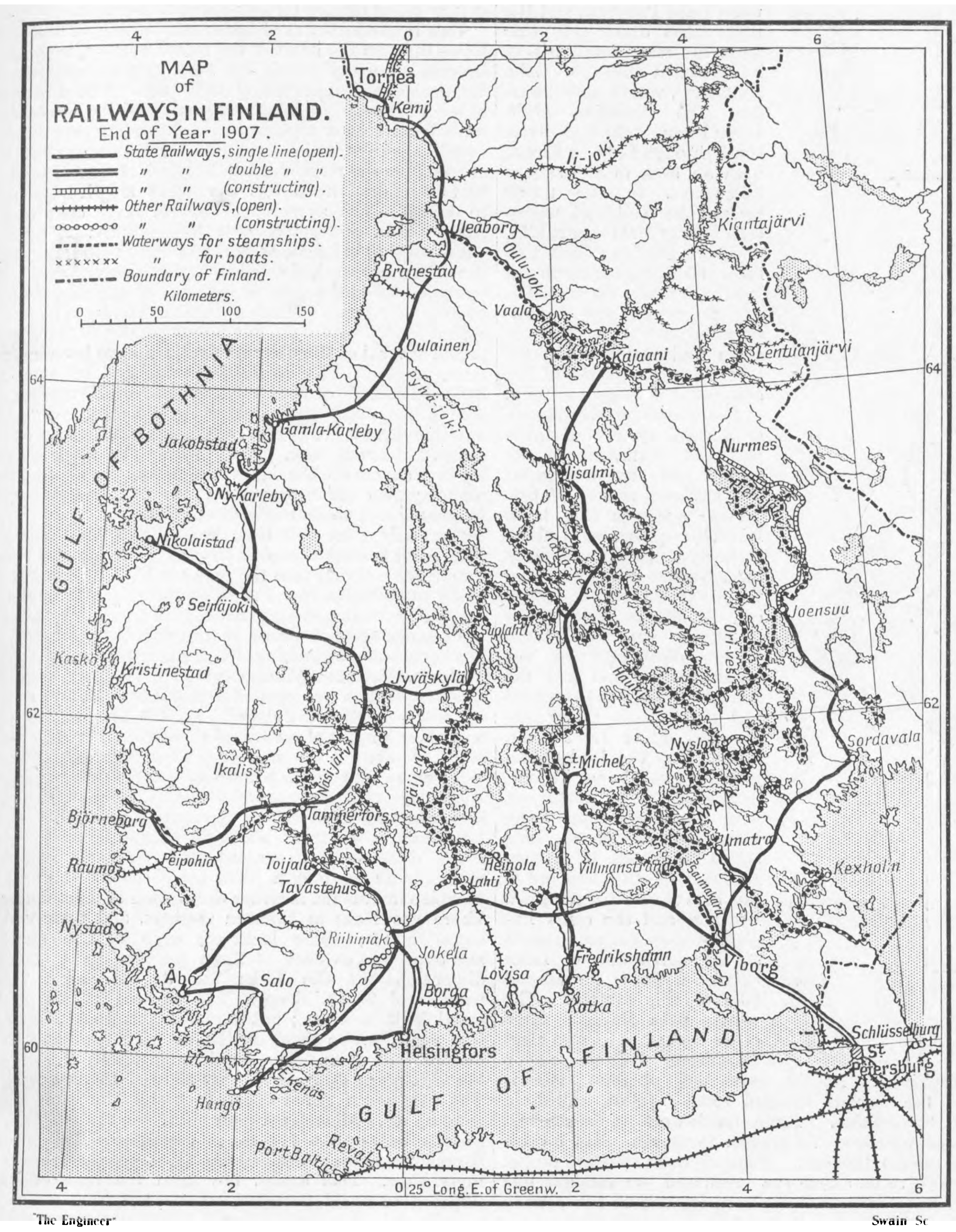

MAP of RAILWAYS IN FINLAND.
End of Year 1907.
State Railways, single line (open).
" " double " "
" " (constructing).
Other Railways, (open).
" " (constructing).
Waterways for steamships.
" for boats.
Boundary of Finland.
Kilometers.
0 50 100 150
GULF OF BOTHNIA
GULF OF FINLAND
Tornea
Kemi
Ii-joki
Uleaborg
Kiantajärvi
Oulu-joki
Vaala
Brahestad
Oulainen
Kajaani
Lentuanjärvi
Gamla-Karleby
Jakobstad
Nykarleby
Nikolaistad
Nurmes
Iisalmi
Seinäjoki
Kaskö
Kristinestad
Jyväskylä
Suolahti
Joensuu
Ikalis
St Michel
Nyslott
Sordavala
Björneborg
Tammerfors
Raumo
Peipohja
Toijala
Tavastehus
Heinola
Lahti
Villmanstrand
Imatra
Kexholm
Nystad
Riihimaki
Jokela
Fredrikshamn
Lovisa
Viborg
Åbo
Salo
Borgå
Kotka
Schlüsselburg
Helsingfors
St Petersburg
Ekenäs
Hangö
Reval
Port Baltic
25° Long. E. of Greenw.
The Engineer
Swain Sc

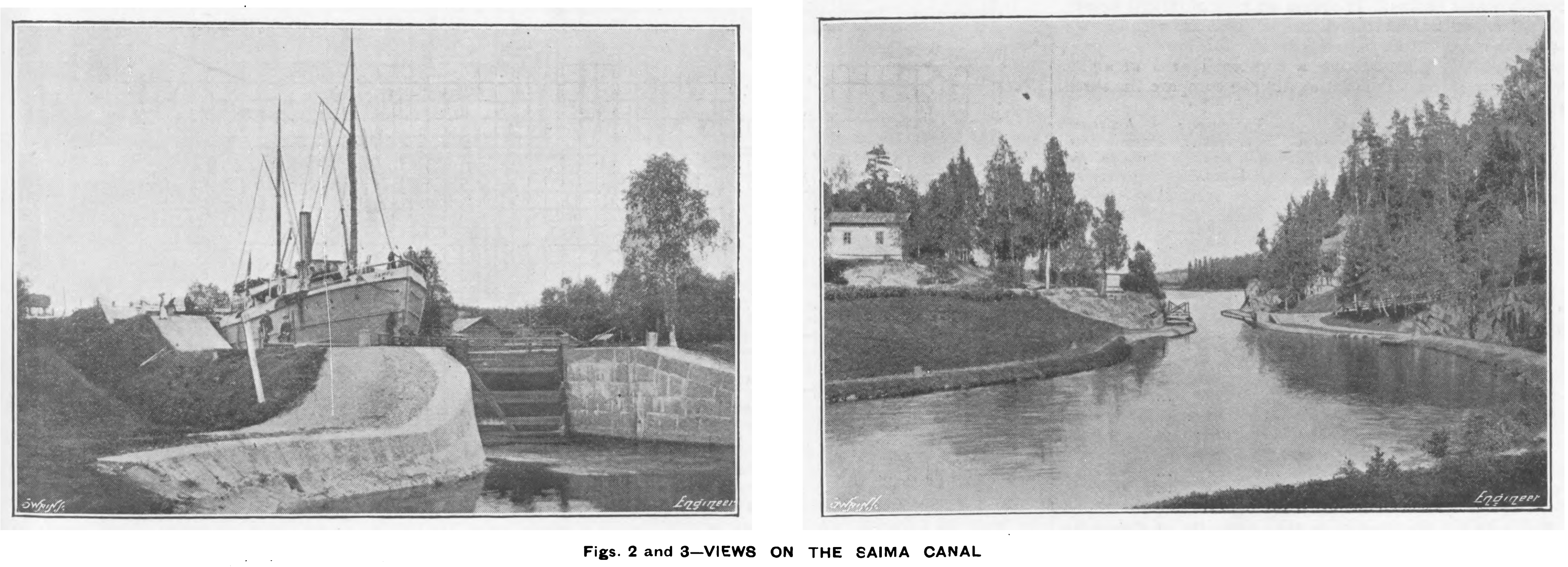
Fig. 1—THE RAILWAYS AND WATERWAYS OF FINLAND

In the extreme north there are many very large rivers, such as the Ivalo, running to the Arctic Ocean; the Luiro and the Ounas, which join the great Kemi, running into the northernmost shore of the Gulf of Bothnia; but the first of much industrial importance is the Uleo, or Oulin, which, with its series of big lakes, runs a length of 300 kiloms. and drains a basin 200 kiloms. broad. Great quantities of timber and of grain come from and past the important town of Kajana and down these rapids to Uleaborg at the river mouth. The improvements on this channel, commenced as long ago as 1824, result in the passage of 1600 barges per year. This sucess is achieved at some expense to the State, because the tolls exacted yield only 1580f., while the costs are 7000f. No one can doubt the good policy of encouraging the traffic at the expense of £200 or £300.

The middle and south part of Finland is divided into three great water basins. The furthest west is that drained by the river Kumo, entering the sea at Björneborg. The gathering ground has an area of 34,000 square kilometres. Its upper part is formed by a northern branch containing the lake Näsi, which is over 100 kiloms. long, and by a southern branch, over most of which stretches the very complicated ramifications of Lake Vanajavesi. The confluence of these two has created the city of Tammerfors, the busiest centre of the existing spinning and weaving trades and one of the most important centres of the timber and paper-making trades. The manufacturing industries of Finland had their origin at Tammerfors, which still takes the lead in this respect. It owed its first success to the water-power yielded by the river, which, however, has long since been surpassed by the needs of the mills, most of which are now steam driven. At the southern extremity of this Kumo water basin lies the important commercial town of Tavastehus.

To facilitate navigation in this basin the State has constructed no less than eight canals of a total length of 730 kiloms., their minimum depth being generally 1.8 m. The amount of traffic may be gauged by the fact that through three of these canals over 4400 ships and barges pass annually. Here again the tolls levied fall short of the working expenses.

The rapids at Tammerfors have a fall of 18 m., and the volumetric flow of the river varies from an average of 63 cubic metres at low water to an average of 164 cubic metres per second in times of flood. The middle basin is that of the Kymmene River, which drains the great Lake Päijänne, whose ramifications stretch over a district measuring 250 kiloms. from north or south, as also the Kivijärvi series of lakes to the south-east, and half a dozen large lakes lying between these. The gathering ground of this water system is 36,000 square kilometres, a little larger than that of the Kumo River. The lake Päijänne has itself an area of 1142 square kilometres. The river Kymmene has a mean volumetric flow varying between 180 and 450 cubic metres per second at low water and in flood. This range of discharge corresponds to a change of level of about 1.7 m. in Lake Päijänne. The lake lies 78 m. above sea level, but it is on the middle and lower reaches of the river, after it has passed through several large lakes, that the falls useful for power generation are found. At nine different points power stations have been built, used chiefly for wood pulp and spinning mills. The more important of these falls are Voikka, with a fall of 6.6 m. and 9240 horse-power in the water; Kuusankoski, with 9.5 m. fall and 13,300 water horse-power; Myllykoski, with 3.6 m. fall and 5040 water horse-power; Anjala, with 7.8 m. fall and 10,900 water horse-power; and Kelttis, with 5.1 m. fall and 7140 water horse-power. The last named is not yet utilised at all, and most of the others only partially. A portion of the water at Anjala, on the east side, is used for power in mills, but the west side, which belongs to the State, is not yet utilised. Except at special places, the banks are low-lying, and the lands on either side of the lower reaches are regularly covered in flood times to the extent of $\frac{3}{4}$ square kilometre. Considerable sums have been expended in building retaining embankments in the neighbourhood of rapids, but these have proved inefficient in preventing floods on the surrounding lands, and new works with this object are projected. To improve the water communications throughout the area of this basin five canals have been built of a total length of 600 kiloms., the standard low-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Figs. 2 and 3—VIEWS ON THE SAIMA CANAL

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* See the "Development of the Industries of Finland," THE ENGINEER, September 3rd, 1909, and "Finnish Railways and their Electrification," THE ENGINEER, September 10th, 1909.

water depth being 1.8 m. With one exception, these are worked at a loss to the State, the exception being that connecting the lakes Vesijärvi and Päijänne. This canal has a length of only 1.3 kiloms. and a depth of 2.1 m. Its construction was finished in 1871. It passes 4300 ships per annum, and the receipts exceed working expenses by an average of £750.

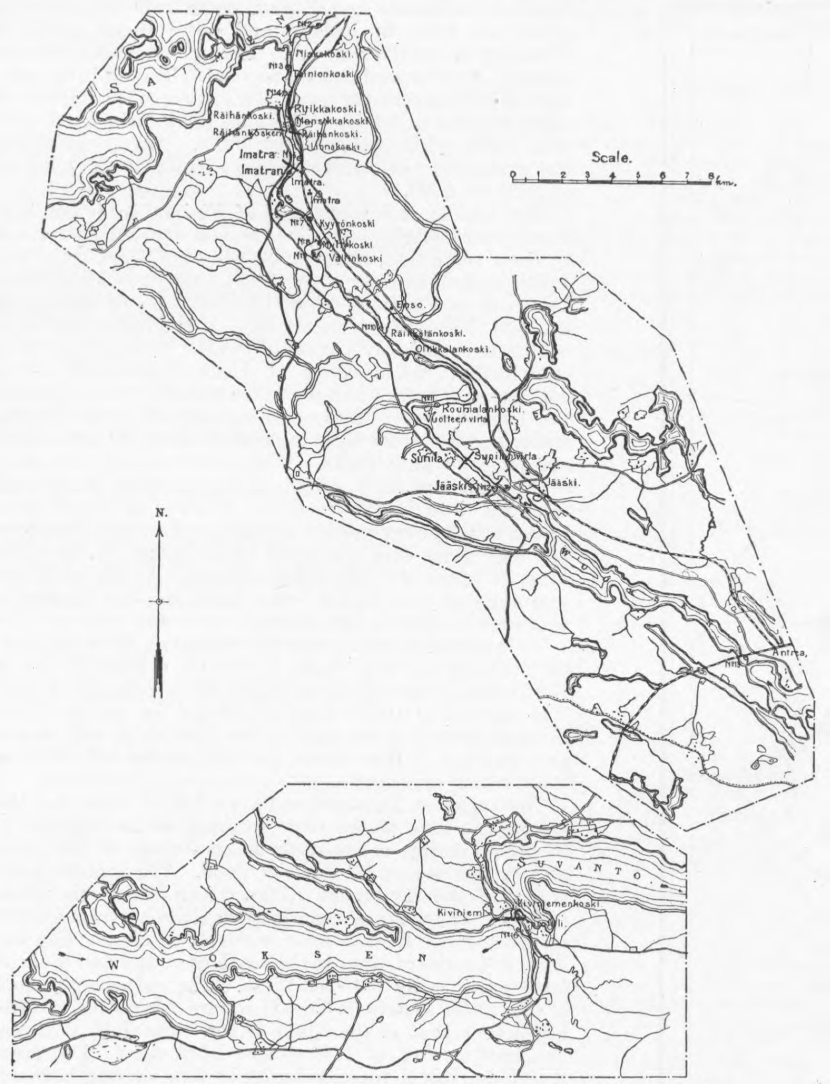


Fig. 4—THE WUOKSEN RIVER

Between four and five million logs of timber are brought down this Kymmene River per year. It was not until 1868 that anyone thought it possible to float the timber down over the waterfalls without destroying its value, and not until 1873 that such flotation was successfully organised, thanks largely to the enterprise of Consul Ahlqvist, and the timber and general merchants, Hackman and Co. Latterly, in order to prevent floating timber from entering the mill-races at Anjala Falls, there has been erected a huge fence or barb-grating, 630ft. long, and slung from fourteen barges, dipping 3ft. under the water surface. In the nineteen years preceding 1907 the number of logs floated down to the mouth of the river increased from 1¼ million to 3½ millions per year, while another million are used annually by the mills on the river itself.

The great water basin covering the south-east of Finland drains itself into Lake Saima, from which the sole outflow to the sea, or rather to the Russian Ladoga, is by the river Wuoksen. This is by far the largest of the Finnish water basins. It covers an area of 60,200 square kilometres, or 24,000 square miles—that is, a square of 155 miles side. More than one-fifth of this area is covered with lakes, the lakes having a combined area of about 5000 square miles. It is interesting to compare the three great basins thus:—

	Water basin area. Sq. kiloms.	Percentage covered by lakos.	Average water flow discharged by river. Cubic metres per second.
Näsijärvi-Kumo	34,000	13·3	300
Päijänne-Kymmene	36,000	19·3	300
Saima-Wuoksen	60,000	20·8	570

Another interesting and important comparison relates to the proportions between low-water, average, and flood-time discharges:—

	Discharge cubic metres per second.		
	Mean low water.	Annual average.	Mean flood water.
Kumo	160	300	570
Kymmene	180	300	450
Wuoksen	480	570	660
	Ratios.		
Kumo	·53	1	1·90
Kymmene	·60	1	1·50
Wuoksen	·84	1	1·15

These figures are given on the authority of Governor Max Alfthan's interesting Mémoire upon the Kymmene River read before the Geographical Society of Finland in April, 1908. The similar ratios for the Rhine are given by Governor Alfthan as .5, 1, and 4.5, and for the lower reaches of the Oder as .35, 1, and 4.7; showing that the seasonal variation in Finnish rivers is very low in comparison with central European rivers. On the Wuoksen River it is only 15 per cent. up and down from the mean.

The three systems of great lakes whose waters are all finally gathered into Lake Saima and discharged by the Wuoksen are too complicated to describe here in detail. The westernmost system begins with a network of seven lakes north and west of the town Iisalmi. This town is only 83 kiloms. south of the town Kajana, the water system of which discharges westwards at Uleaborg, and the watershed of the Saima basin is only 30 kiloms. from Kajana. Iisalmi is situate upon Lake Porovesi, and the lakes that drain into this from the west reach within half-a-dozen miles of Lake Pyhäjärvi, which also drains into the Bothnian Gulf. From Porovesi the waters run south through Lake Onkivesi, with an area of 140 square kilometres, to the much larger lake Kallavesi, whose area is over 1000 square kilometres. Halfway down this lake, 85 kiloms. south of Iisalmi, stands the industrially important and beautifully situated town Kuopio. Lake Kallavesi has a water level 82 m. above that of the sea, and it is 90 kiloms. long.

The waters of the second, or middle, system of lakes join the Kallavesi at its middle and southern parts. The northern branch of this system contains four large lakes, the uppermost of which is the Syväri, and its southern branch seven still larger lakes, the Suvasvesi being the greatest, 50 kiloms. long. The Kallavesi with all these waters discharges by the rapid Konnuskoski and the Konnus Canal, Lake Unnuka, and the Taipale Canal into the still larger Lake Haukivesi. Here the third system joins the two others. It commences in the far north-east with the enormous Lake Pielsijärvi, 100 kiloms. long and 1100 square kilometres in area. At the north end of this lake is situated the town Nurmes, and the other important town Joensuu stands at the north end of Lake Orivesi, which is the second lake of this system. The waters pass through three other lakes of first-class magnitude before pouring into Haukivesi. At the south end of this latter is situated the famous fortified town Nyslott, called in Finnish Savonlinna. From north-west to south-east Haukivesi measures 70 kiloms. in length. Its level is 81.3 m. above the sea. That of Lake Saima proper averages 75.9 m. above sea level, and the straight line distance from Nyslott at the northern end of the lake to Willmanstrand at its southern end is 100 kiloms. Although its north-eastern ramifications receive special names, this sheet of water measures 130 kiloms. from north-east to south-west and 100 kiloms. from north-west at the ancient town St. Michel to south-east at Wuokseniska, which is the name of the small town where the river Wuoksen flows out of the lake. This widespread water surface is thickly strewn with an uncountable number of islands and long straggling peninsulas, which make its waterways for ships extremely tortuous.

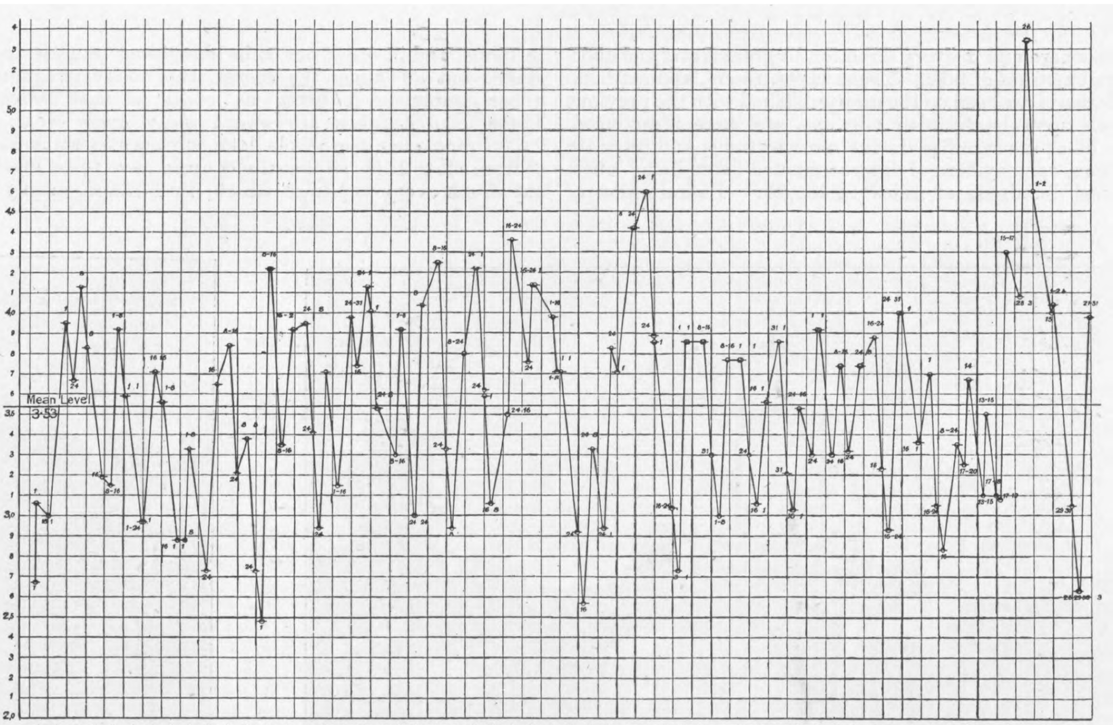


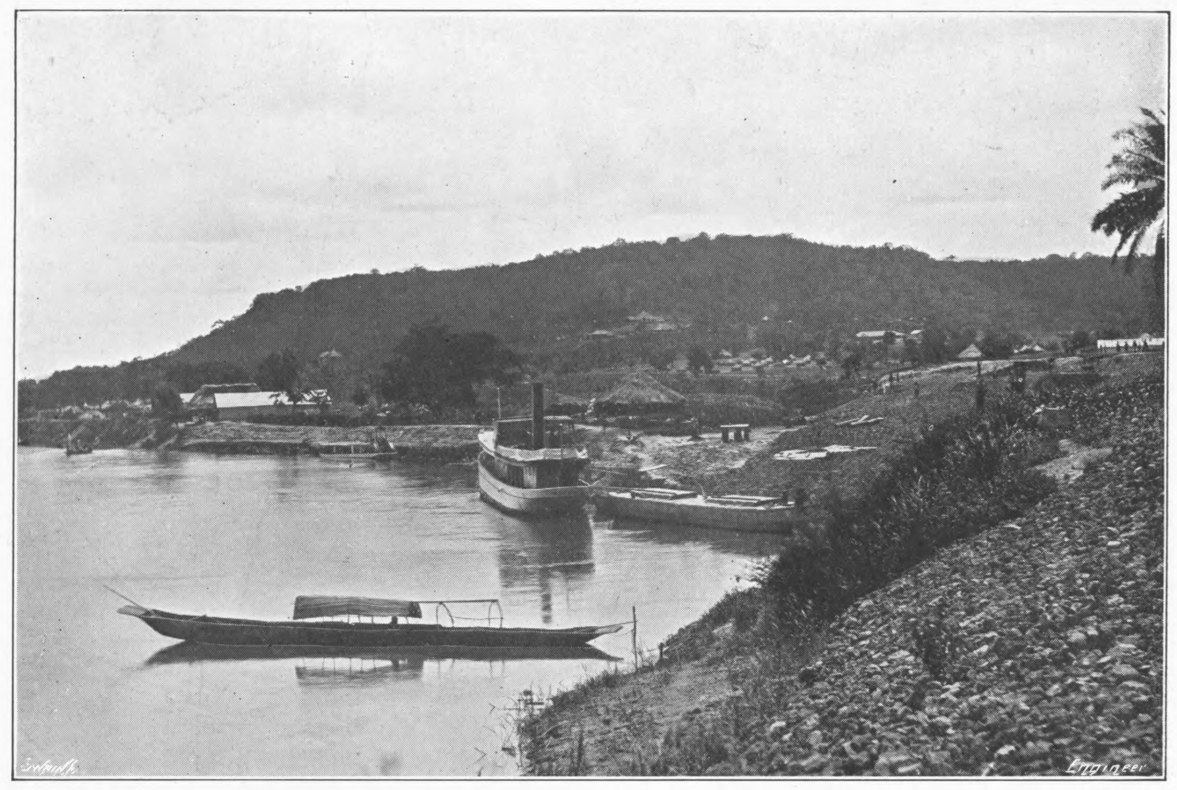
Fig. 5—VARIATIONS IN THE WATER LEVEL OF LAKE SAIMA

A railway 490 kiloms. in length runs from the coast of Kotka up the western boundary of the Saima district to Kajana, passing through St. Michel, Kuopio, and Iisalmi. Another railway runs from Viborg, up its eastern boundary, through Antrea, with a branch to Imatra and Wuokseniska, Elisenvaara, whence a branch runs to Nyslott, Sortavala, and Joensuu, all important towns, and this line is now being carried further north to Nurmes.

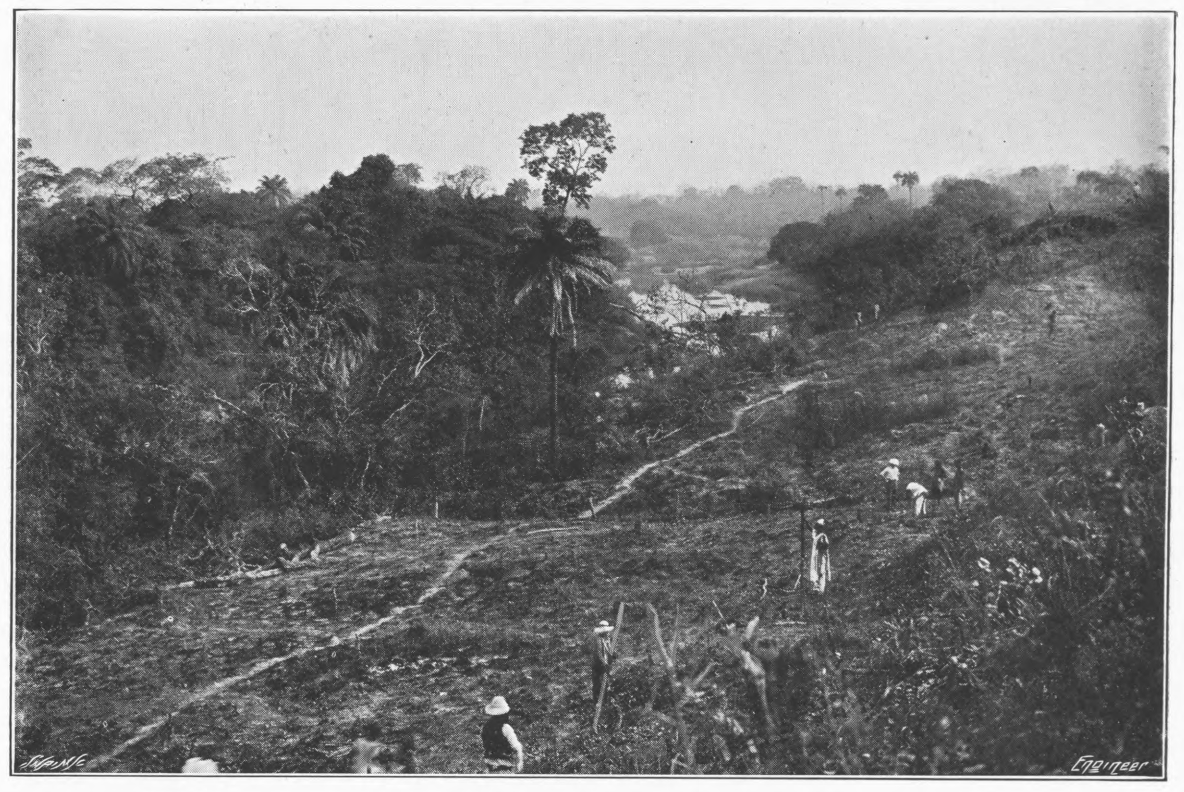
This immense series of lakes, penetrating as it does 300 miles through the heart of the forest country, is the great natural waterway which has been used for centuries for the timber and agricultural industries. The differences of level between the lakes are small, and the whole series have been joined together by a large number of short canals, twenty-four in all, besides a great many excavated channels in the river and lake beds, which enable shipping up to 2 m. draught to pass the whole length from north to south. The accounts of two of these canals show large excess of receipts over expenditure; two others show varying balances of gain and loss in different years; the others are worked at a loss to the State revenue. The indirect gain to the general industry of the country is, of course, very great. Many of these canals have been constructed only within the last fifteen years, and in the same period several of the older navigations have been entirely reconstructed. The ice melts in the end of April, and from the middle of May until the end of November the lake is busy with passenger and goods steamers, barges, and immense timber rafts, which are sometimes over a quarter of a mile long. In the winter the thick sheet of ice that covers all the lakes and rivers forms the chief highway over which travels in all directions the whole passenger and goods traffic of the district.

The only river exit from the Lake is the Wuoksen. The many torrential rapids on this river make it totally unnavigable throughout the upper half of its length, and make canalisation round the waterfalls almost impossible. On this account, and also because the river discharges into the Ladoga and not direct to the sea, the Saima Canal has been built, stretching from Lauritsala on the Lake, 4 kiloms. west from Willmanstrand, to Viborg on the coast. The first section was opened to traffic in 1852, and in 1856 the whole length was finished. From Viborg to Rättijärvi only short lengths of excavated canal to connect a series of lakes are needed, the number of locks required, however, being eight. From this point northwards to the large Lake Nuijamajärvi, a distance of 9 kiloms, most of the canal is cut through rock. From the north end of this lake to Lauritsala, a length of about 22 kiloms., practically the whole distance is excavated, and a towing path runs alongside all this length. The total length is 59 kiloms., of which 36 kiloms. is either excavation or embankment. There are locks at thirteen stations, and twenty-eight locks in all; three locks at each of five stations, and two locks at each of three stations. The standard dimensions of the locks are 35½ m. long, 7½ m. wide, and 2⅔ m. deep. The normal width of the canal itself is 12 m.; but at places it is 15 m., and at a few parts, where great depths of hard rock had to be blasted, only 9 m. The depth is generally 2.7 m, and the maximum draught of boat allowed to pass is 2½ m. The maximum speed allowed outside the lakes varies from 5½ to 7½ kiloms. per hour according to draught. No greater beam than 7.1 m. is permitted. The passage through the canal, especially in the upper part, is exceedingly slow. This arises, not from the limit of speed imposed to avoid destructive wash, but from the excessive loss of time at the locks, and from the crowded condition of the barge traffic all through the six or seven months of summer during which it is open. Sometimes a barge may have to wait a couple of days before it gets a chance to pass a lock. The gates are opened and closed by hand, and the barges are drawn by steam tugs through the lakes. Figs. 2 and 8 give two views upon the canal.

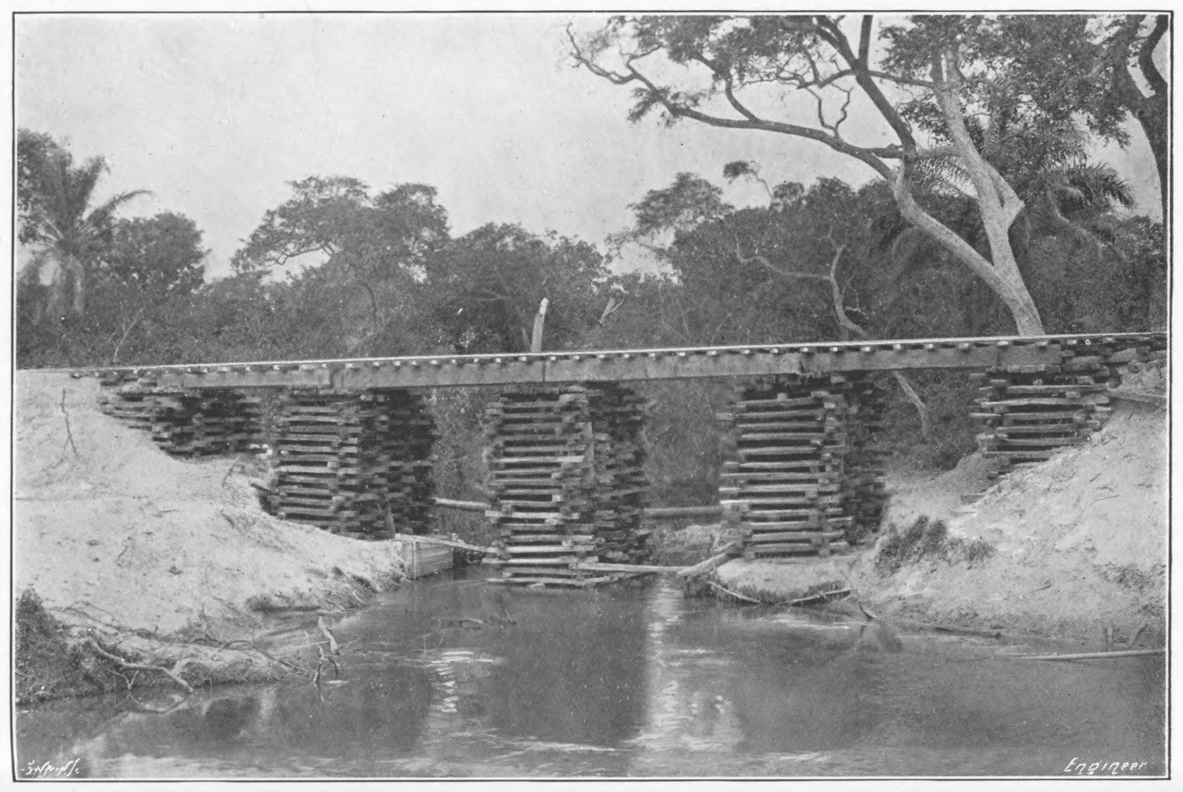
CONSTRUCTION OF THE BARO-KANO RAILWAY, NORTHERN NIGERIA



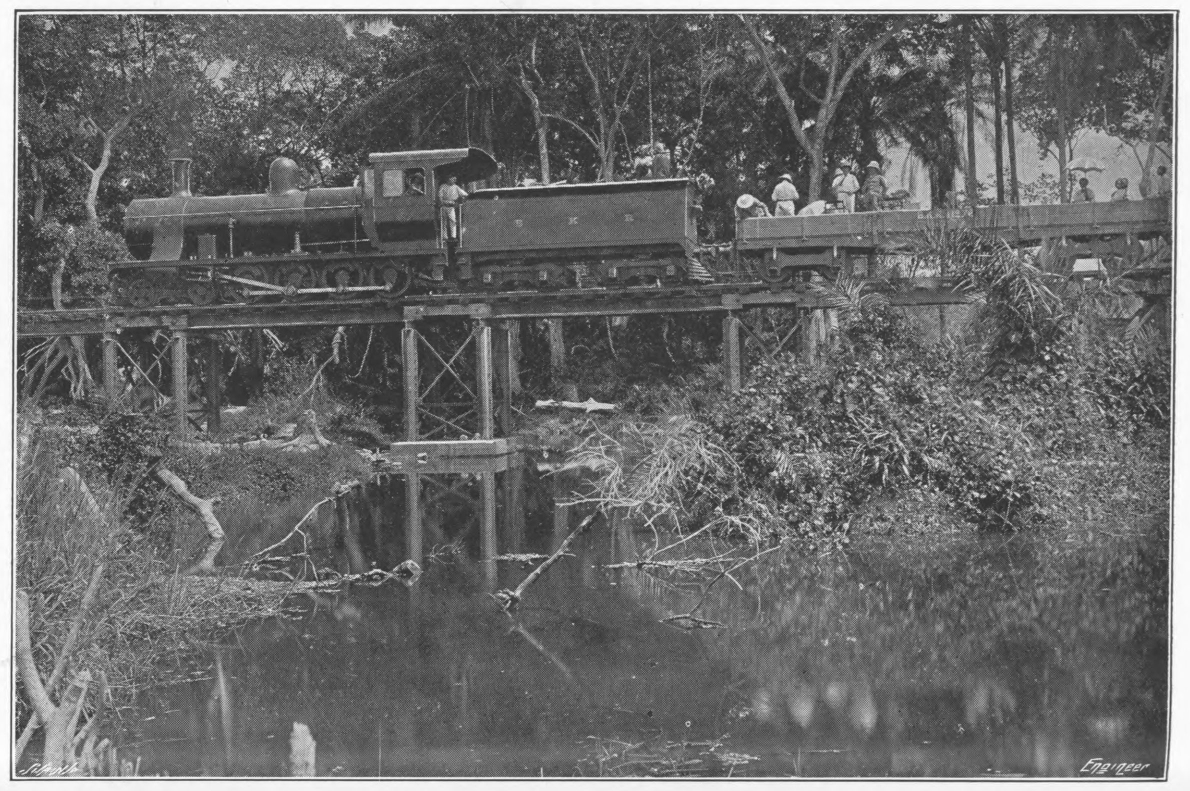
BARO BEACH JUST BEFORE THE RAILWAY WAS BEGUN



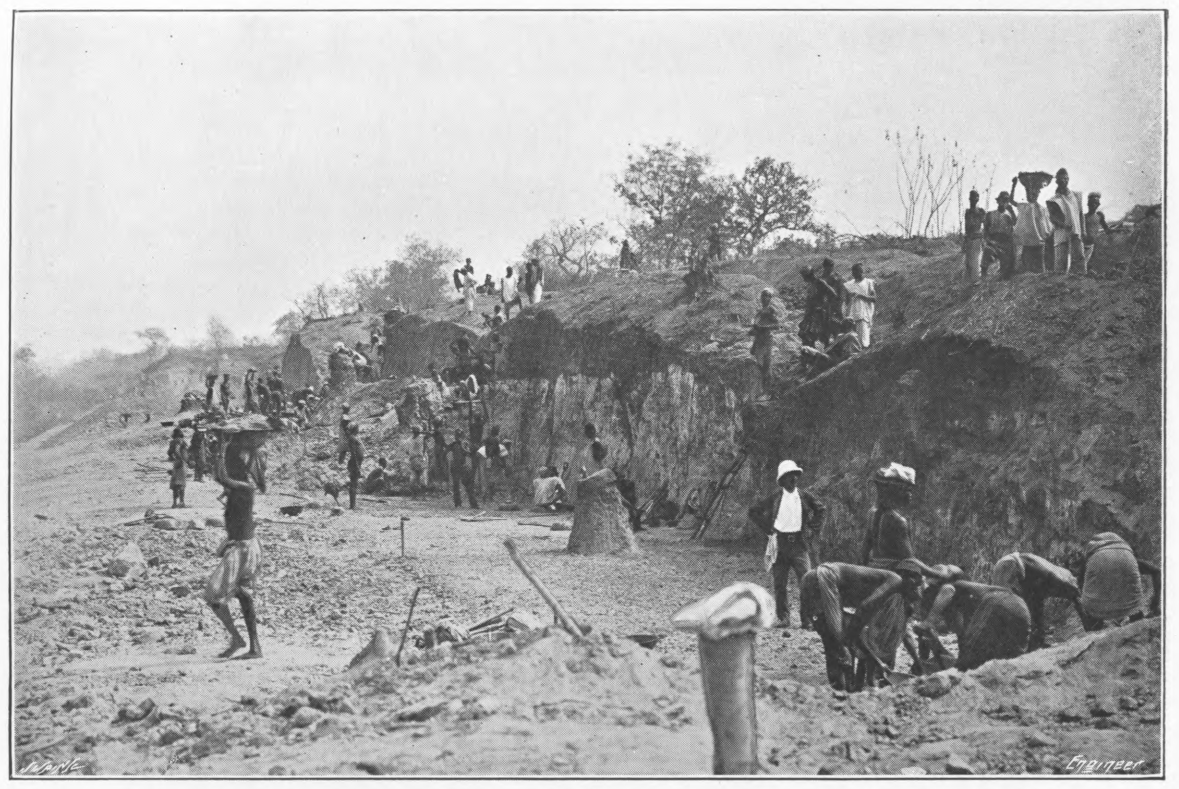
SETTING OUT EARTHWORK AT PATATIFI



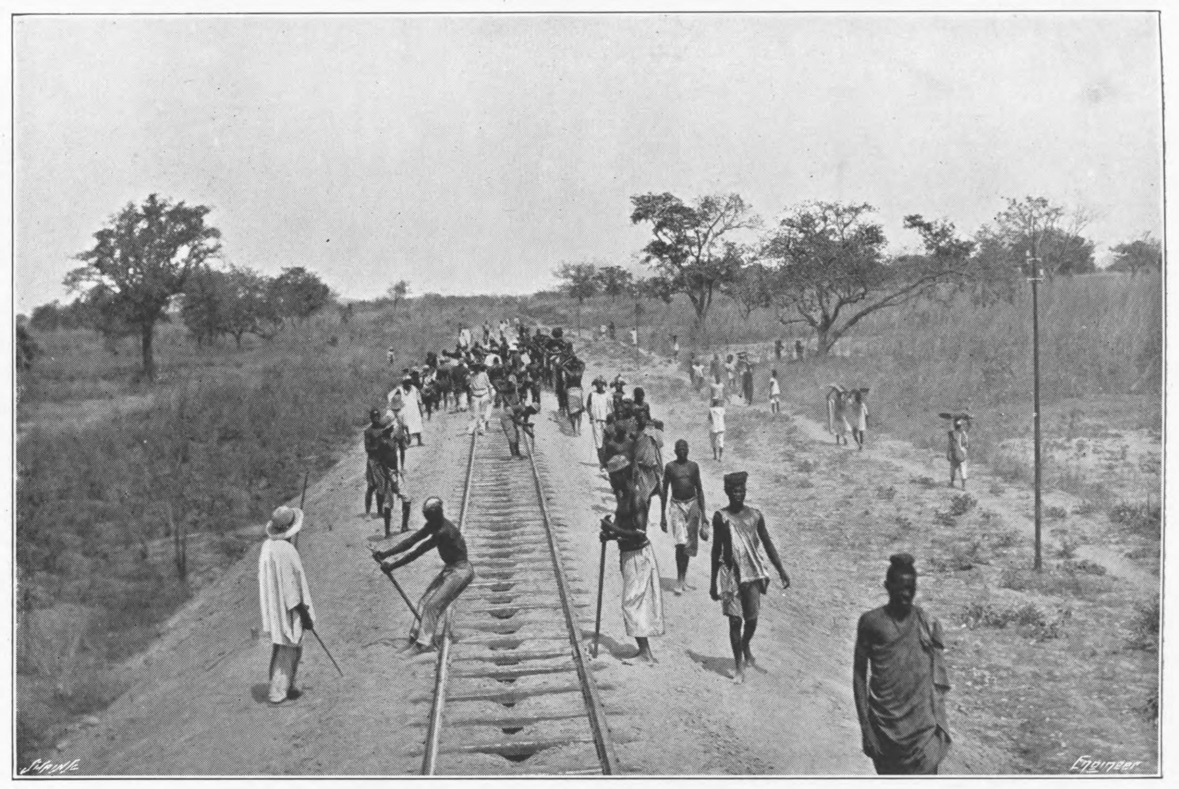
TEMPORARY BRIDGE OVER THE BAKOGI RIVER



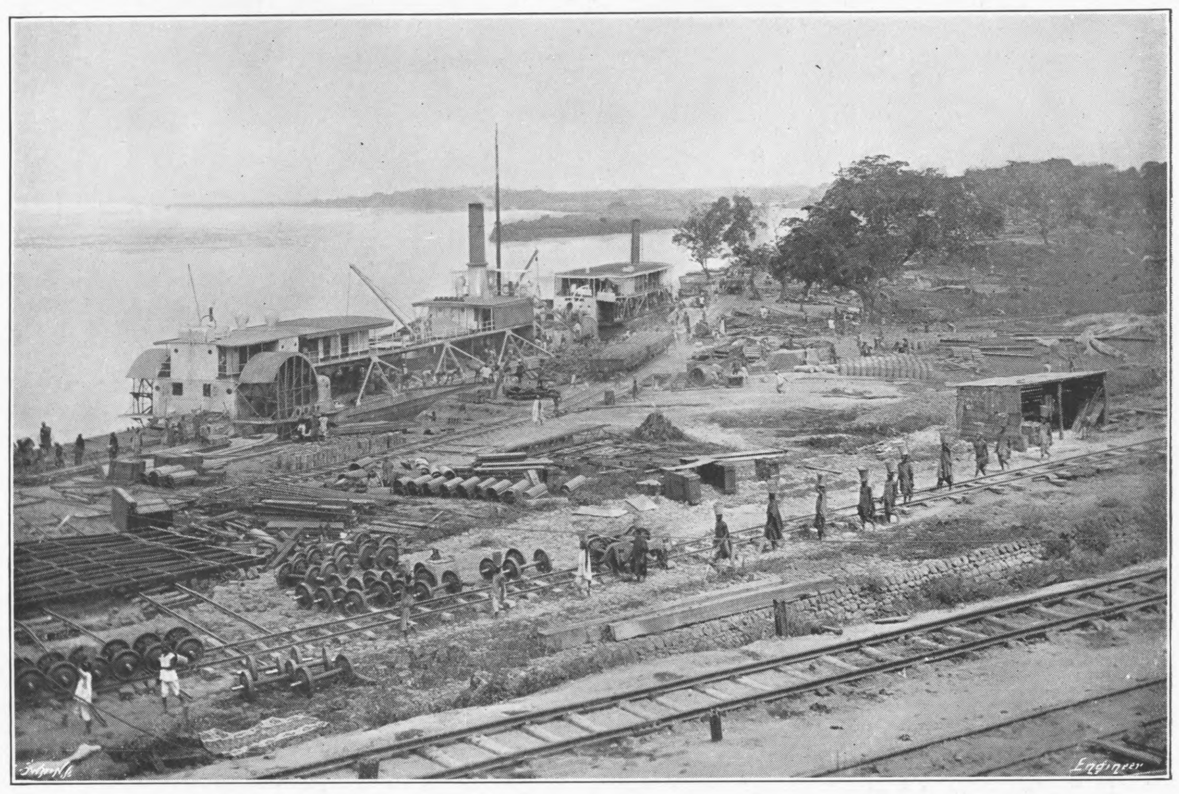
ENGINE OF THE EMIR CLASS ON STEEL BRIDGE



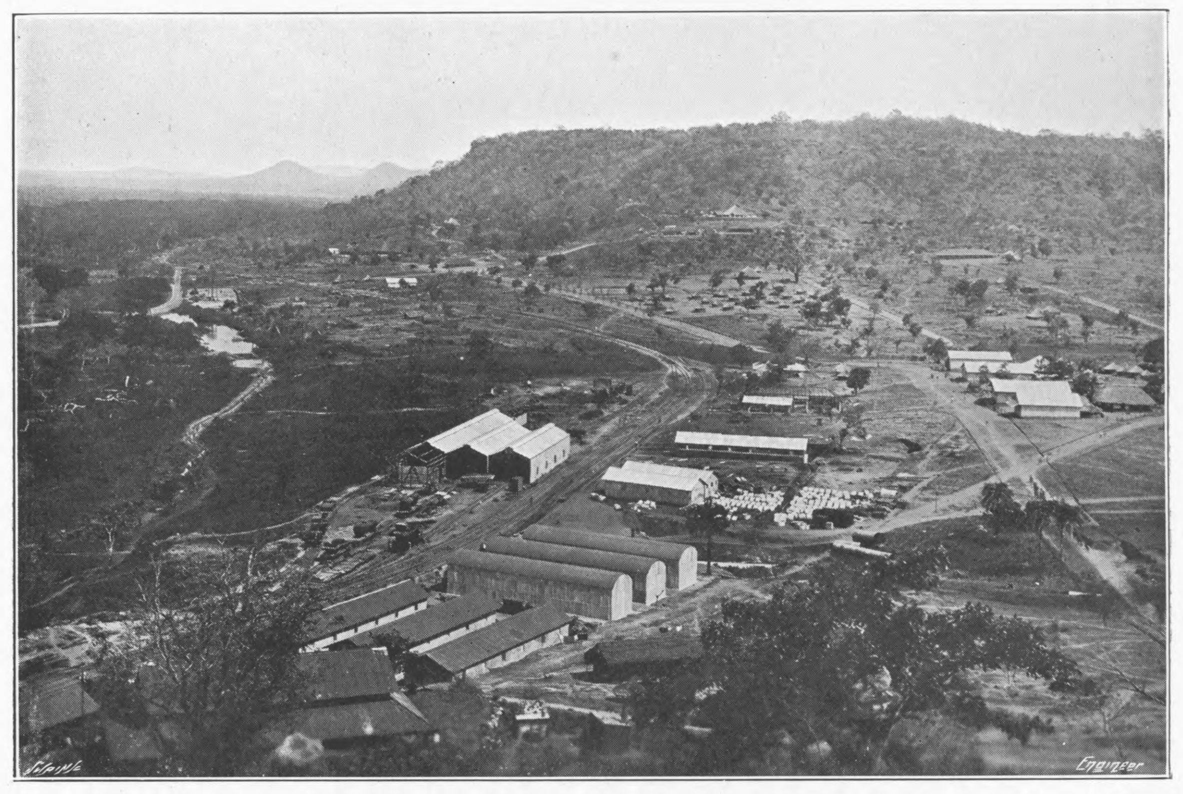
EARTHWORK IN PROGRESS AT PATATIFI BLUFF



STRAIGHTENING ROAD AT RAIL HEAD



NIGER END OF THE LINE—VIEW FROM BARO HILL



GENERAL VIEW OF BARO STATION

In the ten years—1897-1906—the number of boats passed was 67,464, the annual traffic increasing in this period from 5200 to 8200, and to 9836 in 1908. In this period the working expenses have remained stationary on the average of about £8000, while the receipts have advanced from £18,000 to £28,000. The maximum number of boats at one time in the upper part of the canal is 85, and in its lower part 101; that is, 186 in the whole length.

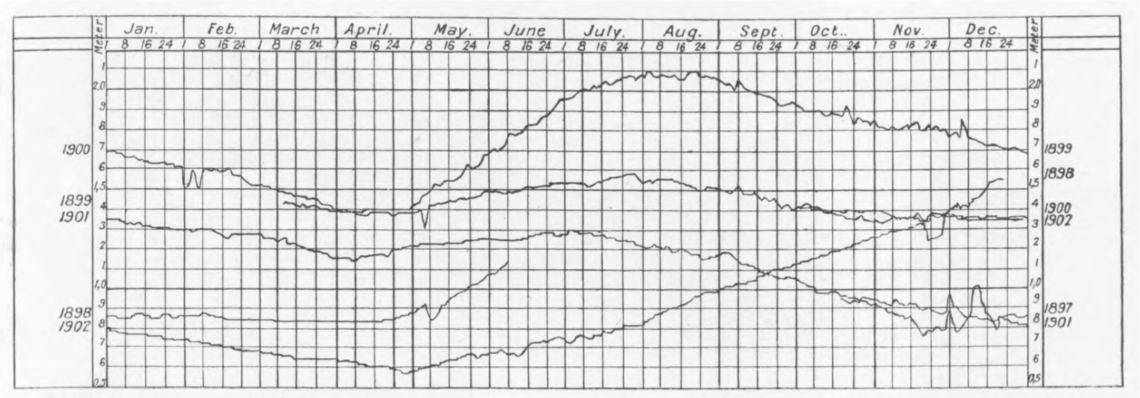


Fig. 6—SEASONAL VARIATIONS IN WATER LEVEL OF LAKE SAIMA

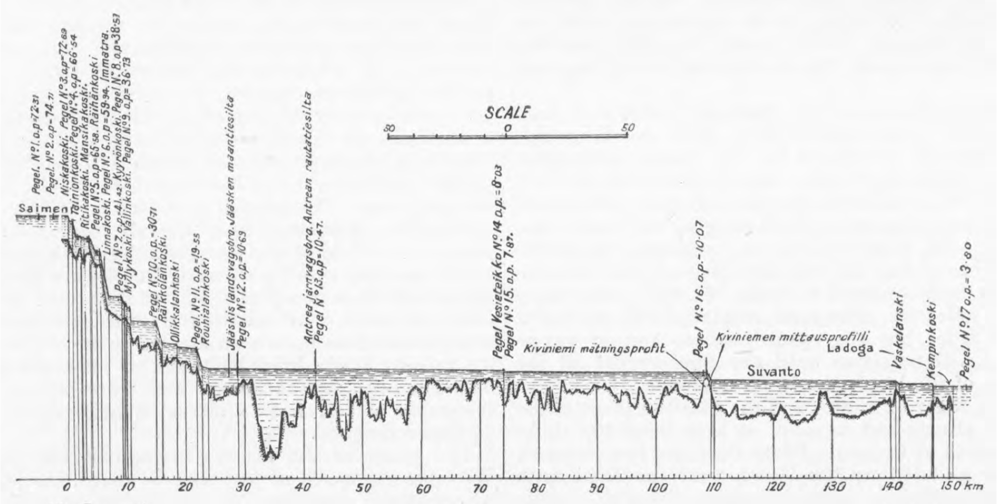


Fig. 7—THE BED OF THE WUOKSEN RIVER

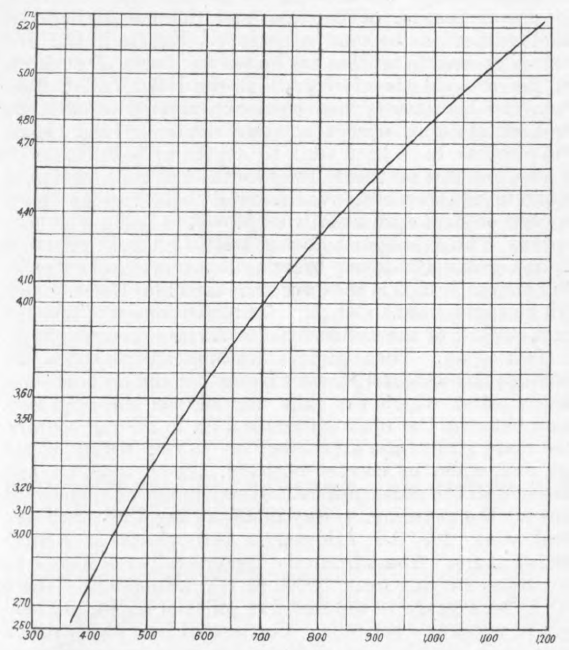


Fig. 8

If the capacity of the canal to pass boats per day were sufficiently increased, it is reckoned that the traffic would be at once doubled, perhaps very quickly trebled. At the request of the State Administration, the chief engineer, Gunnar Lindqvist, has worked out designs and estimates for effecting such increased capacity. His proposals embrace four main alterations, namely, (1) the rebuilding of the locks, abolishing the treble and double stages and making the total fall in one step only at each station, while at the same time doubling the length of each lock so as to take in longer ships or a series of smaller barges end on; (2) the electric lighting of the canal throughout its length, and especially at the locks, so that work may continue 24 hours per day continuously; (3) the application of mechanical power to the opening and closing of the gates; and (4) the substitution of electric traction along the upper half of the canal, where there are few lakes. This electric traction is to take the place of horse haulage, the plan being to lay a narrow-gauge railway along the existing towing path and run electric locomotives thereon, the current transmission being, of course, overhead. The improvements are estimated to increase the capacity of the canal in the ratio $\frac{8}{3}$, and the same crew of four men per boat, whose wages amount to about £11 per month, would be amply sufficient for the larger boats. About 20 electric locomotives would suffice for the increased traffic. The estimate for lighting includes 231 arc lamps of 900 candle-power and 82 of 600 candle-power. The estimated capital outlay needed for these improvements is roughly half a million sterling, and the increase of traffic would pay 4½ per cent. on this capital within a very few years. The toll charged on boats passing through the canal is 0.34f. per registered tonnage on loaded boats, and 0.26f. on empty boats, also per registered ton. For a 200-ton boat the double journey thus costs not less than 120f. plus, at least, 60f. or 70f. for boatmen's wages, plus the cost of steam tug haulage; altogether some £10 or £12.

This canal transit cost has had two clearly marked effects. It has greatly hindered and delayed the development of the industries of this large and rich Saima district by placing a serious obstacle in the way of cheap access to the coast. It is also leading to the erection of large factories along the south shores of Lake Saima, where the timber is converted to paper pulp, to cellulose, to mill bobbins and reels, &c. &c., and where the logs are sawn up, so as to get rid of the waste and avoid the expense of taking it through the canal. This waste wood and sawdust are burnt under the boilers of these factories. Although the local prices for this waste are at present very low, the poor economic value of this form of fuel is well understood by engineers. The erection of further factories in this district would be very greatly promoted by the supply of cheap electric power generated at the waterfalls which exist within a very short distance. The price of wood fuel has already risen considerably, and much greater future scarcity is anticipated by all the factory managers. Coal is impracticable here, as its price in Viborg is 26s. to 27s., and delivery in this district would cost not less than an extra 5s. or 6s. per ton.

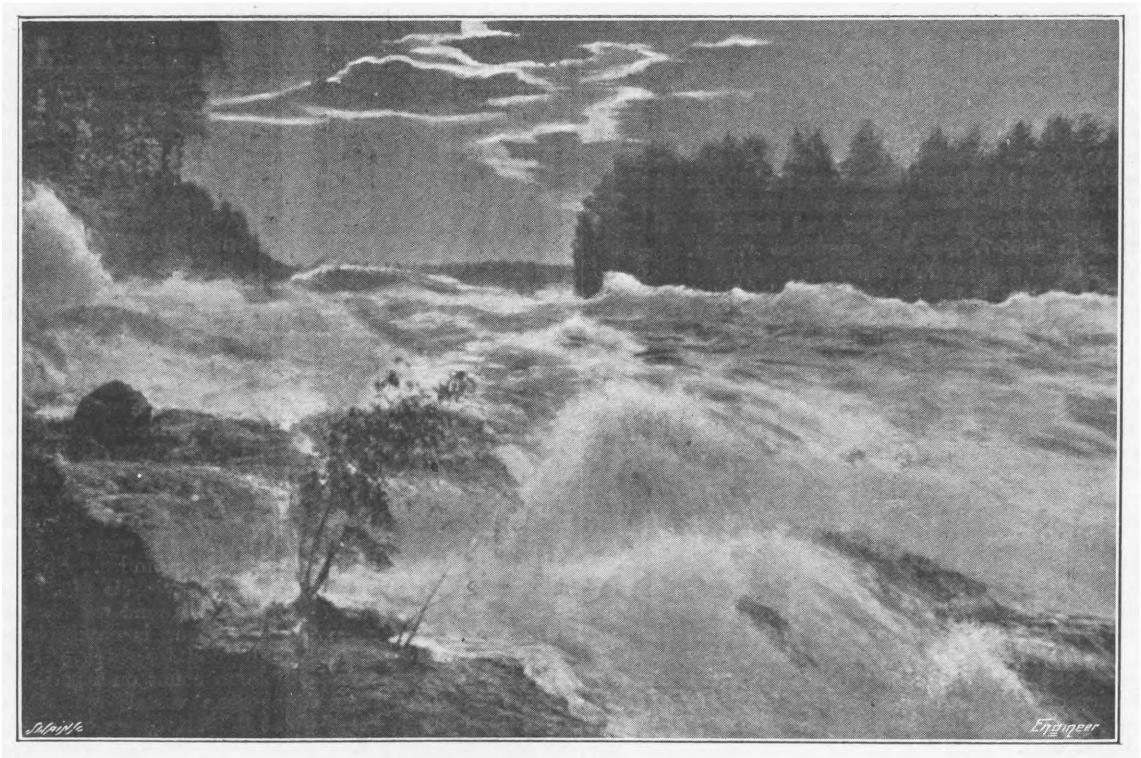


Fig. 9—THE FALLS AT WALLINKOSKI

It may be remarked in passing that the Russian Central Government several years ago withdrew permission to sell copies of the large-scale Survey maps of any part of Finland. This strangely arbitrary proceeding is not so seriously injurious as it might seem at first sight, because the maps are over sixty years old. But the result of the refusal to publish revised Survey maps is that the published small-scale maps reproduced from these are frequently incorrect. As an example, that of the Saima Canal, published in 1908 by the Ponts et Chaussées of Finland (Ofverstyrelsens för Wäg-och Vattenbyggnaderna) for the Eleventh International Congress of Navigation at St. Petersburg, shows one large lake 1½ kiloms. long which has now no existence, having disappeared many years ago by drying up.

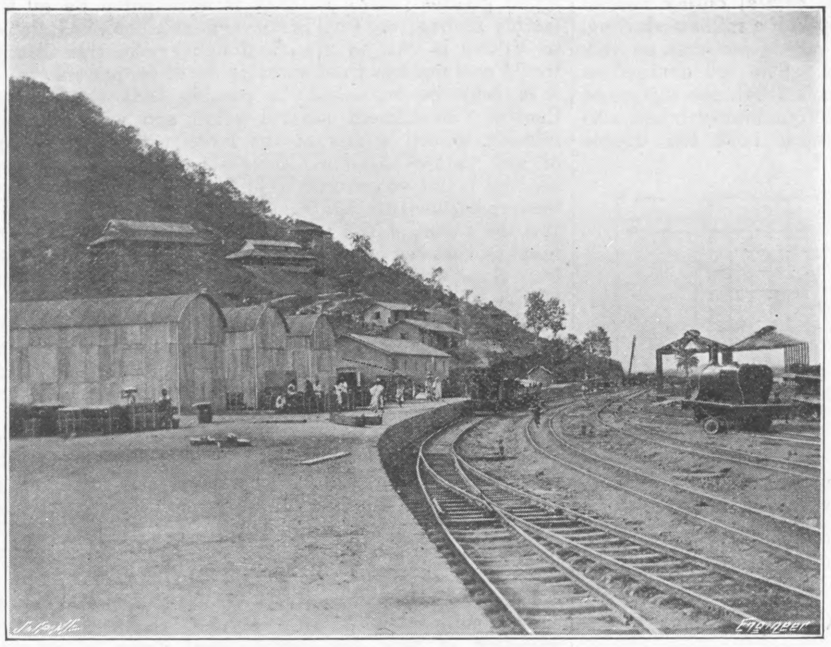
Of nineteen canals of first-class magnitude, nine of them yield receipts in excess of their costs. On the smaller artificial waterways an annual loss of £2800 in all occurs. On the total of all the canals and artificial channels the excess of income over expenditure is £19,500 per year.

THE WUOKSEN RIVER AND FALLS.

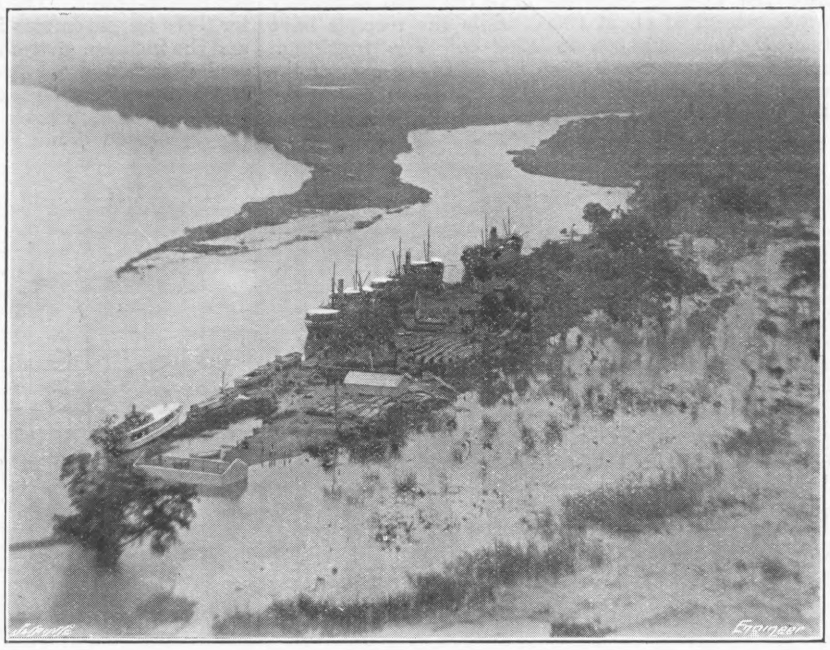
Like the other large rivers of Finland, the Wuoksen suffers comparatively little annual, that is, seasonal, variation of flow, but during short series of years it remains in high flood. These rivers are fed chiefly by the melting of snow and ice, and these really take two or three years before they reach the lakes in liquid form. In the far north wide stretches of country along the lines of the main watersheds are covered by peat bogs and moss morasses. Other long ranges of land are occupied by glacial moraines composed of boulders of very large size and rock detritus, chiefly granite sand. Both of these soak in large volumes of water and deliver them to the lower levels very slowly. Fig. 4 is a map of this river. From 1847 onwards careful records have been kept of the water level in Lake Saima. In that year it stood abnormally low, and two years later 1.5 m. higher, sinking again 1.7 m. to the lowest recorded level in 1859, generally with two yearly periods of maxima and minima, the normal variation in this period being about 1 m. 1872 was a year of extra high level, followed in 1876 by a 1.8 m. lowering, and in 1879 swinging up 2.1 m. higher, and in 1881 down 1.9 m. again. The next great rise was in 1898-99—a rise 2.25 m., followed by a drop of 2.45 m. in 1902, since which date there has been only the normal 1 m. variation. These level readings are shown in Fig. 5. The seasonal variation averages 0.7 m., but in times of great flood it is, of course, more. The lowest point is in the latter half of April, the melting of the snows then causing a rise until July. Another much smaller rise is caused by the later summer and autumn rains. Over the crests of the great waterfalls on the river the variation of level is .1 or .2 m. less; but in exceptional years, such as 1902, it has reached, for example, at Wallinkoski, 1.3 m. from lowest to highest, this being the greatest that has been recorded. One sample diagram of these seasonal variations is seen in Fig. 6.

From 1897 to 1902 exact measurements have been made not only of the levels, but also of the stream velocities and the volumetric flows. Accurate cross sections were made at no less than 20 points at four main stations in the upper and lower reaches of the river. Each section being mapped out in ten equal breadths, the water velocity was measured at each point of the breadth at every ½ m. depth, by means of a propeller-blade speedometer. Complete tables and diagrams of all the observations and the calculations therefrom have been printed and published in a very bulky quarto volume by the Ponts et Chaussées of the Finnish State. This volume, wholly devoted to the Wuoksen River, contains no less than 78 quarto finely engraved square paper diagrams, from which our

BARO-KANO RAILWAY, NORTHERN NIGERIA



BARO YARD



STEAMERS DISCHARGING AT BARO

illustrations are reproduced. There can be no doubt of the great care bestowed on the work nor of its accuracy. Fig. 7 is a longitudinal section of the river bed. In the year of exceptionally low water, 1902, the mean of the measurements of the minima at different stations gave 410 cubic metres per second. In the year 1899 of extraordinarily high water the mean of the maxima was 1152 cubic metres per second. Two of the diagrams above mentioned co-ordinate the volumetric flow with the water levels in Lake Saima and at Kiviniemi, near the mouth of the river. The former is reproduced in Fig. 8. The mean level in the lake since 1847 to 1902 corresponds with a flow of 565 cubic metres per second, which may be taken as the true average flow. This nearly equals the flow in 1901, which otherwise is found to represent a good average year. It also closely agrees with that given by Max Alfthan, as quoted above, namely 570. Adopting the figure 565, and using the 1901 measurements of fall in level, the following are the horse-powers in the water of the larger of the falls on the Wuoksen, a number of small ones being omitted from the list. It must not be imagined that so much horse-power can be developed either mechanically or electrically. Some of the crude water-power inevitably goes to waste, losses occur in the turbines and in the dynamos, &c., and the plant is generally laid down for the *minimum*, not the *average* flow. Odd hundreds are omitted from the calculations.

	Minimum width.	Fall	Water horse-power.	
	Metres.	Metres.	Average.	Minimum.
Niskakoski	190	1·6	12,000	8500
Tainionkoski...	70	5·9	44,000	31,000
Linnakoski	170	5·0	37,000	26,000
Imatra	20	18·3	138,000	98,000
Kyyrön-Mylly-Wallinkoski	115	10·4	78,000	55,000
Räikkölänkoski	45	8·8	66,000	46,500
Rouhialankoski	60	7·5	56,000	39,500
			431,000	304,500

Of these Imatra cannot be utilised for the generation of power, both because of the difficult and expensive character of the necessary construction, and because it is preserved as a national park visited yearly by scores of thousands of visitors of all nationalities. At Tainionkoski 3000 horse-power is at present being used in paper pulp and brown wrapping paper mills and reel and bobbin turning mills; as also 2000 horse-power in chemical chlorate of potash works. This year the dam has been extended so as to take in more water for 3000 extra horse-power, there being an almost continuous demand for more power here. The paper and bobbin mills were started in 1895-7, and the chemical works in 1898. Further down small mills have been established here and there; and at the village of Enso, the Räiköllänkoski has been utilised to take several thousand horse-power out of the water for a paper pulp mill. Elsewhere the falls are not yet employed industrially. Fig. 9 is a view of the very fine Wallinkoski fall. The mere breadth of channel and depth of fall are, of course, no criterion of the cost of construction or of the advantages to be gained. Many other technical considerations which cannot be detailed here come into such calculations. Exclusive of Imatra, there are over 300,000 horse-power in the river with average flow and 200,000 at minimum flow. With the conversion of this to mechanical and electrical power with cheap distribution to factories, the South Saima and Viborg district may become the busiest and most important industrial part of Finland. There is here abundance of power for the navigation of the Saima canal and for the electrification of the busier sections of the railways, as well as for the new factories springing up on the southern shore of the lake, all these being within easy reach for electric transmission at moderate cost.

RAILWAYS IN NORTHERN NIGERIA.

Until the year 1907 the Protectorate of Northern Nigeria possessed in the way of railways but one light 2ft. 6in. tramway of 22 miles in length, which connected Zungeru, the capital, with Barijuko, the nearest navigable point on the river. In May, 1907, Sir Percy Girouard, the Governor, whose name had already become famous in connection with his splendid railway work in the Sudan and in South Africa, formulated a railway policy in which he recommended the construction by the Public Works Department of the Protectorate of a 3ft. 6in. gauge railway from Baro, on the Niger River, to Kano, a distance of a little short of 400 miles, on an estimate of £3000 per mile, and in August of the same year the Imperial Government sanctioned the construction of the proposed line.

That the Governor and his energetic Director of Railways, Mr. John Eaglesome, C.M.G., have not been idle since that period, is shown by the latest telegraphic report from Northern Nigeria, which shows that on June 10th, 1909, 109 miles of earthworks had been completed, with 190 miles in progress; that bridging had been completed to mile 45, with 105 miles in progress; that track-laying had been completed to mile 99, and that location survey had been finished to mile 195, and preliminary location to mile 220. The total length of the railway is about 380 miles, but the exact distance cannot yet be determined with precision until the final survey of the last section of one hundred miles is available.

Baro, the Niger terminus and the starting-place of the railway, is situated at a point on that river 407 miles from its mouth at Burutu. From Baro the line proceeds northwards and follows the Niger until the fourteenth mile, when it strikes in a north-easterly direction, following the Valley of the Bako—a tributary of the Niger—which stream it crosses at mile 99. Railhead is at present at this point, further track-laying being deferred pending the completion of the bridge over the Bako. Beyond, the line follows a small valley to the summit between the Bako and Kaduna Rivers, near which is the site of the junction connecting the Baro-Kano line with the system which, starting from Lagos, runs *viâ* Jebba, at which place it crosses the Niger. Beyond this junction—Minna by name—which is at mile 112, the Baro-Kano line traverses a number of lateral valleys, and after crossing two large rivers—the Dinia and the Kogi Serikin Pawi—reaches Danguna on an important caravan road. Thence the railway ascends the valley of the Kugo to an altitude of 2100ft., and will cross the Kadunar by a bridge nearly 500ft. in length. Over high ground, the section will then run to the important city of Zaria. Up to this point the survey is complete, and good progress is being made with the alignment beyond. From Zaria to the terminus at Kano is a distance of about 90 miles, and along this section the line will still keep to the high ground. The only important river to be crossed on this part of the system is the Shilloa, situated 10 miles from Kano. This city—800 miles in the interior—aptly named the Manchester of the Central Sudan, with its 12 miles of walls and immensely rich cultivated area, is expected to be reached in 1912.

Inseparably connected with this railway is the question of the navigation of the Niger from the sea to the starting-point of the line at Baro, a distance of 400 miles. Immediately after his arrival Sir Percy Girouard had an elaborate series of soundings made in order to establish the total length of shoal water in the Niger at low river, and it was found that in the whole length of 400 miles the total length of shallow water which would require dredging was not more than about five miles. But for these shallows the river would be navigable along the whole of this section all the year round for vessels drawing 6ft. At high Niger the river is navigable to Baro, and even for 100 miles beyond for ships of 1500 tons. Every year it is possible to count on a period of about ten weeks when these ocean vessels can steam right up alongside the wharf at Baro, a voyage of roughly six days from the sea. For deepening the waterway along this section a powerful dredger built on the Clyde has been constructed, and is now on the Niger. She expects to start work in October next. This vessel is a sand pump self-propelling dredger, having a delivery tube 400ft long.

Baro, formerly inhabited chiefly by mosquitoes and the deadly tsetse fly, is now a busy railway centre. Running down to the river bank is a great swamp that has already been drained, and when filled in with the sand pumped by the dredger from the river bed will be the site for export sheds. Further inland have been erected large workshops, engine sheds, stores, foundries, machine shops, a large band-saw mill, and wood-working plant. In connection with the materials for sleepers, &c., in the cutting of which the natives have now become expert, a valuable forest has been discovered in the vicinity, and already over 2000 logs have been cut down and conveyed to the saw mill. In addition, the construction has just been completed of two wharves, or piers, with the necessary cranes for discharging material from the steamers.

To assist in the delivery of material, three powerful stern-wheel tugs, to each of which 100 ton lighters are lashed alongside, have been at work on the Niger for the past year. The success achieved by these craft has justified the departure from the old system of placing cargo in the hold of the stern-wheeler by separating the cargo from the vessel possessing the motive power. The Baro yard when completed will contain four and a-half miles of rails. In addition to the structures above mentioned, there have been erected on the hill overlooking the railway works brick buildings for the accommodation of the railway staff, accounts and store offices, post and telegraph offices, native clerks' quarters, and a well equipped hospital.

The gauge of the railway throughout will be 3ft. 6in. With the exception of the first 6½ miles, the permanent way material consists of 45 lb. rails laid on steel sleepers. Up to the present 150 miles of rails and sleepers have been delivered, and during high water of this year a further consignment of 150 miles will be landed at Baro. The work of platelaying and the erection of locomotives is in the hands of a detachment of Royal Engineers, consisting of three officers, thirty non-commissioned officers and men, under the command of Captain Mance, D.S.O., R.E.

The country is subject to terrific tornadoes, with heavy rains, which occur almost daily during the wet season, thus necessitating some very heavy bridging. It has been found quite impossible to use masonry piers, except on the larger bridge work, owing to the absence of lime in the lower section of the line, and the employment of steel trestles has become necessary. Except in the first 100 miles, trestle bridges are bolted to blocks of concrete on the rocky beds of rivers. In the Bako Valley, however, much difficulty has been experienced in securing good foundations, except at some depth. Wells, square and circular, have been sunk to depths up to 20ft., and it is believed that on this railway for the first time reinforced concrete has been employed for well curbs instead of the wooden or steel curb usually employed in India and elsewhere. The average number of trestle bridges in the first section is about two every three miles, exclusive of culverts. The largest bridge is that over the Kaduna River, which will be some 500ft. in length. This will consist of through steel girders, of the Central South African Railway type, of 100ft. span. These girders are built on the shore, the cross girders and rail bearers being erected on falsework *in situ*, after which the rails are laid on the approach bank between the main girders and on to the rail bearers. The main girders are then lifted on to two trucks, rolled out, and, when in correct position, drawn together and fastened to the cross girders. Here it may be mentioned that all the permanent way material, together with the steel work for the bridges, is throughout of British manufacture. Apart from the larger bridges—that is to say, those varying from 300ft. to 800ft. in length—there will be an average in the first 112 miles of about 50 lineal feet of waterway per mile. Corrugated iron pipes, which have been sent out in sections for easy transport, are being used as culverts, the weight on all over 3ft. in diameter being relieved by means of rails. Pressed steel tubes are being employed under the heavier banks.

The cost of construction, it is now certain, will not exceed the amount voted by Parliament—about £3000 per mile—which may be regarded as a record. This sum includes the equipment of the railway with 16 locomotives and 200 trucks and wagons. Eleven locomotives have already been delivered. Of these five are a modified Cape class eight-wheeled coupled with a leading bogie, and have been named after the Emirs of the various provinces. These engines have been built by the North British Locomotive Company, Limited, to the special instructions of Sir Percy Girouard. They have an axle load of 9½ tons, which has been found to be by no means excessive for a 45 lb. rail using twelve sleepers to the 30ft. rail. There are two small shunting engines of the Lagos Class 1 type, two of the Lagos Class 101 type (eight wheel coupled), and two are Lagos Class 51 type (six wheel coupled) Five further engines are now in course of delivery, of which two are Lagos Class 51 type, and three are specially designed tank engines (six wheel coupled).

One hundred and ninety low-sided trucks and ten covered wagons will be the total equipment of this class of rolling stock, and of these 100 trucks have been delivered. Three specially designed coaches having four compartments, with folding bunks, are now in course of erection for the use of European officials.

The leading principle of pioneer railway construction being to avoid all unnecessary expense above rail level, there will in the ordinary way be no station buildings, except small iron sheds with rail level platforms. At large centres, such as Baro, Zaria, and Kano, where more traffic is to be expected, there will be station buildings, but here again they will be of the simplest description, and will be supplied with platforms. Small roadside flag stations for the convenience of passengers have been fixed every twelve to fourteen miles, and there will be crossing stations at about every 35 miles.

Track laying.—The formation having been levelled and the centre line pegs having been driven at 50ft. intervals along the level surface, a platform of the best sandy material available 7in. deep and 8ft. wide with a central triangular furrow, is laid with correct superelevations on curves. On this the steel sleepers are placed, being afterwards spaced to true centre and strung to a true centre line. The adoption of this sand ballast platform has resulted in a fairly good road, requiring little upkeep behind railhead. In track laying on this line a record for West Africa has been established, the track-laying parties having laid 1½ miles a day.

It has been found absolutely essential in an undertaking of this nature to carry out as much of the work of the railway as possible on the spot. A completed survey is abandoned without hesitation when it is found on further investigation—all plotting being done in Nigeria —that a better alignment can be secured elsewhere.

With regard to earthworks, these are being made up to a full section of 14ft., with 2 to 1 slopes. The cuttings are 18ft. wide at formation level, including side drains, and are invariably protected by catch-water drains. The sides of the cuttings are sloped according to the nature of the soil, and the edges protected by slope drains. Earthworks have never been exceptionally heavy, and survey parties have been careful to dig trial pits at cuttings to avoid as far as possible meeting hard rock. When the line crosses lateral valleys of great length it has been found advisable to use momentum gradients, thus reducing the quantity of earthwork and height of bridge.

Gradients.—In the first section of 112 miles the ruling gradient is .7 per cent., or 1 in 143 up to Kano, and .6 per cent., or 1 in 166, down from Kano, in which direction the heavy traffic is expected. The sharpest curve in use on this section is 6 deg., or 955ft. radius. Throughout the line the American system of per cent. gradients and degree curves has been adopted in place of the old 66ft. chain.

Native labour.—Work on the railway was originally begun with a gang of 1200 natives, but this number has, of course, been vastly increased. The latest available returns show that for the quarter ending March there were on an average between 9000 and 10,000 natives employed on the line. The number varies in accordance with the season, and the fact that at certain periods the people are employed in their own fields at home. Local labour is paid at the rate of sixpence per day. The local labour gangs work immediately under political officers, who practically act as contractors and deal with the men through their village heads, thus ensuring a continuity of native rule, to which the Administration attaches such importance. Under European training these natives, many of them absolutely untamed, one might almost say wild men, show great adaptability, and turn out really excellent labourers, while the more civilised Nupé has made a good riveter and woodworker.

European staff.—The railway is under the immediate supervision of Mr. John Eaglesome, C.M.G., Director of Public Works, and also Director of Railways in the Protectorate, who is himself directly responsible to the Governor. Under him are a staff of about 170 engineers, firemen, accountants, and storekeepers. The members of the staff come from all parts of the Empire, nearly fifty being retrenched British officials from the Transvaal and Orange River Colony.

We give on page 288, and in a supplement, views on the line.

INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

No. II.*

THE fifth triennial Congress of this Association, the opening proceedings in connection with which at Copenhagen were reported in our last issue, continued its sittings on September 8th, when work commenced in the three sections devoted to metals, cement, and sundries. As indicated in last week's issue, some eighty papers in all were down for reading and discussion. It is not proposed to deal with the reports and papers presented at any great length, nor, indeed, is it necessary that this should be done. It will be sufficient briefly to indicate the nature of the problems brought before the various sections of the Association and to state some of the results reached at a congress in which many of the notable workers in the field of operations covered by the reports and papers took part.

The most important of the three sections was undoubtedly that devoted to metals. Some forty reports and papers were allocated to that division of the Congress, which met in the fine council chamber of the Copenhagen Town Hall under the chairmanship of Mr. O. Busse, director of the mechanical department of the Danish State Railways.

The first papers to come up for discussion were those on metallography, and the report on progress made in metallography from the date of the Brussels Congress in 1906 up to the commencement of the present year was presented by Professor E. Heyn. It was pointed out in the report that metallographic research during the period under review had been mainly concerned with the following aims :—(1) The fixing of the foundations of a chemistry of inter-metallic compounds by determining the cooling curves of as large a number of alloys as possible ; (2) to increase knowledge of the iron-carbon system, the formation of graphite and the components of hardened steel ; (3) to study special steels and other alloys ; (4) the application of metallographical results to actual metallurgical research work, particularly that relating to metals other than iron ; (5) improvement in metallographical research in its special bearing upon the testing of materials and the devising of simple processes for controlling the treatment of metals and alloys. With regard to the iron and carbon system, it was pointed out that the question of the separation of graphite had evoked the most lively interest during the period covered by the report, and the view according to which the system iron and graphite is reckoned as stable, and the white graphite free iron as meta-stable, had established itself more and more. It was stated that although the solubility of graphite in iron is generally accepted, its quantitative determination, as fixed by Benedicks, did not yet appear to be quite reliable. It was necessary that consideration should be given to the question as to whether in the cementation process one had to deal with the iron-carbon system *per se*, and not rather with the three component system iron-carbon-nitrogen, in which other equilibrium relations intervened. If this were solved many points still doubtful would be cleared up. The report contained a long list of publications dealing with the various branches of the subject, and it brought out the application of metallography to practical industry, a subject which was more fully dealt with in the lecture which Mr. J. E. Stead delivered at the final meeting of the Congress on Saturday last.

The general opinion was that the report itself was an excellent summary of progress, but that it was somewhat incomplete, while in the bibliography several important British papers would seem to have been ignored. The discussion, in which Dr. Benedicks and M. Le Chatelier took part, centred rather on the colloid theory of troostite, but Professor Heyn indicated his willingness to accept the views of Dr. Benedicks with certain limitations. M. le Chatelier thought it was a mistake to attempt to bring metallurgy too much into the line with mineralogy, and he deprecated, as did other speakers, notably Dr. Rosenhain, the giving of definite names to too many constituents. He would limit the nomenclature to three constituents—(1) martensite ; (2) a combination of troostite and osmondite ; (3) combination of sorbite and pearlite. Mr. J. E. Stead pointed out that the researches carried out in this country as to the composition of the carbon iron phosphorus eutectic, and other researches in connection with the iron phosphorus and carbon phosphorus alloys, had been confirmed by the work of Dr. Wüst during recent years.

It is interesting to note that the question of simplifying the nomenclature of metallography was discussed at a private meeting in which most of the eminent metallographists, including MM. Charpy, Guillet, Heyn, Stead, and Rosenhain took part, and it was decided that the only names to be accepted as of international significance should be ferrite, graphite, cementite, austentite, martensite, pearlite, and osmondite, and a resolution was ultimately passed in which the international definitions of these constituents were set out. Copies of these definitions will be circulated in the three official languages of the Congress—French, German, and English—and the results of metallographic investigation in different countries will in future be made more readily comparable.

The second paper in the Metallographic Section was one on "Special Steels," by Professor Leon Guillet. It was pointed out by the author that much had been done in the direction of simplifying the thermal treatment of pearlitic steels. The manufacture of special steels for structural purposes turned more and more in the direction of pearlitic steels, among which the nickel-chrome steels occupied a position of increasing importance. He pointed out that gamma iron steels were losing ground, and that their use for steam turbine blades was being abandoned. Few new types of steel had been created during the past three years, but there had been a great commercial development of vanadium steels, particularly in the United States, and of the nickel steels with or without chromium.

The third paper in this section was by Mr. Lawford H. Fry on "The Heat Treatment of Spring Steel," being an account of a series of tests carried out at the Baldwin Locomotive Works to determine the effect of certain heat treatment on the transverse elastic limit and on the modulus of elasticity of the steel commonly used in America for locomotive carrying springs. The results of the experiments indicated once again that to obtain good and uniform results it is necessary to have means of heating the steel uniformly to the proper temperature, and cooling it at the desired rate in a cooling medium the temperature and heat conductivity of which can be kept reasonably constant.

In the fourth paper Dr. Walter Rosenhain discussed the importance of slag enclosures in steel. He said that, while some metallurgists appeared to regard slag enclosures as practically harmless, he had repeatedly expressed his views as to their dangerous nature, and recent experience of some definite cases of failure arising from the effects of slag enclosures led him to bring the subject before the International Association. While the work of those who had investigated the problem had thrown much light on the nature of these enclosed impurities, there was still room for doubt as to their true nature and origin, and further study of the subject was obviously required. Professor Guillet, in opening the discussion on the subject, said there was no doubt that slag enclosures had been the cause of various failures. He quoted a case of ships' plates of 42 kilos. per square millimetre resistance, with 20 per cent. elongation, where the plates corroded near the rivet holes. They were found to be full of slag and to have no shock resistance even after annealing. Mr. J. E. Stead said he had investigated this subject for a good many years, and there were no doubt great practical difficulties in the way of getting rid of the trouble. The suggestion he had put forward was to take means to prevent air reaching the steel, as, in his view, the enclosures resulted from the introduction of oxygen into the steel either during the melting or the teeming process.

As the result of the discussion, and the general recognition of the importance of the subject, it was decided on the proposition of the author that the Association should appoint a commission to investigate slag enclosures and their effects upon the mechanical properties of metal.

The subject of international specifications for iron and steel was next discussed in connection with the report of the committee which has had this subject in hand for some considerable period. The report was brought up by Dr. Rieppel. The difficulties of the subject are very widely recognised, and up to the present time very little has been accomplished. In order that the subject might be more adequately discussed, a special meeting, under the presidency of Mr. Webster, was held later in the week. It was pointed out by Mr. Webster that what the committee desired to do before taking any definite steps in the matter was to obtain a representative specification from the various countries represented on the committee. A long discussion took place on the various points involved. At the present time the only countries which have arrived at standard specifications for iron and steel are Great Britain, Germany, and the United States, but it appears that in other countries the difficulties are not so great as might have been imagined. Prof. N. Belelubsky, on behalf of Russia, said that no time should be lost in collecting the necessary data and presenting them to the commission, and another delegate from Russia said that the Government and manufacturers were already in co-operation in regard to draft specifications. Inasmuch as the Government took a very large proportion of the total output it was thought there should not be any great difficulty in arriving at representative specifications. M. Adolphe Greiner said that in Belgium the Government were very large buyers of material and their specifications were generally accepted. In Italy he believed the specifications were Government specifications. In France the matter would be somewhat more difficult because the Government had not the strength to maintain what might be termed standard specifications. The matter was, however, under consideration in France, and no doubt the leading manufacturers would be able to arrive at a decision in the matter. Dr. Dudley pointed out that the success attained in this direction in America was due to the work done by committee. Mr. F. W. Harbord said that the object was to push the work forward as rapidly as possible, and what was really wanted was that those countries which had not got standard specifications would follow the example that had been set by England, the United States, and Germany, and form a body which would set up a standard specification for each material. Until each country had agreed upon a specification of that sort no progress could be made, as it would be impossible for a committee to differentiate between various specifications coming from a single country. He moved a resolution that steps be taken to obtain single specifications for each material from each country. Mr. Stead seconded this resolution, and it was carried.

The only definite steps taken by the Congress in connection with specifications up to the time of this meeting was to the effect that the committee take steps to inquire into the possibilities of specifying pig iron by analysis in place of grading by fracture, a subject which evoked a great deal of discussion ; but the whole subject came up again at the final meeting on Saturday last, and it was decided to do no more at the present time than obtain single specifications from all the countries interested for each material for the purposes of export trade only, and there was a general recognition of the fact that the framing of international specifications was a task which at any rate should not be entered upon at the present time. There was a feeling that the commercial considerations offered a real stumbling block. The suggestion which had been put forward that this committee should undertake the standardisation of pipe threads was negatived. Mr. Leslie Robertson, who was present at the Congress in a consultative capacity, as representing the Engineering Standards Committee, pointed out that a commission convened by the Society of Gas Engineers in France had recently been sitting in Paris, at which most countries were represented, at which that subject received particular attention. Another conference was to be held in the near future, and meanwhile Germany and the other countries interested were to consider the whole question and put definite proposals before the next Commission. His view was that it would be far better to leave that matter for the Paris Commission. This course was assented to by the Copenhagen Congress.

Another specification brought forward was that of the Copper Committee, which was presented by M. Guillet. This report was generally approved by the

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Congress, and there is little doubt that the specification put forward will be widely accepted. The bending test perhaps calls for further definition in respect to the distance from the root of the bend to the point where the two pieces touch, and possibly the Engineering Standards Committee may be asked to take action in that direction. It was decided that this committee should continue their work, and should extend their investigations into the question of copper alloys. It is scarcely likely that uniformity of specification will be obtained in this direction, but there can be no doubt that a great deal of useful information will be gained which would justify an inquiry into the subject of copper alloys.

The opening day in Section B—Cement, Stones, Concrete—presided over by Mr. T. Grut, was devoted to consideration of problems in connection with reinforced concrete. The report of the committee bringing the subject up to date was presented by Professor F. Schüle, who has served as chairman since the resignation of M. Considère last year. The committee have established a programme of work, which includes the following subjects:—(1) The general study of the properties of reinforced concrete, tested by bending, compression, shearing, &c., that is to say, by external forces; (2) the study of the physical properties of reinforced concrete, especially of the influence of temperature, of shelter from the air, and of expansion under water; (3) the study of the influence of external agents, such as fresh water, salt water, aquecus vapours, smoke, sulphurous acid, ammonia, oil, tar, and electric currents; (4) the study of accidents and their causes; (5) the study of practical methods for the testing and the periodical inspection of reinforced concrete. These investigations have already been made the subject of work in several countries, and the Association has been at some pains to limit its work in the manner indicated, in view of the immense field of labour which is opened up by the admission of the study of reinforced concrete to its programme. The report was supplemented by valuable appendices dealing with work in Germany, Italy, Denmark, Holland, and Switzerland, and casualties in reinforced concrete building were discussed in a paper by Dr. Fr. v. Emperger.

The meetings of this section were largely attended, and no fewer than sixty members gave in their names to take part in the discussion, showing the increasing interest taken in this subject. There was little discussion on matters of detail, the object rather being to systematise methods of testing, so that the results of experiments carried on in different parts of the world may be made comparable. The discussion was contributed to by Messrs. Kirsch, Segre, Hüser, and Rabut. Mr. E. O. Sachs emphasised the necessity of obtaining a summary of the research work already done in the different countries as promptly as possible, with a view to preventing the overlapping of experimental programmes. It was obvious, he pointed out, that to obtain a summary of this character would be somewhat costly, and in his opinion the International Commission of Reinforced Concrete would require some support from the Congress of a financial character. A resolution was eventually proposed that the Congress approved of the work of the International Commission, and the programme of future work set out in Professor Schüle's report, and that a summary be obtained at the earliest possible date of the research work already carried out in different parts of the world. The resolution strongly recommended all the authorities and societies concerned to assist the International Commission both with information and, if possible, financially.

The meeting then proceeded to a consideration of several papers dealing with the effect of sea water upon cement, and a notable contribution in this group was a report on the trials carried out by the Society of Scandinavian Portland Cement Manufacturers, giving the results of ten years' experiments. The subjects covered in this report, presented by Mr. A. Poulsen, include mortar and concrete tests. It was shown that the chemical action of sea water alone was not able to destroy mortar. The destruction of the mortar was shown to be mainly due to the mechanical influence of frost, and the destruction of the concrete blocks used in the tests was also held to be sufficiently explained by climatic influences. The long discussion which followed the presentation of the papers dealt largely with matters of detail, a point particularly discussed being the precise amounts of sulphate and gypsum permissible in Portland cement to be used for structures exposed to the action of sea water, and many well-known authorities on the subject participated in the discussion, including Herr Dykerhoff, Professor Gary, M. Rabut, and M. Feret. M. le Duc asked for additional experiments with specially prepared cement, to be introduced into artificial sea water. Mr. Sachs suggested the formation of a commission to summarise the various papers presented at this and previous Congresses, and that this summary be brought up to December, 1910. It was suggested that the same Commission should also inquire into the experience obtained with sea water Portland cement structures of greater age than twenty-five years. After considerable discussion it was decided, on the resolution of Mr. Humphrey, secretary of the General Committee of Reinforced Concrete in America, that this Commission be constituted and be charged also with the work in connection with special Portland cement as proposed by Mr. le Duc. It is understood that this Commission will consist of nine members, and it is hoped that by having all the available information collected and brought up to date, that the discussions, which have hitherto been of a somewhat academic character, may be made more practical at future meetings.

The meeting of the International Commission on Reinforced Concrete referred to above was held in Copenhagen prior to the meeting of the Congress, Professor Schüle presided over the meetings, some twenty-six members, representing fourteen countries, being present, so that it was a thoroughly representative gathering. The main object of the Commission is to bring about a uniformity in methods of investigation in the different countries to obtain a unified algebraical notation, to draw up a scheme of the tests still required to complete the data necessary, and finally to arrive at some uniform method of publishing the reports on such tests. The dissimilarity in the method of presenting results is at the present time the cause of much confusion, and a necessary preliminary to making the experiments of use to the whole industry is the presentation of the data in a form in which it will be available for comparison. Regret was expressed that the Institution of Civil Engineers in this country, which has recently appointed a committee to inquire into the whole subject of reinforced concrete, and which had appointed Professor Unwin as delegate, was not represented. The feeling was that, having regard to the investigations to be undertaken by the Institution of Civil Engineers and the National Physical Laboratory, it would have been well if this research work could have been arranged on international lines. Regarding this question of notation, an agreement will, no doubt, soon be reached, inasmuch as Germany, France, Italy, and the other continental countries have arrived at a common form of notation. The divergent element is at the present time represented by the practice of the United States and Great Britain. As far as Great Britain is concerned, the Concrete Institute have made some effective proposals for the consideration of the Commission, and it is suggested that Great Britain and the United States, if they are unable to fall into line with the continent of Europe, should set up a notation common to both. In that case there will be two standard forms of notation, one for the English-speaking countries and the other for continental countries; or possibly something may be done in the adoption of a three-letter system by way of compromise. On the question of summarising the results of tests already carried out, those countries which have not yet presented their summaries were urged to do so in the near future. When that is done, a form in which the results of tests should be presented for the purposes of unification will be prepared by Professor Schüle for the consideration of all those engaged in the work. It has been arranged that the commission shall meet at least once each year, probably in Europe in 1910 and 1911, and in America in 1912, where it has been decided that the next congress of the Association will take place. Professor Schüle was re-elected chairman of the commission for the next period of three years.

The report of the committee dealing with the uniform nomenclature of iron and steel was presented by Professor Henry Howe. He outlined the progress that had been made since the first report was presented at the Conference held in Brussels in 1906. Particular reference was made to the definition of blister steel. The committee pointed out that just as cast iron properly included all very highly carbonised iron, in spite of the fact that such material may never have been cast, so Bessemer steel which had been carbonised by the cementation process ought to be called blister steel, in spite of its freedom from blisters. The opinion of the Congress was asked for on that particular point. Broadly speaking, the committee had done little more than collect information with a view to future action.

Mr. J. W. Richards, in opening the discussion on the report, said that all the committee had done up to the present time was to discover the existing state of confusion in nomenclature, and while that was certainly the first step towards uniform classification, he hoped that more would have been achieved. Action in the matter had been slow, and the existing state of confusion was being added to. He instanced the case of electric steel, an expression which was used very loosely. The committee had, however, done nothing to avoid this condition of affairs, and, indeed, the term electric steel or electric furnace steel was not even mentioned in their report. The present nomenclature of iron and steel was largely a question of nicknames, and it was necessary for the committee to produce a scheme of nomenclature which would meet all contingencies and would take note of the introduction of new material, because if scientific men did not provide a name for them the commercial world would. In connection with this report MM. Alexandre Pourcel and Adolphe Greiner circulated a statement dealing with the whole subject, and pointing out the objections to some of the existing and proposed definitions. Finally, a proposal was put forward that the committee, consisting of the Iron and Steel Institute, Comité des Forges de France, Verein Deutscher Huttenleute, Jern Kontoret, and the American Society of Mining Engineers be appointed to deal with the matter. Mr. F. W. Harbord, who is a member of the committee, made a short statement dealing with the difficulties of the position, pointing out that the whole subject required very careful consideration before the report was endorsed by the Congress. Ultimately it was decided to seek the assistance of representative institutions in the countries interested, and to bring the whole subject up again at the next Congress.

The visits arranged for the afternoon of Wednesday, September 8th, included an inspection of the Free Port of Copenhagen. The area of the Free Port comprises 88 acres land and 61 acres basins, with a total length of quays of 3.8 kiloms. The depth of water in the various basins varies between 24ft. and 30ft. The breakwater at the entrance to the harbour is constructed from hollow concrete blocks, each weighing 35 tons. The warehouses and sheds cover an area of 107,500 square metres, and there are besides grain silos, with a storing capacity of 18,500 tons. The equipment includes a large number of bridge cranes ranging in capacity from 1.5 to 20 tons and 7 Hunt's coal discharging cranes. Another visit was to the new Central Railway Station now in course of construction. This is designed as a twelve-track through station, and will greatly facilitate the handling of traffic in Copenhagen.

In the evening a reception was given in the Town Hall by the Copenhagen City Council. Over-President Oldenburg offered a formal welcome to the large number of guests who accepted the invitation, and this was acknowledged by Dr. Dykerhoff and Mr. Greiner on behalf of the Association.

SHIPBUILDING NOTES.

SINCE these notes last appeared quite the most interesting event to shipbuilders has been the determination of the Cunard Company to build a vessel to replace the Slavonia, wrecked in June of this year. The Slavonia, which, by the way, was originally named the Yamuna, and was built by Sir J. Laing and Sons in 1903, was bought by the Cunard Company, and was, as will be seen, a comparatively recent ship. The new vessel will be considerably larger than the Slavonia, the dimensions being 601ft. by 71ft. by 44ft., as against 510ft. by 59.5ft. by 33.3ft. The dimensions of the new vessel, which is to be built at the Wallsend yard of Swan, Hunter and Wigham Richardson, Limited, approximate somewhat to those of the Campania, but she will be 6ft. greater in breadth and about 2ft. deeper.

IT is in the nature of a truism that naval design is essentially a matter of compromise, and certainly nothing illustrates the fact more clearly than some of the details connected with the construction of a vessel such as we refer to above. The builder has to solve problems, some of the conditions of which appear at first sight to be absolutely inconsistent with each other. He has to satisfy the owner's requirements as regards the number of passengers to be carried of different classes, the arrangements for their dining, recreation, &c., with only a strictly limited space at his disposal. In order to carry the requisite number he may be compelled to build tiers of superstructures upon the upper deck of the vessel, and having done so, he must guarantee sufficient initial stability to the vessel. The principles of sound design would teach him that the most economical distribution of material would be to incorporate the erections in the structure of the vessel, while the necessity for fulfilling his stability conditions impels him to make them of as light scantlings as possible in order that his centre of gravity may be kept low. We can recall the cases of several vessels where these conditions were found to be so incompatible that long superstructures extending over a considerable part of the vessel's length were constructed of comparatively light materials. We do not know the arrangements proposed in the new vessel, but it may safely be conjectured that the finished product will reflect credit upon the technical advisers of the company.

BEFORE leaving this vessel two further features of interest may be referred to. The first of these is the nature of the machinery to be fitted. Being a vessel of the intermediate type, steaming 16 knots, it appeared a suitable case for the introduction of the combination system, and it has been widely stated that a combination of turbine and reciprocating engines was to be adopted. It is now understood, however, that it has been decided to revert to the ordinary arrangement of twin-screw reciprocating engines. It can hardly be doubted that the matter has been very fully discussed, and this decision supports the opinion expressed here and elsewhere, that it is doubtful whether the economies effected by the adoption of "combination" machinery are of sufficient magnitude to be a suitable set off to the increased first cost of the machinery—an increase, in this case, bound to be very considerable.

THE second question is concerned with the water-tight subdivision of the vessel. The Cunard Company has always made a point of having this carried out in a highly efficient manner, and in this respect its example might well be copied by some other owners. The new vessel will be no exception to the rule—the water-tight sub-division approximating to the degree of efficiency characteristic of his Majesty's ships.

THE output from Scotch shipbuilding yards for the eight months of the present year approximates very closely the output for the same period last year, the total being 222,300 tons, as against 223,900 tons in 1908. The average size of vessel, however, is greater this year than last, since the tonnage for 1908 is in respect of 186 vessels, while that for 1909 represents 145 vessels only. Several large cargo vessels have recently been launched, notably the Ruahine for the New Zealand frozen meat trade. Messrs. C. Connell and Co. are to build a 9000 tons steamer for the Donaldson Line. The construction of this steamer has been contemplated for some considerable time, and she will be similar to the latest vessel of the Donaldson fleet, the Cassandra. Messrs. D. W. Henderson are also proceeding with the construction of a large steamer for Portuguese owners. Altogether, it appears that the Clyde is having a satisfactory proportion of new contracts.

THE two new Channel steamers for the London and South-Western Railway Company, which have been the subject of keen competition, are to be built by Cammell, Laird and Co., Limited. The vessels are to be fitted with turbine engines—they will be the first of the company's fleet to be so fitted—and they will be built under the supervision of Professor J. H. Biles. Amongst other contracts at present in the market is a proposal for a 10,000-ton ore-carrying steamer for British owners. This is of the largest size for this particular trade, being considerably over 400ft. in length, and the internal arrangements are bound to prove interesting. The trouble in these vessels is their excessive stiffness due to the position and density of the cargo. We recall a case in which this was so pronounced that it was proposed to sacrifice half the capacity of the vessel and to carry the ore in a central longitudinal compartment, in width about one-half the breadth of the vessel, so as to secure a proper disposition of the cargo.

IT was a matter for general regret at the combined meetings recently held of the North-East Coast and Clyde Shipbuilders and Engineers that illness prevented Mr. John Ward, the well-known member of the firm of Messrs. William Denny and Bros., from taking the chair. Since then Mr. Ward has been progressing favourably, and his numerous friends in the profession and elsewhere will be glad to learn that he will shortly be able to resume active participation in business affairs.

IT is noticed with pleasure that the reputation of the Fairfield Company as builders of fast cross-Channel steamers is in nowise diminished by the results on trial obtained from the first of the three vessels it is building for the Zeeland Steamship Company's service between Flushing and Queenborough, to which reference has already been made in this column. The maximum speed attained by the Prinses Juliana was 22½ knots, which, with reciprocating engines, is a very satisfactory result.

ON the 9th inst. orders were placed by the Admiralty for twenty destroyers authorised by the programme of the present year. The placing of these had created considerable expectancy, and, so far as geographical considerations are concerned, the distribution could hardly be improved upon. Nine have gone to the Clyde, distributed amongst the Fairfield Company (three), Messrs. J. Brown and Co. (three), Messrs. Denny Bros. (two), and Messrs. A. and J. Inglis (one). Of the remainder, Messrs. Thornycroft, of Southampton, have four, Messrs. White have three, Hawthorn, Leslie and Co. have three, and Swan, Hunter and Wigham Richardson, one. Messrs. Inglis have thus secured their first order for a vessel of this type, but their previous experience with steam turbines should stand them in good stead. The whole represents an expenditure of well over two millions sterling—a substantial contribution to the winter's work.

OIL-FRICTION TESTING MACHINE.

By WILLIAM ALEXANDER, A.M.I.C.E., A.M.I.M.E.

A MACHINE devised to test the friction generated at bearings under different conditions of lubrication should fulfil certain requirements, depending on whether it is intended for commercial or purely educational work. For commercial purposes the machine should allow of testing the suitability of lubricants simply in the matter of friction, and the practicable maximum bearing pressure at different speeds and temperatures. Such information is enough to determine the best lubricant for a particular purpose. For educational work, however, provision should be made for the study of, or even a research on, all the changeable factors that influence journal friction and safe bearing pressure.

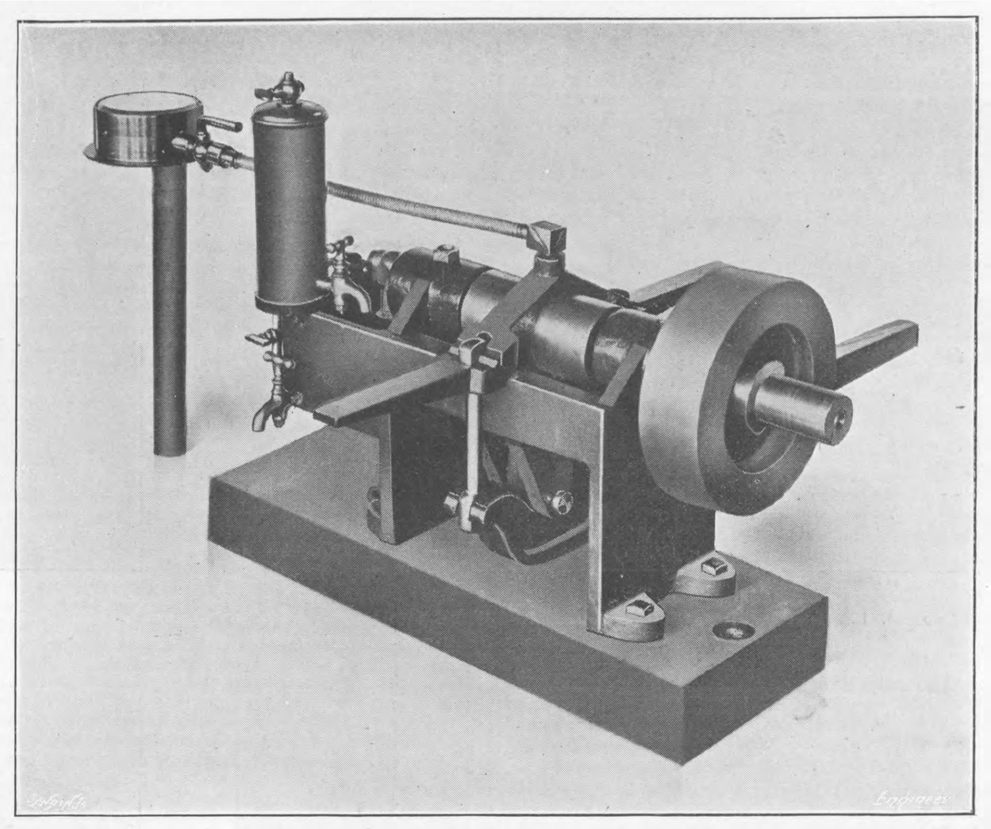
The several available factors that affect the results are:—

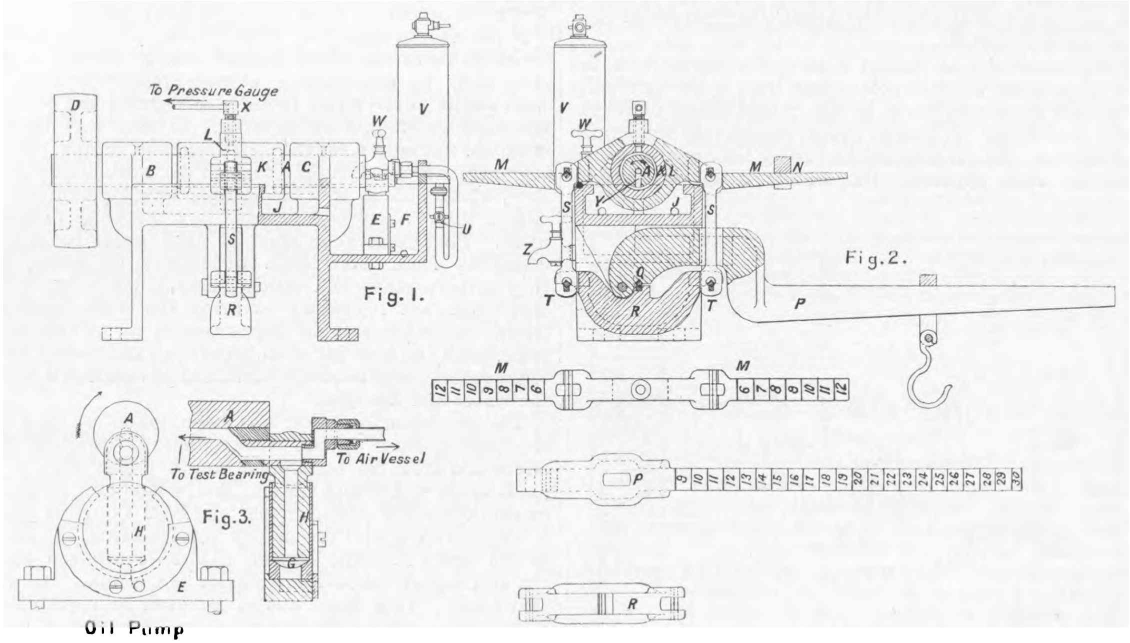
1. Nature of the lubricant.
2. The method of lubrication, and quantity and pressure of lubricant.
3. Temperature of lubricant at the bearing surfaces.
4. Pressure intensity on the bearing.
5. Surface speed at the bearing.
6. Proportions and nature of the bearing.

The varying conditions indicated all obtain in the running of machinery, and they should be capable of being reproduced to any desired extent in a testing machine. No apparatus, as far as the writer is aware, provides for the investigation of all the variables enumerated. For instance, in none is forced lubrication provided, and in few are there arrangements for keeping the temperature of the bearing constant at any desired value.

A commercial machine need not be complete in the above respects. Variations under the second and third heading are not required. One so called "perfect" method of lubrication and one bearing is sufficient, since, first, Tower has shown that practically the same results are obtainable with "splash" and efficient "pad" lubrication, in both of which a continuous oil film is interposed between the relatively rotating surfaces, and, secondly, only a comparative value of the oil as a lubricant is required.

OIL FRICTION TESTING MACHINE





Figs. 1, 2, and 3—OIL TESTING MACHINE—DETAILS

In a machine for students' use the investigation of all the variables that might affect the results should be provided for. The justification, then, for introducing forced lubrication, with either constant or fluctuating pressure, in the oil-friction testing machine is that, although either splash or pad lubrication gives nearly the same friction values as the first mentioned system, yet a student should have the opportunity of ascertaining this fact for himself. Another important reason arises from the consideration of the extended use of forced lubrication in modern machinery.

The machine to be described has been designed to fulfil most of the requirements mentioned above. It is one of several, designed for different purposes, and made in the mechanical workshops of the Wellington Technical School, New Zealand, by the students and workshop instructor.

In Figs. 1 and 2, the shaft A, which is 1½in. in diameter, is supported in the bearings B and C, and is driven by the fly-wheel pulley D. An excentric pin on the end of the shaft drives the specially devised pump E, which works immersed in oil contained in the oil chamber F. The pump is simple and compact, the trunnion or pump journal surrounding the barrel. The oil is drawn into the pump barrel G, Fig. 3, and forced up through the plunger H on the down stroke, thence through the excentric pin and shaft to the experimental bearing K. The bearing K is held in a yoke L, with arms M M, provided with knife edges. The weight N is adjustable in position, so that when the yoke is kept floating between the stops formed by the sides of the machine frame, the friction generated at the journal can be balanced and measured.

Load is applied to the test bearing by means of the lever P, which acts through a knife edge Q, on the middle of the beam R, the ends of which are supported from the yoke by suspension rods S, through knife edges T.

It was thought when the machine was devised that the method of applying the load, by means of the parallel linkage just explained, was novel. Professor Goodman, however, first devised the method, although the knife edge Q in his machine is not in line with the edges T.

When forced lubrication is being experimented with the pressure may be either constant or fluctuating. In the case of constant pressure the cock U is left open, when the air vessel V is brought into action. For fluctuating pressure U is closed. The quantity of oil supplied to the test bearing can be varied by adjusting the opening of the by-pass tap W, which returns the oil to the oil chamber. To enable the pressure of the oil supply to be ascertained the locking pin X is made hollow, and the upper end is connected to a pressure gauge, as shown in Fig. 4. Ordinary lubrication is provided through an interchangeable hollow locking pin arranged for the purpose. In this case any oil previously in the oil chamber is run off through the tap Z. For pad lubrication a fitting containing the pad is placed in the trough J underneath the shaft. Temperatures are ascertained by means of thermometers inserted in holes drilled in the bearing.

The foregoing description applies to the machine as constructed. In the few experiments that the writer had time to make before returning to England the balancing of the yoke between the stops was steady, and accurate readings of the friction generated at any time were obtained. In this latter respect the machine is much superior to those in which the deflection of the load indicates the friction, since in that type the load oscillates, and causes much trouble in reading the deflections.

A difficulty was experienced in that the temperatures could not be adjusted to any desired value. To overcome this defect the supporting bearings B and C should have controllable water circulation through them. For ordinary and for pad lubrication water would be pumped through the shaft to the bearings B and C from the chamber F, into and out of which a continual stream of water would be running. The passage Y, used for forced lubrication, of course, would be plugged.

Variable speeds were obtained by running off different sized pulleys in the workshop. More convenient methods of driving would be obtained by means of either a coned speed pulley on the shaft, or a variable speed electric motor directly connected to the shaft, as in the driving of other testing machines.

STATUS PRIZE.—It will be remembered that this year and for the next four years the Council of the Society of Engineers instituted a prize for the best essay on "How to Improve the Status of Engineers and Engineering, with Special Reference to Consulting Engineers." As the result of this year's competition, Mr. G. Allan Thomas, M.C.M.E.S., has been awarded the prize, and he will read his essay at the meeting of the Society to be held on 4th October at 7.30 p.m. at Caxton Hall, Westminster.

LOCOMOTIVE WORKS ADMINISTRATIVE OFFICES.—A new suite of administrative offices, which has been under construction for some time at the Hydepark Works of the North British Locomotive Company, Limited, was formally opened by Lord Rosebery on September 11th, immediately following his address on the Budget in the Glasgow City Hall, the chairman on the occasion being Mr. William Lorimer, chairman of the Locomotive Company. The new buildings are situated between Flemington and Adamswell streets, close to the works. The main frontage is towards Flemington-street, and the block is four storeys in height. On the ground floor are the orders department, photographic rooms, catalogue and plans rooms, &c. There is also a large hall to be used for meetings of the staff, capable of accommodating about 1000 persons, and it was here, in presence of a company which completely filled it, that Lord Rosebery spoke, and Mr. Lorimer declared that the occasion would be a red-letter day in the records of the company, which was formed by a combination of three firms which had long been engaged in Glasgow in the manufacture of locomotive engines. The combination, he said, had made the works the largest of the kind in Europe. The first floor of the handsome premises contains the managing director's room, chief secretaries' room, and general offices. On the second floor there is a fine suite of directors' and secretaries' rooms, library, dining and smoking-rooms. On the same floor are also recreation and reading rooms for the servants of the company. The third or top floor is entirely occupied by the general drawing-offices, which are, perhaps, the largest of their kind in the country, having an area of 25,600 square feet. Special care has been given to the lighting of this department, both by natural daylight and by artificial means. The disposition and design of the windows and the methods of artificial lighting are matters which have received particular attention. The lighting is so arranged that no shadows can fall on the draughtsmen's desks. The heating and ventilating arrangements of the buildings have also been carried out on scientific principles. A quadrangle, 137ft. by 86ft., is no less noteworthy. The buildings have been erected from plans prepared by Mr. James Miller, A.R.S.A., Glasgow, the contractors being P. and W. Anderson, Limited, Glasgow. It may be added that following upon Lord Rosebery's remarks, Mr. Hugh Reid, of the North British Locomotive Company, presented to his lordship a silver casket containing a selection of photographs of typical Glasgow-built locomotives now in operation all over the world.

IRRIGATION IN THE UNITED STATES OF AMERICA

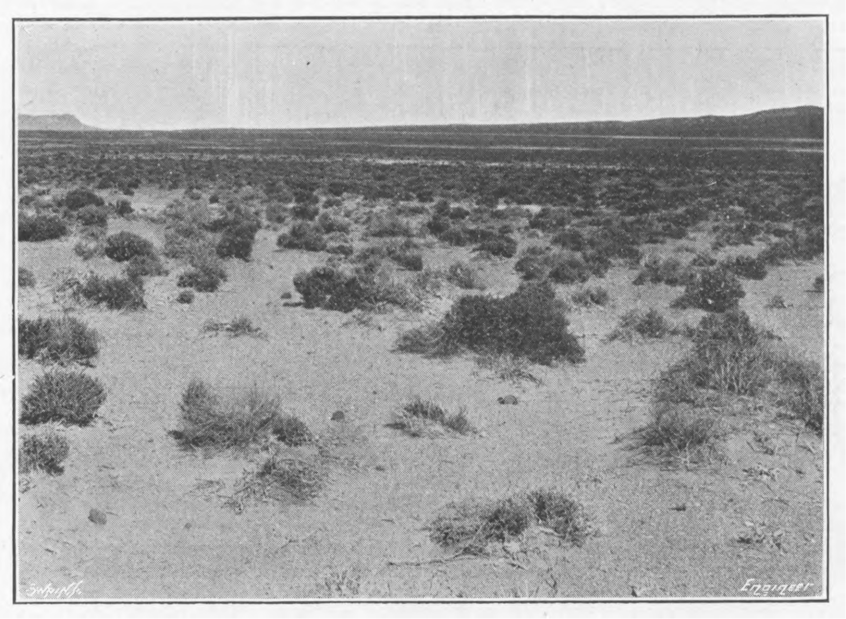

Swain Sc.
Engineer

Fig. 1—NEVADA DESERT. BEFORE IRRIGATION

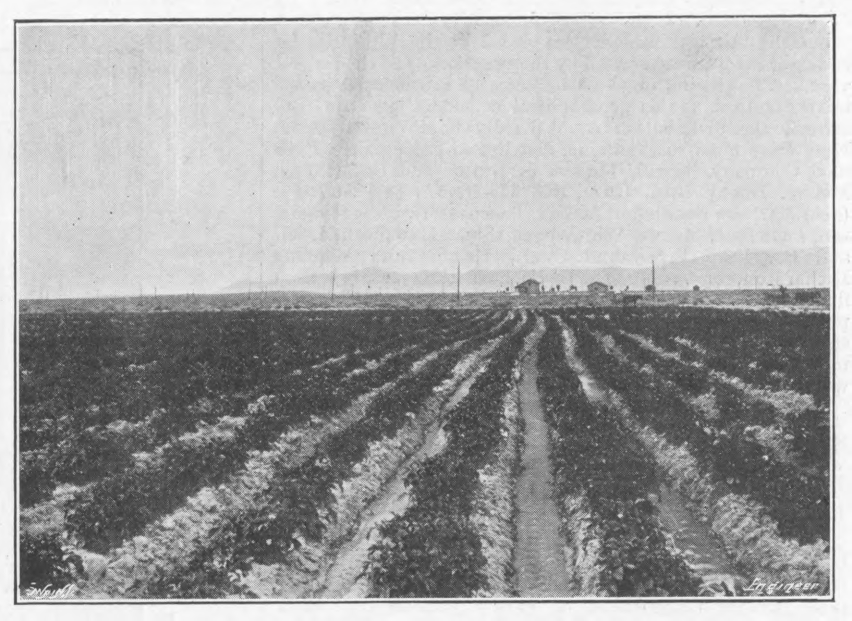

Swain Sc.
Engineer

Fig. 2—AFTER IRRIGATION—NEVADA

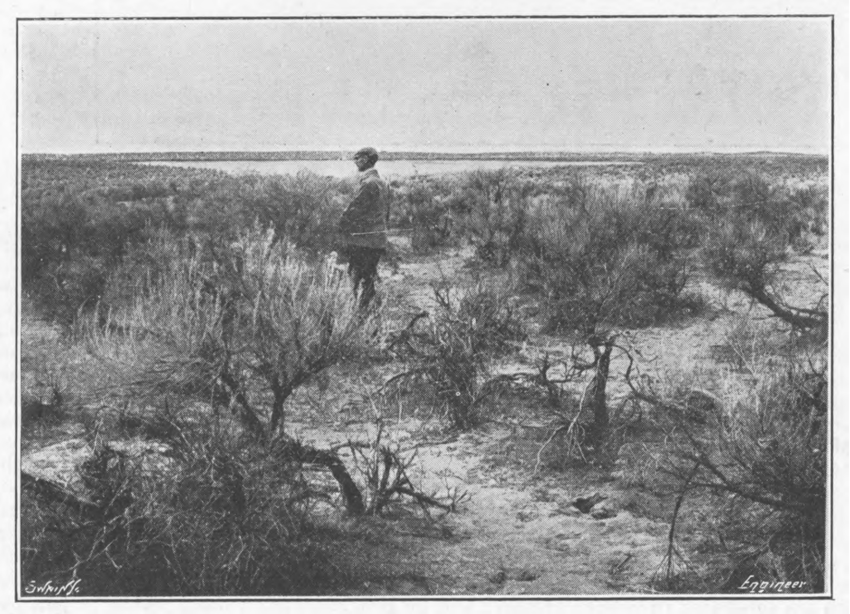

Swain Sc.
Engineer

Fig. 3—ARID REGION OF OREGON

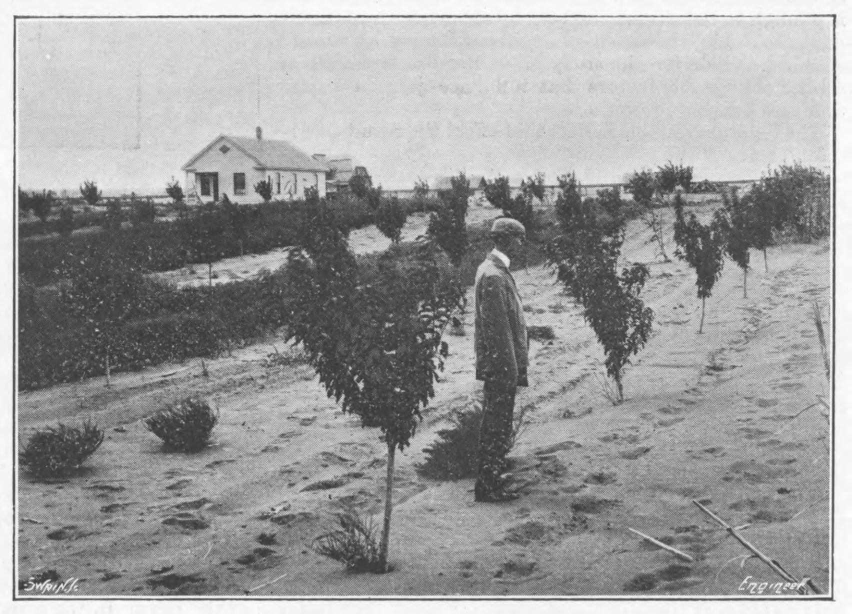

Swain Sc.
Engineer

Fig. 4—ORCHARD ON IRRIGATED LAND—OREGON

IRRIGATION WORKS OF THE UNITED STATES GOVERNMENT.

No. I.

DURING the past few years the Government of the United States have been prosecuting an active policy of land reclamation by the introduction of irrigation in the arid and semi-arid regions of the western part of the country in order to open up these regions for settlement. These regions lie between the Missouri River valley and the Rocky Mountains, and in the south-west section of the country. The "Great American Desert" of old-time geographies has dwindled to comparative insignificance with the intrusion of population along its borders, and vast areas of deserts and arid districts are found to be capable of conversion into agricultural districts of exceptional fertility by the application of water. For this agricultural development, of course, a large and regular supply of water is absolutely necessary. This is now being obtained by the Government; mainly by the establishment of great storage reservoirs in the mountains, and partly by pumping from underground waters which are found in many places. Extensive engineering works in the way of dams, tunnels, aqueducts, canals, &c., are required to hold and store the water, and to bring it to the systems of canals or ditches by which it is distributed throughout the irrigation districts.

On nearly 30 per cent. of the area of the United States the mean annual rainfall is less than 20in., and in a large portion of the arid region—in the great interior basin and the south-west—it is less than 10in. In some parts, such as sandy desert wastes, which produce nothing but cactus or sage brush, it is 3in. to 6in. Even where the larger amount of rainfall prevails, the best lands are valuable mainly for grazing in summer. With a regular and sufficient supply of water, applied artificially by means of irrigation, the region develops great agricultural resources, owing to the great latent fertility of the soil, and to the large amount of sunshine which prevails. Cultivation or farming is precarious—and impracticable on a large scale—in such country when dependent upon a scanty and uncertain rainfall, and upon rivers which have a variable flow, ranging from an almost dry bed to a destructive flood. Under the changed conditions consequent upon irrigation, the lands in many cases become specially suitable for raising high-class products, such as fruit.

In many of the irrigation districts the climate has a temperature variation from 25 deg. below to 100 deg.—or more—above zero, Fah. In others the range is from 20 deg. to 120 deg. above zero. The sensible variation is considerably less, however, owing to the fact that the dryness of the atmosphere in the arid region renders the extremes of heat and cold much less trying or perceptible than in regions where there is greater humidity. The extremes also are exceptional, while the average temperatures continue for long periods.

Irrigation is by no means a new development in the arid region, as considerable areas have been gradually reclaimed in various parts by the introduction of irrigation—sometimes on a large scale—by private enterprise and capital. In such cases the supply has been obtained from the river channels, the waters being diverted by dams and canals and distributed over certain districts. In many of these cases, however, the river supply is limited and uncertain, and irrigation capacity must depend largely upon the flow at low-water periods. If anything beyond this is attempted there is constant danger of disastrous loss of crops due to insufficient water. Many of the rivers also have severe flood periods; but the high water passes off too rapidly to be utilised, even if it does not cause extensive damage by inundating and washing away the land, or destroying dams, headworks, canals, and other works built for irrigation purposes.

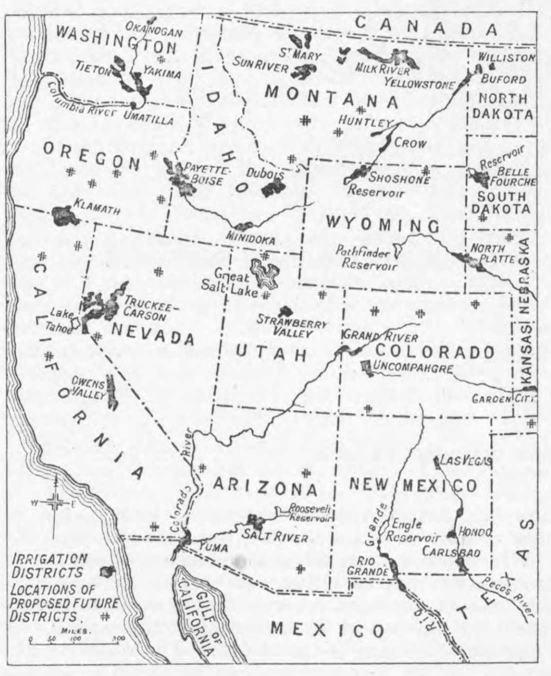

CANADA
WASHINGTON
OKANOGAN
TIETON
YAKIMA
Columbia River
UMATILLA
ST MARY
SUN RIVER
MILK RIVER
YELLOWSTONE
WILLISTON
BUFORD
NORTH DAKOTA
MONTANA
HUNTLEY
CROW
IDAHO
OREGON
PAYETTE-BOISE
Dubois
SHOSHONE Reservoir
Reservoir
BELLE FOURCHE
SOUTH DAKOTA
KLAMATH
MINIDOKA
WYOMING
Pathfinder Reservoir
NORTH PLATTE
NEBRASKA
Great Salt Lake
TRUCKEE-CARSON
Lake Tahoe
NEVADA
STRAWBERRY VALLEY
UTAH
GRAND RIVER
COLORADO
UNCOMPAHGRE
KANSAS
GARDEN CITY
CALIFORNIA
OWENS VALLEY
Colorado River
ARIZONA
NEW MEXICO
LAS VEGAS
Roosevelt Reservoir
SALT RIVER
YUMA
Rio Grande
Engle Reservoir
HONDO
CARLSBAD
RIO GRANDE
TEXAS
Pecos River
W E
IRRIGATION DISTRICTS
LOCATIONS OF PROPOSED FUTURE DISTRICTS. #
MILES.
0 50 100 200
GULF OF CALIFORNIA
MEXICO

Fig. 5—GOVERNMENT IRRIGATION DISTRICTS

A permanent supply of water under control, that will be available as and when needed, can be obtained, as a rule, only by establishing storage reservoirs near the headwaters of the rivers in order to restrain and conserve the flood-waters and winter flow. In this way there is obtained not only a regular and regulated supply, but also a greatly increased supply beyond the normal low-water flow, which admits of a far greater development by irrigation than when the natural flow alone is depended upon. These reservoirs must in most cases be at great distances from the lands dependent on them, and they involve heavy and costly works, while other extensive works are necessary to bring the water upon the lands. Such projects are impracticable for private enterprise, partly on account of the great cost, and mainly owing to the interference between public and private rights in both the water and the land.

The irrigation question has been taken up in a very thorough manner by the Government, in order to open additional areas to settlement and to utilise part of the great areas of dry and desert land which are within the ownership of the Government. In 1902 Congress passed a law providing that the money received from the sale of public lands in some sixteen States—comprised within the arid region—should be set aside as a special "reclamation fund." This fund was to be used in investigation work, and in the construction and maintenance of irrigation works for the storage, diversion and development of waters for the reclamation of arid and semi-arid lands. The law provided that the lands thus reclaimed were to be sold under certain restrictions under the homestead laws, and in tracts of not less than 40 acres or more than 160 acres. In this way the settlers buy their lands direct from the Government, instead of renting or buying them from land and irrigation companies, whose purpose it is to make a profit from such sale or lease. The settlement is thus limited also to the ordinary or individual settler.

While the Government pay the cost of the works, it is recouped by the sale of the lands. The price of the land in any one district is determined by the cost of the works built to provide a supply of water for that district. The revenue thus obtained is turned into the Reclamation Fund, and becomes available for the construction of works for other districts. In this way the fund is made self-perpetuating. The payments for the land may be distributed over a term of not more than ten years. In addition to the price of the land, there is, of course, an annual charge for the water, and this revenue is applied to the maintenance and improvement of the works.

Each complete and individual scheme of irrigation is known as a "project," and at the present time about twenty-six projects have been undertaken. The works are in various stages of progress, some being only commenced or under investigation, while some projects are already supplying water to portions of their dependent areas. It is estimated that a total area of some 30 million acres of land will be reclaimed in this way. This is a vast area, and will most likely be increased; but it forms only a very small portion of that part of the country through which it is distributed. This is shown by the map in Fig. 5, on which the Government irrigation districts are shown by solid black marks. It is to be remembered, however, that this map shows none of the many private irrigation districts.

Nearly one million acres are now ready for irrigation, and it is estimated that over 20,000 people are established already in homes in the erstwhile "arid west" as the result of this work by the Government. More than twenty towns have been established, and over a hundred miles of branch railways have been built to connect trunk lines of railway with newly developed agricultural districts. The Government keep experienced farmers in each district for the purpose of instructing settlers who are not familiar with the special features and requirements of farming in these regions or on land under irrigation. In some of the districts, also, there are Government demonstration farms, upon which are grown the products most suited to the conditions of soil and climate of that particular district. In some districts there is general farming, while others are specially adapted to fruit farming.

The contrast between the lands before and after irrigation is shown in the four accompanying photographic views. Fig. 1 shows a stretch of sandy desert in Nevada, five miles south-east of the town of Wadsworth. Upon it grow bunches of sage brush. Fig. 2 is a view in the same district, showing a tract of land under irrigation and cultivation, producing a crop of potatoes. The straight dark line shows the meeting point of the natural and the cultivated land. The view shows also one of the typical farmhouses, and the poles of the telegraph and telephone lines by which the irrigation works are served, and by which most of the individual farms are in touch with the nearest neighbours, towns, and railway stations. This land is included in the Trucke-Carson irrigation district, the works of which will be described later.

Fig. 3 shows a stretch of sage brush land, with some scrub brush, in the Umatilla district in Oregon, which has been divided into five-acre tracts for cultivation. Fig. 4 shows one of these tracts under cultivation, and planted for an orchard or fruit farm. This land is included in the Umatilla irrigation district.

The irrigation work is in charge of the United States Reclamation Service, which is a bureau of the Department of the Interior. Mr. F. H. Newell—formerly Engineer-in-Chief—is the Director of the bureau. Mr. Arthur P. Davis is Engineer-in-Chief, and the bureau has a large force of engineers and scientific experts engaged in the preliminary investigations, in the laying out and construction of works, and in experimental work on various lines. Some of the construction work is done by contract, but many of the large enterprises are being carried out directly by the Reclamation Service, which employs its own forces under the management of its own engineers. In several cases contractors have abandoned the work, mainly because they had under-estimated the difficulties and cost of work in unsettled country. In these cases the Government have taken over the execution and completion of the work.

To obtain and hold a sufficient working force is one of the great difficulties of engineers and contractors alike. There has been so much railway construction that the demand for labour has exceeded the supply—as far as good material is concerned—so that on each job there is a continual stream of men coming and going. The work is hard, but one great advantage in it is the absence of the drinking saloons, gambling houses, and other "entertainments" which spring up at intervals along new railway lines, and in which the men find amusement and means of spending their money. Another difficulty is that a law limits the working hours on all Government work to eight hours per day. The men, however, expect to get as much pay as they would get for nine, ten, or more hours of work on a railway; if they do not get it they become dissatisfied and leave. There is no occupation for the enforced leisure hours, and as a matter of fact the men would rather be at work, and would be better off if thus employed. The law was demanded by the agitating labour interests to prevent "labour" from being overworked. While it is most desirable that men should not be overworked, this law seems to require them to be underworked. It undoubtedly has some good features, but its application indiscriminately to all Government work illustrates important defects in the system.

A specially interesting feature of the Government work on the Reclamation Service is the practice of cost-keeping, to show in detail the unit costs of the various items of work in each structure. From a report by the Director, Mr. F. H. Newell—formerly Engineer-in-Chief of the United States Reclamation Service—the following notes on this important subject are taken, which is being taken up more and more thoroughly by the engineers of companies and contractors in the United States.

Book-keeping is concerned with fiscal statements only. Cost-keeping analyses such statements to get at their meaning. It enables the engineer to select the most economical methods, and to select, arrange, and operate his machinery and men in the most economical manner. It enables him also to estimate and analyse the cost of proposed work with intelligence and precision. Engineering construction costs, therefore, are the fundamental data of estimates and execution of engineering work.

The design of a structure cannot be economically made without intimate knowledge of the comparative cost of building material in place. The designer must select concrete, stone, steel, or timber out of which to build his structure. These materials must be considered not from the standpoint of market prices only, but also from the standpoint of permanency and cost of erection. All economical designs are therefore equational functions of variable cost data, the empirical constants of which are necessarily derived from preceding records.

The various structures of any engineering project having been designed properly, the estimate of the cost of the whole, with the varying elements entering into the same, can be determined only by a careful consideration of past information along similar lines. The matter of determining the amount of capital necessary to carry on the work, the expense of the executive force, in addition to mere cost of labour, materials, and supplies, must all be largely inferred from the knowledge obtained from preceding experience as formulated for such use.

The constructing engineer is equally concerned in engineering costs. He must know the kind of machinery adapted to a particular kind of work, and must know how to place and manipulate it economically. This he can know only from previous records of output, or what is known as engineering costs or data. In the study of the organisation of men the efficiency of the organisation can be determined only by careful cost records and comparison with the cost of similar work.

The keeping of engineering construction costs has not yet crystallised into uniform methods. There are about as many practices of compiling information of this character as there are engineers who keep cost records. The degree of completeness and the degree of analysis are so uncertain that valuable comparison is almost impossible. This condition is very unfortunate for the engineering public, and the leading engineering societies of the country could render a good service to the engineering profession by unifying engineering cost-keeping methods.

A comprehensive method of cost keeping must necessarily be based on a logical analysis of the elements of cost pertaining to the work under consideration. The degree to which the analysis should be carried depends on the purpose for which the cost is being compiled and on the magnitude of the work. On small jobs a close analysis is both practical and desirable, but on large works of varied character, such as those being constructed by the United States Reclamation Service, in which the necessity for a method adapted to all items of classification of work exists, it is not advisable to enter into laborious refinement. For such engineering works the methods adopted by the Reclamation Service require the distribution of costs under the following heads:—Interest investment, preparatory expenses, plant depreciation, materials, supplies, executive, labour, and engineering.

These heads are defined to cover expenses as outlined below:—(1) Interest investment includes all charges for insurance, bond premium, and interest on cash and borrowed capital. (2) Preparatory expenses include all charges for the construction of roads, erection and drainage of camps, delivery and installation of plant, and other expenses involved before the actual construction begins. (3) Plant depreciation includes all charges for repairs and the depreciation of tools, machinery, buildings, and the like. (4) Materials include all charges, including freight, for expendable property entering into the structure and remaining a part thereof. (5) Supplies include all charges, including freight, for expendable property used in building work and wholly consumed therein. (6) Executive includes all charges for salaries of superintendents, foremen, timekeepers, clerks, watchmen, and for other general administrative expenses. (7) Labour includes all charges for hire of teams and of skilled and common labour not classified in executive. (8) Engineering includes all charges for salaries of engineers and inspectors.

In order to distribute the costs properly in this system they are charged directly to the items of the contract to which they apply where possible, and are otherwise pro-rated during the continuance or at the completion of the contract. For the purpose of facilitating the keeping of costs and of giving full value to the results, the contract items are carefully classified in specification schedules, so as to require bids on each distinctive class of work having a common cost.

The collection of data for this method of cost keeping is made by means of the time-distributing system. In the daily time book, so designed as to serve also as a monthly time book, a separate page is devoted to the records of a single contract item, the entries being made under the heads of engineering, executive, and labour. Likewise a daily-monthly material book is used in which charges against each contract item are similarly made under the heads of plant, materials, and supplies.

The information contained in the daily-monthly time and daily-monthly material books is then carried forward at the end of each month to a ledger, in which entries of monthly progress are made from an estimate book or sheet. In this ledger accounts are carried with each item of the contract, secondary charges being made under the proper heads hereinbefore mentioned. Certain charges, such as those against investment, interest, preparatory expense, and portions of others, are necessarily carried forward *en masse* until the completion of the contract, at which time distribution is made among the items of the contract.

While figures are always essential to the usefulness of cost data, it is recognised that a complete knowledge of the conditions affecting component prices is equally imperative. The character of machinery, the conditions of labour, the geography of the work, the topography of the site of the work, the proximity of constructing material, the condition of the weather, and other similar circumstances, are all important matters for record. Entries in the daily-monthly time books of these elements of cost are, therefore, made by the timekeepers.

THE WIDENING OF BLACKFRIARS BRIDGE.

ANOTHER important step in the solution of the problem of transit in London was completed on Tuesday, September 14th, when the widened Blackfriars Bridge over the Thames was formally opened by the Lord Mayor of London. The work of widening the bridge has been in progress since February, 1907, and has proceeded uninterruptedly since that date. The contract for the whole of the work was placed with Sir William Arrol and Co., Limited, of Glasgow, and the bridge was to be completely finished ready for traffic by February, 1910. So expeditiously has the work been carried out that it has been finished about six months ahead of time and within the estimated cost; and this excellent record has been made, notwithstanding that the additional work for the tramways was undertaken by the firm on the understanding that it would not interfere with the completion of the main contract. It was the original intention of the Corporation to lay the tramway tracks after the main contract was completed. This is a record in bridge building, and the creditable performance is due to the excellent arrangements and foresight displayed by Sir William Arrol and Co., Limited.

A bridge over the Thames has existed on this site for 140 years. The first bridge was an elegant stone structure of nine arches from designs by Mr. Robert Mylne. The foundation-stone was laid on 31st October, 1760, and the bridge was completed in 1769. The completed bridge cost £166,217, of which £13,377 was for the approaches and arching over Fleet Ditch. The increased flow of the river consequent on the removal of old London Bridge caused increased scour in the vicinity of old Blackfriars Bridge and undermined the foundations.

The present bridge as it existed until the spring of 1907 was designed by Mr. Joseph Cubitt, and was the selected design in an open competition. The work was begun in June, 1864, and the bridge was opened on November 6th, 1869. The total cost was £269,000.

The bridge has a total length between abutments of 922ft., and is divided into five spans, the two abutment spans being 155ft., the two intermediate spans 174ft. 5in., and the centre span 186ft. 5in. The two centre piers are 18ft. 2in. wide at the springing and the intermediate piers are 20ft. 6in. wide. The clear width between parapets was 75ft.

Each of the piers is founded upon six independent wrought iron caissons, four of which are rectangular in shape and the other two are curved to a radius to approximate the form of the cutwater. The caissons were sunk into the clay with spaces of 3ft. between them, which were afterwards cleaned out and filled with concrete. The piers are built of granite ashlar with brickwork hearting, and have cutwaters ornamented with polished red granite columns, having Portland stone pediments and capitals. The abutments, which have a total thickness of about 40ft., were built within cofferdams upon concrete foundations. They are formed of concrete and brickwork and faced with granite ashlar.

Each span consisted of nine wrought iron arched ribs spaced about 9ft. apart with suitable cross bracing between them. The ribs supported floor girders upon braced spandrils. The granite setts of the roadway and paving of the footways are supported upon concrete resting upon buckled plates. The ornamental spandrils of the outer ribs are of cast iron, to which an ornate facia is bolted at the footway level. The parapet is of ornamental cast iron. The contractors were Messrs. Thorne and Co., whose resident engineer was Mr. F. W. Bryant, a man of great ability, courage, and resource, all of which were needed.

The desire of the London County Council to run their southern electric trams over the river to relieve the congestion at their termini at the bridges led the Corporation of the City of London, under whose jurisdiction the bridge is, to apply to Parliament for permission to widen the bridge to link up the trams on the Embankment with those on the south side of the river. The engineers for this work were the late Sir Benjamin Baker, K.C.B., K.C.M.G., and Mr. Basil Mott, M. Inst. C.E.

The work involved increased the width of the roadway of the bridge from 43ft. to 73ft., providing a large curved approach from the Embankment to the north span, and laying a double line of electric tramway on the new portion of the road.

The existing abutments and piers had to be extended 30ft. westwards. The extended piers were founded upon heart-shaped caissons which fitted the existing cutwater caissons. These caissons were built over their final position and lowered to the bed of the river. They were sunk under air pressure into the clay and were filled with concrete during the process. A space of 12in. left between the old and new caissons was cleaned out and filled with concrete. The masonry of the pier was then built up inside temporary caissons, which were bolted to the permanent caissons. The cutwaters and ornamental masonry were removed from the old piers and re-erected on the extended piers. Special care had to be taken with the north abutment on account of the proximity of the Metropolitan Railway tunnels. The new foundations were sunk lower than the old foundations of the adjacent works. The original intention was to sink one large caisson, but before beginning the work it was decided to divide the caisson into three parts to reduce the risk, and to drive a line of cast iron sheet piling close to the underground railway to a depth beyond the level of the new foundations. After the caissons were sunk and filled with concrete they were loaded with rails to produce a greater compression on the soil than was possible from the permanent load. The operations were successfully carried out without any disturbance to the existing works. The curve on the underground railway caused the extended abutment to be reduced in width, and the stability was maintained by building cast iron blocks instead of brickwork into the abutment. A steel skewback girder to distribute the thrust of the arched ribs was provided at the springing levels, and was securely bolted to the abutment foundations. The south abutment was built within a cofferdam.

No staging was permitted in the river except round the piers and at the north span. The steelwork of the north span was built upon centering supported upon this staging. It was a condition of the contract that the existing face ribs, with their cast iron spandrils and parapets, should be removed and re-erected as the face ribs of the widened bridge. This was done by means of an overhead traveller, which was built over each face rib after the piers had been extended. By means of suspenders from the traveller passing under the rib the complete rib, with the cast iron spandrils and parapets, was lifted from its bearings and traversed 30ft. westwards and lowered into its final position. The rib was steadied by transverse girders, which were secured to the face rib at one end and passed through suitable slippers on the last remaining rib of the old bridge. After the face rib was in position these cross girders were secured to the ribs on each side of the 30ft. gap and served as staging upon which to erect the three new steel ribs of the widened bridge.

In moving the face ribs to their new position care was taken to transfer them in the order which would produce the least unbalanced thrusts upon the new piers.

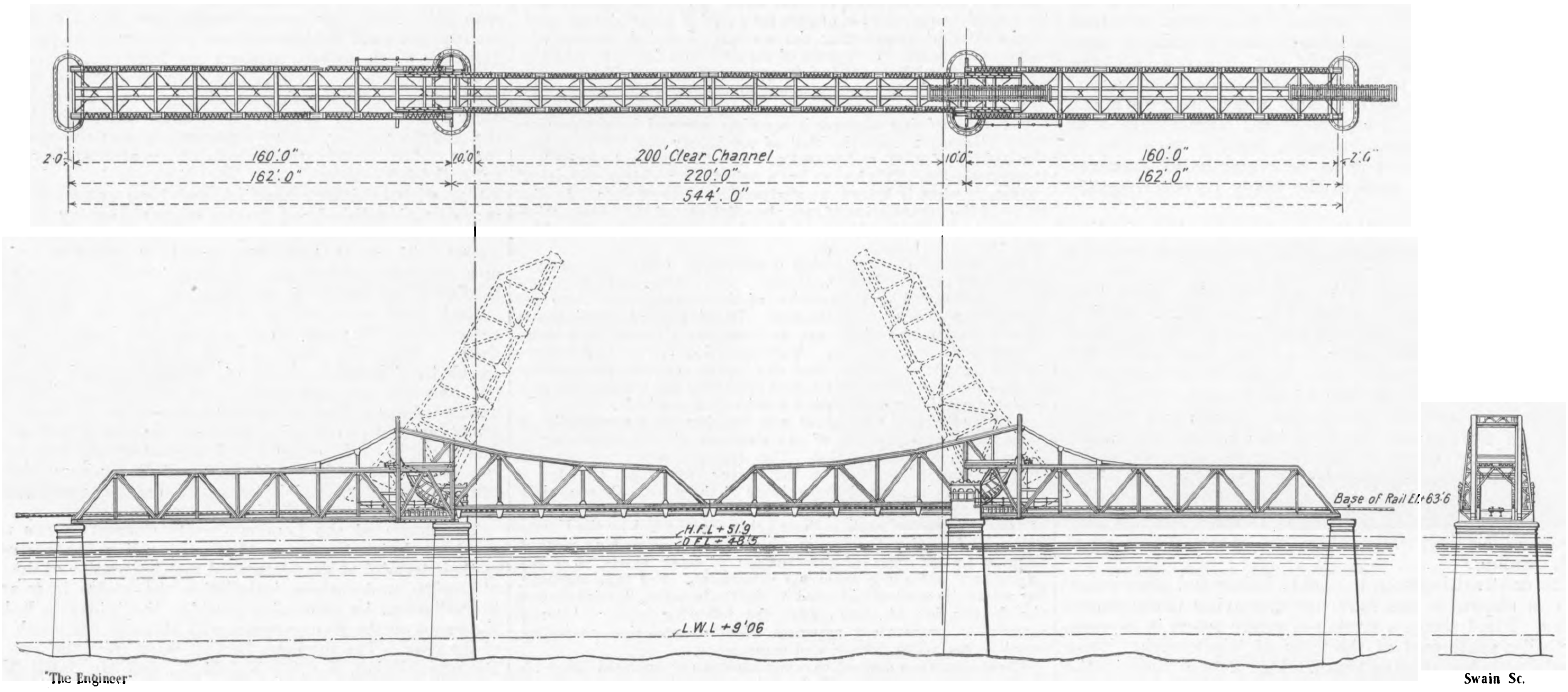
The successful completion of this work so much within the contract time is a matter of congratulation to the Corporation of the City of London, the engineers, and Sir William Arrol and Co., Limited.

THE INSTITUTION OF MINING ENGINEERS.

THE twentieth annual general meeting of this Institution opened at Newcastle-upon-Tyne on Wednesday of this week, when several papers were submitted and discussed. These included "Fire-damp Caps and the Detection of Fire-damp in Mines by means of Safety Lamps," "Equipment for the Study of Flame Caps and for Miscellaneous Experiments on Safety Lamps, "Sinking through Sand at Newbiggin Colliery," and other papers on cognate subjects. Yesterday and to-day were devoted to excursions to various places of professional interest in the neighbourhood, such as the Harton Colliery, the Carville Power Station, and the sinking operations at the Newbiggin Colliery. We propose dealing with the meeting in our next issue.

ROLLING LIFT RAILWAY BRIDGE, BURMA

SPENCER AND CO., LIMITED, MELKSHAM, WILTS, BUILDERS



"The Engineer"

Swain Sc.

Fig. 1—THE BASCULE SPAN AND ITS APPROACHES

SCHERZER ROLLING LIFT BRIDGE ACROSS NGAWUN RIVER, BURMA.

In August, 1904, the Burma Railways Company commenced work on an extension of its line from Henzada to Kyangin, a distance of 65.66 miles. This work required the construction of a bridge to cross the Ngawun River, about 16 miles from Henzada. The original intention was to construct this bridge of fixed spans, grading up the approaches so as to provide a clearance of 40ft. underneath for the passage of vessels, but, as this clearance required a gradient of 1 in 200, it was decided to reduce this to 1 in 300, and to construct a movable bridge for the accommodation of the river traffic. Extensive navigation is carried on along the Ngawun River by the Irrawaddy Flotilla Company, which runs a line of steamers for both passenger and merchandise traffic. For the accommodation of shipping the Government authorities required a clear channel of 200ft., which, with the local conditions to be met, made it necessary to consider carefully the various designs of movable bridges which could be adopted. Eventually arrangements were made for the provision of a double-leaf through bridge constructed by Spencer and Co., Limited, Melksham, Wilts, to the designs and specification of the Scherzer Rolling Lift Bridge Company, of Chicago. The superstructure of this bridge consists of a double-leaf through single-track Scherzer rolling lift bridge, having a span of 220ft. from centre to centre of bearings, flanked on one side by three and on the other by two approach spans of about 160ft. each. The substructure consists of brick masonry piers founded on wells, a method of construction generally used in India and Burma. The design of the bridge was based on the specifications of the Government of India for railway bridges. For the erection of the superstructure of the fixed spans falsework composed of frame bents resting on piles was used, there being four towers of two bents each for each approach span. The leaves of the bascule span were erected in the open position by means of a sliding derrick, which was advanced along the open leaf as each panel was added. The track girders on which the moving leaves roll in opening and closing are carried by the adjacent fixed spans. One of the distinguishing characteristics of the design of this bridge is the economical arrangement and the small size of the piers, providing ample support to the superstructure with the least possible obstruction to the flow of water. The rivers in India and Burma during the rainy season are subject to heavy flooding, and obstructions to the flow of the water cause deep holes to scour in the river bed, calling for the exercise of great care in foundation design. The advantage of the bascule bridge over the old-fashioned type of swing bridge in this respect is apparent from a study of the general plan—Fig. 1. Hand power is used to operate the leaves, and is derived from winches on the deck of the approach spans, being transmitted by a system of gearing to the main operating struts, of which there are two on each leaf lying outside the trusses, the centre line of the struts coinciding with the centre line of the approach trusses. The substructure was completed, and erection started in the spring of 1908, the bridge being finally finished and opened to traffic early in December, 1908. On this page, and on page 296, we give some views of the bridge in various stages of construction. Fig. 2, which is a view taken on September 15th, 1908, shows the south leaf being erected in the open position, and the sliding derrick used. The engraving—Fig. 3—which was taken on September 26th, 1908, shows the progress of erection work on both the north and south leaves. This view shows how the movable leaves were erected without any falsework obstructing the navigable channel. A view taken on October 10th, showing the south leaf counterbalanced, and the method of placing the end floor beam, is given in Fig. 4. In the view—Fig. 5—which was taken on October 22nd, 1908, both leaves are counterbalanced. The engraving—Fig. 6—gives an end view taken on December 2nd, whilst the view—Fig. 7—which was taken on the same date, shows the leaves fully open. It is stated that this is the largest movable bridge yet constructed in Asia, and its successful and satisfactory completion will doubtless influence the construction of other bridges where similar problems are to be solved. By the use of a Scherzer rolling lift bridge the rails may be placed a minimum distance above water, effecting a large saving as compared with the cost of a fixed bridge elevated a sufficient height above the water to allow the passage of vessels underneath the bridge, in which case long and high embankments would have to be constructed to reach the bridge level, and these gradients would be a perpetual tax on all traffic crossing the bridge.

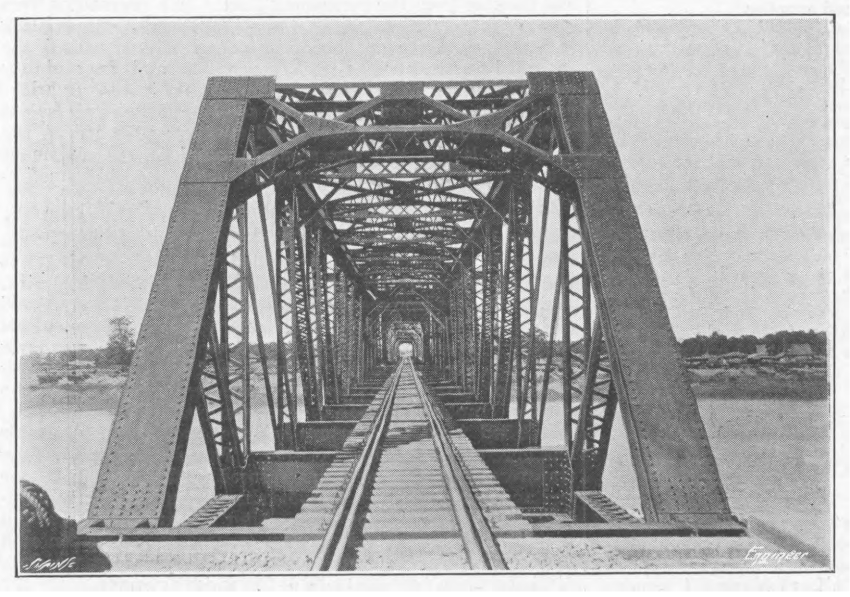


Fig. 6—END VIEW

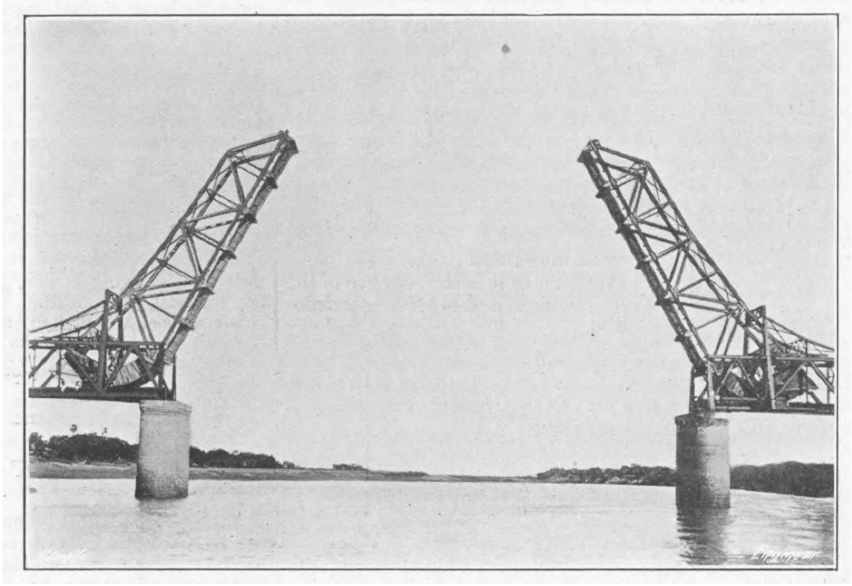


Fig. 7—LEAVES OPENED

The work was executed under the supervision of Messrs. Rendel and Robertson, consulting engineers, 8, Great George-street, Westminster, S.W. Mr. Albert H. Scherzer, president and chief engineer of the Scherzer Rolling Lift Bridge Company, designed the superstructure of the bascule span and the two adjacent approach spans in co-operation with the engineers of the railway company. The substructure was designed by the railway company. Mr. G. Mills was in direct charge of the work as chief engineer of construction for the railway company until the completion of the substructure, being succeeded by Mr. J. A. Despeisis, superintendent of ways and works.

TURBINE STEAMER HUALLAGA.

On Tuesday of last week the above steamer, which has been built by Cammell, Laird and Co., Limited, Birkenhead, for the Compania Peruana Vapores y Dique del Callao, went for her trial trip in the Mersey estuary, and during six hour's continuous steaming with and against the tide maintained an average of nearly 19½ knots. This is the second vessel built at Tranmere for the above company. The first was called the Ucalayi. They are intended for carrying both passengers and cargo, and in addition to being propelled by turbines are fitted to burn oil as fuel. The Huallaga is built on graceful lines, her chief dimensions being:—Length over all, 375ft.; beam amidships, 46ft.; gross tonnage measurement, 3300; and loaded displacement, 6000 tons. High-class accommodation is provided for 112 first and 95 second-class passengers in rooms ranged along the centre line of the ship on the shade and spar decks. There are four decks in all, and the accommodation houses commence just abaft the breakwater forward, and extend aft to the stern of the vessel. At the fore end of the 'tween decks below the spar deck 200 portable berths have been provided for deck passengers. The 'tween deck space is also furnished with portable cattle fittings for the carriage of live stock. The cargo space measures 150,000 cubic feet, and the ship is fitted throughout with electric light.

The propelling machinery, supplied by the builders, consists of a set of Parsons compound steam turbines, driving three shafts. The high-pressure turbine drives the centre shaft, and the wing shafts are driven by low-pressure turbines, the reversing turbines being incorporated with the low-pressure machines. The turbine cases are of cast iron, and the rotors are built up with cast steel wheels and forged steel drums. The centrifugal circulating pumps, feed heater, bilge ballast, and other pumps were supplied by Gwynnes, Limited, London. The boilers are four in number, two double-ended and two single-ended, of the cylindrical return-tube type, constructed for a working pressure of 160 lb. per square inch. They are worked on the closed stokehold system of forced draught by means of four fans. An oil fuel arrangement is provided which can be put into operation at any time after removing the furnace bars, bearers, and bridges used for coal burning, and replacing these by the special furnace fronts, burners, &c. The cargo winches and windlass have been supplied by Messrs. J. H. Wilson and Co., Liverpool. These steamers are intended for service on the West Coast of South America.

RAILWAY MATTERS.

We hear that the Great Northern Company is reconstructing Brayford Swing Bridge, between High-street and East Holmes, at Lincoln, and all main line traffic will in the meantime be worked over a new temporary single line at East Holmes Junction.

According to the *Railway News*, it is proposed to construct a light railway through Corporation-road, Grimsby, to the Great Central Company's deep-water dock at Immingham. It will be a single-track electric railway, with passing places at intervals along the route and shelters for passengers at the termini.

Many of the American railways are arranging to employ telephones for train despatching, the Northern Pacific having already 470 miles of telephone in service and 250 more projected, while the New York Central will have its whole route to Chicago under telephone control when 200 miles of equipment, in addition to the present 250 upon the Michigan Central, is complete.

The Hatfield Light Railway, having passed through both Houses of Parliament, is now within the range of practical politics. Preparations are being pushed forward with a view to the early commencement of the constructive work. The new railway will extend the existing Axholme Light Railway from Hatfield Moor to Black Carr Junction, south of Doncaster. It is understood the contracts will be placed very shortly.

The question of the conveyance of a substantial portion of the mails and parcels by the Kalka-Simla Railway, states the *Indian and Eastern Engineer*, is now under consideration by the Railway Board. The arrangements contemplated do not provide for the cariage of the foreign mails. A rail petrol motor car has been ordered for experimental purposes, and if the experiments prove satisfactory, arrangements for carrying these mails will be considered.

The Shrubb Hill station of the Great Western Company at Worcester, states the *Railway News*, is about to be materially altered and remodelled. A new signalling apparatus has already been brought into use, and it is intended to provide another bridge for conveying luggage over the lines, with a lift at either end. The level crossing and the dwarf signal-boxes at either end of it are to be abolished, and the platform accommodation will be increased. The whole of the work is to be carried out at once.

According to a consular report, within the last year or two some American railway companies have sent out over their lines trains carrying specialists in agriculture, horticulture, dairying and live stock, who give lectures to farmers on their several subjects. These trains are fitted up with all kinds of appliances, implements, and machines, even carrying poultry and milch cows to demonstrate milking machines. The lessons taught are said to be much appreciated by the farmers, and have the effect of inciting them to practise modern methods.

The Secretary of State for the Colonies has sanctioned the construction of a section of the Negombo-Puttalam Railway, or Coast Line north of Colombo, namely, that from Negombo to Chilaw. The money to meet the expenditure is to be derived from surplus funds. The Negombo Railway extension will be completed in December next. It was expected that the line would have been completed by September, but the progress of the work has, it is reported, been hindered by the operations over the Dandugama bridge, the sinking of the cylinders proving an exceedingly difficult task.

An American contemporary states that the construction of a mono-railway through Pelham Park to City Island will be commenced early this autumn. Engineers of the Public Service Commission, who saw the system in operation at the Jamestown Exhibition, say that a speed of 135 miles an hour may be expected over parts of the route where right of way has been granted away from highways, so that the train headway may be unrestricted. If this line meets with the approval of the public, application will be made for permission to operate mono-rail express trains on an upper deck over the present elevated railways in New York.

The first section to be completed of the great network of electric railways, which are to serve the whole region of the Pyrenees in the South of France, is the line from Villefranche to Bourg-Madame. This undertaking will continue the railway from Perpignan to Prades and Villefranche into the Upper Valley of the Tet, and will link together the two lines which join France and Spain—namely, the line following the coast from Perpignan to Barcelona and the railway between Ax and Ripoll, the construction of which is being actively prosecuted. This latter line will unite Toulouse and Barcelona through the valleys of the Ariége and the Sègre.

The *Bulletin Commercial* (Brussels) of 4th September announces, on the authority of the Belgian Consul at Seoul, that a scheme will shortly be submitted to the Legislature at Tokio for the construction of two new railways in Corea—one from Seoul to Wonsan, at a cost of 20,000,000 yen (about £2,000,000), and the other running south, at a cost of 15,000,000 yen (about £1,500,000). The *Bulletin* also announces, on the authority of the Belgian Consul at Batavia, that the Legislature of the Dutch East Indies have granted to a tramway company in that town permission to extend its system of lines (double track) over a distance of 2½ miles.

The new Pennsylvania terminal station in New York is rapidly approaching completion, and the last piece of stone in the exterior finish of the station was recently put in place. The dimensions of this work are unusually large. The exterior walls are nearly half a mile long, and they contain 490,000 cubic feet of granite. Adding to this 60,000 cubic feet of stone used inside the concourse gives a total of 550,000 cubic feet of granite, weighing 47,000 tons, which required 1140 freight cars to transport it from the quarries at Milford, Mass. Into the construction of the building there have also entered 27,000 tons of steel and 15,000,000 bricks, weighing 48,000 tons.

It is announced that, commencing with November 1st next, 773 engines on the Austrian State Railways will use liquid fuel, and probably in a short time liquid fuel will also be introduced on all the mountain railways, especially on the lines of Bregeuz, Trieste, and Pontebu. The reasons assigned for the change are that the supply of coal to these lines is a very expensive item, and the damp atmosphere of the mountainous districts considerably lowers the calorific power of coal, the tunnels being soon destroyed by the smoke and gases produced, while the possibility of making an agreeable smokeless journey into these districts, it is hoped, will attract more tourists from abroad, and thus indirectly raise the profits of the State.

According to the *Electrical Review and Western Electrician*, steadily and surely the electrical zone of the New York Central and Hudson River Railway is reaching out toward Fishkill Landing. So steadily is the extension of the zone going on that to reach these villages is now but a step. Croton, about 25 miles south, is already in the zone, and Peekskill, Cold Spring and Fishkill Landing will be included when the next step northward is taken. Recently the big power plant at Glenwood, near Peekskill, was put in operation. This plant gives the New York Central a power-house which will supply power sufficient to run the cars from New York to Croton-on-Hudson. A similar plant is to be erected either at Fishkill Landing or Poughkeepsie. Level crossings are to be abolished within the zone.

NOTES AND MEMORANDA.

Experiments with rubber-asphalt roadways covering a period of six years are reported to have shown very satisfactory results. Rubber asphalt is claimed to be more plastic and more adhesive than pure asphalt and resists higher temperatures. This product, which is manufactured under a patented process, permits cold applications of the asphalt, which are said to possess all the advantages of hot compressed asphalt without its drawbacks.

An American contemporary states that reports from builders of steam-shovel and dredging machinery show that electricity as a motive power in working these shovels and dredges has gone beyond the experimental stage, and that in the future design of such shovels and dredges electricity is going to play a very important part. In the Western States, especially where water power is available, many shovels and dredges are being put into use and equipped with motors to be operated electrically.

Samples of air at a height of nearly nine miles have been recently obtained and examined for the presence of the rare gases. The collecting apparatus, carried by a large balloon, is a series of vacuum tubes, each drawn out to a fine point at one end. At the desired height, an electro-magnetic device, connected with each tube and operated by a barometer, breaks off the point of the tube, admitting the air. A few minutes later, a second contact sends a current through a platinum wire around the broken end, melting the glass and sealing the tube. All the samples obtained show argon and neon, but no helium was found in air from above six miles.

Electric current may leak to earth from any part of a system through (*a*) the insulation resistance of that part of the system, (*b*) the capacity to earth. In direct-current systems we have only to consider (*a*), but in alternating-current systems a capacity current is always flowing to earth from all parts of the system, and in the case of extra high-tension generators and cable networks the capacity current through the insulation of the winding and the dielectric of the cable may be considerable. Inductive leakage paths do not naturally occur, but they may sometimes be considered, since their presence may be beneficial, and they may be introduced artificially.

Fortunately, says a well-known professor, the delay in establishing electrical traction in this country under wise conditions enables one to say that our gas and water pipes, as well as our telephone, telegraph, electric light, and traction cables, are depreciated little, if at all, by stray currents. Happy is the land where the bonds are good, the positive and negative feeders rightly calculated, and all is under the watchful care of a paternal Board of Trade. This is not the country where one can study electrolysis due to stray currents. The voltmeter and the coulombmeter must be taken to the United States or Germany, where there will be readings worth the taking.

An article in a contemporary describes some fresh determinations of the amount of radium present in sea water, the specimens being taken from the Atlantic at various places, and at once placed in clean new bottles. All possible precautions were taken to eliminate error, and the mean result for the six samples was 9×10^{-16} gm. per gramme of sea water. This is only about one-seventeenth of the value (1.6×10^{-14}) obtained by Joly, but agrees fairly well with the value 6×10^{-16} previously obtained by Mr. A. S. Eve. It is also shown that, when testing for the quantity of radium emanation present in a given solution, about equal accuracy is obtained by collecting the emanation over water or over mercury.

In order to obtain wind records for Berlin an anemometer was in use on the tower of the Joachimsthal Gymnasium from 1884 to 1903. A paper dealing with the investigation gives the monthly means of wind velocity for each year of this period, and also the hourly means for each month for each of the ten-year periods. The records are mainly interesting as showing the influence of the growth of the town on the exposure. The anemometer was fixed 1.7 m. above the parapet of the tower, which is 32 m. above the ground and 15 m. to 20 m. above the general level of the roof. In 1884 the building was in open country; at the end of the period (1903) it was surrounded on all sides by buildings of average height, 22 m. to 25 m. The effective height of the anemometer above ground was thus reduced by this amount. The mean velocities (in metres per second) for successive lustres were as follows:—1884-88, 5.44; 1889-93, 4.80; 1894-98, 4.04; 1899-1903, 3.82.

A recent hailstorm, the direction of which coincided with a high-tension electric overhead transmission system, has given rise to the suggestion that these lines possibly play an important part in meteorology. Experiments have been carried out to test this point, using the electroscope and cylindrical condenser method perfected by Chéneveau and Laborde. The experiments were carried out in the neighbourhood of a three-phase 50,000-volt line. Samples of air close to the wires gave 0.05×10^5 ions per cm^3. Near the lightning arresters, &c., where there was a strong odour of ozone, the number was between 0.04 and 0.05×10^5 ions per cm^3. At a neighbouring town the number varied between 0.07 and 0.09. From these experiments it is concluded that very close to the wires there are sensibly no ions. It is ordinarily stated that the wires are continually giving out ions. But in all cases it was found that the number is less near the wires than in the neighbouring country.

The report of Mr. J. S. Diller, of the United States Geological Survey, on asbestos in the United States, shows how far advanced Canada is over the neighbouring Republic as regards the production of asbestos. The total output of refined asbestos in the United States was £3925, as compared with £2378 in 1907. The main source of raw material continues to be Canada, whence came all but £329 worth of the imports into the United States in 1908, valued at £213,664. Much over half of the asbestos exported by Canada went to the United States. The United States leads all other countries in the manufacture of asbestos products. The best asbestos yet found in the United States is near the bottom of the Grand Canyon of Arizona. It is cross-fibre chrysolite of exceptional quality. The variety of uses for the fireproof and insulating qualities of asbestos is constantly increasing. One of the notable applications in recent years is as a pigment under the name of "asbestine," which, on account of its fibrous structure, has the property of holding up heavier pigments in the paint. Mixtures of asbestos with various compounds play an important part in fireproof construction.

It will be useful, states the *Electrical Engineer*, to give a rule whereby a decision can be arrived at when confronted with the choice between aluminium and copper as a conductor. It is well known that copper is the better conductor for the same size of wire, while aluminium is the better for the same weight, as the difference between the specific gravities of the two metals is so great that an aluminium conductor may exceed a copper conductor sufficiently in cross section to give it the same conductivity and yet be still much lighter than its copper equivalent. It is remarkable, too, that when a copper and aluminium wire have equal conductivity for electricity they have practically the same tensile strength. In other words, the conductivity of aluminium bears the same ratio to that of copper as its tensile strength bears to that of copper. Hence, the question of strength may be disregarded in making the rule. This is that the cost for mere wiring will be the same whether copper or aluminium is used, when the price of the former is to that of the latter as 13 to 25. Obviously if the quotient of aluminium price by copper price is less than $\frac{25}{13}$, the aluminium has the advantage, and *vice versâ*.

MISCELLANEA.

It is reported that in connection with the International Labour Exhibition to be held in Turin in 1911, the Turin Chamber of Commerce offers a prize of £2000 to be given to the author of any invention of whatever kind which in practice will prove advantageous to national economy. But such invention must not be of older date than 1908.

It is announced that observations made by Professor Percival Lowell indicate the presence of oxygen in the atmosphere of Mars. Following the statement that indubitable evidence has been obtained of the presence of aqueous vapour around the planet, Professor Lowell's latest discovery has aroused renewed interest in his theory that life, as it is known upon earth, is possible in Mars.

It is reported that plans for the construction of the first Austro-Hungarian Dreadnought have just been completed. Only meagre information regarding the vessel is obtainable, but it is known that she will have a displacement of over 20,000 tons, will be heavily armoured, and will carry 12in. guns. She will also be provided with a number of 6in. quick-firers. The final decision with regard to the construction and armament will be left to the delegations.

The *Boletin Oficial* (Buenos Aires) of 6th August publishes a Decree approving the contract entered into between the Minister of Public Works and the Government of the province of La Rioja for carrying out a comprehensive scheme for the supply of drinking water to the town of Chilecito. The work must be completed within three years from the date of the ratification of the contract, and the cost is not to exceed the sum sanctioned for the purpose, viz., 400,000 pesos, paper (about £37,000).

Further evidence of China's awakening is furnished in a contract awarded by the Chinese Government to supply a complete common battery telephone plant for the city of Pekin. Heretofore almost nothing in the way of telephone development has been accomplished in China, there having been telephones in only a few of the cities, and these largely in the foreign quarters. The contract just closed covers a complete telephone plant of the most modern type for two complete exchanges, and amounts to about £30,000.

The work of the United States Forest Service has called attention, among many other matters, to the fact that damage to wooden telegraph, telephone, and electric light poles by woodpeckers and similar birds may be prevented by creosoting. The value of this process for the preservation of wood both from decay and from fungous growth and wood-boring insects is well-known. It has now been found that of poles of identical wood those which have been impregnated with creosote are immune from attack by birds of the woodpecker family in districts where untreated poles are severely injured.

The *Bollettino Finanze* (Rome) of 2nd September notifies that the municipal authorities of Palma de Majorca invite the submission of plans with a view to ascertaining whether it is possible to obtain in the island good drinking water in sufficient quantities to supply a population of 85,000 persons. A first prize of 17,500 pesetas (about £630), and a second prize of 4500 pesetas (about £160) will be awarded for the best and second best schemes submitted; and alternatively, if the problem cannot be solved, a prize of 7500 pesetas (about £270) will be awarded to whomsoever can demonstrate conclusively its impracticability.

A chert road built with a bituminous binder in Birmingham, Ala., in 1906, has given unexpectedly good service, according to City Engineer M. Nicholson. The street has a heavy gradient and bad wash. A space 50ft. long running entirely across the roadway and strips 200ft. in length along each gutter for a fourth of the width of the roadway were painted with hot Tarvia, sanded and rolled immediately. Recently the pavement was opened at one place and found to be in fine condition; where the chert had been compacted in the centre of the road the Tarvia had not penetrated very far, although it had effectually prevented washing.

The orders for high-tension electric lighting plants in Germany increased considerably during the year 1908. In telephony the central-battery system did good service. The use of electricity for illuminating purposes on men-of-war and merchantmen is being widely adopted. A constant development also continues of electric-power transmission by means of large electric motors in mines and smelting works. During 1908 large numbers of electric locomotives were adopted for use in mine and industrial railways generally. The experiments with electrical full-gauge railways yielded satisfactory results, *e.g.*, the system adopted in Hamburg; in this respect important plans by the Baden and Prussian railway administrations are awaiting development.

A breakwater which, when completed, will be some 10,000ft. in length, is now in course of construction at Hilo, in the Island of Hawaii, to protect shipping from the heavy seas that sweep from the north-east. At present some 400ft. have been completed, and under the existing contract it is estimated that by the middle of next year a length of some 3000ft will be in position. The material used for construction is a basalt rock resembling heavy granite, which is quarried some 25 miles away, and transported to the works under contract with the Hilo Railway Company. According to the specifications, from a depth of 3ft. below the water-line to the top, boulders of not less than 8 tons in weight are to be used. The contractors are confident that the rock in question, which weighs 165 lb. to the cubic foot, will resist any action of the waves, without the use of cement to bind it.

In the House of Commons recently Sir William Collins asked the President of the Board of Trade whether his attention had been directed to complaints made of nuisance arising by noise and otherwise from the working of an electric substation of the London County Council in Arlington-road, St. Pancras; whether this station had been inspected on behalf of the Board of Trade; whether the working of the station is in accordance with the Board of Trade regulations; and whether the Board had suggested, or would suggest, any action with a view to abate the nuisance complained of. In reply Mr. Churchill said the substation in question had not been inspected on behalf of the Board of Trade and was not liable to such inspection, nor was its working subject to the Board of Trade regulations. He had, however, asked the London County Council for their observations on the nuisance stated to exist, and he would be happy to communicate the reply to his honourable friend.

That coal dust is a most dangerous thing in a mine has been proved by experiments in this country and in France, and the dust produced by mechanical coal cutters is a drawback to be considered. In a paper before the Coal Mining Institute of America, Mr. G. R. Wood gives some figures obtained in actual practice. The dust was measured after passing through a 40-mesh screen, and on the basis of each square foot undercut. At one colliery the dust produced was 1.8 lb. with hand cutting, 4.58 lb. with the puncher machine, and 1.48 lb. with a chain-cutter machine. At another colliery the figures for the puncher and chain machines were 6.18 lb. and 2.43 lb. respectively, whilst at a third colliery the corresponding figures were 6.18 lb. for the puncher and 2.43 lb. and 2.51 lb. for chain machines. It is unfortunate that figures for hand-won coal were not obtained for the last two mines, although the relative dust-producing qualities of the various methods are probably similar with different qualities of coal. The chain machine does not seem to differ much from hand winning, but the puncher machine is clearly a serious dust producer, and in dry or fiery mines this is a point worth remembering.

ROLLING LIFT RAILWAY BRIDGE, BURMA

SPENCER AND CO., LIMITED, MELKSHAM, WILTS, BUILDERS

(For description see page 294)

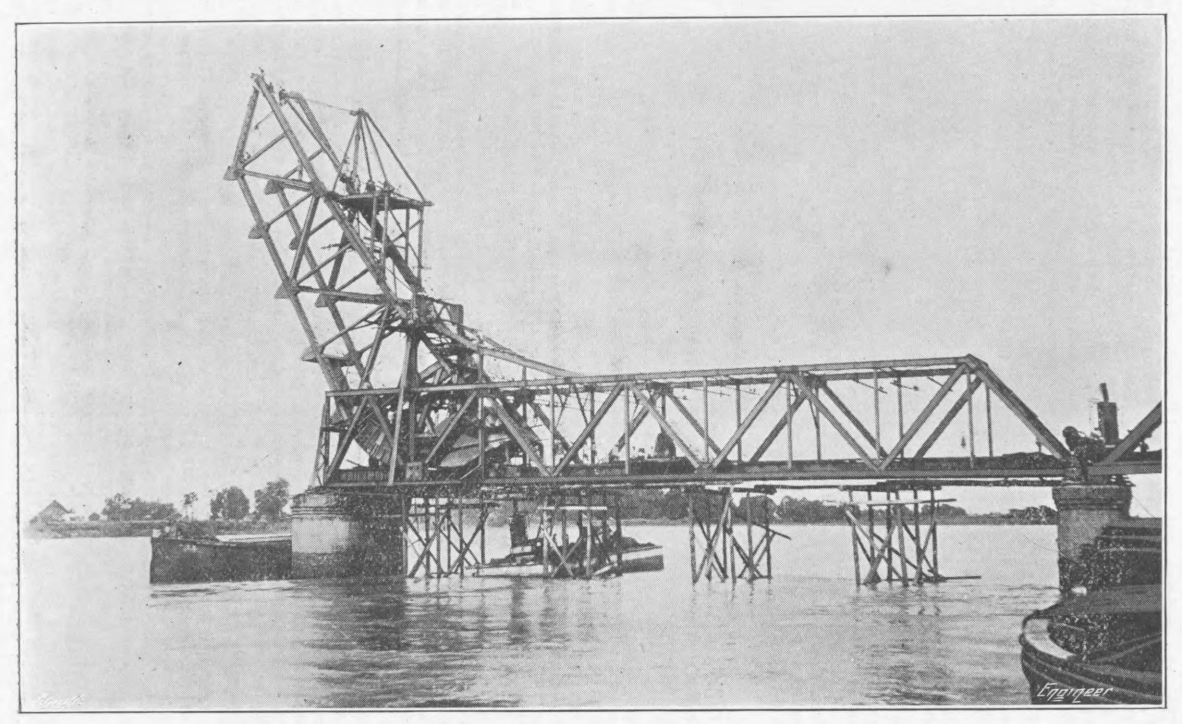


Fig. 2—ERECTION OF LEAF USING SLIDING DERRICK

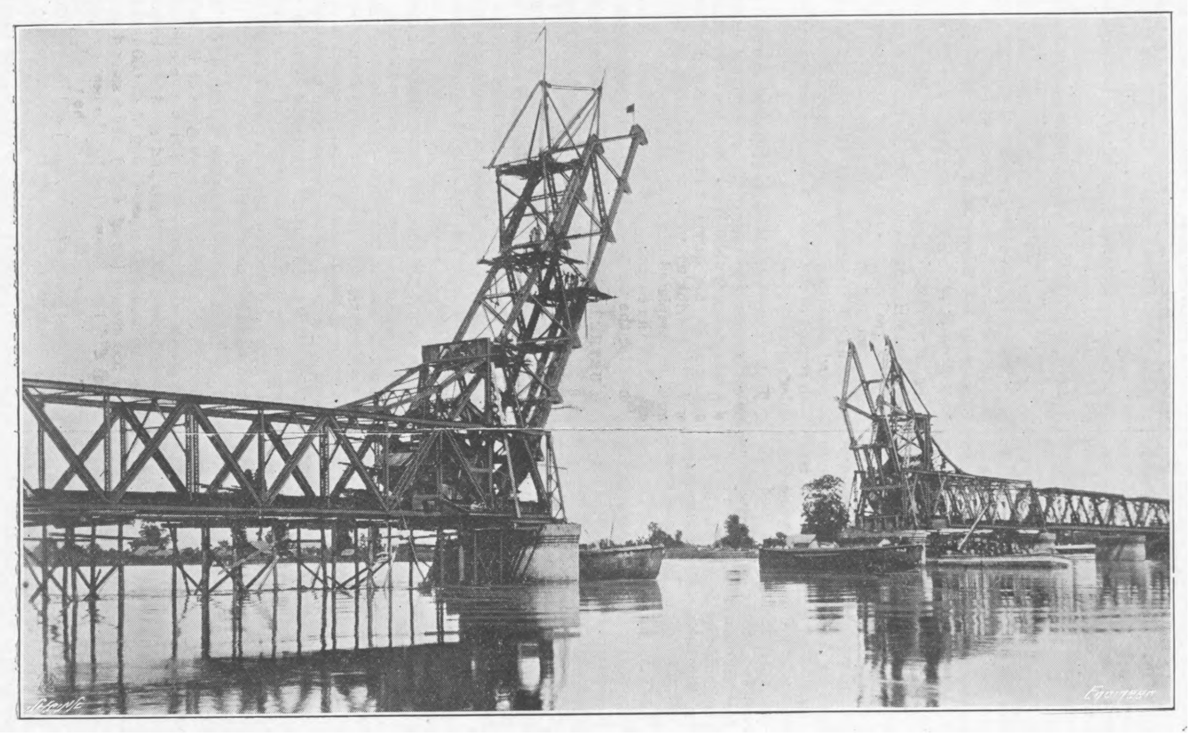


Fig. 3—ERECTION OF NORTH AND SOUTH LEAVES

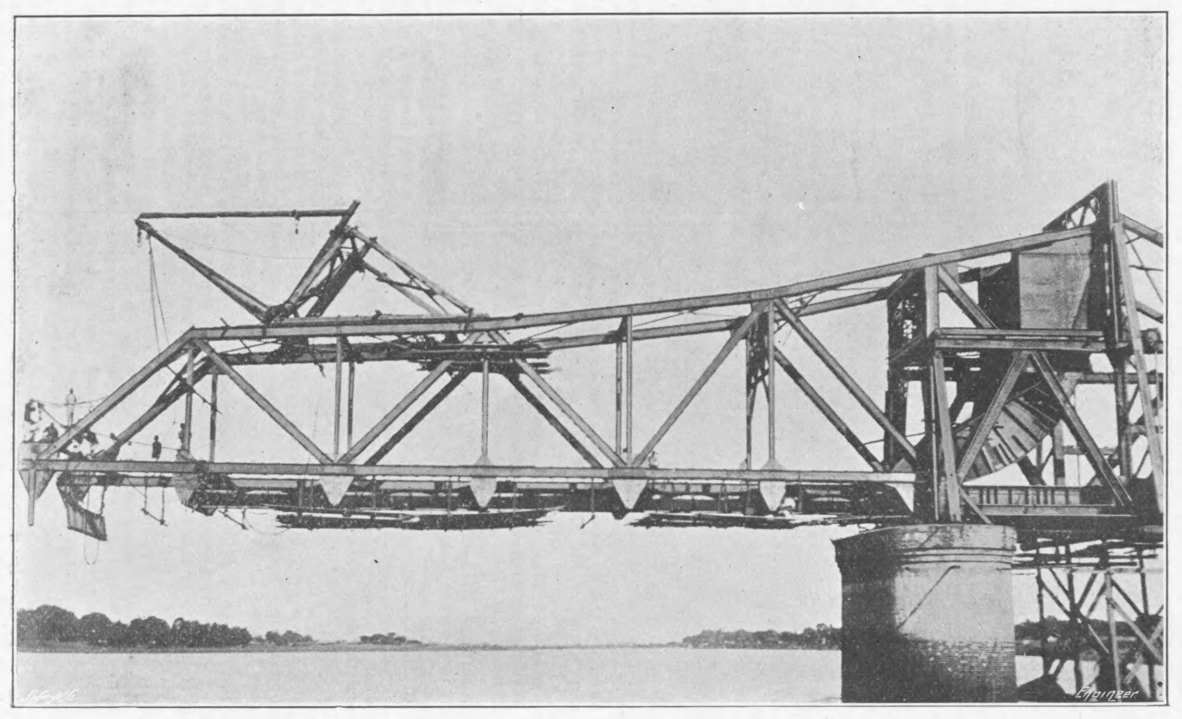


Fig. 4—SOUTH LEAF, SHOWING COUNTERBALANCE

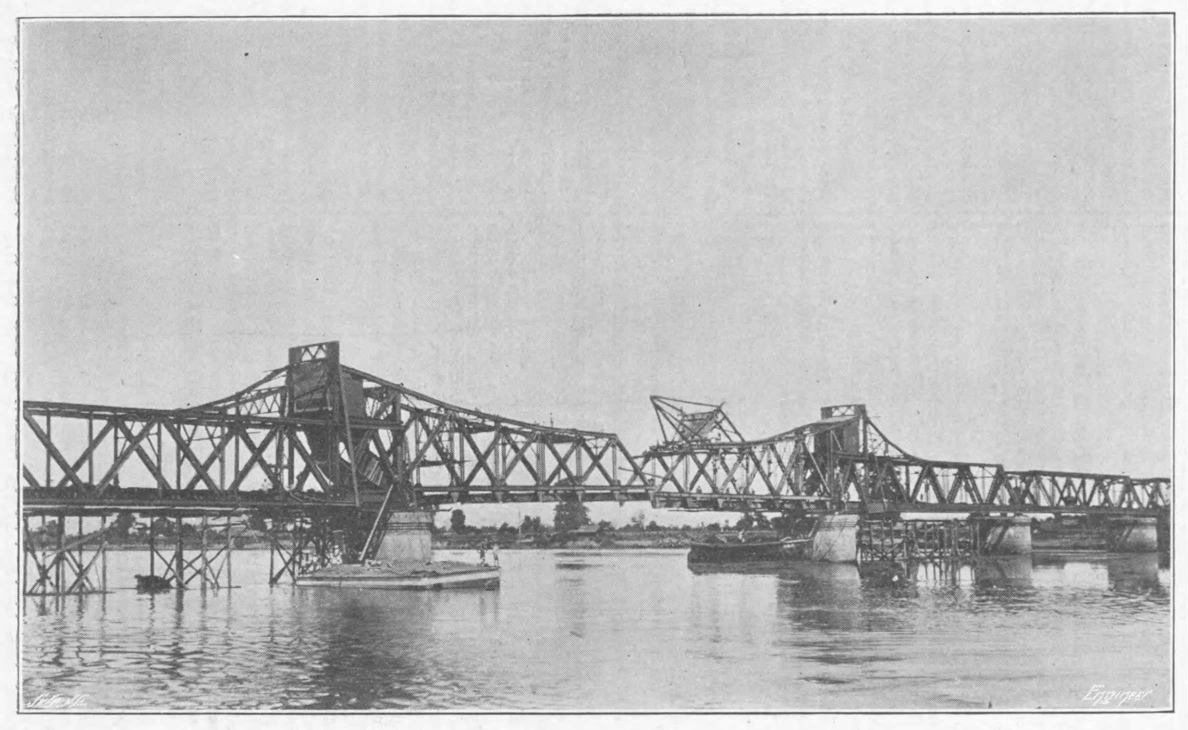


Fig. 5—BRIDGE NEARING COMPLETION

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*** *Coloured Engravings, on art paper, of the Britannia Bridge and Kilsby Tunnel Works on the London and North-Western Railway, suitable for framing, can be had in sets of four at* 1*s.* 3*d. per set, post free.*

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REPLIES.

A. M. T.—It is too soon to think of aerial engineering as a profession; it has not yet got past the early experimental stage.

INQUIRIES.

FIBROUS ROOFING.

SIR,—Can any of your readers oblige me with the names of makers of machinery suitable for manufacturing fibrous roofing felt? FIBROUS.
London, September 14th.

MEETINGS NEXT WEEK.

THE INCORPORATED ASSOCIATION OF MUNICIPAL AND COUNTY ENGINEERS.—Saturday, September 25th, at Lincoln. Eastern District meeting. Discussion of papers: "The 'G.B.' Tramway System, and its Results in Lincoln;" "Main Roads in Lincolnshire (Lindsey), Their History and Maintenance." Visits to the Abattoir and Refrigeration Plant, Cathedral, Electricity Station, and Tramway Station.

THE ENGINEER.

SEPTEMBER 17, 1909.

Engineers and Port of London Rates.

THE period is not very remote when the numerous interests concerned with the Port of London, including importers of iron and steel, engineers and shipbuilders, and manufacturers in general, will be confronted for the first time with the certainty of having to pay rates on goods brought into the port. The Port of London Authority has already prepared a draft schedule of the maximum port rates which are proposed to be levied on "goods," which expression, according to the Act of 1908, includes live stock, minerals, and merchandise of all descriptions. A copy of the draft has been forwarded to the most important trading associations in London with a view to obtaining their observations. When received, these observations will be considered by a committee, and the draft schedule with such alterations as may be thought to be necessary, will be laid before the Port Authority for deliberation before being submitted to the Board of Trade for embodiment in a Provisional Order. A reference to Section 13 of the Port of London Act, 1908, shows that all goods imported from parts beyond the seas or coastwise into the Port of London, or exported to places abroad or coastwise from the port will be subject to the rates fixed by the Authority, excepting the exemptions or rebates which may be contained in the Provisional Order. It is rather important in this connection to emphasise what has apparently often been overlooked, namely, that the port rates are to be charged both on goods entering and on those leaving the port, so that the charges will affect both importers and exporters, as well as those who procure supplies of raw materials by water-borne freights from the East or West Coast. As to the question of exemptions, it is provided that these shall apply to goods imported for transhipment only, or which remain on board the ship in which they were imported for conveyance to another port, and the Provisional Order may determine what goods are for the purpose of the exemption to be treated as goods imported for transhipment only. The Provisional Order to be made by the Board of Trade containing the schedule of maximum rates as finally approved will require the confirmation of Parliament, and the rates are to come into operation within three months of such ratification.

The draft schedule sets out a number of rates for iron and steel products according to a classified scheme; and although they may or may not be considered high, they will at all events affect to some extent the imports of joists, bars, &c., which reach this country from certain continental countries for use in the metropolitan area. Of course, the rates will not apply to iron and steel intended for re-exportation by transhipment, and thus merchants will be exempt from the rates in this particular direction. Among other articles scheduled may be mentioned guns and ammunition, lubricating oils, machinery at 1s. 6d. per ton, motor cars, or parts thereof, at 5s. per ton, and motor cycles at 2s. 6d. each, or at 5s. per ton in parts. The Provisional Order may provide for the method of the collection and recovery of port rates. In the event of the owner or consignee of the goods not having paid the charges by the time the articles are ready to be discharged, the owner or master of the vessel concerned may pay the rates, and he will then have a lien on the goods; and where the goods are to be delivered to a public wharfinger, he may pay the charges, and also have a similar lien on the goods. It will, however, be possible for special arrangements to be made respecting the time and method of payment of port rates by firms or individuals who become liable at frequent intervals to pay rates, whether on their own account or on that of any other persons. It is uncertain for the present, at all events, whether the projected imposts as now drafted, or as finally adopted, will exercise a detrimental effect upon the imports from transmarine countries, as the results of the innovation for the Port of London can only be determined by experience of the working of the new system; but it is possible that the rates may have an unfavourable influence upon the coastwise trade between London and various parts of the United Kingdom.

A large amount of business between firms situated on or near the banks of the Thames, and suppliers of raw and other materials, has hitherto been transacted and been completed by the deliveries being effected by water transport in consequence of its being cheaper than rail-borne traffic, and owing to the exemption of the goods from any charge for being brought within the Port of London. When, however, the new port rates are eventually fixed, the Thames-side firms will be compelled to reconsider the position of affairs. If it is found that the new rates, combined with the cost of shipment from eastern or western ports, are greater than the cost of rail-borne traffic, it is easy to conceive that this particular business will be diverted to the railways. But in any case the comparatively few engineering and shipbuilding firms remaining in the London area will be placed at a further disadvantage in meeting competition when the new port rates have been introduced, as the charges would increase their expenses if they were to adhere to water-borne traffic, whilst recourse to the railways would also imply the payment of higher rates, or the railways would be used to a greater extent than at present. Whichever system is practised, the final result will be additional expense. If both services work out on the same basis it will be necessary either to select that which affords the most convenience, or to follow the example of other firms which have migrated to other parts of the country owing to the pressure of local rates, rates of wages, the distance from supplies of raw materials, and other causes. But as Parliament has ordained that rates shall be levied upon goods as distinct from dues on shipping, the situation must be faced. What the solution of the financial problem will be it is impossible to foresee as yet.

Future of the Steel Rail Trade.

THE future of the steel rail business, from an international competitive standpoint, is provoking much anxious speculation. Hitherto, the manufacture of rails has been confined to comparatively few makers, and co-operative control has been possible. What is known as the International Rail Pool, or syndicate, has had at least a moderately successful career until quite recent months. Trading zones were mapped out, orders shared, and prices fixed by mutual agreement. Recently, however, new competitors have arisen in Russia, Canada, and China, who refuse to enter the "ring." Not only this, but the growing demand for open-hearth steel rails now makes it easy for almost any big steel plant to undertake rail rolling, and many firms are about to do so, whereas formerly, when rail manufacture was practically limited to Bessemer steel, few concerns indulged in the business. Then, again, the rail mill capacity of the United States is being enormously increased, and this is regarded in some quarters as nothing less than a menace to the whole trade.

The conditions in America call for special comment. The steel rail mill capacity of the United States at the close of last year was equal to 5,240,000 tons of rails a year. The completion of the great Gary plant and other extensions, and new constructions which are being rapidly pushed forward, will bring the total capacity of United States mills up to very nearly 7,000,000 tons annually—certainly 6,500,000 tons. Where will it be possible to find a market to absorb six or seven million tons of American rails every year? It must not be forgotten that the United States is fairly well supplied with railroads. The rapid building period is over. The domestic demand on account of renewals, double tracking, and, in a less degree, extensions, will continue to be large, and, during the next eighteen months or so, may be abnormal, due to recent economies and arrears; but an annual demand of anything like six or seven million tons is quite beyond reasonable expectations. In the boom year 1907, when 5212 miles of new railroad were constructed, and when renewals were on an unusually liberal scale, the demand only reached 3,293,000 tons of rails, the total United States output on home and export account being no more than 3,663,000 tons. In the five-year period 1903-7, the annual domestic demand averaged only 2,971,000 tons, and the export trade never reached half-a-million tons a year. At the moment the railroad people are in arrears with their renewals, and for the next few months demand may be somewhat above the average. But even this is questionable, while it is more than doubtful if ever the domestic requirements will be as large after next year as they have been in the past. It seems as if the United States rail makers could not possibly count upon a domestic demand of more than 3,000,000 tons a year. Indeed, we incline strongly to the opinion that the demand will be much less than that after next year. Hitherto the demand for renewals has been quite abnormal in America, because the quality of rail laid has not been the best; but now the railroad people are insisting upon a better rail for their money, and this means eventually a much smaller demand—the rails will last longer.

If, then, as is likely, the United States home demand will not be equal to the absorption of more than half—probably less—the products of the rail mills when running full, what is to become of the other half? This brings us to the question of exports. If, in order to keep their mills adequately employed, American makers will need an export trade of some 3,000,000 or 4,000,000 tons of rails a year—practically ten times as much as they have been accustomed to—the international outlook becomes interesting. Assuming that America is going to make a bold bid for export trade—and, surely, our rivals have not built their mills to stand idle half their time—and also that the International Rail Syndicate will be dissolved, we may be in for a severe competitive struggle in this important branch of the steel trade. And the dissolution of the Rail Syndicate is not improbable. Some of the British rail makers have never been quite satisfied with the international agreement, and now their position is becoming very uncomfortable on account of Russian and Canadian competition. Last year a Russian firm sent some rails into this country at a price below that which our own makers, bound by syndicate agreement, were allowed to quote. This year a well-known Canadian firm, also outside the "ring," has supplied an English railway company with a big consignment of rails while many of our mills were without work. These Russian and Canadian concerns have also secured trade in other markets which have been regarded hitherto as British preserves, while just recently the Russians have annexed a 36,500-ton order from a British Colony, the Transvaal. At the back end of last year the loyalty of the British members of the syndicate was almost at breaking point, and a meeting was held in November to discuss the question of severance. But now the spectacle of Canada doing business in England, and Russia in the Transvaal, while our own mills are in sore need of orders, is quite intolerable. So far, efforts to bring the Russian and Canadian firms into the fold have failed, and if they continue to fail we may see the early collapse of the syndicate.

With an open market and a keen struggle, assuming that this occurs, what will British rail makers have to fear? The two chief rivals will be Germany and America. German competition we know the measure and character of. The uncertain factor is the United States. During the last ten or fifteen years we have often been threatened with keen competition from America. Very shortly our United States rivals will have a blast furnace capacity of about 32,500,000 tons a year, a steel works capacity of about 28,000,000 tons, and a rail mill capacity of nearly 7,000,000 tons. Despite all the glowing accounts of American trade prospects, we refuse to believe that the United States home demand will prove equal to this great productive capacity. It seems, therefore, that our American rivals are going to have an excellent opportunity of carrying out their oft-repeated threat to annex the world's trade in iron and steel. As a matter of fact, they have had a good chance of displaying their competitive powers since October, 1907, for practically half their furnaces and mills have been standing idle since then. But no great efforts have been made to capture all the trade available, and Britain and Germany, between them, have been permitted to take nine-tenths of the world's export trade in iron and steel. Our American rivals have not resorted to "dumping." It appears that "dumping" has been finally abandoned, and if mills are to be kept running at full pressure it must not be at a loss. Orders must be profitable in future, or they will not be accepted.

What, then, are the real competitive powers of the United States as an exporting country? The cardinal point in the problem of competition is cheap production. The next point is cheap transit. That country which can produce and ship at the smallest cost will get the biggest share of the world's export trade. But that country most certainly is not the United States. In America the iron ore deposits are too far removed from the coalfields, and the manufacturing plants are too far from seaboard to permit that country to compete successfully with Great Britain. We enjoy such a combination of natural and geographical advantages over the United States, that we can assemble raw materials at smelters, we can make iron, convert it into steel, roll the steel into rails and other products, and finally put the finished goods on board ship at considerably less cost than our competitors across the Atlantic can. If our rivals did not beat us in the steel rail and other branches of the iron trade ten or a dozen years ago they are not likely to do so now. It is true that Mr. Carnegie has said that the cost of steel production is less in the United States than elsewhere; but Mr. Carnegie did not explain what he meant by steel or what he meant by cost of production. Quality for quality, we can beat the United States, even in the steel rail trade. In the coming struggle, if struggle there be, we need not fear American competition. The great Gary steel rail plant, about which there is so much loud talk, is costing so much money per ton of productive capacity, is so far from its coal, ore, and limestone supplies, and so far from seaboard, that it cannot possibly compete with the rail mills of this country in neutral markets. That competition in the rail trade from some quarters is likely to be keen we admit, but we consider that this country, with plants kept efficient, can hold its own with any rival, while we are quite certain that it can easily beat America.

Locomotive Performance.

THE discussion which has proceeded for some weeks in our correspondence columns on the comparative merits of compound and simple locomotives is of an unusually high order. The disputants know their subject, and state their views without acrimony. They marshal their facts and draw their deductions without losing their temper. Much has been said that was worth saying; and no doubt the ground has been cleared in some directions and a few points have been settled. The prominent defect in the entire correspondence is a certain lack of reality. There is an absence of facts, a superabundance of theory. No one approaches the subject from the point of view of the locomotive superintendent, or the driver, or the fireman. The discussion cannot, we think, be continued further on existing lines. Our correspondents begin to repeat themselves, a fatal mistake when repetition is pushed beyond the point required to secure the understanding of an argument. We think it possible that something may be said here which will direct thought into more practical channels.

Let us consider what the controversy is. Prominently it is whether simple or compound locomotives are most suitable to the conditions of working prevailing on British railways. Not so obtrusive, but none the less real, are the arguments that the compound engine burns less coal than the simple engine, or *vice versâ*. The precise fitness of any particular type for any particular class of work, although not neglected, assumes quite a subsidiary place. The circumstance that in practice there are many standards of excellence has not had due weight attached to it. Unfortunately, the performance of locomotives is a subject so large that it is impossible to handle it with anything like thoroughness within the limits of a newspaper article. We can do little more, indeed, than direct attention to matters of great interest concerning which our correspondents seem to care not at all.

To begin with, a wholly exaggerated importance is attached to coal consumption. Let us suppose that the average consumption of a locomotive is 50 lb. per mile, and that it runs 30,000 miles a year; this means that it burns, in round numbers, 700 tons of coal. Assume that this coal costs 10s. a ton on the tender. Then we have £350 per year as the coal bill; a reduction of 10 per cent. would only mean £35 a year—a sum not to be despised, it is true, but one so small that it can easily be swallowed up by incidental expenses. Thus let us say that it is secured by using steam of 200 lb. or 220 lb. pressure. The first cost of a boiler to carry these pressures is greater than that of boilers to carry 160 lb. to 175 lb.; but besides this, the destruction of fire-boxes seems to increase in rapidity about as the squares of the pressures. Again, water that can be used safely with low cannot be used with high pressures. Nothing is simpler than to sit in an easy chair and prove that if only locomotive superintendents were scientific they would see that high-pressure steam ought to be invariably used. The driver on the foot-plate and the foreman of the running shed have a very different story to tell. The additional cost of repairs and the loss by demurrage not only may, but certainly will, absorb all the saving that can be effected by using high-pressure steam, unless that saving reaches a much larger percentage than has apparently been secured in this country at all events, up to the present. Facts of this kind are not dropped out of sight by those who are responsible for the working of our railways. So far as can be learned, if we reject some obviously mythical statements concerning the performance of engines in other countries, the compound locomotive under suitable conditions gives a fuel economy of about 12 per cent. over the simple engine. Whether this is or is not worth having at the price to be paid for it is one of the points which our correspondents have left practically untouched. They cannot, indeed, touch it at all with advantage unless they have access to figures which are by no means easily obtained by outsiders; and are not always in the possession of the locomotive superintendents themselves, unless particular care is taken to keep time-sheets and the cost of materials for special engines distinct from the ordinary shop accounts. A notable example of neglect of this vital point is supplied by one of our correspondents, who refuses to accept the experience of "A Fireman," on the ground that coal was measured instead of weighed; that the grate of the compound was larger than that of the simple engine, and so on. With this hair splitting the practical man has nothing to do. His whole concern is that one engine working fast long-run trains burns a ton less coal than another engine doing precisely the same work. That is a solid fact that there is no getting over. It stands absolutely to the credit of Mr. Deeley's engine. But what does it mean done into pounds, shillings, and pence? Simply that it represents, with coal at 10s. a ton, a saving of 10s. in the cost of taking a splendid up-to-date train at express speed from Leeds to London, a distance of 196 miles. We may legitimately ask if this is worth having, when we consider the additional wear and tear of the copper fire-box and the tubes due to the increased pressure? We do not, be it observed, say that it is not. Can our correspondents prove that it is?

A tendency is manifested by certain of our correspondents to censure locomotive superintendents for multiplying types. No doubt there is some force in their contention; but after all, what are the consequences? It is with results—in other words, consequences—that the designers have to do. There are not, be it remembered, in Great Britain more than about a dozen men who can design locomotives and get their designs carried out in practice. It is to be expected that certain idiosyncrasies should prevail in the selection or formation of types. But this variation is far from being mischievous. It would be entirely beneficial, as leading up to the selection of the fittest, only that unfortunately there is no fittest. More than half a century ago, Herr Beyer, one of the founders of the celebrated firm Beyer, Peacock and Co., having his attention called to an extremely abnormal locomotive standing on a siding, said, "Ach, anything will for a locomotive do." The differences in merit or demerit on the road are often imperceptible. But if an engine with 6ft. driving wheels is just as good but no better than one with 6ft. 3in. drivers, why not build both kinds? In the eyes of railwaymen, from the chairman of the company to the fireman on the foot-plate, the paramount standard of excellence is the ability of the engine to "get there in time." No matter what happens, that primary condition of efficiency must be satisfied; and it is accountable for more variations in type than any other that can be named. The use of big six-coupled express engines has been sharply criticised. Why have they been introduced? The facts in one case—the Great Western—at all events, are instructive.

Until a comparatively recent period a railway was cut up into districts, and each district was worked more or less exclusively by a type of engine specially adapted for that class of work prevailing in the district. Thus there was the large wheel single for level ground; there was the large wheel four-coupled for moderately difficult country; and there was the small wheel four-coupled for heavy gradients. The train was stopped and engines changed as the districts changed. The long-run system has rendered the practice out of date for certain very fast and heavy trains. The bank engine cannot be used, and so engines must be employed which will deal with the heaviest inclines, though but a few miles long, in, say, Cornwall and Devonshire, as certainly as with the line from Paddington to Swindon. It was found that four-coupled engines could do this until autumn. Express trains were then frequently stalled by dead leaves on the track, and in winter by light snow. The six-coupled engine was introduced in order that the West Country trains might keep time, which they do. Facts such as these are easily forgotten in the armchair. They are exceedingly convincing on the footplate. There seems to be only one objection to the use of a multiplicity of types, and that is lack of interchangeability; but then who wants to use the parts of one engine in another? All the parts of a dozen engines, Class A, may be interchangeable, although they will not do for a dozen engines, Class B. Matters must be very badly managed if a crank shaft has to be taken out of the stock for tank engines to supply the needs of an express locomotive. It is worth keeping in mind that engines of a particular design are seldom if ever given up because they burn too much coal. They go out of use because they will not keep time—the unpardonable offence in the eyes of the railway world and the travelling public alike.

Finally, we may say that we think something would be gained if those who are in a position to deal with the subject would give the working expenses in detail of simple and compound engines, or, indeed, of any particular type of engine. The facts should particularly include the defects which manifested themselves in fire-boxes and tubes, the cost of renewals, and such like; always keeping the working conditions, annual mileage, and punctuality in view. We venture to think that the results will show much more uniformity than our correspondents, to judge from their letters, appear to think possible. Paraphrasing the words of the Irishman, one type of locomotive seems to be as good as another, and better.

THE CONTROL AND MANAGEMENT OF HIGHWAYS.

The efficiency, management and cost of roads are the subject of continual argument and discussion. During the last few years much has been said and written about roads, and almost every aspect of the questions and interests involved has been treated of, and a variety of opinions expressed, both by professional and other contributors to the discussion. Amongst other more or less contentious matter, the control and management of highways by local bodies has received a fair share of attention, and has also led to the expression of divers opinions. At the present time the public roads are maintained by county councils, borough councils, and urban and rural district councils. Altogether, some 1800 to 1900 local authorities share the work of maintenance. The standard and efficiency of the work done and the results obtained varies considerably in different localities.

At the Road Conference held in London, in the spring of this year, three papers on the control and management of highways were read and discussed. The President of the Conference, in his opening address, referred to the fact that the law on highways was not in a satisfactory condition, and it was mentioned that the last consolidation of the law was in the Highways Act of 1835. Since this date a number of measures relating to highways have been placed on the Statute Book, but the Act of 1835 still remains the fountain head from which the law on the subject derives its inspiration. Of late years action on the part of the Government in connection with roads has been strenuously advocated in many quarters. The advocates of Governmental action are not agreed as to the exact line the Government ought to take. All are, however, satisfied that the time has arrived when monies to be expended toward the upkeep of certain roads should be provided from the national exchequer. Being so far in agreement, opinion is much divided as to the allocation of any Government grants and the extent and nature of Government control which it is generally recognised must—as in the case of voluntary schools—in some form or other follow the acceptance of State aid.

It is due largely to this persistent agitation to obtain contributions from the Treasury towards the upkeep of roads that the Development and Road Improvement Funds Bill has been brought forward by the Government. The information at present available is not sufficient to allow of a full and practical discussion of the merits of the Bill. It appears, however, to be conceived in the main for the encouragement and advantage of motor-driven traffic as differentiated from other forms of user, and is, as far as we see at present, a somewhat disappointing measure, viewed from the broad and general standpoint of the improvement and upkeep of existing roads.

The extent to which divided control obtains is no doubt a great mistake. Roads maintained by county boroughs and other towns may for the time being be left out of consideration as a class by themselves. The remainder of the roads are under the control and management of county, urban, and rural district councils. There are sixty-two county councils and 655 rural district councils in England and Wales, each having jurisdiction over a greater or less highway mileage. That a large degree of incompetence and waste exists is not to be wondered at. It is unnecessary to enlarge on the defects of divided control and the multiplicity of authorities and officials concerned therewith. All the great railway companies are built up of a large number of smaller concerns. It was soon realised in the case of railways that numerous small and petty companies owning short mileage could not be worked, administered, and maintained in an efficient manner at a reasonable cost, and to a very large extent this is true in the case of the highways of a county. The admittedly unsatisfactory state of things in the different standards of maintenance, materials used, and cost incurred upon, in many instances, very similar roads in the same county prove that it is so.

Small local councils cannot and do not employ road surveyors, who, as a rule, have the ability or training required. In fact, these officials are not civil engineers, and it is sound engineering training and experience that is necessary in road engineering, as in other branches of the profession. Almost any week in the technical Press advertisements may be seen for rural district council road surveyors, with which office is often combined that of inspector of nuisances, at salaries at anything from £72 to £150 a year, which not infrequently is to cover all travelling expenses. According to the terms of these advertisements, the highest qualifications and experience are required. Of course, the advertisements do not mean what the text implies, and it is impossible to obtain what is asked for at the remuneration offered. In advocating more extended control of the larger and more powerful county councils, the author of one of the papers submitted to the Road Conference stated that he had known farmers, bailiffs, steam roller drivers, builders, a gas-fitter, and a publican to have held posts as district surveyors.

All who are responsible must realise that efficiency and economy are urgently required in the administration of highways and their maintenance. There must be a great effort to economise, a dictum which cannot be too often or too forcibly impressed upon engineers in these days, when the tendency in every direction and in all phases of life is towards extravagance and greatly increasing expenditure. It should be borne in mind that an old definition of an engineer is a man who can do for one sovereign what a fool can do for two.

STEAM TURBINE GOVERNORS.

Steam turbines may be governed in several ways, but the method most commonly employed in this country is that of varying the period of steam admission, and is known as blast governing. This arises from the fact that the majority of turbines in use in England are constructed on the Parsons principle, but on the Continent and in America, where the Curtis, Zoelly, Rateau, De Laval, and other types are in prominence, different means of governing are more often met with. In the blast method, as is now well known, steam is admitted to the turbine by a double beat balanced valve, in puffs of long or short duration, according to the demand for load. When the load is light the valve opens for short periods and remains closed during a greater part of the time, but as the load increases, the period during which the valve is closed becomes shorter, and the turbine consequently receives more steam. The mechanism employed by Mr. Parsons for operating this valve is too well known to need description, but slight modifications have been introduced by the various firms who have taken up the manufacture of this class of turbine.

So far as the running is concerned blast governing has proved eminently satisfactory, the turbines responding remarkably well to sudden and large fluctuations in load. The speed variation from no load to full load can be kept within very fine limits, and provided the governor is in order hunting troubles should be unknown. It is sometimes argued that the relay used for operating the puppet valve involves considerable complication; but this is more imaginary than real. That such a governor is a little more complicated and expensive to construct than one of the ordinary throttle valve type is, of course, quite obvious; but the introduction of the few additional parts gives the charge engineer but little, if any, more trouble. Usually when a relay operated governor fails to work satisfactorily the fault can be traced to the relay plunger sticking, and by removing and cleaning it sluggish governing is generally cured. The object of admitting steam to the turbine in puffs instead of in a continuous stream is to prevent throttling at light loads, the idea being that the full benefit of the high-pressure steam can be secured at all loads. Some turbine manufacturers, however, seem to have come to the conclusion that the blast method has very little, if any, advantage over the plain throttling system; and throttle valves actuated by an ordinary fly-ball governor are to be found in use. In the Willans-Parsons steam turbine, for example, a throttle valve governor is used, and apparently with very satisfactory results. On the other hand, Messrs. Brown, Boveri and Co., who have also taken up the manufacture of Parsons steam turbines, have adhered to the original principle of blast governing; but oil under pressure is used instead of steam in the relay cylinder. The oil used is the same as that employed for lubricating purposes; thus, if the oil pressure fails, the relay piston cannot be lifted, and the turbine consequently stops. The use of oil instead of steam is claimed to have the further advantage that the working of the governor is practically independent of the steam pressure. The Westinghouse-Parsons turbine is also fitted with a blast governor, and the same applies to the Parsons type of turbine as manufactured by the Brush Electrical Engineering Company. Of course, in a turbine like the Parsons or Rateau, where there is a very large number of stages, the blast and throttle methods are the only two to choose from.

Those who are not in favour of the blast method argue that the times of admission of the steam into the turbine casing are far enough apart to allow the inside of the casing to be cooled by the drop in temperature between the puffs. Thus, as in the case of the steam engine, when there is a fresh admission the hot steam makes contact with the relatively cooler walls of the turbine casing and condensation takes place. But it is not easy to say to what extent this is true, and whether the efficiency of the turbine suffers to a great extent owing to this. With throttle governing there is naturally a loss owing to the velocities and pressure in the blades being different at light loads from the pressure and velocities for which the blades were designed, and further, the steam being throttled the pressure is reduced and the available energy derived from expansion is correspondingly less. The throttling process naturally dries the steam, or it may even superheat it; but this can contribute but little towards reducing the losses. It is, of course, a very simple matter to test a turbine at various loads with a throttle and blast governor, and so arrive at the relative efficiencies of each type.

As regards by-pass governing, it is obvious that economy in steam with such a method cannot be looked for, but the usefulness of the system is often great. Sometimes the by-pass valves are operated automatically and come into action as soon as the turbine is overloaded, whilst in other instances they are operated by hand. The practice of admitting steam at boiler pressure at the end of the first section—that is to say, considerably nearer the exhaust than usual—means poor economy, since the steam acts on many less blades; but by admitting steam nearer the exhaust the turbine can be made to develop considerably more power, and this is sometimes very important. In the case of turbines driving dynamos in large power and lighting stations, for example, where it is important that the expenditure on plant should be kept down to a minimum, and where heavy "peak" loads have to be dealt with, the use of by-passes, although uneconomical, can have a favourable effect upon the amount of plant erected. When a set is under repair it is sometimes comforting to know that in the event of another unit coming to grief the remaining turbines are capable of 50 per cent., or even more, overload. But the trouble sometimes lies in the fact that, although the turbines are capable of these very big overloads, the generators are only rated for 25 per cent. overload for two hours and perhaps 50 per cent. for fifteen minutes, but speaking generally, the excess load is of short duration.

The Curtis system of governing by cutting out nozzles is probably the most satisfactory method invented, although it is not suitable for turbines having a large number of stages, as in the Parsons and Rateau types. With this method the full initial pressure is maintained in all the nozzles that are opened, and there is consequently no throttling. Tests carried out on the Curtis turbines show that the steam consumption per horse-power or kilowatt hour does not vary greatly over a considerable range in load, and that this applies more particularly to the larger sizes. At the same time the Parsons, De Laval, and other types have done very well in this respect, and all things considered, it is somewhat difficult to judge which system of governing operates the best. The small size De Laval turbines are fitted with a simple throttle governor, whilst the larger sizes, in the neighbourhood of 200 kilowatts, governing is effected by cutting out nozzles. Needless to say, the latter method gives much better results, but in small turbines where the total quantity of steam used is small, it is scarcely worth while complicating the machine with the necessary gear for varying the number of nozzles. In Germany, from which country most things intricate emanate, a system of governing has been devised in which adjustable slides are arranged in the various stages in front of the inlet openings of the guide vane wreaths, and judging from test figures, the results obtained with the system are highly satisfactory. Such a method of governing, however, is clearly not applicable to turbines having a large number of pressure stages, such as the Parsons and Rateau types.

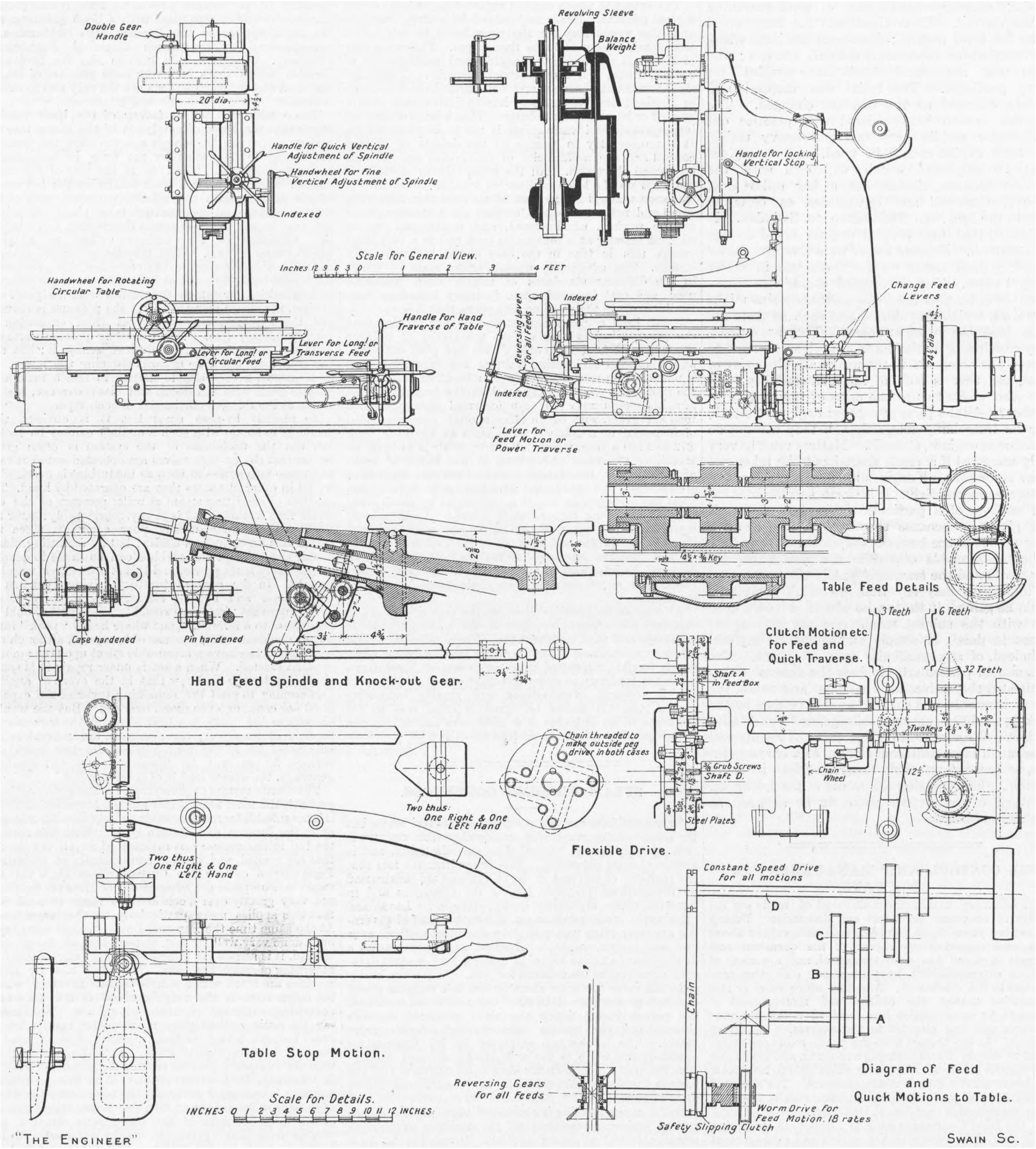
OBITUARY.

ANDERSON RODGER.

We have to record with regret the death, on the 10th inst., of Mr. Anderson Rodger, of the shipbuilding and engineering firm of Messrs. A. Rodger and Co., Port-Glasgow and Govan. Deceased, who was in his sixty-eighth year, had been ill for some time, and his death was not altogether unexpected. When Russell and Co. commenced business in Port-Glasgow some thirty years ago they had only a small yard in the east end of the town, with accommodation to build three ships of average carrying capacity, and in conducting this Mr. Joseph Russell was after a time joined by Mr. Rodger. These were the days when sailing ships were in demand, when big freights were earned, and when shipbuilders could command fair prices for their productions. The firm's business grew rapidly, and some years later, having meantime acquired by lease the Port-Glasgow graving dock, the firm took over the shipyard in Main-street, Greenock, formerly owned by Mr. J. E. Scott, and now occupied by the Greenock and Grangemouth Dockyard Company. Business expansion in course of time necessitated greater outlet, and in the early

VERTICAL MILLING MACHINE—GENERAL VIEWS AND DETAILS

J. ARCHDALE AND CO., LIMITED, BIRMINGHAM, ENGINEERS


Double Gear Handle
20" dia.
Handle for Quick Vertical Adjustment of Spindle
Handwheel for Fine Vertical Adjustment of Spindle
Indexed
Scale for General View.
Inches 12 9 6 3 0 1 2 3 4 FEET
Handwheel for Rotating Circular Table
Lever for Long! or Circular Feed
Lever for Long! or Transverse Feed
Handle for Hand Traverse of Table
Reversing Lever for all Feeds
Indexed
Indexed
Lever for Feed Motion or Power Traverse
Revolving Sleeve
Balance Weight
Handle for locking Vertical Stop
Change Feed Levers
24½" dia
Case hardened
Pin hardened
Hand Feed Spindle and Knock-out Gear.
4½" x ⅜" Key
Table Feed Details
3 Teeth
6 Teeth
Clutch Motion etc. for Feed and Quick Traverse.
32 Teeth
Shaft A in Feed Box
⅜" Grub Screws
Shaft D.
Steel Plates
Two Keys 4⅛" x ⅜"
Chain Wheel
12½"
Chain threaded to make outside peg driver in both cases
Two thus: One Right & One Left Hand
Flexible Drive.
Two thus: One Right & One Left Hand
Table Stop Motion.
Scale for Details.
INCHES 0 1 2 3 4 5 6 7 8 9 10 11 12 INCHES
Constant Speed Drive for all motions
D
C
B
A
Chain
Reversing Gears for all Feeds
Worm Drive for Feed Motion. 18 rates
Safety Slipping Clutch
Diagram of Feed and Quick Motions to Table.
"The Engineer"
Swain Sc.

seventies the firm acquired the favourable site at Kingston, half-way between Port-Glasgow and Greenock, where through improvement and extension at various times there are now thirteen building berths for vessels of the largest tonnage. Sailing ships were long the staple production at Port-Glasgow and Kingston, a large proportion of the output being for French and other continental owners. The largest ships of their time were repeatedly sent off the Kingston stocks, and not only during the period when work was carried on in three yards, but later, when operations were confined to Kingston, the firm of Russell and Co. occupied the leading position in the annual returns of tonnage output. In 1894, on the voluntary retirement from practical connection with shipbuilding of Mr. Joseph Russell, the east end yard was taken over by Mr. Rodger, while Mr. Lithgow remained sole partner at Kingston until his death on June 7th last year. Of the three partners, Mr. Russell alone now survives. Under the designation of A. Rodger and Co., and with Mr. James H. Hutchison as partner, a successful shipbuilding business has since been carried on in the East Bay Yard, Port-Glasgow, while some years ago also Mr. Rodger acquired, and re-established a marine engineering business in Helen-street, Govan, with Mr. E. Hall-Brown as managing co-partner.

A HIGH-SPEED VERTICAL MILLING MACHINE.

THE large vertical milling machine herewith illustrated is the latest pattern of this class of tool as manufactured by James Archdale and Co., Limited, of Birmingham. Several new features are embodied in its design, details of which can be gathered from the engravings and the following description.

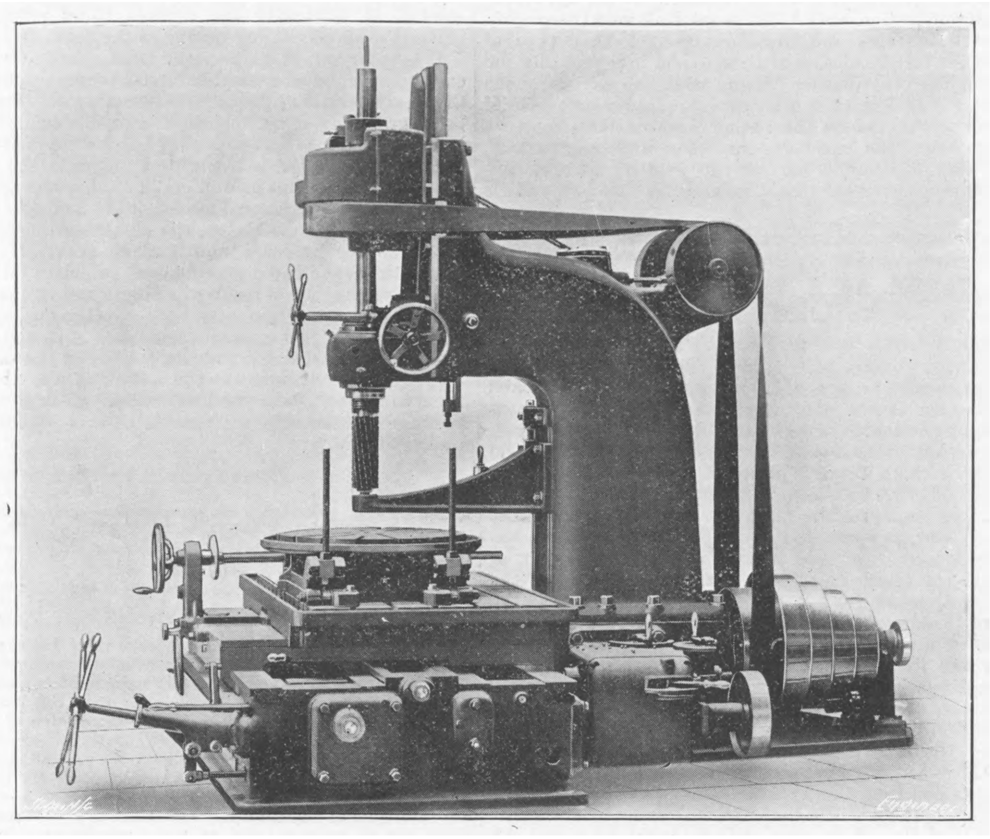
Starting with the driving gear, we notice that the spindle is driven by means of a right-angled belt drive from a four-speed cone mounted on a shaft at the base of the machine. There is thus no gearing between the cone and the spindle except the double gear used for heavy cutting. This gearing is entirely encased in the upper spindle box, which is bolted to the upper part of the machine, and in which also are the bearings for the spindle. Two bearings are provided at this point both for the spindle and for the double gear shaft; thus the overhang sometimes found in other examples of milling machines is avoided. A revolving sleeve surrounds the spindle at its upper end and takes the reaction of the bearings to the pull of the belt. Wear is thus considerably reduced. A slot in the upper half of this sleeve admits a key, which engages the last wheel of the back gear train with the spindle. The belt pulley, the first back gear wheel, and the driving plate, are keyed together, a lock bolt, which is balanced by a weight placed on the same diameter, serving in the usual way to connect the driving plate with the fourth wheel when driving direct. To utilise the double gear, this lock bolt is removed and the double gear shaft, which is mounted eccentrically with its bearings, brought into mesh by means of a lever. The countershaft for the machine being arranged to run at 281 and 96 revolutions per minute, sixteen different spindle speeds, ranging from 7 to 423 revolutions per minute, can be obtained, eight of these being with the gearing and eight without.

A separate casting with long shears forms the sliding head and lower spindle bearing, and is fitted with hard phosphor bronze bushes and washers, the latter taking the upward thrust on the spindle. This sliding head is balanced by a counter weight, and may be quickly raised or lowered by means of the star handle shown in the figure. An indexed circular hand-wheel gives a fine adjustment for the head, which can be held securely afterwards by means of a locking bolt. To regulate the position of the head and to enable it to be brought back to any former position, an adjustable stop is provided. The spindle itself is of crucible steel, and is bored from end to end, thus enabling mandrils to be secured by a draw bolt. In the driving part the spindle is of 3½in. diameter, while in the bottom bearing it is increased to 5¼in. At its nose it is screwed externally to fit larger sized cutters.

The frame of the machine is in two parts, the upper, of substantial box section, being firmly bolted to a strong wide base. There are two tables for carrying the work, one circular of 2ft. 6in. diameter, and one rectangular 5ft. 9in. by 3ft. 2in. They are provided with machined T slots and with suitable drains and suds channels. Long narrow adjustable guides are fitted to the lower table, whereby any tendency to

VERTICAL MILLING MACHINE

J. ARCHDALE AND CO., LIMITED, BIRMINGHAM, ENGINEERS.



twist is counteracted. The circular table is readily removable, and if desired it can be arranged for working in an inclined position. An index wheel is mounted on the shaft which gives the circular table its rotary motion.

When heavy milling is being done, the lower end of the arbor can be supported in a removable steadying bracket. This bracket has a screw adjustment and is fitted with an eye-bolt for lifting purposes.

A feature of the machine is the arrangement of the feed details. Power for this purpose is taken from a separate pulley on the countershaft, thus making the feed speeds independent of the spindle speeds. Eighteen changes of speed, ranging from .64 to 12.25in. per minute can be obtained instantly by setting three levers on the change speed gear box into various combinations, an index board being supplied to indicate the correct position for any desired feed.

The number of revolutions of the spindle per inch of feed depends, of course, on the particular setting of the main drive as well as the rate of feed, and varies from 660 to .6. All feeds are made reversible by means of three spur wheels and a single lever placed on the main feed shaft, and are provided with adjustable automatic stops. Hand feeds are also arranged for and the handles controlling these and other movements are all placed on the front of the machine, so as to be conveniently situated for the operator. The change speed gear box, as will be seen from the diagram, contains four parallel shafts, the first of which is driven direct from the countershaft, and has two gear wheels rigidly keyed to it. Sliding on a key on the second shaft are two gear wheels, either of which can be put into mesh with the two already mentioned by means of a lever. The second shaft, which is hollow, also carries three other toothed wheels, which drive on to three corresponding wheels rigidly fixed to the third shaft. A spindle carrying a key passes along the bore of the second shaft, and can be moved by means of a toothed wheel and rack so that the key engages with any of the three wheels.

The fourth shaft has also three gear wheels on it, and is arranged with a sliding key like the second. This shaft transmits power to the main feed shaft through a flexible coupling, spur wheels, worm wheel, and clutch. In a machine of this size and capacity a large amount of time can be saved by providing a quick power return to the table traverses. Arrangements for this purpose are made on the present machine by means of a silent chain drive from the first shaft in the gear box to the fourth. To utilise this drive the feed clutch is taken out and a second clutch put into gear by a single movement of a lever, which can also be stopped in an intermediate position for hand feeding. A simple device is provided whereby, when using the power feed or return movement, the hand traverse wheel is knocked out of gear, thus preventing it rotating. A friction clutch is provided on the power return drive so as to minimise the chances of breakage by careless handling and to ease the shock of starting the heavy tables into quick motion. A flexible coupling is also provided on the first shaft between the gear wheels and the silent chain drive pulley.

The machine weighs approximately eight tons, and some idea of its capacity will be gathered from the following data:—

Largest diameter admitted	5ft.
Greatest height admitted above rectangular table	2ft. 11in.
Greatest height admitted above circular table ..	2ft. 3in.
Transverse traverse of table (self-acting)	60in.
Longitudinal " " "	30in.
Vertical adjustment of spindle slide	18in.
Floor space	11ft. 6in by 13ft.

HIGH-TENSION INSULATORS AND POLARISED LIGHT.

TO determine the cause of breakage of some high-tension insulators which were put into service on a transmission line in America, a somewhat novel investigation has been carried out, and it was recently dealt with in a paper read at the Worcester Polytechnic Institute by Messrs. S. Richey and F. Bonnet. A few years ago an electric railway company in the United States erected a 30,000-volt transmission line. A ten-mile section was first constructed, and in this part of the line about 4000 glass insulators were used. These insulators the authors designate type A. Contracts for material for the remainder of the line—some 102 miles in length—were let later, and approximately 27,000 glass insulators, which are designated type B, were ordered. The two types were of a somewhat different design, although approximately the same size and weight. Insulators of the type B were chosen for the 102 miles of line to be constructed, partly on account of the manufacturer's willingness to make electrical guarantees, whilst the maker of the type A refused to give any electrical guarantees whatever. When the line was finished and put into operation, the B type insulators began to break, and although there was no absolute uniformity, the breakages occurred most frequently in rainy weather.

During a period of about 18 months 649 failures of the B type insulators were recorded, whilst during the same period but one of the A type failed out of a total of 4000 in use. These breakdowns in type B gave rise to great inconvenience, about 100 miles of electric railway being dependent upon this transmission line for power. After some argument the railway company installed the type A insulators throughout, and refused to pay the manufacturer of the B type for his work. Since the B type insulators have been removed the operation of the transmission line has been entirely satisfactory. The manufacturer of the B type insulators then sued for payment, his claim being that a certain type of insulator had been specified, and that type had been supplied; also that such tests as were specified had been successfully met. These claims the railway company did not deny, but raised the point that the guarantee as to workmanship and material had not been met, in that the insulators had been improperly, imperfectly, or unevenly annealed, and this, of course, had to be proved. The effect of poor annealing has been shown to decrease the specific resistance of glass, thus allowing more leakage current to pass through the pin and heat abnormally the insulator; also to set up uneven and abnormal stresses in the glass, thus rendering it less able to withstand the mechanical strains due to expansion and contraction. This argument was strengthened by the facts that the insulators broke after current was applied to the line, that more insulators broke during rainy than during dry weather, and that the A type insulators on the same line suffered practically no breakage during the time that the B type insulators were breaking constantly.

Two explanations for the failure of the B type insulators suggested themselves. The first was that the chemical composition of the glass differed so materially that one had a less specific resistance than the other. In consequence the glass became heated in service, stresses were set up in the fabric of the insulator, and these, added to the mechanical and electrical stresses, were sufficient to cause the insulator to break. The other explanation was poor annealing. In the case of the ordinary conductors, especially the metals, annealing tends to diminish the resistance to the passage of the electric current, but annealing glass tends to increase very greatly its specific resistance. Analysis showed that the composition of the glass from which the two types of insulators were made to be almost identical, which of course suggested that the difference in the behaviour of the two types was due to internal stresses on account of poor annealing, and in order to prove this a test was carried out with polarised light. When any substance like glass is subjected to strain, it is no longer homogeneous to the action of light, for the planes of stress act in a way similar to certain planes of a double refracting crystal. It is very difficult to obtain large masses of glass which are wholly free from strains and stresses due to very slight irregularities in cooling, and in testing glass this must be borne in mind; but it is, nevertheless, true that there is a very great and marked difference between well and poorly annealed glass tested by polarised light. The method of carrying out the test is to rotate the insulator on its pin axis between the polariser and analyser, which were previously arranged so as to allow no light to pass. If the insulator has been badly annealed stresses are shown by the varying intensity of the light and by the colour changes. The paper states that it is unnecessary for the light to strike the glass surface exactly at right angles; the only precaution necessary being that the section of the glass through which the light passes be approximately the same throughout the test. The test is by no means quantitative, since only a part of the stresses at the best are indicated. But as a qualitative and relative test it is considered valuable. Many of the B type insulators tested in this way appeared to be full of stresses, while a remarkable absence of stresses was found in the A type, which served to uphold the company's position. In conclusion, the authors state that so far as they are aware polarised light has not before been used in the determination of fitness of glass insulators, and they believe that this test, which is so simple in application and so definite in its indications, should be of much value in the determination of the most important qualification of a good high-tension glass insulator.

VACUUM BRAKE IMPROVEMENTS.

IN order to prevent accidents to trains fitted with the automatic vacuum brake which may arise by the failure on the part of the staff to couple up the train pipe to the engine, Gresham and Craven, Limited, Salford, Manchester, are introducing "tell-tale" devices, which show the driver whether the brake connections are in order without his getting down from the foot-plate. Figs. 1 and 2 show two arrangements whereby the act of coupling up the shackle between the tender and train opens a valve, thereby allowing air to enter the engine train pipe through a passage provided in the specially constructed dummy shown. Until the engine hose pipe is removed from the plug and coupled to the train hose pipe again, it is obvious that the driver will be unable to create a vacuum in the train pipe, and will thus be made aware of the fact that the brakes have not been coupled up. The tell-tale valve and dummy may be combined as in Fig. 1 or separate as in Fig. 2. Another device for the same purpose consists of a special gauge connected by means of a pipe to the hollow dummy plug. When the engine or tender hose coupling is on the latter a vacuum is created in this pipe, actuating a tablet in the vacuum gauge and intimating to the driver that the brake pipe is not coupled up to the train. On taking the hose pipe off the dummy air is admitted into the small pipe leading to the gauge, and the tablet on the gauge by the action of a spring indicates that the brake hose is coupled to the train. It may be urged as a defect in the last-named arrangement that if the coupling, after being removed from the dummy, is not connected to the train-pipe the driver is liable to be misled by his tell-tale gauge indicating "Coupled." In practice, however, he would instantly be acquainted with the real state of affairs, owing to the impossibility of creating a vacuum again.

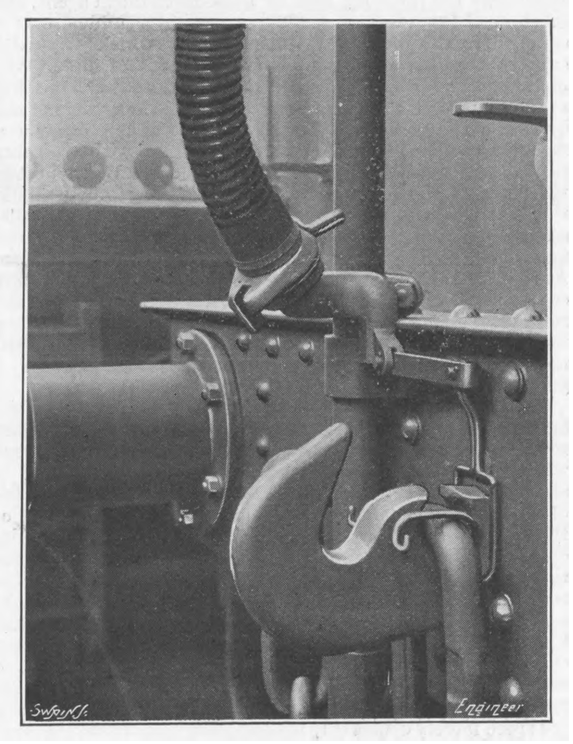


Fig. 1—TELL-TALE VALVE

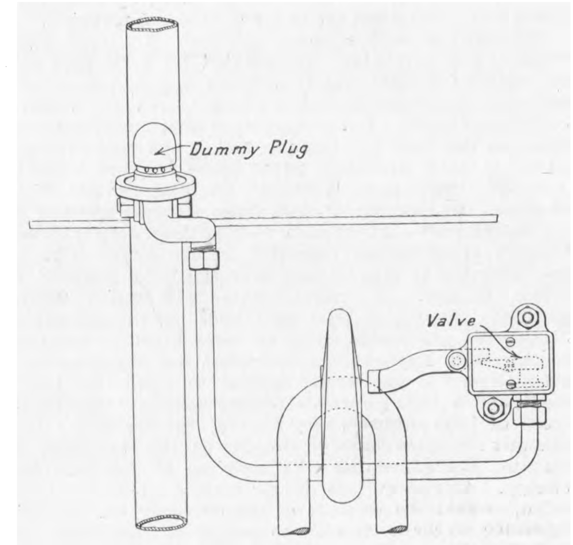


Fig. 2—ALTERNATIVE ARRANGEMENT

On some railways the companies have been put to considerable expense in replacing the rubber joint washers of vacuum brake couplings, which are sometimes pulled out by separating the two halves of the coupling before the vacuum is destroyed, and are frequently removed maliciously. To remedy this, Messrs. Gresham and Craven are introducing a coupling with an improved joint ring. This consists of a steel ring with three projections on its under side, which fit into corresponding slots or recesses in the coupling. This ring holds a special inexpansible rubber joint ring in place. These couplings are made either of steel, malleable iron, or special softened cast iron, the last-named material being recommended on account of its being able to withstand rough usage without bending, and may be coupled up even if the lugs are broken off.

ASYNCHRONOUS GENERATORS.

It has long been known that an induction motor can be made to act as a generator when the rotor is driven at a speed above that of the revolving field, but there must always be an alternating current already supplied to the mains to which the stator is connected, otherwise the machine cannot supply power. If the rotor of an induction motor is set revolving by some mechanical means it cannot act a generator, because it has no magnetising current; but if when the machine is running as a motor the rotor is driven at a higher speed than the revolving field by some mechanical agent, the machine changes from a motor to a generator, and current is supplied to the mains. If the alternator which originally supplied the driving current is switched out of circuit, the motor can no longer act as a generator, because it has nothing to supply it with magnetising current, and the voltage of the system consequently falls to zero. The action of such a machine can be understood to some extent without going very deeply into theoretical considerations. Briefly, when the speed of the rotor rises to that of the revolving field the current in the rotor conductors gradually falls, and when the rotor is revolving at the same speed as the field, the current and motoring torque both become zero. As the speed continues to increase the revolving conductors cut the field in the reverse direction, and the current in the rotor consequently also changes its direction. The reversed rotor current gives rise to a reversed stator current, and when the speed is raised sufficiently the machine acts as a generator.

When running as a generator it still takes from the circuit the wattless magnetising current. Thus, an induction motor when acting as a generator supplies a watt current which represents the power delivered to the circuit, and it also takes a magnetising current from the system, the value of which depends on the voltage and the watt component of the circuit. Such a machine therefore cannot supply its own magnetising current, nor can it supply a lagging current to the external circuit, and there must consequently be at least one ordinary synchronous generator or motor in parallel with it in order to provide the total lagging current of the line, although the capacity of the cables may often help this end considerably. Another peculiarity about such a machine when operating in parallel with a synchronous generator is that the periodicity is independent of the speed. Raising the speed merely causes it to take up more load, whilst lowering the speed reduces the load. The periodicity is dependent upon the speed of the synchronous generator or generators which are at work on the same bus bars, and without which or a rotary condenser the asynchronous machine cannot operate. When a synchronous motor is employed for supplying the magnetising current, however, it follows that since this machine receives its driving current from the asynchronous generator an increase in the turbine or engine speed causes a corresponding increase in the speed of the synchronous motor, and the prime mover determines the periodicity, the synchronous machine slipping behind the generator an amount just sufficient to allow the latter to supply all the power required by the circuit. The synchronous motor must first be run up to speed by some auxiliary source in order that it may supply the asynchronous generator with its necessary magnetising current; but once the two machines are connected in parallel the source of power used for starting the motor is no longer required.

Although an asynchronous generator is a very simple machine and particularly well adapted for high-speed work, its inability to carry lagging currents has caused it to be regarded as a scientific curiosity rather than a machine of commercial value. But in America at least one asynchronous machine has been put into use, and it was dealt with some time ago in an interesting paper which was read before the American Institute of Electrical Engineers by Mr. W. L. Walters. In 1904, Mr. Walters states, a copper smelting and rolling company contemplated putting down a 1200-kilowatt 200-volt direct-current generator for electrolytic work. It was desirable to take advantage of the good points of the steam turbine. A 1200-kilowatt 6000-ampère 200-volt generator running at 1800 revolutions per minute was not considered practicable, and an asynchronous generator, together with a synchronous converter, was suggested as an alternative. It was finally decided to adopt this type of plant, and a 1200-kilowatt six-phase generator running at a speed of 1800 revolutions per minute, together with a 1200-kilowatt six-phase converter running at 150 revolutions per minute, and generating 6000 ampères at 200 volts, were erected. A direct-current exciter for the converter was provided, so that the pressure of the converter can be varied from 100 to 230 volts without danger of instability. The exciter is compound wound to give constant voltage on the direct-current side of the converter.

When starting up the set, the converter is run up to speed from an auxiliary source of direct current, whilst the generator is, of course, driven by its turbine. The two machines are then connected in parallel, and the generator drives the converter as a synchronous motor, the converter supplying the magnetising current of the generator. The governor of the turbine thus decides the periodicity, and the slip of the converter behind the generator is proportional to the load, being 1 per cent. at full load.

This is one instance where the adoption of this apparently inflexible type of generator has resulted in an installation which combines the flexibility of the standard direct or alternating-current generator with the capacity for heavy loads of the synchronous converter and the reliability and robustness of construction of the asynchronous generator. Mr. Walters considers that no other equipment which could have been put down would have given the good results that have been obtained. And, he goes on to state, although the existing conditions rather forced the choice of the equipment in this case, the results so thoroughly met expectations that engineers have begun to consider whether the development of the last few years in regard to prime movers have not changed the asynchronous generator from a scientific curiosity to a machine possessing great advantages for certain conditions of power-station work. The paper deals very thoroughly with the advantages and disadvantages of this type of generator for various classes of service, and it is probably the most complete contribution dealing with the asynchronous generator which has been written. An interesting part of the paper is that where the author draws attention to the fact that where the cable system has a high electrostatic capacity this will supply part of the wattless current, and will reduce the size of the machines used for this purpose.

THE CLYDE AS A SHIPPING AND SHIP-BUILDING PORT.

The Clyde Trustees and their friends representative of the shipping and commerce of Glasgow and the Clyde, on September 7th, made the annual inspection of the harbour and river works, the means of conveyance to the several points where landing was effected being the Trustees' yacht Comet. The first work inspected was that proceeding at Springfield Quay. Sheds which formerly occupied this quay were cleared away about 25 years ago, and the ground equipped with rails, capstans, and cranes for the discharge of iron ore and other minerals. Now, however, that so much accommodation has been provided for this class of traffic at Rothesay Dock at Clydebank, six miles down the river, Springfield—or "the Mineral"—Quay is being restored to its original use by the erection of shedding, 718ft. long by 57½ft. wide. This is set back 36ft. from the face of the cope of the quay wall to afford room for two lines of rails, capstans, and travelling cargo cranes, and another line of rails along the roadway at the back of the sheds. All lines of rails will connect with the "General Terminus" station of the Caledonian Railway, to which the North British and Glasgow and South-Western Railways have access. The capstans will be driven by electric current obtained from the Trustees' installation at Prince's Dock. The lighting of the shedding will be by incandescent gas lamps, and the whole work will probably be completed next spring.

Proceeding down the river, the next works of engineering importance reached were the new basins and quays at Yorkhill, authorised by the Clyde Navigation Act of 1904, on a site obliterating the Kelvinhaugh Slip Dock and Shipyard—a relic of earlier and more modest requirements as to shipbuilding and ship repair—as well as the cattle lairage and timber depôt of more recent construction. These works we described last year, prior to completion, so that only a few facts are now necessary. The construction of the quay walls was entrusted to Messrs. Robert McAlpine and Sons, Glasgow, who commenced operations in the beginning of 1907 and finished about the end of 1908. The dredging out of the basins and quays has been executed by the Trustees' plant, the dredged material having all been sent to sea in hopper barges. These works will provide the harbour of Glasgow with 1148 yards of quayage, with an intended depth of 28ft. at low water and 40ft. at average high water of spring tides, and in addition, the river or harbour at this part is widened by about 60ft. The west basin of the Yorkhill extension to the Glasgow Harbour accommodation is 230ft. in width, and on both east and west sides single-storey goods sheds are in course of completion. On the east side the shed is 436ft. long by 100ft. wide, and on the west 558ft. by 90ft. Along the riverside quay which the works provide single-storey goods sheds are being constructed, 1370ft. long by 100ft. wide. These are placed 41½ft. back from the face of the quay to give room for two lines of rails and capstans and the particular types of travelling cranes required. These sheds are the widest ever provided in the harbour of Glasgow, and being in one span, provide very liberal floor space for the laying down and re-shipment of cargo. The west basin sheds are being built by the Clyde Structural Company, Limited, and the riverside shed by the Steel Construction Company, Limited, both Clydeside concerns. In front and at back of these sheds electric capstans will be provided for haulage of wagons, &c., the current being obtained from the Corporation's supply stations. Gas, however, is being employed for the general lighting of sheds and roadways, the lamps being of the inverted incandescent type.

At Meadowside, on the north, or right, bank of the river, the result of constructing a new quay wall and relative works, and widening the river by about 90ft., was noted with interest. Built departmentally—operations having commenced in July, 1908—the new quay wall is over 1610ft. in length, and the berthage provided, when fully dredged out, will afford a depth of 28ft. below low water and 40ft. at high water of average spring tides. The accommodation is proposed to be devoted to the grain and fruit trades. Passing Linthouse Shipyard, on the south, or left, bank, attention was directed to the extension to Shieldhall Wharf, including the outfall for the south side Glasgow Corporation sewage works. For the length of this wharf, about 900ft. in length, the river has been widened by about 50ft.

The "Rothesay," or Clydebank, Dock, and the Trust's fine repair works at Renfrew, formed perhaps the main objective of the day's inspection. As both of these items in the scheme of the Trust's work of extension and improvement have already been fully described in our columns, it is only necessary now to indicate briefly the latest features. The Trustees' most powerful dredger, the Shieldhall, has been engaged during the whole year—since last inspection—dredging out the inner basin to a depth of 25ft. below low water (or about 36ft. at high water) of spring tides. This work, rendered both difficult and tedious by reason of the extreme hardness of the clay and the frequency of boulders encountered, will render a further available dock area to the Clyde of 19⅔ acres and 2040 yards of quayage. In addition to the dredging out of the inner basin, operations during the year have consisted in the laying out of sidings and the general equipment of quays. The south quay has now been equipped with eight 4-ton electric cranes for the discharge of iron ore, and two electric transporters by Messrs. Babcock and Wilcox, Renfrew, are in course of erection. These will command 160ft. in width of quay, and will be capable of unloading ore and disposing of it either direct into wagons to surface of quay or into bins.

Contracts have been entered into for the erection on the north quay of two other coaling hoists, one being by Cowans, Sheldon and Co., Limited, Carlisle, and the other by the Hamburg firm of Eisenwerk, Limited. As many as eighteen 4-ton electric cranes are now in use on the north and west quay of the outer basin, and on the south quay, and more will be provided as circumstances demand. All hoists, cranes, transporters, capstans, and turntables are worked by electricity, the current being provided by the trustees' own generating station at the dock.

It is intended that Rothesay Dock, wholly, or to a large extent, should deal with the mineral shipping traffic of the Clyde, the railway facilities being ample. This object is being gradually accomplished, and in this connection it may be mentioned that the two coaling hoists already at work loaded during last year 478,451 tons of coal, while the cranes discharged 463,270 tons of iron ore and other minerals.

Speaking at the annual dinner of the Trust held the same evening, Sir Thomas Mason, the chairman, referred at some length to the proposed new graving dock. He contended that if the Clyde had a graving dock sufficient for the largest Dreadnoughts, out of reach of artillery and in the midst of a great industrial community such as Glasgow, any Government would be glad to avail themselves of it, and apart from that, they were bound to provide it. When the Colonies were supplying Dreadnoughts to the nation it was their duty at home to supply those facilities which in time of war were absolutely necessary to maintain this country's place among the nations.

LETTERS TO THE EDITOR.

(*We do not hold ourselves responsible for the opinions of our correspondents.*)

BRITISH LOCOMOTIVE PRACTICE OF TO-DAY.

Sir,—Mr. Riekie says in his last letter: "I fail to see how conditions can in any way affect the successful working of the steam engine." Then he goes on to: "The apparent failure of the compound locomotive . . . &c.," and ends the paragraph by: "The able article which appears in the same issue of your paper now clearly shows that a compound can do better work than a simple when running at high speed." My answer is, I fail to see it in that light, as the following will show:—My letter of two weeks ago gave some details of the working of a well-designed simple engine of about twenty-five years ago. "Fireman" asked if any simple engine could beat the performance given by the compound in question as regards its fuel consumption, which was, if I remember rightly, 0.092 lb. per ton-mile. The simple which I quoted was able to work with 0.081 lb. per ton-mile. Since I last wrote I have been able to procure some official figures of the performances of a link of 4-4-0's having 19in. by 26in. cylinders and 24 square feet of grate area and a heating surface of about 1550 square feet. The distance of the run is over 200 miles, the average speed and weights of trains being 54 miles per hour and 300 tons behind tender respectively. The coal consumption is 25.7 lb. per mile on the average. The engines are fitted for taking hot-feed, and this, no doubt, helps towards attaining so low a figure. This in ton-miles becomes 0.0856. Now, if Mr. Riekie is able to show me better figures for a compound I shall be pleased to back the system up, but until then is it any wonder that I prefer the "simple" system, and that I cannot agree with "the compound can do better work," &c.? The system which Mr. Riekie puts forward is, as I understand from his description, simply an ordinary engine with, say, 18in. or 19in. cylinders, with an additional two low-pressure cylinders of suitable diameter, say, from 26in. to 30in. in diameter. The question is, how is it possible to get two 28in. cylinders into the design? Certainly not outside unless by splitting them up and arranging them "Vauclain" fashion, and having six cylinders in all; such a method would not meet my approval. To get them inside perhaps would be better by inclining them axially to a distant horizontal centre—the crank axle, or by putting one in advance of the other side by side and using a longer piston-rod for one, or by placing them tandem fashion. Any one of these methods I should not, from a financial point of view, care to experiment with. Then, after all, what would happen? How would Mr. Riekie obtain a blast sufficiently powerful when working with a 15 per cent. to 20 per cent. cut-off at 60 to 80 miles per hour? By the time the steam reached the blast pipe I am afraid it would not work "a toy engine." Is not Mr. Riekie labouring under a misconception as to the requirements of a modern express engine? Does he not observe that all successful compounds have high initial pressures combined with a very late high-pressure cut-off? Herein lies the secret of the success of the De Glehn and Deeley-Johnson engines. Give them 160 per square inch and an early high-pressure cut-off, and observe what would happen. In the proposed Riekie system I take it for granted an ordinary boiler pressure would be used and employed exactly as in an ordinary two-cylinder simple. I have very carefully thought over the system as Mr. Riekie propounds it, and I am absolutely convinced that for the work prevailing at the present time it would fail. But could work be found for such an engine to enable it to work at 60 per cent. cut-off in the high-pressure cylinders the whole of the time? I have no doubt it would behave very well, but, as I have said before, no such work exists, and under present conditions the engine would be a white elephant to the company who owned it. I fail to see, as Mr. Riekie would like me to see, how by increasing the cylinder area by double the usual amount, the tendency to slip would be no more than at present. Perhaps it would not if the boiler pressure were reduced by 50 per cent. The two low-pressure cylinders would be equivalent to the two smaller high-pressure cylinders; hence we have in reality four ordinary sized ones, say 18in. to 19in. diameter. Two cylinders will very often slip the wheels more than is sometimes desired, and "heaven only knows" what would happen with four 19in. by 26in. cylinders, and an adhesive weight of 36 tons, especially if the boiler pressure were 200 lb. per square inch. As to having had "to teach the driver how to ascend grades," this was not in England, I know; if it was, it must have been a very exceptional case. I have found the drivers I have come in contact with, on the whole, a very well-educated and intelligent set of men, quite a large number possessing a taste for figures, and fully understanding the higher technicalities of the engines they have under their care. Drivers are not ignorant as to expansive working. One man I know in particular has a perfect craze for expansive working, and it is surprising to see how he ascends inclines in slippery weather with the minimum of "stalling." As to the engine slipping being caused by high pressure at the commencement of the stroke, I might remind Mr. Riekie that this is only partially true. The piston has very little leverage over the crank until fully one-fourth stroke. So that is not the only cause; high average pressure would be more correct.

Now as to Mr. Frank L. Bassett's letter. Without doubt it is a very able one indeed. His reference to the London and North-Western Railway compounds is very well stated, especially when one considers the whole facts of the situation. I quite agree with him that "locomotive design cannot be reasoned from an arm-chair." The only way to obtain any information of the real science of the profession is by that hard, long road, practical experience His paragraphs labelled (1), (2), and (3) contain a lot which must, I think, be taken in the humorous vein, especially No. (2), which is very piquantly put.

Mr. F. W. Brewer's letter, containing as it does some very interesting performances of two radically different designs on the same work, only serves to show that those much-abused compound engines were capable of some really good work. It is a very great pity that Mr. Webb never made more public than he did the history of his attempt to solve that ever-present question of locomotive design. The whole of my argument has been based upon the following doctrine:—"The proportion of the valve gear adopted gives an admission of 78 per cent. of steam in full gear, which can be reduced to 12 per cent. with excellent results, and, as at high speeds the steam is never exhausted, the temperature of the cylinders is maintained, and as much steam is locked up in the cylinders as raises the pressure at the end of the stroke to near that in the steam chest. This makes the engine run very smoothly at high speeds, and turns what would otherwise be an extravagant coal-burner into an economical machine." These words were enunciated by one of England's shrewdest locomotive men—Mr. William Stroudley—more than twenty years ago. With all the vast developments of recent years, I still see no reason to allow my faith in that doctrine to wane. I wish Mr. Riekie would carefully study that, and let me know what his opinions are. With due respect to everyone in this controversy,

London, S.E., September 11th. HENRY W. DEARBERG.

SIR,—I agree with Mr. Riekie and others that the failure of compounding as applied to British locomotives is chiefly due to the improper ratio adopted for the high-pressure and low-pressure cylinders. I consider that the ratio should be at least 1 to 2.9, or even 1 to 3 in order to secure the best results. At the present time, however, it would seem that the locomotive engineers of this country have settled the vexed question of "Simple *v.* Compound" in favour of the simple engine. The newest locomotives on all our railways are, without exception, simple engines. At the time of writing I am not aware that any compounds are being contemplated.

Mr. Brewer draws attention to an interesting, but nevertheless absurd, experiment that was carried out on the London and North-Western Railway in 1897 with a four-cylinder simple and a four-cylinder compound locomotive. At the time the four-cylinder simple engine was built I predicted for it a complete failure. Mr. Webb made many mistakes in his locomotive designs, but this was, perhaps, the most astonishing of all. It is somewhat perplexing how an engineer of such undoubted genius could have imagined that a boiler with only 1409 square feet of heating surface would be sufficient to supply four cylinders, each 15in. diameter, with "live" steam at a pressure of 175 lb. per square inch. If Mr. Webb had been content to use four 12½in. cylinders—the combined area of which is approximately equivalent to that of two 18in. cylinders—the engine might have been a success. With four 15in. cylinders, however, the engine quickly ran herself out of breath.

Mr. Brewer also mentions two very good runs with the altered "Alfreds"—compound 4–4–0 engines. Subject to correction, I should be inclined to think that these particular runs were accomplished in a strong favourable wind, for it is much better work than is usually associated with the compounds. On the other hand, it is a well-known fact that Mr. George Whale's simple 4–4–0 engines, the famous "Precursors," are daily performing work that was previously unheard of on the London and North-Western Railway. A noteworthy feature of all Mr. Whale's engines is that they combine great power with remarkable simplicity. For all-round economy they would be hard to beat.

Mr. Frank L. Bassett has rightly pointed out that there are "fashions" in locomotive design. This is often a good thing, as, for instance, the present general adoption of the extended smoke-box. The "circular-fronted" smoke-boxes are usually carried on a saddle casting, similar to the American practice. One great advantage is that they form a reservoir which greatly assists the maintenance of the draught between each exhaust. Moreover, extended smoke-boxes are more durable, and do not require to be emptied so often as the antiquated smoke-box of the old days, which, after a hard run, I have frequently seen red hot at the front.

It will be very interestiug to see what type of express locomotive will emanate from Crewe Works under the superintendence of Mr. C. J. Bowen Cooke, in view of that gentleman's long acquaintance with the Webb compounds and the more recent simple engines of Mr. Whale's design. CHAS. W. DAUNCEY.

Birmingham, September 13th.

SIR,—I must thank "F. A. L." for replying to my "inaccuracies." The most "sensational" publication I am in the habit of reading dealing with railways is THE ENGINEER, which does not, to the best of my belief, chronicle wild-cat runs. If "F. A. L." will take the same trouble in referring to its back numbers as he advises me to take in estimating train loads he will find some foundation for my remark as to 400-ton loads on the Great Western. I mentioned the "short bits" of 1 in 40 and 1 in 42 as merely illustrating extremes of severity. As a matter of fact, there are 2½ miles of 1 in 42, and I still maintain that there is nothing quite like it on the South-Western or any other line. Another small point is that these grades, as far as the down trains are concerned, have to be faced by engines that have already run nearly 200 miles—that is to say, the fire is dirty and the tubes getting choked. Let me add that I am quite aware this does not apply to many trains. "F. A. L." is good enough to remind me that the work of a great railway is not confined to the running of a few crack trains, and that suburban, goods, and even coal trains, have to be hauled. But he forgets to mention, in his turn, a humble but very important branch of locomotive work, and one involving much wear and tear—that is, shunting. "F. A. L." states that I was unable to advance any reason other than his own for the high cost of repairs and renewals, and that I admitted as much. I admit it now, as I have not the necessary knowledge to enable me to say why a Great Western locomotive should cost so much more to maintain than one on the Great Northern; neither has "F. A. L." But I suggested a possible cause, and one that is quite feasible from my own personal experience. Some years ago I was employed in the locomotive department of a well-known English railway. At the particular depôt of which I write we had some 200 engines and a repairing shop of 10 pits. Being young and enthusiastic, I speedily made myself objectionable to foremen and charge hands by discovering defects in locomotives that were not booked. I well remember finding a broken axle-box pin, to which was attached the spring, on an engine to which we were doing something else. I reported this, and was told to mind my unrepeatable business. This engine went out the next morning with an important train. Being inquisitive, I took the trouble to go under all the engines in the shed at the time. I forget how many I found in a similar plight, but I know it was a not inconsiderable number. At the same depôt we used to re-bore the cylinders with a hammer and cold chisel. That is to say, when new piston heads were fitted the clearances were chipped out and the bore allowed to go. When I mention that there would be perhaps ⅛in. to chip down at the bottom, tapering off to nothing at the top, the beauty of the job can be appreciated. Slide valves were frequently run until they broke, and leaking tubes were not regarded seriously so long as the fire could be kept alight. I have seen axle-boxes merely rasped over after being re-metalled, placed on the journal, and allowed to go, and engines sent out with sand valves inoperative and front smoke-box plates burnt into holes. I might enumerate several other pleasant little practices, but I think I have said enough to show that repairs may be cheap—and nasty. On the other hand, I had excellent opportunities for studying the monthly consumption sheets, and from them it was very evident that repairs and renewals were not the only items to be charged against a locomotive. A. HOCKLEY.

Northampton, September 13th.

SIR,—Mr. Riekie hopes he has now shown clearly the advantages of increasing the cylinder capacity of locomotive engines. Presumably, he thinks that a considerable gain in power and reduction in haulage costs would result from the adoption of his system. If so, it would be interesting to have a concrete example of his proposals. What proportions would he recommend for an engine to haul 350 tons behind the tender from Glasgow to London in nine hours—no pilot or pusher allowed—and how much coal, water, and oil would be used up on the journey? A. L. F.

Glasgow, September 13th.

PURE *v.* PRACTICAL MATHEMATICS.

SIR,—The season for technical classes is now approaching, and it appears to me that a discussion on the above subject would be both interesting and valuable.

My own experience is decidedly in favour of a young engineer learning pure mathematics, and leaving the so-called practical mathematics alone. In pure machematics one section leads naturally to another; the subject is developed into a harmonious whole and the relations between the methods made clear, while the whole structure is raised in orderly succession upon a firm foundation of primary facts.

On the contrary, with practical mathematics a scrappy selection of methods is taught. An endeavour is made to give in one or two hours per week a knowledge of parts of the theory of equations, trigonometry, conics, higher plane curves, differential and integral calculus. The attempt is far too ambitious to be successful. Owing to the extent of the programme the connecting links are necessarily omitted, and the result is a collection of methods—mostly special, as the student's knowledge is too limited for him to understand general methods—without order, without any apparent connection, without reason or proof, and without any discussion of errors and limitations, which last, while most important, is, of course, out of the question when the theory of the methods is not developed.

Thus, for example, the students are told that $(1 + x)^n = 1 + nx$ nearly when x is small, and are instructed to test it in such a case as $\sqrt{101} = 10\,(1 + \frac{1}{100})^{\frac{1}{2}}$, but the binomial theorem, from which it is merely a deduction, is not given, nor are they told that the error is very nearly equal to $\frac{n\,(n-1)}{2\,!}\,x^2$, the next term of the expansion.

Too much time is spent on squared paper work. Ordinary graphs are quite simple to anyone who has studied conics in pure mathematics. Squared paper is exceedingly valuable, but its use can, and does, easily degenerate into abuse: that a question can be solved on squared paper is not evidence that such is the best method—in many cases it is not.

Then take vectors. Anything involving a direction and an amount as its defining quantities is a vector; thus forces, couples, velocities, accelerations, are all vectors, and are mathematically identical from the vector point of view, yet I have known the triangles of forces and of velocities to be spoken of as independent theorems, while other vectors are seldom mentioned. To the student of pure mathematics who knows Argand's diagram, a vector is $x + \imath\,y$, or $r\,(\cos\theta + i\sin\theta)$, and their composition, &c., is contained in the statement that they obey the fundamental laws of algebra.

Students are often instructed to prove a number of mathematical truths for themselves by drawing to scale, *e.g.*, Euclid I. 47. In general, students do not work with any great accuracy, and they commonly prove for themselves that the "truth" is only an approximate one, an idea which it is often difficult to eradicate. It is, in fact, physically impossible to prove such facts by scale drawing, all that can be done is to find that they are approximately true in special cases. For example, if the instruments be such that measurements can be made to one-hundredth of an inch, the hypothenuse of a right-angled triangle of 2in. and 3in. sides will measure 3.61in., the true value being $\sqrt{13}$, or 3.60555 +, so the proof shows the theorem to be incorrect by about one-eighth per cent.

The differential calculus is the mathematics of limits, and an exact notion of a limit is thus indispensable if progress is to be made. The junior student, without much training in mathematical conceptions, is often not in a condition to receive such notions, and much valuable time is wasted. Also, the notation frequently used is somewhat loose, and this, while offering no difficulty to the advanced student who recognises that the notation is simply a convenient abbreviation of a precise, but perhaps complex statement, often leads to wrong conceptions in the mind of juniors. Thus, we often see $\frac{\sin\theta}{\theta} = 1$ when $\theta = 0$. This statement is, in itself, absurd, for if $\theta = 0$, neither θ nor $\sin\theta$ have any existence, but no difficulty occurs when it is realised that what is meant is that $\frac{\sin\theta}{\theta}$ can be made as nearly equal to unity as may be desired by making θ sufficiently small. The junior student is, however, apt to take statements literally, and difficulty arises before long.

My experience of students of practical mathematics, at classes and at actual work, shows that they nearly always learn processes without reasons and limitations, and are thus unable to apply the processes to problems outside the immediate range of the examples given in the classes.

My advice is, given a certain necessary aptitude for mathematics, learn pure mathematics, and give the practical (?) classes a wide berth. There is no royal road.

The question is one of considerable importance to young engineers, and I feel sure that a discussion of the subject by the more experienced readers would be extremely valuable to the juniors. I have given a few views on one side of the question, and hope others will offer their opinions, either in confirmation or the reverse.

Derby, September 10th. P. H. PARR.

EXPERIMENTS WITH A GLASS CARBURETTER.

SIR,—In this week's issue Mr. Bickford discusses my original criticism on the above article. Perhaps you will allow me to express my great regret that my remarks should have caused him resentment. I certainly did not condemn his experiments because they were conducted with the aid of humble apparatus, but because he drew positive conclusions from data gained by his incomplete plant.

Before accepting the bet on which hangs a new hat, we must first agree on what a carburetter is, and what it is intended to do.

The surface carburetter, it will, I think, be agreed, carburates the air in such a manner that no stream of petrol occurs in any part of the induction pipe; on the other hand, in some makes of engines the fuel is injected straight into the cylinder, with no attempt at previous vaporisation. It seems by almost common consent to be agreed that neither of the two extremes is suitable for autocar use, and the jet carburetter is commonly used as coming between and combining the two extremes. Fuel is ejected by the jet as a convenient means of controlling the quantity, and the carburetting function occurs afterwards. The question really is—Must the petrol be evaporated before reaching the inlet valves or not? And if evaporation be necessary, at what point in the feed apparatus must it be concluded? In the ordinary form of induction pipe to a four-cylinder engine there seems little chance of each cylinder getting an equal quantity of petrol if this travels along in the form of a stream, either continuous or in globules, right up to the valves. If, however, the petrol be first deposited on the walls of the induction pipe and then evaporated, a more equal distribution might occur. This possibly explains the separate branch to each cylinder sometimes used, but in such cases the induction pipe itself becomes part of the carburetter, since it takes part in carburetting the air.

Now, a carburetter maker is allowed no voice as regards the form of induction pipe to be used, so that he cannot rely on anything but his own apparatus; hence he must provide for evaporation as far as possible in his design. What are the conditions which best satisfy the conditions will, no doubt, be decided by Mr. Bickford in his future experiments.

My idea of a carburetter is one which carburates the air without relying on the further help of the induction pipe. Mr. Bickford's glass apparatus injected a stream of petrol into a glass tube, this being the induction pipe, but without any provision for atomising the fuel, or providing the necessary heat without which evaporation would be difficult. Hence the continuance of petrol waves on the inner surface. WALTER GILLETT.

London, September 13th.

THE SENSIBLE AND LATENT HEAT OF STEAM.

SIR,—Interesting correspondence has lately appeared in your columns with reference to "latent and sensible heat." And in this connection I would like to quote a practical illustration of the fact that if steam expands without doing work it becomes superheated. A closed copper pan 8ft. diameter by 10ft. deep is fitted with a steam pipe 2in. diameter for steaming out and cleaning the pan after the contents have been discharged at about 150 deg. Fah. through a valve at the bottom 14in. diameter. Steam is supplied at about 7 lb. pressure from the top of a large vertical stand pipe (12in. diameter) acting as a separator. Within about fiteen minutes after the small steam supply is turned on, the temperature in the pan—as registered by tested mercurial thermometers in the pan—is raised to and maintained thereafter steadily at 222 deg. Fah. The large outlet valve remains full open to the atmosphere, and there is certainly no pressure in the pan, yet the temperature corresponds to a pressure of 3 lb. per square inch., as if the pan were merely an enlargement of the steam pipe.

E. C. S.

NAVAL ENGINEER APPOINTMENTS.

THE following appointments have been made by the Admiralty:—

Engineer Commander:—F. Hore, to Torpedo Depôt, Portsmouth Dockyard.

Engineer Lieutenants:—W. L. Moore, to the Blake, additional, for duty in connection with torpedo-boat destroyers and torpedo-boat tenders; J. G. Gundry, to the Topaze, additional, for the Coquette; J. H. Apps, to the Victory, additional, for instruction of engine-room ratings in torpedo boats; E. D. Sydenham, to the Powerful, as Inspector of Coals at Australian and New Zealand Mines.

THE WATERWORKS DIRECTORY AND STATISTICS, 1909.—This is the twenty-eighth edition of this directory, and every effort, it is stated, has been made to bring it up to date and to render the information full and reliable. The preparation of this publication has now received the support of the Association of Water Engineers, and the detailed information of the numerous waterworks of this country and the list of officials connected therewith should make the volume of great value as a source of reference to numerous engineers and others. The book is published by Hazell, Watson, and Viney, Limited, London, price 10s. 6d.

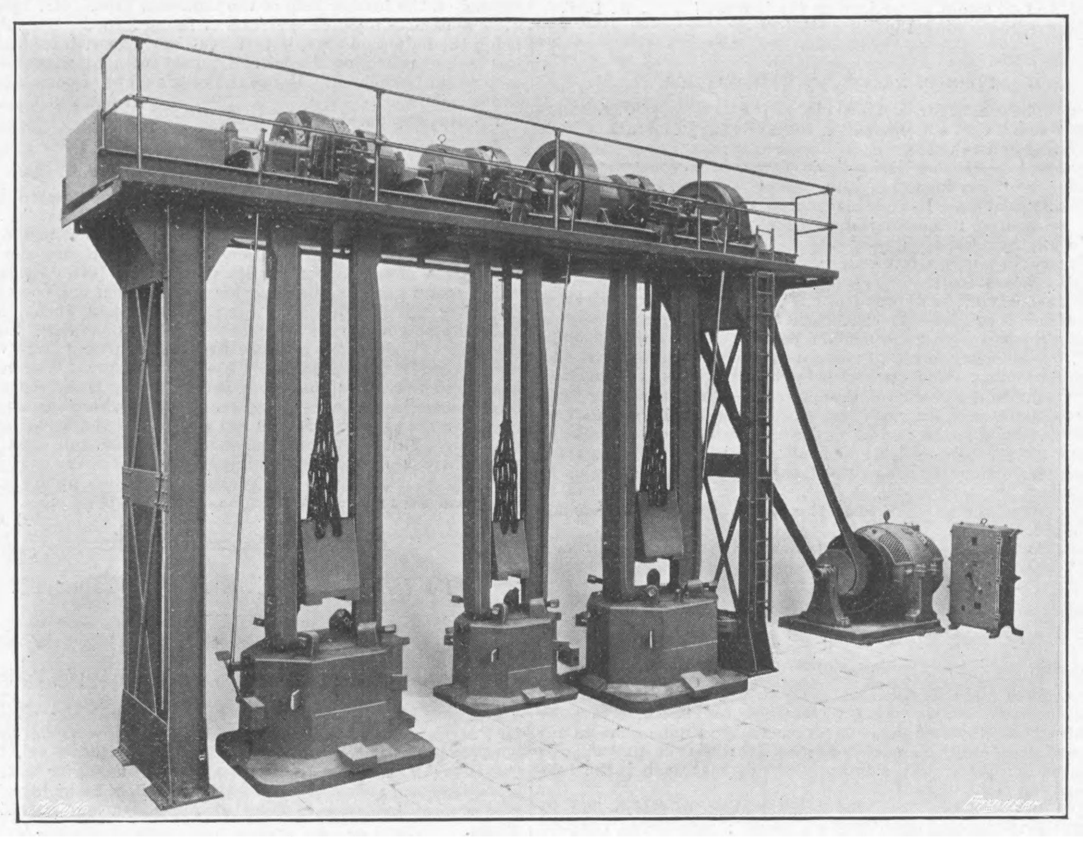
TREATMENT FOR ELECTRIC SHOCK.—In view of the extensive use of electricity in workshops, it is essential that foremen, workmen and others should make themselves familiar with the treatment for electric shock. From the *Electrical Times*, 8, Bream's-buildings, Chancery-lane, E.C., we have received a wall card which has been prepared for hanging in workshops, and which gives concise instructions for treating persons suffering from the effects of electric shock. It gives, in addition to the old method, a much simpler method, which has been approved by the Home-office. With the aid of the drawings, which, we are informed, have been prepared from living models, the instructions can easily be followed by unskilled persons. A blank space is left for the insertion of local information, such as the name of the nearest "first-aid" man in the factory, or the position of the medicine chest. The size of the card, which is varnished and can therefore be washed, is 16in. by 11¼in.

MANY IMPROVEMENTS in the District Railway service are to come into force on October 1st, more through trains and later trains being run on several of the routes. On many of the existing trains more accommodation will be provided. The service from the City during the busy hours is to be increased from thirty-four to thirty-six trains hourly, this being, it is claimed, a world's record. Four additional trains per hour are to run between High-street, Kensington, and the Putney line throughout the greater part of the day. On the Richmond line, where no fast trains have hitherto been tried, the trains now leaving the Mansion House at 4.52 p.m., 5.22 p.m., 5.52 p.m., and 6.22 p.m., will in future start three minutes later, and run without a stop from Sloane-square to Hammersmith. The journey from the Mansion House to Hammersmith will thus take twenty minutes. There is a new train to Mill-hill Park from the Mansion House at 12.39—twenty-three minutes later than the last at present—and additional trains are to be run on the Putney, Wimbledon, Hammersmith, Ealing, Hounslow, and South Harrow lines.

HIGH-SPEED WIRELESS TELEGRAPHY.—On Saturday, September 11th, the Cullercoats radiotelegraphic station at the mouth of the Tyne was the scene of a demonstration of a new high-speed automatic transmitter for use with wireless telegraphy. This station is fitted for working with both the de Forest spark method and the Poulson arc method of radiotelegraphy, but it is for the latter that the high-speed transmitter is adopted. The object of the demonstration was to show that with the employment of this automatic transmitter a speed of sending can be obtained rivalling that obtained with submarine cables. The instrument has been devised by Dr. Poulson. At present there is only one example in existence, at Lyngley, in Denmark, which is about 600 miles from Cullercoats in a direct line and near Copenhagen. The machine is worked on much the same principle as the Wheatstone automatic transmitter, that is to say, the message to be sent is represented by a series of holes punched in a continuous paper strip, those on one side of the central line being the dots of the Morse code and those on the other the dashes. The paper strip is fed into the sending apparatus, which consists essentially of a rotating contact making device, and the holes in it actuate mechanism, by which the waves produced by the arc generator are cut up into lengths, short for the dots and longer for the dashes. The oscillations thus sent out are picked up by the antenna at the receiving station and conducted to a detector. The current from the latter goes to a "string" galvanometer, in which a fine metal wire, normally stretched in a vertical position, is deflected sideways by the action of the current. This string or wire is mounted in the light beam of a Nernst electric lamp with an optical condenser, which throws the light on a narrow slit, behind which a band of photographic paper is moved by an electric motor. The shadow of a small portion of the wire as it vibrates to and fro in response to the signals from the sending station is thus imprinted on this band, which is immediately drawn automatically, first through a developing bath and then through a fixing bath. Thus as fast as the message arrives it can be read on the paper band in the form of a wavy or zig-zag line. Several experiments were carried out in receiving messages on Saturday, but the most severe test consisted in transmitting messages from Lyngley at a speed which well exceeded 100 words per minute. These messages were received at Cullercoats and read without difficulty. The power used at Lyngley is said to be 10 electrical horse-power, and the wave length was 1800 metres.

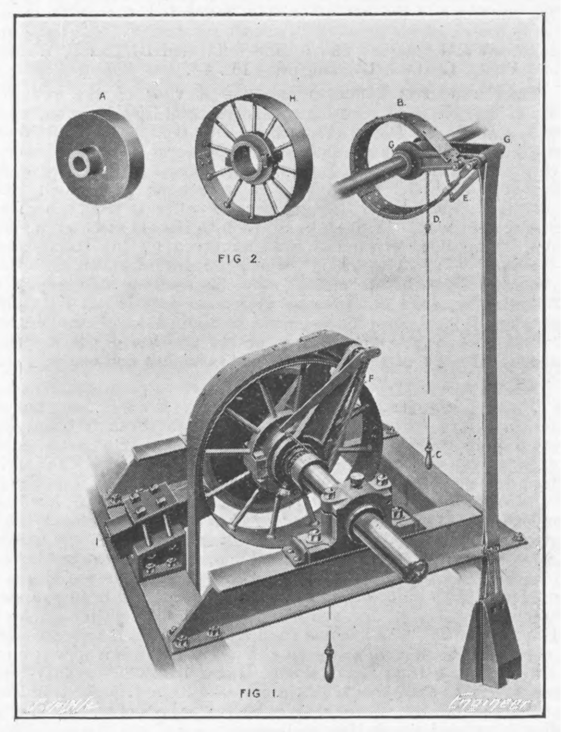
FRICTION DROP STAMP BATTERY

B. AND S. MASSEY, MANCHESTER, ENGINEERS



IMPROVED FRICTION DROP STAMPS.

A BATTERY of drop stamps embracing new features has recently been built by B. and S. Massey, Openshaw, Manchester. The battery is illustrated above, and as will be seen, comprises three friction-driven units, the middle stamp being 10 cwt. and the other two 20 and 15 cwt. respectively. The power for lifting the tups is supplied by means of an electric motor and belt. Figs. 1 and 2 will help to explain the action and construction of the lifting mechanism applied to each unit. This embraces a cast iron friction drum A, which is keyed to the main overhead shaft and rotates with it; a friction band B of steel, lined with hard wood blocks, which encircles the drum, and which by means of the handle C connected to the chain D and lever E, can be made to grip the drum like a band brake; steel lifting arms G centred on the shaft and free to rotate on it in either direction, to which arms the friction band is connected, while to the cross piece at the ends of the arms the lifting ropes are attached; and a loose pulley H mounted between the arms G G, but independent of them and free to revolve in either direction; and a buffer I for the arms to strike against when in their extreme positions. The lifting ropes are of hemp laced together, and the tup is attached to the lower end by a sling rope which can be adjusted in length to suit dies of varying thicknesses. A spring F is provided to disengage the ropes as soon as the handle is released. The method of operation is as follows:—When the handle C is pulled the friction band B is tightened and made to grip the revolving drum, which carries the arms round with it and lifts the tup. As soon as the handle is released the spring F disengages the band from the drum and the tup falls by gravity. The control is rendered extremely sensitive by means of a special device, by which the grip of the friction band on the drum is automatically reduced as the tup rises. This comprises a chain which is wound round the main shaft—as shown—so that as the arms rotate in the lifting direction the chain is automatically unwound and the tension thereby reduced. It is therefore necessary to maintain the pull on the handle so long as it is desired to raise the tup. If the chain be pulled to a certain point and then held stationary, the friction of the band is at once reduced till it is just sufficient to hold the tup suspended and no more. For if the tup were to rise higher the chain would at once become slack, and if the tup were to fall in the slightest degree the chain would be tightened and cause the band to grip more firmly. In this manner an intimate relationship is established between the position of the handle and that of the tup. The pull required is surprisingly light, and the movement of the handle short.



Figs. 1 and 2—LIFTING MECHANISM

A special holding-up gear is also fitted to this battery by means of which the tups can be kept suspended in any position for an indefinite length of time. The gear consists of a band brake of steel with V-shaped wood blocks bolted to its inner surface. This band encircles a grooved pulley cast solid with the arms of the lifter. By means of a foot lever and connecting links the band can be caused to grip or release the pulley instantly, thus holding the tup up or permitting it to drop freely at any instant. A feature of this gear is that there is practically no possibility of the brake slipping, its connections being so arranged that the movement of the drum in the falling direction tends to cause the band to grip, while a movement in the rising direction is not impeded by the band brake at all.

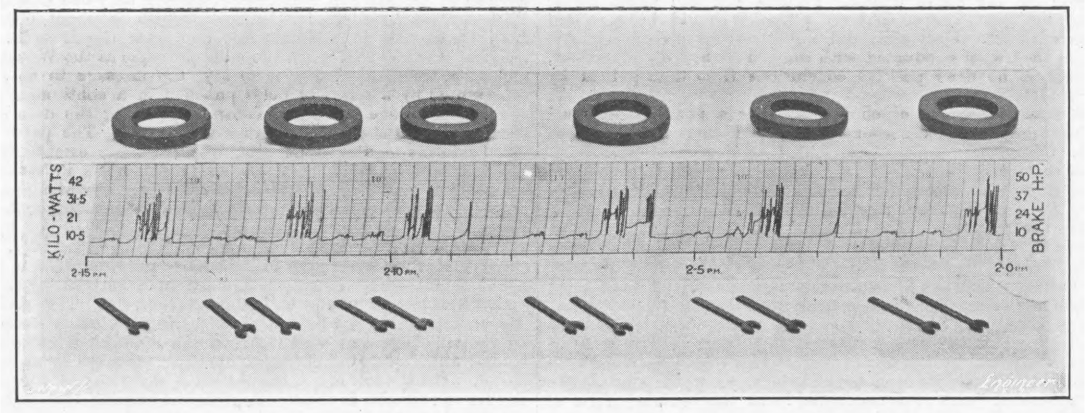


Fig. 3—TEST OF FRICTION DROP STAMPS

To prevent the friction-lifting drums overheating by the contact of the band, the larger sizes of stamps are fitted with a special water cooling arrangement, by means of which a stream of water is caused to circulate through the drums. The lifting gears, shafting, &c., are fixed securely on girders supported by strong stanchions independent of the anvil blocks, and are thus protected from shock and vibration. Easy access to the working parts and bearings is provided by means of a platform surrounded by a hand rail, and approached by a ladder. The guide bars are of cast iron, and rest in tapered recesses in the anvil blocks.

B. and S. Massey have carried out some interesting power-consumption tests with a pair of 5 cwt. and 20 cwt. friction drop stamps, mounted on the same shaft, and driven by means of a belt from a 35 horse-power electric motor. In the larger stamp the tup with the die weighed about 22 cwt., and in the smaller stamp about 5¼ cwt. The lifting speeds were 400ft. and 450ft. per minute respectively. The test lasted 15 min., during which time six 8in. diameter rings were stamped under the 20 cwt., and eleven ⅜in. spanners under the 5 cwt. stamp. The diagram reproduced in Fig. 3 was taken by means of a recording ammeter, and shows the actual amount of power required at each instant during the test. The power curve is horizontal when the motor, shafts, and belts only are running, and rises as soon as the load is increased. The higher peaks show the power taken by the 20 cwt. stamp, and each separate blow can be traced, while the lower peaks show the amount of power taken by the 5 cwt. stamp. A watt-meter was also in circuit, and showed that the energy used to drive the motor, shafts, belts, &c., was 2.36 kilowatt-hours, while the energy actually used to lift the stamps was only 1.42 units, or 3.78 units altogether. It may be mentioned that the shafting was longer than necessary for the two stamps, as it was also used to drive a couple of pneumatic hammers, a trimming press, and an emery wheel, the belts for which were, however, kept on the loose pulleys in all cases except that of the trimming press.

THE HEAT VALUES OF LIQUID FUELS.

SOME time ago a series of experiments was carried out at the Worcester Polytechnic Institute with a view to studying the methods of determining the heat value of liquid fuels. According to an account of these experiments by Mr. L. Stinchfield in the *Journal* of the Worcester Polytechnic Institute, a comparison was made of the three leading methods of experiment, using the bomb, the junker, and the constant-pressure apparatus. In the constant-pressure method the fuel is electrically ignited and burned in a combustion chamber immersed in water. A stream of oxygen flows in this chamber, and the burned gases bubble up through the water. The oxygen is under sufficient pressure to keep the flow correct for complete combustion. In these tests the Rosenhain apparatus was employed. When using the junker calorimeter a known amount of fuel is burned in a cylindrical copper vessel, round the walls of which water is constantly flowing. When the working conditions become settled, the rate of flow of the water, the rate of burning the fuel, and the rise of temperature of the water in the instrument are determined. In the bomb calorimeter the fuel is electrically ignited and burned in oxygen, under 15 to 25 atmospheres pressure, in a strong steel vessel or bomb. The difference between the heat of combustion at constant volume so obtained and the heat of combustion at constant pressure obtained in the Rosenhain and junker instruments is said to be below the limit of experimental error.

An essential point in all three methods is the determination of the weight of the liquid consumed. In the junker instrument the liquid was burned in a Primus burner. This was suspended from one arm of a balance, with a deficiency of weight in the pan hung from the other arm, and the times were observed when the pointer drifted by the zero mark, owing to the combustion of the oil. When making tests with the other instruments, several methods may be used whereby the liquid may be weighed without danger of evaporation loss. The liquid may be absorbed in a porous pellet of known calorific value, and wrapped in a tight cover, also of known calorific value. In the present experiments the absorbent used was a compressed pellet of wood pulp. Tin foil was used as a wrapper. This method proved fairly satisfactory in the bomb apparatus, but in the Rosenhain instrument there was a residue of unconsumed tin, which could not be determined accurately. Various other methods of determining the weight of the fuel are also dealt with.

To compare the three instruments, four widely different oils were burned in each, the specific gravity and flash point of each oil being given in tables in the report. The general conclusions arrived at are that the bomb calorimeter, when in perfect working order, gives good reliable results with all liquid fuels. It is preferable to enclose the fuel in a gelatine capsule rather than to absorb it in a pellet wrapped in tin foil, since the weight of the gelatine is less. The junker apparatus, with a burner adapted to the liquid being tested, is the most convenient method of determining the calorific value of liquid fuels. Its accuracy for nearly all such fuels is shown by the close agreement of the results obtained with those found with the bomb, and by the closeness of the values found for standard pure liquids to those given by other observers. As regards the Rosenhain apparatus, the investigation seems to show that, except for fuels of low volatility, the results are low, which is attributed to incomplete combustion.

THE COLLISION AT MOORGATE-STREET STATION.—The Board of Trade report on the collision that occurred on August 5th at Moorgate-street Station, on the Metropolitan Railway, has just been issued. The mishap was due to an automatic signal that, failing to go to danger after a train had passed, remained at "clear" and permitted a second train, which came into collision with the first, to enter the station. The signal was of a type that had been first used in connection with the work of providing automatic signals now being completed on the Metropolitan Railway between Aldgate and Praed-street. When a signal may be lowered oil is admitted by an electrically-controlled valve into a piston in a cylinder, which forces down the signal-rod and pulls off the signal arm. When the arm has to go to danger, owing to the passage of a train, the oil is released from the cylinder, and, being forced out by the weight of the signal, the latter goes "on." Unfortunately, in this particular signal, some sediment found its way into the valve and prevented the free flow of the oil from the piston, so that the signal failed to go to danger. This weakness having been discovered, the valves on this type of signal, of which there are only 18 or 19, are to be replaced by an improved design. We understand that since automatic signals were introduced on the District Railway less than four years ago there have been on that line and the Tubes approximately 215,000,000 signal movements, and as this is the first accident which has been reported to be due to false "clear" signals, it speaks well for automatic signalling.

CATALOGUES.

Crossley Steam Gauge and Valve Company, 147, Victoria-street, London, E.C.—This is a neat little publication giving a concise comparison of the optical and pencil lever indicators as used on gas engines.

The Lahmeyer Electrical Company, 109-111, New Oxford-street, London, W.C.—This is a well-bound catalogue having reference to vulcanised india-rubber wires and cables. It contains some exceptionally useful conversion tables, and the principal English and foreign wire gauges. It also gives particulars of various conductors, pure and vulcanised india-rubber cables, single-core braided and lead-covered cables, single-core braided and lead-covered cables with wire armour, flexible twin wires, cotton or silk braided, workshop wires and other flexibles, fire-resisting cables, weather-proof cables, pluvius cables, and trailing cables.

The Power Gas Corporation, Limited, 39, Victoria-street, London, S.W.—A new illustrated catalogue, having reference to "Mond" gas producer plants, with and without ammonia recovery, has reached us. It gives particulars of the modifications which have recently been made, and which enable the company to offer the "Mond" plants at a lower price than hitherto. There are many interesting illustrations, and the descriptive matter may be read with advantage by those desirous of gaining information relating to gas producers. Another feature of the catalogue worthy of mention is that it contains three pages of useful data regarding temperatures, melting points, &c.

Siemens Brothers, Caxton House, Westminster, S.W.—Catalogues Nos. 502 and 503, also Price-sheet 504, have reached us, all of which are bound together in a neat binder. Catalogue No. 504 has reference to thermo-electric pyrometers, and deals with thermo couplers, protecting tubes, cooling arrangements, temperature indicators, recording instruments, and potentiometers for thermo-electrical testing. Catalogue No. 503, which supersedes Pamphlet No. 24a, deals with the Siemens water pyrometer, whilst Price-sheet No. 504 is devoted to optical pyrometers. Engineers who have to deal with the measurement of high temperatures will find this collection of literature interesting.

The Union Electric Company, Limited, Park-street, Southwark, London, S.E.—This is a new list, which illustrates, describes, and gives prices of low-tension switch gear. The list deals with knife pattern main switches, both single and double throw, laminated brush main switches, change-over switches, switches for opening circuits with large self-induction, porcelain handle switches of the tubular and cool handle types, laminated brush type switches in cast iron cases, combined main switches and fuses in cast iron cases, ironclad house service fuse-boxes, distribution boards with and without cast iron boxes, and power distribution boards in water-tight cast iron boxes for three-phase circuits and for pressures up to 600 volts.

Langdon Davis Motor Company, Southwark Works, Deverell-street, London, S.E.—Those in any way connected with the erection and operation of electric motors will appreciate the little booklet which has just been issued by this company. In addition to giving particulars of the company's standard sizes and types of motors it also contains some useful tables. There is a table of watts and kilowatts, with the equivalents in English horse-power, French horse-power, and kilogrammetres. Another table gives pulley speeds in feet per minute for pulleys ranging from 9in. to 24in. in diameter. There is also a formula for finding the size of belts, and other information of value to those associated with alternating and continuous-current motors.

Alley and MacLellan, Limited, Glasgow.—Catalogue No. 24e has been forwarded to us. It is a tasteful little publication, having reference to "Sentinel Junior" high-speed engines. First, it deals with the uses for these engines, then there is a general description, and after this the special features are clearly set forth. Other sections of the catalogue are devoted to "Sentinel Junior" dynamo and fan engines, dimensions, prices, and weights of simple and tandem compound engines, powers at various pressures of tandem compound engines, dynamos for "Sentinel" engines, boilers for "Sentinel" engines, larger "Sentinel" engines, &c. Reference is also made to the company's other manufactures. The catalogue is admirably illustrated, and, among many other illustrations, views are given of the latest extensions to the Polmadie works.

John Fowler and Company, Limited, Steam Plough and Locomotive Works, Leeds, England.—Steam-cultivating machinery of all kinds is dealt with in a catalogue which has been forwarded to to us by this company. The catalogue, which is well bound and contains nearly 120 pages, is full of excellent illustrations, and the descriptive matter accompanying these is clear and concise. Needless to say, the various machines dealt with are too numerous to mention. It must suffice to call attention to the fact that since the year 1850, when the late John Fowler first invented and introduced machinery which enabled steam power to be used practically and economically for tillage, the company has been continually perfecting such machinery, and has now adapted it to practically all the operations which are required in connection with the cultivation of the soil.

Vickers, Sons and Maxim, Limited, River Don Works, Sheffield, having recently completed a series of experiments on motor car steels, this company has revised its catalogue dealing with special steels for this class of work, and a copy of this new and interesting publication has been forwarded to us. The first page of the catalogue is devoted to notes on special steels of high tenacity, then it goes on to deal with nickel chromium steel for crank shafts, &c., the casehardening of steel, nickel casehardening steel, mild casehardening steel, homogeneous gear steels, drop stamping alloy steels, and tool steel. The catalogue contains some exceptionally interesting illustrations which will appeal to engineers associated with motor car work. The various steels described are claimed to be the most efficient and reliable obtainable, and by their use weight may be cut down to a minimum without danger of failure. In consequence of this, these steels are also put forward as the most suitable material for use in the moving parts of the engines of aeroplanes and dirigible balloons.

The Union Electric Company, Limited, Park-street, Southwark, London, S.E.—A well compiled pamphlet illustrating and describing modern high and low-tension switchboards has reached us. It deals with completely enclosed iron-clad high-tension distribution switchboards fitted with oil brick fuses and the requisite measuring instruments. Switchboards of this pattern are claimed to be particularly suitable for use in the underground workings of mines, and can be constructed for pressures up to 3000 volts. There are also illustrations of central station switchboards, switch panels for controlling three-phase 3000-volt motors, extra high-tension switches for remote control, completely enclosed mining switchboards suitable for 6000-volt circuits, &c. A switchboard of the cellular pattern which is dealt with is fitted with removable switch units, which are mechanically interlocked, and therefore cannot be withdrawn unless they are first electrically isolated. It will be remembered that this company exhibited an excellent display of switch gear at the Manchester Electrical Exhibition, and some of these exhibits were described in our issue of October 30th, 1908.

The following reference to the construction of a locomotive is taken from a publication in 1826. It reads: "The locomotive engines are made of thick sheet iron, and are obviously of the high-pressure kind."

THE IRON, COAL, AND GENERAL TRADES OF BIRMINGHAM, WOLVERHAMPTON, AND OTHER DISTRICTS.

(*From our own Correspondent.*)

The Outlook.

The outlook continues healthy, advices as to the progress of the American iron trade revival being encouraging, whilst the position on the Continent in some directions seems to be gradually improving. The quarter is drawing to a close in the Midlands in a satisfactory manner, and prospects of renewal of contracts at the October quarterly meeting are giving no anxiety to iron and steel producers. Engineers, recognising that their costs of production—in face of a rising market for materials and for fuel—are bound to be increased, are carefully pricing all new tenders in accordance.

Steel in Good Demand.

There is more regular employment than for a long while past in the steel trade, and quotations are well maintained, with here and there a decided onward tendency, which contrasts strongly with the disposition to make concessions that characterised the market a few months ago. Girder plates are quoted £6 to £6 2s. 6d., and angles £5 17s. 6d. to £6. Mild steel engineering bars range from £6 7s. 6d. to £6 17s. 6d., according to quality, whilst joists are quoted from £5 10s. to £5 15s. A good deal of raw steel is also being ordered; indeed, a recent sale of 4000 tons of sheet bars in one line is reported at £4 15s.

Manufactured Iron Steady.

Unmarked bars continue to constitute, as usual, the chief production of the district as regards quantity, and makers are getting rather better prices than previously, £6 being now the general quotation for common bars. The best ironmakers are well placed for work, marked bars being still quoted £8, with a prospect of an advance at or prior to the October quarterly meeting. Galvanised sheets are in good inquiry on foreign account at £11 to £11 10s. Plain black sheets are still quiet at £7 2s. 6d. to £7 5s. for doubles. There is an improving demand for rivet iron at £6 15s. to £7.

Pig Iron Firm.

The upward tendency of fuel is causing pig iron producers to be very firm in quotations just now, but this does not seem to interfere much with the demand, which still keeps up satisfactorily. North Staffordshire forge sorts are quoted 51s. to 52s. 6d., with best 58s. to 59s. Northamptons are quoted 49s. to 50s., and Derbyshire 50s. to 51s. For South Staffordshire common forge 47s. to 48s. is asked, with part-mines 50s. 6d. to 51s. 6d. Sellers find no difficulty in maintaining the recently raised quotations of all-mine hot-air forge at 85s., foundry 90s, and cold blast 115s.

Worcester Sewerage.

Instead of the proposed screening system, the Worcester City Council have decided to construct a self-cleansing sewer through a portion of the river Severn, the estimated outlay being £7800. The work is to be left in the hands of the city engineer.

Aerial Engineering.

The War-office is said to be making inquiries with a view to securing a considerable piece of land in one of the Midland counties for experiments with airships and flying machines. Aëronautics is, indeed, making great headway in the Midlands. The Shropshire Aëro Club has just been started, with headquarters at Shrewsbury. The Midland Aëroplane Company, Limited, has been registered as a private company, with a capital of £2000 in £1 shares, to carry on the business of manufacturers of and dealers in airships, aëroplanes, balloons, flying machines, &c.

NOTES FROM LANCASHIRE.

(*From our own Correspondent.*)

Manchester, Thursday.

Pig Iron Quieter.

The attendance on the Iron Exchange on Tuesday was about a usual one, but the tone was not so animated as has been the case for some time past. The speculative movement in other centres has quietened down, and on spot there was less inquiry on the part of consumers. Merchants were, however, not anxious sellers, and there was no giving way in prices. If anything, Middlesbrough and Scotch No. 3 foundry iron ruled in buyers' favour by 3d. or 6d. per ton, but other sorts were quietly steady at full rates. Forge iron was obtainable at 6d. to 1s. per ton less money.

Finished Iron and Steel.

Finished iron continues steady, and there is more inquiry for steel and steel products. Billets, both English and foreign, were firm.

Copper.

Manufactured still rules quiet, although there is no change to note in sheets and tubes. Copper ingots were rather higher.

Tin and Sheet Lead.

Both steady and unchanged.

Quotations.

Lincolnshire, No. 3 foundry, 55s. 6d. to 56s.; Staffordshire, 53s. 6d. to 54s.; Derbyshire, 55s; Middlesbrough, open brands, 60s. 4d. Scotch: Gartsherrie, 61s. 6d. to 62s.; Glengarnock, 60s. 6d.; Eglinton, 59s. 6d., delivered Manchester. West Coast hematite, 62s. to 62s. 6d.; East Coast ditto, 60s. 6d., both f.o.t. Delivered Heysham: Gartsherrie, 59s. 6d. to 60s.; Glengarnock, 58s. 6d.; Eglinton, 57s. 6d. Delivered Preston: Gartsherrie, 60s. 6d. to 61s.; Glengarnock, 59s. 6d.; Eglinton, 58s. 6d. Finished iron: Bars, £6 10s.; hoops, £7 12s. 6d.; sheets, £7 15s. to £8. Steel: Bars, £6 2s. 6d. to £6 5s.; Lancashire hoops, £7 5s.; Staffordshire ditto, £6 17s. 6d. to £7; sheets, £7 17s. 6d. to £8; boiler plates, £7 7s. 6d.; plates for tank, girder, and bridge work, £6 5s. to £6 7s. 6d.; English billets, £4 12s. 6d. to £4 15s.; foreign ditto, £4 10s. to £4 12s. 6d.; cold-drawn steel, £9 10s. to £9 15s. Copper: Sheets, £72; tough ingot, £62; best selected, £62 per ton. Copper tubes, $8\frac{1}{2}$d.; brass tubes, $6\frac{7}{8}$d. to $7\frac{1}{8}$d.; condenser, $7\frac{7}{8}$d.; rolled brass, $6\frac{1}{4}$d.; brass wire, $6\frac{1}{2}$d.; brass turning rods, $6\frac{1}{2}$d.; yellow metal, 6d. per lb. Sheet lead, £16 17s. 6d. per ton. English tin ingots, £134 to £134 10s. per ton.

The Lancashire Coal Trade.

There was not a large attendance on the Coal Exchange, and, so far as could be ascertained, there was only a moderate business passing. The future of house coal is still uncertain, best being very scarce, but there is no change to note in price. Inferior sorts were bad to place. Steam coal and slack generally showed no change. It is not thought there will be much change for the present until the cost of working under the Eight Hours Act has been definitely ascertained.

Barrow-in-Furness, Thursday.

Hematites.

The demand for hematite iron is fairly steady, although there have been some fluctuations during the week. Generally speaking, however, the position of the market is undisturbed, and the improvement established a few weeks ago is maintained. There is, further, a disposition towards improvement, as there are indications that the usual sources from which the demand springs are likely to give more volume to business in the not distant future. Much, of course, depends as to the future of the iron trade on the activity of the steel trade, because hematite iron is the basis of steel. The business in hand for the Continent and for the Colonies is not on a large scale, and there are no immediate prospects of any improvement in commercial relations with America. The home demand remains steady, and there are inquiries for large parcels for forward delivery, but makers quote at higher rates for these, as there is a general opinion that before the autumn has proceeded far on its course the prompt demand for iron will have assumed greater volume, and prices may be expected to go up in consequence. Makers are quoting 62s. net f.o.b. for mixed Bessemer numbers, and 63s. to 65s. for special hematites, according to specification. Warrant iron sellers are at 60s. 6d. per ton net cash, and buyers are at 60s. 3d. The sales of special hematite iron have of late been fairly large, and there are prospects that this trade will become a very active one in the near future. Ferro-manganese is a fair business, but buyers are complaining of the high quotations which are ruling. The demand for local charcoal iron is about equal to the production. Some sales of scrap iron are reported. Iron ore is selling better, and the enhanced prices are maintained. Good ordinary sorts are at 12s. net at mines, medium at 14s. 6d., and best at 18s. Foreign ores are coming in in fair bulk, and higher prices are still prevailing.

Steel.

There is regularity of employment in the steel rail trade, and the rail mills are kept on full time; but the orders held are not bulky, and the prospects of business are not very encouraging. Makers, however, hope to maintain the present activity during the winter months. The demand for plates is quiet. A local order for 9000 tons of plates has gone past Barrow makers, and has been placed in South Wales. The plate mills at Barrow have been at a standstill for nineteen months.

Shipbuilding and Engineering.

Apart from the commencement with the work of building two floating docks at the yard of Vickers, Sons and Maxim this week, there is no news to report. Marine engineers are very short of orders.

Shipping and Coal.

There is an improvement to note in the shipping trade. Last week the exports of iron and steel from West Coast ports amounted to 14,763 tons—iron 5615 tons and steel 9148 tons—as against 8430 tons in the corresponding week of last year, an increase of 6333 tons. The aggregate shipment this year to date has reached 426,237 tons, as against 342,506 tons for the corresponding period of last year, an increase of 83,731 tons. Sales o coal and coke are improving, and prices remain steady.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

The Coal Trade.

The holiday season is now over, and the various collieries have got back to work, so far as is possible under present conditions. Differences with labour are still prevalent in the district, and some of the pits are not fully at work. The output is interfered with by the working arrangements consequent on the Miners' Eight Hours Act, and available supplies thus continue to be restricted. The shipping season is drawing to an end, but at present shows no sign of immediate closing. Prices for best hard coal are well maintained at 9s. 3d. to 9s. 6d. per ton.

House Coal.

The demand for house coal is growing brisker, but no alteration in prices has yet been made. This, however, can only be a matter of a few weeks, and the normal advance is expected to be in force on October 1st. Best Barnsley coal is quoted from 11s. 6d. to 13s. per ton, and secondary sorts from 10s. to 11s. per ton. The demand from Lancashire and West Riding for small coal is still brisk, with prices ranging from 4s. 6d. to 5s. 6d. per ton. Gas coals are in better request.

Coke.

The improved demand lately noted for coke continues, and, while the requirements of pig iron manufacturers are a little better, the supplies of coking coals are on the short side, thus causing quotations to be well upheld. Best washed coke fetches from 11s. to 11s. 6d. per ton, and unwashed 10s. 6d. to 11s. per ton.

Pig Iron Market.

The lull which followed the recent outburst of activity in the iron markets continues, and for the moment consumers appear to have satisfied their wants. Makers are holding out for the full advance in rates, and are not pressing sales, believing that they have everything to gain and nothing to lose by this course. For hematite iron some East Coast brands have been offered by merchants at slightly under makers' quotations, which remain unaltered on the week. The official prices of the Lincolnshire Ironmasters' Association are as follows:—No. 3 foundry, 52s. 6d. per ton; No 4 foundry, 51s. 6d. per ton; No. 4 forge, 51s. 6d. per ton; No. 5 forge, mottled and white, 51s. 6d. per ton; basic, 52s. 6d. per ton, all net, delivered Sheffield and Rotherham. There is no change to report in prices of Derbyshire iron, a very fair quantity of which has now been sold by makers, enabling them to take up an independent attitude for the present, and their quotations are nominally about 52s. per ton for No. 3 foundry and 50s. 6d. for No. 4 forge, both net, delivered Sheffield and Rotherham. Quotations for hematite are: East Coast, 65s. to 67s.; West Coast, 68s. to 70s. net, delivered Sheffield and Rotherham. Recent contracts for raw iron were very heavy, but so far specifications have been exceedingly light, indicating that the buying was by no means to cover immediate requirements.

Bars, Hoops, and Sheets.

Specifications continue to come forward very slowly for all classes of finished iron, and what makers are now chiefly concerned about is not any lack of new contracts but the apparent inability of consumers to take material for which they have already contracted. As noted last week, there has been no change in official rates. Bars, £6 10s. per ton; hoops, £7 10s.; sheets, £8 10s. There is still considerable competition from outside districts. The pipe foundries in Derbyshire are reported to be busier.

The Heavy Industries.

Whilst no improvement can yet be recorded in some important branches of these industries, the railway material departments being particularly depressed, the outlook is better for others. The recent placing of orders for twenty torpedo boats is likely to benefit Sheffield rather considerably, a great proportion of the forging, as well as other requirements, coming from this district. Most, if not all, of these new boats are to be turbine-driven, and one or two local firms which have made turbine forgings a speciality will be busy. The weight of these orders, however, is not, of course, so considerable as would be necessary for larger craft. In other directions the inquiry for tool steel and engineers' requisites is stated to be better, but has not yet resulted in much actual booked business.

NORTH OF ENGLAND.

(From our own Correspondent.)

Cleveland Pig Iron.

After buying pretty freely for some time past consumers seem to be satisfied for the present, and business on 'Change in Cleveland pig iron has been somewhat quiet during the last few days, with a slight easing of prices. It is understood, however, that trade generally is as healthy and satisfactory as ever, and that prospects are really encouraging. The commercial news from America is more sanguine in tone; in fact, it appears as if the consumption out there were outstripping the production, which has been increased to well on to the largest output that has ever been recorded. There is all the more probability, therefore, that Great Britain will be again called upon to send considerable quantities to the States, and this will mostly go from the Cleveland district. It is satisfactory to see at last that the reports from the Continent speak of some improvement, but no one expects that Germany will be a large buyer of Cleveland pig iron within the next twelve months, for ironmasters there have very large stocks, and may even compete with English pig iron in America. On the whole, confidence is steadily returning, and it may safely be stated that the tendency of prices is upward. Cleveland iron is now 6s. per ton above the minimum of the year, and higher prices are quoted for forward delivery. Indeed, the prospects are so good that producers are not much disposed to commit themselves heavily ahead. It is a good feature to note the increase in shipments of pig iron to oversea destinations, which would indicate that either trade is actually brisker, or that prospects are so good that consumers think it advisable to replenish stocks. No. 3 Cleveland pig iron has been mostly sold this week at 50s. 9d. for prompt f.o.b. delivery, and the figure asked for delivery over the autumn is 51s. 6d., while for the first quarter of 1910, 52s. is the figure. A large business has been done in warrants at from 50s. 10½d. to 51s. cash buyers, and for delivery in three months about 7d. more has to be paid. The prompt figure for No. 1 is 53s., for No. 4 foundry 49s. 6d., for No. 4 forge 49s., and for mottled and white 48s. 6d., with about 6d. more for delivery up to the end of the year. American inquiries for Cleveland pig iron are still being received, but no actual orders have yet been received. However, a lot of 3000 tons of steel scrap and crop ends have been sold by North of England firms for American consumption, and the steamer has been chartered to carry the same. It is reported that the steel will be supplied from the Jarrow and North-Eastern Steel Works. It is expected that further similar orders will be secured.

Hematite Pig Iron.

The revival in the shipbuilding industry has placed the makers of East Coast hematite pig iron in fairly good positions, and they expect now to be able to reduce the considerable stocks that accumulated in the period of depression over the last two years, the increase occurring notwithstanding the blowing out of a number of furnaces. This week buyers are taking a rest, and not many orders have been distributed; but producers are in a good position. It is usual for consumers of hematite to buy in large lots, and then to be out of the market for weeks. Plate and angle manufacturers have been the chief buyers lately, but Sheffield consumers have also purchased rather freely. Mixed numbers are quoted by most sellers at 59s. for prompt delivery, but makers are holding out for 62s. 6d. for delivery up till March next. Odd lots are still obtainable from second hands at 58s. 6d. Thus hematite prices have only risen 4s. per ton this year, whereas Cleveland have advanced 6s. In hematite, however, the demand has not been speculative, but has been steady, there having been not a single "set-back." The prices of materials for hematite iron making have advanced more rapidly than this, and it can hardly be said that producers are better able to realise profits than they were in the early part of the year. The Consett Iron Company has added an eighth blast furnace to their plant, and this was blown in a few days ago for the production of hematite iron. During the last fortnight sales of Rubio ore have been conspicuous by their absence, and the price is practically nominal at 17s. per ton c.i.f. Middlesbrough. Coke is dear, and promises to be higher still, as the tendency in coal quotations is upwards. Furnace coke is usually obtainable at 16s. 9d. per ton, delivered at Middlesbrough, but considerably more is asked for forward delivery; indeed, 17s. 6d. has been paid for delivery over the first quarter of next year.

Manufactured Iron and Steel.

Improvement is reported by most of the producers of finished iron and steel, though in some cases it is only slight. The latter may be said about the business in steel bars, iron bars, and hoops, though steel bars have been put up in price lately, and probably that has checked buyers for a time. Steel bars can be bought at £6 per ton at works, iron bars at £7, and steel hoops at £6 5s., all less 2½ per cent. f.o.t. The best orders at present are for rails and plates, but the demand for plates has not yet increased enough to allow of the reopening of the closed works at Stockton. However, the prospects for plate makers are encouraging now that the improvement in shipbuilding is so pronounced. Steel and iron ship plates are at £6 per ton, less 2½ per cent. f.o.t. Steel ship angles realise £5 7s. 6d. per ton, but for iron ship plates £1 12s. 6d. more than this has to be given. Steel rails are in good request, and the works with one exception are running to their fullest capacity. At present £5 5s. per ton f.o.b. is the general quotation for heavy steel rails, but it is expected that some advance on this will shortly be made. The black sheet manufacturers have very good order books, as also have the producers of galvanised corrugated steel sheets, whose prices are now at £11 per ton, less 4 per cent. for f.o.b. deliveries of 24 gauge in bundles.

Shipbuilding.

Shipbuilders continue to receive very fair orders for new vessels, and only two or three yards in the North of England are now entirely idle. They have done well, especially on the Tyne, in regard to securing orders from the Admiralty, not only for cruisers but also for smaller craft. Messrs. Swan, Hunter and Wigham Richardson have obtained one of the orders for torpedo boats, and Messrs. Hawthorn, Leslie and Co. will construct three of the destroyers for the British Admiralty.

Coal and Coke.

Business in the more important branches of the coal trade is showing improvement, and the prices of steam coals are again tending upwards, 10s. 10½d. to 11s. per ton f.o.b. being quoted for best qualities. The gas coal business will continue to improve for the rest of the year. The price of best qualities ranges from 10s. 9d. to 11s. f.o.b., with seconds at 9s. 6d. to 10s. Bunker coals are hardly so much in request, and the price is somewhat weaker, varying from 9s. to 9s. 6d. per ton. Messrs. S. A. Sadler and Co., Limited, have decided to open a new colliery at Etherley Dene, near Bishop Auckland, where they have been conducting boring operations for a considerable time, and where they have met with two fine seams of coal. Messrs. S. A. Sadler and Co., Limited, are also the owners of the Malton collieries, between Durham and Lanchester. Coke is in better request, and prices are tending upwards. At least 16s. 9d. must be paid for furnace coke delivered at Middlesbrough works, and for the next half-year 17s. 6d. has been paid. It is generally expected that prices will be higher next year on account of the application of the Miners' Eight Hours Act.

NOTES FROM SCOTLAND.

(From our own Correspondent.)

The General Trade Outlook.

There is not much change in the general business outlook since last report, but any movement that has taken place seems to be in the direction of further improvement. The Clyde has reason to be well satisfied with its share of nine torpedo boats out of the twenty just placed by the Admiralty. Foreign advices this week as to the development of business abroad are somewhat more encouraging. They not merely speak of the American revival as consolidating and getting more expansive, but give a more hopeful view of the state of affairs on the Continent.

The Iron Market.

Although fluctuations in the Glasgow pig iron warrant market have been frequent, the market has shown a ready buoyancy, and a large business has been done in Cleveland iron both for cash and future delivery. Transactions were noted in these warrants from 50s. 10½d. to 51s. 4d., and back to 50s. 10d. cash, 51s. 1d. to 51s. 7d. one month, and 51s. 7½d. to 51s. 9d., and back to 51s. 6½d. three months. Business also took place in Cleveland warrants at 51s. 3d. for delivery in twenty-one days, 51s. 4½d. two months, 51s. 4½d. to 51s. 7d. October 25th, 51s. 3d. October 26th, and 51s. 4½d. November 30th. Quantities of Cumberland hematite warrants changed hands at 60s. 11½d. and 61s. for delivery in one month.

Scotch Makers' Iron.

The business in Scotch makers' pig iron appears to have been considerable, and the orders in hand will keep works well employed for a considerable time. Another furnace has been placed on ordinary iron, and there are now 40 furnaces making ordinary, 38 hematite, and 5 basic iron, the total of 83 thus in operation in Scotland comparing with 75 at this time last year. Prices of Scotch makers' iron are well maintained. Monkland, f.a.s., at Glasgow, No. 1, is quoted 58s. 6d.; No. 3, 56s. 6d.; Carnbroe, No. 1, 60s. 6d.; No. 3, 57s. 6d.; Clyde, No. 1, 62s. 6d.; No. 3, 57s. 6d.; Gartsherrie and Calder, Nos. 1, 63s.; Nos. 3, 58s.; Summerlee and Langloan, Nos. 1, 64s.; Nos. 3, 59s.; Coltness, No. 1, 89s.; No. 3, 59s.; Eglinton, at Ardrossan or Troon, No. 1, 58s.; No. 3, 56s.; Glengarnock, at Ardrossan, No. 1, 63s. 6d.; No. 3, 58s. 6d.; Shotts, at Glasgow or Leith, No. 1, 63s.; No. 3, 58s.; Carron, at Grangemouth, No. 1, 64s. 6d.; No. 3, 58s. 6d. The demand for Scotch hematite pig iron is increasing, but the supply is ample. Current output must not be far, if any, short of present requirements, and besides this, the makers have considerable stocks in their private stores. These facts tend to moderate any change in price, so that the quotations are about the same as before, merchants quoting 61s. 6d. per ton for delivery at the West of Scotland steel works.

Pig Iron Shipments.

There has been practically no expansion on the average in pig iron shipments since the improvement in the iron trade commenced. Those interested have been looking for heavier shipments week by week, but have been so far disappointed. The clearances at the Scottish ports in the past week amounted to 5342 tons, compared with 6105 tons in the corresponding week of last year. There was despatched to Canada 285 tons, South America 164, India 304, France 65, Italy 155, Holland 24, Belgium 80, Spain and Portugal 30, China and Japan 60, other countries 480, the coastwise shipments being 3745 tons, against 2700 tons in the corresponding week. As bearing on the remarks made above regarding the poorness of our foreign trade in pig iron, it may be noted that whereas the foreign shipments at this time last year amounted to 95,439 tons, they now amount for the present year to only 89,340 tons, showing a decrease of 6099 tons, instead of an increase, as might have been anticipated. There is also a decrease in the coastwise shipments of pig iron this year to date of about 8000 tons. The arrivals at Grangemouth of pig iron from Cleveland and district have been 12,770 tons, showing an increase of 4841 tons for the week, and bringing up the increase for the present year to date to 8180 tons.

Finished Iron and Steel.

The improvement in the finished iron department has been considerable, and yet some of the works could do with a material increase in orders. A good deal of plant has been partially idle this week. Foreign business has been increasing. In some quarters there has not been much competition, whilst in other directions this has been excessive. There has been an increasing business in plain sheets, which have been somewhat advanced in price, with the result, it is alleged, that there is likely to be more competition by German houses. For both iron and steel material, and especially for the latter, there is a good inquiry on the basis of prices ruling before recent advances, but it is understood that makers are not inclined to accede to such terms. English and Scotch steelmakers in combination have advanced the price of ship angles 7s. 6d. per ton to £5 15s., and of ship plates 5s. per ton to £6, less 2½ per cent. in each case. Merchants are reported to be supplying Welsh steel to local users below the prices now quoted by Scotch makers. The allegation is made that there is dissatisfaction between some merchants and makers of finished material, because the makers are quoting their best (*i.e.*, lowest) prices only against prompt specifications. Probably there is not much in these rumours, for generally orders are acceptable from good houses under varying circumstances, and it is, of course, well understood that merchants cannot afford to operate without a margin of profit. It is also recognised that in the case of contracts extending over a considerable period, some latitude must be allowed in the sending in of specifications for material that has been secured at contract rates.

Ironfounding and Engineering.

An improvement has been gradually taking place in different branches of the ironfounding trade, but it is not yet by any means general. Some difference of opinion as to the wages of piece-workers in the moulding shops has been causing difficulty, but it is hoped an arrangement will be arrived at with the assistance of the Board of Trade, the wages of time-workers having already been reduced. With a settlement of this difficulty it is thought a better condition of business might be attained. Makers of cast iron pipes are in some cases in want of new work. Marine engineers and those who supply appliances for vessels are beginning to experience an improved trade. Well-known firms in this connection are reported to be increasing the number of their workers.

The Coal Trade.

The coal trade is without much improvement as to current business, but reports are in circulation that buyers are desirous of contracting for future delivery at prices which show an advance on those now current. Supplies of all kinds are ample, and the various qualities of coal are practically unaltered in price.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

State of the Coal Trade.

There has been little change in the situation; one of the principal complaints has been the dearth of tonnage, and the existing difficulties in the coalfields. The possibilities of a strike occurring are such that coalowners are fearful of committing themselves to long contracts. The result has been that in several instances business has gone to Germany. Much more coal would have changed hands but for these hindrances. As it was, Newport (Mon.) dispatched close upon 80,000 tons of coal, Swansea 66,000, and on several occasions a fair dispatch was made from Cardiff. There is little fear but that a demand for coal and the receipt of improved tonnage will follow the settlement of disputes. One marked feature of business is the steady improvement which has taken place in bituminous coal. No. 2 Rhondda and Eastern Valleys are very scarce. For spot positions No. 2 Rhondda rule firmly up to 13s., and Eastern Valleys 13s. and 13s. 6d. It is evident that sellers are bent upon maintaining values.

Latest Market Quotations.

No. 3 Rhondda large and small in demand, holders of No. 2 asking 3d. more. Best large steam, 17s. 6d. to 17s. 9d.; best seconds, 15s. 9d. to 16s. 9d.; ordinary seconds, 15s. 3d. to 15s. 6d.; best drys, 16s. 6d. to 17s.; ordinary drys, 14s. to 14s. 3d.; best washed nuts, 14s. to 15s.; seconds, 13s. to 13s. 6d.; best washed peas, 12s. 6d. to 13s.; seconds, 11s. to 12s.; very best smalls, 8s. 6d. to 9s.; best ordinaries, 6s. 9d. to 7s. 9d.; inferior sorts, 6s. 3d. to 6s. 6d.; very best Monmouthshire black vein, 15s. 6d. to 15s. 9d.; ordinary Western Valleys, 14s. 9d. to 15s. 3d.; best Eastern Valleys, 13s. 3d. to 13s. 6d.; seconds, 12s. 9d. to 13s. Bituminous coal: Best households, 16s. 6d. to 17s. 6d.; best ordinaries, 14s. 6d. to 15s. 6d.; No. 3 Rhondda, 17s. 3d. to 17s. 9d.; brush, 13s. 6d. to 13s. 9d.; smalls, 10s. 6d. to 11s.; No. 2 Rhondda, 12s. to 12s. 6d.; through, 9s. 6d. to 10s.; small, 8s. to 8s. 3d. Patent fuel, 15s. to 15s. 6d. Coke: Special foundry, 24s. 6d. to 25s.; foundry, 19s. to 22s.; furnace, 17s. 3d. to 18s. Pitwood, 20s. to 20s. 6d.

Newport Coal Trade.

Though the discussion continues keen between employers and men with regard to the "bonus hour" there is a steadier feeling in the market, and the undertone is better. Small coal is proving a drug, and stocks accumulating; prices falling. Better tonnage reports coming in. Latest prices.—Best black vein, 15s. 3d. to 15s. 6d.; Western Valleys, 14s. 6d. to 15s.; Eastern Valleys, 13s. to 13s. 3d.; other kinds, 12s. 6d. to 12s. 9d.; best smalls, 7s. to 7s. 3d.; seconds, 6s. 6d. to 6s. 9d.; inferiors, 6s. to 6s. 3d. Bituminous, 15s. to 15s. 3d.; seconds, 14s. to 14s. 3d.; patent fuel, 15s. to 15s. 6d. Coke: Foundry, 18s. 6d. to 19s.; furnace, 17s. to 17s. 6d. Pitwood, ex-ship, 19s. to 19s. 6d.

Swansea Coal Trade.

Like the other ports, Swansea complains of a lack of adequate tonnage. The trade has to grapple with the difficulty of having too large a stock on hand, and prices are being lowered. Some kinds retain the late quotations. Best malting is selling at 24s. to 25s. net; second malting, 21s. 6d. to 22s. 6d. net; big vein, 18s. 6d. to 20s. 6d., less 2½; red vein, 12s. to 12s. 6d., less 2½; machine-made cobbles, 23s. to 24s. net; Paris nuts, 25s. to 25s. 6d. net; French nuts, 25s. to 26s. net; German nuts, 25s. to 26s. net; beans, 17s. 6d. to 18s. 6d. net; machine-made large peas, 11s. 6d. to 12s. 6d. net; fine peas, 10s. to 11s. net; rubbly culm, 5s. to 5s. 6d., less 2½; duff, 3s. to 3s. 3d. net. Steam coal: Best large, 17s. to 17s. 6d., less 2½; seconds, 14s. to 15s. 6d., less 2½; small, 8s. to 10s., less 2½. Bituminous coal: No. 3 Rhondda, 18s. to 18s. 9d.; through, 15s. to 15s. 6d.; small, 10s. to 10s. 6d.; patent fuel, 13s. 6d. to 14s., all less 2½.

Danish Coal Contracts.

The Danish State Railways are in the market for 93,000 tons of first-class locomotive coal, 7000 first-class smokeless locomotive, and 27,000 tons first-class steam coal for ships' use.

Tin-plate.

At the Harbour monthly meeting the tin-plate trade was shown to be in a prosperous state. The chairman stated that in the matter of the harbour trade imports during the past month had increased about 8 per cent., and the exports nearly 10 per cent. Among the items copper ore was improved by 3000 tons, iron ore 4000 tons, pig iron 1000 tons. Lord Glantawe, in seconding the report, said that the increase in galvanised sheets was very remarkable, and disproved the idea that the trade was falling off. The total was 2043 tons, against 1327 tons. The increased trade to Roumania was 1734 tons, and to the United States 2000 tons. The position of the surplus volume of the Trust to meet contingencies and new work was very satisfactory. The chairman showed that the exports of coal, coke, and patent fuel were increased by 31,000 and tin-plates by 4700. Swansea Harbour returns last week were as follows:—Received from works, 78,805 boxes; shipped during the week, 90,547 boxes; stocks remaining at dock, 120,410 boxes. Latest quotations at the Metal Exchange:—Ordinary tin-plates: Bessemer primes, 12s. 1½d. to 12s. 3d.; Siemens primes same; ternes, 21s. 6d. to 21s. 9d.; C.A. roofing sheets, £8 5s. to £8 10s. per ton. Big sheets for galvanising, £8 7s. 6d. to £8 10s. Finished black plates, £9 10s.; galvanised sheets, 24 g., £11 per ton; block tin, £136 cash, £137 2s. 6d. three months.

Iron and Steel.

The slight improvement shown in business last week was of short duration. In local business there was more activity, shipments of iron from Newport to Bristol totalling 715 tons. Iron came in rather slowly. Blaenavon imported 2062 tons ore from Castro Bilbao; Baldwins Company, 2800 tons from Vivero; Swansea imported 440 tons pig iron, but no iron ore; Ebbw Vale imported 3450 tons. Latest market quotations, Swansea:—Hematite pig, mixed numbers, per ton, 60s. 4½d. cash and month; East Coast 63s. to 64s. Steel bars: Siemens, £4 10s. to £4 12s. 6d.; Bessemer, same. Rubio iron ore, 16s. 6d. to 17s.

We are informed that the hopper barges Hercules and Cygnus, built by Lobnitz and Co., Limited, Renfrew, for Sir John Jackson, Limited, for use on the new harbour works at Singapore, arrived safely at Colombo, on the 7th inst. The powerful dredger André Rebouças, and hopper barge Paracury, built by the same firm for the Port of Para, for use by the contractors, Messrs. S. Pearson and Son, Limited, arrived after a satisfactory voyage at Para on the 8th inst.

A consideration of Mr. Longridge's annual report on breakdowns of electrical machinery, brings out a serious defect in electrical insulating materials such as are usually employed on the windings of motors and generators. A very large proportion of the breakdowns were due to failure of the insulation after a few years' running, and this failure was not seldom due to deterioration rather than external damage. Of course, neglect to keep the insulation free from oil and dirt greatly aggravates the troubles; but it does certainly appear that under normal working conditions the insulation often undergoes serious deterioration in the course of a few years. This being so, and the delay and expense involved by re-winding being serious, it is advisable that electrical firms should devote more attention to the production of insulating materials which will maintain their full insulating properties for an indefinite time under all reasonable working conditions. Our technical colleges, with their elaborate electrical, mechanical and chemical equipment and their trained staffs, could be of much service in such a work, and it is certain that such service would be much appreciated.

NOTES FROM GERMANY, FRANCE, BELGIUM, &c.

(*From our own Correspondent.*)

Rheinland-Westphalia.

A LITTLE more firmness is shown in the iron market. According to the *Rhenish-Westphalian Gazette* the majority of Rhenish-Westphalian barmills resolved, at the recent meeting of the Steel Convention, not to book any orders for next year before the 30th inst., and it is reported that several inquiries from large dealers for next year have already been declined in consequence of the above resolution. Quotations for bars have not been altered for the present; but the general aspect is rather less unfavourable than previously, and quotations may here and there meet with an advance towards the end of the present month. The next general meeting of the Steel Convention will probably take place on the 22nd inst. According to figures given by the Statistical Office in Berlin, the foreign trade of Germany has shown some slight alterations lately. Austrian ironmasters have tried, by reducing quotations, to prevent a further increase of German iron and steel; only quite recently a reduction in the prices for heavy plates took place, for Germany has been doing a good trade in this article to Austria-Hungary. In July of this year German export in heavy plates was 191,445 q., or 25,471 q. more than in the same period last year. Total export since January was 1,182,826 q., against 1,173,192 q. in the same period the year before, which is equal to a rise of 9634 q. A large decrease is noticeable in the import of German bars; it amounted to 317,295 q. in July, 1908, and in the same month of this year it was only 275,319 q., or 41,976 q. less. From January to July of 1908 2,385,390 q. were imported, against 1,866,730 q. in the same period of this year, which shows a decrease of 518,660 q.

The German Coal Trade.

Last week's business on the Rhenish-Westphalian coal market was steady, and a rising inquiry could be noticed for better qualities. Also in Silesia a fair demand was experienced for engine as well as for house coal. According to a consular report from Breslau, new layers of brown coal have been found in Silesia (Laussitz), and negotiations are said to be under way regarding the forming of a briquette company. A marked improvement in the export of coal, especially to Austria-Hungary, can be reported. During the period from January to July of this year German export in coal was 126,154,141 q., or 9,896,086 q. more than in the same period of last year. To Austria 52,768,885 q., or 2,164,004 q. more than last year, were imported.

Austria-Hungary.

No change worth reporting has taken place on the iron and steel market. Raw as well as manufactured iron remains in fairly regular demand, and prospects have slightly improved in some branches. Present rates are going to be quoted for sales in the fourth quarter. In the coal trade the somewhat restricted output goes into immediate consumption, and there was a rise in the demand for gas coal. Rates are firm.

Fair Accounts from Belgium.

Confidence is returning on the Belgian iron market, and though a rise in prices has not yet taken place, more stiffness is shown. Plates are remarkably firm at £5 2s. f.o.b. Antwerp, while 130f. to 140f. p.t. are quoted for inland sales. Foreign dealers and consumers come forward with fair offers at 1f. p.t. more than previously quoted. Girders sell regularly, but contracts are not extensive. A satisfactory trade is done in rails, and the mills are well supplied with contracts for weeks ahead. In semi-finished steel a good trade is done, especially to England. Scrap iron is dull.

Firmness in France.

The outlook has improved, not merely in the Meurthe-et-Moselle Department, but also in the Loire-et-Marne district, and the ironworks in the Ardennes report a fairly large amount of orders to be coming in. Manufactured iron shows much firmness; 165f. to 170f. p.t. for bars in iron and steel, and 185f. p.t. for girders are quoted in Paris, while plates obtain 190f. p.t. In the North bars cannot realise more than 150f. p.t. A sufficient amount of work is secured at the iron foundries, whereas the machine factories complain of being hard up for work. In raw iron only a poor export trade is done. Some departments of the coal market show a fluctuating tendency, inferior qualities being decidedly neglected.

AMERICAN NOTES.

(*From our own Correspondent.*)

NEW YORK, September 8th.

THE activity among steel buyers is more pronounced this week, especially throughout the Western States. In fact, buyers of steel products are driving manufacturers for early deliveries to such a degree that premium prices have begun to be offered for deliveries in October and November. Some mills are sold up to the end of the year, it being understood that there are crevices in the business which will admit of "rush" orders. Large consumers in some cases are ordering for delivery during the first half of next year, but with the condition that the prices will be determined by the current rate at time of specification. Anthracite coal has advanced 10 cents a ton in the west. Coke buying is very active. New sources of production are being established. More idle furnaces are blowing in. Bessemer pig advanced 75 cents during July. There is a rush for this product, which means a further advance. Steel bars, boiler plate and structural rivets are all up slightly. Tubes have advanced 2 dols. a ton. Cast pipe will be advanced on September 15th. The Pressed Steel Car Company has ordered 300,000 steel axles from the Carnegie Company, which will be rolled at the Homestead Mills. Large orders continue to be placed for locomotives, passenger cars and steel freight cars. The Baldwin Locomotive Works at Philadelphia have increased their force to its maximum limit—7000 men. The American Locomotive Works will soon have all their plants working full time. The Lake boat yards are filling up with business, and the Atlantic Coast yards are working nearly full time. The volume of rail and coastwise transportation is swelling each week. In copper, electrolytic is selling at 13. Exports have fallen off, August being below July. Arrivals of tin so far this month, 20 tons; afloat, 2870 tons.

OLD TOOLS AT SOHO WORKS.—We must apologise to Mr. Darlington for a slip of the pen by which his name appeared as Mr. Courtney Darlington instead of Mr. Seymour Darlington in our last issue.

THE INSTITUTE OF METALS.—At the autumn meeting of the Institute of Metals, which will be held at Manchester on October 14th and 15th, it is expected that the following papers will be presented:—(1) Mr. J. H. Andrew, M.Sc., and Mr. C. A. Edwards, "The Constitution and Properties of the Ternary Alloys Aluminium-Copper-Tin." (2) Mr. C. O. Bannister and Mr. H. J. Tabor, "The Surface Appearance of Solders." (3) Mr. H. W. Greenwood, "The Technical Assay of Zinc." (4) Mr. J. S. G. Primrose, "Notes on the Production of Pure Spelter." (5) Mr. E. L. Rhead, "Some Causes of the Corrosion of Copper and Brass." (6) Professor C. A. Smith, M.Sc., "The Elastic Breakdown of Ductile Materials." (7) Professor T. Turner, M.Sc., and Mr. M. T. Murray, M.Sc., "The Copper-Zinc Alloys: A Study of Volume Changes during Solidification."

BRITISH PATENT SPECIFICATIONS.

When an invention is communicated from abroad the name and address of the Communicator is printed in italics.

When the abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent-office Sale Branch, 25, Southampton-buildings, Chancery-lane, London, W.C., at 8d. each.

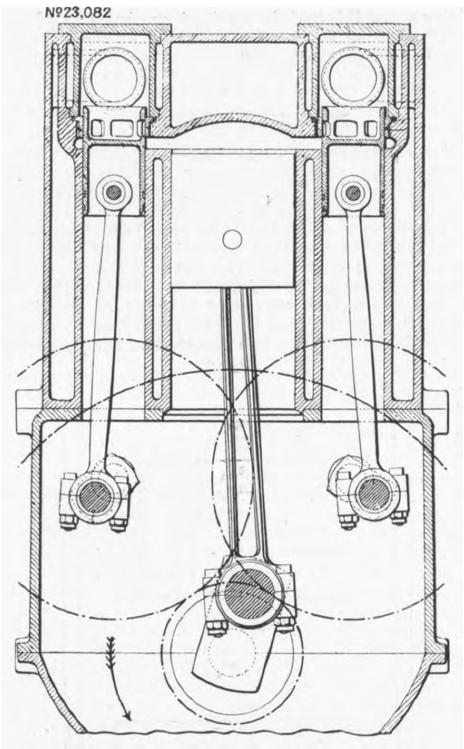
The first date given is the date of application; the second date at the end of the abridgment is the date of the advertisement of the acceptance of the complete specification.

Any person may on any of the grounds mentioned in the Acts, within two months of the date given at the end of the abridgment, give notice at the Patent-office of opposition to the grant of a Patent.

INTERNAL-COMBUSTION ENGINES.

23,082. October 30th, 1908.—IMPROVEMENTS IN VALVES AND VALVE GEAR OF INTERNAL-COMBUSTION ENGINES, Albion Motor Car Company, Limited, of South-street, Scotstoun, in the County of Renfrew, North Britain, and Thomas Blackwood Murray, B.Sc., of the same address.

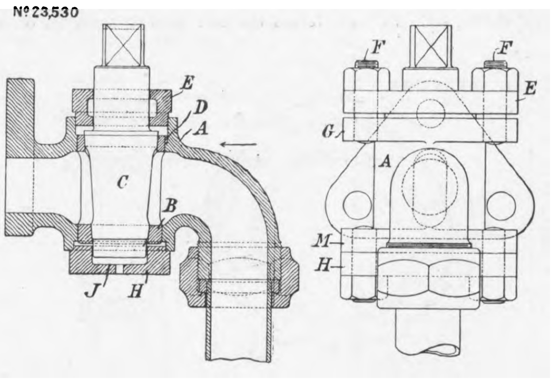
This invention has for its object to provide a simple and effective form of internal-combustion engine—especially such as be operated by a hydro-carbon, such as petrol vaporised—of the type in which the inlet and exhaust valves consist of trunk pistons operated by connecting-rods from cranks or excentrics upon a shaft or shafts parallel with the engine crank shaft, and driven therefrom. In an engine made according to the invention, the pistons operate in cylinders axially parallel with the motor cylinder which they serve, and in which are circumferential ports communicating with the motor cylinder, and covered and uncovered by the upstanding ported walls of the valve pistons in due sequence and in known manner for the distribution of the charge to the motor cylinder and its exhaust therefrom, the inlet and exhaust ports being in the otherwise closed ends of the valve cylinders and above the pistons.—*August 25th*, 1909.



STEAM GENERATORS.

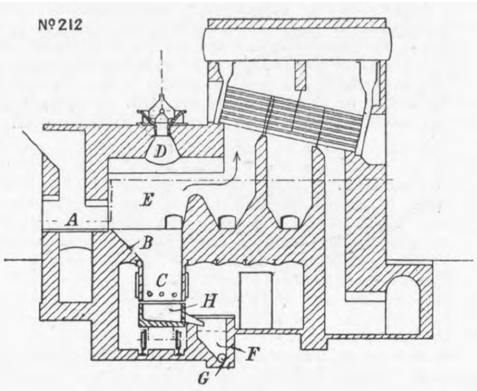
23,530. November 3rd, 1908.—IMPROVEMENTS IN BLOW-OFF COCKS AND THE LIKE, Percy Hulburd, of 150, Leadenhall-street, London.

The seating of the cock extends below the bottom of the aperture in the casing in which it is fitted so as to allow of its being more readily removed than would otherwise be the case, and the lower end of the plug which projects below the seating is covered by a cap bolted to a flange. A indicates the body or casing of the cock, and B the removable seating for the plug C, the seating being fitted into a corresponding recess in the casing, and being provided with a lug or lugs such as D for preventing it from rotating. In practice the portion of the casing in which the seating is fixed, and also the seating itself, are made slightly taper, as shown, to ensure proper fixing, and the seating is arranged so that its smaller end projects through the body A to facilitate its removal from the body. The plug is retained in position by a packing gland or cover E, secured by means of nuts on studs F F on the flange G of the casing, and another cover H is arranged in connection with the flange M at the lower end of the plug, a recess J being formed in the said cover into which the lower end of the said plug will project more or less.—*August 25th*, 1909.



212. January 4th, 1909.—AN IMPROVED COMBINED RUBBISH BURNING AND CLINKER TREATING FURNACE, *Heinrich Stein, of* 23, *Kerpenerstrasse, Cologne, Germany.*

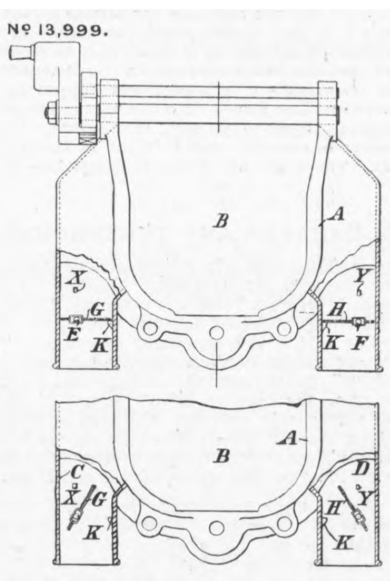
The combustion of the rubbish takes place upon the grate A. After the clinker which here forms has reached a sufficient thickness, it is pushed into the interior of the furnace and passes over the sloping surface B into the blast furnace C. Above this furnace there is a supply opening D through which the flux and the supply of coke for the blast furnace are added. The gases of combustion and those of the fusing process unite in the combustion chamber E above the blast furnace, and pass in the direction indicated by the arrow under the steam boiler. The slag is run off into slag bogie H and discharged into a water vessel F and thereby granulated, and is removed from the water container by means of a travelling screw G to a storage place. The blast furnace is inserted between the combustion furnace and the boiler.



The clinker is rushed into the blast furnace in the red-hot state. The exit gases of the blast furnace are utilised in the same manner as the exit gases of the combustion furnace. In this construction the blast furnace may be worked with excess air, which then serves as a secondary air supply for the complete combustion of any carbonic oxide gas produced in the combustion furnace.—*August 25th*, 1909.

13,999. June 15th, 1909.—IMPROVEMENTS IN OR RELATING TO DOOR FRAMES FOR STEAM BOILER FURNACES, *Franz Marcotty, of Hauptstrasse*, 150, *Schöneberg, near Berlin, Germany.*

On the door frame A the furnace door B is pivoted. C D are two lateral air conduits. In these conduits the pivots E F are arranged, about which the valves G H respectively are supported so as to be able to oscillate. In their closed positions the valves rest on the stops K. The amount by which the valves can open is limited by the stops X and Y. When the grate is covered with coal to such a height that the air cannot pass between the grate bars in a sufficient quantity, the vacuum in the combustion chamber is a maximum. The consequence of this is that the valves G H in the lateral air conduits open, and the supplementary air, in a quantity and at a velocity corresponding to the existing vacuum, is drawn through the open air conduits and over the layer of fuel. With the burning away of the layer of coal the vacuum is reduced, and, consequently simultaneously, the velocity of the entering air, the quantity of which is in itself diminished by the air valves in the air conduits now moving towards their closed position, and finally returning into the position in which they close the air conduits.—*August 25th*, 1909.



TRAMWAYS AND RAILWAYS.

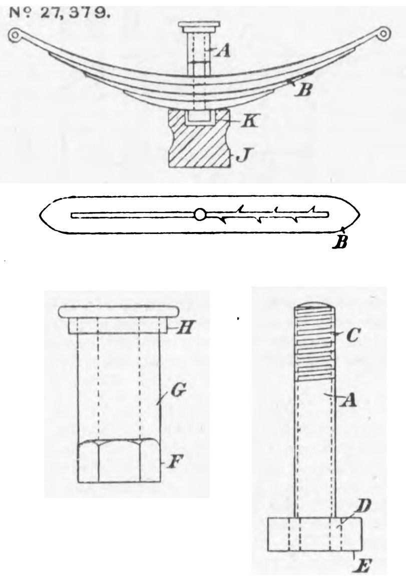
10,163. April 29th, 1909.—AN IMPROVED RAILWAY TIE AND RAIL FASTENING, *George Gates, of* 151, *North Crittenden-street, San Jose, County of Santa Clara, State of California, U.S.A.*

The sleeper A is constructed of concrete of any usual or well-known mixture, and with it is mixed pumice stone, asbestos, and wood pulp, to provide a certain elasticity of the material and resist the tendency to break under shocks. The mass is moulded in a box of suitable size and shape, and barbed wire H is used as a reinforcing agent. Upon the surface of the sleeper A and in the line of the rails which are to be supported thereon a metal plate B is placed of sufficient area, and upon this the rail rests. The plate has sufficient area to prevent the jar and pounding of the rail from cutting into the tie and loosening the support. E is a locking clamp, the inner end of which is thinner than the outer end, forming a shoulder as at F; and these inner ends rest upon the bottom flange of the rail upon opposite sides. The outer thicker ends rest upon the iron plate. Oblong holes are made through these clamps to provide for an adjustment thereof toward and from the flange of the rail, and holes are made through the tie and through the iron plates for the reception of bolts K. These bolts have sufficiently large heads or equivalent washers at the bottom to prevent their cutting into the bottom of the tie, and the upper ends are screw threaded.—*August 25th*, 1909.

MOTOR CARS AND ROAD TRAFFIC.

27,379. December 16th, 1908.—A LUBRICATOR FOR THE LEAF-SPRINGS OF VEHICLES, MORE ESPECIALLY MOTOR VEHICLES, Albert Farnell, of 50, Manningham-lane, Bradford.

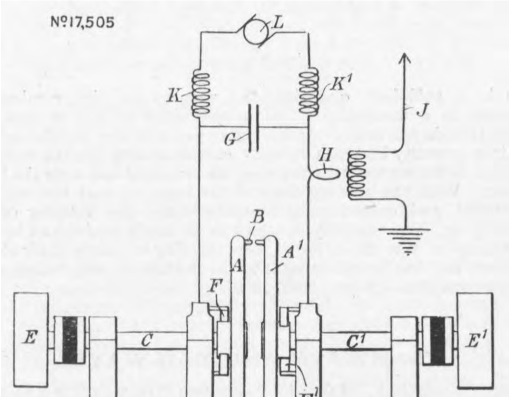
The bolt A passes through the leaves B of the spring in the usual manner, but is provided with two diametrically opposite vertical grooves C on its whole length, the grooves being continued in the form of holes D through the head E of the bolt. The nut F for securing the leaves on the bolt is formed with an upward hollow extension G, itself provided with a suitable spring cap H. This hollow extension G acts as a container or reservoir for the lubricant. The wheel axle J or part against which the middle of the spring presses is sufficiently recessed as at K not only to receive the bolt head E, but to act as a small reservoir for the lubricant, so that, should one of the grooves C or holes D get stopped up, lubricant will feed down the other groove into the axle reservoir, and then up the stopped up groove, to the point of stoppage. In a modified form the grooves or channels may be made in the spring instead of in the bolt. There are five other illustrations.—*August 25th*, 1909.


Nº 27,379.

TELEGRAPHS AND TELEPHONES.

17,505. August 20th, 1908.—IMPROVEMENTS IN APPARATUS FOR WIRELESS TELEGRAPHY, Guglielmo Marconi, LL.D., D Sc., and Marconi's Wireless Telegraph Company, Limited, both of Watergate House, Aldelphi, London, W.C.

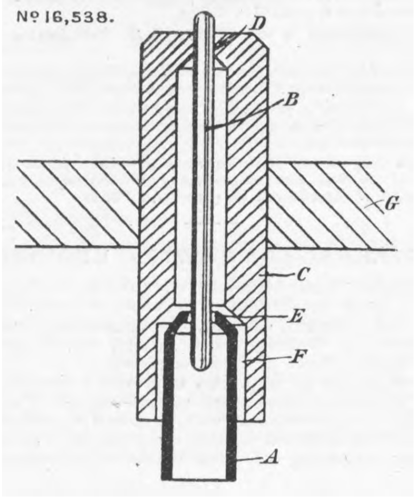
This invention relates to transmitting apparatus. The circuit arrangements are similar to those described in the specification No. 20,119 of 1907, but the generator is connected to the parallel discs instead of to the discs or balls. A and A^1 are the two parallel discs respectively provided with pegs or studs B and B^1 and mounted on shafts C and C^1, which are carried in bearings D and D^1. The studs are preferably equally spaced and the numbers of the studs on the two discs are equal. E and E^1 are motors or pulleys for connecting to motors, by means of which the discs A and A^1 are driven in opposite directions. The bearings D and D^1 are insulated from the ground, and the motors or pulleys E and E^1 are respectively insulated from the shafts C and C^1. The parallel discs A and A^1 are connected by means of brushes F and F^1 to the plates of a condenser G, and this condenser circuit is coupled at H to the aerial J. The plates of the condenser G are also connected through suitable inductances K and K^1 to a generator L. Discs 2ft. in diameter having each two studs and running at a speed of 3000 revolutions per minute are found to work well in practice. It is found, moreover, that far better results are obtained with studs of copper than with studs composed of any other material.—*August 25th*, 1909.


Nº17,505

MEASURING AND TESTING INSTRUMENTS.

16,538. July 15th, 1909.—IMPROVEMENTS IN AND RELATING TO THE BEARINGS OF ELECTRICITY METERS, Siemens Brothers Dynamo Works, Limited, of Caxton House, Tothill-street, Westminster.

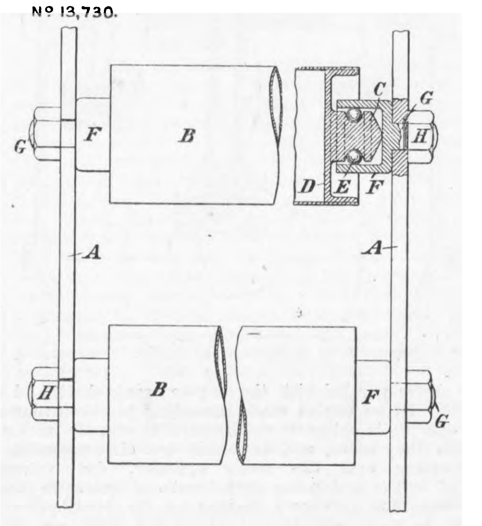
The present invention has reference to improvements in the top bearings of electricity meters whereby the noise due to the vibration of the axle of the meter is prevented. This noise is often particularly noticeable and objectionable in the case of alternating-current meters. The oil well A is fixed to the vertical axle of the meter in any suitable manner and so that the oil which it contains cannot run out. A pin B of steel or other suitable material is fixed to the bearing support C at the point D. Owing to the length of B its lower end will spring backwards and forwards when sidewise pressure is applied. At its lower end B passes through the bearing hole E in the top of A and projects into the oil in A. The well A projects upwards into a cylindrical or slightly conical hole F in the bearing support C, the clearance between the outer wall of F and the side of the hole being large enough to permit A to move sidewise more or less against the resisting force of B, but not to such a degree that B is unduly strained or that it wedges in the hole E. The bearing support C is fixed to or forms part of the meter case G.—*August 25th*, 1909.


Nº 16,538.

MISCELLANEOUS.

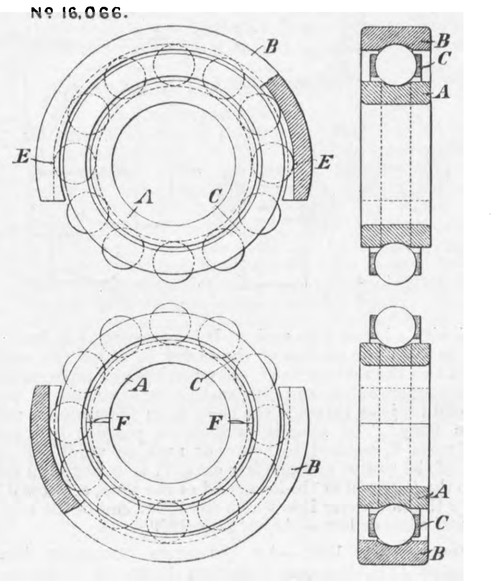
13,730. June 11th, 1909.—IMPROVEMENTS IN OR RELATING TO BALL BEARINGS FOR THE ROLLERS OF GRAVITY CONVEYORS OR CARRIERS AND LIKE ANTI-FRICTIONAL ROLLERS, Thomas Millar Campbell, of 3, Manchester-road, Cubitt Town, London.

In the engraving A A indicate the side bars of a gravity conveyor or carrier between which the hollow anti-friction rollers B are mounted on ball bearings. The end spindles C of the rollers extend from the recessed or dished discs D fitted within the ends of the rollers, the balls E travelling between an annular groove surrounding the spindle, and the one piece cup F, whereof the interior is plain, without any ball groove, and has parallel sides to permit the insertion and removal of the spindle and balls. The end of the spindle C is coned or pointed so as to be adapted to bear with little friction against the bottom of the cup which is closed, having no aperture for the passage of the spindle. Or, alternatively, the end of the spindle may be flat and the cup bottom formed with a male cone. Each cup F is provided with a screw-threaded stem G, which is dropped into a slot in the side bar A, the cup being then firmly secured in place by the nut H. The absence of any internal ball groove in the cup or outer bearing F renders the removal or replacement of the same exceedingly easy, so that the bearing is very readily assembled or taken apart. —*August 25th*, 1909.


Nº 13,730.

16,066. July 9th, 1909.—AN IMPROVED BALL BEARING, *Deutsch-Waffen-und-Munitionsfabriken, of* 43-44, *Dorotheenstrasse, Berlin N. W., Germany.*

The ball bearing shown in the upper engravings is for railway carriage trucks, whilst that shown in the lower engravings is for ships' shafts, &c. In both forms the ball bearing consists of an inner ring A, an outer cup B, and a cage C holding the balls. The inner ring A, as well as the outer cup B, has a race groove. The race groove of the outer shell or cup is concentric with half the circumference of the race groove of the inner ring and then passes away from the points E E tangentially. This construction ensures the balls passing into and out of the race groove in the outer cup without shocks. It will be understood that the race grooves may pass away in a slanting or curved direction; the tangential extension of the race is, however, the most suitable and most simple. Shafts for ships and boats and the like have connection flanges which are frequently made in one piece with the shaft. In this case, in order to allow the inner ring to be fitted on the shaft, it is split as shown. The inner ring A may be divided in various ways; the division must, however, always be so that both ring halves can be easily detached. At the points F F of the division line the race groove of the inner ring has a trough shaped recess, so that at this point the balls are released of pressure, whereby shocks against the meeting edges are prevented.—*August 25th*, 1909.

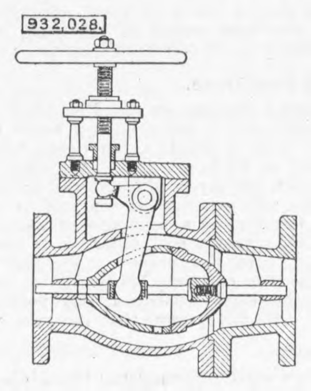

Nº 16,066.

SELECTED AMERICAN PATENTS.

From the United States Patent-office Official Gazette.

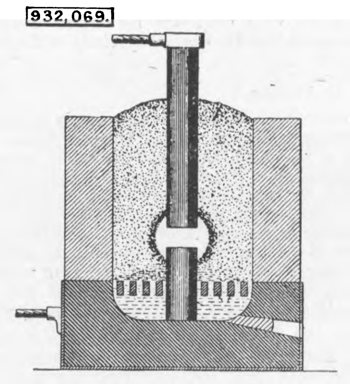
932,028. STOP VALVE, *J. Koenig, Riga, Russia.—Filed October 6th*, 1908.

This patent is for a stop valve, comprising a casing, an ovate hollow plug situated therein whose longitudinal axis lies in the direction of flow, a guide rod passing through the plug and secured to the same, a screw stem passing through the casing wall, and a bent lever pivoted to the casing outside the fluid passage and having one arm substantially parallel with the stem, and having its end jointed to the guide rod and its other arm disposed substantially at a right angle to the stem and jointed thereto. There are two claims.


932,028.

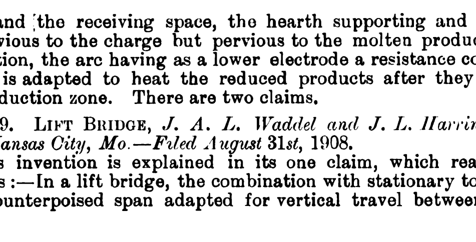
932,069. ELECTRIC FURNACE, *F. J. Tone, Niagara Falls, New York.—Filed December 12th*, 1907.

This invention relates to an electric furnace having an arc reduction zone, a receiving space below this zone for the collection of the molten products, and a hearth situated between the reduction zone and the receiving space, the hearth supporting and being impervious to the charge but pervious to the molten products of reduction, the arc having as a lower electrode a resistance column which is adapted to heat the reduced products after they leave the reduction zone. There are two claims.


932,069.

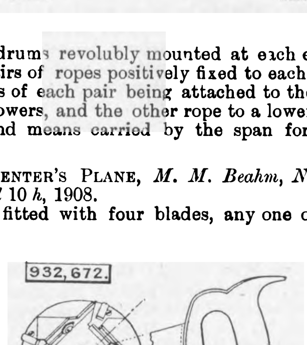
932,359. LIFT BRIDGE, *J. A. L. Waddel and J. L. Harrington, Kansas City, Mo.—Filed August 31st*, 1908.

This invention is explained in its one claim, which reads as follows:—In a lift bridge, the combination with stationary towers, of a counterpoised span adapted for vertical travel between the towers, paired drums revolubly mounted at each end of the span, independent pairs of ropes positively fixed to each of the drums, one of the ropes of each pair being attached to the upper portion of one of the towers, and the other rope to a lower portion of the same tower, and means carried by the span for actuating the drum.


932,359.

932,672. CARPENTER'S PLANE, *M. M. Beahm, Norwood, Ohio.—Filed April 10th*, 1908.

This plane is fitted with four blades, any one of which can be presented for service by rotating the cutter head through approximately 90 deg. There are seven claims.


932,672.

A NOTE ON THE DEFLECTION DUE TO SHEAR.

By W. C. Popplewell.

When estimating the deflections of beams of the more usual proportions, it is the common practice to base the calculations on the theory of bending, which, being dependent on the longitudinal strain of the fibres, gives the numerical values for the deflections as

$$\frac{k\,W\,l^3}{E\,I},$$

the value of the constant k depending on the manner of loading and supporting, W being the total load on the beam, l its span, E the elastic modulus for the material in question, and I the moment of inertia of the section. This gives a very close approximation, and is convenient to use because of its simplicity. At the same time it is a well-known fact that it gives a part only of the deflection, there being an additional amount due to the shear stresses causing sliding along planes normal to the axis of the beam. For beams of relatively long span this shear deflection is small when compared with that which follows from the extension and compression of the horizontal fibres as given by the above formula. In such cases it may be neglected, but where the span is small the deflection due to shear becomes of greater relative importance, and must be taken into account. In cases where it is desired to find the value of Young's Modulus E from the results of experiments on the deflection of a loaded beam, the shear deflection must be taken into account for all but the very longest spans, because it is found that by neglecting it values are obtained which are too low, and which are useless for the purpose of calculating the probable deflections of other beams of the same material. For a beam resting freely on supports, l units of length apart, and having a concentrated load W at its centre, the formula commonly used is

$$\triangle = \frac{W\,l^3}{48\ E\,I}.$$

This deflection is really made up of two parts, $\triangle_1$, due to the direct stresses alone, and $\triangle_2$ due to the shear. The separation of these presents some difficulty. Professor Perry, in his book on "Applied Mechanics," gives an ingenious solution for the case of a rectangular cantilever loaded at its free end. In the following note an attempt is made to show how this same plan may be adopted for beams of more complex section.

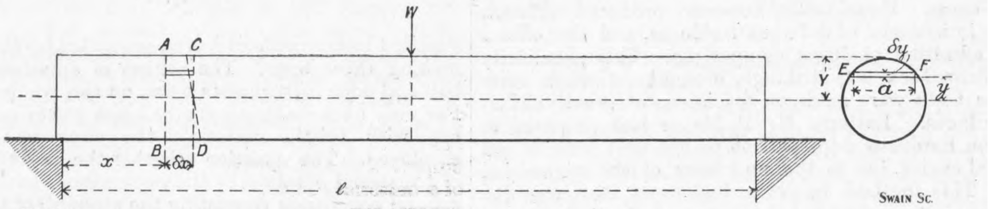


Fig. 1

It may be well to recapitulate the main points of Perry's method. It is somewhat as follows:—

The bending strain energy of, or the work done in straining the material contained in the slice by bending, is expressed in terms of the bending moment, and the shear strain energy in terms of the shearing force at the section. The total internal strain energy obtained by adding these two must be equal to the external work done by the load in deflecting the beam, and on being equated yield a value for the total deflection. The deflection due to bending alone is known, so that a simple subtraction gives the deflection due to shear.

Applying this reasoning to the case of a freely-supported beam loaded at the centre, the following relations are obtained:—In Fig. 1 is shown the beam in question. The strain energy of the slice A B D C will be considered. A B is at a distance x from the left-hand support and the thickness of the slice is δx.

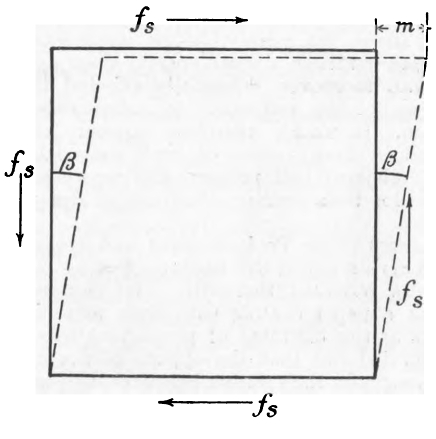


Fig. 2

The total work done, or the strain energy of the slice due to bending, may be written

$$\tfrac{1}{2}\,\frac{M^2}{E\,I}\,\delta x.$$

Where M is the bending moment, I the moment of inertia, and E is Young's Modulus, and for the whole beam it is

$$\epsilon_1 = \frac{W^2\,l^3}{96\ E\,I}.$$

Shearing strain-energy.—The strain energy representing the work done by the shear stress in distorting an elastic cube of unit side—Fig. 2—under horizontal and vertical shear stresses f_s is $\tfrac{1}{2} f_s\, m$; but for small angles $\frac{m}{1} = \beta$, the angle of distortion, and $\beta = \frac{f_s}{G}$, where G is the shear modulus. So that the strain energy may be written as $\frac{f_s^2}{2\,G}$ for unit volume. If this be integrated with respect to x and y, the shear strain energy for the whole beam will be obtained.

For the case in question the magnitude of the shearing force S, upon which f_s depends, is the same for all sections of the beam from $x = o$ to $x = l$. So that the shear strain energy for the beam becomes

$$\epsilon_2 = \frac{l}{2\,G}\int f_s^2\, j\, d\,y.$$

Referring to Fig. 3, which represents the same section as on Fig. 1, it is known that the intensity of the shear stress on P Q at a distance y from the neutral axis is

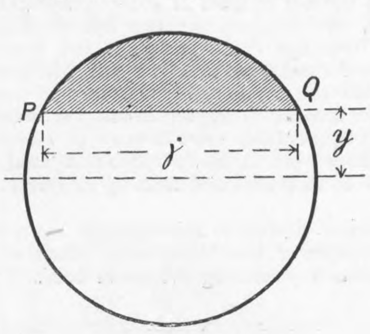


Fig. 3

$$f_s = \frac{A\,Y\,S}{j\,I},$$

where A is the area (shaded in the figures) above P Q, Y the distance of the c.g. of this area from the neutral axis, j the length of the P Q, I the moment of inertia of the whole section, and S the shearing force on the section. Here I is constant for a beam of uniform section, and S is also constant; so that now taking $G = \frac{2}{5}$ E, where Poisson's ratio is 1/4, and $S = \frac{W}{2}$, the shear strain energy becomes

$$\epsilon_2 = \tfrac{5}{16}\,\frac{W^2\,l}{E\,I^2}\,\Omega,$$

$$\text{where } \Omega = \int\left(\frac{A\,Y}{j}\right)^2 j\,d\,y.$$

The total strain may now be written:—

$$= \frac{W^2\,l^3}{96\ E\,I} + \tfrac{5}{16}\,\frac{W^2\,l\,\Omega}{E\,I^2}.$$

The work done by the load W in deflecting the beam through a distance $\triangle$ at the centre is $\frac{W\triangle}{2}$.

This external work is equal to the internal strain energy or

$$\frac{W}{2}\,\triangle = \epsilon = \frac{W^2\,l^3}{96\ E\,I} + \tfrac{5}{16}\,\frac{W^2\,l\,\Omega}{E\,I^2}$$

or

$$\triangle = \frac{W\,l^3}{48\ E\,I} + \tfrac{5}{8}\,\frac{W\,l\,\Omega}{E\,I^2}$$
$$= \triangle_1 + \triangle_2.$$

It is known that $\triangle_1 = \frac{W\,l^3}{48\ E\,I}$, so that $\triangle_2$ must be the remaining portion, $\tfrac{5}{8}\,\frac{W\,l\,\Omega}{E\,I^2}$, which is that due to shear.

For example, take the case of a solid rectangular beam, Fig. 4:—

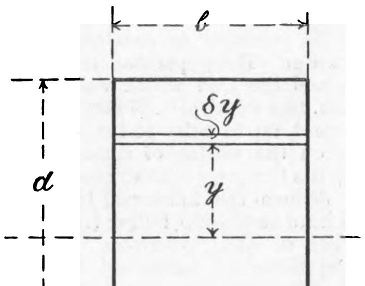


Fig. 4

$$\triangle_2 = \tfrac{5}{8}\,\frac{W\,l}{E\,I^2}\,\Omega = \tfrac{3}{4}\,\frac{W\,l}{E\,b\,d},$$

and the deflection due to bending is

$$\triangle_1 = \frac{W\,l^3}{48\ E\,I} = \frac{W\,l^3}{4\ E\,b\,d^3},$$

so that the total deflection is

$$\triangle = \tfrac{1}{4}\,\frac{W\,l}{E\,b\,d}\left(\frac{l^2}{d^2} + 3\right).$$

In calculating the value of E from the measured load W and observed deflections $\triangle$, it is the frequent practice to say,

$$\text{let } E = \frac{W\,l^3}{4\ \triangle\ b\,d^3},$$

whereas it should be

$$E = \frac{W}{4\ \triangle\ b}\left(\frac{l^3}{d^3} + \frac{3\,l}{d}\right).$$

The error introduced in the usual method is involved in the second term in the bracket. If this is calculated for several values of the ratio $\frac{l}{d} = n$, the following quantities are obtained:—

$n = \frac{l}{d}$	$\frac{l^3}{d^3} = n^3.$	Error % $= \left(\frac{3n}{n^3 + 3\,n}\right)$ 100.
2	8	23·30
4	64	15 80
6	216	7·70
8	512	4 48
10	1,000	2·91
20	8,000	0·74
50	125 000	0 12
100	1,000,000	·03

The rapid increase of this error—for rectangular beams—when the spans become relatively small is shown in the diagram Fig. 5.

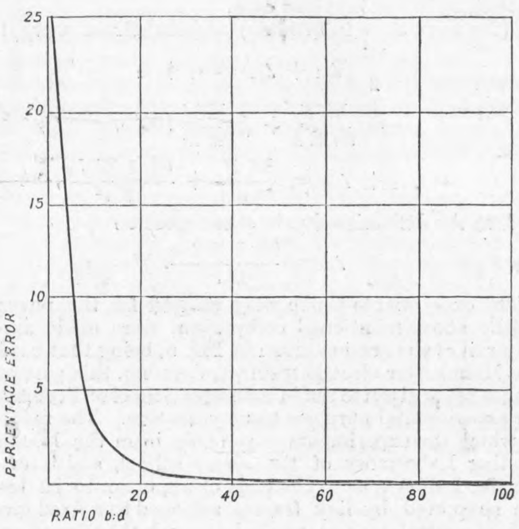


Fig. 5

For beams of simple rectangular section the value of the deflection due to shear is not difficult to calculate, as the above will show, but where the section is of a less simple form the problem must be approached in another manner.

In order to test the following method, and which is partly graphical and partly dependent on direct calculation, the results of a series of deflection experiments on an ordinary tram rail were made use of by the writer. The manner in which the calculations were made will be described.

On Fig. 6 is shown the section of the rail in question. In the first place the moment of inertia for the section was found, by drawing the modulus figures, to be I = 72 inch units. The section was now divided into a number of horizontal strips, each ½in. wide, commencing at the neutral axis. The shear stresses on the horizontal planes through these lines were calculated by the usual formula. In doing this the area A above each line was measured with a planimeter, and its c.g. found by cutting it out in cardboard and balancing. It was easy to measure j as the length of the line where it cuts the section. These are shown in the figure for one of the lines. The values so found are given in the following table:—

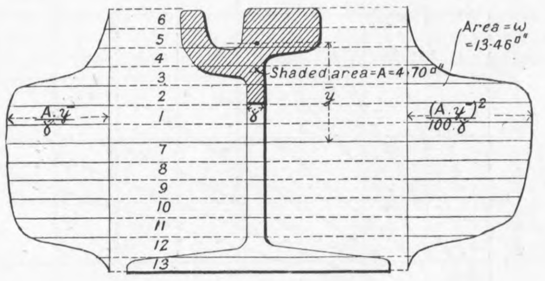


Fig. 6

Area above.	A.	y.	j.	$\frac{A\,y}{j}$.	$\left(\frac{A\,y}{j}\right)^2 j$.
1	4·92	2·52	0·46	26·95	333·8
2	4·70	2·60	0·46	26·56	323·9
3	4·47	2·66	0·48	24·68	292 2
4	3·94	2·75	1·85	5·86	63·5
5	2·78	3·02	2·98	2·82	23·5
6	1·35	3·27	2·65	1·67	7·4
7	4·64	2·64	0·46	26·63	326·5
8	4·41	2·74	0·46	26·27	317·5
9	4·18	2 84	0·46	25·81	307·0
10	3·95	2·94	0·46	25·25	293·0
11	3·72	3·02	0·46	24·42	274·6
12	3·46	3·08	0·56	19·03	166·5
13	2·48	3·20	5·75	1·38	10·9

As S and I do not vary it was only necessary for the present purpose to calculate $\left(\frac{A\,y}{j}\right)$. The values found are given in the fifth column and plotted in Fig. 6 (left).

The curve drawn through the ends of the ordinates is the diagram for variation of shear stress at different points in the section in question. Each ordinate represents $\frac{A\,y}{j}$ for the corresponding layer.

For reasons which will be apparent when the proof is followed, a second diagram—Fig. 6 (right)—was plotted. In this the ordinates represent $\left(\frac{A\,y}{j}\right)^2$ as plotted from the calculated values in the sixth column of the table. In this case the vertical measurements were full size in the original plotting and the horizontal ordinates to a scale of $\frac{1}{100}$.

The enclosed area of this diagram is in square inches.

$$\omega = \tfrac{1}{100} \int \left(\frac{A\,Y}{j}\right)^2 d\,y.$$

Its numerical value in the present case is 13·46 sq. in.

For a centrally loaded beam it has been shown that the bending strain energy,

$$\epsilon_1 = \frac{W^2\,l^3}{96\,E\,I},$$

and that the shear strain energy

$$\epsilon_2 = \tfrac{5}{16}\,\frac{W^2\,l}{E\,I^2} \int \left(\frac{A\,y}{j}\right)^2 j\,d\,y$$

$$= \tfrac{5}{16}\,\frac{W^2\,l}{E\,I^2}\,(100\,\omega),$$

so that, as in the previous case,

(the work done in bending) = (total strain energy)

$$\frac{W}{2}\,(\triangle_1 + \triangle_2) = \epsilon_1 + \epsilon_2$$

$$= \frac{W^2\,l^3}{96\,E\,I} + \tfrac{5}{16}\,\frac{W^2\,l}{E\,I^2}\,100\,\omega,$$

$$\text{or } \triangle_1 + \triangle_2 = \frac{W\,l^3}{48\,E\,I} + \frac{62{\cdot}5\,W\,l\,\omega}{E\,I^2},$$

so that the deflection due to shear must be

$$\triangle_2 = \frac{62{\cdot}5\,W\,l\,\omega}{E\,I^2}.$$

The experiments which were utilised for the purposes of the above-mentioned comparison were made upon a tramrail of the section given in Fig. 6, being that used on the Manchester electric tramways system, this particular length being given to the Manchester School of Technology for experimental purposes some years ago. The machine in which the experiments were made is in the Materials Testing Laboratory of the above school, and is of the Amsler-Laffon type. The ends of the beam to be tested are supported by link frames attached to a fixed girder, and a central load is applied through the ram of an oil cylinder, the ram being forced upwards by castor oil supplied by a rotary pressure pump. In order to enable measurements of sufficient precision to be made, a simple lever deflectometer was arranged, reading directly to $\frac{1}{250}$in., and by estimation to $\frac{1}{1000}$in.

The spans upon which these experiments were made were 5ft., 6ft., 7ft., 8ft., 9ft., 10ft., 11ft., 12ft., and 13ft. The actual deflections corresponding to the various central loads are shown in diagrammatic form on Fig. 7.

From these experimental results it was possible to obtain the actual defections for each span corresponding to certain definite loads or increments of load. It was convenient to take a uniform increment of 3510 lb., this being the total pressure of 100 lb. per square inch on the ram area of 35.1 square inches. The values so obtained are given in the last column of the following table:—

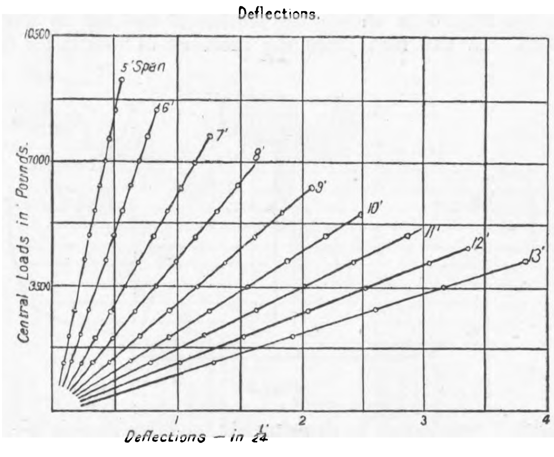


Fig. 7

Table of calculated and observed deflections.

Span, feet.	Deflections by calculation. Inches.			From experiment. Inches.
	$\triangle_1$	$\triangle_2$	$\triangle$	$\triangle$
5	0·0077	0·0012	0·0089	0·0090
6	0·0133	0·0014	0·0147	0·0146
7	0·0212	0·0017	0·0229	0·0229
8	0·0316	0·0019	0·0335	0·0333
9	0·0450	0·0022	0·0472	0·0471
10	0·0619	0·0024	0·0643	0·0641
11	0·0824	0·0026	0·0850	0·0816
12	0·1065	0·0029	0·1094	0·1088
13	0·1355	0·0032	0·1387	0·1388

The values so obtained may be compared with the calculated deflections by working out these from the formulæ already obtained, namely:—

$$\triangle = \frac{W\,l^3}{48\,E\,I} + \frac{62.5\,W\,l\,\omega}{E\,I^2}.$$

Here the central load W is 3510 lb.; the moment of inertia, as previously found, is 72 in inch units; Young's Modulus, also obtained from previous experiments, was found to be 28,400,000 lb. per square inch.

It will be seen on referring to the two last columns in the above table that there is a fairly close agreement between the calculated and observed results, thus showing that by some such method as the present one it is possible to separate the deflection due to shear and that caused by flexure with a reasonable degree of accuracy in beams of any section.

The process which has been described is certainly tedious, and requires a considerable amount of time and patience. Much of the work might be saved by introducing a greater number of purely graphical steps. For instance, the diagram on the left of Fig. 6 could be derived from the modulus figure, and that on the right might be derived from this by a step which would square and divide the ordinates. Whether so many graphical steps, one coming on the top of another, would not result in a very appreciable error is open to question. In any case, further work in the direction indicated, especially in reference to H beams and built-up girders, is worth carrying out.

The writer desires to acknowledge his indebtedness to the commiitee of the Manchester School of Technology for facilities in obtaining the above data.

INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

No. III.*

An important group of papers, which occupied a long sitting of the metal section, discussed problems associated with hardness testing. The official report presented by Dr. P. Ludwik, of Vienna, furnished the introduction to the debate, Dr. Ludwik giving a summary of the recent work and the points which had arisen for decision. He pointed out that in the Brinell test the hardness number was influenced by the size of the ball and by the load. Brinell suggested that the loads should be fixed, recommending 3000 kilos. for iron and steel and 500 kilos. for other metals and alloys, the size of the balls to be 10 mm. in both cases. Equal loads, however, produced different cavities in material of different hardness, and the effects hardly admitted of direct comparison. This peculiarity of the Brinell test was strikingly brought out when comparative tests were made on specimens of greatly differing hardness. Latterly Mr. E. Meyer had proposed to refer the hardness number not to the unit area of the spherical cavity, but to the unit area of the impression circle. This method, however, had more than one disadvantage; it accentuated the defect of the ball test referred to above, and frequently excluded the experimenter from conducting the tests by the determination of the depth of the cavity. In his opinion the Brinell test might be improved by making the angle ω not smaller but greater than 90 deg. (see Fig. 1). For the exact measurements of very small cavity depths Professor Martens had constructed a ball apparatus which allowed of determining differences of 0.01 mm. with a degree of accuracy which no other apparatus approached, and experiments conducted with that apparatus showed that with balls of 5 mm. diameter the ratio between load and depth of cavity might be regarded as constant within the depth range of 0.05 mm. The apparatus therefore determined the hardness and the load which was required to force a ball of 5 mm. to a depth of 0.05 mm. into the specimen. Dr. Ludwik went on to refer to the researches of Rasch and Stribeck on the testing of specially hardened steel. He reminded the Congress that the method of Shore was designed to deduce the hardness from the height of rebound of a hard steel tupp falling from a certain height on the surface of the specimen. Shore's hardness numbers were therefore influenced by the elasticity of the material. The cone pressure test, which marked a transition from the ball pressure methods to scratch methods, was the outcome of efforts to simplify the Brinell tests with the object of making the hardness number independent of the load and of the dimensions of the impression. Hardness numbers which would always be independent of the load would only be realised if the impression remained geometrically similar for all loads. That would be so when the ball was replaced by a cone, and it was the leading principle of the recently proposed cone pressure test. The area of impression was deduced during the test by measuring the depth, the subsequent measurement by means of a special microscope being dispensed with, and the whole operation was rendered more simple as it was possible to make several determinations during a single penetration. When the hardness was derived from the diameter of the impression and not from the depth, the resulting hardness numbers must be independent of the load. The depth measurement was applicable even for materials which did not show well defined impression margins. The diameter measurement was, therefore, preferable only when small impressions had to be used, since in that case the measurement of the depth might be inexact, owing to faulty adjustment of the zero, because the point was rounded off, the cone not completely balanced, or applied under impact, and considerable errors might arise in that way.

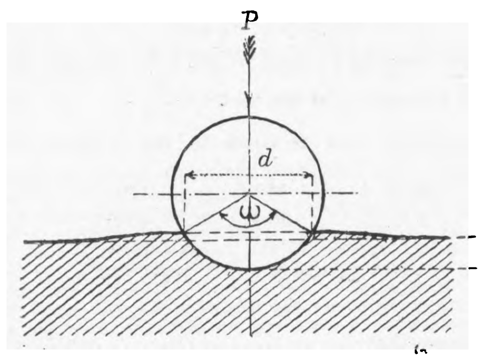


Fig. 1

The cone pressure hardness of a material was defined as that pressure p in kg. per mm.^{2} of permanent impression which was required to force a cone of apex angle $\alpha = 90$ deg. normally to any depth into the material. Referring to Fig. 2, $p = \frac{P}{f}$ where $f = \frac{\pi\,d^2}{4}$. The apparatus for making the cone pressure test could be combined directly with the press of any Brinell ball test instrument. Messrs. J. Amsler-Laffon and Sohn, of Schaffhausen, supplied instruments of a type suggested by the author for making these tests. The ranges of applicability of the ball and cone instruments were, on the whole, the same. For very hard materials the ball test would be preferable, but with brittle materials the cone test should be employed. The question whether the hardness numbers of a material obtained by the two methods admitted of any general conclusion respecting the strength of the material, and in particular of the yield point and the tensile strength, was of considerable practical interest. If the directly applicable and inexpensive hardness tests could replace the expensive testing on machines, which necessitated elaborate preparation of the specimens, a considerable advantage would be gained as regarded the commercial testing of iron and steel. He would briefly allude to the practical results of some of the researches which had been carried out. A direct constant relation between yield points and tensile strength on the one side, and hardness as determined by ball or cone tests on the other, could not exist, since that relation would, among other factors, depend upon the shape of the impression and of the stress strain diagram, and in the case of the tensile strength and hardness of materials which did not contract under test, also upon the cohesion. That admission did not, however, exclude the possibility of deducing from the hardness number, with the aid of a coefficient which would only hold for respective groups of similar materials, the yield point and the tensile strength, with an approximation which would frequently be sufficient for practical purposes. It should, moreover, be pointed out that for materials which undergo contraction the tensile strength could not claim that importance as a quality criterion which was at present ascribed to it by metallurgists. The tensile strength frequently gave for such materials a figure not even approximately the maximum specific breaking stress, but merely like the impression hardness and scratch hardness, a mean specific shearing resistance, which was, moreover, essentially affected by the rate of increase of the resistance to deformation with the elongation. It would, therefore, appear advisable to substitute in many cases of such materials the simpler and cheaper ball pressure and cone pressure hardness tests for tests which exclusively yielded the tensile strength.

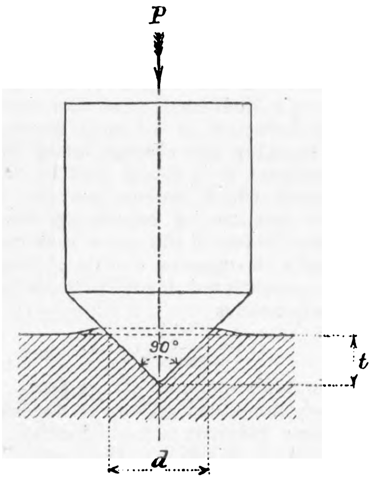


Fig. 2

In a short paper Prof. Martens and Heyn described the Martens simplified ball hardness testing machine and the results obtained therewith. Dr. August Gessner presented a paper dealing with cone pressure tests for determining the hardness of permanent way materials. It was pointed out that the objects of the experiments were to ascertain the relation between the cone pressure hardness and the tensile strength, and to inquire into the suitability of the method for practical purposes. The materials experimented on included rails, bed-plates, fish-plates, and steel crossings as supplied to the Austrian State Railways last year from the Tryznietz ironworks. The experiments indicated that the ratio of tensile strength to cone pressure hardness had a mean value of about 0.335, the range of deviation being ± 6 per cent.; the carbon percentage having no pronounced influence. The lowest tensile strength admissible for rails, 42 tons per square inch, corresponded to a cone pressure hardness of about 190. The tensile strength of sleepers and of other parts of the permanent way varied between 24.75 and 29.8 tons per square inch, the corresponding hardness numbers being 117 and 144. The range of variation was hence approximately the same for the tensile strength as for the hardness numbers. The cone pressure apparatus proved most satisfactory, all the experiments being made with the same plunger, and the results justified the expectation that it would be in many cases possible and advantageous to replace the elaborate tensile strength tests by the cheaper cone pressure hardness tests.

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* Nos I. and II. appeared September 10th and 17th.

Mr. Harold Moore, of Woolwich Arsenal, brought up the results of investigations of the ball pressure tests in the research department at Woolwich. It was stated that the numerous tests made on several different materials in a 4000 kilo. multiple lever machine with load and diameter of ball both varying through a considerable range, had afforded a means of checking the conclusions of other workers as to the effect of variation in load and diameter of ball upon the hardness number. The results obtained had led to the suggestion of a new method of calculating the hardness number. It had long been known that mean pressure per unit area in the ball test increased with increase of angle in impression. The true relation between load and diameter of impression was expressed by the formula $P = a\,\alpha^n$, in which n was a constant for a given metal, and a was a constant for a given metal and a given ball diameter. Meyer had shown that mean pressure per unit area $\frac{4\,P}{\pi\,d^2}$ was constant for a given angle of impression whatever the diameter of ball. It was possible, therefore, if the coefficient n were known, to calculate the mean pressure per unit area for any given angle of impression; it was suggested that 30 deg. be the standard angle. At this angle the diameter of impression = ½ diameter of ball. The hardness number was therefore the mean pressure per unit area, when the diameter of impression was one-half the diameter of ball. The selection of a definite angle of impression, rather than a given load and ball diameter, offered many advantages, and was of perfectly general application. In the great majority of practical hardness tests n might be assumed to be known with quite sufficient accuracy.

The whole subject of hardness testing was then thrown open to discussion.

Professor Guillet said that special steels were very sensitive to heat treatment, and they were very readily tested as regards their condition by the hardness test. To translate the Brinell number into tensile strength called for a coefficient being employed, and that coefficient was different not only in different special steels, but in the same type of special steels, according as they were in the pearlitic or the gamma iron condition. It was possible to have the same number for two steels, one a pearlitic steel and one a gamma iron steel, but it did not follow that you would get the same tensile strength with the same hardness number. Dr. Rosenhain referred to the complications likely to be introduced by deformation of the point of the cone, and the difficulties in connection with the measuring of depth. Attention was also directed by this speaker to the method of measuring hardness, or properties allied to hardness, by the rebound of a small hardened body which slightly indented the surface, in the Shore scleroscope. Professor B. Kirsch considered the cone and rebound tests unnecessary, preferring to rely on the ball test. Professor H. I. Hannover was of opinion that the rebound test was confined to special purposes where the surface of the material was very finely finished. Mr. J. E. Stead said that he had used both the Brinell and Ludwik methods, and had found both useful in connection with micro-mechanical tests for determining which part of a structure was weak in tension. It was finally decided to appoint a committee to carry out abrasion tests in connection with hardness. Both the Martens hardness testing machine and the Brinell apparatus, with the cone adjunct, were shown in operation at the Congress.

Messrs. Sulzer Brothers, of Winterthur, presented a report in connection with the tables of results of experiments on the strength properties of cast iron of various sections taken from separately cast samples and from samples cut out of castings. This report stated that experience proved that separately cast test samples gave higher values for bending and tensile strength than samples cut out of castings. The objects of the two series of tests were to ascertain what influence the slow cooling to which castings might be subjected exercised on the grain or on the strength of the cast iron, and what part was played therein by the different thicknesses of metal. The results went to show that while the separately cast test sample with rectangular and circular sections, and the samples taken from plates of successively reduced sections showed gradually increasing strength values, the samples worked out of hollow castings of all the different sizes experimented with gave values that were much the same. The test samples of circular section showed greater bending and tensile strength than those of rectangular section, but the samples worked out of plates were in strength somewhat behind those separately cast. Similarly the strength figures for the various thicknesses of metal of the hollow castings fell short of those of the separately cast samples, and in a less degree of those of the plates. A comparison of the impact figures showed that these were greater in the samples worked out of larger bodies than in those separately cast, and in like manner the flexure of the former samples was greater than that of the latter, Professor Moldenke said that the test pieces could only be used to test the quality of the metal by casting under the best conditions. Mr. Adolphe Greiner held that a test bar proved nothing, contraction and internal strain depending on the skill of the founder. An example of this was seen in gas engine cylinders, where the trouble was not to find an iron of given strength, but a founder who could cast a good cylinder. Experiments were necessary to determine if any given casting was good or bad.

A method for determining elastic and critical stresses in materials by means of thermo-electric measurements was described by Mr. E. Rasch. The method in question has been worked out at Gross Lichterfelde. The method briefly described in the paper was stated by the author to have proved efficient, among other instances, in determining the stress distribution and the position of the layers of neutral stress in bending tests of girders. The fibres stretched under load were recognised by a fall in temperature (— δ), compressed fibres by a rise in temperature (+ δ); the stress strain distribution and the position of the layer of neutral stress (δ = o) were thus indicated. Experiments with girders provided with broad flanges showed that with small spans the layer of neutral stress was displaced on the tension side to an extraordinary degree. The general character of the experiments is shown in Fig. 3. The curves relate to a brass rod in an annealed condition at line *a*. The galvanometer curve marks the yield point as a sharply defined minimum at P = 3610 *kg*. The other curves show the yield points raised by previous loads.

The utilisation of the magnetic and electric properties of materials for conducting mechanical tests was dealt with in a report presented by Mr. A. Grünhut and Dr. J. Wahn, of Vienna. It was stated that a large number of experiments had been conducted. The experimental data so far available, showed that magnetism was in definite direct or indirect relation to almost all physical phenomena, but that the inter-relation was not sufficiently uniform to allow the physical properties to be determined from magnetic tests.

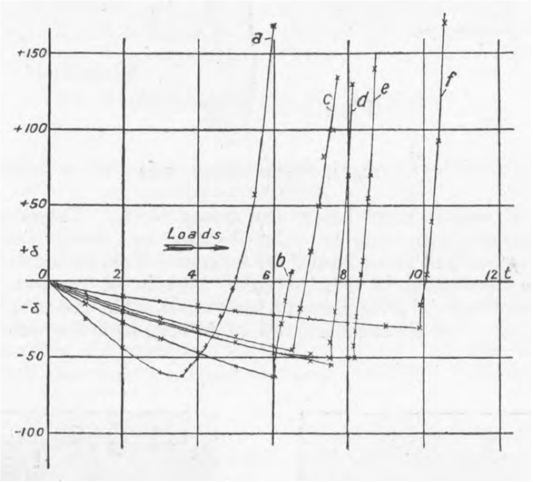
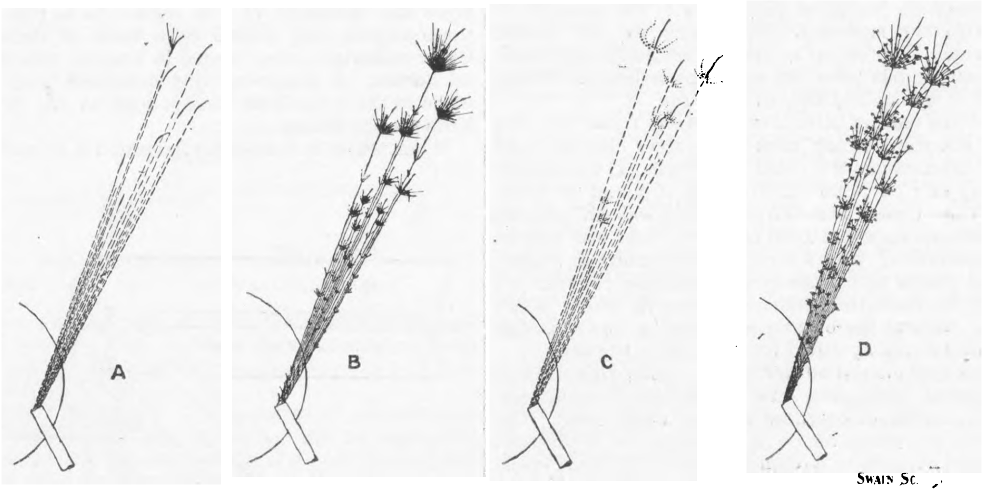


Fig. 3

The employment of the spark test as an indication of different kinds of steel has been the subject of experiment by Mr. Max Bermann, of Buda-Pesth, and he brought the results before the Congress, for whose benefit many of the experiments were repeated. It was explained that the glowing chip thrown off with the peripheral velocity of the emery wheel formed the grinding spark. The explosion-like appearance and articulation of the spark ray was different in the case of different kinds of iron. What he termed the spark sheaf was a combination of spark rays and spark pictures. The practical application of the test was manifold. It was possible by its means to classify different kinds of iron in accordance with percentage of carbon and principal alloy metal. The test was so sensitive that it gave strikingly clear indications of the difference of 0.01 per cent. of carbon, affording a simple and rapid check on the chemical analysis in regard to the amalgamated carbon in steel, as well as a check on the Siemens-Martens process in place of the forge test when analysed standards were made use of for comparison. The assay sample was chilled and the sparks compared with those of the standard. At the taking over of different kinds of iron the spark test afforded a sure means of excluding a material which did not comply with the conditions. It also afforded a very sensitive means of establishing with certainty any differences there might be in the chemical composition at different points in the iron product, and also in finished objects and structural parts. The spark sheaf and the spark pictures provided the possibility of at once determining whether a cast iron was grey or white, and also of distinguishing shades of difference in the individual varieties. In shop work the spark test when once introduced was not easily given up. In the hardening-room this test could be employed to avoid the occurrence of mistakes in the hardening temperature applied. The wire for the manufacture of different spiral springs could also be examined by this method to ascertain whether it had the degree of hardness suitable to the purpose in view. In the forge the spark test would apply to the distinction of good malleable wrought iron from such as was difficult to weld. The spark ray was different in the cases of different kinds of iron, and was quite characteristic. The illustrations show the characteristic spark sheafs of different varieties of steel. In Fig. 4 A shows the spark sheaf of a molybendum rapid steel, B that of a hard carbon steel, C that of a special steel rich in tungsten, D that of a tool steel rich in manganese.



The Engineer

Swain Sc.

Fig. 4

IRRIGATION WORKS OF THE UNITED STATES GOVERNMENT.

No. II.*

Up to the end of 1908, the Reclamation Service had expended about £8,000,000. It had built 7297 canal structures, such as dams, head-works, aqueducts, &c., exclusive of 793 bridges. The canals and ditches had an aggregate length of nearly 3500 miles, and there were 16 miles of tunnels. The earthworks and rock excavations amounted to a total of some 55 million cubic yards. To facilitate the construction work, 983 miles of telephone lines had been erected, and 340 miles of road built, many of the roads being in mountainous country almost inaccessible or impassable. It controls numerous construction camps, some of which are practically industrial towns far removed from railway communication or a base of supplies. The force includes about 1200 officials, engineers, and men of the clerical staff; 5000 labourers employed directly by the Government, and 12,000 labourers in the employ of the different contractors. The equipment owned by the Government includes 30 to 40 miles of railway lines, a cement-making mill, locomotives, dump wagons, excavating machinery of all kinds, steam and petrol engines, electric lighting plants, horses and mules, and a comprehensive outfit of machinery, tools, and camp supplies.

There is, of course, great variety in the engineering works, and great difficulties are encountered in restraining and damming large rivers, the periodical floods of which inundate and damage, or even destroy, the works in their earlier stages. There are also difficulties due to the almost inaccessible positions of some of the works in the canyons of mountain torrents, and to the great distance from bases of supply. Thus large sums have been required for roads to the sites of individual works, and for the transportation of material over considerable distances by wagons. In one case, for instance, it was much cheaper to build a cement-making mill near the site of a big dam than to purchase cement in the market, and transport it to the site. The cost of the locally-made cement was but half that of cement purchased and transported, and the greater part of the actual cost was that of transporting the fuel oil necessary for the kilns.

In some cases there are short dams of great height built across rocky gorges. In others there are embankments or dykes of great length—sometimes more than a mile—and in others there are loose rock dams or weirs built across rivers where there is nothing but sand, gravel, and earth for a foundation. To carry the water from the reservoir to the points of distribution requires many rock tunnels and canals, concrete flumes, and aqueducts on arch spans to carry the canals across gorges and ravines, head-works and gates to divert and control the water, and machinery for operating sluices and gates. Concrete has been used to a great extent in these structures, and many miles of canal in loose ground have been lined with concrete to prevent loss of water by leakage or seepage. In more than one case the water flowing or stored in one valley is conveyed to another by a tunnel driven through the mountain range which separates them. Pumping is employed in different ways. First, to obtain an irrigation supply from deep wells which tap an underground flow of water; secondly, to pump a supply from a river or canal to a canal at a higher level. Water power for direct pumping or for hydro-electric plants is developed at some of the dams, and by vertical falls or drops in the canals.

In no case have the canals been utilised for navigation, and the Bureau has not as yet given any serious attention to this phase of the question. At the present time there appears to be no probability of the canals being used for this purpose, although there are certainly possibilities for the development of navigation. Should the farmers and settlers desire it, navigation may be permitted, providing that it will not interfere with the operation and maintenance of the canals. Obviously, it would not be wise to allow such use without restriction or authority, as it might lead to damage of the canals, especially at landing places. No applications for such use have been made, however, and the Bureau evidently considers the navigation problem as a remote contingency which calls for no particular attention at present, especially as many more immediate problems are pressing for solution.

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* No. I. appeared September 17th.

It would be of no particular interest or value to describe all the projects and their works, but in the present series of articles it is intended to describe such projects and works as will give an idea of the schemes in general, and of the varied engineering features of the very extensive system covered by the present irrigation policy of the United States Government.

THE NORTH PLATTE IRRIGATION DISTRICT.

The North Platte district, in the southern part of Wyoming and part of Nebraska, is one of the large irrigation districts, having an area of about 400,000 acres which can be irrigated. It is at an average elevation of 3800ft. to 4200ft. above sea level, and the temperature extremes are from 20 deg. below to 100 deg. above zero. The average annual rainfall is 15in., but is uncertain, ranging from 9in. to 18in. The soil is a fertile sandy loam, requiring about 2½ acre-feet of water per acre per year. The principal products are alfalfa, Indian corn—or maize—sugar beets, potatoes, &c. Adjacent to the district are great tracts of natural pasture land, available for summer pasturage.

To supply water for this district a great reservoir has been formed by the construction of a masonry dam in a deep rocky gorge of the North Platte River. This not only conserves the winter flow for summer use, but restrains the fierce floods of this turbulent river, which floods have caused immense loss and damage in the past. The watershed area of the reservoir is about 12,000 square miles, with a run-off of about three million acre-feet per annum. The reservoir has a length of about 25 miles, with a maximum width of four miles. Its capacity is about 1,025,000 acre-feet, equivalent to 358 billion gallons, which is sufficient to absorb practically the floods after the supply has been drawn off for irrigation, during the period of diminished flow in the river.

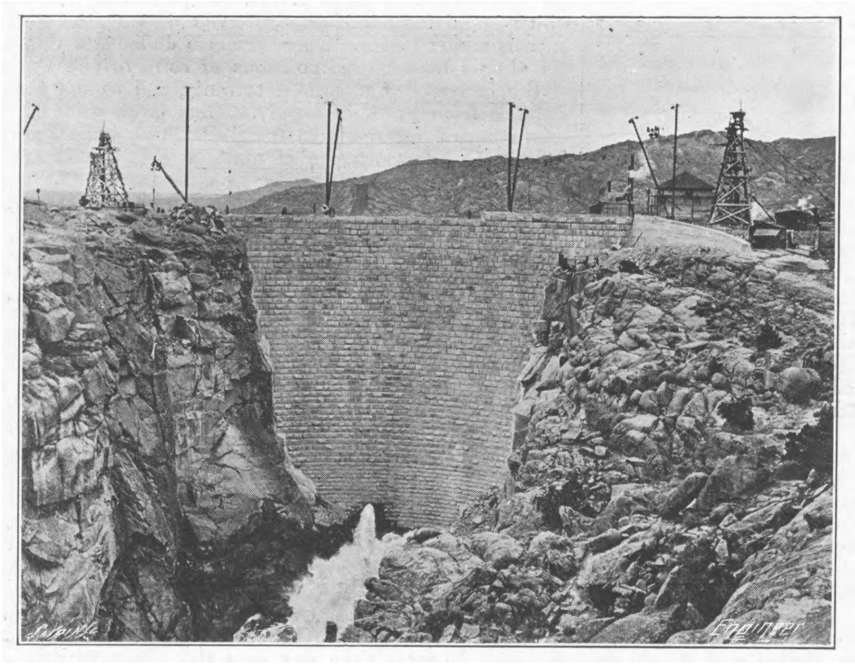


Fig. 7—PATHFINDER DAM—DOWNSTREAM FACE

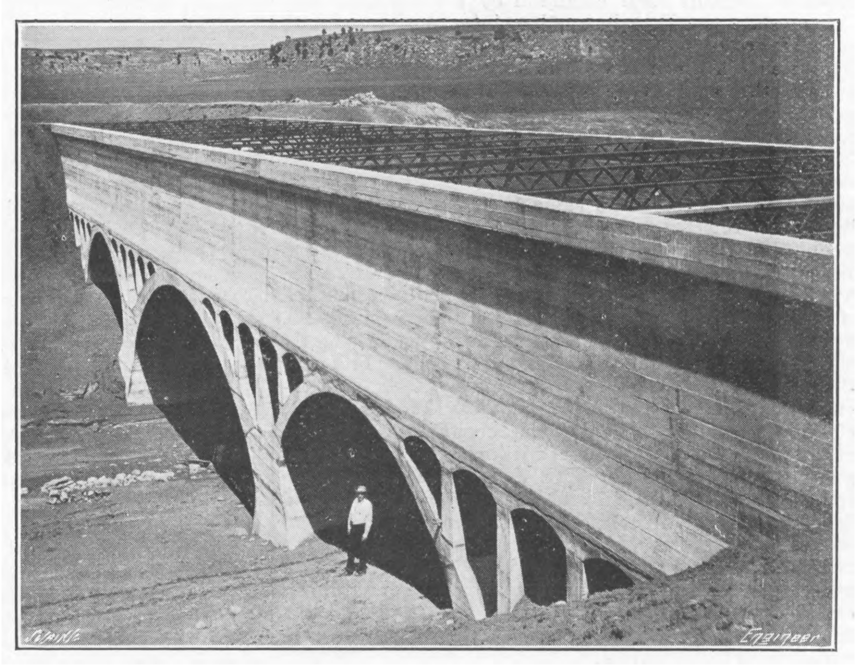


Fig. 8—SPRING CANYON AQUEDUCT

The striking feature of the engineering works for this district is the dam which closes the river channel, and which has been named the Pathfinder Dam. It was named in memory of Col. John C. Fremont (Colonel of Engineering in the United States Army), who was the pioneer explorer of this region in 1838 and 1845, and was known as "the Pathfinder," from his remarkable ability in finding routes and passes across the great mountain ranges. At the site of the dam, the gorge or canyon is about 200ft. deep, 80ft. wide at the bottom and 180ft. at the top, with granite sides almost vertical for 100ft. from the top.

The dam is of curved or arch form in plan, with a radius of 150ft. on the centre line. Its top length is 500ft., exclusive of a weir or overflow portion 150ft. long. The overflow or wasteway has a total length of 600ft., but 450ft. of this consists of a channel cut in the solid rock. The crest of the dam is 5860ft. above sea level, and that of the weir and wasteway is 10ft. lower. The dam has a total height of 215ft., with a maximum depth of 195ft. of water against the face; the water face has an inclination of 20 to 3, while that of the rear face is 4 to 1. The width is 94ft. at the base and 10ft. at the top, which carries a roadway. The volume is about 53,000 cubic yards. The general plan, elevation, and section of the dam are shown in Fig. 6, while Fig. 7 shows the dam practically completed. This latter view shows a discharge from the relief pipes, but these will be closed eventually, as noted later.

The dam is built of cyclopean rubble masonry, most of the material being the granite excavated for the wasteway channel. The faces are of rough cut stone laid in Portland cement mortar. The backing is of quarry blocks averaging four tons apiece, with spaces not less than 6in. wide between them. These vertical spaces are filled with concrete, carefully worked in to fill all interstices. A narrow-gauge railway, during building operations, served the storehouse, quarry, rock-crushing plant, and concrete mixing plant, and delivered the stone and concrete to two 15-ton cableways which spanned the top of the gorge, the carriers of which delivered the material upon the site.

The construction was attended with great difficulty owing to the inaccessibility of the site, the great floods, and the necessity of doing much of the foundation work in severe winter weather, so as to have this preliminary work well in hand before the spring floods. The nearest railway town was 45 miles distant, and from this all supplies had to be hauled by wagons. This included the transportation of nearly 60,000 barrels of cement, for which special arrangements were made. The distance was divided into three sections 15 miles long, each of which had its own equipment of teams and team drivers, so that they knew the condition of the road. As a rule, a train of three wagons was hauled by a team of sixteen horses. Other materials were hauled in wagons with from two to six horses. A telephone line extended from the works office to the town, with connections at the intermediate halts for the teams.

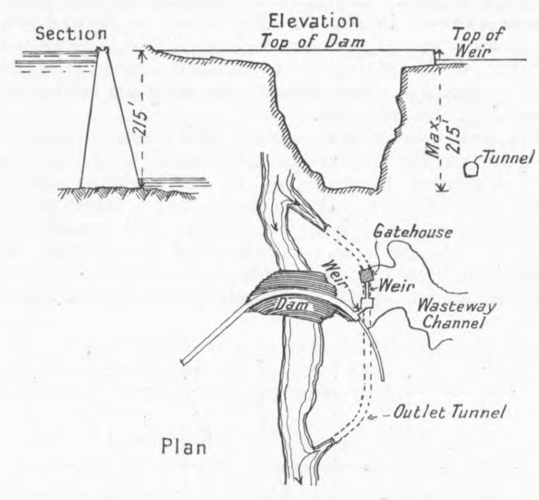


Fig. 6—PATHFINDER DAM

When water is needed for irrigation it is drawn from the reservoir by an outlet tunnel 500ft. long, which is driven through the solid rock of the side of the gorge, and discharges into the river channel below the dam. This tunnel was built first, in order to carry the ordinary flow of the river while the river bed was laid dry by means of a cofferdam for the foundation work and during the construction of the lower part of the dam. Leakage through the cofferdam above the site was taken care of by a timber channel or flume, and by pumps which drained the excavation, discharging the water into the flume. To provide a passage for the low-water flow through the dam when the tunnel was closed to allow the sluice gates to be put in, two temporary lines of 36in. cast iron pipe were laid through the masonry at a level 5ft. above that of the tunnel. At a height of 15ft. above the pipes also an opening 4ft. by 4ft., with arched tops, was left in the masonry, being closed later.

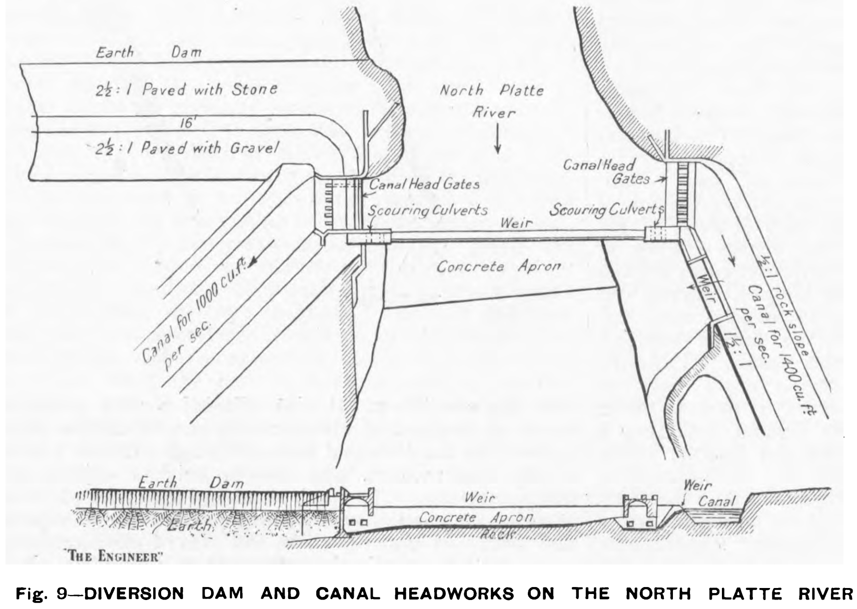


Fig. 9—DIVERSION DAM AND CANAL HEADWORKS ON THE NORTH PLATTE RIVER

The contract was let in September, 1905, and work on the cofferdam commenced in December, in order to be ahead of the spring floods. This winter work was done under great difficulties, due to snow and ice, the handling of frozen gravel, the difficulty of making the dam water-tight with such material, and the general discomfort of working under such conditions. In spite of all efforts, the floods came a few days too soon, filling the foundation excavation and causing the stoppage of all work from the end of March to the beginning of August, 1906. The first stone of the main dam was laid in August, and the dam was completed on May 1st, 1909, at a cost of about £640,000.

The outlet tunnel, mentioned above, is 13ft. wide, 9ft. high to the springing line, and 10ft. to the crown of the roof. Its floor is 194ft. below the crest of the dam. An enlargement of the tunnel forms a gate chamber, with three piers dividing this into four sluiceways 7ft. high and 3ft. 8in. wide. These are lined with steel to prevent erosion. Each sluiceway has two gates, a service gate and an emergency gate, these being about 10ft. apart. Above the chamber is a gallery for the vertical hydraulic operating cylinders, and to receive the gates when raised.

Each gate is 7¾ft. by 4ft., and weighs 5 tons, including the 5in. lifting rod and its piston. The steel operating cylinder is lined with brass, and has an inside diameter of 24in., with a height of 8½ft. It is designed to stand a pressure of 500 lb. The piston has two cup leather packings. Oil is used in the cylinders, and is supplied by a vertical triplex pump capable of delivering 20 gallons of oil per minute when running at 50 strokes per minute. A 15 horse-power petrol engine directly connected to a continuous-current generator of 10 kilowatts, 220 volts, supplies current for a 7½ horse-power electric motor, which is directly connected to the pump. The oil pressure pipes to the cylinders are of brass, 1in. inside diameter and ½in. thick, tested to 1000 lb.

An opening or gap in the side of the reservoir is closed by a dike or embankment 1600ft. long, with a height of about 40ft., and a 20ft. roadway along the top. The main body is of earth and gravel, with 12in. of gravel and 2ft. of block stone paving on the water face, which has a slope of 3 to 1. The rear face has a slope of 2 to 1. Under the dam are three cut-off walls or filled trenches, 6ft. wide and 5ft. deep; the toe of the rear slope ends in a 10ft. trench filled with gravel and having an 8in. drain-pipe in the bottom. The surface was cleared and then planed to a depth of 8in. The material for the embankment was placed in layers not exceeding 6in. in thickness when compacted. Each layer was wetted thoroughly and rolled with rollers weighing 1 ton per lineal foot. These were disc rollers, having alternately large and small discs—varying in diameter by 2in.—mounted on a shaft. All stones over 4in. diameter were removed before rolling, and were laid on the downstream side of the embankment.

About 150 miles below the Pathfinder storage dam the river is crossed by a diversion dam, the main part of which is an earth embankment, 2000ft. long. This is 20ft. high above the natural surface, for 1300ft., and 6ft. high for the remainder. It has a top width of 16ft., and side slopes of 2½ to 1. The remainder of the dam is a concrete weir, flanked at each end by the headworks of an irrigation canal. A plan and elevation of the weir and headworks are shown in Fig. 9. The rock bottom of the river is excavated to form an inclined floor in front of each line of headgates, and at the lower end of the incline are sluicing culverts through the dam. Thus any silt or sediment accumulating in front of the headworks may be swept or scoured away by opening the sluice gates.

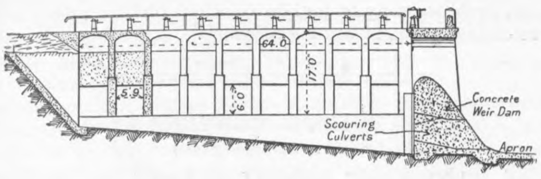


Fig. 10—CANAL HEADWORKS

The headworks are of concrete, and those for the larger canal have nine openings, 5ft. 9in. wide and 6ft. high. This structure is shown in elevation in Fig. 10, which shows also the scouring culverts and the section of the weir. The culverts are of the same size as the openings for the regulating works. Just below the headworks the canal has a weir to discharge excess water into the river below the dam. Fig. 11 is a section through the headworks, showing the hand gear for operating the gates, and showing also the curtain wall which extends between the piers. The headworks on the other side of the river will be of similar construction, but with only seven headgate openings.

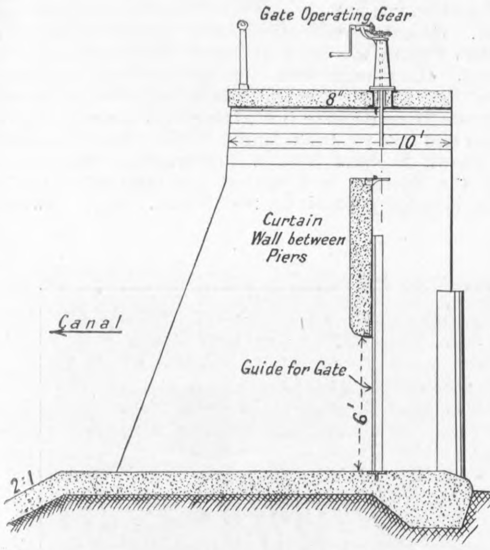


Fig. 11—REGULATOR GATE OPENING

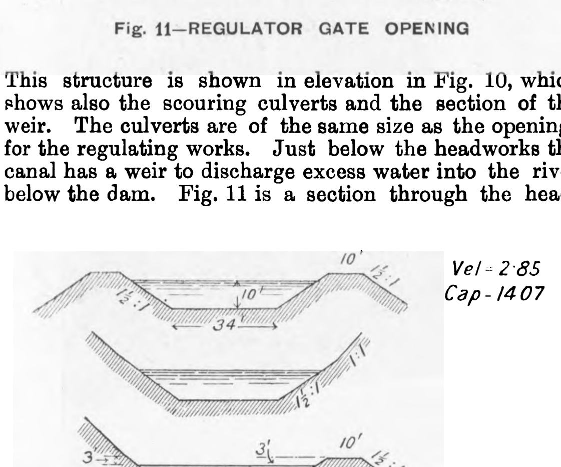


Fig. 12—INTERSTATE IRRIGATION CANAL

The larger canal, known as the Interstate Canal, is now 95 miles in length, but will be extended about 70 miles. Its capacity is 1400 cubic feet per second at the headworks, 1200 cubic feet at the end of 45 miles, and 700 cubic feet per second at 95 miles. The canal has a bottom width of from 22ft. to 45½ft., and carries 8½ft. to 10ft. of water. Some of the sections are shown in Fig. 12. This canal is built partly in cutting, and partly in embankment, or with a combination of cutting and embankment in following across the slopes of the hills. It is lined with concrete for a considerable part of the distance.

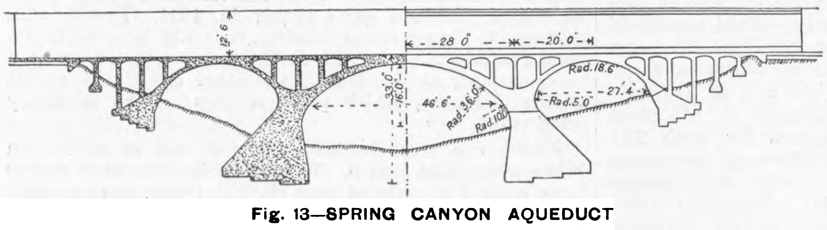


Fig. 13—SPRING CANYON AQUEDUCT

The rough country through which it was built required the construction of several aqueducts to carry the canal across ravines and streams. All of these are of reinforced concrete construction. The Spring Canyon aqueduct—Fig. 8—is a somewhat striking example of these structures. Figs. 13 and 14 show the elevation and section of the aqueduct. It has a central arch span of 51ft., and two side spans of 35ft., with spandril arches and approach arches of 5ft. span. The main arch has a rise of 16ft., and its crown is about 23ft. above the ground—or the dry bed of the stream. The aqueduct channel is 34ft. wide and 12½ft. deep inside. In the top of each side wall is a rolled steel joist, laid flat, and these joists are connected at intervals of 12ft. by steel lattice cross girders, above the level of the water. These tie the walls together, to resist the bursting pressure, and also serve to carry a line of planks for a footpath. The total length of this aqueduct is 210ft.

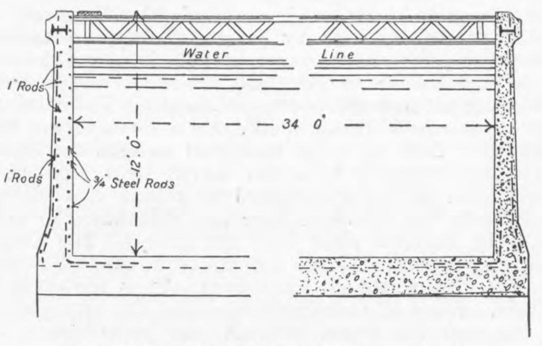


Fig. 14—CROSS SECTION OF AQUEDUCT

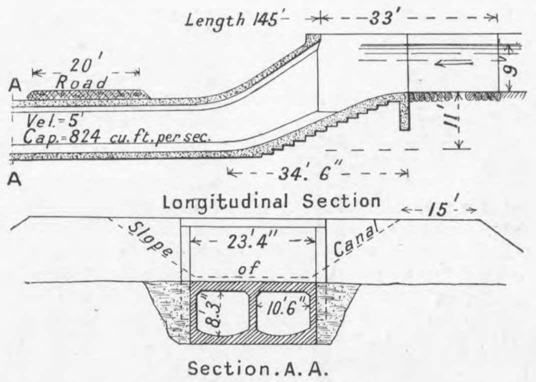


Fig. 15—DOUBLE SYPHON

An interesting type of structure on this and other canals is afforded by syphons of various design to carry the canal under depressions or across valleys. A double-channel syphon carrying the Interstate Canal under a roadway is shown in Fig. 15. It is of reinforced concrete construction, with a length of 145ft. between portals, and a fall—and rise—of 11ft. Syphons for deeper falls—to be described later—have closed inlet chambers to maintain a head in the pipe.

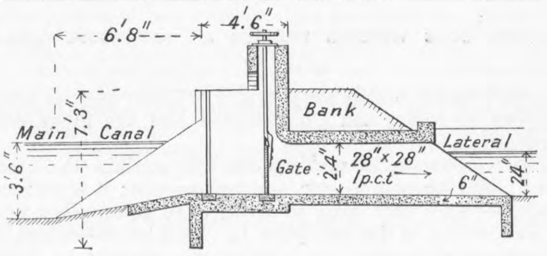


Fig. 16—CONCRETE TURNOUT

This canal discharges into a series of distributing reservoirs with connecting canals having an aggregate length of 4½ miles, and a capacity of 500 cubic feet per second. Beyond these reservoirs several hundred miles of lateral canals and ditches have been constructed to distribute the water over the lands. Fig. 16 shows the design of a turnout for connecting a main distributing canal with a lateral. It is of concrete construction, with a culvert or channel 28in. square. This is closed by a sliding gate attached to a vertical rod which has its upper end threaded to fit a nut which is revolved by a hand wheel. In front of the gate are grooves in the side walls to admit stop planks for closing the opening in case of repairs to the gate. Both the gate and stop planks rest on wooden sills embedded in the concrete floor.

THE INSTITUTION OF MINING ENGINEERS.

THE twentieth annual general meeting of the Institution of Mining Engineers was held at the Wood Memorial Hall, Newcastle-on-Tyne, on Wednesday of last week. There was a large gathering of members. Prior to the business meeting the visitors were accorded a civic reception by the Lord Mayor and the Sheriff of Newcastle. Subsequently, Dr. R. T. Moore, the retiring President, introduced his successor, Mr. J. B. Simpson, who then took the presidential chair. After a vote of thanks had been passed to Dr. Moore for his services during the past year, the hon. secretary—Professor L. T. O'Shea—read the annual report of the Council, in the course of which it was stated that the constitution of the Institution of Mining Engineers remained unchanged, and comprised the following societies:—The Manchester Geological and Mining Society, the Midland Counties Institution of Engineers, the Midland Institute of Mining, Civil, and Mechanical Engineers, the Mining Institute of Scotland, the North of England Institute of Mining and Mechanical Engineers, the North Staffordshire Institute of Mining and Mechanical Engineers, and the South Staffordshire and Warwickshire Institute of Mining Engineers. Founded in 1889, the Institution included four mining societies, and its membership then amounted to 1239. Since that time the number of institutes in the federation had increased to seven, and the members on the register for the year ended July 31st, 1908, numbered 3137, whilst for the financial year just ended there were 3004 members and 53 non-federated members. The following were elected vice-presidents:—Messrs. Wm. Armstrong, Newcastle; John Ashworth, Manchester; T. E. Forster, Newcastle; M. H. Habershon, Sheffield; James Hamilton, Glasgow; Wm. Hay, Mansfield; G. P. Hyslop, Stoke; Robert McLaren, Edinburgh; George May, Darlington; J. H. Merivale, Acklington; T. H. Mottram, Glasgow; Jonathan Piggford, Mansfield; Alex. Smith, Birmingham; S. A. Smith, Manchester; Wm. Walker, Derby; and J. G. Weeks, Willington.

A paper on "Fire-damp Caps and the Detection of Fire-damp in Mines by means of Safety Lamps" was contributed by Mr. E. Bessell Whalley, F.G.S., Assistant Inspector of Mines, and Mr. W. M. Tweedie. They claimed that there was a great diversity of opinion as to the proportion of fire-damp an ordinary man can detect in the atmosphere of a mine with any of the types of safety lamp in common use. Much valuable evidence from many witnesses had been collected by the Royal Commission on Accidents in Mines, and it was premature to discuss many of the questions involved until the Commission issued its report. Some time ago Mr. Tweedie succeeded in producing a photograph of a gas cap, and this, so far as the authors knew, was the first time that gas caps had been successfully photographed. The method commended itself at once as a practicable and accurate means of recording the indications and conditions to be observed in miners' safety lamps. The requirements of practical mining had been kept in view throughout the series of experiments, and an effort made to investigate the following points:—The appearance and nature of a safety-lamp flame; the effect of introducing this flame into an atmosphere containing combustible gas; a practical and accurate method of obtaining a testing flame of constant dimensions; the ratio between the size of the testing flame and the size of the gas cap; a comparison between various illuminants as regards the cap shown by them; the effect of variations of temperature; the effect of the presence of black-damp; and a comparison between the coal-gas and fire-damp caps. Most of the photographs were taken in laboratories, but some were taken in coal mines to verify the laboratory results. The authors described a series of experiments, and claimed that this indicated the desirability of standardising each type of lamp by actual experiment, and they suggested that, if the results were recorded, they would form a valuable aid to those responsible for the examination of the mine. For that purpose photography offered many possibilities. Without some such foundation of fact to work upon, it was difficult for anyone to make accurate estimations, especially if different types of lamps be used day by day under different conditions. Their experiments had shown that to estimate the amount of fire-damp in the atmosphere of a mine was by no means a simple matter. It was certainly practicable to detect small proportions with a safety lamp, but it would seem that for accurate estimation and for checking observations, it was necessary to have periodical analyses.

In a paper, "Equipment for the Study of Flame-caps and for Miscellaneous Experiments on Safety Lamps," Mr. G. R. Thompson, Professor of Mining at the Leeds University, gave some details of the equipment he had adopted for work with safety lamps and of some experiments which might be performed.

In the discussion which followed these two papers, Sir H. H. Cunynghame, C.B., of the Home-office, said they must remember that photography looked at things with eyes different from the human eye. Sometimes it was more sensitive to colour, and they had to satisfy themselves that the instruments and plates they were using were capable of seeing what the human eye could see. A Royal Commission, of which he was a member, was then sitting upon points connected with safety in coal mines, and whilst declining to give his views in connection with that Commission, he mentioned one or two points akin to the discussion. At present the law was that workmen must be removed when the quantity of gas was so great that it was likely to be dangerous. This, he thought, was a difficult section to administer, not only for the inspectors, but also for the managers, because of the doubt as to what was a dangerous amount? Surely common sense would show that the men should be removed before it was dangerous. They could not let it go on until it was dangerous; therefore the law as it stood at present did not help them very much. Suggestions had been made that some percentage of gas should be taken as indicative of danger. The reason he mentioned this was that he wanted to hear their views on that. Occasionally, even in well-conducted mines, you could find gas in remote places, and this gas would not be indicative of a badly managed mine at all, but a mine where conditions were difficult; he thought, therefore, if they were going to apply any such tests a rule could not be laid down that because gas should appear in remote crevices, no men should remain in the pit. It seemed to him that where there was a greater percentage of gas the men should go in under special superintendence. In the main air current he thought there should not be more than a certain percentage of gas, and if there was, men should work there only under special supervision. That seemed to him to be the proposal. If this were the proposal, he would like to know what was the percentage that would be practicable. It was no use fixing it too high, and it was no use fixing it too low, because it could not be administered. What was the figure to be, was it to be 2 per cent., 2½ per cent., 2¾ per cent., or what? He had been told that the mining world had been hitherto under a mistake; when they had seen a cap they thought it was 3 per cent., but it was in reality only 2½ or 2 per cent. There was, no doubt, an inquiry about these caps on foot, and experiments were being made. Subsequent speakers emphasised the impracticability of having a standard of ventilation, Mr. W. C. Blackett pointing out that a standard of ventilation to fire a shot was totally different from the standard of ventilation, say, in a wet place. There were pits with enormous quantities of gas going through them. Were they not to be allowed to go through a certain return because there happened to be 3 per cent. in it? If, on the other hand, he saw 3 per cent. of gas in his intake, he should consider it time he got out of the pit and shut it up. Mr. James Dixon said that in a virgin coalfield, when shafts were newly sunk, it was necessary to have an exception to the rule for a standard of ventilation, and Mr. Simon Tate was of opinion that no man could tell whether there was 10,000ft. or 50,000ft. of air. In the event of the air in the return being foul, it would make the airway inflammable. If a standard of ventilation were fixed it would be futile if it were to be in the working place of a mine. He questioned very much whether a man could tell with an ordinary lamp that he was seeing much less than 2 per cent.

Other papers, "An Account of the Method Employed in Stopping an Extensive Leak, under High-pressure, in the Tubbing of the East Pit, Murton Colliery, 1907," by Mr. W. O. Wood. and "Sinking Through Sand at Newbiggin Colliery," by Mr. E. M. Bainbridge, jun., and W. M. Redfearn, were read and briefly discussed.

The annual dinner of the Institution was held in the evening in the King's Hall, at the Armstrong College, and was largely attended.

Thursday was devoted to a trip on the Tyne and visits to the Carville Power Station, where the visitors were received by Dr. J. T. Merz, the chairman of the Newcastle-upon-Tyne Electric Supply Company, Limited. We have already described this station in our columns.

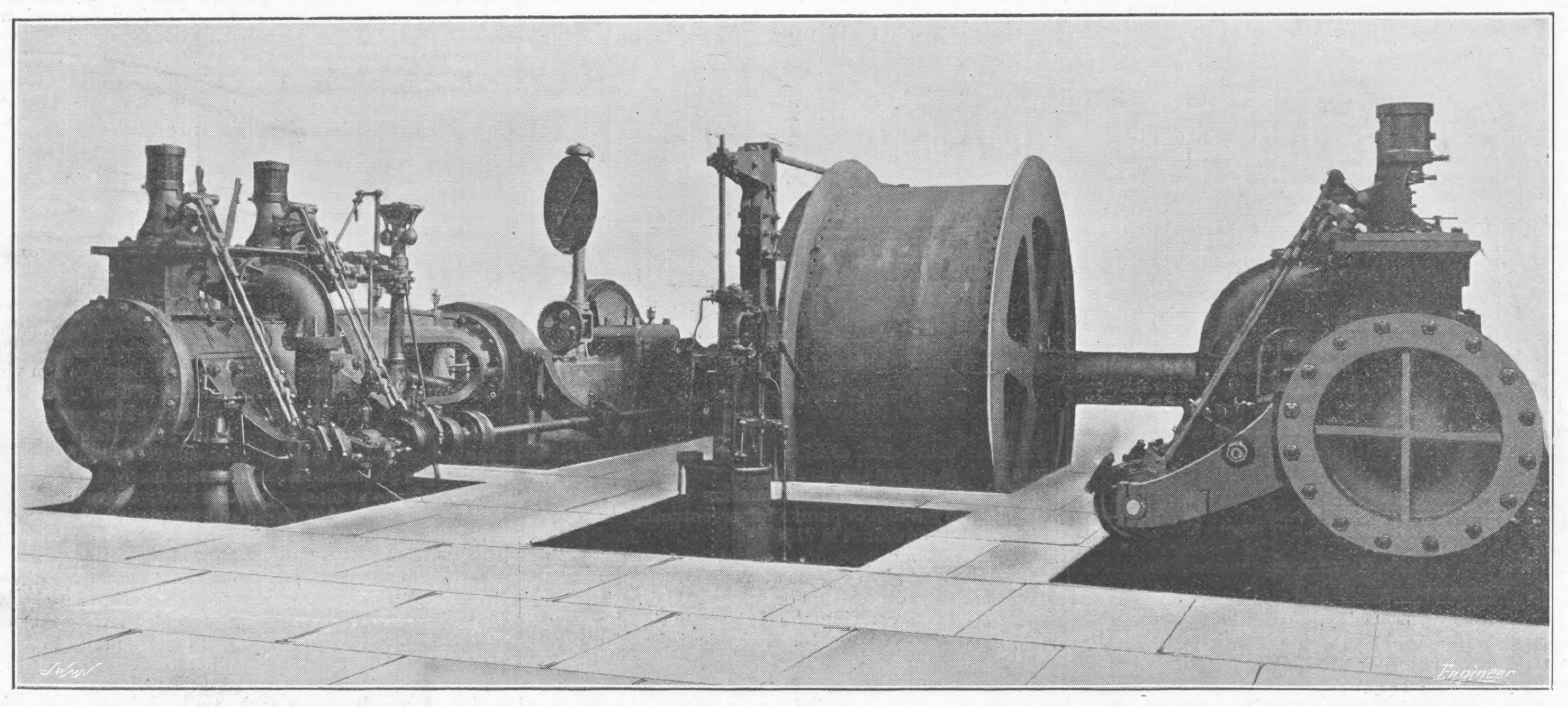
From Carville, the party travelled by the River Tyne Commissioners' steamer to Tyne Dock, and proceeded thence to the Harton Colliery, South Shields, of the Harton Coal Company, Limited. Previous to making an inspection of the appliances at this colliery, all of which are entirely worked by electricity, luncheon, at the invitation of the Harton Coal Company, was partaken of, and the visitors were welcomed by Sir Lindsay Wood. The seams at present being worked at this colliery are the Bensham and Hutton, and the output is about 1200 tons per day of ten hours. A new electrical winding engine has, however, just been erected which is designed to deal with an output of 240 tons per hour.

On Friday two alternative excursions were arranged—one party going to the Newbiggin colliery to inspect the new sinking operations which are proceeding at that place, whilst the other travelled to Corbridge, and was conducted over the Romano-British site of Corstopitum.

The Newbiggin colliery, which is in the progress of being sunk, is situated on the Northumberland coast, about three miles north of Blyth. There are two shafts. No. 2 shaft was at the time of the visit 116ft. deep from the surface, and was passing through freestone, having already passed through the sand. No. 3 shaft is at present in process of being equipped for sinking through the sand. Both shafts when finished will be 18ft. in diameter.

Steam plant.—Steam is supplied at a pressure of 160 lb. per square inch by means of four Lancashire boilers, each 8½ft. in diameter by 30ft. in length, housed in a steel framework structure, the sides and roof of which are covered with corrugated sheeting. The chimney has an internal diameter of 6ft., and is 100ft. high. The boilers are fired by Erith underfeed stokers, and forced draught is supplied by a fan driven by a high-speed engine, the air being conveyed by means of a culvert underneath the stokehole floor and distributed to each boiler by separate pipes from the culvert. The steam from each boiler is led into a steam drum, 3ft. in diameter by 20ft. long, which lies transversely across the range of boilers. From this steam-drum mains are arranged so as to pass the steam through the superheaters or, alternatively, direct into the main steam-range. Two low-service pumps are also installed in the annexe to the boiler-house for the purpose of maintaining the water service of the colliery, and pump into a tank situated adjacent to the boiler-house.

The two winding engines are housed in brick houses, 37ft. square inside measurement, and are exactly alike. They are simple non-condensing engines, with cylinders 24in. in diameter by 40in. stroke. When arranged for coal-winding they will each have two drums 10ft. in diameter, but at present each engine is working with one drum for sinking purposes. Reversing gear of the latest type and steam brakes are provided. These engines were supplied by Robey and Co., Limited, and are illustrated herewith.



ROBEY AND CO.'S WINDING ENGINES AT NEWBIGGIN COLLIERY

Power-house.—The power-house will contain the electrical plant, air compressor, and feed pumps; it is built of brick, covers a floor area of about 3510 square feet, and in plan is shaped like the letter L. This house—which is at present unfinished—will ultimately contain, in addition to the machinery above mentioned, the fan engines and an electrician's workshop. The western wall of the power-house is roughly built, and intended to be pulled down for future extension. The electrical plant consists of two 250-kilowatt three-phase generators, together with two 18-kilowatt continuous-current generators, and a switchboard. The two 250-kilowatt generators supply three-phase current at 600 volts, which is used for power purposes, the exciting current being obtained from the 18-kilowatt continuous-current generators. The 250-kilowatt machines are driven by totally-enclosed compound high-speed engines, with cylinders measuring 15½in. by 26in. with a 10in. stroke, and run at 343 revolutions per minute. The 18-kilowatt generators supply continuous current at 220 volts, and are used for the purpose of supplying the exciting current for the three-phase machines, in addition to supplying the colliery lighting. They are driven by open-type single-cylinder high-speed engines, 10in. in diameter with a 7in. stroke, and run at 325 revolutions per minute. The switchboard is of black enamelled slate, and comprises panels for each 250-kilowatt generator and each 18-kilowatt generator, and a distributing panel fitted with synchroniser and leakage indicator. The air compressor is a compound two-stage machine, with steam cylinders, measuring 12in. by 20in. with 16in. stroke, and air cylinders measuring 11in. by 18in., and supplies air at a pressure of 80 lb. per square inch. It is to be used for the purpose of supplying air to the rock drills for shaft-sinking, its capacity being about 700 cubic feet of free air per minute. The air is stored in a vertical air receiver 5ft. in diameter by 25ft. in length—situated behind the power-house—from which it is conveyed to the shafts. All the exhaust steam from the above described engines in the power-house is taken to an exhaust steam main, which is laid in a trench outside the building. A portion of the exhaust steam from this main is diverted through the feed-heater, the remainder being allowed to escape into the atmosphere. All the winding-engine exhaust mains are also arranged with a view to being ultimately connected with the above exhaust main, so that exhaust steam turbines may be laid down when further extensions of electrical plant become necessary.

THE FULTON CENTENARY.

(*From a Correspondent.*)

The Hudson-Fulton centenary celebration in New York, albeit 102 years have elapsed since the historic voyage of the steamship Clermont, which it partly commemorates, invites attention to the mystery that still envelops the origin and end of Robert Fulton. Are the Americans justified in claiming that famous inventor as a fellow-countryman? Briefly summed up, the American biography, which is accepted by most English works of reference, and accounts for the omission of Fulton's name from the "Dictionary of National Biography," is as follows. They say Fulton was born in 1765 at Little Britain, Pennsylvania, of poor Irish parents, his grandfather having emigrated from Tipperary. His father died when he was three years old, leaving his family in poverty, and all the education young Fulton acquired was the ability to read and write. Recent investigations have, however, pretty well proved that Fulton was born at Beith parish, Ayrshire, in April, 1764. His parents were in comfortable circumstances, and gave their son an excellent education. The American story is open to doubt even from internal evidence. Fulton is a Scotch and not an Irish family name. Fulton himself is well known to have been a Presbyterian, which is in favour of the Scottish and against the Irish origin The American biography continues:—"Fulton early showed a fondness for painting and mechanics, and was so successful with his pencil that before he was twenty-one he had purchased a farm in Pennsylvania for his mother. In 1786 he visited England, and became the pupil of his countryman, the celebrated painter West." The English story states that through the influence of relatives, who had a good commercial position in London, he, when quite a young man, went there to complete his studies. From that period to about 1815 the two biographies are the same. But at the time when the American version makes him die in New York on 24th February, 1815, the English account makes him get into pecuniary difficulties in America, brings him to this country, where he leaves his wife in London, causes him to pay a farewell visit by stealth to relatives in Scotland, and then to retire to the West Indies, where he dies, leaving no family, shortly after 1822. The American biography admits that owing to litigation about patents Fulton's affairs were constantly embarrassed. It speaks of his death producing extraordinary demonstrations of mourning throughout the United States, but no particulars as to his funeral or burial-place are vouchsafed. The statement in the English account about Fulton's stealthy trip to Scotland is explained as being in consequence of his offer to sell torpedo inventions to the French Government in 1801; but he visited England quite openly in 1804. Lastly, with reference to Fulton dying childless, it should be noted that a great-granddaughter of the inventor was reported to have acted sponsor at the launch the other day of the replica of the Clermont, which plays a part in the centenary celebration.

Fulton was much in Manchester as well as in London between the years 1794-6. In the former town he is said to have become acquainted with Robert Owen, the socialist-philanthropist, and Coleridge, and to have met Richard Trevithick. By his contemporaries he was charged with having appropriated English ideas and represented them as his own. The fact that the engine of the Clermont, which he ordered from Boulton and Watt in 1804 without specifying its purpose, was of very nearly the same size as that previously designed by Symington for the Charlotte Dundas is the basis of the charge.

In 1864 there was still living at New Orleans Mr. Jacob

Barker, to whom Fulton's machinery for the Clermont was consigned from the manufactory in England to New York in 1806. Mr. Barker stated that it actually remained in the Commission warehouse six months before the money could be raised to pay the tariff charges.

Although Fulton was far from being the first to apply steam to navigation—in America, between the years 1786 and 1804, eleven different boats had been propelled by steam before his experiments with the Clermont in April, 1807—he was the first to do so with any degree of success, and the first to prove its commercial possibilities. In September, 1807, a regular steamboat service was started upon the Hudson, and from this period steamships came into general use upon the rivers of the United States.

While commemorating Fulton's triumph, the honour due to other contemporary workers in the same field should not be ignored. A memorial to Symington, whose Charlotte Dundas, built in 1801 for Lord Dundas, and for service upon the Forth and Clyde Canal, in which his lordship held a large interest, was undoubtedly the first steam vessel ever constructed expressly for practical use, was placed in St. Botolph's Church, Aldgate, in 1903. It will be recalled that just when the inventor was within an ace of success the death of his second patron, the Duke of Bridgewater, and the repudiation by the executors of that nobleman of his verbal contracts, dashed Symington's hopes to the ground, reducing him to penury and abject poverty, in which state he died in the East End of London in 1831.

The French claim the distinction of inventing steam navigation for Claude François Dorothée, Marquis de Jouffroy (1751-1832). This accomplished mechanician became acquainted with Perier, who brought the first Watt engine to Paris, and the pair took up the idea of steam navigation, but soon fell out. In due time Jouffroy left Paris, and at Beaumes les Dames, a small town in Franche Comité, without any other help than that of a village smith, he constructed his first steamboat, which he launched on the Doubs, June, 1776. This vessel was a tiny affair, 14ft. long by 6ft. in breadth, and its machinery consisted of a Watt engine and a chain carrying duck's-foot paddles. A new engine was built at Lyons in 1780 and fitted to a boat 150ft. long by 16ft., with paddle-wheels 14ft. in diameter. It was publicly tried on the Rhône on 15th July, 1783, and proved successful. But the Academy withheld its endorsement, and the Government declined to grant a monopoly because the trial did not take place at Paris, which disappointment discouraged the inventor from further attempts. In 1884 a memorial to Jouffroy was erected at Besançon, at the initiative of M. Ferdinand de Lesseps, by whom it was publicly inaugurated. It is a fine piece of statuary from the chisel of Charles Gautier.

RAILWAY ACCOUNTS.

In our issue of June 25th last we dealt with the report of the Departmental Committee that have been considering the question of railway accounts. In this, however, we referred more particularly to their labours in the matter of ton mileage. On this particular point it will be remembered that there was a great divergence of opinion, but in other matters of first importance the members of the committee were agreed, and it is to these that we now wish to refer.

Prior to 1868 railway companies were under no obligation other than those in common with other companies under the Companies Clauses Act of 1845, to file any statement of account, but in 1849 a Select Committee of the House of Lords recommended a statutory form. Nothing came of this, and it was not until after another such recommendation by the Royal Commission of 1867 that any steps were taken. In the Act of 1868 it was laid down that every railway company "shall prepare and print, according to the forms contained in the first schedule to this Act, a statement of accounts and balance-sheet for the last preceding half-year." Then, in accordance with the Act of 1871, a return has to be sent to the Board of Trade once a year containing similar information, but in a different form, as well as other particulars. By Section 32 of the Railway and Canal Traffic Act of 1888, the Board of Trade are authorised to modify these latter returns of the Act of 1871.

The first recommendation of the present committee is that the returns for the shareholders and the Board of Trade should be identical and submitted annually. This change, so far as the shareholders are concerned, would necessitate legislative action, and this should provide for the declaration and payment of half-yearly dividends. The next recommendation relates to the receipts and expenditure on joint lines, which are at present embodied in most cases in the accounts of the parent companies, and which shall, it is proposed, in future be made clear.

From the present report it would appear that the railway companies have had the question as to uniform accounts under consideration for some time, a committee of their accountants having been sitting for three years, and having held over fifty meetings. Uniformity in account-keeping was, therefore, a certain recommendation. In order to secure and retain this, the committee recommended that a Standing Committee should be appointed by the Board of Trade to decide on points that might arise, so as to secure uniformity of practice, and that in any legislation that might be necessary as a result of this inquiry the Board of Trade should be given power to make such alterations as might from time to time seem desirable after consultation with the Standing Committee.

As railway companies are now in many cases owners of docks, harbours, and steamships on a large scale, landowners, hotel proprietors, and even caterers, the committee feels that a proper form of accounts for railway companies at the present day must provide for a record of such particulars as will render possible an analysis of the actual railway working as distinct from the subsidiary businesses in which a railway company may be engaged.

The financial accounts are separated from the statistical returns, and are all recast, with a view to illustrate the principal items of revenue and expenditure. Full details are to be given of capital authorised and paid up, how spent and how proposed to be spent. The maintenance of way and works return divides the maintenance of the permanent way into renewal of running lines and repairs of running lines and sidings; the maintenance of roads, bridges, and works under three heads; maintenance of stations and buildings under six heads of the different uses of buildings, stations being separated from engine sheds, and carriage sheds from locomotive workshops, &c., whilst maintenance of signalling and of telegraph are separated from other items. An abstract is proposed as to the expenses of collection and delivery of parcels and goods. Details are to be given as to the receipts and expenditure in respect of omnibuses and other vehicles not running on railways; of refreshment rooms and cars; steamboats; canals; docks, harbours, and wharves; hotels. A very full return is proposed as to the electric light and power account.

In the statistical returns there is to be in the mileage of lines return particulars as to first, second, third, fourth tracks, sidings, &c., and minor and branch lines are to be separated from main lines. In mileage of line authorised but not open, details are to be given of the mileage authorised; completed but not open; under construction and not commenced; and is to show widenings and additions separate from new lines. The number of locomotives return is to give the number of the wheel types; passenger and other coaching vehicles come under ten heads, and the number of passenger carriages of each class and the seating capacity is to be given. Merchandise and mineral vehicles are to have the number under eight heads, varied according to their carrying capacity, *e.g.*, up to 8 tons, 12 tons, 20 tons, and over 20 tons. Another new return is that of railway service vehicles—ballast wagons, tool vans, &c. The acreage of land owned by the company—divided into agricultural, urban, and suburban—and of houses, is to be given; and in the maintenance and renewal of way and works return very full details are to be given as to the amount of ballast, fencing, rails, and sleepers used; and in the maintenance and renewal of rolling stock, the number of locomotives, rail motor cars, coaching vehicles, and wagons renewed, and those that have undergone heavy repairs or light repairs, or are under or awaiting repairs, are to be shown, and whether done in the company's workshops or by contract. Finally, the engine mileage return is to be amplified and very full.

A LARGE ELECTRICAL CONTRACT FOR THE CONTINENT.

We are authoritatively informed that Messrs. Brown, Boveri and Co., of Baden, Switzerland, have quite recently been awarded one of the largest individual orders for electrical generating plant which has ever been placed with any European firm. This generating plant will form one-half of the power equipment of the new generating station now being built for A. S. Rjukanfos and Co., of Christiania, which, on completion, will be the largest electrical power station in the world. The plant is intended for the production of saltpetre from atmospheric nitrogen, and Brown, Boveri and Co.'s order consists of five three-phase generating units, each rated at 17,000 K.V.A. (at 0·6 power factor), at 10,000-11,000 volts and 50 cycles, with direct-coupled exciters of 130 kilowatts for coupling to water turbines of 14,000 horse-power at 250 revolutions per minute. Each of these generators will weigh about 200 tons, and have a diameter of approximately 20ft. The contract was placed solely upon the technical merits of the designs submitted by several of the leading continental electrical manufacturers, and not upon consideration of price, and it is understood that Brown, Boveri and Co. have no financial interest whatever in the project.

LETTERS TO THE EDITOR.

(We do not hold ourselves responsible for the opinions of our correspondents.)

PRACTICAL *versus* PURE MATHEMATICS.

Sir,—Your correspondent, Mr. Parr, in last week's issue, takes a wrong view of the subject. Practical mathematics is not a "scrappy selection of methods," to use your correspondent's words, but is quite as connected and properly arranged as any other branch of science.

Before the establishment of practical mathematics classes in our colleges and schools, engineering students had to wade through a lot of quite useless stuff. There is probably not one student in a hundred who ever requires, or will require, to use conics, infinite series, quaternions, &c., in his every-day work. Practical mathematics consists of those methods which experience has proved to be of practical use in the technical applications of the subject, and with unnecessarily abstruse analytical proofs rejected, and easier understood graphic ones put in their place. Your correspondent thinks that graphic and squared paper methods of proving theorems lead the student to think that those proofs are only approximations. I have rarely found this the case, and my own early experience of these methods leads me to think that they are a very great help. These proofs have been devised so as to make the student realise that he is not merely juggling with symbols, but that the problem he is working is the direct result of the application of mathematical principles to every-day practical works.

To take the case of electrical problems, it would be almost impossible to make a student realise the significance of alternating current formulæ without a course in plotting sine curves.

It should be borne in mind that the majority of engineering students are not mathematical geniuses, but that they have generally more experimental than mathematical ability, and any method which will verify mathematical theorems experimentally will take only half the time to teach. Engineering and science students now-a-days have such a variety of subjects to study that it is impossible for them to give much time to mathematics. This is especially the case with evening students who have only half a dozen hours or so a week to spare. There are some people who believe in getting the mathematics in by every possible method, and very often their labour is entirely wasted.

You cannot develop the mathematical faculty of a student if it is not there to develop, and you certainly cannot do it by cramming. Practical mathematics aims at giving the student a good working knowledge of mathematics with the minimum amount of exertion. Practical mathematics gives great attention to the working of numerical examples, and in most cases the students lack accuracy in their working. This is particularly the case with students who have been used to merely working with symbols. It is not of the slightest use working practical examples if they cannot be worked numerically accurate.

Your correspondent discourses upon vectors. I have never found the idea of a vector to be of very much consequence in numerical examples; and as a matter of fact, in a number of schools they are treated very slightly.

With regard to trigonometry, this is usually treated very fully, and is quite sufficient for practical purposes.

While there is no royal road to mathematics, the use of practical methods renders it easier of understanding.

London, September 21st. F. J. Romer.

EXPERIMENTS WITH A GLASS CARBURETTER.

Sir,—Referring to Mr. Gillett's letter in your issue of this week, I, of course, entirely agree with him. The carburetter should be self-contained, and, to my mind, should turn out a constant mixture and evaporate its petrol. Very possibly this will be found entirely impossible; that has to be seen. But I do not think that there is any doubt that it is desirable.

Mr. Gillett may now perhaps know that a White and Poppe carburetter seems incapable of working with a T-shaped induction pipe, at least the Maudslay Company had to abandon this shape, and I note that the Vauxhall have a Y-shaped pipe, and, I believe, the White and Poppe engine itself.

As Mr. Gillett says, the carburetter maker has no say in the piping arrangements, but sometimes his carburetter speaks for him with no uncertain voice.

What I want to do, as I said, is to connect up a set of standard carburetters to a glass induction pipe and see the result, and also to observe what temperature, if any, will provide complete evaporation; and if so, what the effect on the temperature of the resulting mixture is.

As regards my apparatus. Certainly my carburetter was, so to speak, the induction pipe, but I contend that this was exactly the condition of affairs in the 1904 Mercédès. True, it was not so apparently, but in fact the petrol entered the side of a pipe and the air passed through the pipe. The result was 20 miles per gallon with an 18-28 horse-power car.

One of the experiments I want to try is the connecting up of a petrol feed arrangement and a vena contracta nozzle to a fan blast, turn on the air and petrol in the right proportions, and watch the resulting cloud. I believe a good bit could be learnt about the evaporation of petrol. Then I want to attach to the same apparatus a spring-loaded valve which the air will have to force open. Thus the air and petrol would pass through a hole at constant velocity whatever amount of air was passing. Would this produce a better cloud? And so on. J. S. V. Bickford.

Camborne, September 18th.

OLD TOOLS AT SOHO.

Sir,—I was greatly interested in the article and illustrations *re* the above in your issue of the 10th instant. Through the courtesy of the late Mr. H. W. Blake some considerable number of years ago I was enabled to go through these works; indeed, it was at the very time the oscillating cylinder illustrated was being machined. I do not notice any mention made of a wall-planing machine with a very long travel. The article to be planed remaining stationary, and the tool travelling on guides set up on a wall. The feed was most ingenious. Also the engine driving this shop was, I am informed, one that had been used in one of the earliest steamboats. It was, I remember, of the "Grasshopper" type. I was also shown many interesting things, among others the original copying press, as invented by the great Watt, for the duplication of drawings instead of tracing them. One thing struck me greatly, viz., a letter from Trevithick to Watt with description and sketches of helical tooth gearing, and asking Watt's opinion. There were so many things I cannot recollect them all. My letter of introduction was from Mr. H. W. Blake to the late Mr. Darlington mentioned in your article; he was, unfortunately, away at the time of my visit to Soho. Perhaps this may be of interest to your readers.

Brighton, September 20th. A. C. Franklin.

BRITISH LOCOMOTIVE PRACTICE OF TO-DAY.

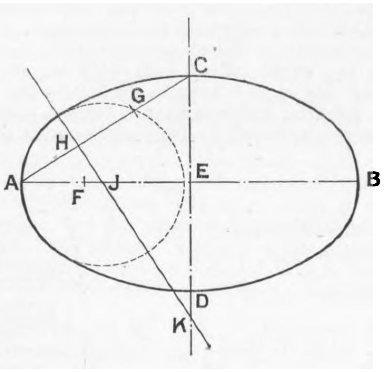
Sir,—As a retired railway engineer, I take a great interest in the correspondence as to the relative merits of compound and simple locomotives, and I note in your leading article of the 17th inst. that it would be desirable to obtain more opinions from those who are engaged in the superintendence and working of the locomotives of British railways. I once asked an old experienced foreman of one of the large London depôts for his opinion of the compounds then under his charge, and his reply, which was very brief and to the point, was as follows:—

"Well, they are good engines to run, they can take heavy loads, and they don't burn much coal, but from a running-shed point of view, *I would much rather be without them.*"

September 22nd. Frank S. Hennell.

DRAWING AN ELLIPSE.

Sir,—I herewith send illustration of method of drawing an ellipse which I have had in my notebook for about ten years, and which, when accurately used, gives as nearly a true ellipse as can be drawn with compasses.



Mark off E F = E C and C G = A F, bisect G A in H by line H J K at right angles to A C. Then J and K are two of the four centres with radius J A and K C to complete ellipse.

Elland, September 15th. J. E. H.

Sir,—With reference to Mr. P. Merry Del Val's letter in your issue of the 10th inst., giving an approximate method of drawing an ellipse, I beg to point out that his method is only approximately true for ellipses having a ratio of 3 to 2.

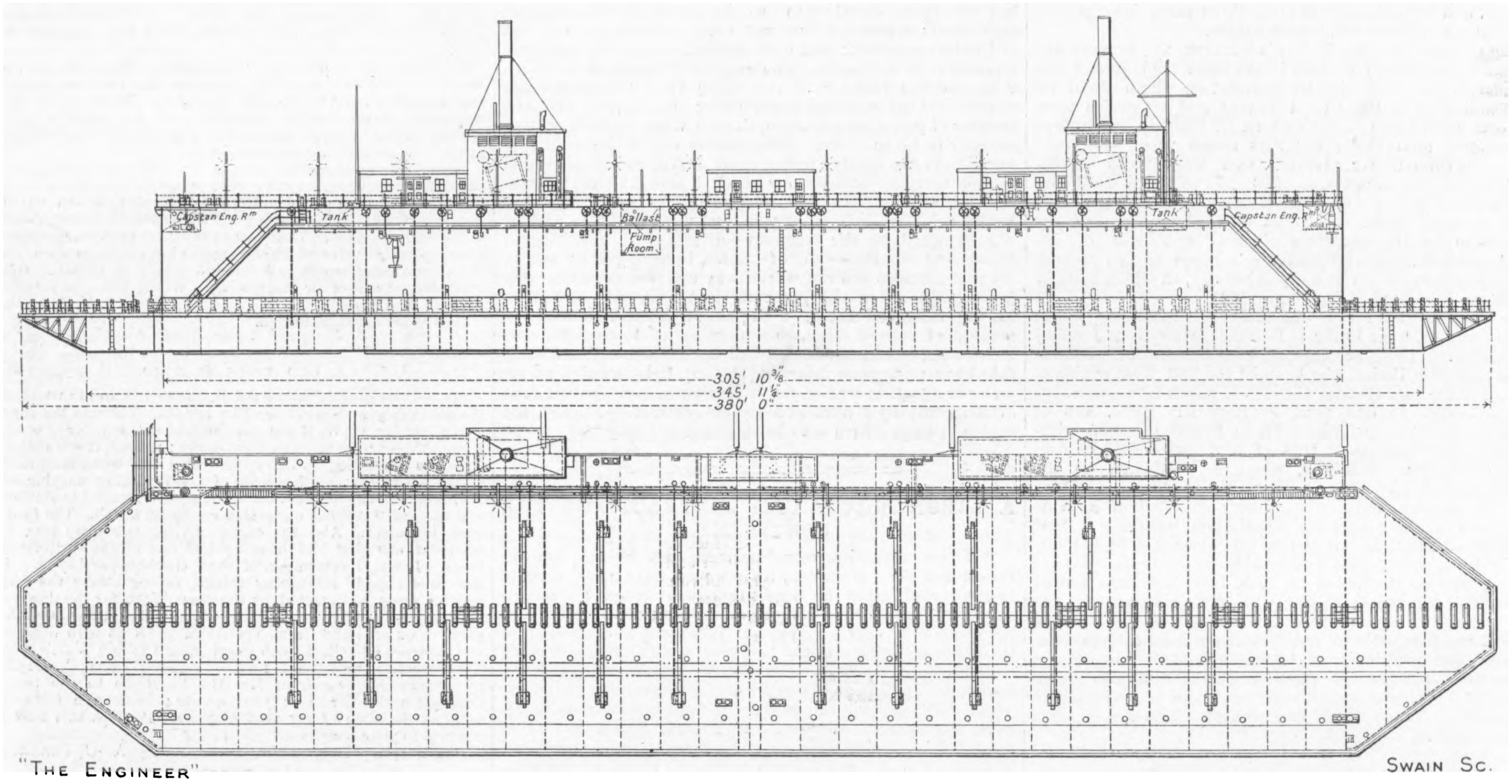
J. H. Bradley.

September 13th.

Some interesting information concerning the electrical industry in Germany is given in a consular report dealing with the trade and commerce of Frankfort. Generally speaking, the report states, it is admitted that the electrical industry has been but little affected by the economic depression. Nevertheless business in 1908 cannot be described as satisfactory in comparison with the results of the immediate past. Whereas 1907 showed an upward movement, which continued during the beginning of 1908, a change took place in the second half of that year. In various electrical branches the economic depression can be largely attributed to the general economic depression in Germany, particularly to that in the iron industry and the building trade, which chiefly affected the electrical machine building industry and that of installations. The threatened danger of the introduction of a tax on electricity, the report goes on to state, also seriously affected this industry. Such a tax on electric energy would have really constituted a double burden upon the entire industry of the country, and its effects would have been far-reaching. It was strongly opposed by chambers of commerce, municipalities, and societies of all kinds. Equally strong protests were raised against the law suggested by Prussia, which aimed at a closer supervision of the whole industry.

AN OFF-SHORE FLOATING DOCK FOR PENARTH.

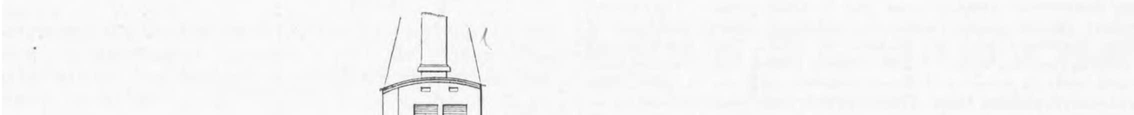
A FLOATING dock, of the "off-shore" or "single-walled" type, has quite recently been completed by Swan, Hunter and Wigham Richardson, Limited, of Wallsend-on-Tyne, to the order of the Penarth Shipbuilding and Ship Repairing Company, Limited, of Penarth Dock, Cardiff. This dock, illustrated in the engraving on this and on page 320, has been built from the designs of Messrs. Clark and Standfield, of Westminster. It has an overall length of about 380ft., an extreme width of 75ft., and it is capable of accommodating vessels having a beam of 55ft. with a draught of water up to 18ft. and a displacement of 4200 tons.



7000-TON SINGLE-WALLED FLOATING DOCK

As the term "off-shore" implies, the dock is intended to be attached to the shore by means of booms and columns, eight in number; the booms will be hinged and pivoted at the dock and shore ends, so as to permit of the lowering and raising of the dock when vessels are being docked and undocked. Two powerful sets of pumping machinery are supplied to the dock, consisting of four centrifugal pumps, and engines for working the same, manufactured by Gwynnes, Limited, of the Hammersmith Ironworks, S.W. Steam is furnished by two Babcock and Wilcox boilers, working at 160 lb. pressure. This plant has been designed to lift a vessel of 7000 tons deadweight in 45 minutes.

For the purposes of self-docking, the dock is divided transversely into two equal halves, each with its own pumping plant, so that one section may be docked by the remaining portion. A powerful steam capstan is fitted at each end of the top wall to assist in warping vessels into position when lifting or otherwise. Eight mechanical side shores are supplied in addition to the usual accessories for facilitating the rapid handling of vessels during the operation of docking and undocking, as, for instance, bilge shores, roller fenders, rubbing timbers, and bollards.



END VIEW OF FLOATING DOCK

A duplex reciprocating pump, with a capacity of 100 tons per hour, has been supplied by Henry Watson and Sons, of Walker Gate. This pump has a connection to the main drain of the dock, and will enable the last drops of water to be pumped from the dock. There is also a connection to the sea. On the delivery side the pump is connected to a service pipe, which has connections at intervals for 3in. delivery hose. The pump is intended to be capable of throwing three jets of water to a height of 40ft.

An interesting feature of this floating dock is that it is wider than the entrance of the wet dock at Penarth into which it has to pass, and consequently the bottom pontoon has been built in two pieces. In the plan it will be seen that there is a longitudinal joint running the entire length of the pontoon. Upon arrival of the dock in the Penarth Roads, this joint will be disconnected and the separate sections towed into the wet dock and thereafter reconnected and the attachments to the quay wall completed.

The dock left the river Tyne on Wednesday of last week in charge of the two tugs Great Emperor and Tritton, of the John Dry Steam Tugs, Limited, of South Shields, and it is expected to reach the Bristol Channel towards the end of the current week. Some few weeks will, however, elapse before this floating dock is ready for commercial service, as the berth for its accommodation at Penarth has not yet been completed.

A STAYLESS FIRE-BOX FOR LOCOMOTIVES.

THE side sheets of locomotive boilers are a source of considerable trouble, from the fact that while they should be allowed freedom to contract and expand with temperature variations, they are rigidly held by hundreds of transverse stay bolts, which connect them to the parallel plates of the outer fire-box. These stay bolts also obstruct the free circulation of water in the water space. The temperature of the fire-box sheet may vary continuously in different parts, owing to the changing conditions of the fire, but its expansion and contraction under these conditions can be taken up only by the buckling of the plate between the stay bolts, or by the bending of these stay bolts. Cracked and leaky fire-boxes and fractured stay-bolts are the natural consequence, especially in the steel sheets of fire-boxes on large American locomotives.

A method which is very generally adopted to minimise the trouble is the use of some system of flexible stay bolts which will allow movement of the sheet without distortion or strain of the stay bolt. In one design the head in the outer sheet has a ball-and-socket fitting. Another method which has been tried in several cases is the corrugation of the fire-box sheets, vertically, so that the expansion and contraction may be taken up by these corrugations between the rows of stay bolts. In the Langbridge fire-box the side sheets are in sections about 18in. wide, connected by vertical splice plates of U-section. A similar horizontal splice plate connects the side sheet with the foundation ring. In the Woods fire-box the sides and crown are formed by a single sheet, which is corrugated in very much the same way as the furnace flue of a Scotch marine boiler. The flat portions between the corrugations receive the stay bolts.

A different type of construction has been introduced recently in the Jacobs-Shupert locomotive boiler, which has three special features:—First, freedom for local or general expansion and contraction; second, an entire absence of stay bolts in the side sheets; third, a sectional construction, which prevents the tearing away of a large area of plate in case of explosion. It is the joint invention of the assistant locomotive superintendent and the boiler foreman of the Atchison, Topeka, and Santa Fé Railway, and is built at the railway company's works. The results so far indicate that the design is satisfactory. At the time of writing, however, only one engine has this fire-box in actual service, but others are being built, and will be applied to engines working under different conditions as to traffic, quality of water for feed, &c.

The general design is clearly shown by the longitudinal section of the fire-box in Fig. 3. The principal elements are transverse channels of pressed steel, bent to the cross-sectional form of the fire-box and stay plates which occupy the steam space and water legs. For the inner fire-box the channels have the flanges outward, and the web slightly curved or buckled inward, so as to give a flexibility to the channel lengthwise of the fire-box. For the outer box the arrangement is similar, except that the channel webs are buckled outward. Sandwiched between the flanges of the channels are the transverse stay plates, which thus connect the inner and outer fire-boxes, being riveted through the flanges. Holes are punched in these plates to allow for the longitudinal movement of the water in circulation, and the lower ends are slotted so as not to rest upon the foundation ring, thus leaving a clear space above the ring for washing out any sediment.

The channels are 10in. wide, and at their lower ends the flanges are eliminated by lapping and flattening; the lapped portions are riveted, and the joints welded by the autogenous process. In this way there is formed a flat surface fitting against and riveted to the foundation ring. The channels are formed from steel plates at the railway locomotive works, being bent in a hydraulic flanging press by the use of special formers. The channels are in the same way bent to the required horseshoe shape. In this way the work is done quickly and cheaply, and the parts are perfect duplicates. For drilling the flanges no laying out is required, a steel template—having holes fitted with hardened steel bushings—being clamped in place.

The stay plates—of horseshoe shape—are also pressed from flat steel plates, and the holes are punched in them in the press. At the crown an opening is cut of such size as to enable a man to crawl through over the crown sheet. When the engine is in use, however, this opening is partly obstructed by a pair of vertical stays fitted to pins in the metal above and below the opening. The piece cut out at this opening is used to form the two sides of the stay plate—or the legs of the horseshoe, which fit in the water spaces on each side of the fire-box. A special riveting machine, with narrow elongated jaws, is used for riveting up the flanges. While these plates extend across the water space, but are pierced to permit of free circulation in a horizontal direction, the spaces between them

STAYLESS LOCOMOTIVE FIRE-BOX

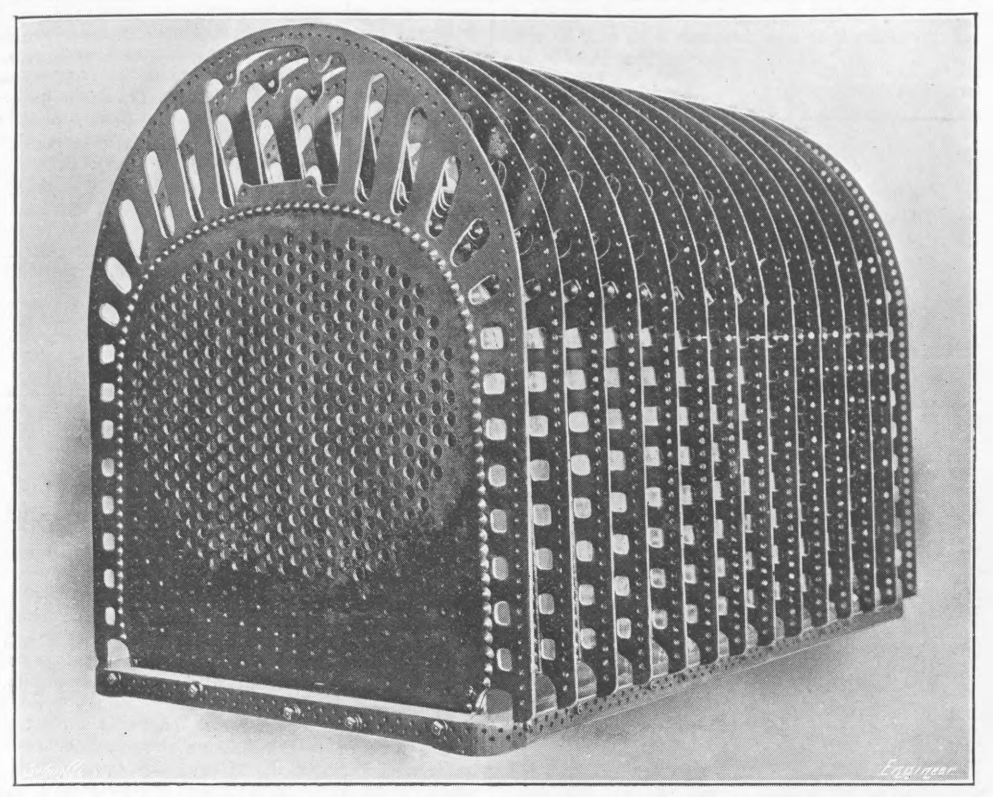


Fig. 1

are absolutely unobstructed. Thus there is ample space for the more rapid and more important vertical circulation, and the current of water rises unbroken along the web of the channel. For this cause an improvement in evaporative capacity is expected.

It is believed that no explosion could result in tearing apart the ribs, each formed of two flanges and a stay plate riveted together. Thus rupture would be confined to the 10in. width of the channel web, and could not extend to the next channel. In many boiler explosions the disastrous results are due to the tearing away of a large area of the fire-box sheet.

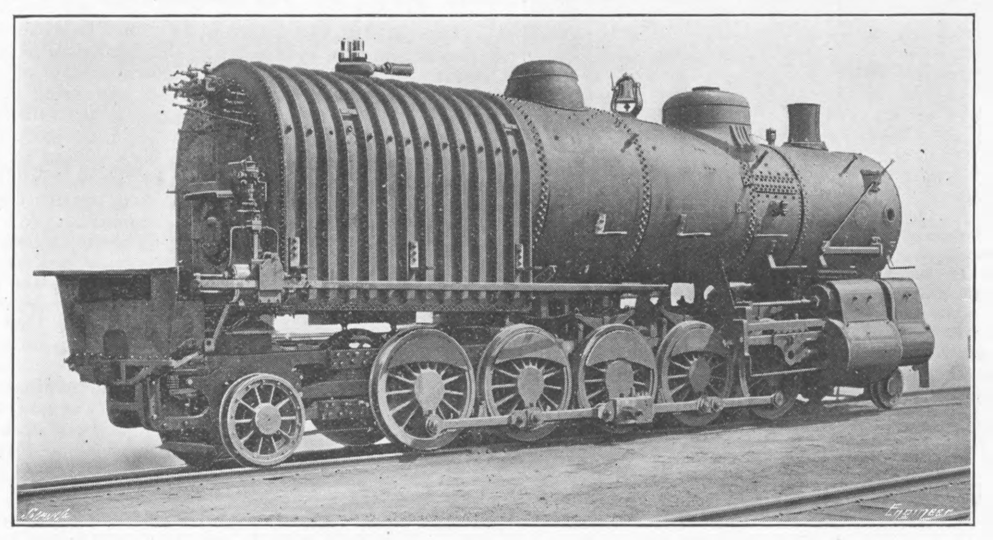
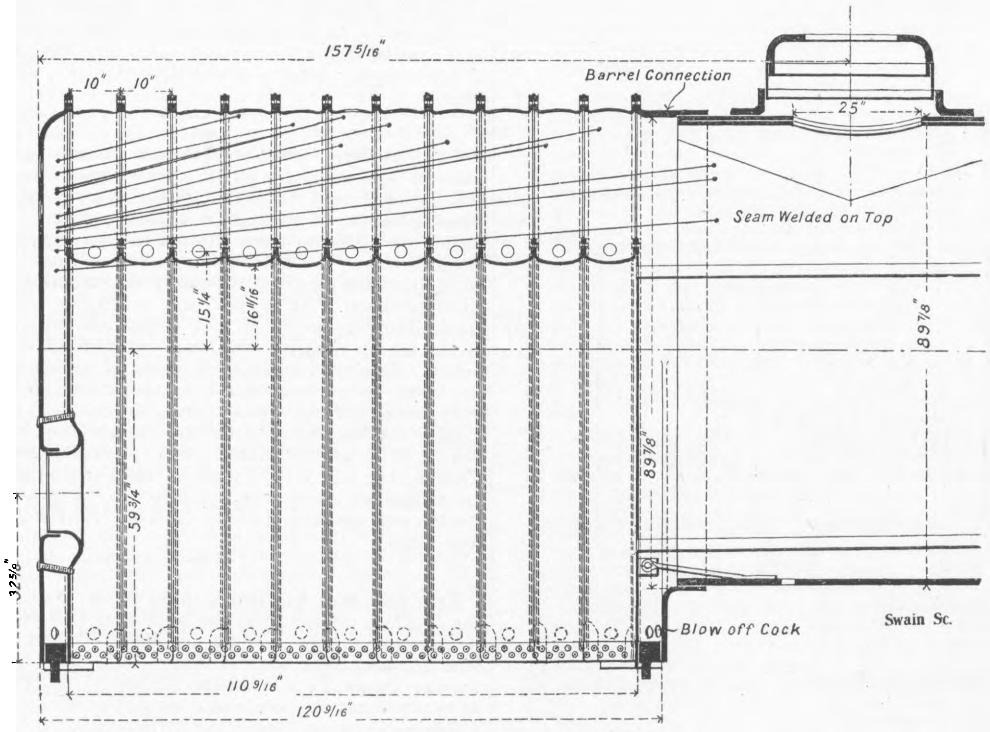


Fig. 2—ENGINE FITTED WITH JACOBS-SHUPERT FIRE-BOX



"The Engineer"

Fig. 3—SECTION OF THE STAYLESS FIRE-BOX

The back head of the boiler is a dished plate having its flanged edges riveted against the flange of the last channel of the outer fire-box. The inside back plate is of the same size, but with the openings into the steam space and water legs—like the horseshoe-shaped stay plates—in addition to the fire door opening. This plate is riveted against the flanges of the last channels of both the inside and outside box. Stay bolts are used to connect these inside and outside plates of the back head.

The fire-box tube sheet is also shaped to the outline of the outside box, and has openings for connecting the water legs and steam space with the barrel, as well as the holes for the tubes. The connection between the fire-box and the barrel is formed by a flanged throat plate, which encircles the end of the barrel and is riveted against the end channel of the fire-box at the top and to the foundation ring at the bottom. Stay bolts are used to connect the tube sheet and throat sheet at the bottom.

The three views also explain the construction very clearly. Fig. 1 is a view of a fire-box with the inner box completed, the channels being riveted to the perforated stay plates and the end plate. It is ready for riveting up the channels of the outer box between the stay plates. Fig. 4 is an interior view of the fire box. Fig. 2 shows the fire-box fitted to a ten-coupled twelve-wheeled engine—of the 2 : 10 : 2 type—for heavy goods service. Oil fuel is used on this engine.

The fire-boxes are being built at the shops of the Atchison, Topeka, and Santa Fé Railway at Topeka, which are of modern construction and equipment. The hydraulic flanging press of the boiler shop is used for shaping the channels and plates, and a special riveting machine has been designed for riveting up the flanges.

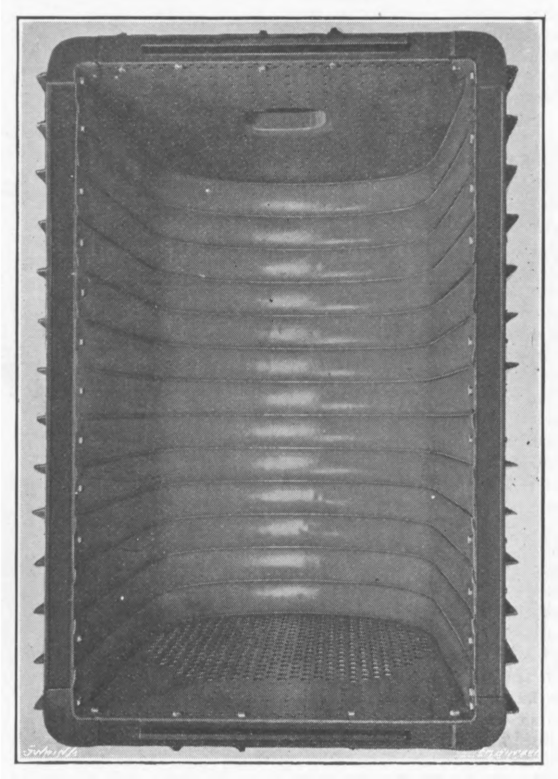


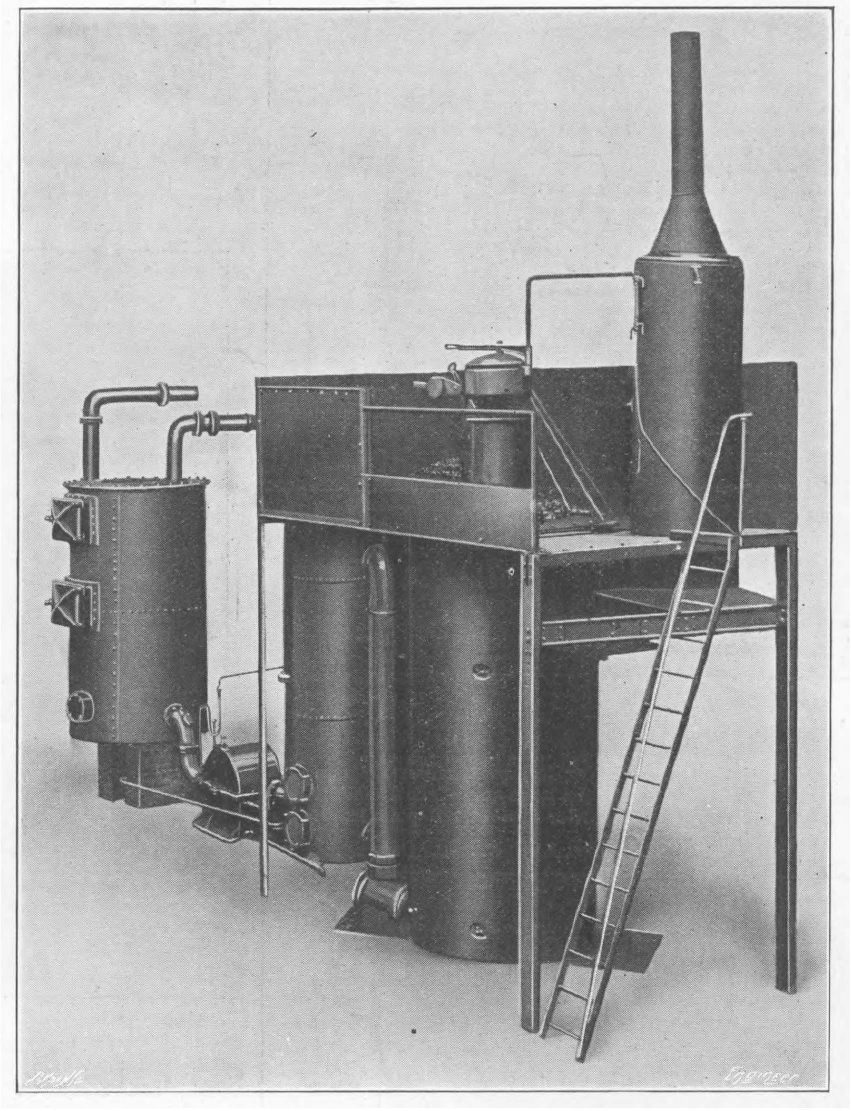
Fig. 4—INTERIOR OF FIRE-BOX

GAS PRODUCER PLANT FOR BITUMINOUS COAL.

THE difficulties encountered in the production of gas from bituminous coal are mainly due to the excessive amount of tarry matter which is set free in the process of distillation to which the fuel is subjected, and this obstacle has been so difficult to surmount that hitherto designers of producer plants have been content to use anthracite and other non-tarry fuels. We had, however, an opportunity afforded us recently of inspecting an apparatus, which has now been working successfully for about a year, using common slack coal of a bituminous nature. This plant, which is installed at the works of the makers and patentees, Fielding and Platt, Limited, Gloucester, has been designed for experimental purposes, but the experience gathered from its working has satisfied the makers that it is quite capable of performing all that they claim for it, and that in future examples any alterations made will be confined to matters of small detail.

The special feature of the process employed is the means adopted of eliminating the tarry products from the gas as supplied to the engine. To this end advantage is taken of the fact that the earlier products of the distillation of coal are almost all tarry in their nature, the gases utilised for power being less volatile and coming off at a later stage and at a higher temperature. This separation of the two classes of products takes place largely in the producer itself, only a small percentage of the undesirable matter being carried over into the scrubbers and washers, so that the extensive apparatus hitherto employed for cleansing the gas derived from bituminous sources is rendered more or less unnecessary. In this respect the apparatus employed for after cleaning compares very favourably with that used for anthracite producers, both as regards simplicity and in the amount of foreign material which it is called upon to remove.

The producer proper falls for classification purposes under the head of the pressure up-draught type of apparatus, and consists of a circular upright steel chamber, water-sealed at the foot so as to enable the ashes to be withdrawn readily, and thus render the process continuous. This chamber is lined with firebrick, and is provided at its top with a double-lidded hopper, the lower lid of which is of the cone type used in blast furnaces. Situated centrally on the floor of the chamber is a perforated cone-shaped nozzle through which a blast of air and steam enters. At a point about half-way up the incandescent mass of fuel an exit is provided for the power-gas, but the inner mouth of this pipe does not open directly on to the fuel, being in communication with an annular space in which the gases from the lower and hotter parts of the mass collect. A somewhat similar pipe and annular space is provided higher up, the space in this case communicating with the less hot portions of the fuel supply. As already stated, the bulk of the tarry vapours are given off from the fuel during the earlier stages of its distillation, and in consequence most of these find their way through this upper pipe, whence they are led to the donkey boiler mounted on the platform from which the hopper is fed. They are here burned, and the steam thus generated is used for admixture with the air blast. On the other hand, the purer gas rising from the hotter regions lower down ascends and passes out through the larger pipe into a cylindrical vessel situated close at hand. In this vessel, as is shown in the diagram, the air and steam blast is led through several bends, and during its passage through these it becomes superheated, while the chamber also serves as a dust collector and as a gas cooler. Leaving this vessel at the foot, the gases pass into a moist coke scrubber, where much of the remaining tarry matter is deposited. From this the gases pass next through a mechanically-driven rotary washer. The exit pipe from this washer connects horizontally with a vertical pipe, which in turn is provided with passages leading to the final scrubber, which is of the "sawdust" type, although we are informed that "wood wool" is found to give very satisfactory results as a cleansing agent. The foot of the vertical pipe leading to the sawdust scrubber is open, and is led into a water seal. In this a certain small amount of dust and tar is collected, the momentum of the particles carrying them vertically downwards past the exits leading to the scrubber. The gases are led directly from the sawdust scrubber to the engine. A small burner is situated on the pipe leading from the rotary washer to the sawdust scrubber, and from the character of the flame given by the gas burning at this point an indication of its purity can be obtained. As witnessed by our representative, it burned with an almost entire absence of the yellow colour characteristic of carbon, and this, it should be noticed, is before the gases receive their final cleansing.



FIELDING AND PLATT'S BITUMINOUS GAS PRODUCER

As shown on the diagram, a small steam engine is employed to drive the blower, which in the example inspected was a small one of the Roots variety, and to drive the rotary washer. This engine receives its supply from the donkey boiler, where steam is generated at a pressure of 30 lb. to 40 lb., and its exhaust is led into the air main from the blower. As an alternative arrangement, the steam engine may be replaced by a small gas engine receiving its supply of gas from the producer, and fitted with a petrol carburetter for starting, in which case steam at about 5 lb. pressure is led directly from the boiler into the air blast.

As the volume of tarry products bears a constant ratio to the volume of the other gases, it will be seen that the quantity of steam generated in the boiler is proportional to the gas consumption, and therefore to the load on the engine which is being driven from the plant. The air blast is arranged so as to permit of separate regulation from the steam, and is provided with automatic means whereby it is adjusted in volume to suit the demand on the producer. It should be noticed that the means adopted in some other producers for securing the air blast, in which reliance is placed on the injector action of the entering steam, are not here utilised, as the makers are convinced of the advantages attaching to independent regulation of the air and steam.

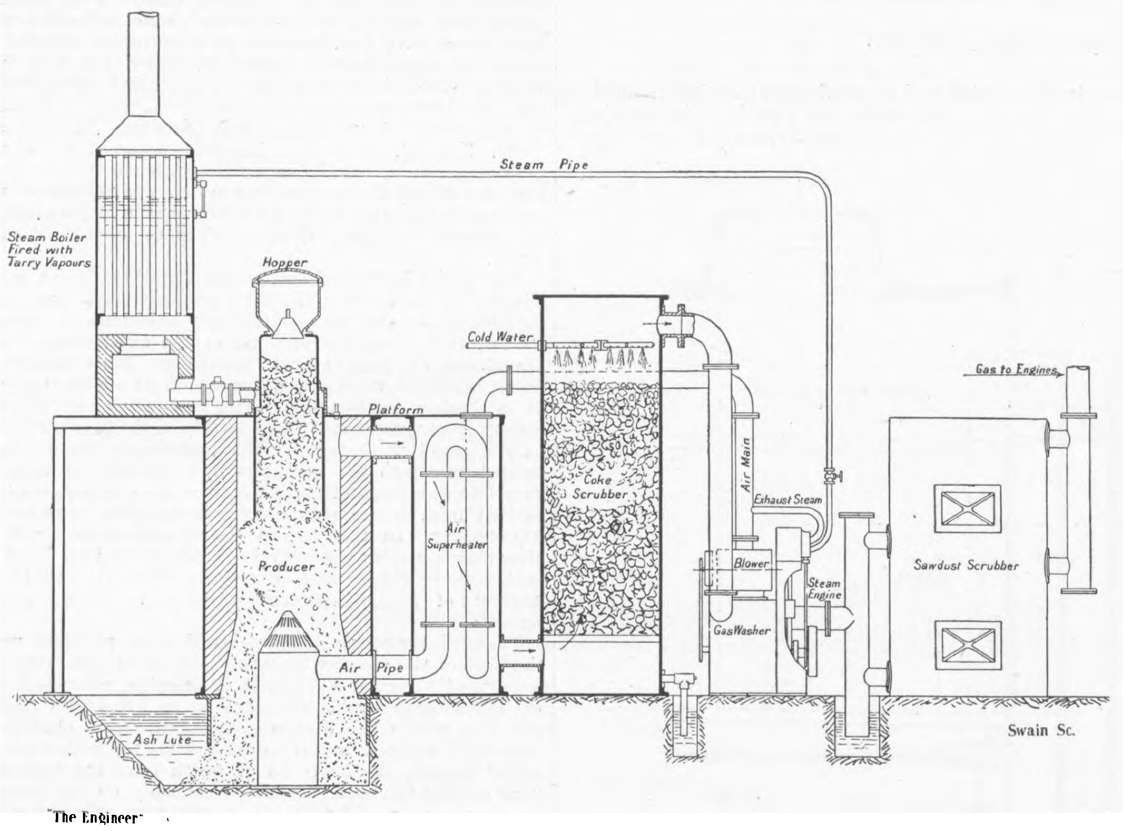


DIAGRAM OF GAS PRODUCER FOR BITUMINOUS FUELS

Owing to the more or less automatic control of the whole plant, the makers claim that this producer is as easy to work as a suction gas plant. In the case of the installation inspected, where an engine of 100 horse-power, receiving its supply of gas from the plant, is in daily operation, it is found that one man is quite capable of looking after the entire plant and attending to the engine as well. No gasholder is required, and the losses in the case of a suction plant entailed by the expenditure of work in drawing the charge over from the producer at each stroke are here avoided. That the initial separation of the tarry vapours from the power gas is successful is shown by the makers' statement that the weight of the tar extracted in the after processes amounts only to about one-tenth of 1 per cent. of the coal fed into the hopper. A further beneficial effect of the method of separation adopted in the increased freedom given to the fuel in the producer to descend without clogging, and on this account the makers claim to be able to use satisfactorily coal of a caking character which otherwise would be useless in a producer as a source of gas. They further state that, in addition to its primary use with bituminous coal, the producer yields excellent results with peat or turf, brown coal, or wood refuse. The analyses appended show the gases obtained in this producer using coal and wood, and that they are of about equal calorific value, while the percentage compositions differ but slightly.

We are further informed that the water consumed in the boiler amounts to $\frac{1}{10}$ of a gallon per brake horse-power per hour, while that used in the scrubbers and rotary washer amounts to $\frac{1}{2}$ gallon per brake horse-power per hour, although this latter can be cooled, stored, and used repeatedly.

Analyses of Gas from Fielding Patented Producer Plant.

Constituent.	A.	A.	B.	B.
CO_2	8.0 %	10.4 %	17.0 %	12.0 %
O	nil	nil	nil	nil
CO..	20.0	20.6	16.0	20.8
H	25.0	26.8	26.6	24.0
CH_4	2.0	1.5	2.7	2.7
Combustibles	47.0 %	48.9 %	45.3 %	47.5 %
Calorific values	160	165	159	167

A. A.—Two samples of semi-bituminous non-caking coal.
B. B.—Two samples of wood.

The calorific values are given in British thermal units per cubic foot, and have been determined on the lower scale.

SHIPBUILDING NOTES.

One is constantly being reminded of the productive capacity of the Belfast shipyards, a capacity which it will be difficult to surpass on the Tyne or Clyde. It is not long ago since we noticed the record tonnage turned out by Messrs. Harland and Wolff in one month, and the delivery of the new Bibby liner Leicestershire marks an important addition to the fleet of large steamers they have constructed. The Leicestershire, 467ft. by 54ft. by 35ft. 6in., is built with a long bridge, poop, and forecastle, and is similar to, but 15ft. longer than the Herefordshire. An interesting feature of the ship is the introduction of the arrangement of the state rooms patented by the owners, by which each room has an outside port in it. The Bibby Line undertakes a large part of the high-class passenger traffic to Burmah, and it can well be imagined that the requirements of this service involve the most careful and skilful arrangement of accommodation.

Congratulations are to be offered to Vickers, Sons and Maxim, Barrow, upon securing the much coveted order for the floating dock for the Brazilian Government, to be used in connection with the two battleships now being built in this country. The dock is a very large one, has a lifting capacity of 22,000 tons, and is to be constructed in eleven months at a cost of £182,700. The floating dock belongs to that order of naval structures much beloved by the shipbuilder—one in which the amount of material used in construction is great compared with the labour expended upon it. We remember in this connection the remarks of a well-known builder of high-class Channel steamers. His experience was that the construction of these very complex ships was not productive of so much profit, relatively, as the construction of an ordinary tramp steamer.

This month has been signalised by the nominal disappearance of a long-established Glasgow shipowning firm. The Allan Line Steamship Company is one of the most important and prosperous concerns of the second city, and it has pursued for a number of years a very enlightened policy with regard to the periodical additions to its fleet. The later vessels of the company—the Hesperian, Virginian, Victorian—are very fine examples of the modern liner. This line was one of the first to test the capacities of the marine steam turbine, and in that respect alone rendered a conspicuous service to naval science. It is a little difficult to appreciate correctly the changes that have taken place, but it appears, as stated above, that by the retirement of several of the Scottish directors, the old firm of James and Alexander Allan now appears as Allan Brothers and Company, and that the centre of gravity of the business has been displaced from Glasgow to Montreal. An interesting personal event in this connection is the retiral of Sir Nathaniel Dunlop from the chairmanship of the company after a connection of fifty years with the firm.

On Tuesday, September 7th, an interesting event took place in Glasgow in the public celebration of the centenary of the Clyde Trust, the body which is concerned with the administration of the city's harbour affairs. Few public bodies can claim to have affected industry so deeply as the Clyde Trustees have done, and fewer still can point to so continuous and beneficial a development resulting from their administration. It is not too much to say that the shipbuilding industry on the upper reaches of the Clyde as we see it to-day is the direct product of the Trustees' policy. During its hundred years of existence the Trust has spent on harbour and river improvements the sum of 9 millions sterling. The quays now extend 11 miles in length, and the result of continuous dredging is a depth of nearly 24ft. at low water. The new Rothesay Dock at Clydebank is one of the Trustees' latest enterprises, and they are addressing themselves resolutely to the task of providing further and adequate docking facilities for the largest ships now built.

The past week has seen a fillip given to shipbuilding on the Wear—a district that was somewhat in need of it—contracts having been booked by Messrs. John Priestman, Messrs. Short Brothers, and Messrs. J. L. Thompson and Co. for the Prince Line. Messrs. Palmer's, of Newcastle, who have at present no merchant work on the stocks, are to build a large steamer for Messrs. A. Currie and Co., of Melbourne, similar to the Hymettus, also built by them for the same owners. In the Stockton district Messrs. Craig, Taylor are to build four cargo vessels, and Messrs. R. Dixon and Co. two of the single-deck type.

RAILWAY MATTERS.

According to the *Japan Chronicle*, the Hachioji-Kafu line of the Japanese Middle District Railway is to be electrified.

According to the *Journal de St. Petersbourg* of 10th September, surveying operations are about to be begun in connection with the construction of a railway along the Black Sea, from Touapsé to Novosenaki *viâ* Soukhoum, the total distance being 225 miles.

According to the *Railway News*, the London and North-Western Company is about to provide a new entrance to Watford Station off St. Albans-road Bridge, with booking and collectors' offices, access to the platforms being given by a new footbridge over the lines.

We hear that a gas-driven street car is now under construction in Philadelphia, which is to be tested on the line of the Metropolitan Street Railway Company of New York in competition with the electric cars of the company. It will be driven by two four-cylinder motors, each of 24 horse-power. These will be water-cooled, and piping will be led from the motor jackets around the interior of the car to heat the latter during winter service.

The *Diario Oficial* (Rio de Janeiro) of 15th August publishes a decree granting to the Compagnie Française du Port de Rio Grande do Sul a concession for the construction of a line from Monte Bonito to Rio Grande, and approving the estimate of 3,397,904 milreis (about £212,000) for the work. The line, which will be about 46 miles long, is intended exclusively for the carriage of stone to be used in connection with the Rio Grande harbour works.

It is reported that the Canadian Pacific is negotiating for a site for a new terminus close to the public gardens in Halifax. Should the idea materialise, it is held that the Canadian Pacific Railway will make that city its winter port for passengers, but will continue to use St. John as its freight port. There is talk of the Canadian Pacific Railway securing running rights over the Inter-colonial Railway from St. John to Halifax, but nothing appears to be definitely settled.

The official inspection of the reconstructed tramway from Nine Elms-lane to Lavender-hill *viâ* Wandsworth-road was made last Tuesday afternoon by Colonel Yorke. Everything was pronounced satisfactory. The completion of the line will prove a great convenience to the working-class population of the district. The continuation of the line to Clapham Junction by way of Lavender-hill will probably be ready for inspection by Thursday or Friday next week. The inspection car was run over a small portion of it yesterday.

The North-Eastern Railway is erecting a huge water-tower—104ft. high and 30ft. diameter—close to the passenger station at York. The structure will be built according to the Kahn system of reinforced concrete, with foundations on piles 60ft. long. The tank at the top of the tower will hold 100,000 gallons, and will weigh about 446 tons. The principal object in view is to secure an adequate pressure of water for cleaning locomotive boilers, &c. A tank of similar construction and height, but of only 20,000 gallons capacity, is to be erected at the carriage works. The water for the tanks will be taken from the river.

A consular report dealing with the consular district of Bilbao states, that during the past few months considerable public interest has been shown in the Anglo-Visco Navarro Railway, in the construction of the completed portion of which British capital took a part. Owing to non-completion of terms of concession the Government foreclosed and took possession of the line from Vitoria to Salinas. It is now hoped that a local company will be formed, under subsidy from provincial deputations, to continue the line to Los Martires on the Zumarraga to Bilbao Railway, and so afford more direct communication between Bilbao and Vitoria. The original project included the continuation of the line to Estella in Navarra, but it is doubtful if this would be a profitable section.

The report by Col. Druitt on the lift accident which occurred on August 2nd at the Oval Station of the City and South London Railway has now been issued. The lift is a hydraulic one, and the sudden descent of the car was caused by a broken pipe leading from the working cylinder. The same accident has happened before, but there are no safety devices which could have come into action. The cage rebounded some 9in., when it was arrested by the slack cable device. The pipes are to be thickened on all the ten lifts of similar design, and relief valves are to be provided to guard against the effect of a momentary rise of pressure caused by a too sudden checking of the lift. The other lifts are electrically worked, and are fitted with safety devices depending on the speed of the cage.

Following the example set by the District Railway in running a through train from Ealing to Southend during the visit of the fleet to London, an experiment which proved highly successful, the management of the Metropolitan Railway recently ran a through train from Harrow to Margate, *viâ* Farringdon-street and Snow-hill. The train was drawn by electric traction direct from Harrow to Farringdon-street—the new arrangements at Baker-street making this possible—where it was turned on to the South-Eastern system and ordinary steam traction employed thence to Margate. The trip was run purely as an experiment, and, should its success warrant it, the service will be continued at frequent intervals, it being considered that such a convenience to residents living in the suburbs upon the Baker-street and Harrow line, who at present have no direct communication with Margate, will be readily patronised.

Of the railway-owned ports of the United Kingdom, none have shown more remarkable development and progress than those of the North British Railway at Methil and Burntisland, where coal is the chief commodity dealt with. At Methil, states the *Railway News*, the record shipment was attained during the week ended 3rd July, 1909, when a total of 74,648 tons of coal were shipped, being equal to an average of 12,441 tons per day. At Burntisland, the record took place during the week ended 11th August, 1909, when 68,100 tons of coal were shipped, being equal to an average of 11,350 tons per day. The record shipment of the combined ports was during the week ended 19th June, 1909, when the total quantity dealt with was 126,466 tons, or an average of 21,077 tons per day. Last year the shipments from Methil were 2,559,500 tons, while at Burntisland during the same twelve months 2,164,293 tons were dealt with, being equal to a total of 4,723,793 tons for the combined ports. For the year 1890, the shipments of the combined ports only represented 1,334,400 tons.

Hitherto the proposals to electrify main lines in Canada have been limited chiefly to the western sections of the Dominion where large water-powers are abundant. Mr. C. A. Steeves, Consul at Moncton, now reports that the electrification of the Grand Trunk Pacific, or National Trans-Continental Railway, from the St. Lawrence River to Moncton, is under the serious consideration of the railway company, the Dominion Government, and the New Brunswick Cabinet. Electrical engineers who have given the subject consideration declare the conditions to be entirely favourable. The distance between the St. Lawrence and Moncton is about 460 miles, and for a considerable part of the distance the line passes through dense forests of spruce and fir in Lower Quebec and Northern New Brunswick, as well as through the rich farming country along the Upper St. John Valley. What has given impulse to the new plan is that at Grand Falls on the St. John River, 170 miles from the St. Lawrence and 160 miles from Moncton, is found water-power estimated to be sufficient to develop energy enough for the working of the whole road.

NOTES AND MEMORANDA.

The Canadian cement industry in 1908 numbered twenty-three plants in operation. The total daily capacity of these plants, it is reported, is 27,500 barrels, or an annual output of about 8,250,000 barrels if all of them should run full time throughout the year.

According to a contemporary, the following mixture will serve in instances where an intermediate grade of babbitt metal is desired:—Lead, 50 lb.; tin, 35 lb.; antimony, 15 lb. This mixture has the advantage of containing no copper, and is easily made in an iron kettle.

A recent discovery of tungsten ore in the Moose River gold-mining district in Nova Scotia shows, so far as exploration has gone, a well-defined vein composed of scheelite, quartz, and a little mispickel. The vein matter is very irregular in composition, varying from pure scheelite to pure quartz or pure mispickel and all combinations of these three.

Sicily is an important market for British coal, nearly the whole of the coal required in the island being derived from the United Kingdom. The total quantity imported in 1908 amounted to 642,185 tons, of which 191,547 tons were discharged at Palermo, 153,558 tons at Messina, 146,190 tons at Catania, and 150,890 tons at seven smaller ports in the island.

The Wissahickon Creek Bridge, Philadelphia, said to be the largest ferro-concrete bridge in the world, is an illustration of the great size now possible for such structures. It is 525ft. long and 147ft. in height, with a main arch 233ft. long and approach spans measuring 53ft. each. Over 300 men were continuously employed for more than two years in building it, using for this purpose more than 19,000 cubic yards of concrete, weighing 40,000 tons. Before the concrete work was begun a false-work bridge was constructed with 360,000ft. of timber and 130 tons of steel. The total cost of the bridge was £52,000.

During the past eight or ten years a good many examples of concrete-sheathed timber pile construction have been built by the State Harbour Commissioners of San Francisco, the object being to obviate the rapid destruction of unprotected timber by the teredo, which is very active in the Bay of San Francisco. Ordinary wooden piles, driven to secure the requisite bearing, were provided with an outer casing of concrete formed in cylindrical moulds placed over the piles after driving. From a recent article by Mr. John G. Little, in the *Engineering News*, it appears that the present condition of piers built on this type of substructure is far from satisfactory, and that in consequence, reinforced concrete cylinder piers are being adopted in the important scheme of harbour improvements now in progress.

In a paper read to the Ontario Association of Architects, Mr. Walter J. Francis, points out that ferro-concrete buildings possess remarkable rigidity and capacity for acting as a unit. In proof of this the author cited the well-known case of a Hennebique coal bunker in France, where one of the main columns was accidently smashed by a derailed locomotive, but without causing the collapse of the bunker with its thousands of tons of coal. He mentioned also some grain warehouses in Tunis, which settled about 25 deg. out of plumb through the escape of quicksand under the foundations. By loading the elevated side and excavating beneath the footings these buildings were brought back to the vertical without developing a crack in the structures. Similar treatment would obviously be impossible with any other material or method of construction.

Certain minerals exhibit the curious optical property known as asterism. That is to say, they show a star-shaped figure when light is reflected from them or transmitted through them. This is seen, for example, in the star stone, a sort of sapphire, and in the star ruby. A note in *Knowledge* describes the asterism of mica. The photograph of a lamp flame taken through a plate of mica shows a six-rayed star, with six fainter radiations between. Outwardly star mica resembles the ordinary form, and shows the same phenomena under polarised light. When examined under the microscope, however, the star mica is found to contain fine needles of another mineral, and these are regularly arranged at angles of 120 deg. To these needles the star seen by transmitted light is due. Star mica has been found in the State of New York, and at Burgess Hill, Ontario.

The occurrence of ores of tungsten in Canada is the subject of a report by Dr. T. L. Walker, recently issued by the Canadian Department of Mines. After pointing out that the metal is used not only in the manufacture of metallic filament electric lamps, but also in the production of tungsten steel and of the tungstates which are employed as a mordant in dyeing, in giving weight to silk goods, and in rendering cotton goods fireproof, he goes on to give particulars of the chief tungsten ores, their geological occurrence, and the methods used in treating them, as well as some statistics of the world's production of them, which has been advancing rapidly of late years. He then gives a detailed account of the occurrence of such ores in Canada, and finally remarks that, though no tungsten production has yet been credited to the Dominion, and that she has no well-developed and established tungsten ore mines, still there are many districts where such ores occur.

The judges' report upon the official test by the Roads Improvement Association of the dust-laying qualities of calcium chloride has just been issued. The material was laid upon the road in May and June last, and the effect upon the road surface and in keeping down the dust has been noted since that date. The report includes paragraphs dealing with the nature and properties of the material, analysis of the road surface after the material had been upon the road a certain time. Schedules are attached giving the actual cost of applying the material and also daily observations of its effect upon the road. In summing up the report, the judges state:—"We are of opinion that the results of the test of calcium chloride applied in granular form by the 'dry' method have shown that it is a very effective dust layer, and, provided no ill effects are experienced in winter as a consequence of the treatment, we are of opinion it is a cheaper and preferable process to that of street watering, which, as now carried out, is undoubtedly very injurious to macadamised roads."

Some time ago Mr. W. B. Woodhouse referred to the question of supplying electricity to power users from small central stations in the following terms:—"Practice has shown that the small generating station cannot produce electricity at a price sufficiently low to enable it to be supplied to power users at a competitive price. A station of 1000 kilowatts, for example, cannot hope to supply a power user requiring 300 kilowatts as cheaply as the power user can generate for himself; this for several reasons. First, the capital cost of the generating plant will be practically the same per kilowatt, while the public supply is burdened with an additional cost for mains; secondly, the owner of an isolated power plant will usually erect a smaller proportion of stand-by machinery, setting the increased risk of shut-down against the reduced capital charges; thirdly, the public supply stations must run continuously, often at very inefficient loads, whereas the isolated plant, a mill engine for instance, is only run during certain definite hours, so that the "working load factor" is greater and the works cost less in the case of the latter. Apart from this, one finds the owners of isolated power plants very frequently do not include any allowance for rent, management charges, &c., in estimating their power costs, so that the difficulty of the supply authority obtaining such a load is increased by the power user's want of appreciation of all the items making up power costs.

MISCELLANEA.

It is reported that the sprinkling of the streets of Ottawa and Toronto with crude oil has considerably lessened the dust nuisance.

A new telegraph cable has recently been laid right across the Forth Bridge. The cable, which was laid by the Post-office, and is their property, has taken the place of the former one, which was found to be unsatisfactory. A train of six wagons was employed to convey the cable, and this moved slowly across the bridge while the men laid the cable down on the footpath on the up line side of the bridge.

The British Vice-Consul at Gijon reports that, on account of objections raised to sending vessels to the port of Musel to load iron ore on the ground of danger of striking on the rock bottom, dredging has been carried on at the port; the loading berth for iron ore may now be considered quite safe for steamers of 21ft. draught. Steamers are loaded by an electric tip capable of handling 150 tons of iron ore or coal per hour.

The construction of works for the naval base at Rosyth has made good progress during the past six weeks, the weather having been unusually calm for the Firth of Forth. The most easterly of the cofferdams is expected to be finished before the middle of October, and the westward bank has now reached fully a mile from the shore. The construction of a third bank between the two, which is to extend as far as Dhu Craig Island, will begin next week. As soon as a junction has been effected the work of reclamation will be begun.

The latest innovation in wireless telegraphy is the construction of an underground station in Paris. It is being erected in the Champ de Mars, and will probably be open for use next month. The station will be fitted up on the latest approved lines, and comprise a machine-room, a transmitting pole, and accommodation for the officials. By the introduction of a 100 horse-power engine it is hoped that messages may be exchanged with places about 5000 miles distant. The result of the experiment will be awaited with much interest.

The *Electrical World* reports that Professor R. A. Fessenden has recently submitted a proposition to the U.S.A. Navy Department for the equipment, experimentally, of a war vessel with turbo-electric drive. Professor Fessenden's plan is to use steam turbine three-phase generators, with induction motors on the propeller shafts. He claims that higher power can be obtained with less weight under this system than with any other. The Navy Department has as yet made no decision as to whether it will make the experiment.

The Chief Inspector of Machinery for the Transvaal is proceeding to Europe and America on a tour of inspection, in company with Mr. Harbord. All the principal foundries in the two continents are to be visited. The chief mechanical engineer of the Central South African Railways is also leaving shortly for the purpose of investigating locomotive manufacture and practice in the United States. By some this move is considered a preliminary towards the manufacture of locomotives locally, but such a scheme is scarcely possible in existing circumstances without the installation of costly plant.

According to an American contemporary, a new development of the greatest importance to the industrial world has been brought to light by the announcement that the United States Steel Corporation—the largest user of steam power in America, and perhaps in the world—has decided to consign all apparatus used for steam power to the scrap heap, and to substitute modern gas and electric engines and motors. This change is based on the calculation that it will result in a saving of not less than 50 per cent. in the cost of power. Gas engines capable of producing about 1,250,000 horse-power will have to be used.

A curious accident, illustrating the trouble which might arise from using tramway standards as stay poles, is described in the *National Telephone Journal* by Mr. E. Harper, local manager N.T.C., Bournemouth. Six or seven years ago, when the electric tramways were constructed, a small route, carrying a few wires, was placed underground where it crossed the tramways, the cable terminating on the poles at either side of the road. Permission was given in one case for the back stay to be stayed back to the nearest tramway standard, which happened to be in the direct line of pull. Recently the trolley arm of a car jumped the trolley wire, and the driver pulled up at a point, which caused the metal end of the trolley arm to connect the live wire with the trolley arm supporting it on the standard to which the stay was attached. This standard was not apparently connected to earth beyond the connection it obtained through being set in cement in the ground. A portion of the tramway current passed along the stay, which was touching the pot-head at the top of the pole, and thus found its way to earth along the lead sheathing of the cable, burning a hole about 2in. long in the cable sheathing. Mr. Harper explains that, in order to avoid further trouble, one of the tramway authority's strain insulators has been inserted in the stay wire.

In the House of Commons on September 15th, Mr. Markham asked the Secretary of State for the Home Department what was the definition of a completely enclosed motor in the Home-office rules relating to electricity in mines, and whether a flame-proof motor not totally enclosed was covered by the definition completely enclosed. Mr. Gladstone replied: I am advised that the enclosure required by Special Rule 37 is total enclosure, and this, I understand, is the view generally taken in the industry. The case of a "flame-proof motor not totally enclosed" would not, therefore, be a compliance with the rule; but the point has been noticed for reference to the committee on the rules which I am about to appoint. Mr. Markham: Is the right hon. gentleman aware that a member of the committee which drew up these rules stated that "completely enclosed" meant nothing to the mind of the Commissioners more than "totally enclosed"? Mr. W. E. Harvey: In view of the loss of life which has occurred recently in mines, and which is attributed to electricity, I wish to know if the Government are prepared to undertake some experiments with regard to electricity in mines. Mr. Gladstone: As I have already stated, I am about to appoint a committee, and it is extremely probable that the committee will extend its inquiries to this question.

We hear that the Transvaal Government have set aside a fairly large sum for the erection of an experimental scrap iron smelting works. Possibly the movement may eventually extend so that larger works may be built to deal with the native ore. This ore has already been employed with good results in the manufacture of different articles. Speaking of Pretoria ore, the foreman of the C.S.A.R. workshops says that the ore is easily fluxed and good iron obtained free of sulphur and phosphorus. A test of local hematite was recently carried out and 633 lb. of iron was obtained from 1100 lb. of ore used. The Transvaal mines' consumption of iron and steel is estimated at 50,000 tons yearly, valued at £900,000; of this £600,000 consists of rails, sleepers, pipes and pipe fittings, rock drills and spares. The C.S.A.R. also purchases about 32,000 tons of rails and sleepers annually. There is therefore scope for the opening of works, but the Government Mining Engineer considers that the provision of blast furnaces must be a matter for private enterprise. Perhaps some day South Africa may take its place among the great manufacturing countries of the world, but that state of affairs is a long way off at present, and for many years this country will have to depend on its gold and diamonds, and in a lesser degree on its agricultural productions.

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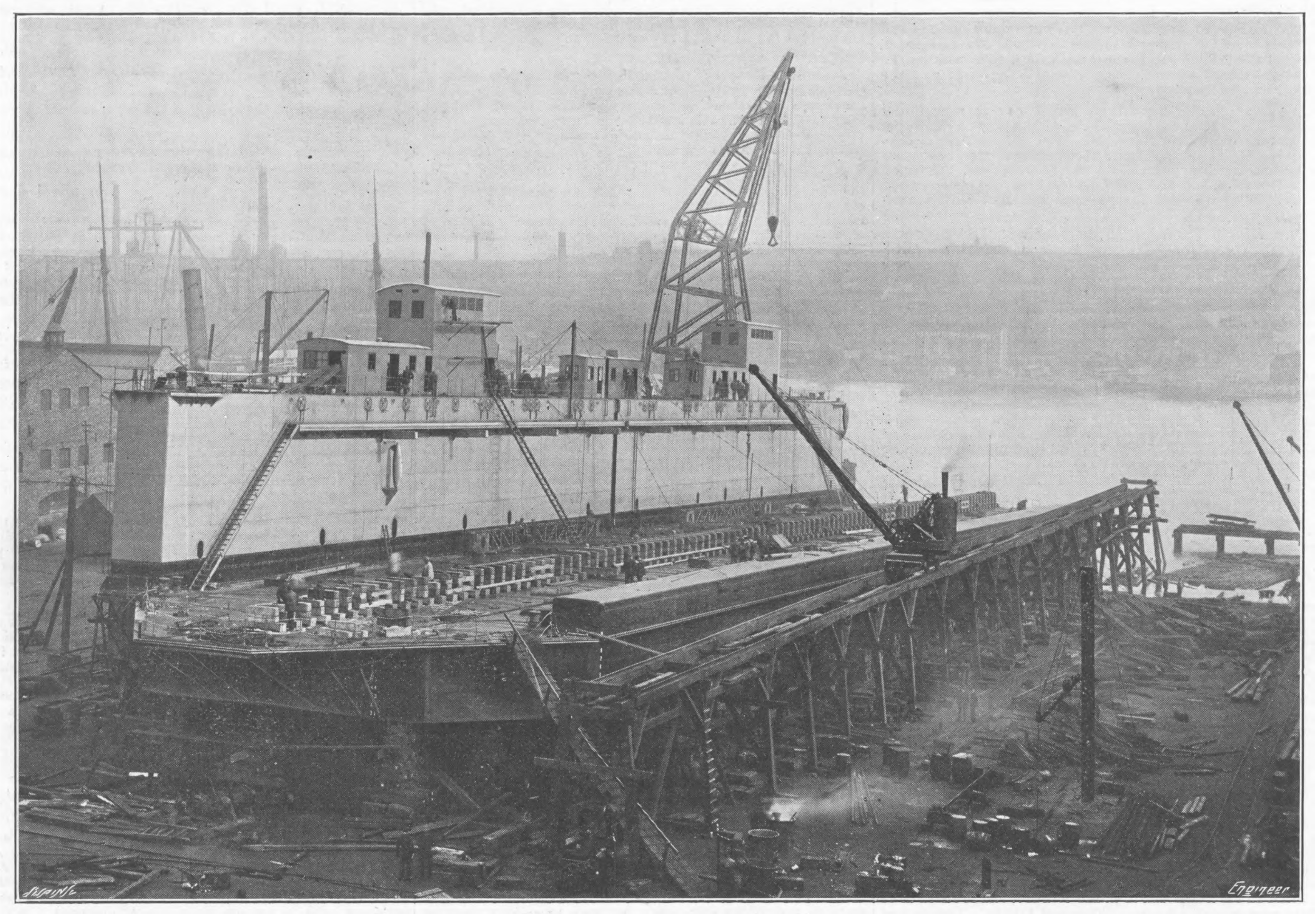

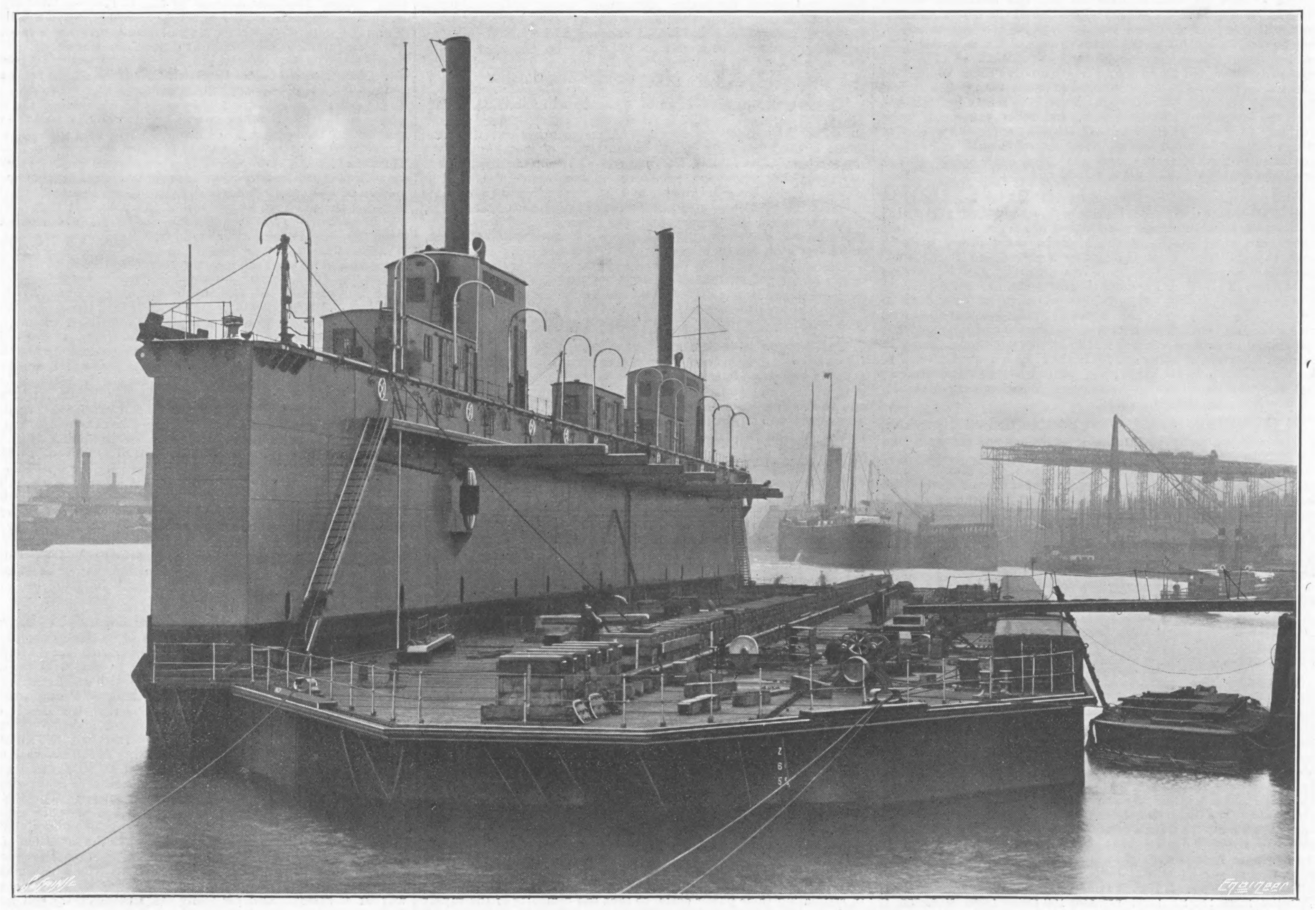

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TO CORRESPONDENTS.

☞ *In order to avoid trouble and confusion we find it necessary to inform correspondents that letters of inquiry addressed to the public, and intended for insertion in this column, must in all cases be accompanied by a large envelope legibly directed by the writer to himself, and stamped, in order that answers received by us may be forwarded to their destination. No notice can be taken of communications which do not comply with these instructions.*

☞ ***All letters intended for insertion in*** **THE ENGINEER**, ***or containing questions, should be accompanied by*** *the name and address of the writer,* ***not necessarily for publication, but*** *as a proof of good faith. No notice* ***whatever can be taken of anonymous*** *communications.*

☞ ***We cannot undertake to return drawings or manuscripts; we must, therefore, request correspondents to keep copies.***

REPLIES.

C. J. S. (Levenshulme).—Try Joseph Baker and Sons, Willesden.

H. G. L. (Bimingham).—Certainly you can have packing rings made to spring inwards instead of outwards. Ask any of the regular piston ring makers or any good firm of mechanical engineers.

A. A. (Beirut).—You can arrange a two years' course in almost any of the engineering schools. There are several such schools in London, for example:—The Central Institute, S. Kensington; Royal College of Science, S. Kensington; King's College, Strand; University College, Gower-street, and so on. In Manchester there is the Victoria University, in Birmingham Mason College, in Liverpool the University, in Glasgow and Durham the Univesity, and so on. There is no end to them.

MEETINGS NEXT WEEK.

THE IRON AND STEEL INSTITUTE.—Monday, September 27th, to Friday, October 1st, at the Institution of Civil Engineers, Great George-street, Westminster. Autumn meeting.

THE JUNIOR INSTITUTION OF ENGINEERS.—Saturday, September 25th, at 3 p.m. Visit the Imperial International Exhibition, Shepherd's Bush, for Inspection of Engineering, Scientific, and other features of interest.

INSTITUTE OF MARINE ENGINEERS.—Monday, September 27th, at 8 p.m., at 58, Romford-road, Stratford, E. Papers: "Water Hammer," by Mr. Bishop N. King. "Hydraulic Cargo Gear," by Mr. A. M. McAlister.

THE ENGINEER.

SEPTEMBER 24, 1909.

Technical Guarantees in Engineering Contracts.

THE increase of technical knowledge among the public generally, the keen competition among manufacturers that has taken place of recent years, and the difficulties that arise when judging the merits of a number of different tenders, all of a somewhat similar nature, has led to the demand by the purchaser or his consultant of a number of undertakings and guarantees frequently backed by financial clauses which were practically unknown in the earlier days of engineering. This question of guarantees is of much greater importance in contracts relating to mechanical and electrical engineering than it is in civil engineering work. In the latter case the civil engineer draws up his plans and designs and gets out a schedule of prices, the work being carried out under the engineer's direction. In the case of any difficulty after the completion of the work the contractor cannot in equity be held liable, unless it can be shown that he has departed from the instructions of the consulting engineer, or supplied work or materials of a bad quality, the responsibility resting mainly with the engineer. In the case of electrical or mechanical contracts the question is entirely different. The purchaser or his engineer usually states his requirements, and gives general particulars as to the arrangements most suitable for his business, leaving to the contractors the question of detailed design, and on the latter the main responsibility rests for the due performance of the plant. In many cases, especially those relating to electric power station work, the contract specifications are based on drawings and particulars supplied, sometimes at considerable cost, by competing contractors. The engineer is not so much concerned about the methods to be used as to the results obtained, and he, therefore, looks to the guarantees of competing firms as an indication of the value or quality of the plant they turn out.

There are many classes of guarantees which have to be entered into in contracts for plant—the output of the plant, the horse-power in the case of a steam engine or kilowatts of a generator, the evaporative power of a boiler, the carrying capacity of a conveyor, lifting capacity of a crane, and the amount of work a machine tool can deal with. Or again, the efficiency, the steam consumption per brake or indicated horse-power, the efficiency of a generator, the coal consumption of a boiler per pound of steam, the steam per kilowatt in the case of a combined plant, the output of a machine tool on specified work or the percentage of waste in the case of mining machinery. Guarantees are usually made as to durability, which are to a certain extent covered by a period of free maintenance, though in some cases arrangements for repairs are made over a period of years as in the case of contracts for electric accumulators. Some special technical guarantees are usually also made, such as temperature rise and power factor in electrical plant, or the consumption of oil and other consumable stores in a steam engine or other machine. There is also the question of delivery, which though not strictly technical, frequently gives rise to much friction. All these questions of guarantees lead to considerable complications, even for an expert, when the relative values of different tenders have to be decided on. It does not by any means follow that the best guarantee imply the best or most economical plant, and the acceptance may not only lead to difficulties for the purchaser, but injustice to other contractors. This technical competition between contractors has led to considerable improvement in machines and has materially helped progress, but unless carefully handled tends to put a premium on exaggeration.

There has been some hesitation in the employment of consulting engineers, more particularly in electrical and other specialised branches of mining and industrial work during the last few years, owing to the action of a certain number of consulting engineers in confining their orders to special firms and refusing to give others an opportunity of quoting or discussing prospective business, and this results in the purchase of plant on an almost non-competitive basis, giving the impression to the trade of a tied house arrangement. As a consequence, many important contracts are settled by engineers, managers, or directors who have little detailed knowledge of the special branch dealt with, and are therefore somewhat liable to be imposed upon by the less scrupulous contractor. To take an example, a mine or factory has to be supplied with some special machinery, and the owner's engineer communicates with, say, half a dozen firms, and obtains information, catalogues, &c., and then discusses the question with the firm's representatives. He then draws up a specification, more or less detailed, based largely on information received, and invites tenders. It is found on the receipt of these that one firm, manufacturing plant that does not differ to any great extent from the others, offers guarantees materially better than the average, and when doubts are raised by the purchaser, the contractor states that he has obtained these results in practice, that he can refer to clients who have been satisfied, and that he will agree to a substantial penalty for the non-performance of his contract. The problem before a rival contractor's representative is a very difficult one. He may know from experience that the results guaranteed cannot be obtained in commercial practice, and that his own machine can give practically as good results; but he dare not represent that the results claimed by his rival cannot be obtained in daily work, for he knows that in the United Kingdom to run down an opponent is the worst possible argument. If he advances only results that he knows he can obtain day after day, he stands in great danger of losing the contract, especially with a non-expert engineer. The reply he will receive from the engineer will be that his machine is inferior because he cannot get the same results as his competitors, who have similar machines at work, and from whom under their contract he can exact a heavy penalty if the guarantees are not attained, with the further right of rejecting the machine altogether if it is unsatisfactory.

Now, it may be remarked that tests carried out at a contractor's works under artificial conditions have often very little practical value; it is usually difficult to arrange for the plant to be tested under normal working conditions until some time after delivery, and even then it is frequently impossible to carry out accurate tests. In many cases, if the machine is rated with too high an output, or has bad wearing qualities, the difficulties do not appear until the machine is paid for and the maintenance period has expired. Once a machine is at work and works well, the actual efficiency is frequently not worried about; and if tested and found to be deficient, in most cases of commercial work, the factory or mineowner cannot afford to shut down any part of his plant in order to throw out the defaulting machine. In cases where exceptional guarantees have been given and the plant has failed to come up to expectation, there is some hesitation in exacting full penalties, as this would be an acknowledgment of a mistake by the parties responsible for the purchase. There is, then, a great temptation to a representative to promise impossible deliveries where plant is wanted in a hurry, as when the plant does arrive customers are only too anxious to get it to work, and do not trouble about penalties. There have been at times great complaints in these respects with regard to the action of some continental firms, both in the home and foreign markets. In Great Britain, owing to the *camaraderie* that exists among engineers, any breakdowns or difficulties quickly become common property, and it is not difficult for the agent of a foreign firm to point to the failure of particular machines, while stating that such difficulty had never been experienced with his own plant. On the Continent, owing to the secrecy that exists, and the close financial connection between various factories, it is exceedingly difficult to get accurate information concerning the performance of machines, especially when a purchaser who cannot speak the language makes application or pays a visit to some works. In most parts of the Continent people take a pride in the products of their own country—a feeling only too rare over here—and therefore there is a tendency to minimise the shortcomings of plant where there is a possibility of a native firm obtaining orders abroad. Furthermore, the strong financial backing of many continental firms enables guarantee risks to be taken which would be somewhat difficult with British concerns, and the complex organisation of the former enables strong pressure to be brought to bear when difficulties arise.

It is not too much to say that during the last few years some very large contracts for machinery have been placed abroad owing to the technical and commercial guarantees which leading firms in this country making equally good plant have not cared to give. It cannot be said for one moment that manufacturing firms in this country are free from blame in questions of this kind, but of recent years the competition, coupled with sharp practice of several continental and American firms, has, it is to be feared, forced some British firms in self-defence to follow suit. The purchasers are really to blame for this state of affairs, and there seems to be some truth in the old saying that the British public likes to be humbugged. It should be thoroughly understood by consultants, managers, and directors, that guarantees which cannot be justified by any marked superiority in design or construction are usually made by those who cannot get orders otherwise. In these days it always pays to deal with trustworthy firms, even at the expense of extra first cost and medium guarantees.

Water Hammer.

THE annual "Memorandum" of the chief engineer—Mr. Stromeyer—of the Manchester Steam Users' Association has just been published. It contains another memorandum, by Mr. Bateman, the Association's secretary, who says that Mr. Stromeyer, "having constructed a glass model of a steam pipe arrangement, he found that he could reproduce on a small scale the same classes of water hammer which, according to Board of Trade reports, have been the cause of about 120 steam pipe explosions, and the present memorandum is entirely devoted to comparing these cases with the theory of water hammer which has been put forward by Mr. Stromeyer." What this gentleman has to say on a subject which he has made peculiarly his own will always be read with interest. For the moment, however, he has found nothing new to tell us, nor has he added anything which will strengthen his position. Few people will, we think, dispute the soundness of his theory up to a certain point. Given certain stated conditions, and a catastrophe is almost certain to happen. The question about his argument is that water hammer takes place and pipes and valve-boxes are broken when, so far as can be seen, the essential conditions do not exist.

Mr. Stromeyer begins by complaining of the difficulties which he meets with in getting at the truth when a pipe is burst, and he gives various reasons for this. Thus it is essential to know what a man did just before the explosion. It is obvious that knowledge of this kind is all important; but the noise of the explosion and the confusion which follows tend to prevent clear thinking, and so survivors are not in a condition to supply an accurate detailed statement of the progress of events just before the catastrophe. Was a drain valve open or not? How far had the stop valve been opened? How long before water hammering started? This is just the kind of information most wanted. Furthermore, Mr. Stromeyer has to rely on the Board of Trade reports for information, and these he criticises very sharply indeed. "With regard," he writes, "to formal investigations into cases of water hammer, one may safely say that little scientific information can be drawn from them, even if the newspaper reports of proceedings are consulted. Generally speaking, the legal influence predominates so strongly on these Commissions, that their proceedings are in danger of being reduced almost to the level of ancient coroners' inquests, against whose misleading findings in cases of boiler explosions our founder, Sir William Fairbairn, protested loudly and persistently." The courts of inquiry, although convened to decide a technical question, are more concerned in weighing the conflicting statements of persons who fear to be blamed. The drawings given by the Board of Trade surveyors are inadequate, and often misleading. We have had occasion before now to say much what Mr. Stromeyer has said; but we think he takes a somewhat erroneous view when he maintains that a court has to settle a technical question. It has to do nothing of the kind. That is largely the duty of the Board of Trade surveyors who carried out the preliminary inquiry. The subsequent duty of the Court is to fix the proper amount of blame on the responsible parties. Getting away from this, he proceeds to deal with the total of 121 Board of Trade reports on the fracture of steam pipes, &c. Of these he rejects 19 as doubtful, the remaining 102 cases he describes, and he illustrates the pipe arrangements diagrammatically.

Before going further it is necessary to say that, as we understand Mr. Stromeyer, it is essential that a vacuum, or something very like one, must be produced in a steam pipe. If, then, there is any water in the pipe, it will be blown straight ahead like a bullet when a steam valve is opened. If it strikes an obstruction it will behave like a sledge hammer. If it strikes other water, then a wave of pressure will be transmitted through it which will suffice to smash up pipes and stop valves. The theory has been very fully dealt with in our columns not long since. It is surrounded with difficulties. It is excessively ingenious. No doubt it satisfactorily explains a great many cases; but it leaves a considerable percentage about which, to say the least, uncertainty must exist. In order that hammering may take place it is necessary that, as we have said, a vacuum must be established somewhere. Not infrequently it is impossible to see how the steam can have been condensed. Let us take the case of a long horizontal pipe. This pipe contains steam and hot water. This water is, indeed, very nearly, if not quite, as hot as the steam. A drain cock is opened and an explosion follows. The opening of the cock sets the water in motion. How can this establish a vacuum? Why should hot water condense steam? In his own words, speaking of seven cases, he writes:—"These cases embrace those explosions of steam pipes which have been caused by accumulation of water in a low-lying steam pipe, which water was then partly drained off, whereby a long surface of relatively cold water was exposed to the steam in the upper portion of the pipe. This water surface would condense large quantities of steam which, rushing through a restricted channel, would raise up waves and thereby isolate the further-away portion of the steam; this steam would condense and leave a vacuum into which the raised wave would shoot with great velocity and deliver a water hammer blow." Here he begs the whole question. Why should drawing off a portion of the water expose a long surface of relatively cold water? There is a total absence of any attempt to prove that the water is cold. Assuming that condensed water would lie in strata, so to speak, the colder at the bottom, the hotter at the top, if left to itself, it must be kept in mind that the hot metal of a clothed steam pipe would maintain the temperature of the water by conducting heat to the bottom. This is, for the cases named, the crux of the whole question. Was the water relatively cold, or was it not? We have only Mr. Stromeyer's assumption that it was cold. There are cases in which the water was beyond all question cold. To these we may apply Mr. Stromeyer's theory without hesitation. The weakness of it is that it will not apply all round. In several instances Mr. Stromeyer can only maintain his views by rejecting evidence as probably untrue. We may cite case 61 as an example. Again, in case 69 he gives alternative explanations of what the conditions may have been, but obviously he does not know what they really were. In case 70 the sluice valve was fractured apparently by a blow on the wrong side. To explain this somewhat awkward fact he suggests that the breakage was due to vibration in the steam pipe, or that after the explosion, when the valve was repaired, the box was turned end for end, and so misled those who investigated the circumstances. We could, if it was necessary, give many other examples of the purely speculative way in which Mr. Stromeyer handles his subject. One deduction from Mr. Stromeyer's own experiments and from his examination of actual failures would appear to be justified. It is that, since a vacuum is the cause of water hammer, the prevention or destruction of a vacuum will prevent the phenomenon. It should, then, only be necessary to fit snifting valves at suitable places on a range of pipes—or if automatic valves are not desirable, small cocks, to be opened by hand—to remove all traces of danger. Mr. Stromeyer is unwilling to admit this, but there is no clear reason why in the majority, if not all cases, it should not be a perfect cure if Mr. Stromeyer's view of the cause is correct.

We may, we think, venture to say without hurting Mr. Stromeyer's susceptibilities that while we admit that there is much about his theory which is entirely satisfactory, several things remain to be, not explained—because he supplies explanations—but put on a solid basis of fact. He will, we think, admit that he finds much reluctance among other engineers to accept his views in full about the formation of a vacuum. Glass models do not establish all the working conditions. Thus it is quite possible to have cold water in the bottom of a glass horizontal tube when it could not be had in an iron or brass tube, because glass is a bad conductor. Again, hammering takes place in pipes which, so far as can be seen, have absolutely no water in them when the stop valve is opened; and further it must not be forgotten that while water hammer explosions are very rare, the conditions which, according to Mr. Stromeyer, produce them prevail all round. The opening and closing of stop valves goes on every day and night by the thousand. Mr. Stromeyer may be said to prove too much. If, indeed, he is right, a new problem is presented for solution, and he will have to explain not why water hammer explosions occur, but why they do not.

Exports of Machinery.

THE question of tariff revisions which have recently either been completed or are in contemplation in various countries lends a certain amount of interest to the development of the British export trade in all classes of machinery which has taken place in the past few years, notwithstanding the operation in different lands of tariffs which cannot be considered favourable to imports from the United Kingdom. It is almost difficult to realise the enormous progress made in the value of British exports of machinery since 1904, when the turnover in this direction, according to the Board of Trade returns, reached the sum of £21,065,000. Although this amount represents an important total, it was exceeded in each of the two following years, whilst the formidable figures of £31,743,000 were attained in 1907, or an advance of over ten millions sterling as contrasted with 1904. Even in the succeeding year of 1908, which stood under the influence of the period of economic depression, the value of the exports of machinery only declined by £725,000 as compared with the record year of 1907. The circumstance that the diminution in 1908 was not of greater extent may be explained by the fact that machinery, in contradistinction to products manufactured on a bulk scale, has to be contracted for some time in advance in order to secure delivery when required, and it is therefore quite probable that the total exports in 1908 included a fairly large amount of work forming the subject of contracts concluded in the preceding year. The retrogression in the current year has, however, been accentuated in so far as the exports in the first eight months are concerned, and the complete year's foreign trade promises to be considerably more unfavourable than that in 1908. Apart from the present year, which reflects the general effects of the economic depression which has prevailed throughout the civilised world, but which is now believed to be passing away in favour of improved times, it has to be admitted that the export values of machinery in the past three years demonstrate in a remarkable manner the great vitality and enterprise of the British engineering industries, the average value for the four years ended with 1908 having exceeded £28,000,000.

The splendid progress made in the last four years has been accomplished despite the revision on a higher scale of the Customs tariffs of Germany, Russia, Austria-Hungary, and one or two other countries, as quite irrespective of any fluctuations or limitations in our machinery exports to these particular countries, the requirements of the world as a whole have largely increased, and British engineering firms have succeeded in securing a considerable share of the greater amount of trade opened up by the general expansion. It seems, however, that further tariff revisions recently concluded, or in prospect, threaten to place additional obstacles in the way of the exports of machinery from the United Kingdom. In the case of the United States tariff the duty on jute manufacturing machinery, linotype, and all type-setting machines, machine tools, printing presses, and steam engines, has been lowered from 45 per cent. to 30 per cent. *ad valorem*; but as the British exports in these classes are not of important dimensions, the value of the concession is insignificant, having regard to the domestic production in these trades in the United States. The former duty of 45 per cent. is being continued, with certain temporary exceptions, on embroidery machines and lace-making machines, including machines for manufacturing lace curtains, nets, or nettings. Thus all embroidery machines, and lever or go-through lace-making machines, machines used only for the weaving of linen cloth from flax and flax fibre, and tar and oil-spreading machines employed in the construction and maintenance of roads, are to be admitted free of duty until January 1st, 1911. Of course, the object of this provisional concession aims at the encouragement of native industries, particularly the textile trades, as was the case in Germany twenty or thirty years ago. Yet Germany, with the exception of British India, still remains our largest individual customer for textile machinery at the present time, although Japan approached that country very closely from the value point of view in 1908.

The reductions made by the United States under the new tariff cannot be regarded as being likely to exercise a favourable influence upon British exports to that country, if we except the exemption from duty of the before mentioned textile machinery and tar and oil-spreading machines, and in these particular cases a detrimental reaction would probably follow any expansion in the exports down to the end of 1910 unless a decided change for the better took place in the home demand in the United States. On the other hand, a large increase in the productive capacity in that country without a corresponding augmentation in the consumption would in itself seriously affect the exports of textile manufacturers from the United Kingdom to that part of the American continent. The United States tariff having now come into operation, there still remain other schemes of revision to be settled, as, for instance, those of France, Sweden, and Brazil, whilst Holland is reported to have the intention of adopting a system of protection in consequence of the unfavourable position of the finances of the country. The French tariff, which projects higher duties on machinery and iron and steel, was thought likely to be abandoned owing to the opposition of the Government, but it is now declared that the scheme as prepared by the committee of the Chamber of Deputies will result in a compromise, and, if this should prove to be the case, higher duties will be probable, although not to the extent suggested by the committee. The Swedish machinery trades, which have expanded their exports in the past few years, are also to be granted a greater measure of protection, the projected duties being high, and likely to be brought forward for decision in the course of the next few months. The intentions of Holland will also soon be announced, and those of Brazil may likewise be ascertained at an early date, whilst the Turkish duties are to be raised from 11 to 15 per cent. in the near future. All the circumstances point to the great probability of other nations becoming of a more protectionist character than at present, and to an increase in the difficulties attending the export of machinery to different countries. But if British machinery makers and exporters have been able to achieve the magnificent results recorded in the past four years, they should be able to look forward with the hope, and with the confidence, that if some markets become more difficult others may become more extensive and new spheres of activity may be opened, so that they may derive a share in the future expansion of trade throughout the world.

LITERATURE.

The Construction of the Balance. By Dr. E. Brauer; translated by H. C. Walters. Published by the Incorporated Society of Inspectors of Weights and Measures.

IT seems strange that hitherto there has been no book in existence in this country dealing exclusively and in a scientific fashion with the subject of weighing machines. That such an important branch of mechanics should receive so little attention from the hands of competent writers was an omission which it was essential to remedy. Accordingly, some time ago the Incorporated Society of Inspectors of Weights and Measures determined on the translation, in default of an original work, of Dr. Brauer's "Konstruktion der Wage," and entrusted the work to Mr. H. C. Walters, of Bury St. Edmunds, who, by his long residence in Germany, and his knowledge of the manufacture of scientific instruments, was well fitted for the task.

Dr. Brauer's book, which in its original form had run to three editions, was founded on an earlier treatise on the same subject by Hartmann, and during its last appearance in Germany received careful revision from Herr Fr. Lawaczeck. The book had thus a guarantee for accuracy and modern ideas on the subject which could hardly have been excelled by an original work, and in its present form it should prove of great value to many in this country to whom it has hitherto been inaccessible. It now appears with much the same general scheme of treatment given to the different subjects as was observed by its original author, and we consequently find it divided into four parts which, taken in order, deal with (1) the balance and weighing in general, (2) the geometrical and mechanical properties of the various weighing mechanisms, (3) the most important details of balances, and finally (4), a description of balances as used for different purposes. The text is throughout fully illustrated, and the manner of description and the statement of the various mathematical theorems involved leave little to criticise otherwise than favourably.

In the first part we find careful attention given to the theoretical side of the subject. The distinction between mass and weight is pointed out, and the exact purpose of weighing clearly stated. From theoretical considerations the several different classes into which balances can be divided are deduced, and these are shown to be divisible primarily into bent-lever balances, weight balances, and arm balances. Immersion balances—hydrometers, &c.—and spring balances are not included in these, although the first may be classified with the other three under the general title of gravity balances.

It is pointed out that while there is an infinite number of possible mechanisms whereby the comparison of masses may be carried out, we are limited by certain practical considerations to a comparatively few designs. What these considerations are will be best seen from a statement of the claims which a good balance should satisfy. Of these the first is that the equilibrium should be stable, that is to say, that a balance loaded with a weight within the range for which it has been constructed should on being disturbed from its position of equilibrium return to its former position after a few oscillations. Secondly, it should be capable of measuring masses correctly to within a required fraction of the unit of weight employed. The exact sensibility demanded of a particular balance will, of course, depend on the purpose for which it is intended. It is pointed out that the usual mathematical measure of the sensibility of a balance, namely, the angle of deflection of the beam under a given load gives only a partial statement as to the utility of the balance. Finally, repeated weighings should agree. It is probable that repeated weighings of the same mass with the same balance never do agree with mathematical accuracy, but in a good design the discrepancies should be well within the limit of sensibility.

The sources of error in weighing instruments are next classified, and of these friction is said to be the principal, the elasticity of the materials used in their construction and the buoyancy of the air being also of account in this direction.

Coming to Part II., we find the kinematics and kinetics of many useful mechanisms fully detailed. Simple machines are first considered. Of these the bent-lever machines, typified in some letter balances, give equilibrium in positions dependent on the load, so that the mass is determined by observing the position which the moving mechanism finally takes up, and from a knowledge of the fixed weight embodied in the design. An interesting discussion is given, the result of which is to show that the sensibility of this type of balance is greatest when the load to be measured is such as to produce an angular deflection of amount equal to half the angle contained between the two arms of the balance. When a machine of this class oscillates about its position of rest the frictional forces act, of course, in a direction opposite to that in which the arms, &c., are at the instant moving. It is therefore possible for the same weight to give two different readings depending on the direction in which the last swing took place. The other simple machines dealt with are of the well-known beam type as exemplified in chemical balances, and lastly of the steel-yard variety. Such simple instruments have certain drawbacks which limit their usefulness, and in some circumstances their use would give rise to errors of considerable magnitude. The difficulty of comparing large masses with equal arm balances is apparent, but if we try to avoid the necessity of employing a large number of verified weights as counterpoises by utilising balances with unequal arms, we find that the great length of the weight arm necessary when the ratio of weight to load becomes less than one-tenth gives rise to fresh difficulties, as, for practical reasons, the load arm cannot be diminished beyond a certain length. Hence arises the necessity for the class of machines known as combination balances. In such balances we are no longer confined to the simple vertical forces acting in the previous cases, but have to take account of the horizontal or oblique forces which are called into play by the stresses in the members of the mechanism.

The author next considers in Part III. many questions of a practical nature connected with the manufacture of the component parts of different classes of balances, and in connection therewith has some interesting remarks to make about knife-edges. Starting with the assumption that the finest knife-edge is in reality circular in profile, he states that for knife-edge bearings preference should be given to a flat surface rather than a V-shaped or cylindrical depression. When it is necessary to confine the knife-edge to a particular position, the V-bearing is, of course, unavoidable, but it is subject to sliding friction. and hence the other two forms are more perfect. In the case of the cylindrical bearing it is shown that it is possible for the knife-edge to rest elsewhere than at the lowest point, a circumstance which in some instruments would interfere with their accuracy. As regards the maximum admissible pressure on knife-edges, authorities differ somewhat, some giving 1000 kilos. per centimetre of length, others 4000; but such a method of expressing the stresses on knife-edges is at best indeterminate. Great divergence of opinion is likewise expressed regarding the most suitable angle for knife-edges, but as a general rule it may be taken that the greater the load the greater should be this angle. In practice angles varying from 60 deg. to 120 deg. are found. An ingenious machine for grinding and adjusting the knife-edges of equal armed balances which has been designed by Hasemann, of Berlin, is described.

The errors caused by the non-parallelism of the knife-edges, and devices for compensating these, are next considered. The introduction of a second knife-edge suspended by a stirrup at right angles to and below the first partially compensates for the errors caused by warped knife-edges, while to secure the elimination of still further errors a third knife-edge is sometimes found below the second and parallel to it. Arrestment and relieving contrivances next engage the author's attention, and the amount of space—40 pages—devoted to this subject indicates its importance.

Part IV. is given up to a description of many examples of weighing instruments for all purposes, from the determination of atomic weights to the weighing of locomotives, and the designs illustrated indicate the extraordinary degree of refinement to which the manufacture of this class of apparatus has been carried. It is remarked that the chemical balance as now made affords means for some of the finest measurements which it is possible for man to make, and that it is comparatively easy to measure a weight of, say, 1000 grammes correctly to the last thousandth of a gramme; that is to say, to one part in a million. To obviate the disturbances due to the opening of the balance case many devices have been proposed. Among those described is one made by Bunge, of Hamburg, capable of weighing up to 500 grammes, in which all the weights are placed in position from outside the case. The weights in this example consist of small cylinders provided with horizontal axes at either end. Each of these weights is carried on a horizontal arm, of which there are nineteen, and can be moved forward so as to engage on one of two pronged forks, suspended from the arm which would otherwise carry the weight-pan. Other scientific balances are described, including examples wherein the scale pans are interchangeable, or which possess other means for eliminating errors due to any inequality, temporary or otherwise, in the length of the arms.

Trade balances next fall to be considered, but the conflicting variety of these renders a summary of little use. We will, therefore, leave the reader interested in such matters to a study of the book itself.

Although the work bears traces at times, in its phraseology, of being a translation, a fault which we hope to see remedied in future editions, most readers, whether they are merely desirous of extending their knowledge of scientific instrument making, or whether they are professionally interested in weighing machines, will have little difficulty in following the discussions given of the various subjects. The matter is, in parts, essentially mathematical, but the author has refrained from overburdening his text with symbols, and where this is unavoidable, has introduced the calculus sparingly. We can cordially recommend the book to many engineers, as the principles underlying the work dealt with are fundamental, and of wide application in many branches of the engineering industry.

SHORT NOTICES.

Reinforced Concrete in Europe. By A. L. Colby. Published by the Chemical Publishing Company, Easton, Pa. London: Williams and Norgate.—This book is the outcome of a report to a small number of subscribers, to collect the information for which the author visited the principal countries of Europe during 1908. The theoretical side of reinforced concrete design is barely touched upon, as it was desired to accumulate particulars connected with the practical aspects of this class of work. We consequently find that the author deals chiefly with such subjects as the endurance and economics of the material, while considerable space is devoted to a description of the various British and continental systems of reinforcing. The nature of the mechanical bond, the metal used, its strength and composition, are discussed, and opinions and recommendations thereon compared, succeeding which the cement and concrete used in the various countries are reported upon. The book then closes with several appendices, in which information connected with the various systems and the firms engaged thereon and other matter is tabulated.

Hydro-electric Developments and Engineering. By F. Koester. New York: D. Van Nostrand Company. 21s. net. —This book treats of the considerations connected with the installation and development of hydro-electric power stations, and is illustrated with numerous diagrams and figures showing the various details associated with such works. It is divided into two parts, dealing with the transformation of water power into electrical energy and the transmission of high-tension electrical current respectively. In the first part we find chapters devoted to the description and illustration of numerous examples of the various details associated with the mechanical and civil engineering side of the work, such as dams, conduits, racks and gates, penstocks, and the turbines and their housings, while the last chapter of this part is devoted to a description of the electrical equipment. In the second part high-tension current conductors, their supports and insulators, and the different details found in the sub-stations of actual installations of this class of work are to be found described and fully illustrated. As an appendix a detailed description is added of eight American and European hydro-electric developments. The book appears to us to be very complete, and although covering a large ground it should at least prove of value as a source of reference to what has been done elsewhere in connection with the utilisation of water power for generating electrical energy.

A NEW IMPULSE STEAM TURBINE.

In view of the growing demand for impulse turbines, Willans and Robinson, Limited, of Rugby, have taken up the manufacture of this class of plant. It is not the company's intention to discontinue building the Willans-Parsons turbine, which has met with so much success, but the object of this new development is merely to place the firm in a position to meet the present-day requirements. That impulse turbines are steadily gaining prominence in this country is well known, and, notwithstanding the fact that the type invented by Mr. Parsons, and now constructed by so many firms, will in all probability always hold its own as long as steam turbines exist; it is nevertheless not surprising to find a firm securing for itself a good footing by taking up the manufacture of these two distinct types. A few days ago we visited the Rugby works, when we were afforded an opportunity of seeing the first Willans impulse turbine in operation. It is capable of developing 1100 brake horse-power or 750 kilowatts, and runs at a speed of 3000 revolutions per minute. Although, of course, all steam turbines occupy remarkably little space, as compared with the slow-speed engines which were almost exclusively employed for driving electrical machinery up till a few years ago, we could not help comparing this little machine with some of these giants of the past, and wondering how many of us some twenty years back would have believed that such a revolution in the size of prime movers could take place.

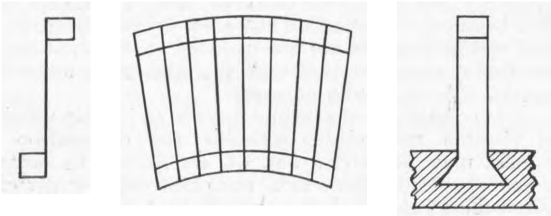
Our illustration on page 325 shows the turbine to which we refer, the top half of the casing being removed for inspection purposes. This and the illustration of the rotor shown below it will, no doubt, convey to many of our readers the lines on which the firm is working, the turbine clearly being of the multiple-velocity type, and, so far as the internal construction is concerned, resembling the well-known Curtis turbine. There are, however, several points about the internal design which differ from those of the same class of turbine manufactured by other firms, and which are claimed to possess special advantages. Essentially these turbines consist of one, two or three rotating wheels, each wheel having mounted on it one, two or three sets of moving blades. Between these blades a stationary row of blades is fixed, these latter blades being attached to the outer casing. The object of these guide blades is, of course, to bring the steam back to its original direction of motion. We understand that after careful consideration had been given to the various designs of impulse turbines hitherto produced, the company finally decided that this type was the best of those embracing the features of the impulse system. It will be gathered that the turbine illustrated has but two stages, and consequently but two revolving wheels, this design being adhered to in sets up to 1500 kilowatts, running at the above-mentioned speed. Thus it will be seen that in placing these impulse turbines on the market the company's one great aim has been simplicity. At the same time the question of steam consumption has naturally been kept well in mind, and we are informed that the economy realised compares favourably with that of any other type of turbine on the market.

As in other turbines constructed on this principle, the steam after expanding and acquiring velocity in the first set of nozzles acts upon the rows of moving blades on the first wheel, each row being designed to extract a certain amount of the total energy from the steam. The steam then passes into the second set of nozzles where more kinetic energy is generated, and after passing through the second set of fixed and moving blades, all the useful energy available between the limits of steam pressure has been transferred to the wheel.

As regards the nozzles, these naturally resemble the ordinary type originally invented by De Laval, although a novel arrangement of the nozzle plates is being used, which is claimed to embody an efficient design combined with a simple method of manufacture. The system of blading to be used with these turbines is stated to possess some noteworthy features. The turbine which we illustrate is apparently not fitted with this special system, but the design of the blading, which was explained to us at the time of our visit to the Rugby works, and which is to be fitted to all future impulse turbines, can be gathered from the diagrammatic sketch shown herewith. It will be seen that at each end of the blade there is a lug, and these lugs point in opposite directions. In this way each individual blade provides its own portion of the shrouding and its own distance piece. The feet of the lugs are dovetailed, and fit into grooves of the same form in the casing and wheels, the blades being inserted one by one, and no separate shrouding or spacing pieces being required. In the case of the wheels gaps are left for the insertion of the blades. These gaps, after all the blades have been put in, are covered by means of small plates fitting flush with the sides of the wheels. The last blade in the casing is fixed by a simple locking piece. The operation of blading thus becomes a very simple matter requiring but very little skill, and we should say that in the event of a turbine, or part of a turbine, requiring re-blading the work might be carried out by an ordinary fitter, whereas with some systems of blading highly skilled men are required. It should be understood that the sketch is purely diagrammatic, and is merely intended to show the general scheme.

The question of how long blades will last in turbines of this type is naturally very important, and this brings us to another special point. We are told that experiments have been carried out for some considerable time past with a view to finding a material for the blades which will combine strength, resistance to erosion, and, finally, can be cast in such a way that the fixing and replacement, if necessary, of the blades can be carried out in the simple and cheap method above referred to. The material finally selected for casting the blades has, we are informed, proved eminently satisfactory, and long tests have shown no effect on the material owing to the action of the steam. Another point worthy of mention is that the blades undergo no machining process whatever, the castings being finished by means of the buff.

Turning now to the glands, here again we come to another feature to which the firm attaches some importance. The standard Willans gland as used on the other type of turbine is employed throughout—that is to say, at the ends of the shaft, and also for packing the discs in the turbine through which the shaft passes. For the benefit of those who are not familiar with these glands, we may say that the packings used embody slight modifications of the well-known Parsons type. The flow of steam is baffled by wire-drawing it through a series of constrictions, the velocity generated at each constriction being dissipated in fluid friction before the steam arrives at the next. The pressure is thus gradually destroyed, and the steam issues from the last constriction at a velocity much less than that due to the total head. It is claimed that the modified method adopted by this company for making a joint round a rotating shaft, although, in the case of the end glands, entailing the use of a small quantity of steam, as is done with the Parsons turbine, is a safeguard against any possible trouble arising owing to the shaft coming in contact with these glands. This, of course, is very important in the case of the internal glands, namely, those employed for packing the discs in the turbine through which the shaft passes. It is, in fact, now generally appreciated that these internal glands in a turbine of the impulse type are the most frequent source of trouble in the direction of coming in contact with the shaft and distorting it. The glands used in the Willans impulse turbine are claimed to minimise this risk, and are guaranteed not to produce trouble of this kind even in the event of contact taking place.


SKETCH OF TURBINE BLADES

Following the practice adopted by the company in the construction of the Willans-Parsons turbine, a throttle valve actuated by a simple fly-ball governor has been adopted for controlling the speed, but at the same time the number of active nozzles in the first stage can be regulated by hand. Thus, with this arrangement it is possible by cutting out nozzles and reducing the amount of throttling to secure a reasonable steam consumption at light loads. The experience gained by the company has, we are informed, given rise to this method of governing being adopted in preference to the system in which the governor controls the number of nozzles in operation. It is obvious that in a turbine of this type no by-pass valve is necessary to enable a heavy overload to be dealt with, since this end can be attained by increasing the number of active nozzles in the first stage. At the same time, however, in cases where it is necessary to deal with heavy intermittent peak loads, the company is prepared to fit a device which will open the nozzles automatically.

As will be gathered from the illustration on page 325 the practice of opening the top half of the casing on hinges has been adhered to in this new type, this design being claimed to give the advantage of easy access to the internal parts of the casing. The method of lubricating the bearings and other working parts is also carried out on the same lines as in the Willans-Parsons turbine, namely, by means of a positive action rotary pump which is driven direct from the turbine. The pump, being always flooded, ensures a complete oil supply as soon as the turbine starts. A hand pump is also provided which delivers oil into the main supply pipes, so that the bearings can be flushed before the turbine is started. The general design of this new impulse turbine can be summed up in a few words by saying that so far as the governor gear, bearings, and accessories are concerned, it is identical with those of the Willans-Parsons turbine. In fact, the main difference in these two types is that the new design has one, two, or at the most three high-speed wheels, whereas the interior of the other machine contains the large number of pressure stages common to all turbines constructed on the Parsons principle. The great advantage of standardising the bearings, governor, gear, &c., lies in the fact that the individual parts of the new impulse turbine can be made interchangeable with the stock already carried for the Willans-Parsons turbine.

THE ELECTRIFICATION OF TRUNK LINES.

When considering the question of electrifying trunk lines, there are four systems from which a choice can be made —namely, the direct-current system, the single-phase alternating-current system, the three-phase alternating-current system, and a combination in which alternating current is used on the line and converted into direct current on the locomotive for use in the motors. In a paper read before the Michigan branch of the American Institute of Electrical Engineers on "The Choice of a System of Electrification for Trunk Lines," Mr. C. L. De Muralt compares these four schemes, and arrives at the conclusion that for trunk lines the three-phase method is preferable. Starting with the generating stations, the author states that in all four systems we find that three-phase machines are used. Thus, there is no real difference in the type of generator, nor need there be any difference in the cost per kilowatt capacity. Whichever scheme be adopted, the same power will have to be available at the driving axles of the trains, but the losses between driving axles and power-house vary with different systems. The single-phase systems have, he points out, the greatest losses, and therefore require the largest power-house capacity for the same service. The three-phase scheme is, he considers, the most efficient, and therefore requires the least power-house capacity. The relative amount of plant for each scheme is roughly estimated as follows:—For each 100 kilowatts in power-house capacity which the direct-current system requires, the single-phase scheme necessitates about 180 kilowatts and the three-phase about 70 kilowatts.

Turning to the line equipment, the author first deals with the use of the transmission line directly as a contact line where distances are not too great and traffic is not too heavy. With 10,000 volts distances of forty miles and even greater may thus be covered. The more locomotives on the road at the same time, the shorter would this distance become, owing to the increased pressure drop in the line. But even with light traffic the author sees no advantage in feeding the contact line direct from the power-house, as it necessarily multiplies the number of power-houses. On a 150-mile line there would be at least two or three comparatively small power-houses, and the effect of these on the working expenses would, he argues, be unfavourable. Everything considered, Mr. De Muralt believes that the use of an independent transmission line with transformer sub-stations, and an independent contact line, is by far the best arrangement.

With the transmission line, it is stated, we find essentially the same practice in all four systems. Preferably all use three-phase alternating current, although for single-phase schemes two phases are used separately. In the sub-stations static transformers are used with the single-phase and three-phase schemes, whilst rotary machinery is necessary when direct current is used on the locomotive motors. Whether or not an overhead contact line can be used depends on the line pressure.

As regards the rolling stock, the following are the author's main conclusions. The single-phase motor is admittedly a makeshift. Being a makeshift, it naturally possesses a good many faults. If the single-phase and direct-current motor have the same current input for a certain speed, any increase in current due to a greater power output will produce considerably more drop in speed in the single-phase motor than in one of the direct current type. The single-phase motor has also much larger copper bosses; hence, with a good starting torque, a large amount of heat is produced. The three-phase motor runs at practically constant speed from no load to full load, and the rate of acceleration is practically constant. The three-phase motor is able to accelerate much faster than machines of either the direct-current or single-phase types. The heat due to the losses in a three-phase motor will reach the outside surface of the case more readily. It is not difficult to obtain 90 per cent. efficiency in three-phase motors, while the efficiency of direct-current type is somewhere between 75 and 85 per cent., and that of single-phase motors is hardly better than 60 to 70 per cent. For the foregoing reasons, if the motors are of the same size the three-phase machine will run much cooler than the direct-current motor, and the latter much cooler than the single-phase machine. The difference in motor weight introduces differences in locomotive weights. Actual locomotives plainly show this. The New Haven single-phase locomotives weigh 102.5 tons, and produce 1000 horse-power at the usual one hour rating. The New York Central direct-current locomotives weigh about 95 tons, and produce 2200 horse-power on the one hour rating. The Simplon three-phase locomotives weigh about 70 tons, and produce 2700 horse-power on the one hour rating. These figures correspond to about 200 lb., 90 lb., and 50 lb. per horse-power respectively. It is the weight question that principally acts against the use of the fourth kind of system above referred to, but whether these converter locomotives weigh much more than single-phase locomotives remains an open question.

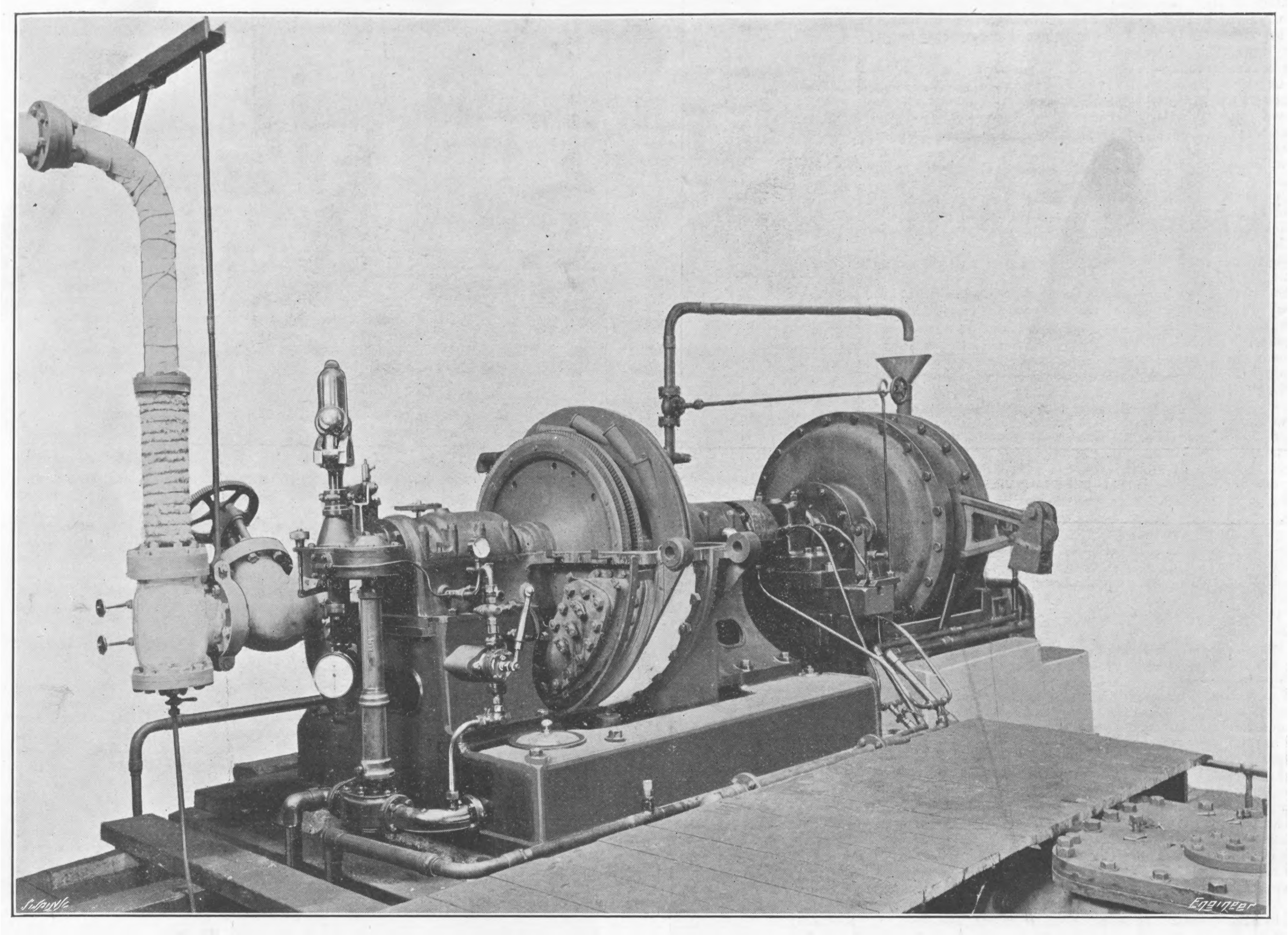
After thus considering the three parts of electric trunk line equipment, the power-house, the line equipment, and the rolling stock, the author then puts the three parts together in order to determine the comparative advantages and disadvantages of the various systems taken as a whole. First he establishes the overall efficiency for each system from power-house to the driving axles. Starting from the power-house, he states that we find that the amounts of power required for hauling any given trailing load are different on account of the differences in locomotive weights. Combining this with the efficiency of the transmission sub-station and overhead conductor or rail and motor losses, he obtains the same approximate relations for power-house outputs as previously, namely, 70, 100, and 180. The energy consumed during the year is approximately in the same ratio. The general conclusions are that, wherever traffic is dense and rolling stock plays a prominent part as compared with line equipment, without question the single-phase system will be most expensive. Whether the direct current or the three-phase system is more suitable in such a case is somewhat doubtful, but the odds are in favour of the three-phase system. When a line is very long and the traffic light rolling stock is less important compared with line equipment, and in this case it is possible that the direct-current system will be out of the question due to the great cost of converter sub-stations. Whether the three-phase or the single-phase system should be used in such a case must be carefully investigated. The single-phase line equipment may be cheaper, but the difference is small. In most cases the three-phase system will be preferable. It requires a very long line combined with very light traffic to show an advantage for the single-phase system. As a matter of fact, if the traffic dwindles to five or six trains a day, which is about the point where the single-phase system may show to advantage over the three-phase system, then it is generally found that steam trains are preferable. It will thus be seen, the author states, that for real trunk line service the three-phase alternating-current system will be found best in almost all cases. The paper then goes on to show that all the disadvantages claimed against the three-phase system are negligible except the two overhead wires. These, it is admitted, remain a disadvantage from the designer's standpoint, but for the operating engineer the three-phase system possesses no disadvantages. One matter that the author calls attention to which is worthy of mention is that it is frequently claimed that the three-phase locomotive possesses only one efficient speed, but he maintains that those who make this claim do not seem to realise that the direct-current locomotive acts in exactly the same manner in this respect.

The Institute of Metals.—The autumn meeting of the Institute of Metals will be held in Manchester on Thursday and Friday, 14th and 15th October, 1909, commencing each day at 10 a.m. On the Thursday a general meeting of members will be held in the hall of the Municipal School of Technology, Sackville-street, at 10 a.m., when, after a reception by the Lord Mayor, a selection of papers will be read and discussed. In the afternoon the University of Manchester and the Municipal School of Technology will be visited. On the Friday the reading and discussion of papers will be resumed at 10 a.m., and in the afternoon members will disperse to the various works which they may choose to visit, the meeting formally ending with departure from the works. The following is a list of the papers that are expected to be submitted:—(1) Messrs. J. H. Andrew and C. A. Edwards on "The Constitution and Properties of the Ternary Alloys Aluminium-Copper-Tin"; (2) Messrs. C. O. Bannister and H. J. Tabor on "The Surface Appearance of Solders"; (3) Mr. H. W. Greenwood on "The Technical Assay of Zinc"; (4) Mr. J. S. Glen Primrose on "Notes on the Production of Pure Spelter"; (5) Mr. E L. Rhead on "Some Causes of the Corrosion of Copper and Brass"; (6) Professor C. A. Smith on "The Elastic Breakdown of Non-Ferrous Metals"; and (7) Professor T. Turner and Mr. M. T. Murray on "The Copper-Zinc Alloys: A Study of Volume Chances during Solidification." The following is a list of works to which members have been invited:—Baxendale and Co., lead mills, Trafford Park; The British Westinghouse Electric Company, Trafford Park; Richard Johnson and Nephew, Limited, Salford; Smith Bros., goldbeaters, Bridge-street; and Isaac Storey and Co., Limited, Cornbrook.

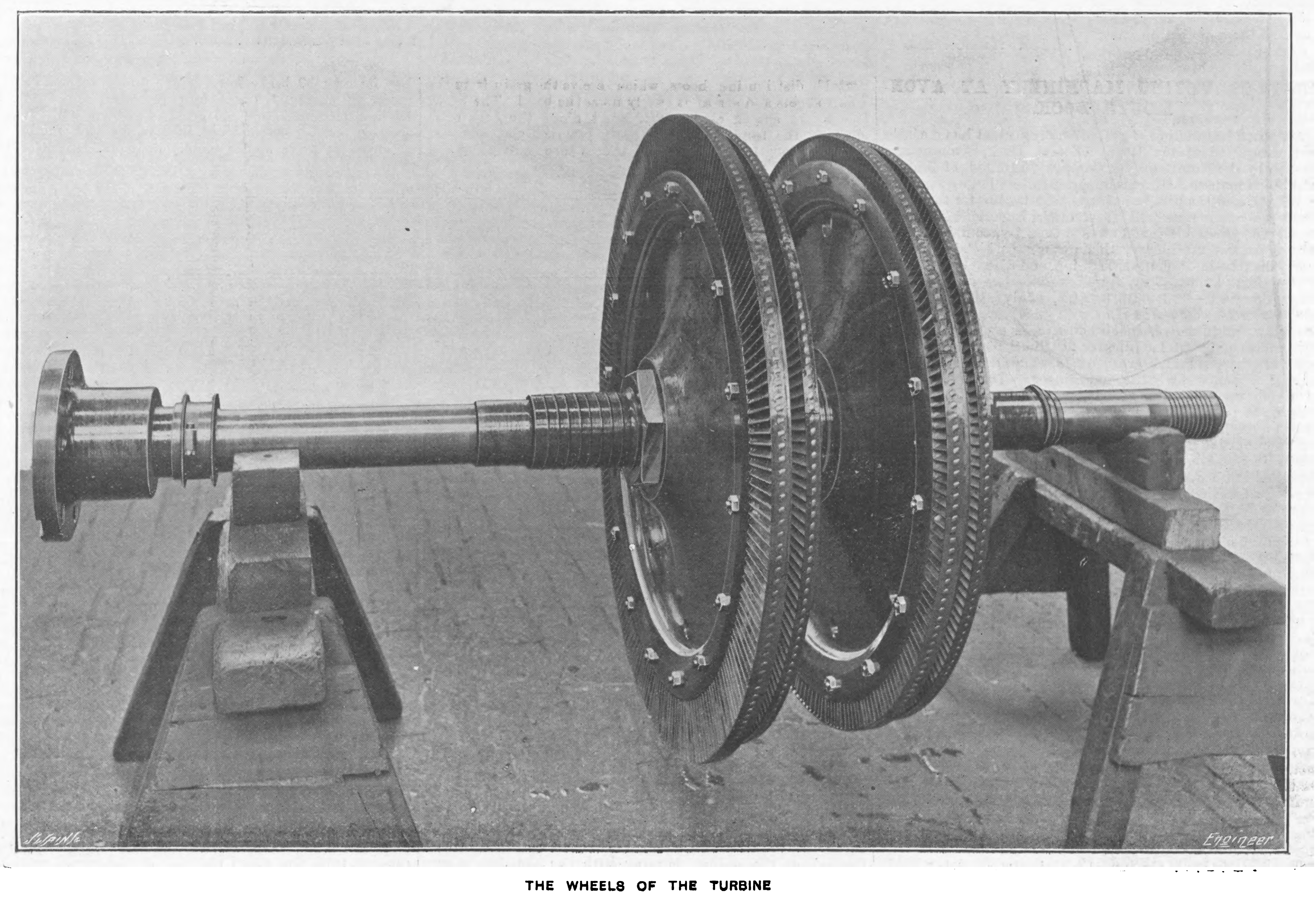
1100 BRAKE HORSE-POWER IMPULSE STEAM TURBINE

WILLANS AND ROBINSON, LIMITED, RUGBY, ENGINEERS

(For description see page 324)


Swain Sc
Engineer

THE TURBINE ON THE TEST BED CONNECTED TO THE BRAKE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THE WHEELS OF THE TURBINE

GRAIN-CONVEYING PLANT AT AVONMOUTH

THE NEW CONVEYOR COMPANY, LIMITED, SMETHWICK, ENGINEERS

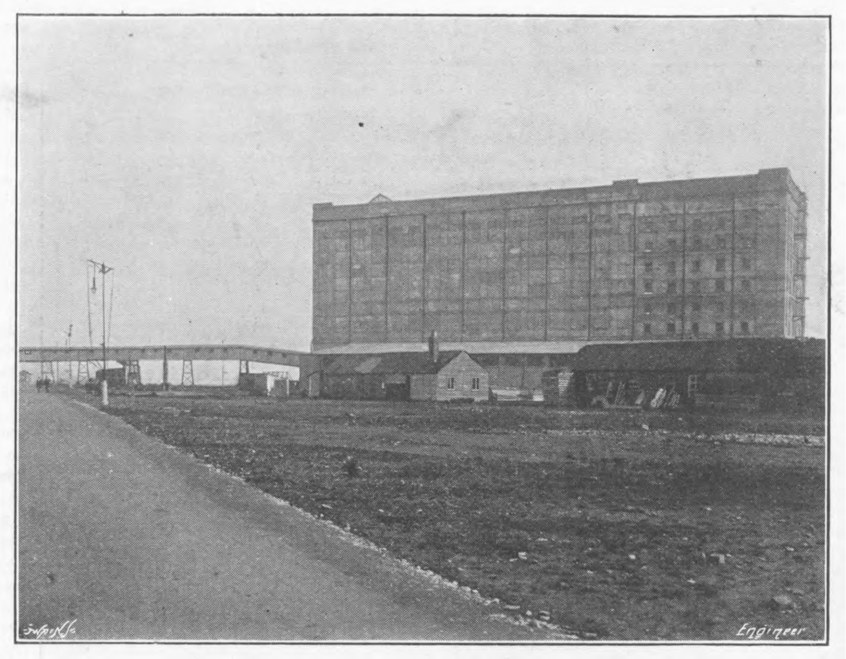


Fig. 1—GENERAL VIEW OF THE GRANARY

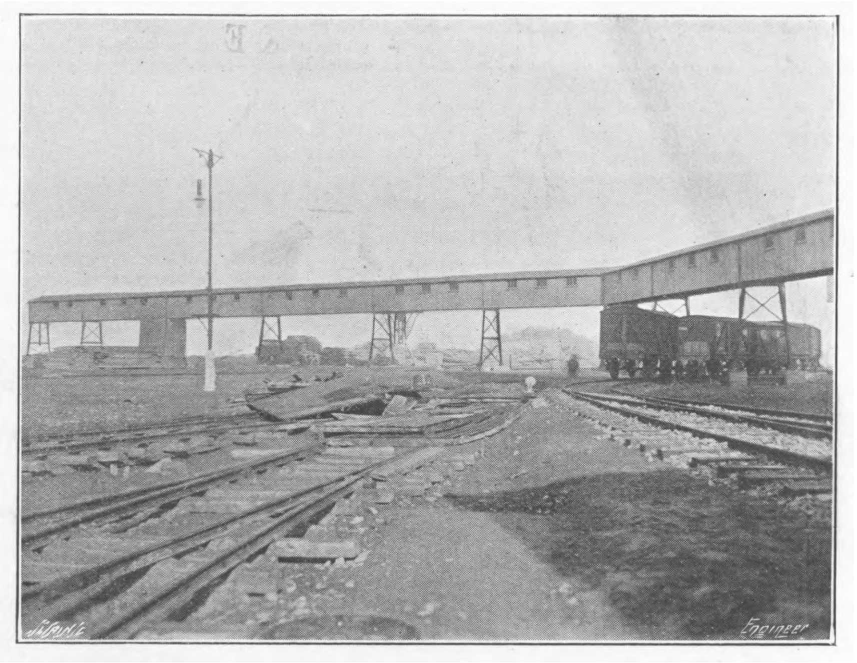


Fig. 2—SACK CONVEYOR GALLERY FROM GRANARY TO DOCK

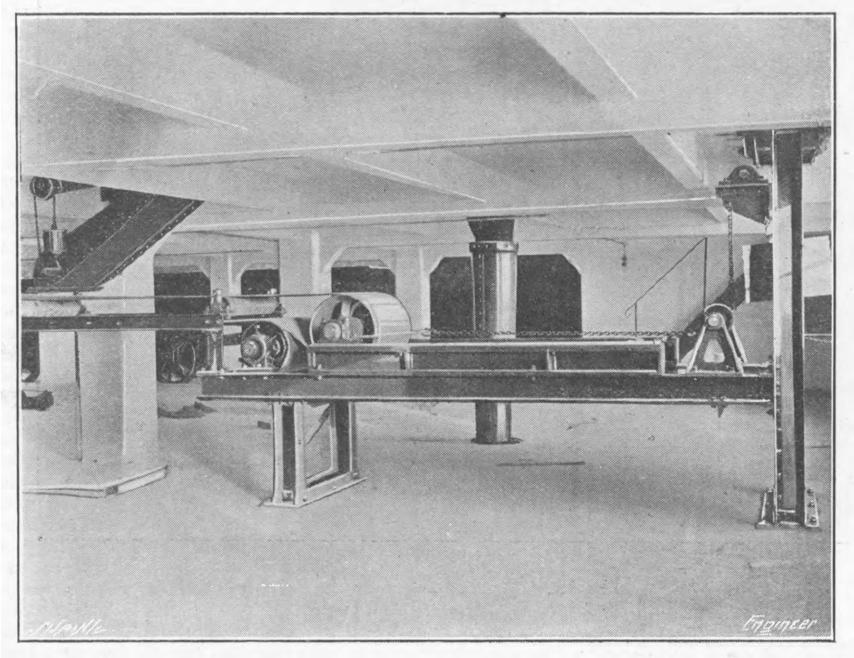


Fig. 3—A TENSION END

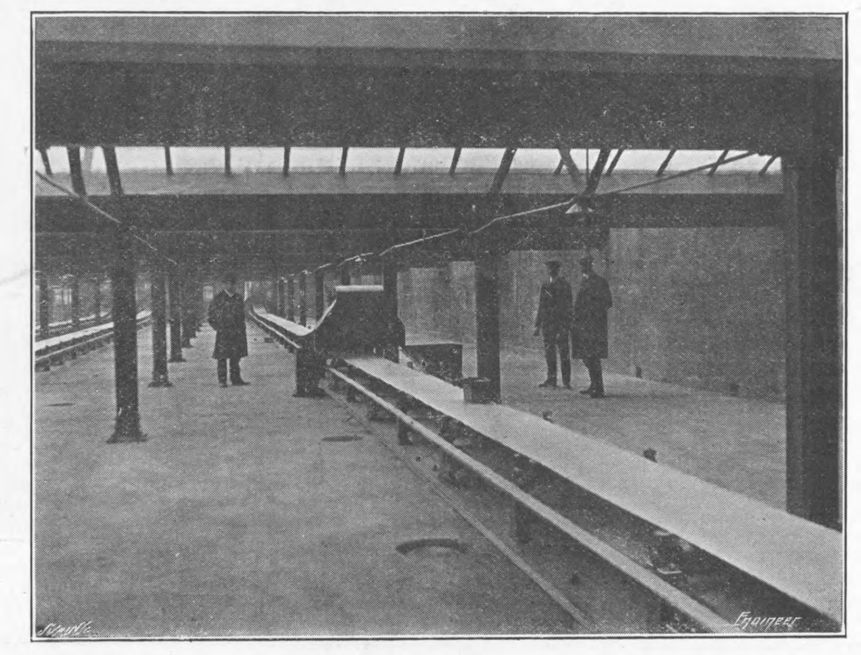


Fig. 4—TOP GRANARY FLOOR

GRAIN-CONVEYING MACHINERY AT AVONMOUTH DOCK.

A LARGE installation of grain handling plant has recently been completed at the Royal Edward Dock, Avonmouth, Bristol, by the New Conveyor Company, Limited, of Smethwick, Birmingham. Grain is imported in very large quantities at Bristol, and the port has always been famous for the rapid discharge of this as well as of other imports. With its recently acquired additional storage capacity, combined with the very latest machinery, this western port claims to be easily the first in discharging, storing, and distributing grain.

The fine building in ferro-concrete has already been fully described—THE ENGINEER, July 10th, 1908—and we need only remark with reference to it that the silos, grain floors, weigh-house, and sacking-off floor, with shoots and other facilities for distribution and trimming, were all designed and arranged in conjunction with the general scheme for the machinery. The machinery, of which we propose to give a general description in what follows, is possibly the most complete of its kind in this country, and is designed to carry grain at the rate of 400 tons per hour continuously from the wharf side to the granary, where it is automatically sorted, weighed, checked, and deposited in the various silos or upon the floors. This result is attained without in any way obstructing the traffic at the wharf or on the neighbouring roads and railway sidings, by the adoption of a subway or tunnel built in ferro-concrete at the back of the dock wall. The tunnel is arranged longitudinally in three sections, the first two of which are continuous behind and parallel to the dock wall, while the third section is at 90 deg. with the second section and extends from the water side to the granary basement.

The conveyors are of the endless-band type, arranged in parallel lines in the tunnel. The bands, which are made of cotton and india-rubber, are 22in. wide, and are capable of sustaining a tensile stress of 800 lb. per inch of width. The bands are carried throughout on steel rollers about 6ft. apart, and automatic tension gears are provided. The speed of the motors is 600 revolutions per minute, and the band speed 650ft. per minute, which speed represents 100 tons of grain carried per band per hour. The grain is, in the first instance, elevated and discharged from the ship into portable hoppers on the wharf. These hoppers fit over cast iron shoots built into the wharf and communicating with the subway. Valves are provided in the hoppers, and on the lower ends of the wharf shoots for the proper regulation of the grain as it is discharged into the shoots and upon the conveyor bands.

The first section of the tunnel contains two conveyor bands 570ft. long between terminals, and each band is fitted with portable distributing shoots, which receive the grain from the wharf shoots and spread it evenly upon the band. The wharf shoots are spaced about 52ft. apart along the dock side, enabling the bands to receive grain practically at any part of their length. The wharf shoots are covered by a special water-tight cover when not in use. The two conveyors in the first section of the tunnel are continuous throughout the section, forming, with the addition of two other bands, four complete and independent conveyors; each has its own 30 brake horse-power motor, tension gear, and receiving shoots. These four conveyors are 750ft. long between terminals, and are broken at about 200ft. from the forward end for convenience in driving, each motor being arranged to drive approximately an equal length of band.

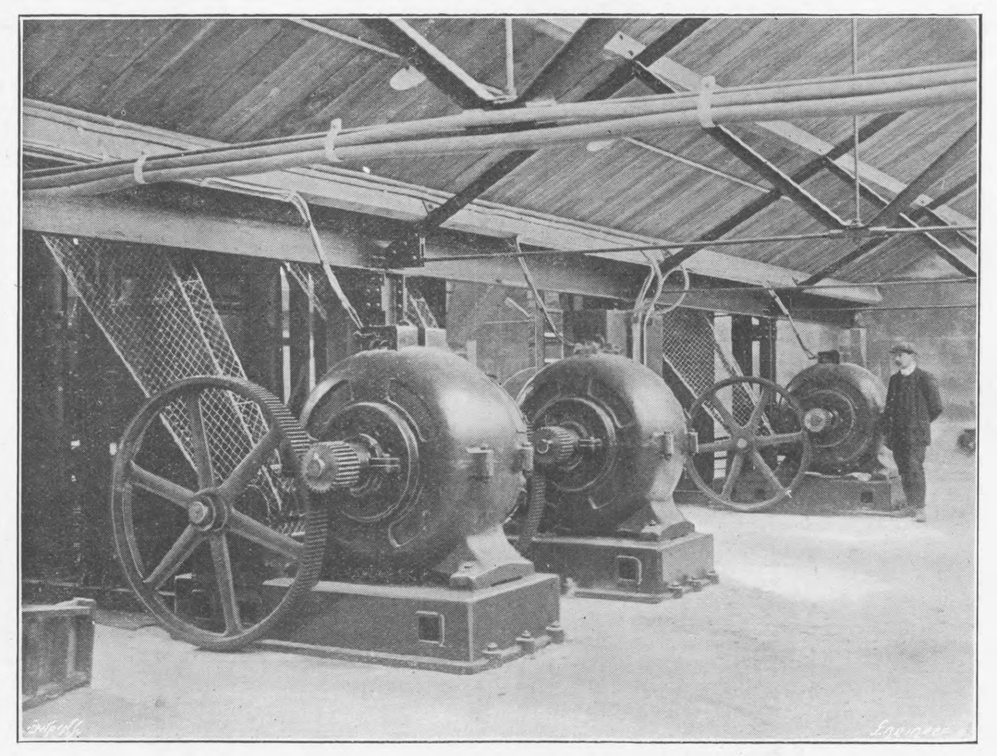
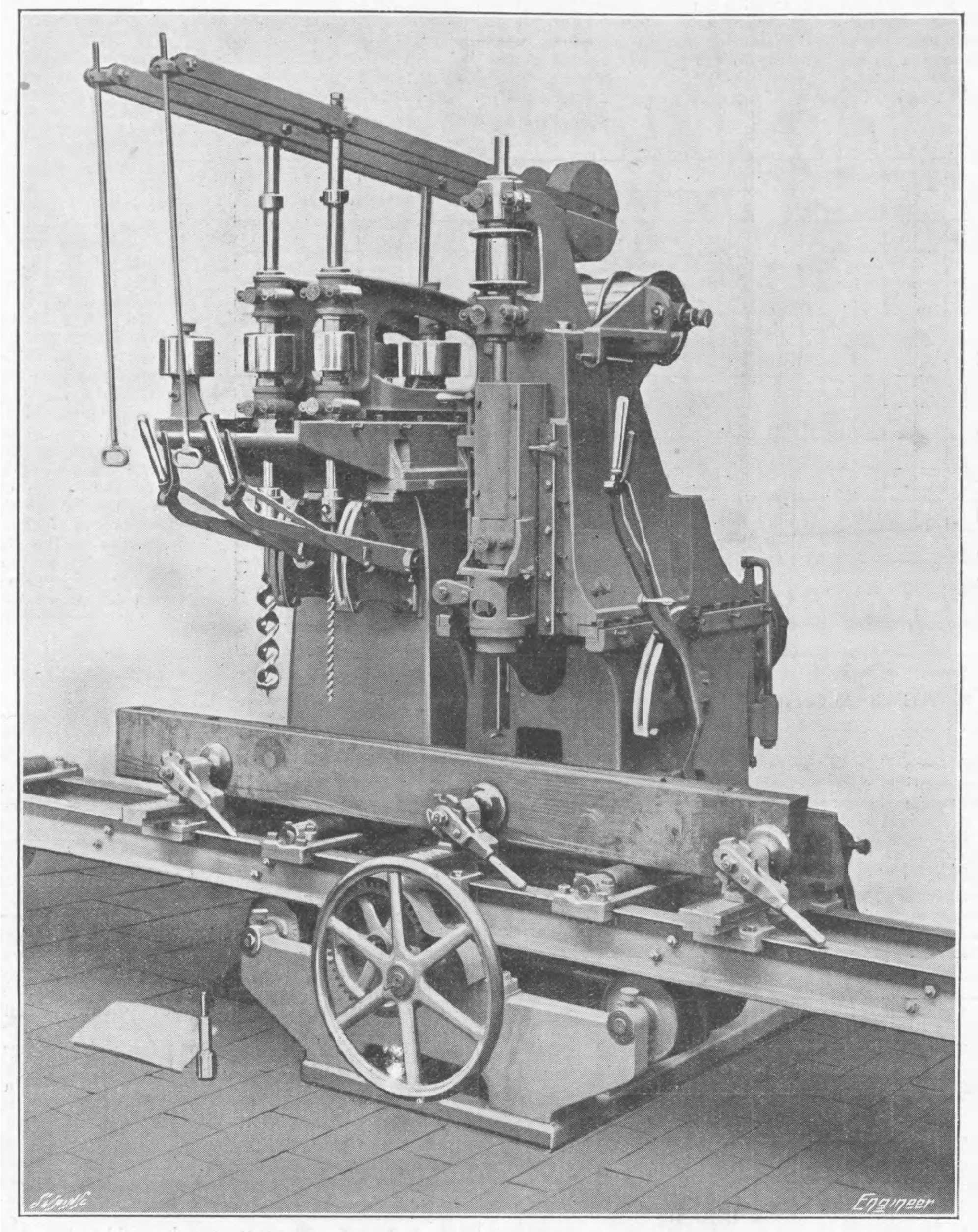


Fig. 5—PART OF THE CONVEYOR DRIVING GEAR

The two conveyors in the first section of the tunnel are disposed at the dock side of the tunnel, and can be fed directly from the wharf shoots. In the second section the third and fourth conveyors are fed indirectly from the wharf

HOLLOW CHISEL MORTISING MACHINE

A. RANSOME AND CO., LIMITED, NEWARK-ON-TRENT, ENGINEERS



shoots by means of short "cross-conveyors" mounted on travelling carriages above the main bands. These carriages traverse the whole length of the second section of the tunnel, the cross band receiving grain from any one of the wharf shoots and discharging upon either of the second pair of main bands by way of a two-way distributor.

The cross-travelling bands are each driven by a 15 brake horse-power enclosed motor mounted on the carriage, plug boxes and leads being arranged at suitable intervals. The four conveyor bands are continued through the second tunnel section to the junction with the third section, where the tunnel makes a square turn and runs from the dock wall to the basement of the granary. The conveyors in the third section are about 320ft. between terminals, and to equalise the drive some 200ft. length of bands in the second section are driven at the angle by means of cut bevel gearing and roller chain drives. Thus each length of band per motor is approximately equal, and similar 30 brake horse-power motors are adopted for each conveyor. The conveyors in the third section are provided with travelling "throw-offs" for use near the extreme end where the tunnel opens out into a spacious chamber near the granary basement. Here any interchanging that may be necessary is carried out between any one of the four weighing machines. These machines are fitted with large hoppers above and below for the receipt of the grain, and weigh 2000 lb. per turn of the scale. The grain is discharged into the boots of the four main elevators, each capable of lifting 100 tons per hour to the top of the floor of the granary.

The main elevators deliver the grain to the four bands traversing the whole length of the granary over the heads of the silo bins and grain floors, and by means of travelling "throw-offs" provided on each of the bands the grain is discharged into any one of the seventy-eight silos or upon any of the grain floors. The four weighing elevators and four main elevators are driven each by a 30 brake horse-power motor of the enclosed type through a roller-chain drive and cut gearing, each motor at the same time driving a length of conveyor band by similar chain drives. The grain floors are fitted with 12in. diameter steel shoots, continuous through all the floors down to the sacking off platform, valves being fitted for receiving and discharging the grain at any floor.

An interesting feature in connection with this machinery is the arrangement of "re-elevating" bands in two small subways constructed under the granary. By means of these conveyors grain can be taken from any silo or grain floor, re-weighed and re-elevated to another silo and placed upon any other floor as may be desired, or heated grain can be circulated from silo to floor or *vice versâ*, and small parcels of grain can be removed from the silo to a floor to make room for incoming grain. Each of these bands is driven by a 15 brake horse-power enclosed type motor, through cut gearing and chain drive as before mentioned.

For the despatch of grain to coasting steamers or other small craft a special conveyor for carrying loaded sacks or loose grain has been erected in an overhead gallery which is shown in the illustrations—Fig. 2. The inner end of this conveyor extends below the sacking-off platform. The sacks of loose grain are passed through openings in the platform on to the band, and are delivered at the dock side through special shoots into various craft. This conveyor is fitted with two-speed gear, the band speed for loose grain being 650ft. per minute. The band is in two sections of unequal length. The inner section of 450ft. is driven by a 30 brake horse-power motor of the type mentioned in connection with the tunnel conveyors, and the outer length of about 220ft. by a 15 brake horse-power motor placed in a house below the gallery. A special "throw off" for loaded sacks is provided at the junction of the two sections, the bands not being in the same line.

The whole of the twenty-four motors needed for the running of this plant were supplied by the General Electric Company, Limited, of Witton, Birmingham; the starting gears by the Electric Construction Company, Limited, of Wolverhampton; the cut gearing by David Brown and Sons, Limited, Huddersfield; and the conveyor bands by the India-rubber, Gutta-percha, and Telegraph Works Company, Limited, of Silvertown.

We are enabled to reproduce herewith a series of photographs of different parts of this installation. Fig. 1 shows the granary itself; Fig. 2 the gallery for conveying sacks from the granary to the dock; Fig. 3 a tension end of a conveyor; Fig. 4 the top granary floor; and Fig. 5 part of the driving gear of the grain conveyors.

HOLLOW CHISEL MORTISING MACHINE.

A MACHINE has been recently specially designed by A. Ransome and Co., Limited, of Newark-on-Trent, for mortising, boring, and recessing heavy timber for railway carriage and wagon works. It is designed to operate chisels up to 2in. square, and to make mortises of any length, as well as to bore holes up to 3in. in diameter through timber of any size up to 12in. square. An illustration of this machine is given herewith. As will be seen, the main standard is of box section. The mortising chisel is mounted on a carriage which slides vertically in the top half of the main standard. The slide is fitted with ball bearings, the balls being held in place by gun-metal cages. The mortising is effected by means of a reciprocating hollow square chisel having an auger revolving in its centre. The chisel squares the holes made by the auger. The auger as it revolves removes the chips made by itself and the chisel from the hole. The chisel has an automatic reciprocating motion imparted by means of a strong square-threaded screw actuated by mitre gearing, and fitted with one fast and two loose pulleys with belt shifting gear for working in both directions with a quick return motion.

Mortises of any desired length can be made by continually cutting one hole after another on the same line. The boring spindle runs in two adjustable gun-metal bearings, and is driven by means of a pulley carried in a sleeve between these bearings, and driven over guide pulleys from a countershaft fixed to the main standard of the machine, which is fitted with fast and loose pulleys, so that the mortising apparatus can be stopped when not required.

The machine is provided with two independent boring spindles, each having a vertical range of 16in., and is capable of boring holes up to 3in. in diameter. Each boring apparatus consists of a headstock into which the spindle bearings are fitted. The under side of the headstocks have V grooves planed in them, and slide on a series of steel balls fitted into a gun-metal cage so that they cannot be lost. Each boring spindle is provided with a cast iron sleeve and pulley. The sleeve runs in two pairs of hard gun-metal bearings, adjustable for taking up wear, and the two spindles are rotated by means of one belt driven from a double flange pulley on a countershaft placed at the back of the machine. The belt passes alternatively round a boring spindle and a guide pulley, and is so arranged that as one headstock is brought forward the belt is shortened on the one side of it and lengthened to a corresponding degree on the other side, and thus the belt always remains at the same tension. An apparatus is provided with an adjustable guide pulley for taking up stretch in the belt. Each boring spindle is brought separately into action by means of a pulling rod placed in front of the machine, and is counterbalanced, so that when the handle is released the auger rises clear of the work.

The mortising headstock and the two boring spindles are provided with adjustments transversely across the work independently of each other by means of hand levers, which enable the tool to be instantly brought into any desired position for the work. These levers are fitted with a locking handle actuating a double pawl, which on being released at once locks the slide. The table for supporting the material consists of a steel travelling bed, with the feed being brought about by means of a rack-and-pinion motion actuated by a large hand wheel in front of the machine. The table runs on friction rollers, and is fitted with a fence and quick-acting cramps for holding the material firmly in position. The machine is provided with two steel countershafts, one for driving the mortising apparatus and the other for driving the boring spindles.

A NEW CENTRAL AMERICAN STEAMSHIP SERVICE.

IN the course of the article relative to the "Tehuantepec Railway and Terminal Ports," published in THE ENGINEER of September 10th, mention was made of the intention of the Salvador Railway Company to start a new weekly steamship service between Acajutla, the terminus of the Salvador railway system, and Salina Cruz. To supplement the information we have already published, it may be stated that Acajutla is 420 miles from Salina Cruz and 1000 miles from Panama. A passenger from Salvador arriving at Panama, and desiring to go to Europe or the United States, finds that only one way is open to him, namely, to take the train to Colon and then go by ship. On the other hand, a passenger arriving in Salina Cruz finds that there is a railway connecting with the general system of Mexico and the United States, as well as Canada, with a daily service of express trains. This is, of course, in addition to the Tehuantepec Railway, which goes straight across to the Atlantic side, and has two trains operating between Salina Cruz and Puerto Mexico every day. The service at present on the Pacific has been maintained by the Pacific Mail Steamship Company, an American undertaking, and also by the Kosmos Company, running under the German flag. The Pacific Mail runs a service from San Francisco to Panama, calling at all the Central American ports. The Kosmos steamers come out from Europe through the Magellan Straits, and also call not only at the Central American ports, but at the ports of the western coast of South America as well. Between Acajutla and Salina Cruz the Guatemala ports are San Jose, Champerico, and Ocos, and there is also a Mexican port of Tonala. Calling at all these places, and frequently remaining at the more important two or even three days, the sea journey between Acajutla and Salina Cruz often occupies over a week, and occasionally a fortnight, although the distance is only 420 miles. The Salvador Railway Company intends to remedy this by the establishment of a weekly steamship service between Acajutla and Salina Cruz, which will cover the distance in about thirty-six hours. The saving of time will, however, not be the only benefit resulting from the new enterprise, as the existing facilities are also irregular. Boats do not arrive at Acajutla when they are expected, neither do they leave when they are expected to leave; and it has frequently been the case that passengers arriving at Acajutla with the view to going forward by a steamer have, after waiting all day at the port, been told that the steamer would not come in until the next day; and then, having once arrived, she remains two or three days, more especially during the coffee season. Such irregularity, coupled with a slow schedule, has not encouraged the Salvadoreans to travel; but yet, despite all these disadvantages, there has been a steady increase in the passenger traffic outwards and inwards from and to the Republic, *viâ* Acajutla. The new service will be started about the middle of December, and the steamer was launched on Thursday of last week from the Neptune Shipyard of Swan, Hunter and Wigham Richardson, Limited, of Walker-on-Tyne. She has an overall length of 225ft., with a beam of 33ft. 6in., and is being built under special survey to Class 100 A 1 Lloyd's. The Salvador is fitted by Swan, Hunter and Wigham Richardson, Limited, with triple-expansion engines capable of giving a speed of 11 knots on service, when loaded with a cargo of coffee. Accommodation for twenty first-class passengers is arranged in deck-houses amidships, with upper deck-house for captain, and chart-room and officers and engineers in side-houses. The Salvador has teak decks, and her general outfit is of a high order, being eminently suitable for the service for which she is intended. The vessel is expected to leave the Tyne for its destination on October 12th. She will sail under the British flag, and be officered by British subjects.

THE *Feuille Fédérale Suisse* of 8th September publishes a decree granting to the Compagnie du Chemin de Fer Lac de Constance-Toggenbourg a concession for the construction and working of a line from Ebnat to Nasslau. The line must be completed within two years from the date of the commencement of the work.

BOILER CORROSION AS AN ELECTRO-CHEMICAL ACTION.*

By Prof. C. F. BURGESS, University of Wisconsin.

Iron and steel under most influences to which it is exposed undergo deterioration in various ways. The most prominent type of deterioration is that designated as corrosion.

In analysing the causes of and remedies for corrosion, we are drawn to the conclusion that the term corrosion is not the name of one disease, but it is a generic term, covering a large number of diseases with which iron may be afflicted.

The particular uses to which iron is put has a marked influence on the kind of corrosion which it will develop. Thus we have certain diseases contracted by iron pipes through association with electric railway lines, which diseases are different both as to cause and effect from those encountered in steel smoke stacks. We have one kind of corrosion of galvanised fence wire which is different from that produced by iron exposed to sea water.

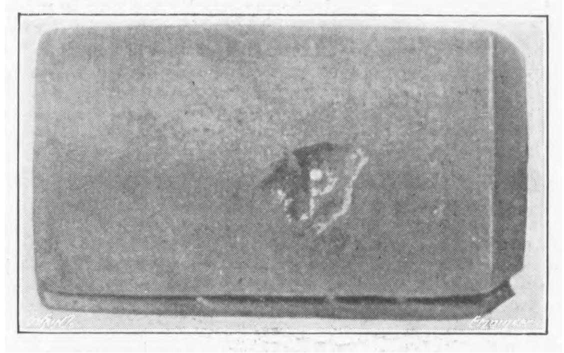


Fig. 1—Pitting of a Boiler Tube

Dr. Cushman, of the Department of Agriculture, has asserted that all kinds of corrosion of iron, whether it be on pipes buried in the city of New York or on the plains of North Dakota, of fence wire or on battleships, is due to one and the same cause—electrolytic action, or galvanic action, as it is more commonly termed.

This is, perhaps, a radical assertion, but it is one to which we can bring much experimental data and information in support of its accuracy. It is this fact that furnishes the justification for presenting this paper on iron corrosion to the Electrical Section of the Western Society of Engineers.

Your attention is being called particularly to corrosion in steam boilers, and to the possibility of its being due to electrolytic action. If this be true, then the prevention of boiler corrosion becomes a problem worthy of study by electrically trained men.

It is not a modern idea that corrosion in steam boilers may be attributable to electrolytic action, since based upon this supposition, we have the frequently suggested, though less commonly practised, use of zinc to prevent such corrosion.

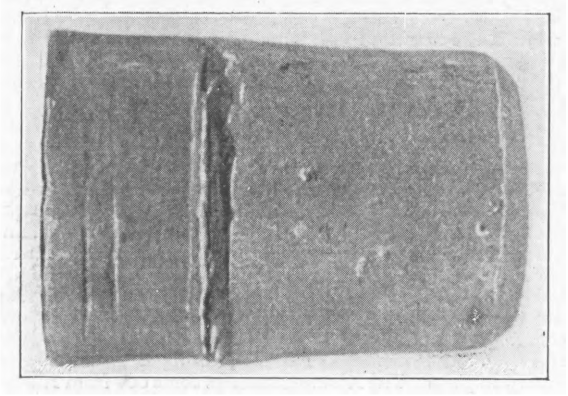


Fig. 2—Grooving of a Boiler Tube

The influence of inequalities of temperature and of galvanic action resulting from this and other causes, have been classified among those which are considered to be of minor importance, but it is upon these factors that special emphasis is to be laid here, due to the belief of the writer, founded upon experimental observation, that if electrolytic action were entirely absent, or could be exactly neutralised, there would be practically no internal boiler corrosion to be encountered.

To produce electrolytic action, we must have an electrochemical system, consisting of two different metallically conducting electrodes at differences of electrical potential, and making contact with an electrolyte. The system becomes active when the two electrodes are connected together, furnishing a metallic path as well as an electrolytic path for the flow of current. It is a fundamental law of electrolysis that the anode is subjected to an oxidising action and the cathode to a reducing action. The oxidation at the anode must be considered in its general sense—that is, the union of the metal with oxygen or some other electonegative element or radical. The result of this oxidation may be the formation either of a soluble or an insoluble material, and, without taking up a detailed consideration of the factors which influence this solubility or insolubility of the resultant product, it may suffice to state that iron as an anode in waters commonly employed for boiler purposes, and with the low current densities which are encountered, the iron will form, in the main, soluble products, such as iron chloride, sulphate, nitrate, and the like.

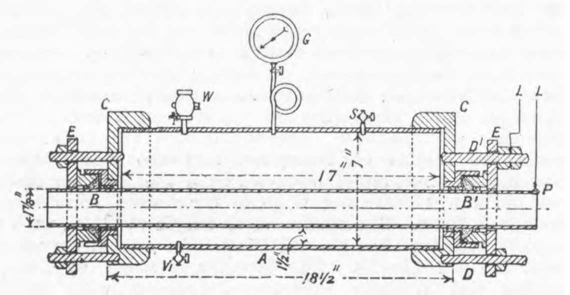
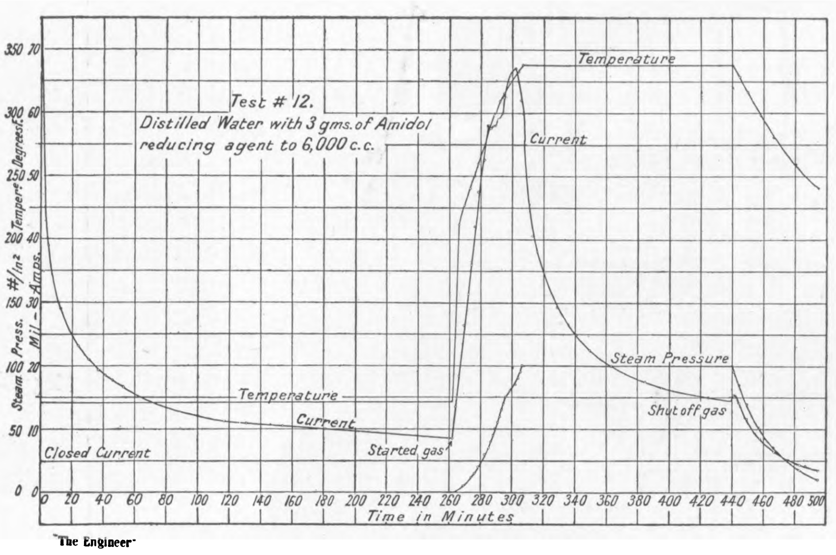


Fig. 3—Apparatus for Studying Boiler Corrosion

In the locomotive boiler which will be taken as our typical case for examination we have one continuous metallic structure enclosing a body of water which constitutes an electrolytic conductor. To find in such a boiler an electro-chemical system, we must find differently charged electrodes which are in metallic contact. That there are such various combinations will be pointed out.

Any metallic conductor making contact with an electrolytic conductor sets up at such point of contact a potential difference, the amount depending upon the nature of the two conductors. Thus we have zinc setting up a higher potential against the solution than will iron against that same solution, and were these two metals to be brought into metallic contact, electrolytic action will result, the current being proportional to this difference of potential and inversely as the resistance, providing, of course, there is no polarisation to act contrary to the primary electro-motive force.

In the electro-chemical series of elements we have a classification of materials according to the potentials which they will set up, the electro-positive ones becoming the anode as against any substance lower in the series. With a piece of zinc in contact with iron and a common electrolyte in contact with both, the zinc becomes the anode and subject to corrosion, and the more electro-negative iron becomes the cathode, and is thereby protected from corrosion. On the other hand, with a particle of carbon or cinder or other material electro-negative to iron, the iron becomes the corroding anode material, and it is upon this basis that the common explanation is given for the production of certain pitting attributable to the presence of a small particle of cinder or black oxide scale or similar material which makes the iron immediately around it the anode.



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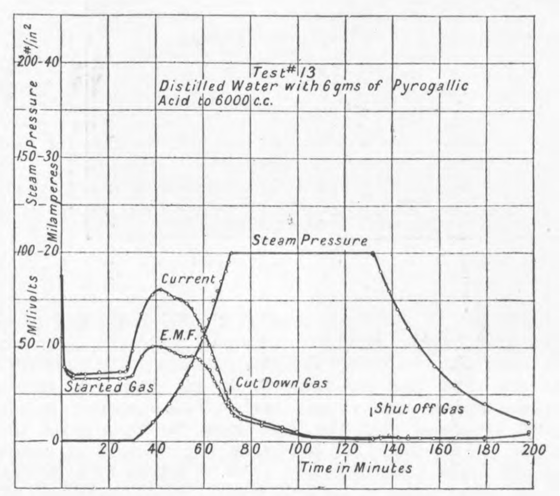
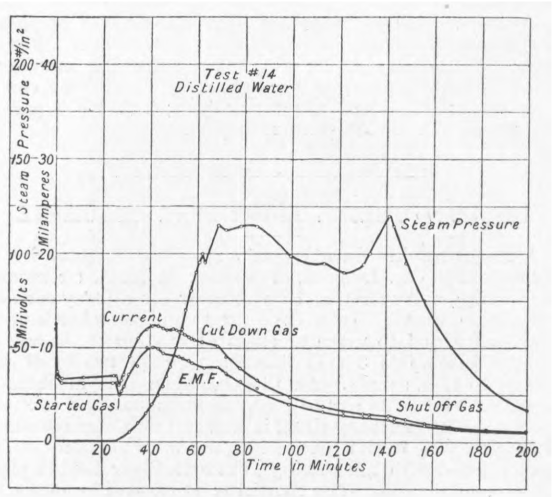
Test 12—Variation in Current with Changes in Time, Temperature, and Steam Pressure



Test 13—Effect of Acid in the Electrolyte

It is not an uncommon boiler practice to insert a copper ferrule between the tube and the tube sheet to ensure a tight joint. This constitutes a voltaic couple, the portion of the copper in contact with the boiler constituting a cathode and the surface of the iron in its neighbourhood the anode.

To have other electrolytic couples it is not necessary to assume the presence of such other electro-negative metal or to the influence of embedded cinders or carbon, or to the segregation of impurities in the iron. Iron itself may set up such couples, depending upon its previous physical treatment, pressure of strains, and inequality of temperature.



Test 14—Test with Distilled Water

Upon a suggestion from Mr. Walter Alexander, of the Motive Power Department of the Milwaukee shops, C. M. and St. P. Ry. Co., some investigations were begun about two years ago in the chemical engineering laboratories of the University of Wisconsin, to study some of the peculiar types of corrosion which are encountered in the practical operation of locomotive boilers.

The peculiar types of corrosion to which attention was particularly called were pitting of tubes, most frequently found on the lower side of the bottom tier of tubes; also the grooving, found most generally just within the tube sheet at the front end of the boiler.

After a large amount of preliminary work, which need not be described here, marked evidence was found tending to support the supposition that electro-motive forces are developed within boilers, due to the inequalities of temperature between tubes and shells, and also that such electro-motive forces were of sufficient magnitude to cause the passage of enough electric current to produce appreciable corrosion within a short time.

It was found that the electro-motive forces varied with the kind of feed water employed, and with varying conditions within the boiler; and, naturally, the variations in the electric currents which were established varied in greater degree, due to the varying electrical conductivity in different kinds of feed water.

It appeared desirable to conduct these electrical measurements upon a locomotive boiler under actual conditions of service, but such tests have had to be postponed until laboratory investigations had been made, and it is hoped that the larger scale investigations will be conducted during the coming year.

The latest type of laboratory apparatus upon which most of the observations have been made is illustrated in Fig. 3. This consists of an iron pipe A, 7in. in diameter and 17in. long, closed by iron caps screwed on the ends. B and B^1 are stuffing-boxes, placed below the centre of the caps, through which the pipe P passes. The purpose of this stuffing-box is to insulate the pipe from the steel cylinder, at the same time allowing this joint to stand a high steam pressure. Asbestos packing was found to serve this purpose admirably. The cylinder was fitted with a steam gauge and steam cock for the release of pressure, and another opening for the introduction and drawing off of water and sediment. Heat was applied to the apparatus by means of a blast flame inside of the smaller tube.

Electrical connections L L were made between the inside and outside tubes through the electrical measuring instruments, consisting of a mil-ammeter and a mil-voltmeter. A large number of tests were made by means of this apparatus, employing various kinds of boiler water, and operating under a variety of conditions as regards pressure, rapidity of heating, cleaning out of the apparatus, &c.

In each of the test runs which will be described here, the inner tube and the interior of the larger tube were thoroughly cleaned prior to each run or series of runs on a given feed water. There was introduced each time 6000 c.c. of water, always leaving a given gas space of a volume of equivalent about 2000 c.c.

The experimental work, and the compilation of results, was done by Mr. J. H. Thickens.

The various test runs which are referred to here are designated by Nos. 12, 13, 14, 15, 16, 17, 18, 19, 24 and 25. The results of the tests are given without attempting to explain all of the features or peculiarities noted in connection with the data obtained. This lack of explanation we shall have to attribute to inability rather than to neglect, and it is hoped that further investigation which is to be carried on, and that suggestions which may be offered by others interested in this work, may make it possible to bring about a clearer understanding of the various phenomena which are involved.

As to test No. 12, curves are given which show the variation of current between the inner and outer tube with variations in time temperature and steam pressure within the experimental boiler. Distilled water was employed containing 3 grammes of amidol as a reducing agent, to the 6000 c.c. of solution. The distilled water employed in these and other experiments was produced under conditions such that it became aerated, and the presence of air is undoubtedly an important factor. Upon introducing the water it was noted that there was a momentary flow of current of 0·075 ampères, which, during the first few minutes decreased rapidly and then more slowly, falling to 0·0085 ampères at the end of 260 minutes. The initial electro-motive force which caused this flow of current may perhaps be attributed to differences in the composition or previous treatment of the iron, constituting the inner and outer tube respectively, and the decrease of the current which is here noted may be due to polarisation effect, both at the anode and at the cathode.

In all of the curves, it is to be noted that the current and electro-motive force when plotted above the base line, indicate that the inner tube is the anode, while, when they fall below, indicate that the outer tube is the anode.

At the end of 260 minutes, heat was applied to the inner tube, and the current rapidly increased to a maximum of 0.067 ampères, which maximum point was reached somewhat before the maximum steam pressure of 100 lb. per square inch had been attained. After this the current fell off, rapidly at first and then more slowly, until after 440 minutes the source of heat was removed, when the current rose for an instant and then fell off more rapidly.

It does not appear from these curves that the amount of current is a function of the temperature alone or of the differences of temperature, but it appears that it is also dependent upon the amount of some constituent in the electrolyte itself.

In test No. 13 6 grammes of pyrogallic acid were added to the distilled water, and values of both the current and the open-circuit electro-motive force were obtained during the progress of the test. In this case, after the heat was applied, the current and electro-motive force attained maximum values considerably before the maximum steam pressure was reached, and the values then decreased rapidly until they became almost negligible.

Test No. 14 was similar to test No. 13, with the exception that distilled water alone was employed, and in this we have values of electro-motive force similar to those in the previous experiment, but the corresponding amounts of current were materially less, due probably to the decreased conductivity of the solution. In this experiment the steam pressure was not kept at a constant value, but was allowed to vary through a wide range to determine what influence, if any, the steam pressure might have on the current and electro-motive force values. The conclusion seems to be that there is little, if any, such influence.

To test the influence of an oxidising agent in the electrolyte was the purpose of test No. 15, for which a solution containing 40 c.c. of 3 per cent. hydrogen peroxide were added. This solution was found to be slightly acid. The increased corrodibility of this solution is shown by the increase of current and electro-motive force curves.

That the corrosion is proportional to the area included in the current curve, and that such corrosion results in a diminution in the corroding agent, is shown by test No. 16, which is a repetition of No. 15, in which the apparatus was allowed to cool down and stand for sixteen hours before beginning this test, the same solution as used in test No. 15 being kept in the apparatus. The current in this case was much smaller than in the previous run. After cooling down and again heating, the current curve is still smaller.

In test No. 17 distilled water was used, containing 1·82 grammes of soda ash to the 6000 c.c. of water. This is equivalent to about one pound per thousand gallons, and is an amount frequently used in locomotive boiler practice.

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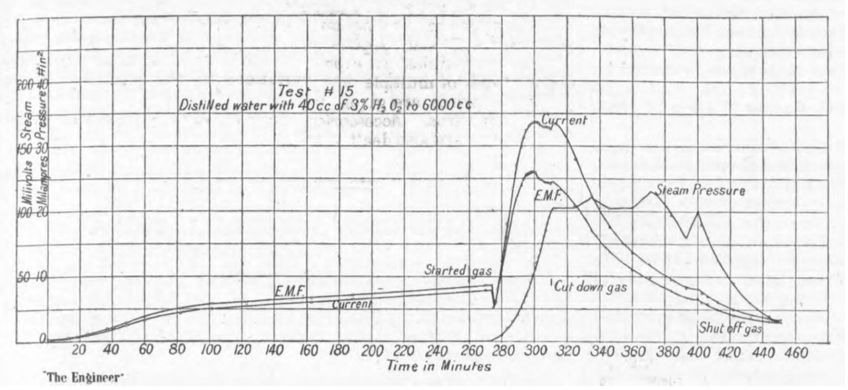
* Presented before the Electrical Section of the Western Society of Engineers, Chicago, January 15th, 1909, and reprinted by permission from the *Journal* of the Western Society of Engineers.

The most noticeable influence of the effect of this soda ash is to increase the conductivity of the electrolyte and thus increase the current flow, although it is also noted that the electro-motive force is somewhat higher than is found with the untreated distilled water.



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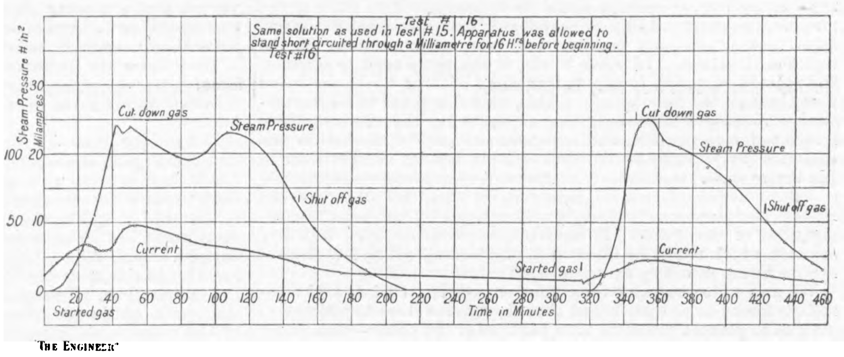
Test 15—Showing Effect of an Qxidising Agent in the Electrolyte on Current and on E.M.F.



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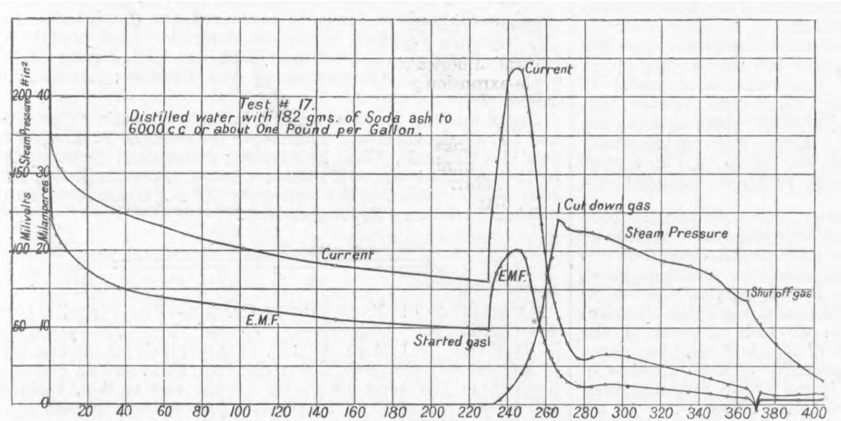
Test 16—Repetition of No. 15, with Rest Interval, Cooling off Apparatus



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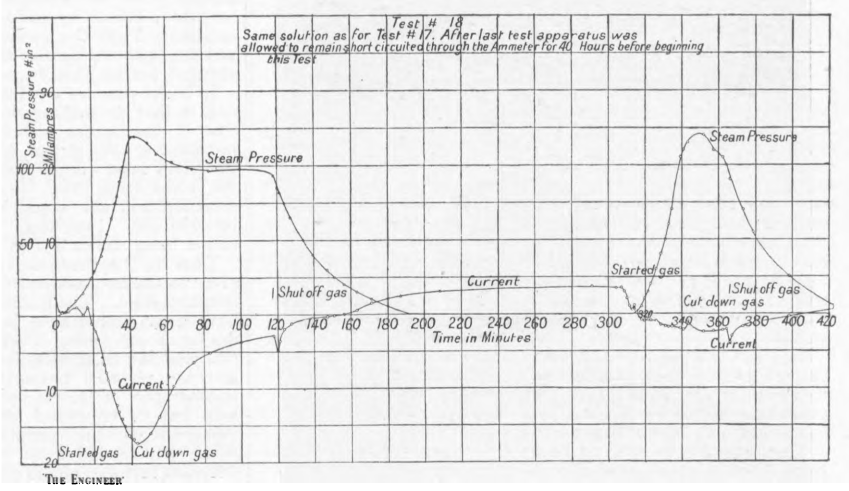
Test 17—Water Made Alkaline, with Soda Ash, Showing Increase of Current and E.M.F.



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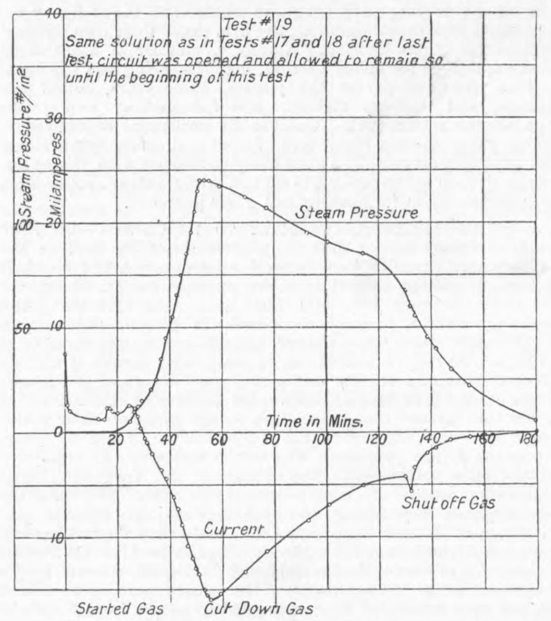
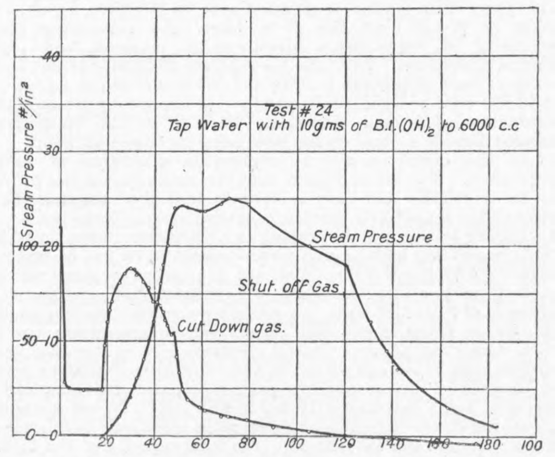
Test 18—Repetition of No. 17, with Rest Interval, Cooling off Apparatus

Test No. 18 is a continuation of No. 17, after the apparatus had been allowed to remain short-circuited forty hours, and again applying the heat. This would correspond to the practical condition where a locomotive boiler containing this kind of feed water is allowed to cool off and is again brought up to normal steam pressure. The first half of the current curve in No. 18 shows that the inner tube now becomes the cathode, and such electrolytic corrosion as there may be is on the outer shell of the boiler. On allowing the steam pressure to fall off by standing, but not waiting for it to become cold and then applying heat, the current is found to be materially less, and this may, perhaps, be attributed to the fact that in the second portion of the curve the temperature differences were less than in the first curve.



Test 19—Repetition of Nos. 17 and 18, with Longer Interval for Cooling off

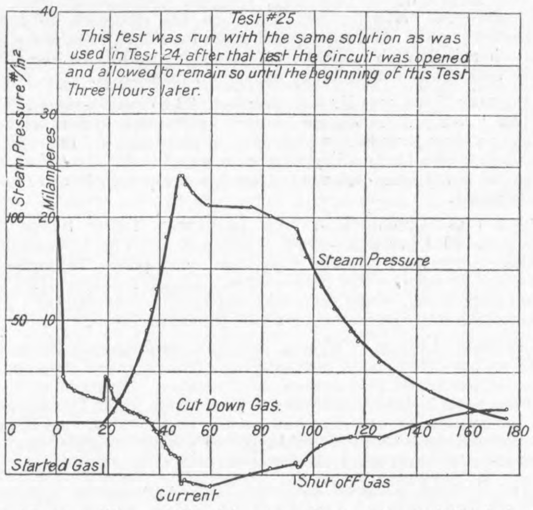


Test 24—Water Made Alkaline, with Barium Hydrate

That this diminution is due to a diminution in temperature differences rather than to the consumption of some element in the solution is shown from test No. 19, where the apparatus and solution used in test No. 18 had been allowed to stand seventeen hours, when the test was again repeated. In this case the negative-current values are greatly increased.

Test No. 24 shows the influence of the introduction of barium hydrate on lake water, and test No. 25 is a repetition of the former test after the same solution in the apparatus had been allowed to remain for three hours, the circuit being opened. On repeating the heating operation, the current decreased until it became negative, and the inner tube became the cathode, as was the case in a more marked degree with the soda-ash solution.

Among the striking factors for which no explanation is offered we may mention test No. 14, in which there is a momentary decrease in the current and electro-motive force just after the heat is applied, which is also shown in tests Nos. 15 and 16. Again, on shutting off the gas, there is a critical point in the curves in tests Nos. 12, 14, 15, 17, 18, 19, 21, and 25.



Test 25—Repetition of No. 24, same Electrolyte, but Cooled off

It is known that if the apparatus had not been cleaned out prior to each test, different relationships would have been shown, and the oxidation scale which forms on the inner tube is undoubtedly an important factor. In most cases this scale consisted of a firmly adherent black oxide, but in the case of the use of sodium carbonate, where the inner tube was the cathode, the coating consisted of a loosely adherent brown oxide rust.

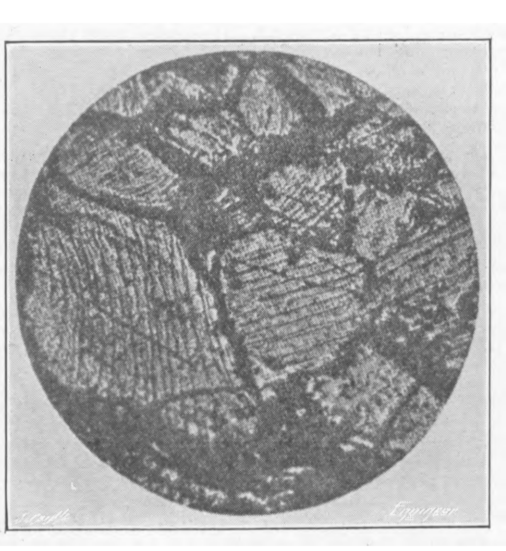


Fig. 4—Strained Swedish Iron (300 diameters)

In most of the tests, the character of the corrosion on the inner tube was similar to the corrosion observed in locomotive boiler tubes. Incipient pitting was noted along the tube, and especially in the lower portion. A marked pitting and grooving was also observed at the ends of the tubes.

It is, of course, appreciated that absolute conclusions cannot be drawn from a small experimental apparatus such as has been described, as to what will take place in large boilers, but these experiments do demonstrate the possibility of marked electrolytic action. It is possible that we have a demonstration of the conclusion which is drawn from practice in boiler operation that repeated heating and cooling promotes corrosion, and that corrosion is greatly influenced by the quality of the water as regards purity and the "compositions" which are used for the prevention of scale.

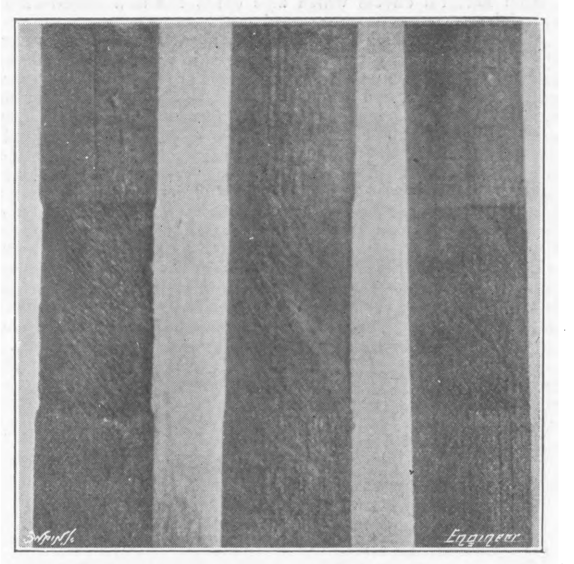


Fig. 5—Corroded Torsion Specimens

We believe that in a small experimental apparatus of this sort the qualitative and quantitative influence of various kinds of feed water can be studied, the results being procurable in a short time. If we may draw conclusions from some of the experimental runs which we have made, one of them is to the effect that the presence of sodium carbonate in considerable quantity will result in the heated tubes becoming the cathode, and consequently free from corrosion, the corrosion being on the other portions of the boiler; this, we understand, agrees with actual experience in certain sections of the country where an excess of sodium carbonate is found in the boiler feed water employed.

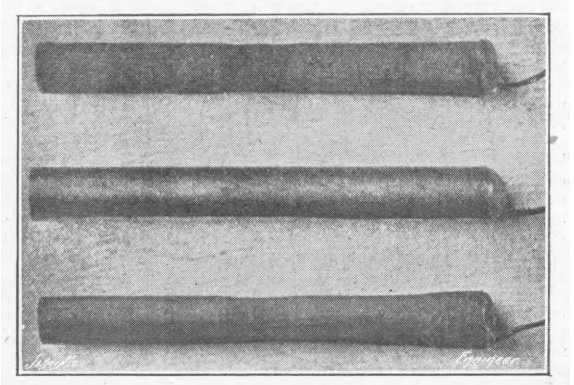


Fig. 6—Corroded Tension Specimens

If electrolytic action, maintained by differences in temperature, is responsible for a major or even a large portion of boilor corrosion, the remedy must naturally be found in means for preventing such electrolytic action, and it becomes therefore largely an electrical problem. Looking at the various possibilities from the electrical point of view, we have the following considerations:—Electrolytic action can be prevented if the solution be made a non-conductor, which, of course, is impossible from the practical point of view, since, aside from cost, even distilled water is known to possess appreciable conductivity. Another method for interrupting the flow of current would be to prevent those parts of the metallic structure which are heated and therefore electro-positive from making metallic contact with the other portions of the metallic structure. In other words, if the tubes tend to corrode, the remedy would be to use an insulating packing where the tubes pass through the tube sheet. This, again, appears to be impractical. Attention may be given to reducing the electro-motive forces as far as possible, and improvement may be effected in this direction by a study of the influence of various compositions in the boiler water, and that this electro-motive force is subject to a certain amount of control is shown by the fact that we can reverse the directions of the flow of current by varying the compositions of the water. It does not appear, however, that any solution which might be discovered which would set up low electro-motive forces would be in stable equilibrium.

We may note the more important suggestion, that the electro-motive forces be so distributed that the current flows in a direction such as to protect the more vital portions of the boiler—that is, by making such portions of the boiler the cathode, the corrosion is prevented. This has been done by the use of zinc—a metal which is highly electro-positive with respect to the iron and which, in contact with iron and the electrolyte, will make such iron the cathode. This protection is offered only at the expense of the consumption of the zinc, and many boiler users object to this remedy on account of the cost of the zinc, the difficulty of properly distributing it in the boiler and making metallic contact therewith, to the rapid disintegration of the zinc, and to the alleged harmful effects which zinc oxide has as a scale-forming material.

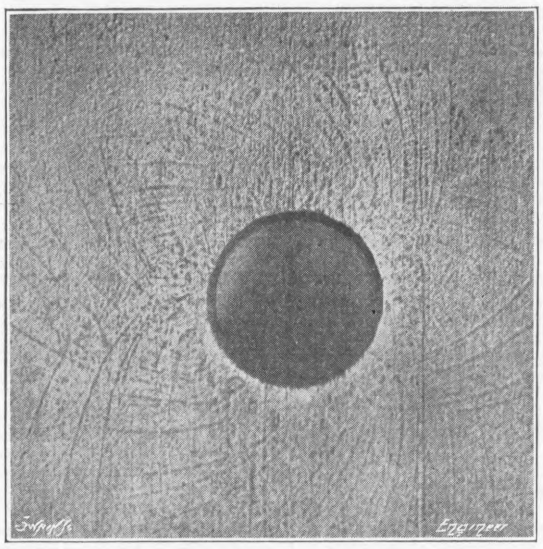


Fig. 7—Corroded Punched Plate

A proposition which is not entirely new, though I believe one which has not been given sufficient trial in practice, is to employ some other anode material which will not have the disadvantageous properties of zinc, and maintaining this as the anode, not by the energy which it possessed in itself, but from energy derived from an external force. For example, if an iron bar be made to take the place of one of the fire tubes in the locomotive boiler by passing it through the tube sheet by an insulating packing. This might be made the anode, and all of the internal corrosion centred upon it by connecting it externally to the positive terminal of a source of electrical energy, such as a battery or small dynamo, the negative of which is connected to the boiler structure. If such anode could be properly placed, it is possible that protection could be afforded with the consumption of a small amount of electrical energy—in fact, an electro-motive force greater than one-half volt would probably not have to be employed and the current density could in all probability be kept at a very low figure. This is not given with the claim that it will cure boiler corrosion, but rather as an expedient which is worthy of further investigation.

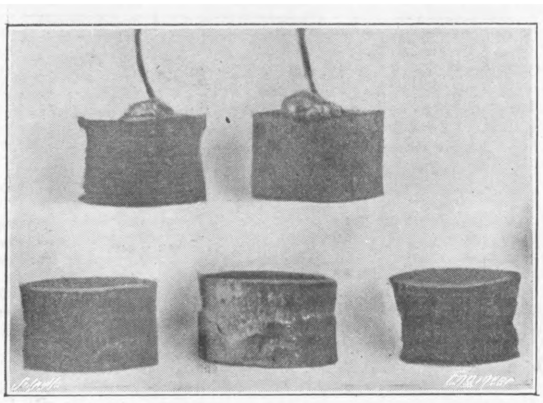


Fig 8—Corroded Punchings

In the experiments which have here been described, electro-motive forces of measurable magnitude have been found, but further experimental work will have to be performed before the source or sources of these electro-motive forces can be accurately located. In measuring the potential difference between two electrodes we have the summation of two potentials, that at the anode and that at the cathode, and the electro-motive forces which are referred to in this paper are such summations. A decrease in electro-motive force may be due to change in the contact potentials against the electrolyte of the metals themselves, or it may be due to polarisation phenomena, caused by the liberation of hydrogen or some other material at the cathode, and by the liberation of oxygen or some similar material at the anode. These polarisation phenomena oppose electrolytic corrosion, and any factor which reduces the polarisation will therefore promote corrosion. It is an idea commonly held that the presence of free oxygen in water is harmful in steam boilers, in that it unites with the iron, resulting thereby in its corrosion, but Dr. W. H. Walker has pointed out with special emphasis the important fact that free oxygen promotes corrosion, not by uniting with the iron, but by uniting with the hydrogen liberated at the cathodic portions of the metallic structure. The oxygen uniting with the hydrogen reduces the polarisation at one place, and thereby promotes the corrosion of iron at another. Any other oxidising agent in the electrolyte may be assumed to act in a similar manner. Likewise, a reducing agent dissolved or otherwise diffused throughout an electrolyte may have a depolarising action at the anode.

To obtain a more definite and clearer idea of the electrolytic phenomena herein described, it is desirable to study the changes in single potential at the separate electrodes; that is, the potential changes between the inner tube and the electrolyte should be noted as the temperature and other conditions are varied, and a similar study should be devoted to the outer tube, corresponding to the boiler shell. This can be done by employing a so-called normal, or constant, potential electrode.

That there are galvanic couples other than those produced by differences of temperature has been pointed out, and some illustrations are given here to show the influence of some of these factors.

It has long been known that iron and steel which has been strained beyond the elastic limit has its internal energy changed, which thereby sets up a different potential toward an electrolyte than would a normal metal. Quantitative effect of this straining is discussed in "The Corrosion of Iron from the Electro-chemical Standpoint"—"Transactions" of the American Electro-chemical Society, April 30th, 1908. A microscopic section of a pure Swedish iron is shown in Fig. A, which has been strained beyond the elastic limit. The groove lines running across the grains are the result of this straining, these grooves having been produced by the more rapid attack by a corroding agent than is produced on the remaining portions of the metal. That this uneven corrosion is not alone a microscopic phenomenon is shown by Figs. 5 and 6, which are photographs from samples of mild steel which had been strained either by tension or torsion, and then ground down to uniform cylindrical surface and subsequently corroded, either by making it an anode or by using a corrosive solution. That the strained portion has been the more electro-positive is shown by the more rapid removal of the iron from the strained portion than from the unstrained.

In boiler practice a drilled rivet hole is preferable to a punched one, in that the drilling does not weaken the surrounding metal. One of the causes of weakness of the surrounding metal by punching are the strains set up, which extend some distance from the rivet hole. Some steel plates ¾in. thick were punched cold, the holes being 1in. in diameter. These were subsequently corroded and the strain lines, which are shown in Fig. 7, were brought out. Punchings were likewise corroded, a non-uniform action being shown in Fig. 8.

Thus far it appears that comparatively little attention has been given to the microscope as a means for studying the corrosion of iron and steel. The histology of iron and steel has been shown to have great importance in the work done by metallographists during recent years. Their attention has been given, however, to studying the relationships between the metallographic structure and the physical properties. When we look at some of the photographs of microscopic sections of iron and steel we cannot help but be impressed with the possibility of the existence of numerous galvanic couples, the galvanic action resulting from which will depend upon the electro-motive forces set up by the different metallographic constituents.

CATALOGUES.

Veritys Limited, 31, King-street, Covent Garden, W.C.—This is a tasteful little pamphlet which gives illustrations, prices, &c., of "Ashton" electric radiators. The pamphlet deals with several new designs, including the non-luminous radiator as used on H.M. battleships and cruisers.

The Leeds Forge Company, Limited, Leeds.—Two well got up catalogues have reached us. One has reference to Lane's patented pressed steel corrugated doors for railway wagons, whilst the other deals with pressed steel frames for railway rolling stock. Both catalogues contain many excellent illustrations.

Vickers, Sons and Maxim, Limited, 32, Victoria-street, S.W.—The "V.S.M." automatic forced lubrication system is dealt with in a new pamphlet which has just reached us. The system, which is applicable to all types of bearings, is fully described, and with the aid of some coloured drawings the principle can readily be followed.

The Gas Economising and Improved Light Syndicate, Limited, 138, Leadenhall-street, London, E.C.—This is a pamphlet giving particulars of the Blanchard high-power incandescent paraffin oil lamp. The advantages claimed for this lamp are clearly set forth, whilst the illustrations give the reader a good idea of the many purposes for which the lamps are suitable.

Johnson Lundell Works, Southall, Middlesex.—From this firm we have received a new catalogue descriptive of the Johnson Lundell laminated field motors and dynamos. Illustrations of the various parts of these machines are given, from which the character of the general construction can readily be gathered. At the end of the catalogue there are tables giving speeds, weights, outputs, and prices of these machines for circuits of various pressures.

The Witton Kramer Electric Tool and Hoist Company, Witton, Birmingham.—Leaflets K 6, K 7, K 8, and K 12 have reached us, dealing with electric polishing machines, electric winches, electric grinders, and flexible shafting respectively. Two types of electric grinders are dealt with in leaflet K 8, one for use on the tool rest of a lathe or for use on a milling machine, whilst the other may be used for grinding commutators while the armature remains in its own bearings.

Worthington Pump Company, Limited, 153, Queen Victoria-street, E.C.—This is a new catalogue having reference to Worthington condensing apparatus. It contains much useful information concerning the condensers built by the company, which are of the jet and surface types. The catalogue also deals with auxiliary apparatus for use in connection with condensing plants, such as pumps, oil separators, relief valves, &c. There are many excellent illustrations.

The Globe Electrical Company, Limited, 11, Farringdon-avenue, London, E.C.—This is a catalogue which illustrates and describes "Santoni" arc lamps for direct and alternating-current circuits. Prices, dimensions, and other particulars of interest to buyers are given in tabular form. The prices of line resistances, auto-transformers, special flame carbons, &c., are also dealt with. The catalogue has reference to various kinds of arc lamps, and they are suitable for a large number of purposes.

Bruce Peebles and Company, Limited, Edinburgh.—Pamphlet No 20A has reached us. It contains a considerable amount of information relating to the Peebles-La Cour motor converters, and should prove interesting to central station engineers and others associated with the generation and distribution of electric power. The pamphlet sets forth the principle of these machines in a manner which enables the action and advantages to be easily understood, and the diagrams showing the electrical connections are exceptionally good. At the end of the pamphlet the motor converter is compared with rotaries and motor generators. There is also a long list of users of these machines.

The Electric and Ordnance Accessories Company, Limited, Cheston-road, Ashton, Birmingham.—A new catalogue has just been published by this company, which deals with electric cooking and heating apparatus. The heating units used in the company's system consist of a special resistance material insulated with mica, and enclosed in a thin metal casing. We are informed that this resistance material is able to withstand a temperature of 2500 degs. Fah. without risk of breakdown. The company is prepared to supply kettles, jugs, glue-pots, plate warmers, and various other utensils used in the home, all of which are illustrated and described in this new catalogue. The company has also prepared a useful table showing the cost of operating these goods.

Pirelli, Limited, 45, Basinghall-street, London, E.C.—A copy of this company's newly issued cable and wire catalogue has been sent to us. The character of the publication may be gauged to some extent when it is stated that the goods with which it deals range from large armoured cables to instrument wires, all of which are of the company's own manufacture. Cables of various carrying capacities for lighting and power service are illustrated and priced, and the same applies to all types of gutta-percha cables, wires, and flexibles for every purpose. The catalogue describes several types of multiple telephone cables for indoor and outdoor work, and prices are given for cotton and silk covered bell and instrument wires. Accessories, such as tapes, ebonite sheets, and tubing, &c., are also dealt with.

LAUNCHES AND TRIAL TRIPS.

Viking, torpedo boat destroyer; built by Palmer's Shipbuilding and Iron Company; to the order of the British Government; dimensions, 280ft. by 27ft. 3in. by 17ft.; the propelling machinery consists of turbines of the Parsons type of 15,500 horse-power; launch, September 14th.

Ashtree, steel screw steamer; built by Craig, Taylor and Co., Limited; dimensions, 255ft. 9in. by 36ft. 9in. by 18in.; engines, triple-expansion, 19in., 31in., 51in. by 36in. stroke, pressure 180 lb.; constructed by the North-Eastern Marine Engineering Company; launch, September 16th.

Florinda, steel screw steamer; built by Swan, Hunter and Wigham Richardson, Limited; to the order of the Salvador Railway Company, Limited, for service along the coast of Salvador, Central America; dimensions, 225ft. by 33½ft. beam; engines, triple-expansion; constructed by the builders; launch, September 16th.

Bendew, steel screw steamer; built by Irvine's Shipbuilding and Dry Docks Company, Limited, to the order of Furness, Withy and Co., Limited, West Hartlepool; dimensions, 360ft. by 51ft. by 25ft. 6in.; to carry 6300 tons; engines, triple-expansion, 25in., 40in., 67in. by 45in. stroke; pressure 180 lb.; constructed by the builders; trial trip, September 18th.

Association of Engineers-in-Charge.—The council of this Association has unanimously elected Mr. Henry Adams, M. Inst. C.E., M.I. Mech. E., &c., as their president, in succession to Mr. James Swinburne, F.R.S., M. Inst. C.E., and an attractive programme has been drawn up for the new session, including papers and several social functions. Among the members of the Association Mr. Adams is one of the oldest of the engineers-in-charge, having so far back as 1865 been in responsible charge of the outdoor department of Sir W. G. Armstrong and Co., of Elswick Works.

Society of Engineers.—The fourth vacation visit of the present session took place on Wednesday, September 22nd, 1909, when, by the courtesy of Messrs. Wm. Hill and Son, facilities were given for a party of members of the Society and their friends to inspect the organ building works of this firm at Camden-road, Islington, N. The present works in York-road were built in 1873. They consist of offices, a large hall, 80ft. by 40ft., in which the organs are erected after the different parts have been prepared, and an engineering shop where, in addition to the ordinary work connected with organ building, the firm make their own hydraulic engines for organ blowing. Among a number of other departments are shops for metal casting, manufacturing and voicing the various pipes, shops for the joiners, casemakers, sound-board makers, and bellows makers, and for making and putting together the action-work. Outside the workshops is an extensive timber yard, where a large stock of hard and soft woods is stacked and kept to mature. The machinery connected with the works is driven by a 30 horse-power gas engine, while a steam boiler is used to generate steam for heating and other purposes.

A South Yorkshire Colliery to be Closed.—On Friday last it was made known that the proprietors of the Carlton Main Colliery near Barnsley had decided, in consequence of the strike at present existing, to shut down the pit permanently. This decision will affect between 1000 and 1200 men, who only about three weeks ago decided to come out on strike in order to settle a number of grievances which they alleged against the management of the colliery. The men's complaints, of the precise nature of which we have not seen any definite statement, were discussed at a meeting of the Joint Committee of Coalowners and Miners held in Sheffield. It was then agreed that if the men would suspend their notices, which were about to expire, the whole matter would be brought before the Joint Committee, who would endeavour to bring about a satisfactory settlement. The officials of the Yorkshire Miners' Association advised the men to accept this offer. The men, however, rejected their advice, and by a large majority decided not to withdraw at all from the position they had taken up, but to permit their notice to expire and stop the pit. The Carlton Main Colliery is an old one, and in view of the development of Grimethorpe and Trickley there was always the possibility of the owners deciding to close the pit and work what coal there remained to be got from the Grimethorpe shafts, as the two coal areas are contiguous. This, presumably, is what will be done. The colliery has had a very successful career. Sunk in 1875, it has worked a large area of the well-known Barnsley seam, touching no other seam of coal at any time.

The Thury Direct-current System.—The well-known series direct-current transmission line from Moutiers to Lyons, which has been in operation since 1905, has proved such a success that important developments are to be carried out on the same lines. The generating station is situated near to Moutiers, Savoy, and takes its power from the river Isere, the generating plant consisting of high-tension direct-current machines and high-tension alternators. The total horse-power of direct-current high-tension plant at present is 6400, and is transmitted at a pressure of 57,600 volts to Lyons, a distance of 180 kiloms., by means of two conductors of 9 mm. diameter. Parallel to the continuous-current line is a three-phase line going to the same point. At Lyons the direct current is utilised in a number of motor generators. We are informed that the series system has proved to be so reliable and easy to operate that the companies have decided to immediately carry out extensions on a large scale. A generating station is to be erected at La Bridoire, Savoy, in which three generating high-tension direct-current units will be erected, each of 2000 horse-power, and are to run at a speed of 428 revolutions per minute. They will generate 150 ampères at a pressure of 8000-9125 volts. A second generating station on the Roziers, at Bogel, Savoy, will consist of two generating groups, each consisting of two double machines driven by the same turbine, and capable of giving an output of 3500-4000 horse-power at a speed of 428 revolutions per minute, and delivering of 150 ampères, and a pressure of 16,000-18,250 volts. A corresponding amount of direct-current motor generator plant will be placed in the Vaulx-en-Velin sub-station. The total capacity of the direct-current high-tension generating plant, when the extensions are complete, will be 15,000 kilowatts, and the three generating stations connected in series will deliver 150 ampères at 100,000 volts. This will be a notable development, as for the first time in Europe an operating voltage of 100,000 volts will be reached, and it is claimed that this pressure is not the limit which can be achieved on this system.

THE IRON, COAL, AND GENERAL TRADES OF BIRMINGHAM, WOLVERHAMPTON, AND OTHER DISTRICTS.

(*From our own Correspondent.*)

Pig Iron Quieter.

PIG iron is quieter in this district than recently, and there is no question that buying has fallen off somewhat. The less satisfactory state of the northern iron markets is being repeated just now on the Birmingham Exchange. Buyers are holding their hand, and the situation is voted less encouraging than recently. Some uncertainty respecting the future is now again a dominant note, and the late expansion is scarcely being maintained. In view of the heavy buying in pig iron which has been in progress during the past few weeks a slackening of activity was only to be expected, but it is now admitted in most quarters that the movement was, to some extent, in the nature of a speculative outburst, and that improved conditions are not yet permanently established. It is, however, gratifying that there is no suggestion of any weakening in prices, which continue firm. The principal quotations are:—Forge pig iron: Staffordshire common, 47s. to 48s.; part-mine, 50s. 6d. to 51s. 6d.; best all-mine forge, 85s.; foundry, 90s.; cold blast, 115s.; Northamptonshire, 49s. to 50s.; Derbyshire, 50s. to 51s.; North Staffordshire forge, 51s. 6d. to 52s. 6d.; best, 58s. to 59s.

Manufactured Iron and Quarterly Meeting Prospects.

While some makers of manufactured iron report an increasing trade, others express disappointment at the course business is taking. They say that although there is more buying than there was in August, the general conditions have not improved to the extent that was expected, and in view of the high cost of raw materials transactions in rolled iron at prevailing rates do not yield a satisfactory return. The general quotation for unmarked bars is now about £6 2s. 6d., delivered Birmingham, but some makers state that orders are difficult to obtain at above £6 per ton. The quotation for nut and bolt iron is slightly firmer, the average being about £5 17s. 6d. Makers of marked bars continue to do a fairly steady business on the basis of £8 for best qualities and £7 for second grade, Earl Dudley's L.W.R.O. brand being £8 12s. 6d. The October quarterly meeting will be held on the 14th of next month, and that marked bars will be advanced seems less probable than a few weeks ago.

Sheet Iron Trade and Galvanisers.

There is some revival in the black sheet industry in sympathy with the increased demand for galvanised sheets. Black doubles are now quoted at £7 5s. to £7 7s. 6d., and other gauges in proportion. The galvanisers have as much work on hand as they can cope with. The leading makers quote £11 10s. for 24 gauge corrugated sheets f.o.b. Liverpool. There is corresponding activity in the spelter trade. Zinc sheets are advanced 10s., to £26 2s. 6d. This is the second advance in a fortnight.

Steel.

The steel trade mostly continues in an improved position, though all firms are not doing equally well, and the demand for sections for constructive engineering purposes is still much below the output capacity of the district. A revival in this department of the rolled steel trade is, to tell the truth, badly needed just now. The demand for raw steel is steady, and generally of a gratifying sort in respect of bars and billets. There is some talk this week on the market of an advance in raw steel bars, though where it comes in it is difficult to say. Prices are quoted:—Bessemer sheet bars, £4 15s.; Siemens sheet bars, £4 17s. 6d.; angles, £5 17s. 6d. to £6; girder plates, £6 to £6 2s. 6d.; boiler plates, £7 5s.; joists, £5 10s. to £5 15s.; mild bars, £6 7s. 6d. to £6 17s 6d.

Coal Rising.

The coal question just now looms large. Ironmasters are anticipating a definite advance on October 1st, and owing to the expectation of additional advances as the winter months proceed, iron consumers are finding it difficult to place forward contracts running into 1910, except at a sensible advance upon current selling price. The situation is critical, and until next month comes in and it is seen what course the coalmasters really intend to take ironmasters are certain to pursue a waiting policy respecting booking forward.

NOTES FROM LANCASHIRE.

(*From our own Correspondent.*)

MANCHESTER, Thursday.

Pig Iron Variable.

THERE was a full attendance on the Iron Exchange on Tuesday, but the tone was decidedly quiet. It was quite evident that the recent "boom" has exhausted itself, and consumers are for the present holding their hands from further buying. Indeed, notwithstanding reports to the contrary, prices had a downward tendency, but an exception may be made in Lincolnshire, which was held for a premium of 1s. for prompt, with 1s. 6d. per ton more for delivery over next year. Staffordshire is also held for full rates. There is not much change in other respects. Scotch is on the easy side, but hematite is steady. Forge iron shows a reduction on last week of about 6d. per ton.

Finished Iron and Steel.

There is a very quiet feeling in all departments, and little or no change to note in prices.

Copper.

In manufactured there was absolutely no business being done.

Sheet Lead and Tin Ingots.

About unchanged for the former, though the last named were £1 to £2 per ton higher.

Quotations.

Lincolnshire, No. 3 foundry, 56s.; Staffordshire, 54s.; Derbyshire, 55s.; Middlesbrough, open brands, 60s. 4d. Scotch: Gartsherrie, 61s. 6d. to 62s.; Glengarnock, 60s. 6d.; Eglinton, 59s. 6d., delivered Manchester. West Coast hematite, 63s. 6d.; East Coast ditto, 60s. to 60s. 6d., both f.o.t. Delivered Heysham: Gartsherrie, 59s. 6d. to 60s.; Glengarnock, 58s. 6d.; Eglinton, 57s. 6d. Delivered Preston: Gartsherrie, 60s. 6d. to 61s.; Glengarnock, 59s. 6d.; Eglinton, 58s. 6d. Finished iron: Bars, £6 10s.; hoops, £7 12s. 6d.; sheets, £7 15s. to £8. Steel: Bars, £6 2s. 6d. to £6 5s.; Lancashire hoops, £7 5s.; Staffordshire ditto, £6 17s. 6d. to £7; sheets, £7 17s. 6d. to £8; boiler plates, £7 5s. to £7 7s. 6d.; plates for tank, girder, and bridge work, £6 5s. to £6 7s. 6d.; English billets, £4 12s. 6d. to £4 15s.; foreign ditto, £4 10s. to £4 12s. 6d.; cold-drawn steel, £9 10s. to £9 15s. Copper: Sheets, £71; tough ingot, £62; best selected, £62 per ton. Copper tubes, 8⅜d.; brass tubes, 6¾d.; condenser, 7¾d.; rolled brass, 6¼d.; brass wire, 6½d.; brass turning rods, 6½d.; yellow metal, 6d. per lb. Sheet lead, £16 17s. 6d. per ton. English tin ingots, £137 10s. to £138 per ton.

The Lancashire Coal Trade.

Up to the time of writing no information was obtainable as to the course of winter prices. Heretofore a meeting has been held of coal proprietors who have as a rule advanced prices 10d. per ton, but owing to the passing of the Eight Hours Bill this course does not appear to have been pursued this year. There is no need for it, so the merchants urge; but, on the other hand, coalowners say they may be compelled to advance prices 10d. per ton for the reason given above. For all, except best sorts, it is not expected there will be any great change. For the present official rates are unaltered.

BARROW-IN-FURNESS, Thursday.

Hematites.

There is no change to note in the hematite iron trade, but great steadiness characterises the market, and the amount of business doing is maintained on the improved platform established a month or six weeks ago. The market has not, however, shown still further improvement, as was expected. This is due to the fact that foreign, colonial, and continental orders are not coming to hand as freely as it was thought probable they would do. Makers, however, are satisfied that the recent increase in trade is maintained, and they profess to see prospects of an enlarged business during the autumn months. Generally speaking, orders are well held, and there is certainly no increase in stocks, showing that all the metal being produced is going into consumption. There is now in warrant stores 15,510 tons, which is, of course, regarded as a small holding. Prices show little or no change. Mixed Bessemer numbers are at 62s. net f.o.b. Special hematite ranges from 63s. 6d. to 65s. 6d., according to quality, and warrant iron remains at 60s. 6d. net cash sellers, buyers 3d. less. A good business is being done in special hematite iron. Ferro-manganese is selling fairly well, and there is a good market for spiegeleisen. Iron ore is quiet at 12s., 14s. 6d., and 18s. net at mines for ordinary, medium, and best classes.

Steel.

There is no improvement in the steel trade, but makers are busy on rails, although they have not many orders on hand, and although the demand at the moment is not considerable. Heavy sections are at £5 5s. per ton net f.o.b. Steel plates are not in inquiry. Merchant steel is in small request.

Shipbuilding and Engineering.

Vickers, Sons and Maxim are tendering for a large floating dock for the Admiralty, and also for one of the four new scouts of the improved Bristol class to be given out to private builders. Marine engineering shops remain quiet.

Shipping and Coal.

The shipments of iron and steel from West Coast ports last week amounted to 12,866 tons—iron 5754 tons and steel 7112 tons, as against 11,667 tons for the corresponding period of last year, an increase of 1199 tons. For the year to date the shipments aggregate at 439,103 tons, against 354,173 tons for the corresponding period of last year, an increase of 84,930 tons. Coal and coke are in moderate sale.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

Steam Coal Active.

THE steam coal trade continues to be very brisk, and there is every prospect of the export business finishing up with exceptional activity. The latest available return—that for the week ending 14th September—shows that the weight of coal forwarded from Hull to distant markets during that period amounted to 92,760 tons, which compares with 62,650 tons for the corresponding week of last year. Cronstadt was the principal market, taking 27,139 tons, Alexandria coming next with 6149 tons, Rotterdam third with 5247 tons, and Buenos Aires fourth with 5072 tons. The pits are fully employed, and there are no stocks on hand. Prices for hard coal of the best quality are firmly maintained at 9s. 3d. to 9s. 6d. per ton, and for prompt shipment of special lots as much as 10s. per ton is reported in several instances. The position in the steam coal export trade is regarded as exceedingly satisfactory. Inquiries are already being made about export contracts for next year, which it is thought probable will be renewed at higher rates than have prevailed since contracts were arranged early in the present year. These early inquiries on export account are looked upon as evidence of the increased strength of the hard coal market.

House and Gas Coal.

Collieries supplying house coal are expected to advance prices on October 1st, and for forward delivery are at present asking higher rates. Merchants are more disposed to stock quantities, in view of stiffening rates. For London and the southern markets generally the demand for the best qualities of Barnsley "softs" has been very strong, and with other markets an improvement is reported in secondary grades. Best Barnsley continues at 11s. 6d. to 13s. per ton., secondary sorts from 10s. to 11s. per ton. The shortening days are causing the gas companies and Corporation gas departments to increase their demands on coalowners. This, however, is only normal at this season of the year.

Small Coal Brisk—Coke Dearer.

At present the demand for small coal, which might be expected, from the shorter work, to be less than the supply, is quite equal to the output, consequent on the small tonnage being raised, through causes already mentioned, chief among them the operation of the Eight Hours Act. From Lancashire cotton and Yorkshire woollen districts the call for small coal is firmly maintained, prices ranging from 4s 6d. to 5s. 6d. per ton. Coke continues firm, and prices have advanced somewhat from last week's quotations. Best washed coke now realises from 11s. 3d. to 11s. 9d. per ton, and unwashed from 10s. 9d. to 11s. 3d. per ton. The advance is owing partly to the increase in price of iron and partly also to the small supply of coking coal.

The Iron Market.

Very little buying is reported in the pig iron market. Makers of Lincolnshire and Derbyshire iron are well sold forward, and are not pushing sales, standing firmly out for the late advance in rates. Makers' quotations, in hematites, remain unaltered on the week, the tendency being rather firmer than otherwise:—West Coast hematites, 68s. to 70s. per ton; East Coast, 65s. to 67s. per ton, net, delivered in Sheffield and Rotherham. The Lincolnshire Ironmasters' Association met last Friday, but no alteration was made in prices. Current Lincolnshire quotations are as follows:—No. 3 foundry, 52s. 6d. per ton; No. 4 foundry, 51s. 6d. per ton; No. 4 forge, 51s. 6d. per ton; No. 5 forge, mottled and white, 51s. 6d. per ton; basic, 52s. 6d. per ton, all net, delivered in Sheffield and Rotherham. Derbyshire No. 3 foundry, 52s. per ton; No. 4 forge, 50s. 6d. per ton, both net, delivered in Sheffield and Rotherham.

Finished Iron, &c.

We cannot hear of much change for the better in the various classes of finished iron. A little more activity is reported in the Derbyshire pipe foundries. The demand for bars and hoops leaves much to be desired. Bars remain at £6 10s. per ton, hoops at £7 10s. per ton, and sheets at £8 10s. per ton. Prices of steel material have not followed the upward lead given in the iron market as far as the superior grades are concerned. No change has taken place in the official quotations for high carbon billets, but lower grade material is dearer, an advance of 2s. 6d. to 5s. per ton, and in some cases even more, being required. It is stated that users of steel have been buying billets and other material more freely, several of them having booked heavy contracts.

The Heavy Trades.

The tenders for the four improved cruisers of the Bristol type are reported to have been sent in, and the results are being awaited with much interest. Sheffield, with its stake on the Clyde, will be particularly benefited if orders are placed in that direction, which may be considered probable. In regard to the placing of orders for twenty torpedo boats, referred to last week, orders are at present in hand in Sheffield for forgings and other work, and it is expected that these will be followed by others in due course. The general inquiry for tool steel and engineering specialities continues to show improvement, but not as yet in any great volume. A similar remark applies also to railway material, requirements in this department being still very moderate. For high-class steel wire the demand is well maintained, more particularly in the haulage rope department. The local wire works have been very well employed during the year. The trouble in Sweden with regard to the strike may be taken as practically over. A little inconvenience is felt, owing to the interruption of supplies. This, it is anticipated, will soon rectify itself when the men get back to work under normal conditions.

A Sheffield Firm Purchases the Lucania.

Thomas W. Ward and Company, Limited, Albion Works, Sheffield, have purchased the Cunard liner Lucania. The vessel, it will be remembered, caught fire at Liverpool, and the owners decided not to reconstruct it. The Lucania, which is 620ft. in length, was built some seventeen years ago, at a cost of about £650,000. Messrs. Ward have made in late years numerous purchases of obsolete warships and other vessels; but this is the largest ship that has ever been re-sold, with the exception of the Great Eastern. It has not yet been decided what is to be done with the Lucania.

NORTH OF ENGLAND.

(*From our own Correspondent.*)

Shipbuilding.

No one can now doubt the fact that a substantial revival is in progress in the shipbuilding industry of this country, and it is showing itself rather strongly at present in this district. Every week the work at our shipyards is increasing; owners, being apparently convinced that we have seen the lowest in prices for new vessels, are losing no time in placing orders. This is a matter of much importance to the iron and steel trades of the North of England, because there are several branches which depend largely upon the shipbuilding industry for work. Among the orders given out within the last fortnight it may be stated that the Prince Line, of Newcastle, has concluded negotiations for the building of four steamers, two of which will be constructed by Messrs. John Priestman and Co., of Southwick-on-the-Wear; one by Messrs. Short Brothers, of Pallion, Sunderland; and one with Messrs. John Readhead and Sons, of South Shields. The Constantine and Pickering Steamship Company has placed an order with Messrs. Ropner and Sons, of Stockton, for two large steamers, and the Meteor Steamship Company has ordered a coasting steamer to be built by Smith's Dry Dock Company at South Bank, near Middlesbrough. It is understood that the last named will be the first boat to be constructed by Smith's at their new shipyard at South Bank. They are transferring plant and machinery from their North Shields yard to this new establishment. Messrs. Hawthorn, Leslie and Co., of Newcastle, are among the firms which will build torpedo-boat destroyers for the British Admiralty. They will supply three vessels, each of 1000 tons, and with a speed of 28 knots; they will be fitted with Parsons turbine engines. It is also stated that orders are being offered to shipbuilders in this country for nine large steamers of 70,000 tons in the aggregate, which are intended for a new weekly service between Liverpool and South American ports. It may thus fairly be asserted that the tide of prosperity has begun to flow at a fair rate. One result of this is that the South Durham Steel and Iron Company has determined to re-start its West Hartlepool Works fully. Last year they were closed altogether and also for a portion of this, but latterly one steel furnace has been in operation. Three more furnaces and the plate mills will recommence operations next week. There are no indications yet of the re-opening of the company's Moor Steel Works at Stockton, which roll steel plates exclusively, but have been idle for nearly two years.

Engineering.

Improvement is to be reported in the engineering industry, and more particularly at the marine engine works. Robert Stephenson and Co., Limited, Darlington, have secured an order for four heavy express locomotives for the Soudanese Government Railways, to run between Port Soudan and Atbara Junction and also between Wadi Halfa and Halfaya (North Khartoum). They will be shipped in February next direct from Middlesbrough to Port Soudan. Considerable progress has been made by Sir William Arrol and Co. in the construction of the transporter bridge at Seaham Harbour. Messrs. Graydon and Sons, of Durham, have just completed a bridge which they have built entirely of reinforced concrete. It crosses the South Hetton and North-Eastern Railway Company's coal lines at Swinelodge. Reinforced concrete is a somewhat new idea for bridges in this district.

Cleveland Iron.

The iron market continues in an encouraging condition and the tone is buoyant, though buying is perhaps a little slacker than it was in the first half of the month. However, prices of warrants have touched a higher figure than has been known for more than twelve months, buyers offering up to 51s. 7d. cash. It cannot be said, however, that the local statistics are very favourable, for shipments are quieter than they were last month and stocks still increase in the public stores. But in view of the general revival of trade, this causes no uneasiness among traders. The poor figures relating to this district are amply counteracted by the reports of improvement in most leading countries. Somewhat better features are reported by private advices from Germany, and consumers there have bought Cleveland iron rather more freely. American reports notify practically another boom in progress, and production is certainly very much larger than it was last year. The American inquiries have not yet been followed by orders for ordinary Cleveland pig iron, but some business has been done in spiegel. However, that is a trade which goes on whether trade is depressed or not. The fact that speculators are offering 8d. per ton more for three months' deliveries of warrants than they will give for prompt indicates that they look for advances in prices. The general price for No. 3 Cleveland pig iron this week for prompt delivery is 51s. 3d. per ton, with 1s. 6d. to 2s. more for delivery during the first half of next year. No. 1 is at 53s. 6d. for prompt, No. 4 foundry at 49s. 9d., and No. 4 forge 49s. 3d.

Hematite Iron.

With such a spurt in the shipbuilding industry as has now to be reported, the outlook for producers of hematite iron in this district may be accounted encouraging, and there is some chance of their making up for the late unprofitable character of their business. No hematite furnaces have been re-started in this district, but two have been re-lighted on the West Coast. Makers have a great idea with respect to prices for next year's delivery, for they are asking 3s. 6d. per ton more for delivery in the first quarter of 1910 than they will accept for prompt mixed numbers, the latter figure being 59s. per ton, and 60s. will be accepted for delivery up to the end of the year. Rubio ore has not been bought freely during the last two or three weeks, and it may be said that the nominal price is 17s. per ton c.i.f. Middlesbrough, early delivery. The prices for next year's delivery cannot be ascertained, as the Spanish mineowners have not decided upon what they shall ask. The rate of freight, Bilbao to Middlesbrough, has risen to 4s. 7½d. per ton, which is 6d. per ton more than the figure ruling a short time ago. Furnace coke is strong at 17s. per ton for early delivery Middlesbrough works, and the tendency is towards still higher prices.

Cleveland Ironstone Miners.

The question of the application of the Eight Hours Act is leading to trouble at the Cleveland mines, and this week the owners met a deputation from the men's association to discuss the cases of the wages of youths employed in driving and other capacities. The men's representatives stated that since the shortening of the hours under the Act there had been as much work done in many instances by the persons employed as during the longer hours prior to the Act coming into force. The employers did not see their way to grant an advance on this statement, but intimated that they were quite ready to make a thorough investigation into the assertions which had been brought forward, and would permit the men to verify the facts if they chose through accountants of the men's own appointment. The ascertainment of the actual state of things would not take long, after which the owners would at once grant a further meeting, to see what the justice of the case demanded.

Manufactured Iron and Steel.

The position continues to improve in most branches of the steel trade, and the tone of business generally is cheerful; but further advances in prices cannot be reported this week, though the tendency is certainly upwards, more especially in the rail and plate departments. At present £5 5s. is quoted for heavy steel rails, £6 for iron and steel ship plates, £5 7s. 6d. for steel ship angles, £7 for iron ship angles, £5 5s. for packing iron and steel, £7 10s. for steel sheets (black), £6 5s. for steel hoops, £6 2s. 6d. for steel strip, £7 for iron bars, £6 for steel bars, all less 2½ per cent. f.o.t. except rails, which are net f.o.b. Cast iron railway chairs may be bought at £3 10s. net f.o.b. The workmen employed at Messrs. Bolckow, Vaughan and Co.'s have their wages regulated by sliding scale, the basis being the average price obtained by the firm for steel rails, this being verified by a public accountant. The last ascertainment gives the men an advance of 1½ per cent. on the wages of the last two months, making them 19 per cent. above the base rate, and only 1 per cent. below the maximum. Messrs. Waring and Lomas have purchased the Lumley Steelworks at West Hartlepool, and will shortly resume operations there.

Coal and Coke.

Improvement can be reported in the leading branches of the coal trade, and prospects are good for the remainder of the year, more especially in the gas coal branch. The sellers of these are realising 11s. per ton f.o.b. for best, and 9s. 6d. for seconds. Deliveries of gas coal have been good this month, and will continue to increase during the remainder of the year. The demand for bunker coals is scarcely as good as might be looked for, considering that so many more vessels are in work. Sellers are asking 9s 6d. per ton f.o.b. Tyne Docks. Coke for foundry purposes is up to about 18s. per ton, and furnace coke is at 17s.

NOTES FROM SCOTLAND.

(*From our own Correspondent.*)

The General Business Outlook.

A HOPEFUL view is everywhere taken of the prospects of trade, although the revival is slow. The chairmen of two of the principal Scottish railways, at the half-yearly meetings this week, spoke in an encouraging way, although they could not so far record any material improvement in traffic. Important shipbuilding orders are expected to be added to those now in the hands of builders, and, whether the Clyde's share of these be large or small, they will help to improve the state of trade generally. The capacity for output in many departments of manufacture is now so great, owing to the adoption of the best machinery and appliances, that a very large number of orders is required to keep works in anything like full operation, and complaints are not uncommon of lack of employment.

The Pig Iron Market.

There has been some irregularity in the pig iron warrant market this week, and fluctuations have taken place in prices. Early in the week there was an easier tendency in the market, but its tone was strengthened later by reports of advancing prices in America. Business has been done in Cleveland warrants from 51s. 2d. to 51s. 6d. cash, 51s. 4d. to 51s. 8d. one month, and 51s. 11d, to 52s. 2d. three months. Transactions are also noted at 51s. 2d. for delivery in nine days, 51s. 3d. ten days, 51s. 8½d. and 51s. 9d. two months, and 51s. 7d. twenty-seven days. The current business is, indeed, largely for future delivery. There has been less inquiry for Cumberland hematite warrants.

Scotch Makers' Iron.

Business in Scotch makers' iron is quiet so far as new orders are concerned, but makers are understood to have plenty of orders in hand, deliveries under which will go forward for a considerable time. There has been less talk in the last few days of an increase in the output, and, in fact, the recent addition of one furnace in the manufacture of ordinary iron has been neutralised by the putting out of a furnace. There are now 82 furnaces in blast in Scotland, compared with 83 last week, and 75 at this time last year. The prices of Scotch makers' pig iron are well maintained. Monkland is quoted, f.a.s., at Glasgow, No. 1, 58s. 6d.; No. 3, 56s. 6d.; Carnbroe, No. 1, 60s.; No. 3, 57s.; Clyde, No. 1, 62s. 6d.; No. 3, 57s. 6d.; Gartsherrie and Calder, Nos. 1, 63s.; Nos. 3, 58s.; Summerlee, No. 1, 63s. 6d.; No. 3, 58s. 6d.; Langloan, No. 1, 64s.; No. 3, 59s.; Coltness, No. 1, 89s. 6d.; No. 3, 59s.; Eglinton, at Ardrossan or Troon, No. 1, 58s.; No. 3, 56s.; Glengarnock, at Ardrossan, No. 1, 63s. 6d.; No. 3, 59s. 6d.; Dalmellington, at Ayr, No. 1, 62s.; No. 3, 57s.; Shotts, at Glasgow or Leith, No. 1, 63s.; No. 3, 58s.; Carron, at Grangemouth, No. 1, 64s. 6d.; No. 3, 58s. 6d.

Pig Iron Shipments.

The pig iron shipments have been rather better, and it is hoped that they may now show some permanent expansion. They amounted in the past week to 7319 tons, compared with 4790 in the corresponding week. There was the large shipment of 2500 tons to Italy, and 1345 tons went to Canada, the other items being India 196 tons, South America 70, France 30, Germany 70, Holland 360, Spain and Portugal 290, China and Japan 50, other countries 242, the coastwise shipments being 2166 tons, against 3348 in the corresponding week of 1908. Arrivals at Grangemouth of pig iron from Cleveland and district were smaller than usual, amounting to 5162 tons, being 4818 tons less than in the corresponding week.

Hematite Ore and Pig Iron.

The imports of ore into the Clyde this week have been large, embracing no fewer than twenty-one large cargoes. Since the beginning of the year the aggregate imports amount to about 780,000 tons, which is nearly 100,000 tons more than in the same period of 1908. Latterly there has been an improvement in ore freights, which are now on the basis of 4s. 6d. per ton Bilbao to Glasgow, which shows an improvement of about 8d. a ton on the lowest rate recorded this year. The business in hematite pig iron is encouraging, although it has not attained to the proportions expected some time ago. Merchants quote Scotch hematite 61s. 6d. per ton for delivery at the West of Scotland steelworks, but there has been an impression that the price may harden somewhat, especially if rumours now current as to likely exports should meet with confirmation. Both Canada and the United States are reported to have been in treaty for shipments of Scotch hematite pig iron. Their inquiries hitherto have had reference to Cleveland hematite, but it is recognised that shipments could go quite advantageously from the Clyde, and of course in less time, than from the Tees. The initiation of such business would certainly be an advantage to Scotch makers of hematite pig iron, who have a large output and considerable stocks out of which the iron might be shipped without delay.

Finished Iron and Steel.

A less sanguine view is taken of the position of the manufacturing trades, this being due, it would appear, to the difficulty that certain makers find in obtaining specifications in such a regular manner as to keep their works in full operation. Specifications for shipbuilding material especially are difficult to obtain, and some large rolling mills have had to close down. There is a better demand for structural material for export, and it is reported that for girders and joists makers are obtaining 2s. 6d. advance in prices. Orders to the extent of 1500 tons for sheets and thin plates have been received for shipment to Canada, from which also came inquiries for other kinds of finished material. A Lanarkshire firm (the Weldless Chain Company, of Coatbridge) has an order from a Russian firm for a ⅝in. diameter weldless chain, 2640 yards in length, with a breaking stress of 18 tons, and which will weigh 13 tons. Orders for similar work have also been obtained from English firms. It is reported that steel angles are selling for local delivery, prompt specification, at £5 4s. 9d. a ton net, and ship plates in similar terms at £5 12s. The steelmakers held a meeting in Glasgow on Wednesday to consider prices, but no alterations were made. Makers of finished iron have been working short time this week in a number of instances. They quote crown bars £5 10s. to £5 15s., angles £5 10s., tees £6, and unbranded bars £5 7s. 6d. per ton. The arrangement with North of England makers does not appear to be giving the Scotch steelmakers satisfaction, it being alleged that since the last adjustment of prices the latter are not securing a fair share of orders.

The Coal Trade.

There is now a little better inquiry for coal for future delivery, but the current business is unsatisfactory in amount. Prices both for home use and shipment are without material change.

WALES AND ADJOINING COUNTIES.

(*From our own Correspondent.*)

State of the Welsh Coal Trade.

THIS has not been in a satisfactory way, and there is little doubt but that the uncertainty of future prospects has had a good deal to do in limiting the coming in of tonnage. The objectionable circular, it is true, has been withdrawn, and the fear of a partial, much less a general stoppage, is allayed. But it remains to be seen what the Conciliation Committee on Saturday will do. Very wisely the coalowners have left the matter in the hands of the Committee, and it is considered that, if the workmen's representatives show a temperate spirit, trade will improve. With German coals and North of England offered to buyers without any fear of restriction, of stoppage, or strike, at reasonable prices, compared with Welsh best steam coal, the Welsh coalowners have to exercise caution in regard to booking for the future. One of the important bookings still unsettled is that of the Egyptian State Railways, and speculation is very active at present as to the figures quoted. The ruling course for coalowners is, as one remarks, to hold fairly tightly. "Drys were easier; small steams quiet and weak."

Latest Coal Prices, Cardiff.

Tonnage coming more freely, but not to the extent needed. Disposition to "bear" prices noticeable, but coalowners firmer, and concessions not given easily. There is a belief growing stronger that better times are at hand, and October will prove this. Latest market quotations:—Best large steam, 17s. 6d. to 17s. 9d.; best seconds, 16s. to 17s.; ordinary seconds, 15s. to 15s. 6d.; best drys, 16s. 6d. to 16s. 9d.; ordinary drys, 14s. to 14s. 3d.; best washed nuts, 14s. to 15s.; seconds, 13s. to 13s. 6d.; best washed peas, 12s. 6d. to 13s.; seconds, 11s. to 12s.; very best smalls, 8s. 6d. to 9s. 3d.; best ordinaries, 7s. to 7s. 9d.; inferior sorts, 6s. 3d. to 6s. 9d.; very best black vein, 15s. 6d. to 15s. 9d.; ordinary Western Valleys, 14s. 9d. to 15s.; best Eastern Valleys, 13s. 3d. to 13s. 6d.; seconds, 12s. 9d. to 13s. Bituminous coal: Very best households, 17s. to 18s.; best ordinaries, 15s. to 16s.; No. 3 Rhondda, 17s. 3d. to 17s. 9d.; brush, 13s. 6d. to 13s. 9d.; smalls, 10s. 6d. to 11s.; No. 2 Rhondda, large, 12s. 3d. to 12s. 9d.; through, 9s. 6d. to 10s. 3d.; smalls, 7s. 6d. to 8s. Patent fuel, 15s. to 15s. 6d. Coke: Special, 24s. 6d. to 25s.; foundry, 19s. to 22s.; furnace, 17s. 3d. to 18s. Pitwood, 18s. 6d. to 18s. 9d. Latest movements:—More inquiry for prompt. Prices steady.

Newport Coal.

Quietness continues for prompt and forward. The uncertainty existing about trade continues to cripple; there is no change in the difficulty of arranging for future business. Bulk of business has been with inferior coals; sellers firm about prices for best. Latest:—Best black vein, 15s. 3d. to 15s. 6d.; Western Valleys, 14s. 6d. to 14s. 9d.; Eastern Valleys, 13s. to 13s. 3d.; other kinds, 12s. 6d. to 12s. 9d.; best smalls, 6s. 9d. to 7s.; seconds, 6s. 3d. to 6s. 6d.; inferiors, 6s. to 6s. 3d. Bituminous coal:—Best house, 15s. to 15s. 6d.; seconds, 14s. to 14s. 6d. Patent fuel, 15s. to 15s. 6d. Coke: Foundry, 18s. 6d. to 19s.; furnace, 17s. to 17s. 6d. Pitwood, 18s. 9d. to 19s.

Swansea Prices.

No alteration of any note. Supply in excess of demand. Best hand-picked malting anthracite, 24s. to 24s. 6d. net; second, 21s. 6d. to 22s. 6d. net; big vein, 18s. to 20s., less 2½; red vein, 12s. to 12s. 9d., less 2½; machine-made cobbles, 23s. 6d. to 24s. net; Paris nuts, 25s. to 26s. net; French nuts, same; German nuts, 25s. to 26s. net; beans, 17s. 6d. to 18s. 6d. net; machine-made large peas, 11s. 6d. to 12s. 6d. net; fine peas, 10s. 6d. to 11s. 6d.; rubbly culm, 5s. 6d. to 5s. 9d., less 2½; duff, 3s. to 3s. 3d. Steam coal: Best large, 17s. to 18s.; seconds, 14s. 6d. to 15s; bunkers, 9s. 6d. to 10s. 6d.; small, 7s. 6d. to 9s. 6d.; all less 2½. Bituminous: No. 3 Rhondda, 18s. to 18s. 6d.; through, 14s. 9d. to 15s. 6d.; small, 10s. 6d. to 11s., all less 2½; patent fuel, 13s. 6d. to 14s., less 2½.

Iron and Steel.

Operations were rather of a limited character last week at Dowlais, but one or two hopeful features were prominent; one was a steady demand for bar iron, and this is the case in other parts of the district. I note that last week the whole of the furnaces in the Morriston group were at work, and the output of the various bar-rolling furnaces was absorbed at the local tin-plate mills. No less than 118 mills were in action, the largest number that has been worked at the same time. One substantial cargo of rails was sent to Kurachee from Dowlais, *viâ* Cardiff, on account of the India State Railways. From Bruges 1146 tons of bars came to Newport last week, and various cargoes of scrap iron and steel. The only cargoes of note of iron ore came to Ebbw Vale from Bilbao, one of 3300, another of 2500, and a third of 1790 tons. Latest quotations, Swansea:—Pig iron: hematite, mixed numbers, 60s. 6d. cash and month; Middlesbrough, 51s. 9d. cash and month; Scotch, 57s. 6d. cash and month; Welsh hematite, 65s. to 66s. d.d.; East Coast hematite, 64s., 65s. c.i.f.; steel bars, Siemens, £4 12s. 6d. to £4 15s.; Bessemer, £4 10s. to £4 12s. 6d. Other quotations: Block tin, £137 15s. cash; £158 17s. 6d. three months; copper, £59 5s. cash, and £60 1s. 3d. three months; lead, £13 3s. 9d.; spelter, £23; silver, 23¾d. per oz. 1650 tons iron ore came this week to Swansea from Drontheim, 2240 tons from Bilbao to the Blaenavon Company, 2000 to Ebbw Vale from Castro, and 2380 to Naylor, Benson and Co., from Benisaf.

Tin-plate.

The make and shipment of tin-plate were nearly equal last week, total make being 98,740 boxes and despatch 99,015 boxes. Stocks now consist of 120,135 boxes. The market continues very firm. Inquiry is good, well sustained, and, in the opinion of authorities, higher prices are justified both by the demand and the increase in costs. Several of the larger manufacturers are refusing to sell C. 18¾ × 14 under 12s. 9d., C. 28 × 20 under 25s., and C. 20 × 14 under 12s. 3d. to 12s. 6d. Some business is being placed at these figures. A higher level of prices is regarded as a certainty. Latest quotations are:—Ordinary plates, Bessemer cokes, 12s. 6d. to 12s. 9d.; C A. roofing sheets, £8 10s.; big sheets, £8 10s. to £8 15s.; finished black plates, 24 g., £11 to £11 5s.

PERSONAL.—Mr. T. Mather, F.R.S., has been appointed by the Executive Committee of the City and Guilds of London Institute Professor of Electrical Engineering at the City and Guilds Central Technical College in succession to Professor Ayrton. Professor Mather was Professor Ayrton's chief assistant for many years, and was appointed Acting-Professor during last session.

CONTRACTS.—Jens Orten-Böving and Co., of London, have been successful in securing the order for the water turbines which the city of Winnipeg is about to instal. The contract is to deliver five turbines of 5300 horse-power, and two of 450 horse-power, these turbines being of the Francis type, and the largest of their type in the world. We gather that though a considerable amount of the work will be done in this country, the main hydraulic part will be delivered from Sweden.—Ed. Bennis and Co., Limited, have recently received orders for stokers of various types, representing a total of twenty-four pairs of stokers from twelve customers, the majority being repeat orders. The same firm has received an order for coal conveyors from the Wigan Corporation.—We are advised that the Paterson Engineering Company, Limited, has received from the Admiralty a repeat order for oil eliminating plant with quartz sand filter for H.M. Dockyard at Chatham, together with the necessary steel carrying structure and pipe work. The total capacity of the Paterson purifier at this station will now be 10,000 gallons per hour.

IT may be noticed, states a well-known electrical engineer, that there is no such thing as a gas-tight motor, even if the shaft worked through a stuffing-box. The expulsion of, say, 15 per cent. of the enclosed atmosphere when it was heated and the entry of the same amount of gaseous air from the outside on cooling would cause the average condition of the atmosphere outside and inside soon to be similar. To enclose a motor tightly to keep out noxious gases is a delusion. In an explosive atmosphere they must be totally enclosed and strong enough to withstand an internal explosion. Experience with open motors exposed to various noxious chemical fumes shows that although the motor's appearance may be spoiled and soldered joints affected, yet the motors last so long that it is better to let them wear out and buy new ones rather than put up with the troubles from enclosing them. The reasons given for totally enclosing any but very small motors, according to this authority, are usually mistakes. In the case of insurance risk they tend to defeat the object in view. In nearly every place where power is required for manufacturing, open motors may be used and easily protected against the real or supposed dangers of its particular environment.

BY the use of the electrophone the London *Evening News* was able to print a verbatim report of Lord Rosebery's speech on the Budget proposals the same afternoon, the sentences being in type almost as soon as they were delivered in the Glasgow City Hall. In all 2000 miles of telephone wires were used to connect the Glasgow City Hall with Carmelite House in London. The route was from the City Hall, Glasgow, to the Glasgow Post-office by underground wires, and then, by the overhead trunk system, *viâ* Carlisle railway station, Leeds Post-office, Hunslet railway station, Sheffield railway station, London-road Station, Nottingham, Luton railway station, and Finchley-road Station to the York-road Post-office. Then, by underground wires, the route was to the trunk telephone exchange in Carter-lane, and from there to Carmelite House. A staff of a dozen shorthand writers listened to the speech at the London end, each working two minutes at a time and then transcribing his notes. The arrangements were so complete that the slips of "copy" were in the printers' hands a few minutes after the words were heard in London, which was four seconds after they were uttered in Glasgow. The electrophone, as now improved by the introduction of a new transmitter, has been tested over artificial circuits representing 3500 miles of wire, and gives a loud-sounding reproduction of the voice.

ENGINEERS' WAGES IN MANCHESTER.—After taking a ballot of the men in the Manchester district, an agreement has at length been reached which has settled the wages question in the local engineering trades for a period of at least three years. It will be remembered that, owing to the slackness of trade which existed in the above district, the men about nine months ago agreed to a reduction in wages of one shilling per week, and 2½ per cent. off piece-work prices, with the proviso that if there was no improvement in six months the matter was to be discussed again by the Manchester District Engineering Trades Employers' Association and representatives of the several trade unions affected, with a view to a further similar reduction. When the subject came up for discussion again the representatives of the men declined to accede to the further reduction, and the masters proposed in lieu of the reduction an arrangement whereby the existing rates should remain in force for a period of five years. The representatives of the men accepted the proposition subject to a ballot of the men being taken on the question. When this was done, the men declined to bind themselves for five years. A further proposition was then made that the current rates should remain in force for three years, and, after a second ballot of the men, this has now been accepted subject to two months' notice of any proposed alteration being given by either side at the end of the three years' term, which commences at the end of the present month. The workers affected include members of some twelve unions, of which the Amalgamated Society of Engineers claims about 108,000

NOTES FROM GERMANY, FRANCE, BELGIUM, &c.

(*From our own Correspondent.*)

No Change in Rheinland-Westphalia.

The reports of last week can only be repeated, for there is absolutely no alteration of any kind to be reported in connection with the iron and steel industry. Some establishments have been more fortunate lately as regards the booking of orders, but there are a good many shops that can hardly keep up even a moderate activity. Very little is gained on the present quotations, but the worst seems past, as regards prices, for here and there a slight tendency upwards could be felt. From the Siegerland, for instance, better accounts are to hand, both the iron ore mines and the Martin steel works reporting increasing employment. For sales in the first quarter of next year raised quotations have been given. The business in Siegerland crude iron is not favourable, even spiegeleisen meeting with only moderate request; stocks in pig iron have increased, and a somewhat pessimistic view is taken of this branch of the iron industry. The Union of German hoop mills resolved upon a rise of M. 2.50 p.t. for the first quarter of next year.

Good Accounts from Silesia.

The fact that quotations for some articles in iron and steel have been raised seems to indicate an improvement in the Silesian iron trade. Breslau dealers issued a circular on the 5th inst. intimating an official advance of M. 5 p.t. for Silesian bars, and M. 2.50 p.t. for plates, against the prices ruling since January 6th of this year. At a meeting of the Upper Silesian Pig Iron Convention, which was held on the 11th inst., the minimum quotations from July 1st of this year were raised M. 1 p.t. in consequence of a more favourable state of the iron market. The Rhenish-Westphalian and Silesian tin-plate mills have arranged to form a convention. Negotiations continue to be carried on regarding the forming of a German bar syndicate. The Prussian and Bavarian State Railways have now come forward with their orders for rolling stock, the former ordering 2225 passenger cars and 16,731 trucks, valued at 187 million marks. From America some fairly large orders for war material have recently come in.

Production of Pig Iron.

According to official accounts given by the Union of German Iron and Steelmasters, the output of pig iron in Germany, including Luxemburg, was for August of this year 1,100,671 t., as compared with 1,091,059 t. in July, 1909, and 935,445 t. in August, 1908. Production in the different sorts of pig iron was as follows:—Foundry pig, 217,022 t., against 278,270 t. last year; Bessemer, 37,381 t., against 28,189 t.; basic, 688,738 t., against 622,831 t.; steel and spiegeleisen, 101,363 t., against 62,182 t.; forge pig, 56,167 t., against 44,073 t. in August last year. Production during the period from January to August of this year was 8,440,692 t., as compared with 7,995,936 t. for the same period last year.

Latest List Quotations.

The following are the present list rates, per ton at works:—Raw spathose ore, M. 10.90; roasted ditto, M. 15.50; Nassau red iron ore, M. 11.50 net at mines; spiegeleisen, 10 to 12 p.c. grade, M. 60 to 63; white forge pig, M. 55 to 58; German Bessemer, M. 56 to 58; basic, M. 48 to 50; Luxemburg forge pig, free Luxemburg, M. 43 to 45; ditto foundry pig, M. 46 to 48; German foundry pig No. 1, M. 55 to 57; No. 3, M. 54 to 56; German hematite, M. 56 to 58; bars in basic, M. 96 to 102; the same in iron, M. 122.50 to 125; hoops, M. 122.50; common plates in steel, M. 104 to 110; boiler plates, M. 115 to 120; sheets, M. 118 to 125; steel wire, M. 127.50.

Increased Import in Iron Ore.

The increase in the import of iron ore to Germany during the present year has been in marked contrast to the consumption of iron ore over here. In August, of the present year, a rise of 33 per cent. over last year was reported, and in the first eight months the import was 58,117,555 q., as compared with 49,648,858 q. in the same period last year; this shows a rise of 15 per cent. It must be added, however, that last year's imports in iron ore were particularly small and much lower than in 1907. Spanish supplies in iron ore have also risen, while from Sweden only 16.25 million q., against 20.82 million q. in 1907, have been imported. In French iron ore also an increase was reported, while imports from Belgium and Russia have decreased. German export in iron ore has been lower than previously, as may be seen from the following figures:—

	1908.	1909.
Import	49,648,858 ..	58,117,555
Export	21,420,791 ..	18,360,506
Increase in import	28,228,067 ..	39,757,049

The German Coal Market.

A steady though rather quiet trade is done in coal and coke, both in Rheinland-Westphalia and in Silesia. In house fuel an abatement in demand when compared with the end of August may be reported.

Austria-Hungary.

A slow trade is being done in iron and steel, but prices have been well maintained in all departments. Coal has met with a fair and slightly improving demand during the week.

Firm Tone in Belgium.

Both demand and inquiry have been better than in the past month, and there are indications of a further improvement in several departments. So long as the German iron market remains in the present dull condition, and German competition in Belgium increases, there is but little hope for a thorough improvement in the Belgian iron trade. Still, the number of orders that have been coming in is sufficient to keep up a fairly good employment at the shops. The pig iron market, which had been slightly troubled by cheap offers in pig iron from Luxemburg early in August, has gained in firmness since these offers ceased, and 61f. p.t. for forge pig, 67.50f. p.t. for basic, and 65.50f. p.t. for foundry pig, free at works, are the prices now generally quoted. Numerous and fairly large orders are being booked in finished iron, the rail department being rather favoured; prices for foreign orders have stiffened. For girders and merchant iron the prices formerly quoted still prevail. Engine coal is firm in price, while house fuel is a shade easier. On the 22nd inst. the large tenders for coal for the Belgian State Railways will be taken in Brussels, not in Liège and Charleroi as previously; the present prices are likely to be maintained.

A consular report on the trade of the district of Chiengmai states that the progress of the railway towards the northern port of Siam is naturally the most important factor in the commercial development of this district. It seems to be the general opinion that at least two years from the beginning of 1909 will elapse before the railway is opened for traffic to Me Phuak, the nearest point of approach to the town of Phre as at present contemplated, and some 16 miles distant therefrom. The distance from the present railhead to the point mentioned is approximately some 20 miles. Later advices state that the Siamese Government have decided to abandon definitely the continuation of this line beyond Sala Me Phuak (Phre) for the present. The work, however, is to continue until the railhead reaches Sala Me Phuak, all work in the other sections between Chiengmai and Sala Me Phuak being immediately abandoned. The reason for this move is apparently lack of money.

BRITISH PATENT SPECIFICATIONS.

When an invention is communicated from abroad the name and address of the Communicator is printed in italics.

When the abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent-office Sale Branch, 25, Southampton-buildings, Chancery-lane, London, W.C., at 8d. each.

The first date given is the date of application; the second date at the end of the abridgment is the date of the advertisement of the acceptance of the complete specification.

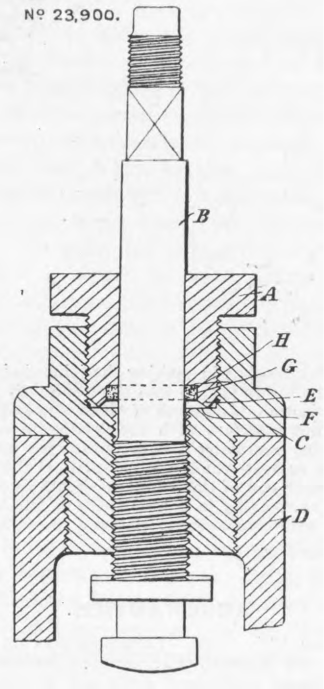
Any person may on any of the grounds mentioned in the Acts, within two months of the date given at the end of the abridgment, give notice at the Patent-office of opposition to the grant of a Patent.

STEAM ENGINES.

23,900. November 7th, 1908.—Improvements in and relating to Packings for Valve Spindles and the like, Stanley Brotherhood and Charles William Bryant, of Peterborough.

In carrying this invention into effect according to the construction shown, as applied in packing a spindle of a high-pressure valve, a gland A, bored to fit the spindle B, is secured in a casting C which is screwed into the valve chest D. The bottom or inner end of the gland A is turned to an edge E which bears on a turned face F in the casting C or chest D. A recess G is turned inside the gland A at its inner end, and within it is inserted a leather or other suitable packing ring H. The inner periphery of the ring H fits the spindle B, and the outer periphery fits the wall of the recess G. The outer side of the packing ring H bears against the bottom of the recess G, and its other side is towards the fluid which is to be kept from leaking. By this arrangement the greater the pressure of fluid the tighter will the ring H pack into its recess G and against the spindle B. The spindle may be of the screwed or direct-sliding type.—*September 1st*, 1909.

Nº 23,900.

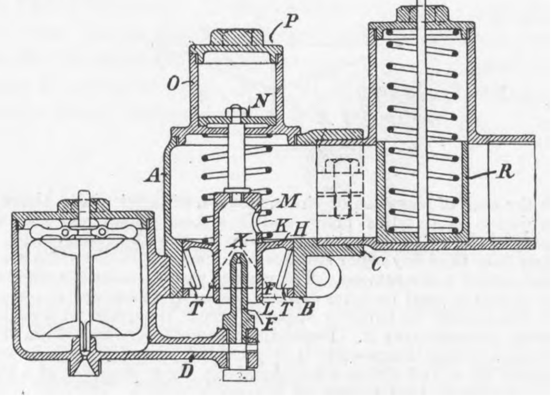


INTERNAL COMBUSTION ENGINES.

17,490. August 20th, 1908.—Improvements in Carburetters for Internal Combustion Engines, Frank Egerton Walker, of Pine Cottage, Heath-road, Weybridge, Surrey, and George Rupert Swetnan, of 28, Britannia-street, Coventry.

The object is to produce an automatic carburetter of which the construction shall be simple, the parts easily removed and replaced strong and durable, the automatic action correct and regular, and which shall be especially applicable for engines of small power. A casing A has an open base B which serves as the air inlet and a side outlet C for the mixture. An extension D from the float chamber carries the jet E. A cleaning or regulating needle may be provided. Within the casing there is a bell-shaped regulator provided with a crown H, a mixing tube L, an extension M above the crown with a passage (or passages) K for the mixture, and an outer tube F with triangular or like-shaped passage or passages T, for the automatic regulation of the air supply. The regulator H is attached or connected to the piston N of a dashpot O, the sensitiveness of which may be adjusted by a screw-regulated orifice in a closing plug P. A spring is provided to facilitate the control. The mixture outlet is provided with any suitable throttle valve, preferably a spring controlled piston valve R, operated by a Bowden wire S^1. A strainer consisting of a sheet of perforated metal or wire gauze, mounted on a ring of metal, may be inserted between the carburetter and the throttle valve. A dome-shaped strainer may also be provided at the air inlet B. The crown H of the bell is preferably dished as shown and drain holes X provided. —*September 1st*, 1909.

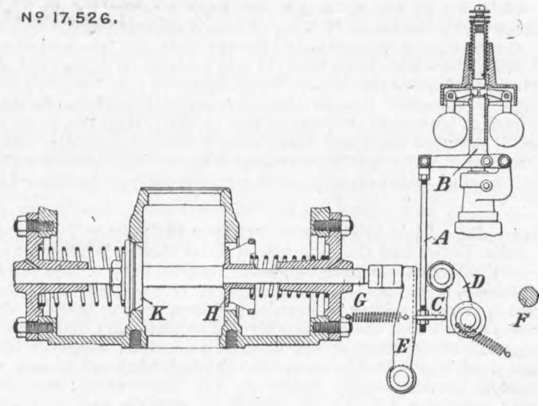
Nº 17,490.



17,526. August 20th, 1908.—Improvements in and relating to Governing Mechanism for Internal Combustion Engines, Henry Nield Bickerton and Philip Warwick Robson, both of Wellington Works, Ashton-under-Lyne.

This invention relates to governing mechanism for internal combustion engines, and has for its object to construct governing mechanism which shall be simple in construction and sensitive and which shall come into operation quickly whenever a change of the load on the engine occurs. On a rod A depending from the ordinary centrifugal governor B, a pusher C is mounted, which is adjustable upon the rod A, and is situated in a horizontal position between vertical faces of two levers D E. One of these levers D is pivoted above the pusher, and is operated by the cam shaft F so that it receives a definite angular motion at every charging stroke of the engine. The other lever E, referred to as the controlling lever, is pivoted below the pusher, and its upper end bears against a valve spindle G. On this valve spindle are placed two valves; one, H, which has always a certain amount of opening, controls the air supply, while the other, K, controls the gas. Both valves are opened by the movement of the lever E, operating on the end of the valve spindle G. These valves are situated outside the inlet valve to the cylinder, which is operated in the usual manner Two other drawings are given.—*September 1st*, 1909.

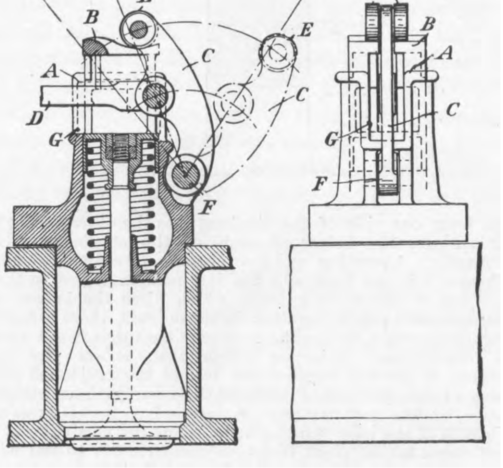
Nº 17,526.



17,605. August 21st, 1908.—Improvements in Valve Gear for Internal Combustion Engines, *Siegfried Barth*, of 43, *Brend'amourstrasse, Düsseldorf-Obercassel, Germany.*

The present invention has for its object mechanism for operating the valves of internal combustion and explosion motors, in which the member such as a cap or cam upon which the operating gear acts is arranged directly upon the valve head. The cap or cam B provided with an appropriately-shaped operating face is arranged upon the upper part A of the valve; it may be formed in one piece with the part A or detachably mounted thereon. A lever C acts through friction-reducing rollers E upon the cam B, it is pivoted to the driving rod D. The lever C is rotably mounted at F, and in its rocking movements presses on the cam B and the valve is opened in a vertical direction. The upper part of the valve is slotted and the driving rod D is carried through the slot G.—*September 1st*, 1909.

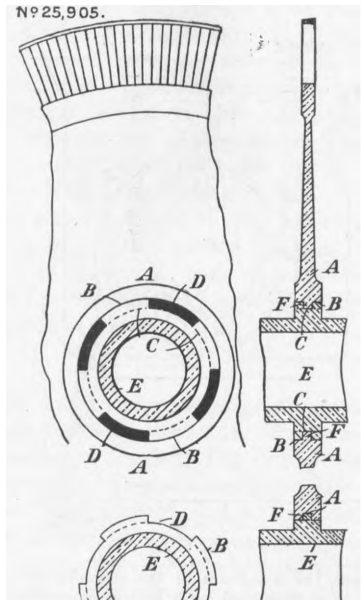
Nº 17,605



TURBINE MACHINERY.

25,905. December 1st, 1908.—Improvements in Turbine Engines, Arthur William Cooper, of 2, Westfield-place, Westfield-road, Broughty Ferry, Forfarshire.

Nº 25,905.

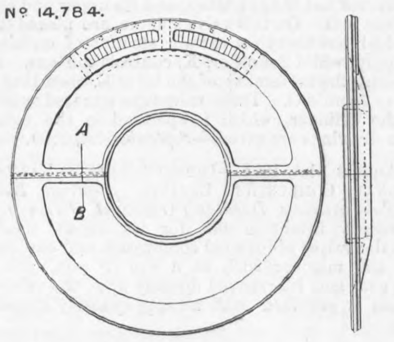


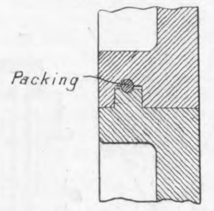
This invention has reference to improvements in turbine engines, and consists of an improvement in the bodies of rotor wheels, in order to prevent damage to blading by the possible warping or end movement of the wheels, in the event of such wheels being exposed to a considerable rise in temperature whereby they might expand quicker than the drum or shaft upon which the wheels or rings may be placed. A is the hub of the wheel or ring. B, the drum or shaft where fitting to larger bore of wheel. C, the bottom of centre rib on the wheel bearing upon drum or shaft. D, is a recess with key filling, which is expanded into a space between hub of wheel and seat on shaft. E is the shaft or drum. F is a feather formed on the wheel which enters the recess in drum or shaft. The shaft and also wheel are so formed that wheels may be passed axially upon drum or shaft, the recess D being of such a circumferential length that the feather F formed on wheel will pass axially across same and allow the wheel to be brought into position on drum or shaft by entering feather into groove about centre of hub for reception of same. The wheel is moved circumferentially until the feather F is flush at both ends of recess on hub or shaft, then the filling of recess D prevents the wheel being moved circumferentially, while the feather F which fills the recess on drum or shaft prevents the wheel moving either axially or circumferentially.—*September* 1*st*, 1909.

14,784. June 24th, 1909.—Improvements in Impulse Turbines, John Brown and Co., Limited, of Atlas Works, Sheffield, and of Clydebank, Dumbarton, and Thomas Bell, of the latter address.

This invention relates to impulse turbines, such as those of the Curtis type in which the casing is divided by stationary diaphragms into a series of separate compartments into which steam or like motive fluid is admitted in succession through what are known as expansion nozzles usually bolted to the diaphragms; and the present invention has for its object to provide improved and simple means for preventing or minimising the possible leakage of steam from one side of the diaphragm to the other through the joint between the halves of each of the stationary division diaphragms. According to the present invention where the diaphragm is in the form of a flat disc made in halves, in the surface of one of the meeting faces, which when the halves of the diaphragm are brought together form the joint, there is formed a longitudinal recess, and in the surface of the other face a counterpart longitudinal projection which then enters the recess. Clearance is allowed between the top of the projection and the bottom of the recess, and between these two surfaces packing of asbestos, or like soft material, is inserted so that it extends the full length of the joint thus formed. Thus the possibility of leakage of steam taking place from one compartment to the next in succession is effectually prevented or minimised.—*September* 1*st*, 1909.

Nº 14,784.





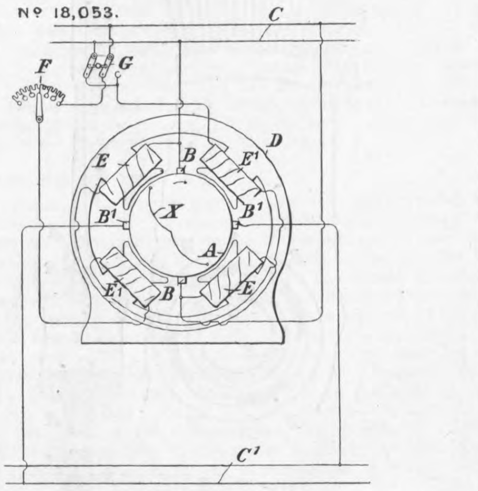
Section on line A.B.

DYNAMOS AND MOTORS.

18,053. August 27th, 1908.—Improvements in and relating to Dynamo Electric Machines, The British Thomson-Houston Company, 82, Cannon-street, E.C.

This invention relates to rotary converters for transforming direct-current from one voltage to another, as, for instance, for deriving a constant direct-current voltage from a supply circuit, the voltage of which varies, or for deriving a direct-current voltage, variable at will, from a constant potential direct-current circuit. A represents the armature, which is provided with two sets of commutator brushes, one set B B connected to the supply circuit C, and the other set $B^1 B^1$ connected to the load circuit C^1. The two sets of brushes are displaced from each other ninety electrical degrees, the armature in the machine shown having a bi-polar winding, as indicated both by the diametrically opposite positions of the two brushes connected to the same circuit, and also by the span of the armature coil X, which indicates diagrammatically the pitch of the armature winding. The field magnet D is provided with two sets of poles, one set carrying the coils E E, and the other set the coils $E^1 E^1$. These two sets of poles are displaced from each other by ninety electrical degrees, and the poles of each set, as, for instance, the two poles carrying the coils E E, are of opposite polarity. The two left-hand poles form in effect a single pole, as far as the brushes B B are concerned, the right-hand poles forming in effect the other pole for these brushes; while for the brushes $B^1 B^1$ the two upper polar projections form in effect a single pole, and the lower projections the other. The coils E E are connected in shunt to the brushes B B, and consequently are traversed by currents of constant strength, and maintain the poles on which they are placed at substantially constant magnetic strength. The coils $E^1 E^1$ are connected to the supply circuit C through a manually operated rheostat or automatic voltage regulator F and a reversing switch G. The operation of the machine is fully dealt with.—*September* 1*st*, 1909.

Nº 18,053.

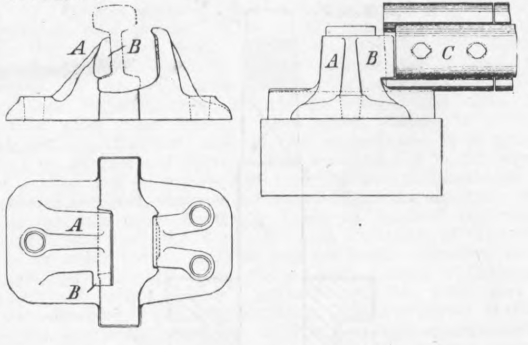


TRAMWAYS AND RAILWAYS.

28,029. December 23rd, 1908.—An Improvement in Railway Chairs, William Alfred Sabine Messer, Engineers' Office, South-Eastern and Chatham Railways, London Bridge Station.

A well-known trouble on the permanent way of a railway is the creeping of the rails, which is particularly liable to occur on an incline. This could be prevented by arranging that the end of the inside fish-plate should abut against the inside jaw of the joint chair; in present practice, however, this is impossible with the standard British fish-plate because the outside fish-plate would then interfere with the driving in of the compressed oak key. The present invention consists in making the joint chair with a lateral projection on the inside jaw, so that the inside fish-plate may abut against the projection, the length of which is such that the outside fishplate does not interfere with the driving in of the key. In the accompanying engraving A is the inside jaw and B is the projection thereon against which the fish-plate C abuts. When it is desirable that each end of the fish-plate should have such an abutment, to prevent creeping in either direction, the two joint chairs are made with a right-hand and a left-hand projection respectively. —*September* 1*st*, 1909.

Nº 28,029.

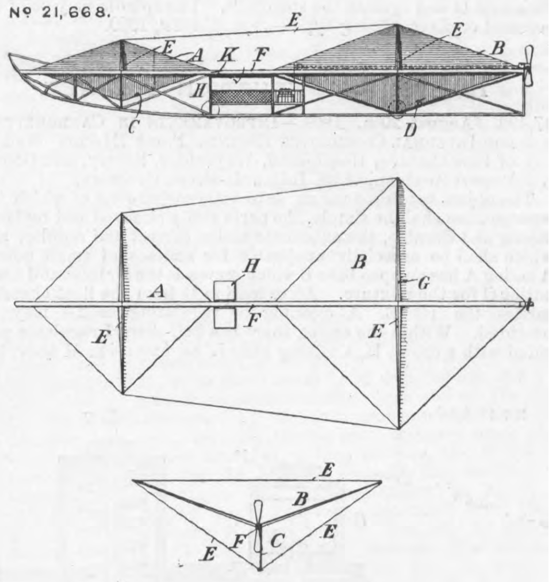


AERONAUTICS.

21,668. October 13th, 1908.—Improvements in Aeroplanes, William Frank Howard, of 18, Egerton-gardens, West Ealing, London.

Beneath two pairs of planes A and B vertical planes C and D are provided to form a keel. These vertical planes C and D form a keel, which is one of the essential features of the invention, and gives stability and direction to the aeroplane as a whole, and, moreover, prevents the overturning of the aeroplane in a side wind. The area of each of the keel planes C and D is made equal to the area of elevation of the inclined horizontal plane above it projected on a vertical plane, and these keel planes may take the form of isosceles triangles, as shown in the upper engraving, or they may take any other suitable form, so long as the areas are of the correct measurement. The various planes are braced together by means of steel or other suitable wires E, which are connected in some cases to suitably disposed struts G carried by a central boom or main stay F. Depending from the central boom F a motor carrying framework H is provided, and the motor is connected up to and drives a comparatively small propeller at a high speed.—*September* 1*st*, 1909.

Nº 21,668.

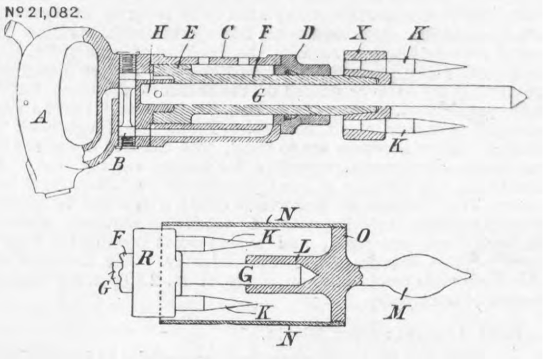


MACHINE TOOLS AND SHOP APPLIANCES.

21,082. October 6th, 1908.—An Improved Percussive Hand Tool, George Henry Rayner, of 24, Edgehill-road, Nether Edge, Sheffield.

This invention relates to a percussive hand tool, which is designed with the object of reproducing by machinery the action of the collier's pick, that is to say, the pick is thrown against the coal or rock, pulled back from same, and again thrown forward, the machine being used without supporting pillars or struts. A is a handle provided with control valves and inlets for the air; B is a valve of the automatic self-locking type, and C is a cylinder fitted with end cover D. E is the piston, and F is the piston-rod, both of which are bored out to accommodate and slide freely upon a rod or distance piece G, which is secured at H to the handle portion of the tool. The forward end of the piston-rod F is provided with a holder X for the picks K. The forward end of the rod or distance piece G is pointed as shown, or it may be provided with a bowl or roller. In the lower engraving L is a socket to receive the end of the rod G, the socket being provided with an integral or detachable wedge M, and a cylinder or other projector N is attached to a flange O on the socket to enclose the reciprocating picks K, and thus minimise danger to the operator. The holder R is in this case used as a reciprocating hammer, striking upon the end of the socket, and thus driving the wedge M into the channel.—*September* 1*st*, 1909.

Nº 21,082.



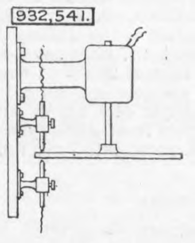
SELECTED AMERICAN PATENTS.

From the United States Patent-office Official Gazette.

932,541. Abnormal Potential-discharging and Arc-disrupting Device, *F. W. Erickson and F. W. Lord, New York, N.Y.—Filed April 27th*, 1907.

The claims, four in number, of this patent are remarkable for the ingenuity with which the greatest possible number of words has been employed to describe a very simple thing. The use of a disc, which can be rotated between two discharging and running points, as shown in the drawing, is the invention.

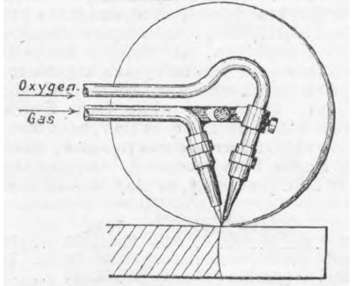
932,541.



932,740. Device for Severing Metal Bodies, *E. Wiss, Griesheim-on-the-Main, Germany, assignor to Chemische Fabrik Griesheim Electron, Frankfort-on-the-Main, Germany, a Corporation of Germany.—Filed January 5th*, 1907.

This is for improvements in the method of severing metals by the use of an oxyhydrogen blow pipe. The patent is for the combination in an apparatus for severing metals, of separated parallel wheels axially in line and two nozzles arranged at equal angles on opposite sides of the said axis, converging at their lower ends to bring the jets therefrom together at the plane supporting the wheels, and means for supplying different gases to the two nozzles.

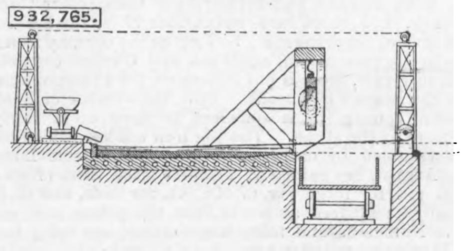
932,740.



932,765. Apparatus for Handling Slag, *D. T. Croxton, Cleveland, Ohio.—Filed November 18th*, 1907.

This patent is for the combination of a stationary table for casting and cooling molten slag, the floor being shaped to permit the solidified slag sheet being slid off one side thereof, retaining walls to hold the molten slag on the table in a layer of desired thickness, and mechanical means for positively sliding the solidified slag over the delivery edge of the table, and means for breaking the slag into fragments as it slides off the table. There are three claims.

932,765.



A Board of Trade inquiry has been held at Belfast regarding the burning and loss of the s.s. Lord Londonderry while on a voyage from Spain to the United States. The vessel loaded at Huelva 3325 tons of washed iron pyrites (sulphur ore) from the Tharsis mines, and it was suggested that this material was liable to spontaneous combustion, that it was dangerous cargo, and that it was owing to its presence on board that the Lord Londonderry caught fire and was lost. The court found that washed iron pyrites are not liable to spontaneous combustion, that they are not dangerous cargo, and that the cause of the fire was the spontaneous combustion of coal in the lower cross bunker. This coal came from the Brynynimin and Ton Philip mines in the Rhondda Valley, and according to the evidence of Mr. Dwyer Lewis, Government Inspector of Mines in the Swansea district, is of a highly bituminous nature, principally used for gas-producing purposes, high in carbon and in sulphur, and large heaps of it on board ship would be liable to spontaneous combustion.

SEPTEMBER.

The science of aviation has exacted a heavy toll in human lives during the past month. Previous meetings at Rheims and elsewhere had been carried out with a singular freedom from serious accidents, which gave to everyone an exaggerated faith in the safety of mechanical flight. The first casualty was the accident to Lefebvre, who, it will be remembered, astonished the public by performing acrobatic feats on a Wright machine until he was stopped by the officials, who fined him for indulging in this dangerous amusement. He was trying a new Wright machine at Juvisy when the apparatus suddenly dived to the ground, and Lefebvre was picked up dead. It is supposed that the wires actuating the elevating planes broke, and the unfortunate pilot was unable to control his machine; but, as the apparatus was utterly smashed, it is impossible to ascertain the true cause of the disaster. At Boulogne Captain Ferber lost his life through an accident that has happened to many aviators. While flying too low, the end of one of his planes touched the ground, and, catching in a watercourse, the machine capsized, when the engine fell on Captain Ferber and broke his back. He crawled out as if there was nothing the matter with him, remarking to those who came to his assistance that it was a "stupid accident," and in a few minutes he was dead. Captain Ferber was one of the pioneers of aviation in France. Starting with gliding planes many years ago, he experimented with all kinds of apparatus, and under the name of De Rue piloted machines at various meetings, although he was generally unlucky. He sacrificed his military career in order to devote himself entirely to aviation.

While these fatal accidents to aviators caused profound regret, the collapse of the dirigible balloon République, and the death of the four officers on board, is regarded in France as a national calamity. The République is of the Lebaudy type, and was recently delivered to the War Department, when it started from Paris to join the army engaged in manœuvres in the Centre. On its outward journey there was trouble with the engine, when the balloon descended, and was damaged by coming in contact with a tree. It was repaired by the Army Ballooning Corps, and resumed the journey a few days afterwards, when it was employed successfully in the manœuvres. On Saturday it was returning to the military balloon station at Chalais-Meudon, near Paris, and had got beyond Moulins when the catastrophe took place. One of the propeller blades became detached, and, flying upwards, went clean through the balloon, which collapsed and fell from a height of 600ft. like a stone. The four unfortunate officers were killed instantly. As the disaster was due to a purely mechanical defect it does not affect the principle of the motor balloon, which in fine weather has always performed consistently, although it is more and more obvious that it has considerable limitations. Nevertheless, the destruction of the République, and the fatal accidents to aviators, make it abundantly clear that danger exists in all mechanical forms of aerial locomotion, and while profoundly sympathising with the French over these disasters, we may hope that they will give pause to the many hundreds of novices who are purchasing aeroplanes with a view of indulging in the new "sport."

The enormous difficulty of salvage work in the open sea has been again proved by the failure of the attempt to raise the submarine C 11, which has now been finally abandoned. She was, it will be remembered, successfully raised some fifty feet or so from the bottom, and, slung beneath the salvage vessel, was being borne towards a harbour, when, having travelled but a short distance, she encountered some obstruction below, reported to be a wreck, and as she could not be cleared, had again to be lowered to the bottom. Here operations were again continued, but the divers found it possible to descend on very few occasions—twelve in all—and then only for a few minutes at a time. They were not able even to ascertain what the obstruction is, and they reported so much sand that work was practically impossible. Hope, however, was not given up till the middle of the month, when examination showed not only that the submarine was being covered with sand outside, but that it had found an ingress through the rupture and through the conning tower, and that the vessel was filling inside. Under the circumstances it was felt that further efforts were fruitless, and the attempt was abandoned, an impressive end to the whole painful story being afforded by the funeral service for the twelve men, who sank with her, which was held on board the cruiser Vindictive close to the grave of the submarine. The loss of the vessel shows the necessity of some sort of salvage vessel being added to the King's fleet. We have already described those owned by the Germans—see The Engineer, October 30th, 1908—and the French—The Engineer, June 11th, 1909. It is time we had one of our own. Preparations were indeed being made for the construction of outriggers and hoisting tackle which would permit the C 11 to be brought up to the surface beside the salvage vessel, instead of, as now, beneath her, but they were not finished when the announcement of abandonment of the wreck was made. We trust the work will be proceeded with, so that on another occasion there may be no delay.

The electrification of the South London line is now to all intents and purposes complete, and the official inspection by the Board of Trade has been recently made with perfectly satisfactory results. The company, however, does not propose to open the service as yet, and although trains are, and have been for some weeks, running daily, it will be nearly Christmas time before they are at the disposal of the public. Mr. Forbes and Mr. Dawson are determined that everything shall be in perfect order before they open the service, and they would rather spend a few weeks in running things down to their bearings than take the risk of trouble by starting the service at once. Time, however, is not being wasted. All sorts of tests, which it will be difficult to carry out later, are now being made. A train has been fitted up with suitable instruments, and such things as the total train resistance, the efficiency, and the power factor are being determined. It is said that the electrical losses average about 5½ per cent., and the load factor touches just 80 per cent., both very favourable results. An interesting point which is being looked into is the wear of the overhead conductor. This wire is of copper, and it is ½in. diameter. It was prophesied that it would be worn out quickly by the friction of the collector. As a matter of fact, it appears that the wear of the wire is inappreciable, the whole abrasion taking place on the strips of aluminium which form the rubbing face of the collector, and which are cheaply and quickly renewable.

The deliberations at the International Trade Union Conference held in Paris last month showed a singular want of unanimity between the foreign unions and the Confédération Générale du Travail. Being the guests of the Confederation, the foreign delegates tried to put themselves as much at their ease as possible, but there was clearly very little sympathy between them, the visitors being constantly on the alert lest they should be drawn into approving of the advanced revolutionary doctrines of the C.G.T. The wirepullers of the Confederation brought forward one motion after another which aimed at uniting all the trade unions of the world in one great effort to secure the "freedom of labour," by which is meant the reduction of working hours to a minimum and the fixing of wages which are apparently to advance in inverse ratio to the smaller amount of work done; but while the foreign delegates would doubtless hail this millennium, they had too much sense to grasp at the shadow, and the foreign delegates spent most of their time in checkmating the ingenious moves of the Confederation. Before the conference was opened, the president of the American Federation of Labour addressed the French organisation, and told them that they had nothing to gain by their policy of intimidation, and similar advice was given during the conference by some of the other foreign delegates. Unfortunately, this had little effect upon the C.G.T., which exists on agitation, and despite the reserved attitude of the foreign delegates the French wirepullers brought forward their motions in favour of anti-militarism and the organisation of a general strike, which, however, they had to withdraw. If the conference has done nothing else it has shown that the foreign trade unions have no intention of abandoning their policy of employing political means of attaining their ends, while the C.G.T. stands alone in openly adopting revolutionary methods.

The "Dreadnought idea" is spreading persistently with some tendency—on paper at least—to out-dreadnought the Dreadnought. In the United States the Navy Department has been steadily increasing the size of battleships with each succeeding design, and the two latest, which have just been placed under contract, are believed to outdo the "big ships" of European navies. These two new battleships, the Arkansas and Wyoming, are to be 545ft. long and 92ft. beam, with a displacement of 26,000 tons on a draught of 29ft. They are rated for a speed of 21 knots, and their engine power is to be 33,000 horse-power. Each will carry 1100 officers and men. The side armour will be 8in. thick, and that of the belt and barbettes 11in. thick. The armament will comprise twelve 12in. guns, all capable of being fired on a broadside, sixteen 5in. quick-firers, and a secondary battery of smaller pieces. The lowest tender for the hull of each ship was £895,000, and under the American law the contracts for the two vessels had to be awarded to different firms.

On Tuesday, September 14th, the widened Blackfriars Bridge was formally opened to the public by the Lord Mayor, and at the same time a new service of the London County Council's electric cars was put into operation across the bridge. This is now the widest bridge in London, having a width of 105ft. between the parapets, instead of 78ft. as formerly. The work, which was described in our issue of the 17th ult., was carried out by Sir William Arrol and Co. for the City Corporation at a cost of £203,000, and a noteworthy feature is that the contract was completed six months before the specified time. A bridge over the Thames has existed on this site for 140 years. The first was a stone structure of nine arches, designed by Mr. Robert Mylne. The foundation-stone was laid on 31st October, 1760, and the work was completed in 1769. The present bridge was designed by Mr. Joseph Cubitt, and was the selected design in an open competition. The work of construction was commenced in June, 1864, and the bridge was opened to the public on November 6th, 1869. Although it is now the widest bridge in London, it is still excelled by other structures, the Alexander III. Bridge in Paris, which is 131ft. between the parapets, having the distinction of being the widest bridge in Europe.

Arctic and Antarctic expeditions have been somewhat prominently before the public eye during the last week or two. First of all an American—Dr. Cook—suddenly sprang upon the world the announcement that he had been to the North Pole. But a very short time afterwards Commander Peary—also an American—made a similar claim. Both these explorers state that they have reached the Pole; the first during last year, the other this year—and there the matter remains. Meanwhile the other side of the globe has had attention drawn to it by the arrival in the Thames of the Nimrod, the vessel in which Lieutenant Shackleton and his intrepid companions made their voyage, which ended in the nearest approach to the South Pole yet achieved. Further than this, Captain R. F. Scott is engaged in preparations for another Antarctic expedition. Whatever opinions may be held as to the practical advantages to be gained by reaching the Poles, all must unite in admiration of the skill and energy possessed by those who venture into these ice-bound solitudes of continuous cold. The pluck and daring evinced are monumental, and in spite of the hardships, discomforts, and dangers encountered, it is noticeable that when once a man has ventured into these unknown wastes he is all anxiety to go again.

It will be remembered that some months ago a disastrous strike took place in the button-making industry at Méru, in France, when the house of one of the factory owners was wrecked and damage was done to the nearly all the factories in the neighbourhood. Backed up by the C.G.T., the button workers claimed an advance in wages, which were to be unified throughout the district; but as this would mean the ruin of the industry, which had a great deal of difficulty in meeting competition from Japan, many of the owners decided to shut down their factories and start business elsewhere. The result is that the button-making industry at Méru has been nearly ruined, and hundreds of hands have for months been out of employment. The families have fallen into such a state of destitution that a philanthropist has devoted a large amount of capital to the creation of a button-making industry on a co-operative basis, and the Méru families have been transferred to the new centre. Accommodation of the most comfortable kind, with all sorts of up-to-date conveniences, is being provided for the workers and their families, who will not only receive good wages but will participate in the profits, if any. It is very doubtful whether this experiment will prove a success, and it remains to be seen whether the philanthropist will continue to advance capital to keep the industry going. There is so little of this philanthropical spirit that the working community would be wise not to follow the example of the Méru button workers, although, as things go at present, it would seem as if they are of the opinion that strikes with violence offer a panacea for all their troubles. There have rarely been so many strikes in the various trades throughout France as have been recorded during the past few weeks.

A peculiar and widespread magnetic disturbance occurred on Saturday, September 25th. Points as far distant from one another as England, the United States, South America, Russia, and Australia are, at the time of writing, known to have been affected, and without doubt the disturbance spread over the whole globe. Visible results were observed in Australia, throughout which continent gorgeous displays of aurora were witnessed, while northern lights were distinctly seen in St. Petersburg and at Wenden in Livonia. The most important result of the "magnetic storm" was the fact that telegraphic lines were greatly interfered with. At the present time it is not exactly known how much delay was caused on foreign lines, but in this country it varied from one to three and a-half hours.

According to a Reuter message from New York, the telegraph and cable service there was "badly crippled." At the Cheltenham—Maryland—Observatory, according to another message from the same agency, the disturbance was so acute that it moved the indicators beyond the limits of the record sheets, and upset the adjustments of the instruments. The Meteorological Institute, Utrecht, reported two important magnetic deviations occurring close to one another. In this country the part north of Newcastle was perhaps most severely affected. Glasgow could not communicate with the Western Hebrides. Severe local thunderstorms occurred in many places, the East Coast apparently experiencing the worst of these. It would be interesting to know how the various wireless installations throughout the world behaved during this curious phenomenon, which apparently terminated at about 9.30 p.m. As usual meteorologists are associating the disturbance with the appearance of sun spots.

As we advance into the twentieth century, centenaries of great scientific and engineering events will grow thick about us, for the first fifty years or less of the nineteenth century saw the birth of many epoch making inventions and witnessed many notable discoveries. We have already in a mild way celebrated the Watt centenary in this country, and during the present month America is showing us, in the Hudson-Fulton celebrations, *her* way of remembering her famous men. Young America is getting the idea that Fulton was the inventor of the steam boat, and is honouring the Clermont as the first vessel of its kind. That is, of course, a mistake, as Americans who have studied the history are well aware. Fulton was not only anticipated by several projects, notably that of Jonathan Hulls, but by many boats which actually ran successfully both in Europe and America. Indeed, the first steamboat of which we have any record anticipated the Clermont by precisely one hundred years, having been built by Papin in 1707. It had a water-wheel in the centre, over which water raised by the engine was pumped. In this connection too, the name of Stevens, a contemporary of Fulton's, must never be forgotten. There was, of course, always a party with vested interests who opposed such changes as the steamboat would effect, and Fulton's great work was that he succeeded not only in overcoming opposition, but in raising sufficient money to build a really presentable and workmanlike boat, not a makeshift as some of its predecessors were. In later years, when a Transatlantic service was talked of, another American, Junius Smith, met with the same sort of difficulties. The owners of sailing packets used all their influence and exercised all their ridicule to destroy his Bills. As we know, he ultimately succeeded in raising money to build first a small and then a larger vessel, and established the first Transatlantic sea service, although the Sirius and the Great Western reached New York before his vessel, the British Queen, was ready.

A commission appointed by the Paris Municipal Council has recently been making a tour of inspection through the city to see whether anything can be done to reduce the obstructions due to surface works in connection with the Metropolitan tramways and the electric and compressed air mains. Some streets have been completely blocked up for months. On the Esplanade des Invalides the Commission found that behind the huge hoardings which disfigured this part of Paris there were offices, lodgings, and gardens producing flowers and vegetables. In many cases the hoardings have been set back, and contractors have been informed that they must terminate their work and remove the obstructions within a stipulated time. The contractors, however, point out that if these hoardings have remained so long it is principally on account of the strikes, which have continually interfered with operations, and they can never depend upon the men working from one day to another. To make matters worse, a further obstruction has occurred in the Rue St. Lazare, through the blowing up of one half of the roadway. While a violent storm was in progress during the night, it is supposed that the pressure of the water in the drains was so enormous that they burst, making a hole in the roadway about 200ft. long.

The past month has witnessed some further Atlantic records. The first was made in a westward passage by the Lusitania on her first voyage after the alterations to her propellers. Leaving Daunt's Rock at the entrance to Queenstown Harbour on Sunday morning, August 29th, she passed the Ambrose Lightship at New York at 4.50 in the afternoon on Thursday, September 2nd, having made the passage in 4 days 11 hours 42 min. Up to that time the record for the westward passage had been that set up by the Mauretania in the voyage which ended on August 19th, and which occupied 4 days 14 hours 38 min. She was not, however, to hold this record long, for the latter vessel in her very next westward crossing made 7 minutes better time. Seven minutes in time represents under three miles in distance, and it is quite within the bounds of possibility that the Lusitania made the longer voyage to this extent. In any case, supposing the weather conditions met with to have been more or less the same, there does not appear now to be much difference in the speed of these two huge liners, and it would be no surprise if the Lusitania after another run or two were again to make a faster passage than her rival. The Mauretania, we may add, made the fastest eastward passage—4 days 13 hours 41 min.—during the month, and the North German liner Kronprinzessin Cecile ran from New York to Plymouth in record time for that port—5 days 7 hours 25 min.

During the past month several successful aeroplane flights have been carried out by Mr. S. F. Cody, though, unfortunately, on the evening of September 14th, he met with a mishap on Laffan's Plain, where his experiments have been made. He, on this occasion, had circled round the plain in good style, attaining a fair height, and travelling very evenly. In coming to the ground at the conclusion of the flight a buckled wheel on touching the ground suddenly stopped. The aeroplane was brought to an abrupt standstill, and Mr. Cody was thrown to the ground, with the result that he was slightly injured, the machine also being damaged. On Saturday evening, September 25th, however, he made two more flights. The first lasted 20 minutes, and was made with the object of testing the new elevating planes, a new compass, and a speedometer. In the second flight, which lasted 63 minutes, Mr. Cody carried a passenger. Interesting speed tests were also carried out on Monday evening, September 27th, and with a passenger on the machine he succeeded in flying a distance of a little more than a mile in 1 min. 15 sec. Then flying alone he reduced the time for the mile to 1 min. 5 sec., representing a speed of 45 miles an hour. These tests certainly showed that the machine is capable of remarkable speed. Afterwards Mr. Cody did some "cross country" flying, his elevation at times being from 150ft. to 200ft. Returning to the plain again, the engine was stopped at a height of 100ft., and an easy descent made to the ground.

Before M. Picard resigned his office as Minister of the French Marine he prepared a budget which provided for the expenditure of a considerable sum of money upon the reorganisation of the navy, notably in completing the armament of existing vessels and replenishing stocks of ammunition, and the new constructions for 1910 were to be limited to ten destroyers of 750 tons. His intention was to prepare a new programme of naval constructions before asking for credits for the building of battleships. The new minister, Admiral Boué de Lapeyère, is anxious to start upon the construction of battleships during 1910, and he is reported to be preparing a new budget in which the ten destroyers of 750 tons will be replaced by six destroyers of 700 tons, two destroyers of 450 tons, and four torpedo boats of 200 tons. At the same time it is hoped to start upon the building of three battleships of 22,000 tons, carrying twelve guns of 30 cm. It is considered, however, extremely unlikely that the minister will be able to carry out the latter part of his programme in 1910, for the reason that the law of 1907 will not allow of vessels of more than 1000 tons being put on the stocks without a special vote of Parliament, and it has, moreover, been decided that no credits will henceforth be voted for vessels until their plans are terminated and everything is ready for the giving out of orders. It is obviously difficult to complete these plans in time for the budget of 1910, and it seems hardly possible that Admiral Boué de Lapeyère will be able to do more than start upon the construction of small units in the coming year and leave the battleships for 1911.

On Saturday, September 11th, wireless telegraph signals were received at the Cullercoats Wireless Telegraph Station from Lyngley, in Denmark, at the rate of 100 words per minute, the distance being about 600 miles. The Cullercoats station is equipped with the Poulson arc apparatus, and also the less modern Spark system, but it was with the former that these tests were made. For high-speed transmission an automatic sender is used, with punched tape—as in the Wheatstone system. It was not possible to transmit messages from the Cullercoats station at this high speed, since the only automatic transmitter which has so far been constructed is at Lyngley. The receiver at Cullercoats consists of a photographic recorder in which a shadow of a wire which vibrates under the action of the waves is projected on to sensitised paper, and a trace resembling somewhat the record of a syphon recorder is produced. This record is said to be extremely clear and easy to read. Speed of transmission in wireless telegraphy is being continuously increased, and for the comparatively short time the various systems have been in existence, the progress made has been really wonderful.

WAGES, PROFITS, AND ROYALTIES IN THE COAL TRADE.

(By a Correspondent.)

At the present moment no apology need be offered for presenting a rough estimate of the average wages, profits, and royalties per ton of coal raised in Great Britain. To get at the exact figures is, of course, impossible; but we may come near enough to the mark of accuracy for all practical purposes of public interest. First, let us dispel a popular fallacy about wages. During the last two years or so prominent Socialist writers and speakers have been constantly declaring that miners' wages average only 2s. per ton of coal. Indeed, at least two well known Socialist journals have recently told their readers that miners' wages only average 1s. per ton of coal. The value of these statements may be gathered from the fact that the average annual output of coal is considerably less than 300 tons per worker employed at our mines, so that if wages only amount to 2s. per ton our miners receive considerably less than 600s. each for a whole year's work—say, 11s. per week—while if wages equal only 1s. per ton, then the miners get little more than 5s. a week. As a matter of fact, the average wages-cost of a ton of coal is from three to six times as much as the Socialists seek to make out.

Last year we had 987,813 workers employed under the Coal Mines Regulation Act. After making allowance for the raising of minerals other than coal, we may put the number engaged in raising coal at 900,000. These workers produced in the year 261,512,214 tons of coal. This means a *per capita* output of about 290 tons. Thus, at 1s. per ton the miners would have received £14 10s. for the year, or less than 5s. 7d. per week. At 2s. per ton, which is the more general estimate of the Socialists and their sympathisers, the average wage would have been 11s. 1d. per week. No competent authority will put the average weekly wage of the British coal mine worker at less than 30s. At that figure the average wages-cost of a ton of coal last year would be only a trifle less than 6s., and in 1907 it would be a little over 6s. per ton—say, 6s. per ton spread over the last two years. It may fairly be said that the labour cost of a ton of coal is more, rather than less, than two-thirds of the pit-mouth price. A prominent employer, Sir Christoper Furness, has put the labour part of the cost of production at 77 per cent. of the total, while a prominent Labour leader, Mr. T. Richards, has put it at 75 per cent. If the figures which have recently appeared in three of our leading Socialist weekly journals were correct, labour would be getting only from 11 to 22 per cent. of the selling price of coal.

In estimating profits it will be best to take, first, a long series of years, covering both "booms" and depressions, and then calculate from the figures of a normal and recent year. By this method we shall also get additional light on the wages question. From Board of Trade returns covering fifteen years, 1886-1900, we get these figures:—Tons drawn, 2,802,395,000; value at pit mouth, £953,477,000 (equal to 6s. 9.65d. per ton); paid in wages, £642,386,000 (equal to 4s. 7.01d. per ton).

These figures show that during that period of years labour received two-thirds of the price of coal. Seeing that the miners' daily wage is considerably higher now than it was then, while his daily output of coal is somewhat less, we are quite justified in putting the present cost of labour at about 6s. per ton. Now, the figures for those fifteen years show that, after labour received its share, there was left an amount equal to 2s. 2.64d. per ton of coal to provide for rents and royalties, rates and taxes, upkeep of plant, equipment, and appliances, materials, management expenses, and profits all told. As clear profit an estimate from the Board of Trade returns gave 6d. per ton, while Inland Revenue returns gave 5½d. From Inland Revenue returns for twenty-one years, 1880-1900, we get an average of 11½d. per ton to divide between lessors and lessees—that is, between royalty owners and colliery proprietors. The lessors' share of that 11½d. was, in 1889, according to the report of the Royal Commission on Mining Royalties, about 5¾d. That would leave another 5¾d. per ton as profit for the colliery proprietors—a figure not differing materially from the others just given.

Now let us examine present figures, so far as they can be ascertained. We shall not be far wrong in putting the average pit-mouth price of coal during the last twelve months—July, 1908, June, 1909—at 8s. 4d.—100 pence. And we may put the labour cost at 70 per cent., or 5s. 10d. per ton. This leaves us with 2s. 6d. per ton for royalties, upkeep, and profits. How much of this 2s. 6d. will be clear profit? A well-known expert on mining matters, Mr. J. H. Merivale, of Newcastle, has estimated the cost of materials used in coal mining, such as timber, horse food, oil, &c., at 7½d. per ton of coal raised, and salaries, commissions, compensation, rates, &c., at 6½d., making a total of 1s. 2d. per ton expenses. Taking 1s. 2d. from 2s. 6d., we are left with 1s. 4d. to divide between lessors and lessees, or 4½d. more than the average for 1880–1900. How much of this 1s. 4d. will be clear profit after rents and royalties are paid?

What royalties average is a debatable point, and is well worth attention in view of the proposal to tax royalty owners. As already mentioned, the Royal Commission on Mining Royalties put them at 5¾d. per ton of coal in 1889. But that was a year of depression and low prices. In recent years coal prices have been from a third to a half higher than in 1889, and as royalties are in many cases based on a sliding scale principle, it is safe to say that they will recently have averaged 8d. per ton on the Royal Commissioners' calculation. Against this we have had the estimate put forward by one gentleman that royalties now average 1s. per ton. This 1s. a ton calculation, however, covers ironstone, lead, and tin, as well as coal, so that we may assume that this authority will admit that coal royalties, on his own estimate, will be somewhat below 1s. per ton, and if we make allowance for the few cases where the colliery proprietor is a freeholder, we shall have to make

IRRIGATION DAMS IN THE UNITED STATES

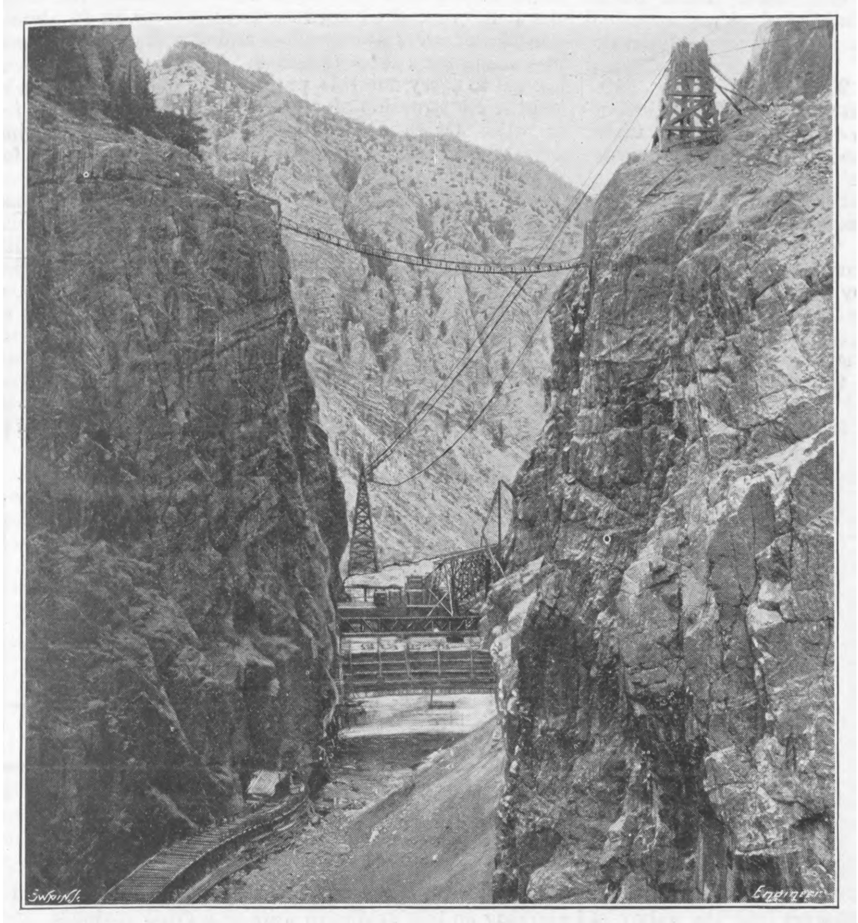


Fig. 17—THE SHOSHONE DAM

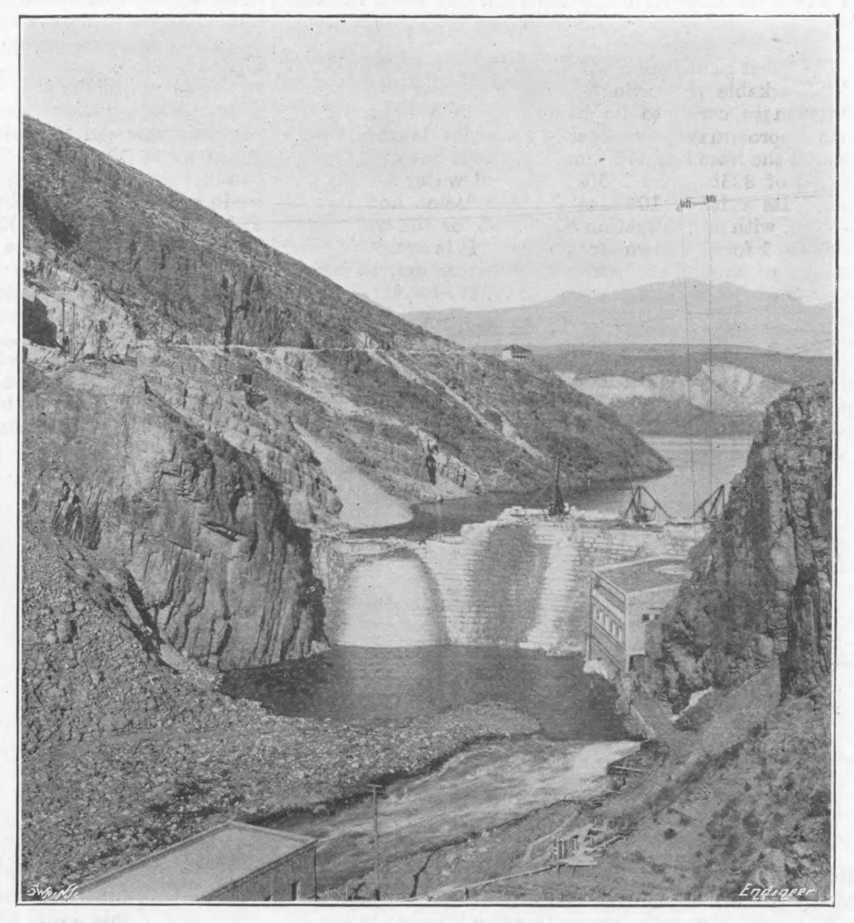


Fig. 18—THE ROOSEVELT DAM

a further deduction from this 1s. a ton estimate of royalties, so far as coal is concerned. On the other hand, we cannot accept the estimate of the Royal Commission that coal royalties were as low as 5¾d. in 1889, or that they will be as low as 8d. now. In the first place, the Commissioners admitted that their report was based upon "meagre" information. Tenants were reluctant to give full accounts in public evidence. Secondly, the Commissioners either absolutely ignored, or palpably underrated, some important points in such evidence as was given. They took little or no account of such royalty charges as lease fees, waterleaves, and airleaves, and, in the case of Scotland, they gave it in their report that the maximum coal royalty was 1s. 3d. per ton, after it had been proved to them that the maximum was not less than 2s. 6d. per ton. Indeed, two prominent members of the Commission themselves tendered evidence completely at variance with the "findings" of the report, which, nevertheless, they signed without protest. And, thirdly, the basis of royalties has been put up in sympathy with the rise in coal in the case of new leases and renewals since 1889. We shall be amply justified, therefore, in putting present coal royalties at 10d. per ton, on the average, for while they are as low as 2d. in one case they reach 2s. 6d. in another. Taking 10d. as royalties from the 1s. 4d. we have estimated as the amount divided between lessors and lessees, we are left with 6d. per ton profit for the colliery proprietor. This is the same figure arrived at by Mr. Merivale, after elaborate calculations made about seven years ago.

All the available evidence, then, supports the contention that profits on coal-mining in the United Kingdom, spread over a reasonable period of years, or in a normal year, average about 6d. per ton. What does this mean in shape of dividend on capital invested? As near as can be made out, the capital invested in coal mining is equal to 10s. per ton of output, or a little over £130,000,000. At 6d. per ton profit the dividend will be 5 per cent. gross. But it must be remembered that most collieries are leasehold, and allowing for redemption of capital within the average lease period, which is understood to be something over thirty years, practically two-fifths of the gross profits are absorbed, leaving only 3 per cent., or £3,900,000 per annum, as net dividend on the capital invested in an industry yielding not less than £76,000,000 a year in wages.

IRRIGATION WORKS OF THE UNITED STATES GOVERNMENT.

No. III.*

THE SHOSHONE IRRIGATION DISTRICT.

The Shoshone District, in the State of Wyoming, provides for the irrigation of about 150,000 acres of land having a light sandy loam and clayey soil. The district has an elevation of from 4000ft. to 5000ft. above sea level, and the temperature range is from 30 to 95 deg. Fah. The average annual rainfall is from 6in. to 10in. Hay and grain are the principal products.

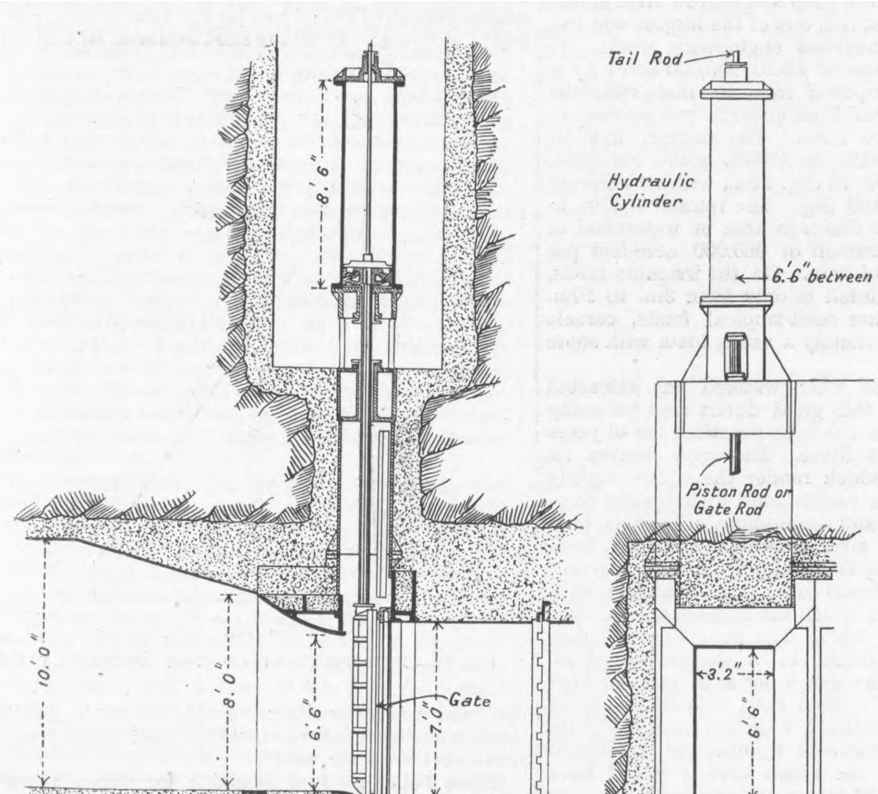


Fig. 19—GATE VALVE, SHOSHONE DAM

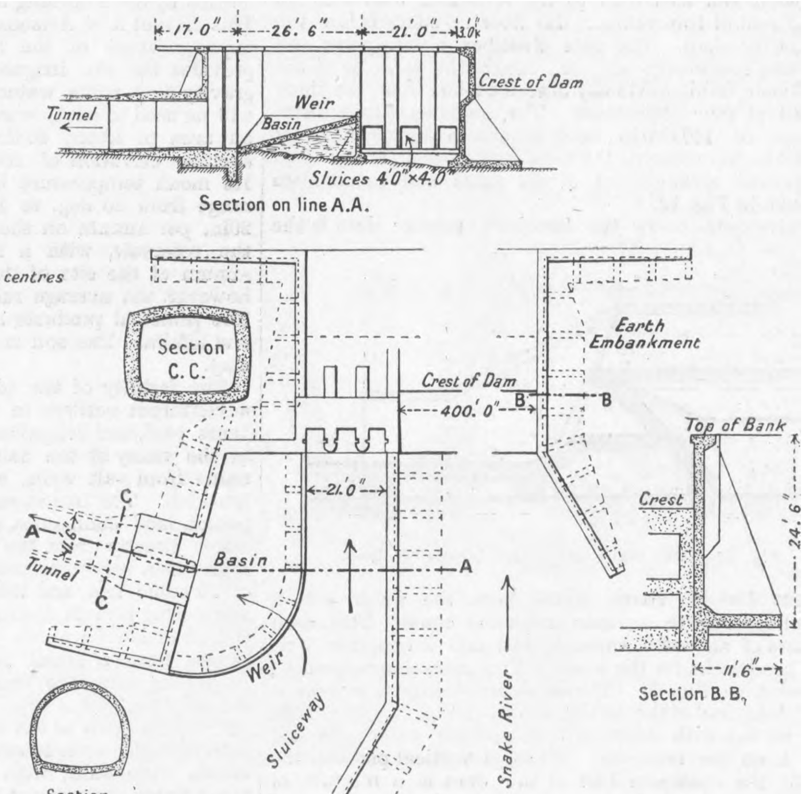


Fig. 20—THE CORBETT DIVERSION DAM

The irrigation water supply is obtained from a great reservoir formed by the construction of a dam in a narrow rocky canyon or gorge by which the Shoshone river breaks through the mountain range. The gorge is about 8 miles long, and at its entrance the width is only 60ft. at the bottom, increasing to only 200ft. at a height of about 300ft. The reservoir or lake thus formed will have an area of 10 square miles, with an average depth of 70ft. —maximum 243ft., and a capacity of 456,000 acre-feet.

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* No. II. appeared September 24th.

Its watershed area is 1380 square miles, with an average annual run-off of 1,027,000 acre-feet. The river flow ranges from 2000 to 15,000 cubic feet per second. The stored water will be discharged as needed by an outlet tunnel to the river channel below the dam, and about 12 miles down the river it will be diverted by a dam into a tunnel leading to the main canal.

The great Shoshone dam, which forms the reservoir, is of remarkable proportions, being of great height, but short length, owing to its being built in a narrow gorge with approximately vertical walls. Its length is only 85ft. at the base and 176ft. on top, but it has a maximum height of 326ft., with 243ft. depth of water against the face. Its width is 108ft. at the foundation and 10ft. at the top, with an inclination of 20 to 3 for the water face and 4 to 1 for the down-stream face It is arched in plan, and is of monolithic concrete construction, having a volume of 69,000 cubic yards. Fig. 17 is a view of this dam under construction, with the cableway by which material is handled, and the rope suspension bridge spanning the gorge. The cableway has one tower at the top of one side of the gorge, while the other is at the bottom of the opposite side, the cables crossing the site of the dam diagonally. The river bed is laid dry, the flow being diverted through the future outlet tunnel, and carried off by the timber-box aqueduct on the left.

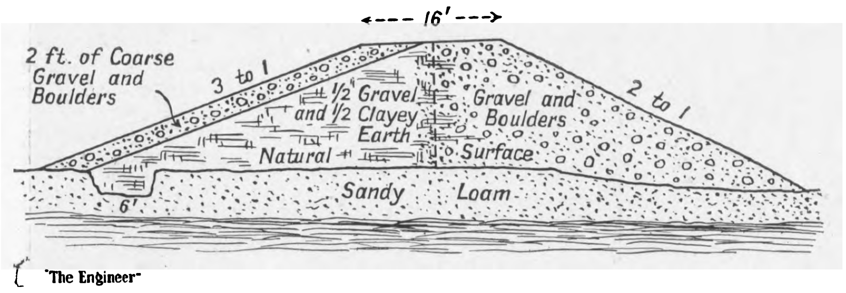


Fig. 21—CROSS-SECTION OF THE CORBETT DAM

The work here was extremely difficult owing to the inaccessibility of the site. A road eight miles long had to to be cut in the wall of the gorge, and a cableway was thrown across the top of the gorge for handling and placing material. Much of the drilling work for blasting was done by men suspended by ropes, and finding a precarious footing in the face of the cliffs.

The outlet tunnel of the reservoir was built first to carry the low-water flow of the river during the foundation work of the dam. A temporary crib dam, with rock filling, was built to divert this flow into the tunnel, the dam being 430ft. long and 17ft. high. To carry the river previous to the opening of the tunnel, a timber flume or canal was built from the temporary dam to a point below the site of the main dam. This had a capacity of 2000 cubic feet per second.

Through the side of the gorge is driven a tunnel, which serves as the outlet for the reservoir. It is 480ft. long, 10ft. wide, and 10ft. high to the springing line, with an arched roof of 10ft. radius. Its floor is 233ft. below the crest of the dam. The gate chamber, sluice gates and operating machinery are very much the same as at the Pathfinder Dam, previously described, but there are three instead of four sluiceways. The gates sustain a water pressure of 440,000 lb., and require a lifting force of 120,000 lb. to overcome the total friction and gravity load. The general arrangement of the gates and mechanism is shown in Fig. 19.

Twelve miles below the Shoshone storage dam is the Corbett diversion dam, which turns the water into a tunnel leading to a main irrigation canal. This dam consists of an earth embankment and a concrete weir with headworks for the canal. The general arrangement is shown in Fig. 20. The earth embankment or dam is 450ft. long, and of the section shown in Fig. 21. It is 16ft. wide on top, with slopes of 3 to 1 on the water side and 2 to 1 on the rear side. From a vertical plane in the middle the upstream half of the dam is a mixture of natural gravel and clayey earth in equal proportions laid in 6in. courses, each sprinkled and rolled with a roller weighing one ton per foot of width. The slope is faced with 2ft. of coarse gravel and boulders. The downstream half is composed of gravel placed in 12in. layers. Under each toe is a trench 6ft. wide and 4ft. deep, well filled and rammed to form a cut-off. Where the embankment is laid against the masonry abutment of the weir it is composed of gravel and earth deposited in layers and puddled with an excess of water.

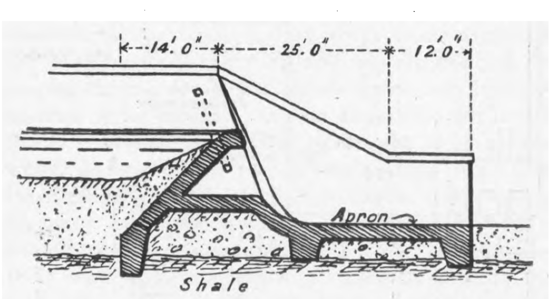


Fig. 23—THE WEIR OF THE CORBETT DAM

The weir is a reinforced concrete structure 400ft. long, with a height of 18ft. It is of peculiar design, Fig. 23 having an inclined face and a crest, 30in. thick, supported by cross walls or buttresses 24in. thick and 14ft. between centres. It has no back wall, and the triangular spaces between the buttresses are open on the downstream side. The dam is built on shale and gravel, and has a wide flat base or platform with three cut-off walls carried down into the shale formation to prevent any leakage under the dam. The platform extends below the weir, forming a wide apron to receive the force of the falling water and prevent erosion. This apron is 24in. thick and extends 35ft. below the dam. The entire structure is a monolithic mass of concrete, reinforced by steel bars. There being no sand in the vicinity, a stone crushing plant was installed to crush small boulders to a size suitable as a substitute for sand.

At one end of the weir—Fig. 20—is a sluiceway, 21ft. wide, extending about 100ft. upstream. The lower end of the sluiceway—in line with the dam—is closed by three sluice gates 5ft. wide. The land side of the sluiceway channel forms a weir, over which the water flows into a basin having a floor sloping to the mouth of the tunnel. This tunnel is 10ft. by 10ft. in section, with an enlarged entrance for two sluices $6\frac{1}{2}$ft. wide, fitted with gates. Grooves are made in the masonry of all sluices so that these openings may be closed by stop planks to permit of access to the gates for inspection and repair. The tunnel is $3\frac{1}{4}$ miles long, driven through a shale that disintegrates very rapidly when exposed, so that timber lining had to be used in several places to hold the excavation until the concrete lining could be built.

The water from the tunnel is delivered into a small reservoir or settling basin formed by closing an opening between two hills. A sluicing tunnel is driven from the lower end of this basin, and discharges into the valley of the Shoshone River. The main canal is taken off from the lower end of the reservoir, the head works having six regulator gates 4ft. wide and 8ft. high. The normal water level is 18in. above the top of the gate opening, and the maximum height a head is 8ft. above the openings. The short dam or wing on either side of the headworks, extending to the slope of the hills, is of cellular construction. There are two vertical walls 8in. thick, 14ft. high and 14ft. apart, connected at 10ft. intervals by cross walls; all walls are of concrete and extend about 3ft. into rock. The rectangular spaces are filled with earth, puddled and rammed. All the concrete of the headworks and wings is heavily reinforced with steel. The canal is 20ft. wide on the bottom.

THE SALT RIVER IRRIGATION DISTRICT.

This is a third district which is served by a reservoir formed by the damming of a deep and narrow river gorge. This district is in Arizona, it is one of the largest and has required some of the heaviest engineering works. It provides for the irrigation of about 200,000 acres by a gravity flow, while water-power from the main reservoir will be used to pump water from underground sources on an area of about 40,000 acres. The district has an average elevation of 1000ft. to 1300ft. above sea level. Its mean temperature is 70 deg. Fah., with an extreme range from 20 deg. to 120 deg. The rainfall is 10in. to 20in. per annum on the drainage area or watershed of the reservoir, with a run-off of 663,000 acre-feet per annum at the site of the dam. On the irrigable lands, however, the average rainfall is only from 3in. to 10in. The principal products are semi-tropical fruits, cereals and alfalfa. The soil is mainly a sandy loam with some clay.

The fertility of the soil when watered has attracted adventurous settlers to this great desert area for many years past, and irrigation has been practised for 40 years in the valley of the Salt River. The river derives its name from salt wells, which render the water slightly brackish. The irrigation canals, built by irrigation companies, land companies, and associations of farmers, took water directly from the river channel. The river, however, has a very uncertain flow, ranging between extremes of 55 cubic feet and 200,000 cubic feet per second, with alternating periods during which the average annual flow is high or low for a few years. The actual annual flow ranges from a small stream to a destructive flood. Beginning with 1885, there was a series of years of high annual flow, with a supply more than sufficient to meet the requirements of the existing irrigation canals. With this seeming encouragement a number of additional canals were built, with the result that it would have taken twice the amount of water ordinarily available to supply the canals to their capacity.

According to a statement by Mr. A. P. Davis, chief engineer of the Reclamation Bureau, there were on the north side of the valley four main canals aggregating 120 miles in length, and with capacities from 100 cubic feet to 1000 cubic feet per second. On the south side there were six main canals aggregating 128 miles in length, and with capacities from 52 cubic feet to 600 cubic feet per second. The combined capacity of the ten canals was 2900 cubic feet per second. A series of years of unprecedented draught began in 1898, and resulted in great loss in the irrigation districts. It was evident that the unregulated river flow could not be relied on for any extensive development by irrigation. But it was evident also that there were great possibilities in the storage and conservation of the water in the mountains, before reaching the channel traversing the desert plains. The cost of the necessary works and the complications of land ownership and use of water made it quite impossible for such a plan to be carried out by private enterprise and capital. In 1902 the matter was taken up by the Government, and put into the hands of the Reclamation Bureau. Extended explorations and surveys were made, and a site was found near the headwaters of the river, in an almost inaccessible mountain region, and at a distance of some 60 miles from the irrigation district. When it was decided to carry out this project one of the first works was the construction of a road to the site. This ran for 20 miles across an absolutely waterless desert, giving growth to nothing but the weird cactus tree, and then for 40 miles through a wild mountainous country.

For the work of construction of the main dam—named the Roosevelt Dam—and the auxiliary works an industrial town was established near the site, and provided with waterworks, electric light, and other modern conveniences, in order to make life as comfortable as possible. Sawmills were established in a forest 30 miles distant to supply timber for the buildings and construction work, and all this timber had to be hauled to the site by wagons, which necessitated the construction of roads. No less than 150 miles of road in all were built for this project. A lime-kiln, stone-crushing plant, machine and blacksmith shops, refrigerating and ice-making plant, telephone lines, &c, were among the varied equipment necessary for carrying on this extensive work at a great distance from railways and centres of population.

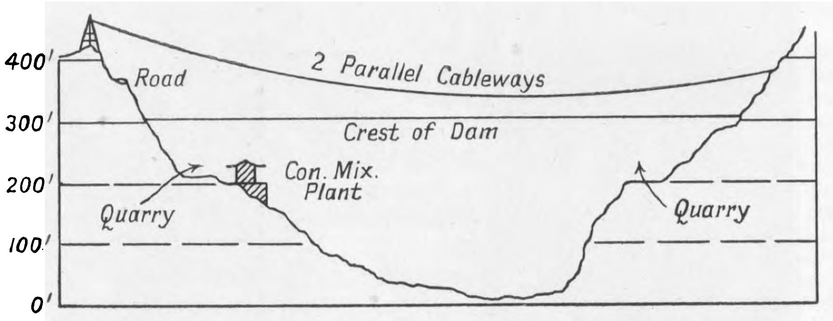


Fig. 22—DIAGRAMMATIC ELEVATION OF THE ROOSEVELT DAM

The great cost of transporting material in wagons for long distances was an important feature to be considered in relation to the cost of the work. In particular, the cost of transporting the quantity of cement required—about 250,000 barrels—was so great that the engineers considered plans for a cement-making plant, using raw materials obtainable within easy reach. The Government invited tenders for the supply of the cement, but the result was that it was deemed economical to instal a complete plant to be operated under the direction of the Government engineers. The capacity is from 300 to 400 barrels of Portland cement daily. Experience has shown that the cost of the locally manufactured cement, including charges of every kind, is less than half of what it would have been if purchased from manufacturing plants and transported by rail and wagon to the point of use. More than half of the local cost is represented by the transportation of the oil fuel for the kilns, which is brought from California. As all the sand available was mixed with clay, and was otherwise unsuitable for use in concrete, a stone-crushing plant was installed, and crushed dolomite rock substituted for sand.

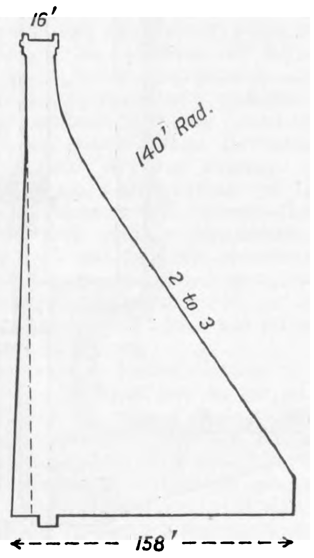


Fig. 24—CROSS-SECTION OF THE ROOSEVELT DAM

There being no fuel available for steam power, the engineers established a hydro-electric plant. A dam was built 20 miles up the river, diverting part of the flow into a concrete-lined canal, which crosses lateral gorges by numerous concrete aqueducts, With a penstock tunnel 620ft. long and a vertical fall of 250ft. at the site of the main dam, the plant developed 4400 horse-power, which was utilised for a variety of purposes. This plant is for permanent use, and will be enlarged. The project includes the development of water power at the dam, and by vertical drops in the canal, aggregating 26,000 horse-power. The current will be transmitted to a station about 90 miles down the river, where it will be used to operate pumping plants drawing water from underground sources to irrigate a tract of some 50,000 acres.

The reservoir formed by the Roosevelt dam will be 25 miles long, and will cover an area of about 30 square miles. It will have a capacity of 1,284,000 acre-feet at a level of 220ft. above low water. The dam is 700ft. long on the top, and its height above foundation is 284ft., with a maximum depth of 242ft. of water against the face. The water side has an inclination of 20 to 1, while that of the downstream side is 3 to 2. The width is 170ft. at the bottom and 16ft. at the top, with a roadway along the crest. The volume of the dam is about 340,000 cubic yards. It is built of rock-faced hard sandstone for the faces, laid up in Portland cement in random courses. The backing or interior mass is of rough quarry blocks laid in concrete. It is of curved form, acting as an arch, and has a radius of 420ft. The work was many times interrupted by floods, some of which washed away the construction plant and the cofferdams built to divert the low-water flow through the outlet tunnel during the construction of the foundations. Two parallel cable-ways, 1200ft. long, were stretched across the gorge for handling material, and masons' derricks were used for setting the stones in place. The contract was let in 1905, and in May, 1909, the masonry had reached a height of from 125ft. to 152ft. A view of the work is shown in Fig. 18, while its elevation and cross-section are shown in Figs. 22 and 24.

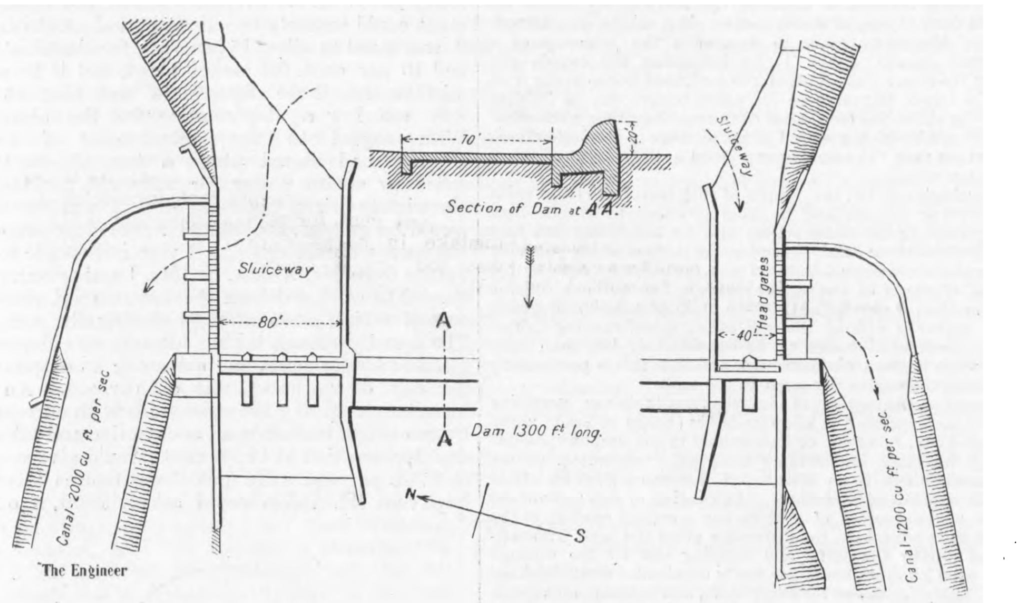


Fig. 25—THE SALT RIVER DAM

The outlet from the reservoir is a tunnel 500ft. long, driven through the hill against which one end of the dam abuts. This tunnel discharges into the natural channel of the river below the dam. In section it is 12ft. wide and 10ft. high, with a flat arch roof. The floor is 290ft. below the crest of the dam. In the tunnel is formed a gate chamber 19½ft. wide, which is divided by two piers into three openings or sluice-ways, 10ft. high and 5ft. wide. Each opening has two gates 11½ft. by 6⅓ft., one being for service and the other for emergency.

Over the gate chamber is a gallery in which the gates stand when raised, and above this again is a chamber for the vertical operating cylinders. All these chambers are cut out of the rock. Each gate has a 6in. piston-rod 32ft. long, the piston being in a steel cylinder designed to carry 700 lb. pressure. The gates are of the Stoney type, with rollers moving in guides. The bronze seat is made with a slope on the face, so that the gate does not come to a full bearing until just as it is closed; while in opening, the rollers take the pressure as soon as the gate moves. In this way all friction and grinding between the gate and seat are avoided. The general arrangement is similar to that at the Shoshone and Pathfinder dams, previously described, and shown in Fig. 19. The gates are the largest ever built to work under the great pressure of 100 lb. per square inch. In addition to the tunnel, there is a 10ft. conduit through the dam, at a height of 75ft. above the river bed. Besides the main dam, the reservoir has two overflows or waste-ways, having a combined length of 320ft. When water is needed for irrigation, the sluices in the outlet tunnel will be opened to the extent required, and the water will flow into the river channel below the dam.

About 55 miles down the river is the granite reef diversion dam, turning the water through the headworks of a main irrigation canal on each side of the river. It raises the level of the Salt River—and its tributary the Verde River—about 15ft., and is made long and shallow to prevent raising the flood waters too high. The crest is 1310ft. above sea level. The general arrangement of the dam, with its sluices and canal headworks, is shown in Fig. 25. The dam is 1300ft. long, and has an ogee form for the lower face, with a slope of 4 to 7, and a bottom curve ending in a wide apron to prevent erosion of the river bed. The depth to bed rock is too great to permit of carrying the foundations to rock. The dam is built therefore upon the deep stratum of gravel and boulders, special means being taken to prevent undermining by the percolation which will occur under the pressure due to the heed of water at the dam. The dam is of monolithic concrete construction, reinforced by steel bars. It is 40ft. high above the foundation, and 20ft. above the river bed. The curtain walls or cut-off walls are to check seepage, but 6in. openings are made in the second wall to permit the escape of any water that may percolate through the material, and so prevent any upward pressure against the base of the dam. These openings are 5ft. apart and 6ft. above the bottom of the wall.

An apron extends 75ft. beyond the dam, and is laid on a prepared bed of boulders 4½ft. thick. The concrete is 18in. thick, and was laid in sections 10ft. square, with 3in. spaces between them to permit the escape of any underlying water held by the curtain wall at the lower end of the apron. When the water was first raised at the dam by closing the sluices, the pressure caused a slight flow through these openings, but this ceased in a short time. The river bed is now covered with a blanket or layer of silt deposited by the still water of the pool above the dam, and this serves effectually to prevent seepage through the material beneath it. The pool acts thus as a settling basin, so that practically clear water is drawn off for the irrigation canals.

At each end of the dam is a sluiceway, with the headworks for a main canal. The sluiceway on the north side is 80ft. wide, with four sluices. As originally planned, the water was to flow over a side weir into a basin, across which were the headworks—with regulating gates—for a canal 40ft. wide, and having a flow capacity of 2000 cubic feet per second. As built, however, the gates are in a wall which takes the place of the weir, and the basin forms the head of the canal.

The sluiceway on the south side is 40ft. wide, and its floor has a slope of 1 in 66. The floor is 8ft. below the crest of the dam. In line with the dam are the sluice gates, a central pier forming two openings, each fitted with a vertically sliding gate 15ft. wide and 9ft. high. The river side of the sluiceway is a wall as high as the dam. The shore side was to be a weir discharging into an entrance basin, as noted above, but in construction the weir was replaced with a concrete wall 15ft. higher than the dam, with nine openings, 5ft. high and 7ft. wide, for the regulator gates or head gates of the canal. The sills of these openings are 4ft. below the crest of the dam and 4ft. above the floor of the sluiceway, so that when the flood water is running through the sluiceways the heavy silt will be carried near the bottom and will not enter the canal. When the gates are closed, also, the sediment or silt will collect on the floor, below the canal openings. This canal has a capacity of 1200 cubic feet per second.

The sluice gates are steel boxes filled with concrete, and weigh six tons each. They are operated by cables led through a tunnel under the sluiceway and passing up shafts to pulleys on top of the piers and sidewalls, from which they pass down to the gates. All the cables pass round a segmental drum of 7ft. radius and up a shore shaft to a power-house. Their ends are attached to a crosshead on the piston-rod of an inverted vertical cylinder 26in. by 96in., a nut on the tail rod providing for locking the gates in any position. The operating pressure in the cylinder is about 700 lb., and is maintained by a pump driven by an 8 horse-power petrol engine.

The regulator gates are raised by nuts on the threaded stems, these nuts having ball bearings and bevel gears driven by a running rope from a winch connected to the petrol engine.

Institute of Marine Engineers.—The Denny Gold Medal, provided for by the late Peter Denny, LL.D., has been awarded this year to Mr. William P. Durtnall for his paper on the "Generation and Electrical Transmission of Power for Main Marine Propulsion and Speed Regulation," read at the Franco-British Exhibition in July, 1908, which was adjudged by the Council of the Institute to be the best paper submitted in competition for the Medal during session 1908-09.

IRON AND STEEL INSTITUTE.

The autumn meeting of the Iron and Steel Institute, which opened in the hall of the Institution of Civil Engineers on Tuesday last, is distinguished as having attracted the largest number of members who have ever given in their names to attend any similar conference. The last time the Institute held an autumn meeting in London was in 1906, when a joint conference took place with the American Institute of Mining Engineers. In all, the Reception Committee had to make provision in the social programme, and in the arrangements for visits, for some 1300 persons, and the demand for accommodation had the result of making it necessary to refuse many applications of inclusion in special functions for which, as in the majority of cases, a limit was put upon the number participating. The Reception Committee and the secretarial staff did all that was possible in the way of obtaining increased facilities for the visits, but there was still a considerable surplus of applications with which it was impossible to comply.

Lord Airedale presided at the opening meeting in the absence of the President, Sir Hugh Bell, and was supported by the Duke of Devonshire, the President-elect; Lord Glantawe, Str John Alleyne, Mr. E. P. Martin, Mr. A. Tannet Walker, Mr. Percy C. Gilchrist, and other vice-presidents and members of council.

The secretary announced the names of the retiring vice-presidents, Mr. Arthur Keen, Sir Wm. Thomas Lewis, and Mr. Percy G. Gilchrist, F.R.S. The retiring members of the Council are Messrs. C. J. Bagley, Wm. Evans, J. H. Darby, J. E. Stead, and Sir Alfred Hickman.

The first paper taken was that by Mr. E. J. Ljungberg "On the Refining of Steel by Electricity," which we give in full below.

On the whole there is at present not much more to add to what has already been published concerning the melting of steel by use of electric current. Many types of furnace have been evolved and constructed—the Héroult, Kjellin, Stassano, Girod, Röchling-Rodenhauser, and others. It is also well known that furnaces up to a capacity of 15 tons have been built for making special steel with good commercial results. For making steel of ordinary quality the electric method still seems to be too expensive, even where cheap water power is available.

At Gysinge, one of the works belonging to the Stora Kopparbergs Bergslag, there is one Kjellin induction furnace with a capacity of two tons, but as this is working as a Talbot furnace, not more than about one ton at a time is tapped.

The continuous current used in this furnace represents about 200 kilowatts, and the output in 300 days amounts to about 1200 tons of ingots, using 50 per cent. pig and 50 per cent. scrap.

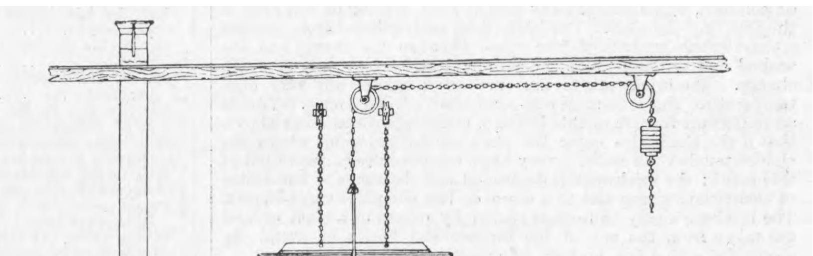


Fig. 1—ELECTRIC SMELTING FURNACE

As no other pig iron is used except the famous Dannemora brand made by the firm, which, as every one knows, is extremely low in phosphorus and sulphur, the process can hardly be called a refining process. The product is a carbon steel of high quality, possessing some superiority over steel made by the ordinary melting processes, the quality which I would instance specially being that it is comparatively soft to work, either hot or cold, although high in carbon. It is a superior carbon tool steel. It may be of interest to state that the company makes about 15,000 tons of Dannemora charcoal pig iron annually, of which about one-third is exported and two-thirds are used at the works at Söderfors and Elfkarleö for the manufacture of Dannemora Walloon bar iron, open-hearth and crucible steel.

In the electric furnace, as well as in the crucible plant, there are also produced, among different kinds of special steel, high-speed self-hardening steel, tungsten steel, chromium steel, and nickel steel. Such steels can easily be made in electric furnaces when the necessary care is taken. When speaking of high quality steel, all steel makers know that the utmost care in heating, hammering, rolling, and tempering is necessary if a good result is to be obtained.

For a country like Sweden, possessing practically no coal mines but numerous waterfalls, the manufacture of iron and steel direct from ore by the agency of the electric current is of much more interest than the melting of pig and scrap to make steel. At the works at Domnarfvet extensive and costly trials have therefore been made in the direct reduction of ore during this and the past few years.

In these experiments two modifications of a furnace constructed by Mr. Wallin in Berlin and several modifications of a furnace constructed by Messrs. Grönvall and Lindblad (the Electro-metal Company), Ludvika, have been tried. Of these it is needless to describe any except the latest form.

The accompanying drawing—Fig. 1—shows a furnace similar to a common blast furnace, but with three electrodes fed by three-phase alternating current at about 40 volts, 60 cycles, and 9500 ampères, averaging 674 horse-power, instead of tuyeres. In this furnace, which has been running for 1903 hours, there have been produced 28 tons of iron, containing from 0.95 to 3.09 per cent. of carbon.

In the manufacture of this quantity there was used :—

	Tons.
Ore	412
Lime	24
Coke	41
Charcoal	58
Electrodes, total	6.5
Electric current (kilowatt-hours)	891,623

or per metric ton of pig iron produced :—

		Kilos.
Coke and charcoal		353.3
Power, horse-power year		0.492
Electrodes, effective	8.8 kilos.	
Wasted ends	13.9 ,,	
		22.7
Pig iron from ore and lime		60.02
Pig iron from ore alone		63.50
Pig iron per horse-power year..		2.03 tons.

The temperature of the escaping gases from the furnace is generally very low, and these contain on an average about 22 per cent. of carbon dioxide (from 8 to 41 per cent.). The amount of carbon monoxide varies from 39.4 per cent. to 61 per cent. The gases contain practically no nitrogen, but steam from the water in the ore, lime, coke, or charcoal is present.

The efficiency of the electric current ought to be higher than hitherto, if the considerable loss of heat by cooling water and radiation can be reduced. These losses seem to be about 30 per cent.

No air whatever is used in the process, and the gases are produced from the carbon in the charcoal and coke and the oxygen in the ores ($FeO + C = Fe + CO$). Either charcoal or coke may be used, but the consumption of fuel will be practically the same in either case.

According to the description of the inventor, the figure shows a vertical section through the furnace, which consists of a lower portion or smelting chamber, corresponding to the hearth of a blast furnace, and a top section or shaft. The latter is supported on columns, which prevent any weight from bearing on the arch of the smelting chamber. The latter is so proportioned as to provide a considerable amount of free space between the charge and the arched roof through which the carbon electrodes project into the charge. The brickwork is thus protected against any very high temperature and remains a non-conductor of electricity. This is an important feature of this furnace, since experiment has shown that if the electrodes enter the chamber at the point where the charge touches the walls, a very high temperature is generated at this point; the brickwork is destroyed and becomes a conductor of electricity, giving rise to a more or less complete short-circuit. The brickwork may be further cooled by means of a blast of cool gas taken from the top of the furnace and blown in round the electrodes with a fan, no heat being lost by this proceeding.

The ore and fuel are crushed to a suitable size, and are fed into the top of the furnace through the bell hopper in the usual way, the ore being partially reduced by the carbon monoxide rising through the charge. The latter spreads out in the smelting chamber as shown, and the reduction is there completed. Since the electrodes project well into the charge, the highest temperature occurs in the centre of the latter, and the brickwork is thus kept cool, compared with the walls of an ordinary blast furnace.

It will be seen from the figures given in the paper that a step has been taken in the direction of replacing a considerable part of the fuel used in making iron and steel by the electric current, and that the problem is technically solved. As regards its commercial value, it is too early to make any definite statement yet, but this will be readily understood by all iron and steel makers when they reflect how many years it has taken to bring the Bessemer, the open-hearth, and the basic processes to their present state of perfection.

Mr. P. R. Cobb said that the writer of the paper commented on the fact that there had been practically no advance in the commercial use of the furnace. That was not quite the fact; he had recently had an interview with one of the inventors, Mr. Grönvall, who had just returned from Canada, where considerable developments were promised. Mr. Grönvall had fixed up some contracts involving the use of three furnaces of large capacity at Sault St. Marie by one of the principal iron-producing establishments. Ironmasters in Canada were taking a very favourable view of the prospects of the furnace, and were backing their opinion by putting down money. These furnaces were expected to be running some time towards the middle of next year, and after experience of the working of this plant it would be possible to say something of the performance of this type of furnace on the commercial side.

Lord Airedale, in moving a vote of thanks to the author, said that the subject was one of very great importance. The production of iron without the use of coal as fuel by making use of water power would be a great step forward.

Mr. C. A. Ablett then submitted his paper, "The Determination of the Economy of Reversing Rolling Mills." The following is an abstract of it :—

Since the last autumn meeting of the Iron and Steel Institute five steel works have decided to adopt electrically driven reversing rolling mills, making in all over twenty firms who have come to this decision, and twelve such plants are at work in different parts of the world, one at least being installed to replace an engine less than ten years old, which was in good condition.

The reasons influencing this decision may be briefly summarised as follows:—(I.) Greater economy in fuel consumption. (II.) Larger output from plant. (III.) Reduced running costs, *i.e.*, reduction in cost of repairs, attendance, oil, &c., the reduction in the cost of oil being very striking. (IV.) Greater convenience and reduction of management expenses due to centralisation of power supply. (V.) The great economy of the electrical plant is maintained throughout the life of the plant, and does not diminish as the parts wear.

The capital cost of an electrically driven reversing mill is greater than that of a steam driven mill driven by a plain two-cylinder engine, but in the last two years the experience gained in setting a number of such plants to work has enabled the capital cost to be very materially reduced. Further reductions in the capital cost are scarcely possible unless some entirely new method of reversing mill driving is evolved in place of the Ilgner system, which has been employed exclusively up to the present, and the present state of electrical knowledge does not offer much prospect of this.

In a very large number of cases the economies which could be effected by the adoption of electric driving are found amply to justify the increased capital expenditure. At the present time the question of saving in fuel consumption appeals to most steelmakers as the chief inducement offered by electrical driving, as the possibilities in the direction of greater output are not fully recognised, there being as yet no published figures relating to this. It is therefore of interest to consider the methods by which the economy in fuel, power, or steam consumption can be ascertained.

Tests are frequently made to determine the economy of a reversing-mill engine, either (1) by indicating the engine and estimating the steam consumption per indicated horse-power from some of the larger diagrams, or (2) where boilers can be isolated by measuring either the feed water or the coal burnt for a considerable period, and keeping a record of the tonnage of steel rolled over that period, so that the result is expressed in lb. of coal or lb. of steam per ton rolled.

In the author's opinion the results of such tests have little value for the following reasons, and he then proceeds to discuss tests made by indicating the steam engine and by measuring the feed water or the fuel burnt, and concludes this portion of his paper by saying the above-mentioned tests do not furnish any clue to the mechanical efficiency of the engine, and in the author's opinion the usual method of arriving at this—*i.e.*, taking indicator diagrams when the engine is driving the mill at full speed running light—shows the mechanical losses to be considerably less than they really are when ingots are being rolled, and that this is particularly the case when the engine is geared to the mill.

The energy consumption of an electrically-driven reversing rolling mill as expressed in kilowatt-hours (Board of Trade units) per ton rolled can, however, be determined in the simplest possible manner by inserting an ordinary integrating wattmeter in the supply system, which is an instrument that can always be left in circuit and requires no attention. If a reading of this instrument before the commencemet of a shift and a second reading at the end of the shift are taken, the difference gives the total kilowatt-hours used during the shift, and dividing this by the tonnage rolled the total kilowatt-hours per ton is obtained. Such readings can quite easily be taken for every shift, and a continuous check on the energy consumption can be kept. Results expressed in kilowatt-hours per ton are generally found most useful, as the cost of the kilowatt-hour varies according to local conditions, and knowing this cost, the total cost of power can be arrived at directly. The efficiency of the electrical plant can also be checked in the simplest possible manner by placing a second integrating wattmeter in the armature circuit of the mill motor.

The records of this wattmeter will be less than those of the one placed in the supply circuit, the difference being the losses in the electrical plant. This does not take account of the efficiency of the mill motor armature, but as this is of the order of 97 to 98 per cent. it can well be neglected. The following figures show some characteristic values for the kilowatt-hours per ton rolled obtained from tests on reversing mills :—

	Kilowatt-hours per ton.
4½in. by 4½in. billets from 2.5-ton ingots. Output, 53 tons per hour	22.5
6in. by 6in. blooms from 2.5-ton ingots. Output, 63 tons per hour	17.5
8in. by 8in. blooms from 2.5-ton ingots. Output, 80 tons per hour	13.0
12in. by 9½in. blooms from 7-ton ingots measuring 34½in. by 25in. Output, 65 tons per hour..	11.2
32in. by 9in. slabs from 6-ton ingots measuring 35in. by 19½in. Output, 40 tons per hour	4.3
32in. by 5in. slabs from 6-ton ingots measuring 36in. by 19½in. Output, 40 tons per hour	5.8
Flange rails, 100 lb. per yard, from 2-ton ingots. Output, 30 tons per hour	48.0
Beams, 120 lb. per yard, from 1.5-ton ingots	36.0
Channels, 92 lb. per yard, from 1.5-ton ingots..	37.0

Mr. Andrew Lamberton, in opening the discussion, said that no doubt nothing was further from the desire of the author than to give rise to any misconception, but having said that, he (Mr. Lamberton) felt it right to express the fear that the statements made in the paper would give rise to misconception. The title of the paper was "The Determination of the Economy of Reversing Rolling Mills." That referred to the electrically-driven mill, and on the first page of the paper it was stated that five other steelworks had gone in for the electrification of their reversing rolling mills, and in one case had thrown out a steam engine in good condition only ten years old. Various claims were put forward by the author, under five heads, at the outset of his paper. The title of the paper, with this statement of claims, would naturally lead to the inference that Mr. Ablett intended to show that the electrical driving of reversing rolling mills would result in great economy. He had read the paper carefully through more than once, and there was not a single figure to substantiate those claims. Mr. Ablett gave on the last page of the paper a statement of the consumption in kilowatt-hours for rolling certain sections. Mr. Ablett had given results in that form in a paper read at the Middlesbrough meeting of the Institute a year ago. It was then pointed out that it would be very useful if Mr. Ablett would give his results of rolling sections, not in kilowatt-hours, but in actual money costs. Mr. Ablett's reply to that suggestion was that, having the figures for kilowatt-hours, it was a simple matter to find out the actual cost per ton. All that was necessary was to find the cost of the unit, which would vary in different places and under different conditions. Mr. Ablett had again presented his results of electrical rolling in kilowatt-hours. Mr. Greiner, who took part in the discussion at Middlesbrough, referred to the experience of the electrically-driven reversing mill in Germany. Mr. Greiner pointed out that experience indicated that with coal at then prices—and it was higher in Germany than this country—and allowing 15 per cent. depreciation on the first cost of the plant, electrical rolling was nearly as cheap as rolling by steam plant. It was pointed out, however, that in that comparison the prime movers in the electrical system were gas engines running on waste gases, for which nothing was charged, so that the cost of the electrical system would be much higher where coal fuel had to be employed. Mr. Ablett had not met that statement, and critics were entitled to say that he did not in the paper substantiate the claims he put forward. The title of the paper ought rather to be "The Determination of the Power Taken in Reversing Rolling Mills"—for no economy was proved. The steel maker wanted to know the £ s. d., and it was not entirely made up of the kilowatt multiplied by the cost of the unit. There was the important question of the relative first costs of steam and electric plant and the interest and depreciation that had to be charged against it. There was a statement in the paper that with the electrical plant there was a reduction in the cost of repairs, but there was nothing to substantiate that claim. He noted, moreover, that no less an authority than Mr. Michael Longridge, in his annual report for insurance purposes, stated that the upkeep of motors cost twice as much as that of steam engines, and, as a matter of fact, the insurance premiums for motors and dynamos were twice those charged for steam engines. It appeared to him that Mr. Ablett's claim as to the low repair costs of the electrical rolling plant could scarcely be substantiated. As to depreciation, it was usual to allow 15 per cent. for electrical machinery and 10 per cent. for steam plant, and if there was any mistake in those figures it was that 15 per cent. was too low a depreciation for the electrical plant. With regard to the actual cost of rolling, Mr. Greiner had stated that a ton of steel could be rolled by steam power for under 6d. per ton. By the electrically-driven reversing mill it was stated the cost would be greater, the actual figure depending upon the conditions obtaining. As it was impossible to get actual figures from Mr. Ablett, he (Mr. Lamberton), had endeavoured to work out from the commercial standpoint the cost of rolling a ton of rails electrically and by steam. The cost by steam, taking interest and depreciation on plant at 10 per cent., and assuming an output of 300 tons per day of ten hours, was 6d. per ton. An electrical installation driving the same mills with current generated by gas plant, including all accessories and taking interest and depreciation at 15 per cent., would give working costs of 8.8d. per ton. He put those figures forward in the hope that Mr. Ablett would attack them, if only for the reason that he had up to the present time evaded the issue. The figure of 6d. was arrived at by taking the coal used for raising steam at 6s. per ton; the figures for the electrical plant, 8.8d., included nothing for actual cost of fuel. If the steam installation were credited with one-third of the thermal units used in the electrically-driven plant the figure of 6d. would be reduced to under 5d., and the two plants were then compared on an equal basis. It was stated in the paper that further reductions in the capital cost of the electrically-driven mills were scarcely possible, unless a new method of driving were evolved to take the place of the Ilgner system, and this led him to refer to a method which he had outlined at the last autumn meeting of the Institute. It was admitted that the electrical driving of mills by continuously running motors was the right thing to do, but it was all a question of pounds, shillings, and pence. His suggestion was to do away with the Ilgner arrangement, at least in the smaller plants, by a clutch reversing mill. Such mills had been very successful in the past, but were open to two objections: they were exceedingly noisy and very destructive on the clutches. His proposal was to improve that type of mill. The constantly running motor would be used to obtain the flywheel effect necessary for high peak loads and to equalise current. He illustrated by a diagram which we reproduce in Fig. 2, the arrangement proposed, in which he made use of a friction clutch, say of the coil clutch type, simply for the purpose of starting the mill from rest easily and without shock. As soon as the

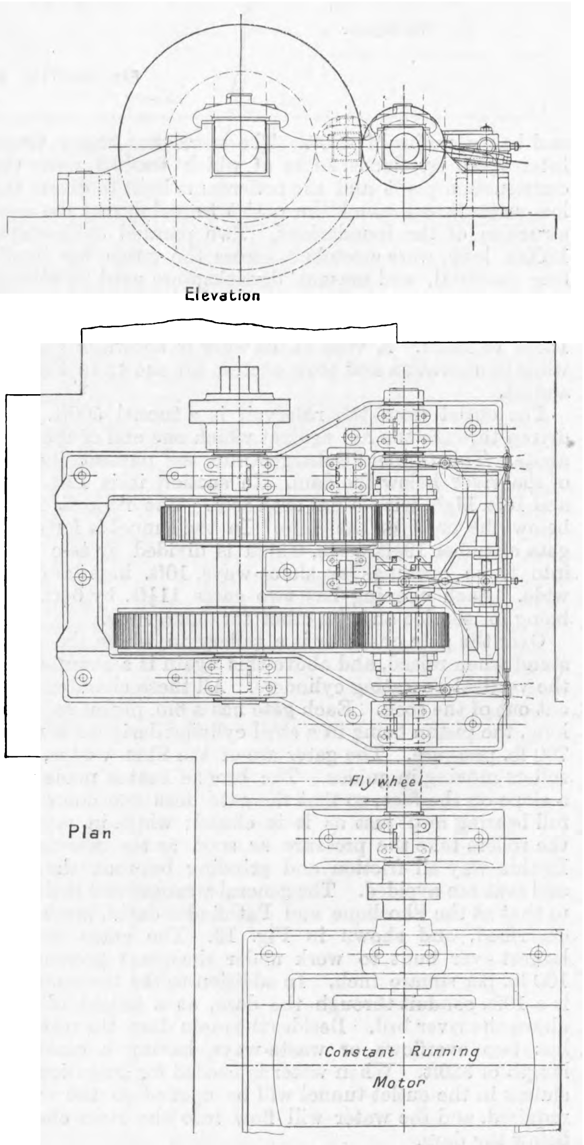


Fig. 2—ELECTRIC ROLLING MILL DRIVE

speed was accelerated to within 5 per cent. of the normal speed of the mill, then the positive clutch was automatically put in, and the whole load of rolling taken on the positive clutch, the friction clutch being entirely relieved of stress. On reversal the converse action took place. In this manner the shocks and loads due to rolling were not put upon the friction clutches, which had been proved in experience to be unable to withstand the strains such service put upon them. In the system suggested these clutches were only required to start the mill from rest, and the positive clutch, being put in at coincident speed, was made to work under the best conditions. For mills up to 30in. diameter such an arrangement would be an advantage.

Lord Airedale said that Mr. Lamberton discussed the subject with great authority, and had given figures of comparative cost. That, however, did not dispose of Mr. Ablett, and he could conceive of cases in which rolling was an intermittent, and not a continuous process, and in which there would be a great advantage in the combination of the electrically-driven mill if power were taken from a central source and not paid for when not required.

Mr. Alex. Siemens said that the most deaf were those who would not hear. Mr. Lamberton said that to give the cost in kilowatt-hours was absolutely academic. The paper drew attention, however, to the fact that that method had been adopted because of the variation in the cost of the kilowatt in different localities. Mr. Lamberton had himself drawn attention to that fact by pointing out the different prime movers used for generating electricity. He personally, from twenty years' experience of a 1600-kilowatt generating plant in the works of his company, was able to say that, including depreciation, repairs, and all possible charges, the cost came out at .25d. per kilowatt-hour, so that all that was necessary was to divide the figures on the last page of the paper by four, with such a cost, to get the result in pounds, shillings, and pence for rolling materials. As regarded the upkeep of electrical machinery, many users overlooked the fact that it was cheaper to employ a larger motor rather than a small one. Users had complained to him of excessive current consumption, and in a particular case where a motor of double the size had been put in the current consumption was halved. It was forgotten that a motor too small for the work consumed current in heating and in other ways, whereas with a large motor, which did not heat in service, the current absolutely corresponded to the load. He pointed that out in a lecture as long since as 1881, and people were still acquiring that knowledge. That led him to say that a depreciation of 15 per cent. was not necessary when the system was properly designed. Insurance companies would charge as high a premium as possible, but insurance companies, like other people, had to live. He was able to state that the plant which had been in operation at his own works for twenty years had cost very little indeed for repairs. With regard to Mr. Lamberton's clutch method, it was obvious that any such system would wear out when subjected to the shocks of a rolling mill, and that was the advantage of the electrical system, where the shocks were not mechanical.

Mr. Ablett, in replying on the discussion, said he did not read the paper to prove the economy of the electrically-driven mill, but to show the steel maker how to make proper tests of the system. About a fortnight before the last autumn meeting at Middlesbrough, a new mill was set to work at the Rheinische Stahlwerke. It was found that with steam driving the cogging mill was not able to cope with the work. That was the mill referred to as being only ten years old. The intention was to put down a second mill, but the electrical engineer promised 30 per cent. more output, and an electrically-driven mill was installed. The promise made of 30 per cent. more output had been carried out. The mill had been running continuously since September 4th, 1908, and had effected a considerable saving in the rolling costs—on an output of 5000 tons per week. The oil consumption had also been materially reduced. Since that mill had been set to work three other large steel works in the neighbourhood had placed contracts for electrically driven reversing mills. With regard to depreciation, he would refer to the plant of the Niagara Falls Power Company, where a 5000 horse-power generator plant was put in service fourteen years ago. He was personally acquainted with that plant, and when, after ten years running, it was found necessary to rewind the machines, the cost was comparatively small. After rewinding there was no reason why the machines should not run for another ten years. In his opinion 15 per cent. depreciation on electrical plant was too high a figure.

A cordial vote of thanks was accorded to the author of the paper.

The third paper was by Professors H. F. Rugan and H. C. H. Carpenter—the first being Research Fellow in Metallurgy and the second Professor of Metallurgy at the Victoria University, Manchester. It was entitled the "Growth of Cast Irons after Repeated Heatings." This paper, which is a painstaking record of an exhaustive series of experiments on cast irons of different chemical constitution under the influence of repeated heatings, extends to over one hundred pages of text, and is far too long either to lend itself to reproduction at the present time or to satisfactory abridgment. A general outline of its scope must therefore suffice.

It has been long known to engineers that certain types of cast iron permanently expand or "grow" after repeated heatings. The ultimate object of the investigators was to discover a particular mixture—or particular mixtures—of cast iron which would not exhibit this phenomenon. A particular sized bar was chosen for all the experiments, and a careful analysis was made of the material of each bar, and each bar was separately heated at certain temperatures and for certain periods, the temperature being measured by a platinum, platinum-iridium thermo junction, and a direct-reading portable pyrometer. Careful records were kept of the measurements of each bar after it had become cold after each reading, and the records tabulated in the paper represent a vast amount of industry and labour.

It will be impossible here to deal in detail with the results obtained, but we may briefly refer to some of them. It was first of all sought to determine the conditions under which the maximum growth of cast irons was brought about by repeated heatings, and it was observed that for growth to take place both heating and cooling were required. Three commercial cast irons were first investigated. They grew at different rates and to different extents. After ninety-four heats they reached a constant volume. The growths varied between 35.21 and 37.5 per cent. An increase of weight was found in all cases.

The next step consisted in an attempt to correlate growth with chemical composition, and irons of different compositions were experimented upon. In the first of these the carbon ranged between 4.03 and 0.15 per cent., the other constituents being low and constant. With sand-cast white-iron alloys the final results after thirty-nine to seventy-eight heats was a permanent shrinkage in all cases, which in six out of eight cases was not more than 0.5 per cent. A diminution in weight was found in seven out of eight cases, which followed nearly the same order as the carbon. With chill-cast white-iron alloys the results were similar to those obtained with the sand-cast alloys, although the permanent shrinkage was not so fully marked. These results gave the authors the solution of the problem of finding an alloy whose volume would remain constant after repeated heatings at about 900 deg. Cent. Such an alloy would be a white-iron, having about 3 per cent. of carbon and only small quantities of other constituents, of which for this purpose silicon is the most important, and should not exceed about 0.2 to 0.3 per cent.

Experiments with high carbon medium silicon alloys containing small amounts of graphite and 0.5 to 0.8 per cent. of silicon showed that these alloys grew from the outset, and reached their maximum growth in from fifty to sixty heats. The bar with the lowest silicon content showed the smallest, and that with the highest the largest growth. Free carbon, whether graphite or temper, was thus proved to be an indispensable factor in the growth of cast iron under these conditions.

The influence of silicon was next tested. Alloys containing carbon 3.4 to 3.98 per cent., silicon 1 to 6 per cent. in steps of 1 per cent. were experimented with. The other constituents were low and constant. Growths of between 15 and 63 per cent., were found. It was shown that they were, broadly speaking, proportional to the silicon present, and far in excess of what could be caused by the conversion of combined to free carbon. It was found that the growth of any particular sample depended upon the position in the casting from which it had been taken. Bars cut from the gate grew more rapidly than those from the risers. Moreover, the ends of the bars grew more quickly than the centres. It then became quite evident to the experimenters that gases played an important part in the growth. The curves of rate of increase in weight were seen to be similar to those of growth, and established an intimate connection between the two. The final increase in weight followed the same order as the percentages of silicon. It was shown to be the resultant of three processes :—(*a*) A partial oxidation of carbon which diminished with increase of silicon and became nil at 6 per cent.; (*b*) a probably complete oxidation of silicon, originally present as the silicide of iron, to a mixture of iron oxide and silica; (*c*) a partial oxidation of iron uncombined with silicon. It was ascertained that large amounts of gases were dissolved at certain stages. Graphite was found to be displaced from its original position—the places left being oxidised—and numerous small holes were formed, the structure being revolutionised.

Iron silicon alloys containing from 0.65 to 2.71 per cent. of silicon and no graphite were shown not to grow appreciably after repeated heatings.

An alloy which gives 62 per cent. in a muffle not only did not grow when heated in vacuo, but actually contracted slightly. In doing so it gave up 1.11 times its volume of gas, which consisted of 87.5 per cent. of hydrogen and 12.5 per cent. of oxygen. Another bar after being heated in vacuo until it had ceased evolving gas was heated in a muffle, and ultimately grew 67.7 per cent.

The explanations of other phenomena met with are given by the authors, who conclude by saying that the researches they have carried out disclose the fact that there are grey iron alloys whose growth in air on heating is entirely due to oxidising gases penetrating their interior, and also alloys in which this may not be the sole agent, but in the case of which dissolved gases contribute to some extent to the growth.

Mr. J. E. Stead said that the paper represented an enormous amount of work and gave a great deal of valuable information. It had been known for a long time that white-iron did not "grow" so rapidly, or become so easily distorted as grey iron. Some of the theoretical conclusions of the authors might be disputed, but until they had the results of more research before them he, at least, would not venture on any such criticism. He would like the authors to give the combined carbon present, because it would be found, he believed, that the more combined carbon present the less rapid would be the oxidation or growth. The paper practically said that, but in many instances the amount of combined carbon was not ascertained.

Professor Thos. Turner said that the points discussed were of both theoretical interest and of practical application. He might mention a case which came under his notice some years ago in connection with the grids of gas muffle furnaces. When the grids were heated they "grew" rapidly, and the slits were closed up, and when forced open closed up again after fresh heating. He regarded the explanations of the phenomena observed under various heads. In the first place, whenever a constituent separated for solution, there was an increase in volume which could be easily measured. As long as white iron remained white there was no expansion, but as soon as, owing to the presence of silicon, deposits were made, whether in the form of graphite or temper carbon, there was expansion. He might refer to another point which the authors did not mention. If one imagined iron to be in a soft state and to be surrounded by a hard skin, it was quite possible that particles of iron when hot expanded, and when they wanted to shrink back they could not, like lead expanding on a roof. The paper was a valuable addition to the literature of the subject.

Mr. E. H. Saniter said there had been few papers brought before the Institute during recent years equal to that under discussion. He had pointed out the shrinkage which took place in rolled steel plates when heated and cooled a large number of times, and it was suggested that the elongated grains produced in the rolling gradually tried to assume the round form again. The same tendency had been noted in cases of cylinder distortion.

Dr. Rosenhain said it would be interesting if the authors could inquire into the connection between growth and mechanical properties.

Professor Carpenter is to reply in writing, but he informs us that the line of research indicated by Dr. Rosenhain is being followed in America by Professor Rugan.

On the motion of Lord Airedale, a hearty vote of thanks was accorded to the authors.

There were several alternative visits arranged for the afternoon, these being to the works of Siemens Brothers and Co., Limited, at Woolwich; to the Royal Arsenal; to the works of Fraser and Chalmers, Limited, at Erith; and to the London County Council Electricity Generating Station at Greenwich. Opportunity was also given of inspecting the halls of the Armourers and Braziers and of the Ironmongers' Companies. With the first four of these our readers are already familiar, and we need say nothing further about them in the present instance. A few words about the halls of the two City Companies may not, however, be out of place. The hall of the Armourers' Company—known as "The Brethren of the Craft and Mystery Armorers"—was acquired in the seventh year of the reign of Henry VI., 1428, and comprised the Dragon and five shops in Coleman-street. It escaped the Fire of London in 1666, and between 1750 and 1777 was much enlarged. The amalgamation of the Braziers' Guild with the Company took place in 1708. The entire building was taken down and re-erected in its present form in 1839-41, but most of the internal arrangements were remodelled in 1872. The present Ironmongers' Hall is believed to be the third which has stood on the site. The first is supposed to have been built about the year 1457, and the second, in 1587. This narrowly escaped destruction in the Fire, while the present building was erected in 1745.

OBITUARY.

THOMAS PERCEVAL WILSON.

It is with regret that we have to announce the death of Mr. Thomas Perceval Wilson, M. Inst. C.E., which took place at his home at Southampton on Monday morning, September 27th. Mr. Wilson, who was the son of the late Rev. R. F. Wilson, vicar of Rownhams, was born in March, 1850, and he was therefore fifty-nine years of age. At the time of his death he was an active partner in the firm of Easton, Courtney, and Darbishire. His health has been in a precarious condition for some few years, and on Monday morning last he had a heart seizure which terminated his life.

Mr. Wilson commenced his engineering career as pupil to Easton, Amos, and Anderson, and was subsequently engaged by the late Mr. E. A. Cowper in erecting pumping machinery in Sweden. After this work was completed he was engaged by Head, Wrightson and Co., Limited, of Thornaby-on-Tees. Later on he returned to Easton and Anderson, for which firm he took charge of the execution of the South Hants Waterworks, proceeding thence in 1870 to Antwerp, where he had charge of the construction of the Antwerp Waterworks. On the completion of this contract he went to Seville, where he was also responsible for the execution of the water supply work. He was retained as consulting engineer for both these latter water supplies, and subsequently advised on sundry other Spanish water undertakings. In 1880 he joined the board of Easton and Anderson, Limited, and on the death of Mr. James Easton he became chairman of that company.

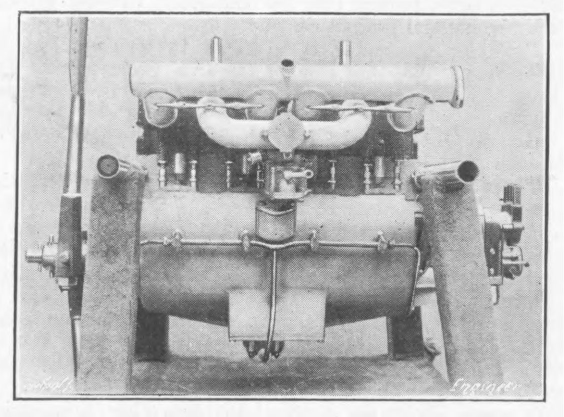
H.M.S. NEPTUNE.

At Portsmouth yesterday the Duchess of Albany successfully launched our eighth Dreadnought, the Neptune. This vessel shows, of course, a considerable advance not only upon the prototype but on any preceding vessel. As in her sisters, she carries ten 12in. guns, but they are so arranged that all ten can fire on either broadside, and thus one of the criticisms of the general type is answered. Her length is 600ft. and her beam 88ft. She will displace in fighting trim at least 20,250 tons, and she will be propelled by turbines of 25,000 horse-power at about 21 knots. It is interesting to note that the 36-knot destroyers develop far more than is required by the Neptune. The Swift, for example, has engines designed for 30,000 horse-power, and it is reported that they have been forced up to no less than 50,000. The Neptune will not be ready for commission for two years, and when she sails will be worth something like two millions sterling.

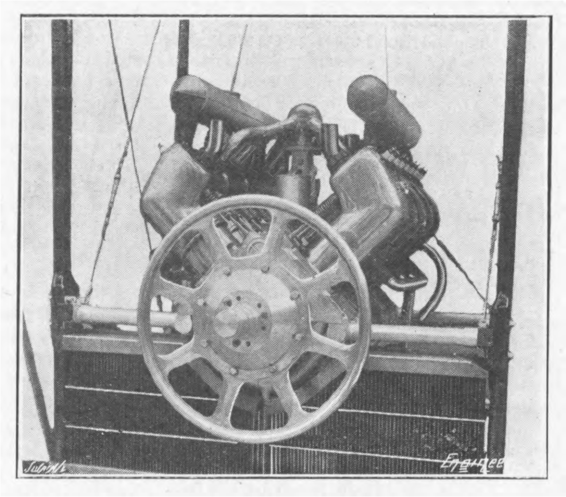
Five concrete switchboards, each 76ft. long, and containing numerous pigeon-hole compartments for instruments that must be isolated, have been built in America. The main walls are 9in. thick, and the barrier walls for the compartments from 2in. to 7½in., depending on their position and the weight of the apparatus on the horizontal slabs which they support. The boards were built in 16ft. sections with felt expansion joints, and contain only 92 cubic yards of concrete, though the superficial area is over 42,000 square feet. The material was a 1 : 2 Portland cement mortar.

AERONAUTICAL MOTORS IN PARIS.

The first International Exhibition of Aerial Locomotion was opened in Paris last week by the President of the Republic, and alike as regards the importance of the exhibits and the attendance of visitors it must be pronounced a distinct success. From the point of view of the manufacturer the interest of the show lay principally in the motors, for it is upon these that depends the future of all flying machines. Having built aeroplanes that fly more or less satisfactorily, makers are looking for really reliable engines offering the greatest possible reduction in weight. At the show there continued to be a great divergence of opinion as to whether the aeronautical motor should be developed upon standard lines with the weight reduced by simplifying details and employing high resistance metals and aluminium, or whether it should be specially designed with a view to suppressing the fly-wheel and reducing the number of parts to a strict minimum. In the latter case a vast amount of experimental work is obviously necessary. As the result of the success of certain types of special engines at the Rheims and other meetings, it appears as if the tendency at the moment is in the direction of departing from standard practice and designing engines upon new principles for aviation work. Among the firms which have preferred to utilise experience as automobile engine builders are the Aster Company, whose engine is built upon the lines of the ordinary petrol motor, with a reduction of weight by the employment of high resistance metals. The engine exhibited had 130 mm. bore and 140 mm. stroke, and developed 50 horse-power at 1000 revolutions per minute. The weight of the engine was 240 lb. As is the case with most aeronautical motors, the induction and exhaust valves are placed on the same side for the sake of employing one cam shaft. A special type of engine which has been used somewhat extensively on aeroplanes was exhibited by the E.N.V. Motor Syndicate, Limited, an English concern having works at Courbevoie, near Paris. This engine, which is the outcome of some years' experience, has eight cylinders, in pairs of four arranged V-fashion, with all the valves actuated by one cam shaft. The carburetter and magneto are placed between the two sets of cylinders, thus forming a very compact arrangement. The cylinders are turned and bored out of solid steel, and machined to the minimum thickness it is possible to give them with safety, and a thin water jacket is shrunk on and electrically coated with copper. Flying machine motors are almost invariably lubricated under pressure by a pump. The 60 horse-power E.N.V. engine exhibited had a 105 mm. bore and 110 mm. stroke, and the weight was declared to be 292 lb.

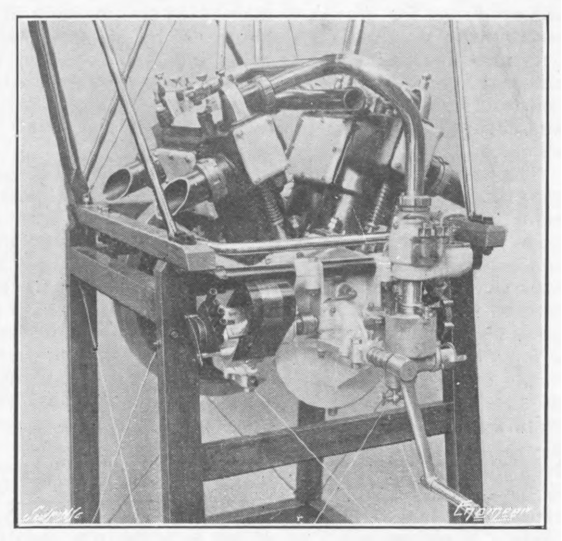


50-H.P. ASTER MOTOR



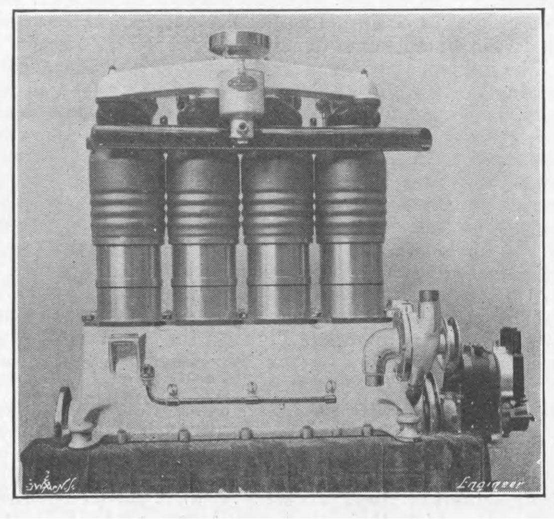
50-H.P. E.N.V. MOTOR:

In most cases the automobile builders are content to take their standard engines and reduce weight in every possible way, but in the Mors we have an instance of a motor car firm creating an entirely new type of engine for aeroplanes. In adopting the V-pattern engine, however, the Mors Company is reverting to a type it was the first to employ in the early days of the automobile, and it now appears to be coming a standard form for aerial apparatus on account of the facility it offers for the use of a number of cylinders with a short crank shaft, while the possibility of securing a better balance of the engine in this way, as well as ensuring compactness, are also points of merit. Another feature of the Mors engine is the position of the cranks, which are so set as to give a thrust at each half revolution. The four cylinders, cast in pairs, are of 110 mm. bore and 130 mm. stroke, and the engine is rated at 45 horse-power at 1700 revolutions per minute. The weight is 213 lb. The Panhard et Levassor aviation engine has four cylinders machined out of the solid, with copper water jackets. It has 110 mm. bore and 140 mm. stroke, and weighs 217 lb. The valves on the tops of the cylinders are concentric, that is to say, the stem of the exhaust valve passes through the induction valve, and both are actuated from one cam. This arrangement of concentric valves has often been employed in petrol motors, it being claimed as an advantage that the incoming gas tends to keep down the temperature of the exhaust valve, while, of course, the principal object aimed at is to reduce the number of parts as much as possible.

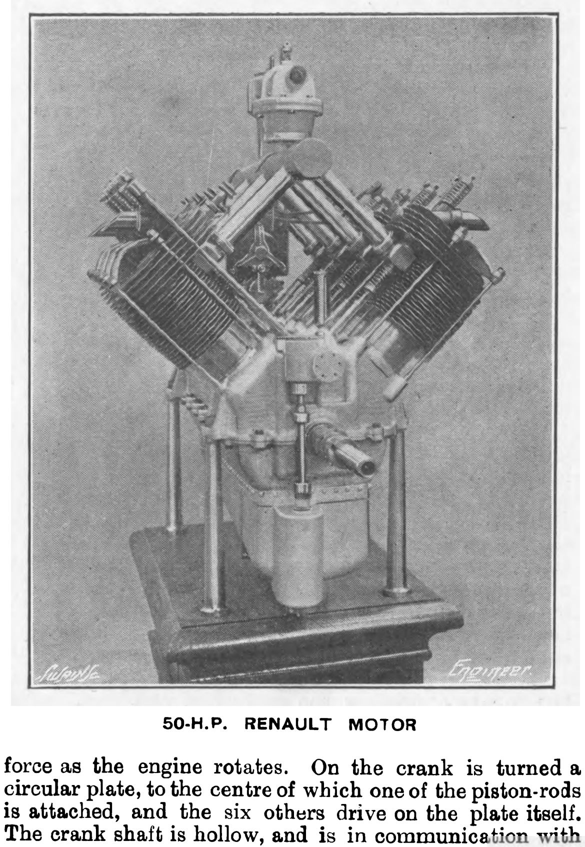


45.H.P. MORS MOTOR

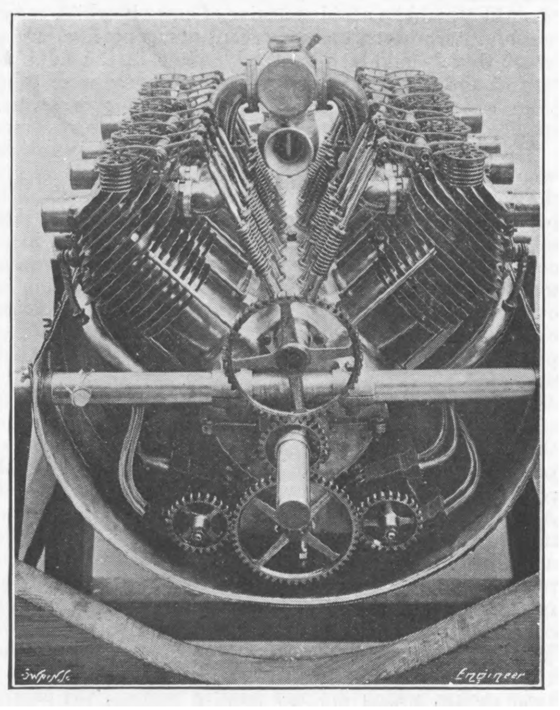
The Gnome engine, which was exhibited for the first time at the Paris Automobile Show towards the end of last year, has acquired considerable reputation as the result of its performance at Rheims. This engine is composed essentially of an air-tight circular crank case, around which are grouped seven ribbed cylinders. Each cylinder is inserted in the case with a segment, and is, so to speak, wedged into the case by the centrifugal force as the engine rotates. On the crank is turned a circular plate, to the centre of which one of the piston-rods is attached, and the six others drive on the plate itself. The crank shaft is hollow, and is in communication with the carburetter, so that the gas is drawn into the air-tight crank case, and thence into the combustion chambers by automatic valves. The exhaust valve on the top of each cylinder is actuated by a stem and tappet, and both valves are fitted with a system of counterweight to prevent their being affected by the centrifugal force. The cylinders, with their cooling ribs, crank case, piston-rods, and other parts are machined out of nickel steel forgings. Economy of manufacture is not, as a rule, conspicuous in aeronautical engines. The cost of the motor frequently accounts for about two-thirds in the price of the aeroplane. The Gnome engine develops 50 horse-power at 1200 revolutions per minute, and weighs 167 lb. It was stated that the consumption of petrol was 300 to 350 grammes per horse-power per hour. The consumption of lubricating oil, which is supplied under pressure to all bearings, is about 4½ pints per hour. Naturally, one of the advantages claimed for the revolving cylinders is the facility for cooling. Another ingenious engine of the same class is the Bertin, in which there are six pairs of ribbed cylinders arranged around the circular case. The pistons actuate worm wheels gearing on to a central wheel. Into the efficiency of this class of engine we are not prepared at the moment to enter. There are many novel features about the Bertin motor. It has no carburetter, petrol being pumped into the combustion chamber where it mixes with air by a very small plunger pump driven by a cone on the exhaust valve stem. Any travel can be given to the plunger for varying the admission. The petrol passes through an orifice in the automatic induction valve, so that when the valve is on its seat the supply is cut off. In the same way the admission of air is cut off through a port in the combustion chamber. The bottom of each cylinder is cut away for a small fan which draws air into the crank chambers and keeps down the temperature of the working parts. The pistons make 1600 revolutions per minute, and the cylinders revolve at the rate of 400 revolutions per minute. It is claimed that the weight of the 60 horse-power engine is 198 kilos. In the Clerget four-cylinder vertical engine the most noteworthy thing is that the pistons are of aluminium, prolonged tests having shown that the metal is peculiarly suited for this purpose. The cylinders are cast iron, and are recessed in the aluminium case, where they are clamped down by bolts and plates. The induction and exhaust valves are actuated from the same cam-shaft by a solid stem passing through a hollow stem, something similar to the arrangement in the Panhard and Levassor engine. The dimensions of the engine are 110 by 120, and it develops 50 horse power at 1650 revolutions per minute. The weight complete is 162 lb.



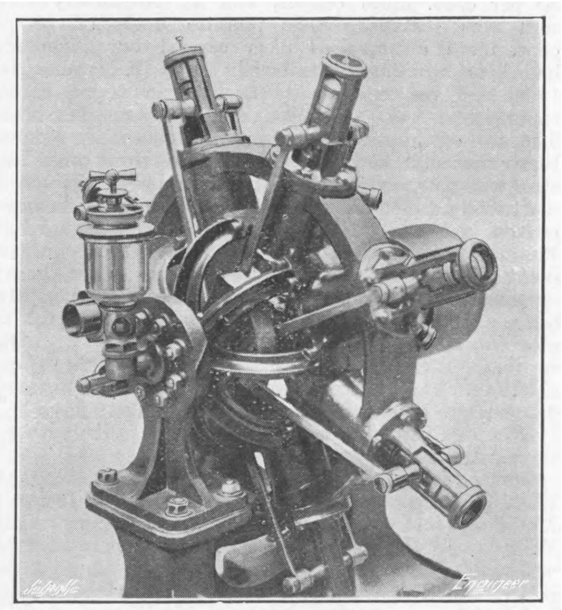
45-H.P. PANHARD MOTOR



50-H.P. RENAULT MOTOR

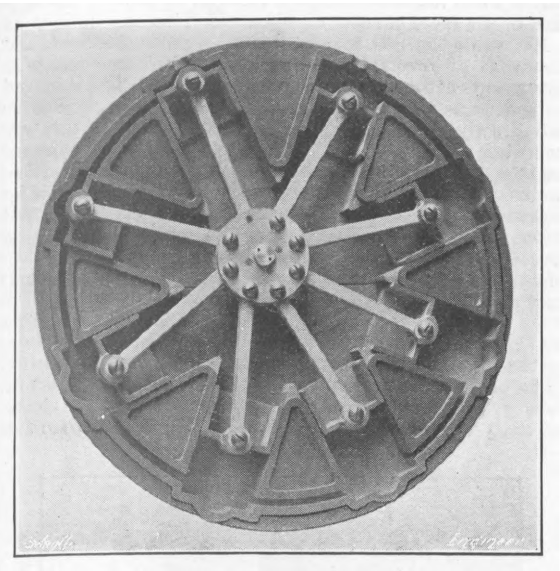


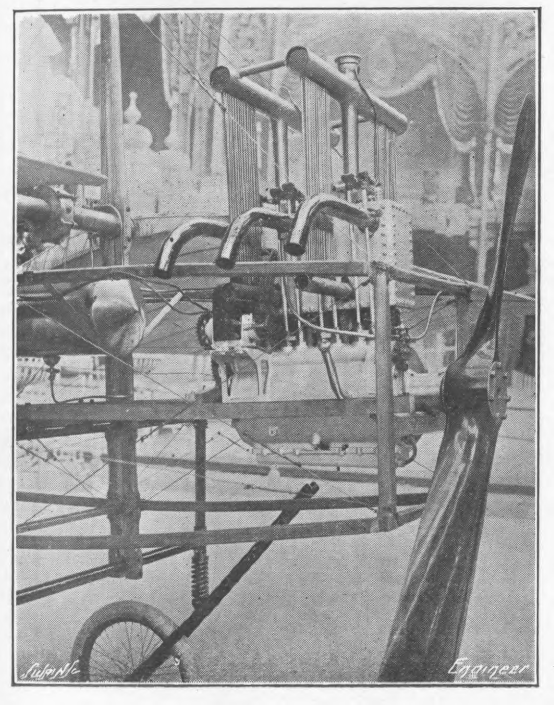
50-H.P. FIAT MOTOR

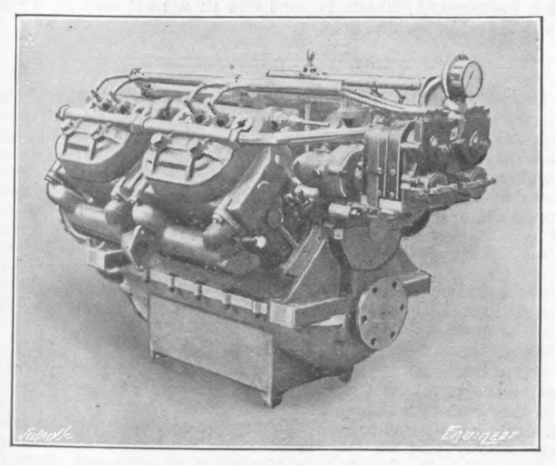


COLONEL RENARD'S MOTOR

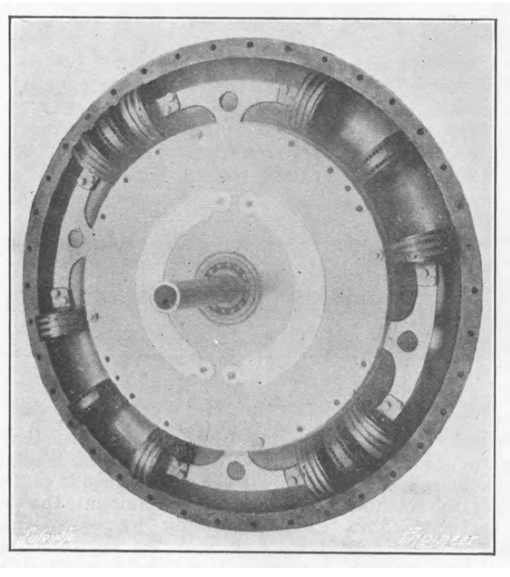
The Anzani engine has been much talked about since Blériot used it on his Trans-Channel aeroplane. This engine has three cylinders arranged fan fashion, with the piston-rods working on one crank. The first motors made were ribbed for air cooling, and the weight of the engine, 105 by 130, was 143 lb. At the show, however, more prominence was given to the water-cooled engine, the weight of the 30·35 horse-power, with 100 mm. bore and 120 mm. stroke, being 182 lb. It was observable that while a number of engines with ribbed cylinders were exhibited, air-cooling has by no means become the general rule, and the majority of aviators still show a preference for water-cooled motors. Renault Frères exhibited both water and air-cooled engines, the latter having eight cylinders and arranged in the classic V fashion. All the valves are operated mechanically by one cam shaft. There is nothing calling for particular remark in its design, except that the engine is enclosed in a cylindrical sheet iron case through which air is forced by a fan. The dimensions of the engine are 90 by 120, and the weight complete 374 lb. In the recent A.C.F. tests it developed 58 horse-power at 1800 revolutions per minute. It should be mentioned that the propeller is keyed, not on the crank shaft, but on the cam shaft, which is, of course, made with a due regard to the duty it has to perform. The water-cooled Renault is of the four-cylinder vertical type, built upon much the same lines as their automobile engine, except that it has steel cylinders and copper water jacket casings. Fiat also presented a V-shaped engine with two sets of four-ribbed cylinders, the whole turned out of the solid, and all the parts drilled with holes where possible, for the sake of lightness. It was a splendid example of workmanship, and beautifully finished. This engine was also enclosed in a sheet steel case, through which air was driven by a fan.


COLONEL RENARD'S MOTOR


40-H.P. GREGOIRE-GYP


8-CYLINDER DE DION MOTOR

Darracq and Co., Limited, exhibited an engine of the type they built for the famous Demoiselle aeroplane of Santos Dumont, who has for many months been trying to develop a small and cheap type of apparatus which could be easily transportable, and would come within the range of the "man of moderate means." His recent flight with the Demoiselle proves that he has succeeded to a very large extent. His aeroplane, weighing 242 lb. all complete, has a carrying surface of not more than ten square metres. The engine used has two horizontal cylinders in the same axis, with the pistons actuating the same crank shaft. The crank shaft terminates in a bevel wheel which drives the magneto, while a cam actuates long stems with tappets at each end of the cylinder. The carburetter is carried on the induction pipes. The compression in the crank chamber is utilised for forcing oil to all the bearings. The engine was said to develop 30 horse-power, and its weight was 121 lb. The Darracq Company claim an exclusive right to the manufacture of this engine, and as Santos Dumont has entered into an arrangement with Clement-Bayard for the construction of his small aeroplanes, it is understood that legal proceedings are in progress regarding the engine. The same principle of two or more horizontal cylinders with one crank shaft is adopted by Duthenil, Chalmers and Co., who exhibited one of their four-cylinder engines, 125 by 120, and rated at 40 horse-power. The weight is 264 lb. The cylinders are strongly stayed to the crank case by rods, and it has a very rigid appearance. As is frequently the case on aviation engines, the induction valves are automatic, and the stems of the exhaust valves have cup-shaped deflectors near the valve seats for spreading out the flames and protecting the tappets and other parts in close proximity. The engines used on the Wright aeroplanes are modifications of the standard four-cylinder vertical engine. Aluminium is employed whereover possible. The valves are on top, the induction valve being automatic. The only English aeroplane engine on view was one exhibited by Green's Motor Patents Syndicate, Limited, which compared favourably with anything shown by French makers, some of whom appeared to carry weight-cutting to an excess. The Wolseley Tool and Motor Car Company, Limited, exhibited a six-cylinder engine for dirigible balloons, and a 200 horse-power engine, 190 by 230, and weighing 1100 lb. with clutch and reducing gear when running with two propellers, was shown by Clement-Bayard. For motor balloons the tendency is to use two sets of engines and two propellers, so that if one should stop it may be disconnected, and the remaining engine coupled up to both propellers.


BECK ROTARY MOTOR

It is impossible to devote space to all the engines shown, but we have on this page and on page 346 illustrated a large number of them. Some of these are referred to above, and the others will be found instructive in themselves even without description.

ELECTRICITY IN STEEL WORKS.

A PAPER read by Mr. R. Tschentscher, at the Twenty-sixth Annual Convention of the American Institute of Electrical Engineers, deals with "Electric Power Problems in Steel Plants." After considering the different classes of steel mills in existence, the author turns his attention to the plant of the Illinois Steel Company at South Chicago, considers some of the problems encountered in electrifying these works, and gives a general description of the electrical machinery which has been put into use. This is a self-contained mill, being equipped with blast furnaces, steel furnaces, and rolling mills for finishing the product. Power is also supplied to outside works, such as cement mills and other consumers. Naturally it is in such plants that the greater variety of electrical problems exist, and where the application of electricity is most extensive. Prior to September, 1904, the electrical equipment of this plant consisted of a direct-current generating plant of 2900 kilowatts capacity. The pressure was 250 volts. Even at that time this was the largest electric installation in an American steel plant. How this plant has grown during the last five years can be gathered when it is stated that there are now 2000 direct and alternating-current motors in use, with an aggregate horse-power of 75,000. There is an alternating-current generating plant capable of developing 16,000 kilowatts, and an additional plant of 9000 kilowatts is at present being erected. In addition there is a direct-current plant capable of developing 3000 kilowatts; thus the total generating equipment has a capacity of 28,000 kilowatts. Converting machinery with a capacity of 6500 kilowatts has also been put down, whilst the static transformers increase this figure to 31,000 kilowatts. The total storage battery capacity amounts to 1200 kilowatts. The voltages in use are 110, 250, 1100, 2200, and 22,000.

In connection with the new plant of 9000 kilowatts capacity, which is at present being erected, it is interesting to note that a low-pressure turbine is to be used. Compound condensing reciprocating engines in the power station and in an adjoining blowing engine station will normally supply the steam for this turbine. Each compound engine will be so arranged that it may exhaust into its present condenser or into the turbine main at a pressure slightly above that of the atmosphere. When the supply of exhaust steam is insufficient the deficiency may be supplied from the high-pressure main, the turbine being so arranged that this high-pressure steam will be economically used by means of a separate valve and nozzle chamber. Should no low-pressure steam be available the full capacity of the plant with high-pressure steam may be obtained.

One problem in connection with this plant which presented itself was the question of improving the power factor. The installation of alternating-current roll motors, miscellaneous small alternating current motors, and the expansion of the cement works where induction motors are principally used, has so affected the wattless current that at present the station power factor is about .7. The largest item which has brought about this condition is a load of induction motors of approximately 7000 kilowatts at a cement works supplied by a ten-mile transmission line working at a pressure of 22,000 volts. Improvement of the power factor by corrective means at the cement works at once suggested itself. In order to render the installation of a rotary condenser as beneficial as possible, it was desirable that the machine should perform mechanical work in addition to supplying the magnetising current of the motors, so that a proportion of its initial cost and operation could be charged against it, making the charge for power factor correction correspondingly less. Unfortunately, however, mechanical work of sufficient magnitude did not exist at the cement works, and the problem resolved itself into determining whether such a machine operating idle would prove commercially satisfactory. By it the losses due to the low power factor will be reduced on account of less current being required for erecting the fields of the generators, and because the cables and transmission lines carry less current. The transformer and wiring losses will also be reduced for the same reason. Against the foregoing there is the energy required to operate the machine itself. With a delivered load of approximately 7000 kilowatts, and a power factor of ·7, the overall efficiency is approximately 83 per cent. The use of two 1650 K.V.A. synchronous motors will raise this overall efficiency to 87.5 per cent., the net gain of power being approximately 300 kilowatts, which at ¼d. per unit represents a yearly saving of approximately £2000. In addition to this the power station capacity will be appreciably increased.

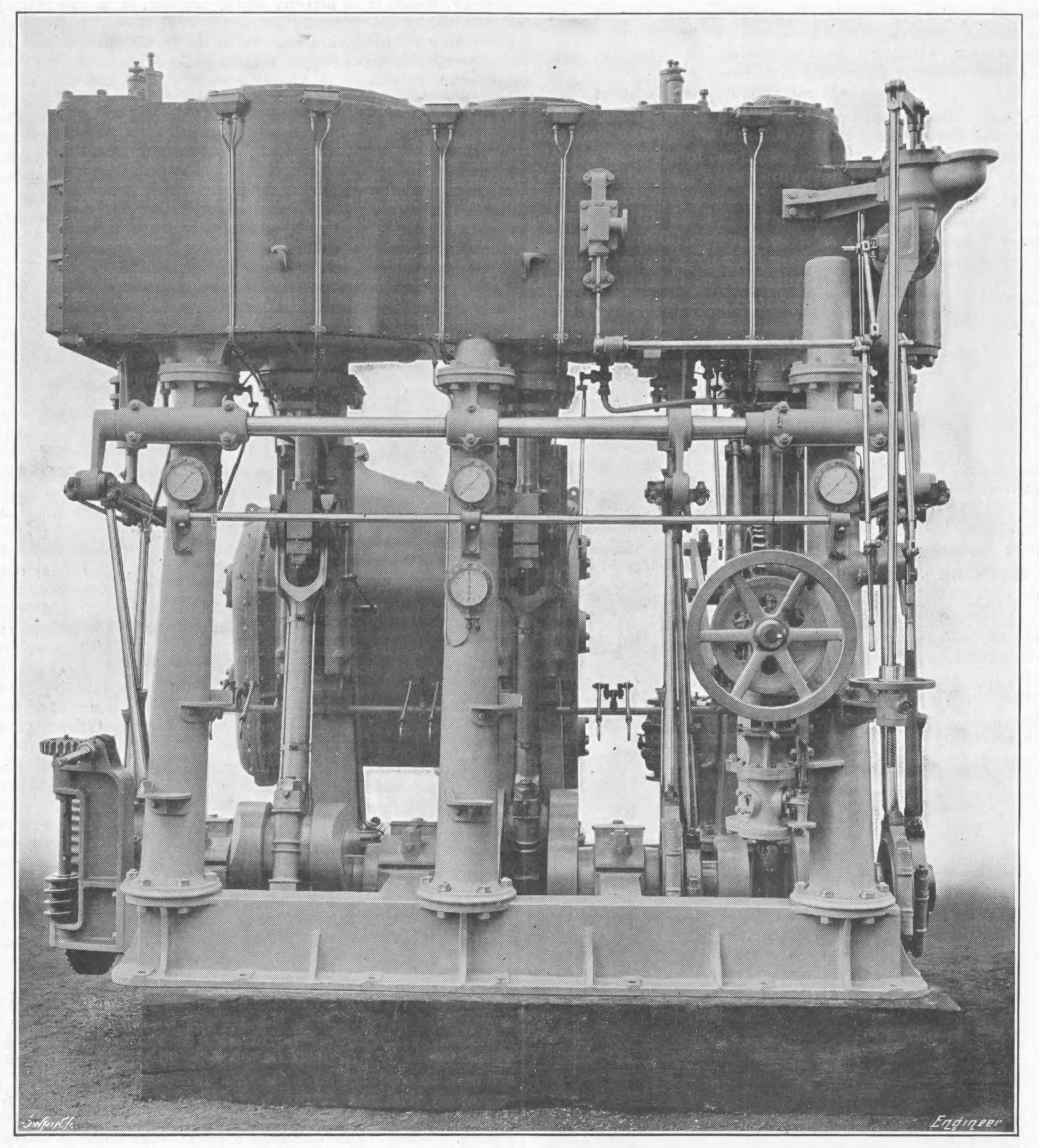
Towards the end of the paper the author deals with the manufacture of steel by means of electric power, and mention is made of the fact that the Illinois Steel Company has in operation a 15-ton electric furnace of the carbon arc type. Three 750 K.V.A., 2200 to 100 volt, 25-cycle transformers, are used in conjunction with this furnace. The opinion is expressed that the future will demonstrate that America's largest power generating stations will be found at her steel plants. When it is considered that a steel-making furnace plant utilising electric power to generate the necessary heat, and having a capacity of 4000 tons per twenty four hours, requires a plant of from 20,000 to 30,000 kilowatts capacity, this statement appears probable.

Lastly, the author deals with a plant wherein he considers the application of electricity would be supreme. A million tons per year self-contained plant, where coal, flux, ore, and other raw materials enter, and where all class of steel products, together with cement and the by-products of coke ovens, leave the plant as finished product, might, it is stated, consist of a blast furnace plant and Bessemer condenser plant, an electric steel refining plant, a number of rolling mills, a cement plant, and a coke oven plant. Assuming the works to finish three-fifths of its products as rails, one-fifth as plates, and one-fifth as structural shapes, it is estimated that an electrical plant of 100,000 kilowatts capacity would be required, and the author believes that it is quite likely that the necessary electric power could be generated with the waste gases from the blast furnaces and coke plants, and by the utilisation of other waste heat.

THE London, Brighton, and South Coast Railway Company announces the revision of its service for the winter months. One noticeable feature is the extension in various directions of the rail motor service, which the company started three years ago. The trains on the Epsom Downs branch will be discontinued, and replaced by an entirely new rail motor, the effect being to double the service, and to give travellers in that district a much better London connection, including a late theatre service from Victoria on Wednesdays and Saturdays. A novel feature of this new service is that the motor engine will be situated in the middle of the train, although the driver will have a position at the front, from which he will control the motor. The compartments will be first and third-class only.

As might be expected, papers read on traction subjects are very numerous in American engineering "proceedings," and, as in this country, the question of energy consumption on cars has come to the front. Quite recently a paper on the subject, read apparently with the view of putting forward the claims of the mercury motor meter for this class of work, produced an interesting discussion. Thus, it appears that seven trips, under test conditions, on the loop and metropolitan sections of the West Side Company, Chicago, showed energy consumptions of 3.67 and 2.30 kilowatt-hours per car mile respectively, using a 33-ton motor car and 16-ton trailer. Seven carelessly driven trips showed energy consumptions of 4.29 and 2.90 kilowatt-hours respectively. An average gain of 2 per cent. in time and an excess of energy consumption of 26 per cent. occurred in the last seven trips. The higher energy consumption on the loop was due to frequent stopping and starting. In view of the above, the operating efficiency of each motorman, as regards power consumption, will in future be entered on his record of service, a copy of each entry being sent to him. At Cleveland a series of tests of energy consumption on city and inter-urban cars, fourteen of each kind being tested, showed that, while the inter-urban cars weighed 50 per cent. more than the city cars, the energy consumption of the former averaged 3.75 kilowatt-hours per car mile, against 3.84 kilowatt-hours in the latter case. This is equivalent to 88 watt-hours per ton-mile, against 125 watt-hours, the difference being due to the inter-urban stops averaging fifteen, against sixty-five in the case of the city cars.

ENGINES OF THE S.S. GRACEFUL



ENGINES OF THE STEAMSHIP GRACEFUL.

THE set of engines illustrated in a supplement and above has recently been fitted into the s.s. Graceful, a quarter-deck type steel vessel 195ft. by 30ft. by 13ft. 10in. moulded depth, built by W. Harkess and Son, Limited, Middlesbrough, to the order of Messrs. F. H. Powell and Co., Liverpool, under the superintendence of Mr. W. L. Roxbugh. The vessel is specially designed for the coasting trade, having large capacity and being able to carry 1000 tons of cargo in addition to bunkers and stores on a very light draught. The engines, which have been built by Richardsons, Westgarth and Co., Limited, Middlesbrough, represent the latest design for cargo boats, and have cylinders 16in., 27in. and 44in. diameter respectively, with a stroke of 30in., and are supplied with steam from two boilers working at 180 lb. pressure.

The feature of particular interest about the engine is the condenser, which, though of the Contraflo type, is novel in many respects. It is designed with the object of making the air passing to the air pump as dense as conditions will permit, and this it effects, of course, by reducing the temperature and removing as far as possible all water vapour. Broadly speaking, the condenser, whilst being of the ordinary Contraflo type, is provided with two extra chambers, one above the other, at the bottom. These chambers are fitted with tubes passing between plates just as in the ordinary part of the condenser. Through these tubes the circulating water flows first, and they are therefore always at the lowest temperature. Connecting the bottom of the condenser proper and the lowermost chamber is a pipe fitted with a cylindrical valve, which is seen clearly in our supplement. The water of condensation passes from the condenser through this valve into the lowermost chamber, where it is further cooled by its passage amongst the tubes. From this lower chamber this cooled water finds egress into the chamber immediately above through a comparatively small aperture. Now to this second chamber none of the water of condensation finds admission in the ordinary way, it contains only air and water vapour, and the cold water rising from below condenses the vapour and leaves little or nothing but air. Hence the air pump which draws from this chamber receives its charge in as dense a condition as possible. That is, very broadly, the construction of the condenser; we hope to be able to deal with it more fully on another occasion.

The point of great interest is the control valve to which we have already referred. It can be adjusted to permit just so much of the water of condensation to pass into the lower chambers as may be desired, so that the air pump discharge may be maintained at a practically constant temperature, notwithstanding considerable variations in load and temperature of the circulating water. Speaking of this device recently at the Liverpool Engineering Society, Mr. Morrison said:—"If the air leakage is within the capacity of the air pump, or if the required vacuum of, say, 26in. to 27in. can be maintained in a boat fitted with reciprocating engines when the condensed water at maximum temperature passes through the pump, the regulating valve is lowered and the regulating tank becomes inoperative, but if the air leakage is sufficient to lower the vacuum below the desired amount, the pump may be increased in effective capacity by bye-passing a portion of the condensed water through the regulating tank. Again, if the air leakage is normal, but the vacuum falls by reason of high temperature of sea water increasing the volume of the aërated vapour in the condenser base, the bye-passing of a portion of the condensed water through the regulating tank will suffice to raise the vacuum to the desired standard. The arrangement, in fact, provides an air pump of great flexibility in capacity, whereby the highest temperature of feed can be obtained for a given vacuum with a given air leakage in varying temperatures of sea water."

So satisfied are the makers with this system that they have, they inform us, practically adopted it as their standard practice. Broadly, the results claimed are that the most economical vacuum can be maintained in all temperatures of sea water—in other words, the power efficiency of the engines as affected by the vacuum is constant in all sea waters, thus favourably influencing the average speed of a ship on her voyage. In cargo boats especially the prevailing practice is to maintain a comparatively low vacuum in order to obtain high temperature feed-water, but if this high temperature of feed-water can be obtained by utilising the waste heat in the engine-room auxiliaries, such as the steam from the evaporator and the various high temperature drains, the relation between low vacuum and hot feed can be severed, and that degree of vacuum can be carried which is best adapted to the power efficiency of the engines. In tropical waters there is invariably a considerable fall in vacuum, and in practically all cases this fall is attributable to insufficiency of air pump. Mere increase in size of pump has, it is said, but little influence, but its air withdrawing capacity is quickly responsive to decreased temperature; therefore, if the temperature of the pump can be regulated to meet the requirements of the air leakage prevailing, the highly detrimental effect of surplus air to the condenser is obviated and a steady vacuum is maintained.

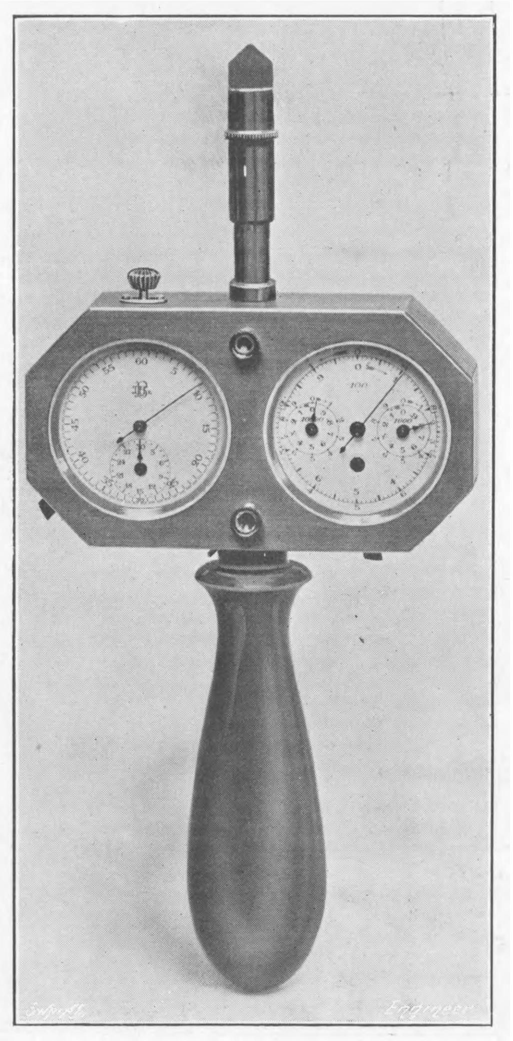
On the loaded trial which took place on Saturday, 25th ult., a speed of 10.6 knots was maintained with 709 indicated horse-power, and at a vacuum of fully 28in. the temperature of the hotwell was within 3 deg. of the corresponding temperature.

We understand Richardsons, Westgarth and Co., Limited, have now on order at their Hartlepool Middlesbrough Works seventeen sets of marine engines ranging up to 2500 indicated horse-power which are to be fitted with this system.

COMBINED COUNTER AND CHRONOGRAPH.

ANYONE possessing but a slight acquaintance with engine testing must recognise that a reduction in the number of readings which have to be taken simultaneously, or as nearly so as possible, will tend greatly towards the increased accuracy and trustworthiness of the figures obtained.

The little instrument which we illustrate on this page is manufactured by Moul and Co., 76, York-street, Westminster, and as a step in the above direction it should prove of great assistance to many engineers. It consists of a speed counter—on the right—and a non-magnetic chronograph mounted in an aluminium frame having a detachable vulcanite handle. The chronograph large hand makes one complete circuit in one minute, the scale reading to fifths of a second; while the smaller hand indicates complete minutes up to 30. The large hand of the speed counter numbers individual revolutions up to 100, while the two smaller hands register hundreds and thousands of revolutions respectively. It is customary in instruments of this kind to engrave two sets of figures round the dial, so as to enable revolutions in either direction to be read directly. Some confusion is liable to arise in this way even when the tachometer is in the hands of an experienced observer, but in using the instrument under description there can be no excuse for errors of this nature. The scale for clockwise rotation is printed in red for all three circles, that for the other direction being in black. Immediately below the centre of the dial is a small hole in the face, and when commencing to read, a disc seen through this hole shows half black and half red. This disc moves when the instrument is in use until all red or all black is shown, thereby indicating the scale on the dial which is to be read. The spindle carrying the rubber bit is, when not in use, pushed out by a spring. When pressure is applied at its extremity it is pressed in, thereby engaging the recording mechanism and simultaneously starting the chronograph. For the two smaller hands of the counter and for the watch, fly-back mechanism is provided, the larger hand of the counter being set by a small thumb-screw at the back. Provision is made for oiling through the small cups shown on the face. The small size and light weight—10½ oz.—of this counter are noticeable features, while the makers claim that it may be used for recording all speeds from the lowest up to 20,000 revolutions per minute. Three differently shaped bits are supplied with each instrument, which is sent out in a neat case of a size quite suitable for the pocket.

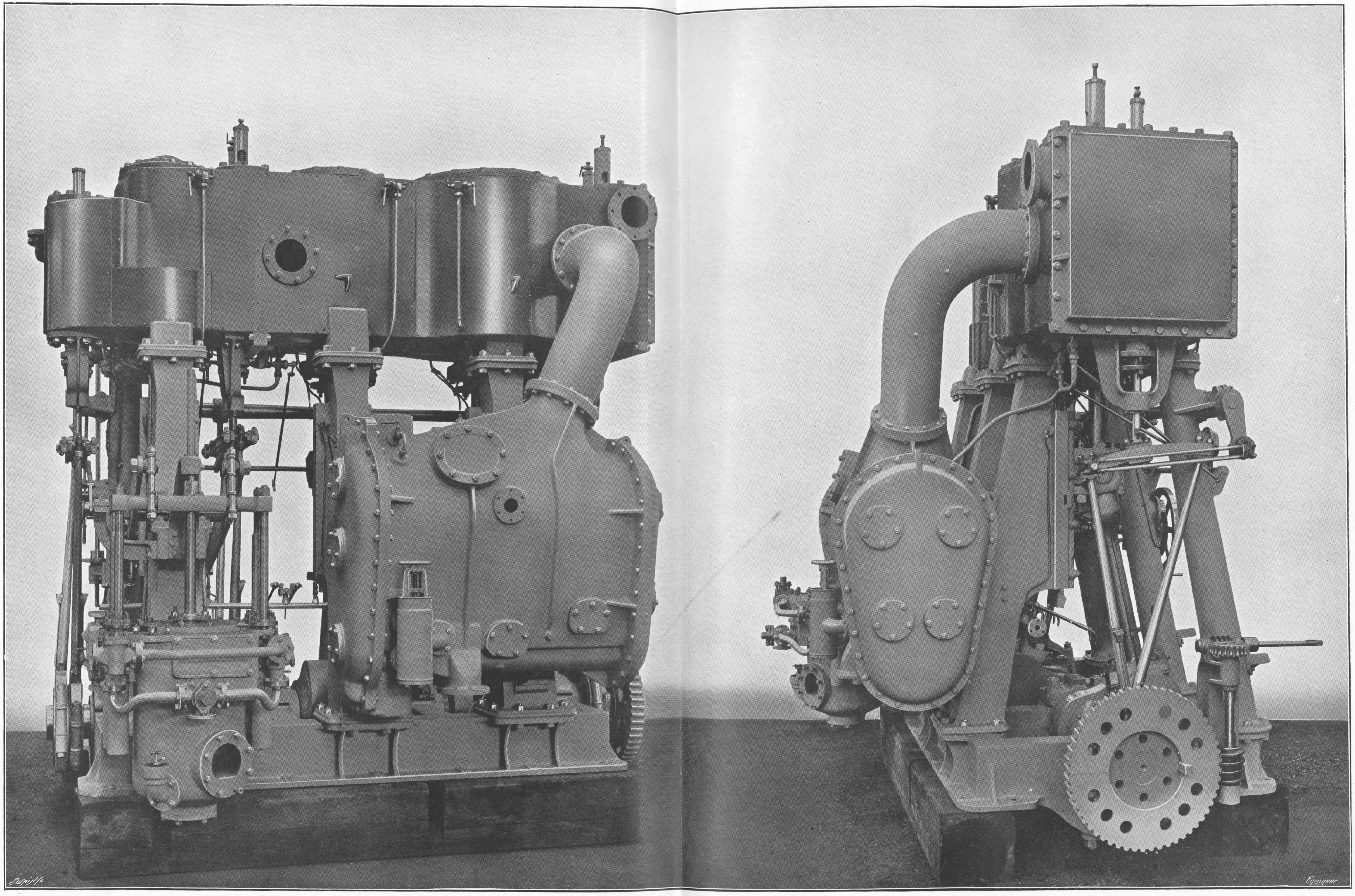

REVOLUTION COUNTER

Engineering Golfing Society.—The autumn meeting of the Society will be held on the Woking Golf Club's Course on Thursday, 7th inst. In the morning there will be an 18 hole medal round, to be played in two divisions, the first division including members with handicaps of 10 and under and the second division those with handicaps of 11 and over. There will be first and second prize in each division. In the afternoon there will be an 18 hole foursome competition, match play against bogey under three-eighths of the aggregate handicap, for the Hadfield Challenge Cups. Mementoes and second prizes will also be given. There will also be a prize for the best scratch score in the morning round. Further particulars of the meeting and of the Society itself may be obtained from the hon. secretary, Mr. Seymour Price Williams, of 5, Victoria-street, Westminster, S W.

Apprenticeship Scheme for Engineers.—Arrangements have been made with several of the leading engineering firms in Glasgow and elsewhere by which students of the South-Western Polytechnic Institute are allowed to enter their apprenticeship. Students who satisfactorily perform the work in the mechanical engineering department in the first year may proceed at once and continue their work at one of the firms arranged for, and students who have satisfactorily finished the second year course are allowed to proceed with their apprenticeship and return to the college and continue their third session. Furthermore, students who obtain the diploma of their college will have their apprenticeship reduced. Under these conditions a student can obtain a first-class training as an engineer, and apprentices who perform satisfactorily in the workshop are allowed to enter the drawing-office. Only students who show an aptitude for engineering will be recommended. No premiums are charged, and apprentices are to be allowed the standard rate of wages.

ENGINES OF THE STEAMSHIP GRACEFUL

RICHARDSONS, WESTGARTH AND CO., LIMITED, MIDDLESBROUGH, ENGINEERS


Swain Sc
Engineer

RAILWAY MATTERS.

According to an article in the *Bollettino Finanze* (Rome) of 9th September, the Turkish Legislature have officially agreed to the construction of a railway from the Servian frontier, through Turkish territory, to the Montenegrin port of Antivari, thus linking up the Danube with the Adriatic.

The *Sole* (Milan) of 18th September contains an article to the effect that the General Directorate of the Swiss Federal Railways have definitely approved the plans for the construction of the Hauenstein Railway—Busse Tunnel—which is designed to shorten the route between St. Gothard and Basilea by about 40 miles.

It is estimated that in the proposed new subway system for New York City a total of more than 100,000 tons of structural steel and steel rails will be required. This will involve an expenditure of upward of £400,000 for the steel alone. The new subway will probably require 1200 cars, which will take 18,000 tons of steel of various shapes, estimated to cost at the mills £110,000.

Two schemes for the electrification of tramways by means of the overhead trolley system are at present stopped owing to the objection of the Astronomer Royal, who alleges that the overhead wires are likely to interfere with the working of the instruments at the Greenwich Observatory. These are the lines from Eltham to Woolwich and from Beresford-square, Woolwich, to the Free Ferry.

The following information is from the report by H.M. Consul at Malaga on the trade of that district in 1908, which will shortly be issued:—Preparations for the laying of a new railway to Coin are in active progress, and it is hoped that it will be finished within two years. The line already built by the same company—Ferrocarriles Suburbanos de Malaga—which has been working since January, 1908, is apparently giving good results. Further preparations for the new coast line from Malaga to Cadiz, passing near Gibraltar, are also in progress; but, judging from appearances, it will take several years to complete.

From the Administration Report on the Railways in India for 1908, it appears that during the year 616 miles of line were opened to traffic, bringing the total mileage open up to 30,576 miles. There were 643 miles of line sanctioned during the year. Up to the end of March, 1909, the mileages were: Lines open, 30,809; lines under construction or sanctioned, 2992. The actual outlay—excluding premia for the purchase of companies' lines—from the commencement on all lines, open and under construction, amounted at the close of 1908 to Rs. 42,067 lakhs (£280,000,000). The sum of £10,000,000 has been provided for expenditure for 1909-10.

A ballast wagon of peculiar design, which is intended to prevent the sticking of the load, has been tried on the Duluth, Missabe and Northern Railway for handling ore. The body or box is supported by trusses on either side, and consists of two parts, hinged together at the top at the mid-length of the wagon. Under each end of the body is an air cylinder for elevating the end, so that the two portions separate at the middle and the contents are discharged between the rails. The maximum width of opening is 5ft., with the two parts inclined at an angle of 50 deg. The wagon is 22ft. long, weighs 17 tons, and has a carrying capacity of 50 tons.

We hear that Norderney, the island health resort off the East Friesland coast, is to be connected by an electric railway with the main line terminus at Norddeich on the mainland. The passage, although short, is usually very bad, and the building of the viaduct presents some difficulties. The platform for the permanent way will be supported on twenty-five great reinforced concrete piers, with pile foundations sunk in the sandy bottom. The total distance of the line will be about six miles, and the cost will be over £100,000. The overhead trolley system is, we understand, to be adopted. The line is to be reserved for passenger traffic during the daytime and for goods transport during the night

In the first seven months of 1909 the railways of the United States ordered 53,900 freight cars, compared with 8040 and 105,620 during the same period in 1908 and 1907 respectively. The locomotive orders at the same time amounted to 1009 in 1909, 386 in 1908, and 2685 in 1907. These figures show that while the railway equipment business is far ahead of last year it is still nearly 50 per cent. behind that of 1907 as regards freight cars, and 60 per cent. behind as regards locomotives. The difference between 1909 and 1907 is due to the fact that while in 1907 orders were placed in good volume from the first of the year, in 1909 the roads only ordered equipment spasmodically until June, when the genuine rush to buy began, 28,985 freight cars out of a total of 53,990 having been purchased in June and July of the latter year.

Except for a few short distances, totalling 127 miles, automatic block signals now extend from the Atlantic to the Pacific Ocean. According to the *Railroad Age Gazette*, of the distance unprotected by this system, 93.4 miles on the Southern Pacific in the Sierra Nevada Mountains uses the electric-train staff. The next longest gap, 20 miles in length, occurs where a change of line is about to be made. The remaining gaps are due to bridges and points where changes are in progress. The line thus operated by the block system extends from Jersey City on the Atlantic to Oakland on the Pacific, over a total distance of 3245 miles, and it includes the Lehigh Valley Railway to Buffalo, the Lake Shore and Michigan Southern to Chicago, the Chicago and North-Western to Council Bluffs, the Union Pacific Railway to Ogden, and the Southern Pacific Railway to Oakland.

An official report, made at Welshpool on Monday last, shows that the magnetic storm was so severely felt on the Cambrian Railway system that the train service was dislocated, except on the coast section. The phenomenon was first felt at 11 a.m., when the needle circuits broke down. This was followed by a failure of the block system, by which the single line is worked, and considerable delay ensued owing to the trains having to be "piloted." The magnetic disturbance affected the wires most seriously where they ran in a south-westerly direction from Oswestry to Brecon and Aberystwyth, and more particularly between Welshpool and Moat Lane Junction. Curiously enough, on the section running almost direct north-south from Pwllheli to Glandyfi there was no disturbance. The magnetic storm lasted until 9 p.m., and towards its close a display was witnessed at Welshpool of the Aurora Borealis.

A remarkable tunnelling record has been made in one of the tunnels of the new aqueduct for the water supply of Los Angeles. The progress in the Red Rock Tunnel—75 square feet sectional area—was 1061½ft. during the month of August, working three shifts of thirteen men in one heading in sandstone. This is a "world's record," the previous record being the 1013ft. progress of the Loetschberg railway tunnel in Switzerland for the month of July. Up to this time American records have been far behind European records, the highest figure having been only 476ft. It is of interest to note in this connection that the Red Rock Tunnel is not being driven by a contractor's force, but by a part of the force organised by the city's engineers for the construction of the new aqueduct system which will give the city a new and abundant supply of water from mountain reservoirs 235 miles distant from the city. After due consideration, the city authorities decided that money could be saved if the city did its own work, under a special organisation, and this opinion appears to be substantiated by the rapid tunnelling work noted above.

NOTES AND MEMORANDA.

Blast-furnace slag waste, of which there are millions of tons at present disfiguring the face of the country, especially in the West of Scotland, is, we understand, being successfully treated, chemically and otherwise, for utilisation as cement, the product being claimed as superior even to Portland cement, and much cheaper.

Titanium is being used extensively in the steel rail industry in the United States. Its effect on the steel is very similar to that of vanadium, increasing its ability to resist wear. It is introduced into the steel in the form of ferro-titanium, an alloy containing from 12 to 15 per cent. of metallic titanium, the balance being iron.

The total value of the natural abrasive materials produced in the United States in 1908, according to a report by Mr. W. C. Phalen, of the United States Geological Survey, was £212,000, a decline of £101,000 from the figures for 1907. The value of the artificial abrasives produced was £125,000, a decline of £80,000 from the 1907 value. The natural abrasives include oilstones and scythe stones, grindstones and pulp stones, burr stones and millstones, pumice, infusorial earth and tripoli, abrasive quartz and feldspar, garnet, corundum and emery. These were produced in twenty-three States.

In a paper before the South Wales Institute of Engineers Mr. C. B. Chartres proposed that a turbo-compressors should deliver the air to existing reciprocating compressors at about 15 lb. per square inch, and thus double the capacity of the compressor plant. This proposal is specially intended for collieries where low-pressure turbines can often be put down to work with the exhaust steam from the winding and auxiliary engines. It is well known that turbo-compressors are inefficient for high compressions, but this defect is not very marked at low pressures, and is offset by advantage in the form of small size and simplicity; and also, in some instances, of first cost.

In a paper read before the American Society for Testing Materials, Mr. Robert Job describes a simple test of the value of lubricating oils under service conditions. He found that when heated to a temperature of 450 deg. Fah. the oils which had given bad results showed a very marked darkening of colour, while those which had proved satisfactory showed very little change. Another experimenter, Mr. E. Camerman, of the Belgian State Railways, has devised a test of oils for lubricating engine cylinders. By treating the oil to 400 deg. Fah. for six hours it is possible to determine the percentage of oil available for lubrication after allowing for that which escapes with the steam. This varies from a very low figure to as much as 60 per cent.

According to an American contemporary, prison cells have been built of reinforced concrete at the Allegheny County Workhouse, Clairmont, Pa., thus allowing the use of the unskilled convict labour, amounting to 90 per cent. of the total labour required. The building itself is also of reinforced concrete, faced on the outside with dressed cast stone slabs. The cell walls are 3in. thick, reinforced with wire netting. The forms were of sheet iron, the full height of the walls 9ft., and were kept apart by gas pipe separators which were allowed to remain in the walls as supports for the cots. Cork expansion joints ⅝in. thick were placed at intervals of every twenty cells, or 100ft. apart. The concrete was in proportions of 1 : 2 : 4, made with gravel and Portland cement.

One of the latest pieces of apparatus for testing hysteresis and eddy-current losses is that by Epstein. Twenty-two pounds of test strips are required to make a test, and there has to be some careful machining to get the joints to butt accurately. This has led Messrs. Lloyd and Fisher to devise a similar apparatus to that of Epstein, but which only requires about 4½ lb. of testing iron, each strip measuring 10in. by 2in. No machining is required, because instead of butting the ends together they are interleaved at the edges by special corner pieces, and in this way leakage is reduced. An interesting point brought out by tests with it is that hysteresis of both ordinary and silicon steels, magnetised normal to the direction of rolling, is 5 to 10 per cent. higher than that of those magnetised parallel to rolling, but the eddy-current loss is the same in each case. Artificial "ageing" by baking always increases the hysteresis loss, but may increase or may decrease the eddy-current loss. It may also alter the law of variation of hysteresis with flux density.

In view of the unsatisfactory results obtained during the cholera epidemic, which has lasted more than a year, in connection with the purification of the water of the Neva by means of ordinary sand filters, the water-distribution system being exposed to constantly renewed cholera infection, the municipal Duma and city authorities have decided to adopt the ozone process for the sterilising of drinking water, and to erect a large ozone water-works. The sanitary authorities both of the City of St. Petersburg and of the State are, in fact, of opinion that only by the ozone method will effective purification of the drinking water of St. Petersburg be obtained. as their own investigations, in agreement with those of the German Imperial Sanitary-office and the Pasteur and Koch Institutes, have shown ozone to be the safest means of ensuring the complete destruction of bacteria in water. The large ozone works which is to be installed in connection with what is called a "rapid filtering plant" (Howatson system) is to be designed according to the combined Siemens-De Frise-Otto ozonising system.

The turbo-generator, if it is to oust the engine type of machine, states Mr. Mills Walker, must have carbon brushes, or, at least, brushes which hardly wear at all and do not wear the commutator. It is true that metal-brush machines are made to operate fairly satisfactorily in the hands of careful attendants. But if the brushes are left without attention, they soon wear so as to cover the wrong arc, and begin sparking and burning. Even in the best hands the wear of the brushes is considerable, the whole set having to be renewed every two or three months. The wear of the brushes fills the air with fine copper dust, which settles on insulating surfaces, and is often the cause of breakdowns. Carbon brushes can be made which will run for years without renewal, always occupying the same arc and giving to the commutator a bright gloss, so that after years of running only the slightest wear can be detected. Electrical engineers owe a great deal to the makers of carbon brushes for the way in which they have solved the problem of brush manufacture and given us such excellent brushes. It is a pity to throw away all the advantages of carbon brushes and go back to metal brushes.

In the early days, when 110 volts only had to be dealt with, flexibles insulated with lapped rubber tape were successfully employed. When, however, 220 volts came into use, this class of insulation was found to be insufficient, the faults mostly occurring in the switch wires. This was largely due to considerations of price, which led to the employment of insulation material containing sometimes from 50 per cent. to 70 per cent. of rubber substitutes, and also to faulty manufacture in giving too small an overlap to the rubber tape spirals, so that in some cases the wire was uncovered. Under the new German regulations taped rubber flexibles may only be used in dry living rooms for pressures up to 125 volts. They may not be used under fabrics or for portable fittings, and may not be installed in cellars, under floors, in bedrooms, or halls. Vulcanised rubber in the form of a continuous sheath may, however, be used up to 1000 volts for fixed apparatus and up to 500 volts for portable purposes. The trouble at 220 volts with taped rubber flexibles is due, not so much to a direct short-circuit, which would blow the fuses, as to the persistent arcs of low current value, which are carried by the fuses.

MISCELLANEA.

A contract has been signed at Washington for the construction of a dry dock at Pearl Harbour, Hawaii. As it is to be 1195ft. long it will be the largest ever built for the use of the United States navy. The contract marks another step in the policy which recognised the strategic importance of the Sandwich Islands, and aims at making them a naval and military stronghold—a really strong link between the Philippines and the Pacific Coast.

The Italian Government appointed a Commission recently to consider the question of establishing a new strong naval base on the Adriatic coastline. This naval base is to be capable of accommodating the new large type of battleship of 20,000 tons, or even of greater displacement. The Technical Commission has visited Venice, Ravenna, Brindisi, and Ancona, and Ancona has been selected as the site of the new naval base. The estimated cost of the work that will have to be carried out at Ancona is £4,000,000.

The extent to which the industry of aërial navigation is becoming developed in France is hardly realised by any others than those living inside the radius of the aëro clubs and the national association of that country. Six months ago the builders of aëroplanes in Paris could be counted on the fingers of one hand. Now there are in full operation fifteen factories devoted to the manufacture of materials and the construction of aëroplanes of all sizes, forms, and designs, besides a dozen or more inventors who are making under cover and more or less secretly individual machines which embody their special and more or less original ideas of what the aëroplane or dirigible airship of the future ought to be.

A system of wireless signalling for airships has been invented by Dr. Friedrich Lux. The idea of the inventor, states the *Electrical Engineer*, is that all airships should be equipped with a receiving apparatus which will weigh only 6 lb., and that wireless signalling stations should be equipped all over the country at about 50 kiloms. apart. At intervals of five minutes these signal stations should send out wireless messages by which they could be identified and aviators informed of their whereabouts. A combination of a few letters would, it is suggested, be sufficient to distinguish one station from another; and by the increasing or decreasing strength of the electric impulse the aviator could tell whether he was approaching or receding from a particular station.

A summary of the reports received from mines inspectors in the United States shows that there were 2450 men killed and 6772 injured in the coal mines during last year. These figures compare with 3125 killed and 5316 injured in 1907. Colossal as these figures are, they do not represent the actual total, as there are several States in which no mines inspection law is in operation. It is fair to say, however, that those States which report accidents contribute over 98 per cent. of the total coal output of the country. The year 1907 was the worst in the history of the United States as regards the number of lives sacrificed in the mines. This was due to the succession of serious disasters that occurred in December of that year in the Appalachian bituminous coalfield, each involving a heavy death roll

It is reported that the airship Clement-Bayard, which is to fly across the Channel, will be ready in a fortnight, and will at once begin its trials with a view to the flight. A French journal, which is opening a national subscription for the support of the military aeronautic movement, prints, in addition to the first list of contributions amounting to close on £1000, an appeal to the public to make a great effort similar to that put forth by Germany when she replaced the wrecked Zeppelin. The fund will be divided into two portions, the first of which will be devoted to replacing the lost airship after providing adequately for the families of the victims, and the second to presenting the army with several aeroplanes. In the present position of aerial locomotion, it is stated, it is certain that aeroplanes can be employed concurrently with steerable balloons in military reconnaissances pending their utilisation as engines of war. On these grounds the journal appeals for a patriotic effort on the lines indicated.

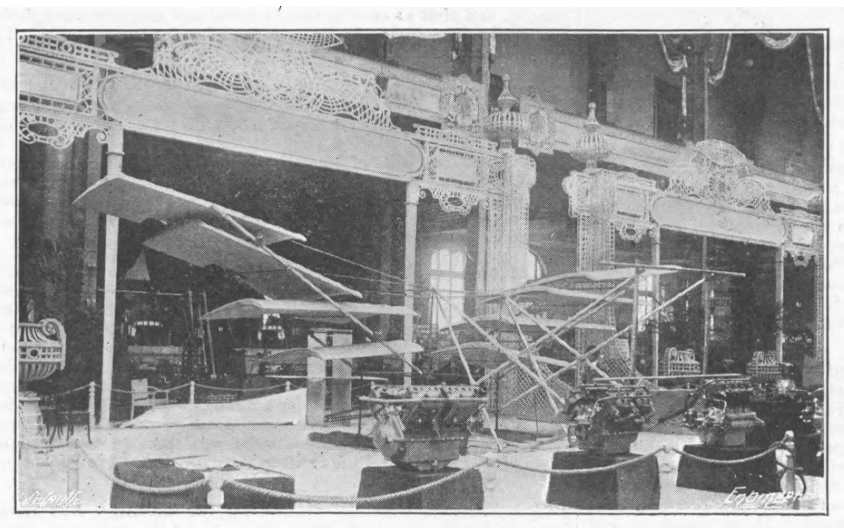
It is pointed out by the *Frankfürter Zeitung* that the situation of the Roumanian petroleum industry at the present time is not very favourable. As a proof of this circumstance it is mentioned that the production of crude oil in the first half of 1909 amounted to 611,386 tons, as compared with 570,729 tons in the corresponding period of 1908, 560,064 tons in that of 1907, and 409,511 tons in that of 1906. The export figures show a similar increase up to last year, but in the first half of 1909 the quantity exported amounted to only 186,400 tons, as compared with 216,000 tons in the equivalent period of 1908, 195,000 tons in that of 1907, and 151,000 tons in that of 1906. The decline in the exports this year is attributed largely to the influence of the competition and low prices of Galician petroleum. Naturally the diminution in the exports has not been without effect upon the crude oil producers, many of whom have to contend with difficulties. As a consequence the demand for the establishment of a petroleum bank has arisen from a certain pressure, and a memorial dealing with the question has been presented to the King.

A consular report dealing with the trade and commerce of the district of Gothenburg during the year 1908 states that in the mechanical engineering industry a decline has to be recorded, which must be attributed, however, less to the purchasing power of customers than to uncertainty in the labour market. The difficulty that workshops find in pledging themselves to execute orders within a certain time without reservations as to possible strikes has led to the postponement of planned work and the placing of orders with foreign contractors. The workshops have thus found themselves obliged to reduce the number of hands by about 10 per cent., while in many places the hours of work have also had to be curtailed. Seeing, however, that at the turn of the preceding year the number of hands at a great many factories had been increased beyond the ordinary number, the reduction may be said to bring things back to normal conditions. As to the workmen's wages, a rise of, on an average, 25 per cent. has taken place since 1904, according to an investigation instituted by the Association of Mechanical Workshops of Sweden. From the beginning of the year the price of raw material continued to decline, though a change could be noticed during the last quarter, accompanied by some improvement in the demand.

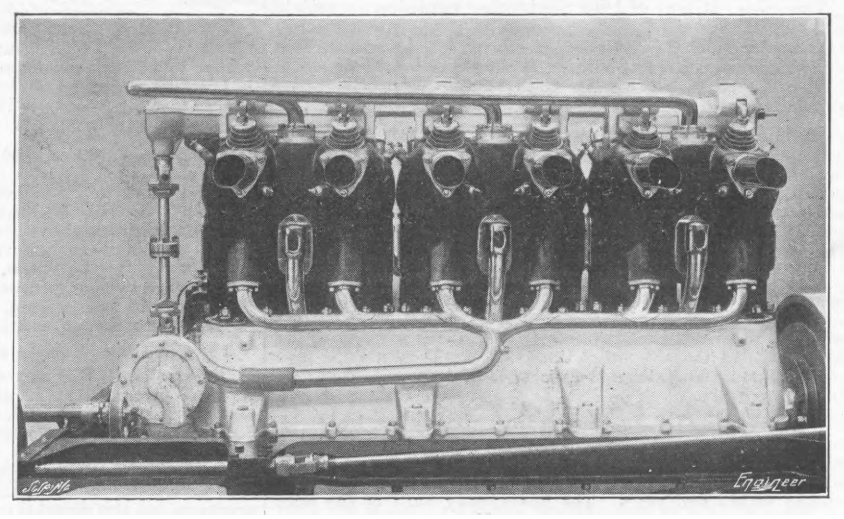
According to a contemporary, Professor Fessenden has proposed to the United States Navy Department the building of a turbo-electric vessel, wherein a steam turbine alternator would drive the propellers through induction motors, but so far the proposition has not been accepted. The claim is that there would be a great saving in weight, as the turbine could be operated at an efficiently high speed and so be made much smaller than when designed to be directly connected to the propellers. The same object, states our contemporary, will probably be more economically accomplished by the marine turbine reducing gear patented jointly by Rear-Admiral George W. Melville, U.S.N., retired, formerly chief engineer of the United States navy, and Mr. John H. McAlpine, who was also formerly in the navy. The first model of this gear was recently completed at East Pittsburg, Pa. It consists of a floating frame supporting two spiral gears. Each has a 22in. face; the smaller, of 14in. pitch diameter, is connected to the turbine shaft, while the larger, of 70in. pitch diameter, is connected to the propeller shaft. The tensile strength of the steel used is 90,000 lb. per square inch, and it is expected that the gear will transmit 6000 horse-power. It is suggested that it will greatly reduce the weight and cost of Trans-atlantic steamship and battleship power plants.

AERONAUTICAL MOTORS AT THE PARIS EXHIBITION

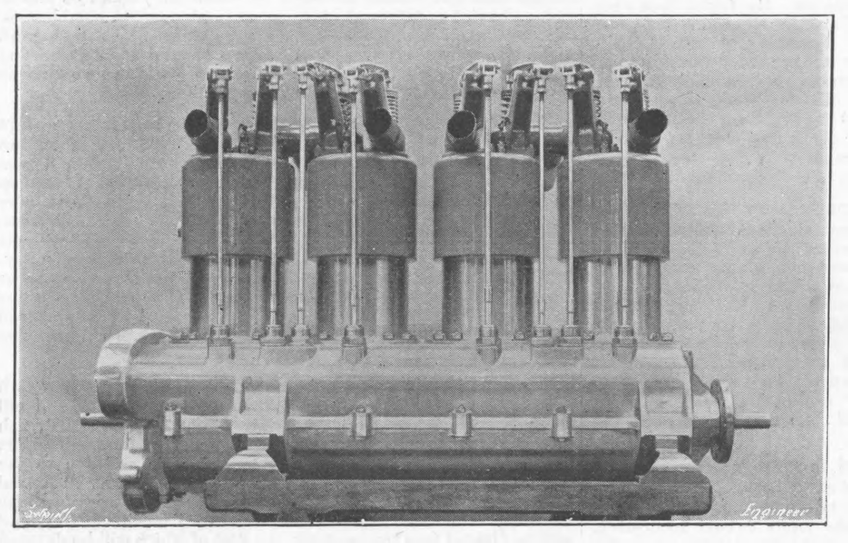
(For description see page 342)



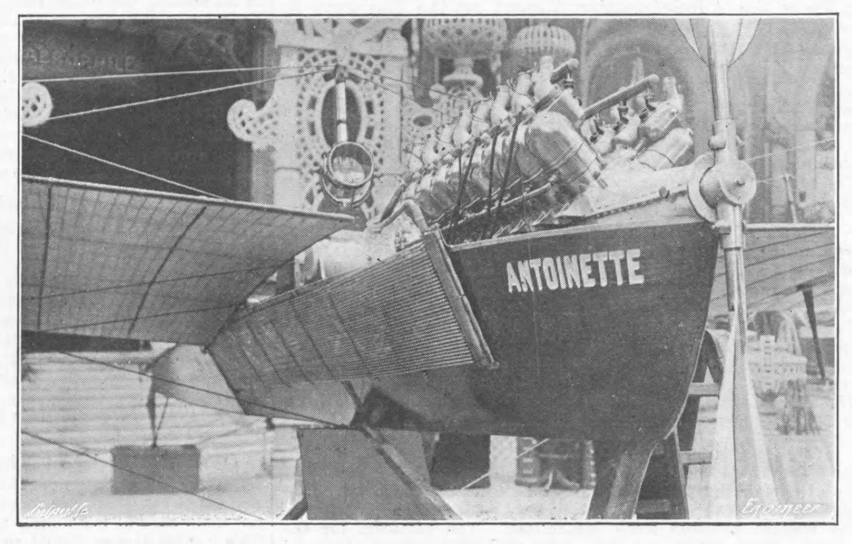
DE DION ENGINES AND AEROPLANE



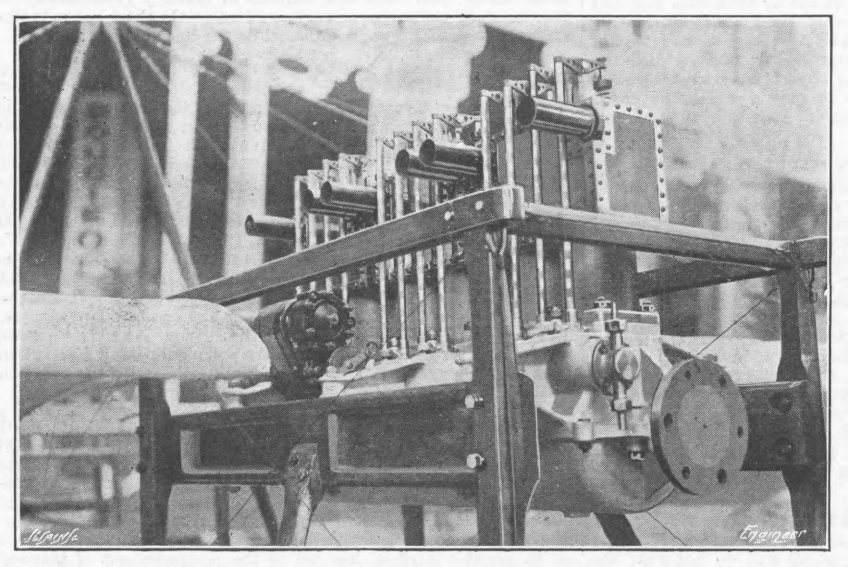
170-H.P. BAYARD-CLEMENT MOTOR



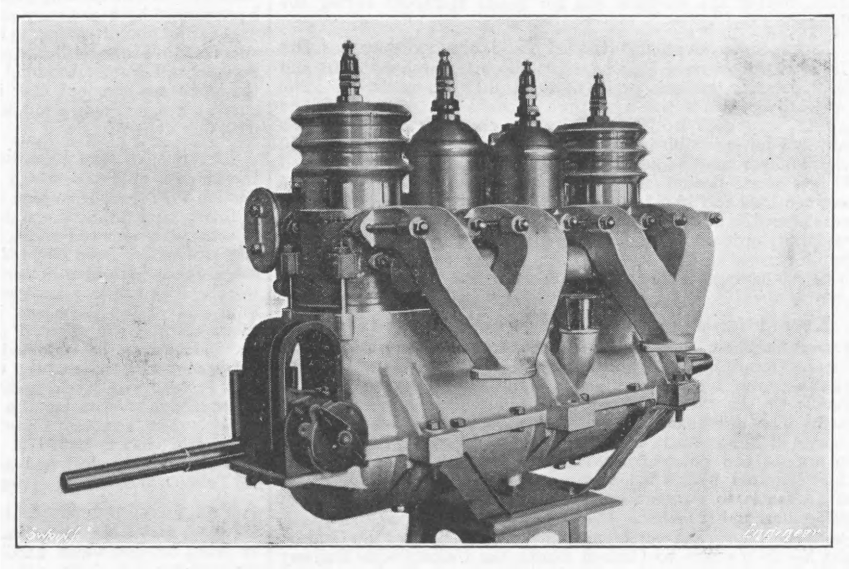
35-H.P. DARRACQ MOTOR


ANTOINETTE
Engineer

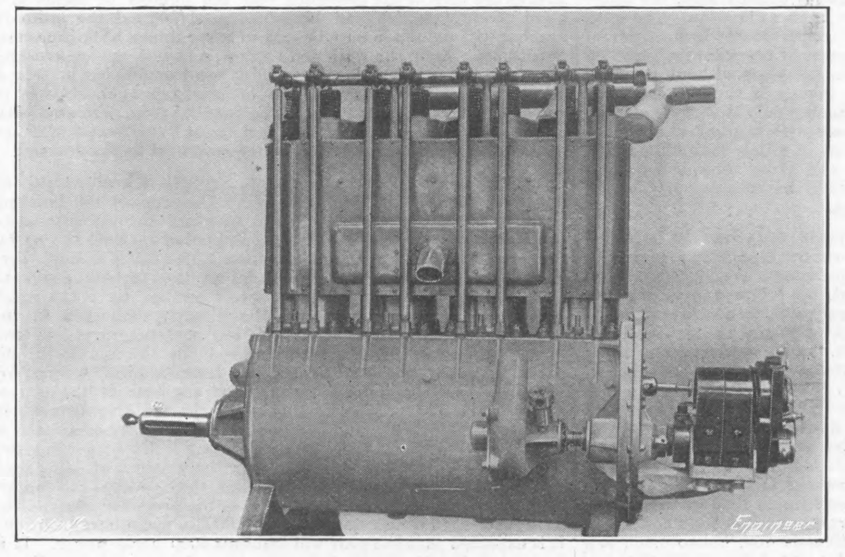
100-H.P. 16-CYLINDER ANTOINETTE MOTOR



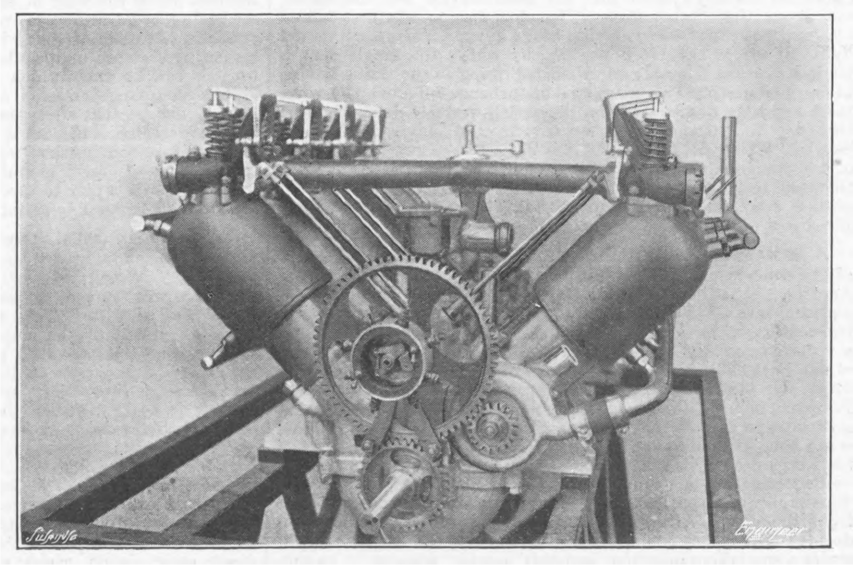
50-H.P. BUCHET MOTOR



PRINCE BERTHAND MOTOR



60-H.P. ROUGIER MOTOR



60-H.P. BROUHOT MOTOR

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Advertisements cannot be inserted unless delivered before Five o'clock on Thursday evening, and in consequence of the necessity for going to press early with a portion of the edition ALTERATIONS to standing advertisements should arrive not later than Ten o'clock on Tuesday morning in each week

Letters relating to Advertisements and the Publishing Department of the Paper are to be addressed to the Publisher, Mr. Sydney White; all other Letters to be addressed to the Editor of The Engineer.

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PUBLISHER'S NOTICES.

⁂ *With this week's number is issued, as a Supplement, a Two-page Engraving of the Engines of the Steamship Graceful. Every copy as issued by the Publisher includes a copy of this Supplement, and subscribers are requested to notify the fact should they not receive it.*

H.M.S. BELLEROPHON.

⁂ *Copies of the fine* Wood Engraving *of H M.S. Bellerophon, suitable for framing, can be sent on a roller to any address at home or abroad, price 8d. each, post free.*

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TO CORRESPONDENTS.

☛ *In order to avoid trouble and confusion we find it necessary to inform correspondents that letters of inquiry addressed to the public, and intended for insertion in this column, must in all cases be accompanied by a large envelope legibly directed by the writer to himself, and stamped, in order that answers received by us may be forwarded to their destination. No notice can be taken of communications which do not comply with these instructions.*

☛ *We cannot undertake to return drawings or manuscripts; we must, therefore, request correspondents to keep copies.*

REPLIES.

A. L. (London).—None of the steamers you mention have independent paddle wheels. Independent wheels are very frequently fitted on tug-boats.

E. M.—You will find it easier to get a berth if you have worked in a marine shop, and we should recommend that course. See Sothern's "Verbal Notes and Sketches for Marine Engineers;" Munro and Co.

W. T. E. (Trowbridge).—No list is published. The only thing would be to inquire at local land agents' offices, and so on. The town clerks in some cases circulate books expatiating on the advantages of their districts, and in such cases might be disposed to help you. The list we published was the result of inquiries from various sources.

T. H. B.—We regret we are unable to assist you, but suggest that you should inquire of the Secretary of the Chartered Institute of Patent Agents. Permit us to remind you that hundreds of engines of the kind have been invented, and thousands of pounds spent on them fruitlessly. We mention this so that you may advance with care.

MEETINGS NEXT WEEK.

Society of Engineers.—Monday, October 4th, at 7.30 p.m., in Room 18, Caxton Hall, Westminster. Ordinary meeting. Paper, "The Status of the Engineering Profession," by G. Allan Thomas.

Civil and Mechanical Engineers' Society.—Thursday, October 7th, at 8 p.m., at the Caxton Hall, Westminster, S.W. Mr. W. Noble Twelvetrees, M.I.M.E., A.M.I.E.E., will deliver his Presidential Address.

The Birmingham Association of Mechanical Engineers.—Saturday, October 2nd, at 7 p.m., at the Grand Hotel, Colmore-row. Opening meeting. Monday, October 4th, at 2.30 p.m. Visit the Works of the District Iron and Steel Company, Limited, Smethwick.

The Incorporated Association of Municipal and County Engineers.—Saturday, October 9th, at 11.30 a.m., at the Guildhall, Winchester. Home District meeting. Discussion on papers: "Some Notes on the Separation of Solids from Sewage and Waste Liquors," by J. P. Norrington, A.M.I.C.E. "The Maintenance of Rural Roads in Hampshire," by G. E. Carter, Surveyor to the Rural District Council of Winchester. Visits have been arranged to inspect the Destructors and Sewage Pumping Station, the Restoration Works at Cathedral, the Ancient Westgate, and the Gas-works.

THE ENGINEER.

OCTOBER 1, 1909.

The Hudson Fulton Centenary.

It is to be feared that the history of early engineering is likely to fall into as great a complexity as, shall we say, the political history of England under the Tudors. Many of the records have been badly kept, and many are incomplete or biassed. Moreover, the lapse of time, instead of obliterating the errors of the moment, tends, if anything, to accentuate them. Look, for example, at the Fulton centenary, which is at this moment being celebrated in America. The result of the celebration must inevitably be to convince many young Americans that Fulton was the true and first inventor of the steamboat. Of course he was nothing of the kind; the steamboat was invented long before the Clermont was built, and the possibility of propelling vessels by steam power was proved in Europe before it was demonstrated on the Hudson. Fulton was certainly the first to make steam navigation a success, and on that score all honour must be allowed to him.

As to what Fulton really did, there is in existence an abundance of information. We have in the first place, a rather rare book, "Mémoire sur les Bateaux à Vapeur des Etats-Unis d'Amerique," written by Monsieur M. Marestier, Ingénieur de la Marine Royale, published in 1824. The author had been sent by the French Government to learn all that he could about steam navigation, and the result is a bulky volume accompanied by an atlas of plates. He gives a very full illustrated description of the Clermont. Again, we have Morrison's fairly complete history of American steam navigation, published in New York by Messrs. Sametz and Co., 1903; and amongst smaller books Thurston's "Life of Fulton." Far from originating with Fulton, the idea of propelling ships by steam was nearly a century old when he took the subject up. It is a matter of considerable interest that Papin in 1707—precisely one hundred years before Fulton's Clermont was built—constructed a steamboat which actually ran successfully, but was destroyed by the mob who, as usual in those days, looked upon mechanical forces as manifestations of witchcraft. Then Jonathan Hulls obtained a patent for a stern-wheel steamboat as far back as 1736, the year in which James Watt was born. His engine was to work on the principle of Newcomen's, ropes and ratchet wheels being used to turn the paddle-wheel. Indeed, it is not too much to say that Fulton was anticipated a dozen times over. Many Americans even were before him. Henry built a successful boat in 1763; Rumsey another in 1786, which worked on the hydraulic principle and ran on the Potomac. In 1790 Fitch actually opened a service between Philadelphia, Burlington, Bristol, Bordentown, and Trenton with a boat of his own design. He died in 1798, and was buried with a model of his boat beside him. In 1793 Morey ran a boat on the Connecticut, and in 1807 came Stevens, one of America's most brilliant inventors, who possibly did even more than Fulton to develop steam navigation. In Europe Jouffroy ran a boat at Lyons in 1783, and the Charlotte Dundas, Symington's boat, ran on the Forth and Clyde Canal in 1801. The reason why Fulton looms so large is to be found, then, in some other cause than original invention; it is very instructive, and deserves attention.

The men who do the world's work are not the inventors either of machines or ideas, but the men who carry inventions or ideas into successful practice. The point deserves to be insisted upon; it is continually overlooked. It is a comparatively easy thing to make even clever inventions. There must be thousands, if not hundreds of thousands, of worthy people who can do this much. If there were not, whence would come the 30,000 claims for a patent made every year in Great Britain alone. The combination of abilities which enables men to achieve commercial success is, on the other hand, difficult to find. It demands above all things great power of clear perception, and a very keen and far-reaching sense of proportion—that sense which enables its possessor to appraise at its precise value each part of a machine, each step in a process, each trait of the men who work under him or with him. This quality Fulton seems to have possessed in an eminent degree. Knowing what had been done before, he recognised the importance of trying to establish steam navigation on a sufficiently large scale. Those who had preceded him never appreciated this truth; above all, they failed to give the steam a chance by providing power enough. Fulton succeeded in persuading capitalists to come forward with money. That was a very clever thing to do. We may concentrate all our attention for the moment on the Clermont. It is the custom to speak of this craft as a kind of big open boat. In point of fact, she was a beautifully-designed and carefully-constructed vessel. She was the first boat without a flat bottom used on the Hudson, and had well-shaped bow and stern lines. She was 133ft. long between perpendiculars, 29ft. beam, and drew 6ft. 3in. She cost 465,000f., or £18,600—a very large sum to spend on a river boat in those days. Her boiler was of copper, and cost about 160,000f., or £6400. She was very handsomely fitted up, with twenty-two berths and a good dining saloon. Her engine was of the steeple type, with timber frames. The cylinder was 36in. diameter, the stroke 4ft. There was on the crank shaft a toothed wheel which drove another toothed wheel of less diameter on the paddle shaft. A fly-wheel took the crank over the dead point. The paddle-wheels were 15ft. 5in. in diameter, and each carried eight floats 5ft. long and 2ft. 4in. deep. It will be seen that we have here no toy. Nothing, indeed, was wanted but a pressure greater than that of about 1 lb. above the atmosphere to make her a conspicuous success. As it was she made about 6½ knots—quite a respectable speed as compared with that of the sailing boats which were in use previously. The wheels made 15 to 20 revolutions per minute; the normal rate seems to have been 18½. She burned 20 to 25 "steres" of pine wood on her trips between New York and Albany, a distance of 150 miles. Fulton left no stone unturned to make the boat acceptable to the public. He took precautions to avoid breakdowns, and acted in a way quite unlike that of the enthusiastic inventor, who, having accomplished something, leaves it to its fate and proceeds with the production of something else. The result was that he "caught on," in American phrase, and the Fulton was quickly followed by the Chancellor Livingstone—a boat with improved passenger accommodation—the Paragon, and the Richmond. The crews generally numbered about forty all told.

We have no intention of re-writing a history of the progress of steam navigation in early days. We dealt with it very fully in our 84th, 85th, and 86th volumes. We have said enough, we think, to enforce the lesson that it is to Robert Fulton as a business man, and not as an inventor, that honour should be done. We have never been able to side with those who hold that the inventor's intellect must be of a higher order than that of the man who makes things succeed. We may place them on the same plane, and honour them accordingly. But their equality ought to be recognised. As we have said, dozens of individuals invented schemes for propelling vessels by steam power; but Fulton was the first man to convert these dry bones into a living structure. He was himself far too poor to do much; but he so favourably impressed Robert H. Livingstone, a man of considerable wealth, that he was enabled to build the Clermont. The name of Livingstone should not be forgotten, he was himself an inventor, and one who saw far ahead. That the United States does well to celebrate the centenary of the Clermont, which really fell two years ago—for that is one real object of the fêtes now being held in New York—is certain. But it is worth while to remind those who rejoice and who are proud, of the true nature and result of the work done by the man whose name they celebrate; and inventors at home and abroad will do well to bear in mind that ability to invent will not alone secure wealth, or indeed a living.

Heating by Friction.

Every engineer is but too familiar with hot bearings. No one, be he engineer or scientist, knows why they get hot. Benjamin Thompson, Count Rumford, was the first to prove that friction produced heat. His experiments are detailed in a paper read before the Royal Society in 1798. It was entitled "An Inquiry Concerning the Source of Heat which is Excited by Friction." Before that date "Caloric" was regarded as a kind of fluid which, already in the metals, was rubbed out or squeezed out by friction. That friction will produce heat seems to have been known even by prehistoric man, certainly by savages even of a low type. The fact remains that the way in which work is transformed into heat is as little understood as the converse operation. If we examine what has been written on the subject, we shall find that for the most part authors deal with lubrication and lubricants. Others advance theories concerning the assumed interlacing of the surfaces in contact. But no one has done more than attempt to arrive at some explicit statement of the actual *modus operandi* by which a badly-lubricated bearing becomes hot.

There are some special cases of heating which are very difficult to explain. That is to say, the performance of the materials concerned is apparently entirely abnormal. It may be taken for granted that heat is conducted at some fixed rate through a metal. Indeed, tables of these rates can be found in numerous text-books. Again, it is always assumed that for some reason the amount of pressure forcing two rubbing surfaces against each other is a powerful factor. Its influence is usually explained by saying that there is a certain pressure beyond which the oil is squeezed out and metallic contact obtains. An old theory was that the molecules of the lubricant acted as miniature roller bearings. It is now held that the lubricant only acts by preventing metallic contact. Be this as it may, heating by friction not infrequently manifests phenomena which, as we have just said, it is difficult to explain. Such cases come repeatedly under the notice of marine engineers. A piston-rod is running, so far as is known, quite cool. Suddenly, without warning, it becomes bright red-hot at one side, and at one side only. No attempt can be made to cool the rod quickly. It has been bent by the local heat, and will remain bent if water is put on it. The engine must be slowed down. Then the heat will, so to speak, run round the rod, which cools down behind the passing heat wave. The rod is never red-hot all round at once. Why does such a bar of polished steel, six or eight inches in diameter, running in a hemp packing—heating will take place even more readily with hemp than it will with soft metal, or gauze rings—become red-hot in a few seconds under the eye of the greaser? We once saw a compound locomotive run into a station with the oil on the guide bars flaming. No heating had taken place during a run of some 40 miles at a very high speed. When the steam was shut off the oil fired—that is to say, in about one-fourth of a minute the piston-rod became bright red-hot. It then bent and seized the brass gland of the stuffing-box, breaking it in two. We have seen a heavy wall bearing in a mill at one moment quite cool, the next molten brass was running down the wall. This instantaneous heating is, indeed, well within the experience of most engineers. It by no means represents all that might be said concerning the abnormal heating of bearings. The chief engineer of a very large mail steamer told us recently that he had at one time a remarkable experience. He was serving as second in a somewhat similar ship. She had new triple-expansion engines fitted with steam jackets. The chief wished to test the value of the jackets, and to that end ran sometimes with steam in the jackets, and sometimes shut out of them. It was found that the high-pressure piston rods always ran cool when the jackets were in use, and always heated, no matter what was done when the jackets were out of use. The heating in this case was not sudden, but gradual and steady. It is so difficult to trace any connection here, that were it not that the evidence is irrefragable, we would not have credited the story. But it is well to remember that apparently minute conditions suffice to bring about excessive frictional heating. Thus in cold drawing tubes a very minute speck of hard material in the die will very greatly augment the resistance, and set up heating. The only evidence left on the tube is probably a scratch which can hardly be seen without a magnifying glass. The opening or shutting of an engine-house door has been known to settle whether the crank shaft will run cool or hot. It is quite possible that locomotive crank pins would not run cool if they were boxed up so that a current of cold air could not get at them.

It may with some truth be observed that cases such as those of which we have written are very unusual, and that the conditions which give us cool bearings of all kinds are well understood, and need no further investigation. But the sudden heating of piston-rods and bearings is, after all, not very exceptional. They are events, at any rate, which the marine engineer on watch is always anticipating; and even if this were not so, this fact that an enormous conversion of work into heat can be brought about by apparently entirely inadequate means is an extremely interesting physical truth. We have got into the habit of regarding much that is really complex and puzzling as a matter of course. No one attends to what is going on day after day. Abundance of such every-day physical facts remain not only unexplained, but without any attempt being made to explain them; and yet it is certain that in the past some of our greatest advances have resulted from the careful investigation of common and well-known things. The sudden heating of a big steel bar by rubbing against wet hemp rings is, we think, a thing for which it would be worth while to find an explanation. The end is the conversion of work into heat; the means by which the conversion is effected seems to be wholly inadequate to that end.

Railway Passenger Classes.

The engineers and directors associated with the construction or initiation of the deep level underground electric railways in London introduced an innovation in railway working in Great Britain by establishing the system of a single class for the accommodation of passengers, upon whose custom it was expected that the proprietary companies would have solely to depend for patronage owing to the comparative short length of the lines and the absence of physical junctions with other railways, and the consequent lack of any possible goods or mineral traffic. The City and South London Railway, which was the initial undertaking of the kind, first started this practice, and the example has been followed in the case of all the similar lines which have been built subsequently. No doubt the institution of a one-class train service was decided upon for a variety of reasons. One of these was represented by the desire to obviate the additional outlay which would have been necessitated by the provision and working of different types of coaches for first or second-class passengers on lines which were already heavily burdened by the enormous capital expenditure per mile of track. At the same time the question also received consideration, particularly with regard to the later lines, that the single class coach equipment would meet all possible requirements of the public for short-distance traffic, and that the construction of carriages superior to those contemplated would consequently be entirely unnecessary. It is quite reasonable to conclude that this assumption has been proved by experience to be correct, the expansion in the passenger traffic on the tube lines in 1908 being represented by an increase of many millions as compared with the preceding year, although additional facilities were placed at the disposal of the public. The circumstances therefore suggest that passengers have accepted the one-class system with thankfulness for the accommodation provided, and without making any complaints for the short journeys which the trains on these railways are able to make; but the satisfaction expressed with present conditions would be mingled with discontent on the part of a large number of passengers if the distances to be travelled were considerably longer and approximated to those of a main line railway.

Certain observations made by chairmen at the last half-yearly meetings of the steam railways seemed to foreshadow further developments in the restriction of the number of classes. In the first place, the Great Western Railway, although having experienced a growth in the number and receipts from the first-class traffic as compared with the corresponding half in 1908, found that the second class underwent a very considerable diminution represented by nearly £60,000 as contrasted with the equivalent six months in 1908. These figures, Lord Churchill remarked, showed the wisdom of the board in deciding to abolish the second class throughout the system as soon as the company could conveniently do so. On the other hand, the directors and officials of the London and North-Western Railway have perfectly open minds on the question of the number of classes forming the trains. Thus whilst some small branch lines are served by single-class trains, only first and third-class trains are run on certain other lines. But Lord Stalbridge, it will be recalled, informed the shareholders that the abandonment of the second class at the present moment would result in a loss, after taking into consideration every saving which might thereby be effected. The qualification implied by the words "present moment" inferentially suggested that the matter would not be overlooked in the future, when abolition might be proceeded with without the prospect of a loss. At the meeting of the Great Northern Railway, Lord Allerton gave utterance to a fresh complaint regarding the unprofitable character of the first-class traffic, and he observed that the cheaper fares and increasing luxury provided for third-class passengers were the causes of persons travelling more and more in the latter class. The chairman added that he did not know whether the time would ever come to have only one class, but "he hankered very much after trying" some all third-class trains for the suburban traffic, and he intimated that something would have to be done, and that the question was under consideration.

It is exceedingly doubtful whether the steam railway companies will ever proceed to such a drastic course as to adopt the single-class system in use on the London deep level electric railways, as there is, and in all probability always will be, large numbers of people prepared to pay higher fares for superior accommodation and convenience, together with freedom from the disadvantages or annoyances sometimes encountered in third-class coaches. But if the railway companies continue to improve the facilities placed at the disposal of third-class passengers in recent years, they must expect further diversions to take place from the higher classes, and it will ultimately be found that the intermediate class will have to be abandoned, and only two classes, whatever they may be called, will remain in existence. Several of the railways discontinued second-class traffic on their main lines many years ago, and although they may or may not have experienced a temporary monetary loss from the abolition, those railway do not lose anything to-day from the working of only two classes. No doubt the progress in this respect will be very gradual in its character unless the second class passengers transfer their patronage to the third class more rapidly than has hitherto been the case. The difference between first and second-class fares has for a long time been little more than nominal on the London and North-Western and Great Western. On the former, at all events, the second class retains its popularity because the company carries large numbers of emigrants, cattle men, firemen, &c., whose company is not welcome to the ordinary travellers, who is therefore prepared to pay a little more than third-class fare to avoid it. It is well to bear in mind that in the democratic United States, although there is in theory only one class, "Palace cars" are eminently popular and remunerative. But after all, it has to be remembered that the financial backbone of the passenger traffic is represented by the third-class travellers, and although the second class may be retained where the demand for such accommodation continues, the general adoption of only two classes is not very remote.

INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

No. IV.*

An important series of papers dealing with impact tests on metal was introduced by the official report of Mr. G. Charpy.

Mr. Charpy pointed out that the use of impact methods had, since the introduction of notched bar tests, been the subject of much discussion and of many researches. The Congress of 1906 rejected the resolution demanding that the use of notched bar tests should be standardised. It was impossible not to recognise, however, that the application of these tests had undergone considerable developments since 1906, and they had now been introduced into some official specifications. The development had certainly been hampered by the failure of the Brussels Congress to define the experimental conditions to be adopted, but the German Association for dealing with methods of testing materials had appointed a commission which recommended the use of notched bar impact tests. The mechanical tests of metals undoubtedly presented for solution a great number of scientific and technical problems. To utilise the tests in industrial practice, it was sufficient to regard them as means for the identification and classification of metals, but as they could not all be applied in every-day work, an endeavour must be made to classify them in groups which would yield analogous results, so that it would be possible to carry out one of the tests of each group to obtain the desired result. The tensile strength test and the impact test of notched bars clearly belonged to different groups. The latter would, with reference to the former, always furnish supplementary information which would be very useful, and in some cases absolutely necessary. It was important to apply these tests, to compare them with other tests and with experience gained in the practical utilisation of the metal, but it was necessary to arrive at a fixed method which would in all cases give results safely comparable with one another. He therefore proposed that the Congress should define a typical method to be recommended as a comparative test. It was highly important that the Congress should decide the circumstances under which notched bar impact bending tests should be applied. Experimental data suggested that such tests furnished information which other tests did not give. The question had been raised whether there was any corelation between the results of notched bar tests and the behaviour of metals in use. That opened up a very important problem. Experience could be quoted that investigation of cases of fracture of marine engine shafts had shown that such fractures were less frequent when use was made only of materials which had stood notched bar bending tests well, and in recent contracts for marine engine shafts, notched bar impact tests had been stipulated. Satisfactory results had also been obtained in connection with the rods of steam hammers at the Forges de St. Jacques at Montlucon by the adoption of notched bar impact tests. Armour plates appeared likely to lend themselves to instructive comparison, and the French navy had for several years been making use of such tests. It had been stated that these tests constituted a good guide in the manufacture of armour plates, but it should be pointed out that Messrs. Snyders and Hackstroh, of the general staff of the Dutch army, had described experiments which pointed to a different conclusion, armour plates which had given poor results in notched bar tests giving a satisfactory performance in the firing tests. He proposed that the Congress should address an appeal to all engineers and constructors who could give direct information to send to duly equipped laboratories specimens in which interesting features had been observed, and that a commission be appointed for the purpose of centralising the results obtained and to draw up propositions to be submitted to the next Congress.

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* No. III. appeared September 24th

In addition to the report itself, no less than eight papers were presented dealing with various branches of impact testing.

Professor Schüle, in conjunction with Mr. Ed. Brunner, dealt with notched bar impact bending tests, describing the direct-fall machine and giving his interpretation of the experimental data. He contended that it was shown that by determining the volume strained beyond the yield point in a test bar polished on both sides, and by calculating the work done in fracture per unit of this volume, the influence of the depth of the notch could be eliminated and the influence of the shape of the notch on the strength of the material determined.

The definition of resilience in impact tests was undertaken by M. Louis Révillon. His experiments, it was stated, tended to prove that in impact tests the quantities resulting from experiments made on specimens of different dimensions might be rendered comparable by referring the quantities to the cross sections of the plain—not notched—bar, provided the test bars were of the same type, enlarged or diminished in dimension in a certain ratio, and that the distance between the points of support be varied in the same ratio.

Impact tests at variable temperatures was the subject of a short paper of which the joint authors were Professor Guillet and M. Révillon. The experiments were not yet completed, said Professor Guillet, but the investigation made showed that in the case of steels, the resistance to shock having increased up to a temperature of about 200 deg. Cent., began to fall and passed through a minimum before again increasing. The temperature of maximum fragility was always the same, and equal to 475 deg. Cent., the temperature of incipient red glow, and not the so-called blue heat. It was the commonly accepted theory of fragility at blue heat which it was particularly desired to investigate. There was a maximum of resilience less fixed at from 150 deg. Cent. to 200 deg. Cent., depending upon the nature of the steel. No relation appeared to exist between the variation of the resilience and the transformation points of the steel.

The same authors also brought up the first results of an investigation into the application of modern testing methods to copper alloys, but the work is still far from being completed, and no rules of practical value can yet be drawn up.

M. Pierre Breuil contributed to the subject the conclusions drawn from tests whereby he had endeavoured to show the relations which exist between the results obtained by static and dynamic tensile tests. The special object was to ascertain whether tensile tests were, as had been asserted, really powerless to reveal brittleness in metals. In the opinion of the author it would be better to ascertain the brittleness of a metal by testing it in small bars—sectional area 50 mm.^{2} and a prismatic length of 60 mm.—by an impact tensile test. In that way it was possible for purposes of comparison to measure the elongation and contraction of the metal.

Comparative static and dynamic notched-bar bending tests were dealt with in a report by Messrs. A. Leon and P. Ludwik. It was stated that the results suggested that no uniform relation existed between static tensile tests and notched-bar impact tests.

Mr. P. Wélikhow, of Moscow, presented a paper on the rupture of normal cylindrical test samples by longitudinal impact. The author put in a plea that the impact tensile test should come into use side by side with the impact bending test.

As an outcome of the discussion on the general subject, and of the many points raised, it was decided that a typical method of testing by impact be established, which should be recommended by the Congress to be employed for purposes of comparison. The preparatory work of settling the various details of the method has already been done by the German Association, as indicated in Mr. Charpey's report, and the resolution moved suggested that this would serve as a basis for settling the standard method of testing. Stress was laid on the necessity of leaving a certain amount of latitude with regard to details, which there was no absolute necessity to fix rigidly. This typical method of testing having been determined, it was proposed that a Commission should be appointed to collate results for the purposes of comparison with the behaviour of metals in service.

The Cement Section of the Congress had before it a long series of reports on progress in methods of testing.

The Association had not, prior to the present Congress, adopted any of the testing methods of which the special committee have been making a study, but now that the committee have commenced to make recommendations definite steps are to be taken.

An excellent report was brought up by Professor F. Schüle on uniform tests of hydraulic cements by means of prisms and on standard sands. Special attention was directed in the report to the fact that the smaller strength figures given by the prism method corresponded better with the strengths which had to be dealt with in practice than the high degrees of strength of mortar of earth-moist consistency subjected to hard ramming. Further, the testing method with prisms gave the compression tests the importance which they deserved, which far exceeded that of the tensile and bending strength, whether by reason of their regard to regularity or of their practical importance.

The report presented by Mr. Bertram Blount on accelerated tests and the constancy of volume of cements was followed by a very controversial discussion, of which the echoes have not yet died away. Briefly, the committee which has had this investigation in hand asked the Congress to recommend the method of Le Chatelier as the standard accelerated test for the constancy of volume of cements. It had been shown, said the author in presenting the report, that no difficulty occurred with the Chatelier apparatus in comparatively rough use, and it was established in England as the standard method with which makers, users, and engineers were satisfied. Although at first strenuously resisted by manufacturers, it had now been unreservedly accepted in England. In his own practice, which included cements of every origin, this test had proved absolutely satisfactory to both buyer and consumer, and it presented no difficulty to the British maker, although it was true that German and American cement manufacturers had found it rather troublesome.

The recommendation to adopt the Le Chatelier test was only carried after a long discussion, and when at the final meeting of the whole Congress this sectional resolution came up for confirmation, although it was again carried, a formal protest was handed in on behalf of German manufacturers and consumers.

This was the notable feature of the discussion on the cement reports, but reference should be made to a contribution by Professor Constant Zichenski on the development of the setting of Roman and Portland cements in paste, in mortars, and in concrete, which contained much valuable information.

The question of standard sand for testing came up for discussion, and it was decided to establish a Commission to investigate the subject with a view to specifying a uniform standard sand for different countries, or if that were not found possible, to define the difference between the various standard sands in the countries interested.

An interesting group of papers was that which related to the weathering resistance of building stones. The subjects dealt with were influence of frost on natural stones, schemes for testing natural building stones, and the determination of the longevity of stones. A number of reports also came before this section, these including a report on the new German standards for the uniform testing of Portland cement.

In the section to which under the general description of " Sundries " all other questions were relegated, there were four reports and papers dealing with metallic structures. Profs. Heyn and Bauer were jointly responsible for a paper on the corrosion of iron in water and aqueous solutions. The paper cited the two essential factors which determined corrosion as the presence of the water in its liquid state and of oxygen. The presence of carbon dioxide was not essential. It was necessary, therefore, to exclude oxygen. The paper discussed the whole subject at considerable length, and the results were given of comparative experiments on the action of various liquids in furthering the corrosion of iron at ordinary temperatures. Certain generally accepted theories, notably with regard to the alleged protective effect of sodium carbonate, were challenged, and chromic acid and its salts were stated to be the most efficient protection against the rusting of iron. Finally, the author discussed the electrolytic potential differences between iron and various solutions. Following this came an excellent little paper on "Rust-preventing Paints," by Mr. E. Camerman, of the Belgian State Railways.

The other papers included a *résumé*, presented by Mr. S. S. Voorhees, of work done by the American Society for Testing Materials on preservative coatings of iron and steel. The experiments were referred to as not being sufficiently advanced for positive recommendations to be issued, but the belief was expressed that they would give valuable information at an early date. The tests being made under normal conditions include the painting by nineteen manufacturers of the Pennsylvania Railroad Bridge over the Susquehanna River at Havre de Grace, and panel tests at Pittsburg and Atlantic City.

Mr. G. Cruickshank Smith, who read a paper on " Protective Coatings " before the last spring meeting of the Iron and Steel Institute, asked the Congress to investigate the subject on international lines, the results to be submitted to the next triennial Congress. He admitted the expense of the work, but hoped that, in view of its importance, grants would be furnished from scientific, industrial, and public bodies. Mr. Cruickshank Smith was not present in person to advocate his views, and the section of the Congress to which the proposition was submitted declined to entertain it, being generally indisposed to extend its sphere of operations. It was decided, however, that the fouling of the hulls of ships should be investigated at Gross Lichterfelde.

Other topics before this section were the present status of timber tests in the United States, introduced by Professor W. H. Hatt. The paper was limited to a presentation of the conclusions derived from the various studies in which the strength of the wood is determined, and it found a vigorous critic in a Japanese delegate, who made a statement as to what was being done in this connection at Tokio.

The report of Dr. Max Albrecht on the supply of oils for technical applications opened up a short discussion. Mr. Camerman brought before the Congress a description of a method of testing the percentage of a given specimen of oil which would be available for use in lubricating the walls of a cylinder into which it was introduced—that is to say, the amount remaining after the evaporation of the quantity carried away by the steam. The test could, Mr. Camerman stated, be quite easily conducted in any laboratory, and would give results closely approximating to actual practice. Some oils used commercially for steam cylinders were found to contain no less than 60 per cent. of actually available lubricant at the temperature of the cylinder. The tests brought out an enormous difference in the percentage of lubricant available, thus ranging from a very low figure indeed up to 60 per cent. in the case referred to. In the tests the oil was heated to a temperature of 400 deg. Fah. for six hours.

A subject which created considerable interest was raised by Dr. W. Exner, of Vienna, in a short statement on the international regulation of technical testing. The heads of the address were a review of the laws relating to particular branches of testing, and the legal definition of the nature of the certificates to be issued as public documents by the testing establishments and State regulation. Dr. Exner, in this latter connection, proposed an extension of the Austrian law by international agreement. He urged in brief the suppression of the private testing establishment, basing his views on the undesirability of testing on which the lives of workers and the public depended being entrusted to establishments working for profit. Dr. Exner, in particular, strongly urged the creation of State testing establishments for power vehicles. No definite action was, however, taken in the matter, although the importance of the subject was generally admitted.

The other matters discussed in this section were the mechanical testing of caoutchouc, of soft rubber, and of paper. Some surprise was expressed in certain quarters that no action has yet been taken by the Association with regard to the testing of yarns, threads, and textile materials generally. The matter is stated to be one of considerable interest to the British industry, and more will probably be heard of it in the near future.

At the final meeting of the Conference on Saturday, September 11th, Mr. J. E. Stead gave a lecture, an abstract of which will be found in later issue, on the application of the microscope to the workshop and the foundry. A number of formal resolutions, of which the more important have been referred to in the report of the Congress, were confirmed.

Mr. Alex. Foss, the President, in referring to the losses by death sustained by the Association since the last Congress, made a sympathetic reference to the death of Mr. Bennett H. Brough, and lauded his efforts to create interest in the work of the Association in Great Britain.

It was announced that the Triennial Congress in 1912 would be held in the United States, and Dr. C. B. Dudley, the President of the American Society, was elected President of the Association in succession to Mr. Foss, who, in consideration of his services during the past three years, was made a life member of the Association.

VISITS TO WORKS.

The programme for the concluding days of the Congress included an inspection of the machine shop and shipbuilding yard of Messrs. Burmeister and Wain. These comprise a dockyard with a dry dock 146.5 m. long, a floating dock of 11,000 tons capacity, and three building slips, on which, among other boats, the large train ferry steamers of the Danish State Railways have been built. The machine and engine departments are well equipped with modern plant, and the output includes steam turbines of the Parsons type, Diesel engines, and dairy machinery. A good deal of work was in hand when the visit was made, and much interest was shown in a marine engine being built for use with highly superheated steam, to which drop valves were being fitted. The other shops include a foundry, steel works, and smith's forge, with hydraulic presses up to 2000 tons capacity. The works have to import coal and pig iron, but export bar iron to England, Germany, Russia, and other countries.

The State Testing Laboratory, also visited, has been in existence since 1896, but until the present year, when it was taken over by the State, was maintained by the Danish Association of Civil Engineers. Previous to 1896 there had only been a laboratory for testing cement. The State laboratory is under the direction of Professor H. I.

EVAPORATIVE CONDENSER AT BERMONDSEY

EDWARD DEANE AND BEAL, LIMITED, LONDON, ENGINEERS

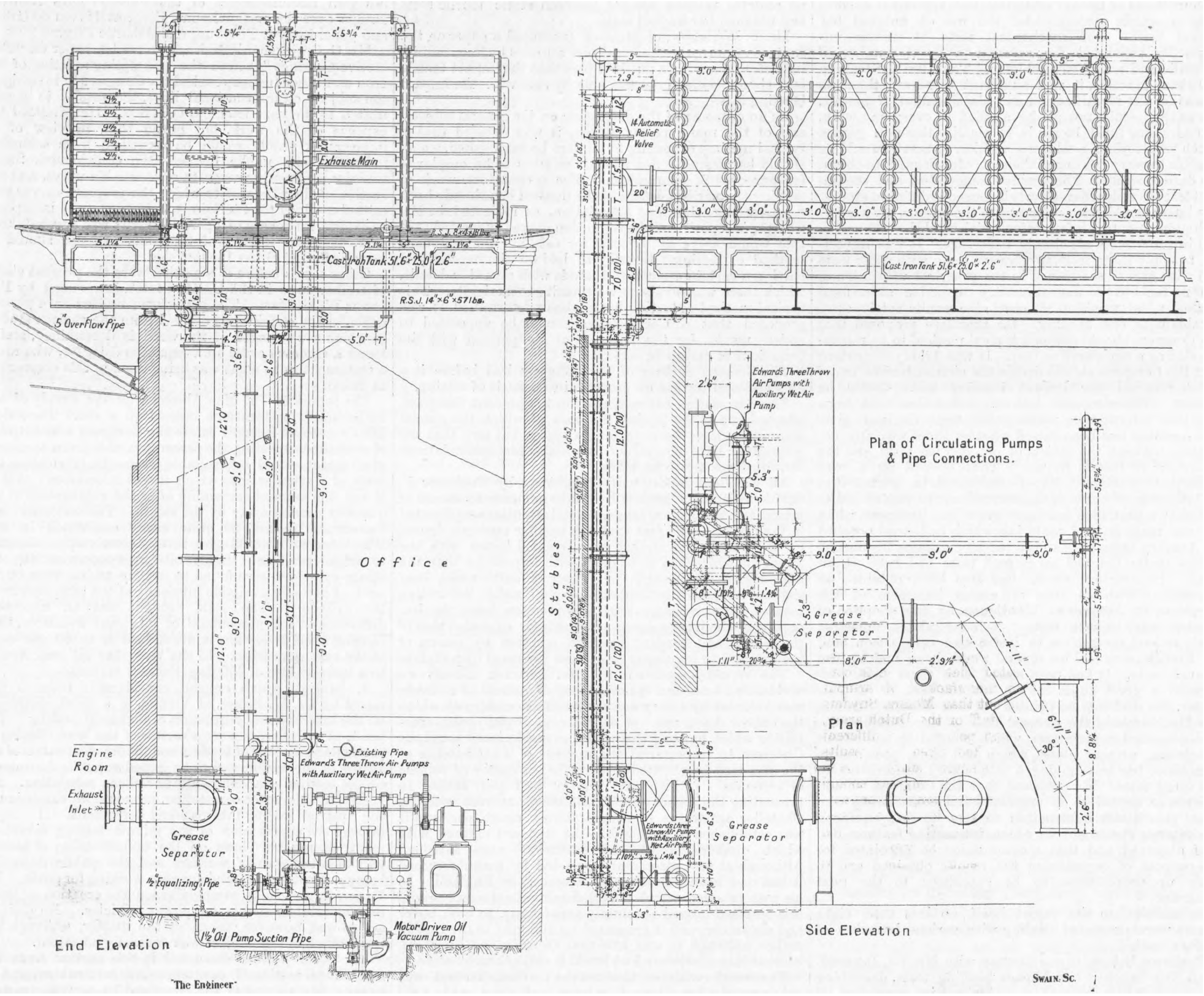

Exhaust Main
Cast Iron Tank 51.6" × 25.0" × 2.6"
R.S.J. 14" × 6" × 57 lbs.
5" Overflow Pipe
Office
Engine Room
Exhaust Inlet
Grease Separator
½" Equalizing Pipe
Existing Pipe
Edward's Three Throw Air Pumps with Auxiliary Wet Air Pump
1½" Oil Pump Suction Pipe
Motor Driven Oil Vacuum Pump
End Elevation
The Engineer
14" Automatic Relief Valve
Stables
Edwards Three Throw Air Pumps with Auxiliary Wet Air Pump
Plan of Circulating Pumps & Pipe Connections.
Grease Separator
Plan
Grease Separator
Side Elevation
Swain Sc.

Fig. 1—GENERAL ARRANGEMENT OF CONDENSER

Hanhover, and has carried out some important work on rust prevention and on the application of infusorial earth in brick manufacture. The laboratory is a fairly extensive one, but is cramped for space, both on the chemical and the mechanical side. The cement testing plant is very complete, but the equipment otherwise may be described as of the generally useful type. The Polytechnic Academy dates back to 1829. Here there is an excellent equipment, and the physical collection is well known. It includes the Orsted magnetic needle. Among the instruments inspected was an ingenious arrangement for calibrating indicator springs by an absolute dead-weight method.

A large party numbering several hundreds participated in the visit to the Harbour of Copenhagen. The narrow waterway between Sealand and the Island of Amaget, and the channels separating the various islands constitute a natural harbour, which has been improved and extended from time to time. During recent years large new areas have been absorbed into the harbour both north and south, and extensive works were undertaken last year. The dam constructed at the southern entrance has largely increased the area of the harbour to the south. The regulation of the current, there being no tides, is through sluices. The depth of water in the main channel is about 28ft. A feature of the harbour is to be noted is its bridges. The Langebro is a swing bridge which was opened in 1903. The swinging span, of 67 m., weighs 850 tons, and is lifted 85 cm. by hydraulic pressure. Double tracks for tramways and railway wagons have been laid. Knippelsbro, opened in 1908, is a bascule drawbridge, the channel being too narrow for a swing bridge. The Strauss method of construction has been employed. The visit to the harbour was followed by a very largely attended dinner at Skodsborg, whither guests were conveyed by steamer.

The final visit was to Elsinore, where the shipbuilding yards were visited. The yard has built ferry steamers for the Danish services.

Following the visit to Elsinore a farewell dinner was held at Marienlyst.

OIL FUEL IN THE NAVY.

It is now known that the Admiralty have decided to return to the use of liquid fuel for destroyers, and the vessels recently ordered will probably all be fitted for its use. Why there should have been the sudden suspension of oil fuel and then a return to it after a brief interval is not very obvious, but it is probably not unconnected with the oil market, which is subject to more or less violent fluctuations. Presumably satisfactory contracts have been entered into for some years ahead, and the stores in the large Admiralty tanks must now be accumulating, as a good number of the tanks are already complete. In view of the fact that results have been obtained with oil fuel which could not be approached with coal, it is a matter for congratulation that the Admiralty have seen their way to return to its use.

University of London.—The following courses for engineers in practice and graduates in engineering have been arranged :—(1) "Steam Turbines," by W. J. Goudie, B.Sc., and E. G. Izod. (2) "Railway Engineering," by H. Deans, M. Inst. C E, of the Great Western Railway. (3) "Waterways, Harbours and Docks," by A. T. Walmisley, M. Inst. C.E., Engineer of Dover Harbour. (4) "Roads, Street Paving, and Tramways," by W. N. Blair, M. Inst. C.E., Borough Engineer, St. Pancras. (5) "Recent Methods and Instruments in Surveying," by M. T. Ormsby, M. Inst. C.E.I. (6) Water Supply, Sewerage, and Lighting," by Reginald E. Middleton, M. Inst. C.E, M. Inst. Mech. E. (7) "Municipal Hygiene," by Professor Henry Kenwood, Medical Officer of Health, Stoke Newington. (8) "The Ideal Arch, Metal and Masonry, Theory and Design," by Professor Karl Pearson, F.R.S. (9) "Electrical Design," by H. M. Hobart, M. Inst. C.E., M. Inst. E.E. In connection with the opening of the session a public introductory lecture will be given on Wednesday, the 6th inst., at 5 p.m., by Professor J. A. Fleming on "Electrical Inventions and the Training of Electrical Engineers." The chair will be taken by Mr. W. M. Mordey.

Manchester Association of Engineers.—We have received a copy of the syllabus of the fifty-fourth discussion session of the above Society. On October 5th by invitation of the President, Mr. J. H. Stubbs, a conversazione is to be held in the Whitworth Institute, and on October 9th Mr. Stubbs will deliver his presidential address. "The Mechanism of Cotton Spinning, &c., Machinery" is the title of a paper to be read on October 23rd by Mr. W. H. Cook; Mr. J. N Bailey will read a paper on November 13th on "The Exhaust Steam Turbine ;" Mr. G. J. Wells is down on the list for a paper on November 27th on "The Design of a Winding Engine ;" on December 11th Mr. J. S. Peck will read a paper on the "Control and Application of Electric Power ;" another textile engineering paper will be read January 8th, 1910, by Mr. Frank Nasmith on the "Mechanism of Weaving Machinery;" and on January 22nd there will be a paper by Mr. G. B. Storie on the "Application of the Steam Turbine to the Driving of Textile Mills." The anniversary dinner will be held on February 11th ; on February 26th Mr. Percy Longmuir is to read a paper on "Steel Foundry Practice ;" on March 12th Mr. James Robinson will contribute a paper on "Calico Printing ;" and the concluding meeting of an interesting session will be held on March 26th, when Mr. A. Etchells will read a paper on "Hydraulic Machinery."

THE CONSUMMATE EVAPORATIVE CONDENSER.

An example of what is called by its makers, Edward Deane and Beal, Limited, of 676, Old Kent-road, S.E., the Consummate evaporative condenser has for some time now been working at the Bermondsey electric lighting station. We were recently invited to inspect this plant, and were enabled to do so by the courtesy of Mr. W. E. J. Heenan, the electrical engineer to the Borough of Bermondsey, to whom we are also indebted for certain figures of tests and costs which we give later on in this article.

Speaking generally, this condenser consists of a number of gilled tubes placed with their axes horizontally and arranged vertically in tiers one above the other. Alternate ends of each tier of pipes are connected together with headers, so that what is practically a continuous coil of tubes from top to bottom is formed. Each horizontal tube is divided into two parts in the middle, and the ends at this point are brought into contact with one another, being so made that where they butt together a sort of intercepting chamber is formed—see Fig. 4. The pipes are also slotted on their lower sides where they butt together, so that a small drainage aperture is formed for the escape of the condensed water. The intercepting chambers of each tier of tubes are all connected by a vertical pipe, and all the vertical pipes from the various tiers of tubes are in their turn connected to a common discharge pipe which leads to a wet air pump. Consequently, the condensed water as it is formed is withdrawn from the system and is delivered to the hotwell at a temperature of about 128 deg. Fah. All the horizontal tubes are laid with a slight fall towards their respective intercepting chambers, so that the condensed water may drain to the latter.

The tubes themselves are heavily gilled, these gills being peculiar in that they are placed excentrically to the axis of the bore, and so that the invert of the tubes is smooth. The shape of the corrugations may be seen in Fig. 4. The manufacturers make a point of this, claiming that all the water will drain away as it is condensed, and that none will remain stagnant in the pipes, as is the case in those pipes in which the corrugations are concentric with the axis of the bore.

The cooling water is circulated by means of a centrifugal pump capable of delivering 25,000 gallons of water per hour, This draws its supply from a reservoir arranged under the condenser, the latter being, in fact, carried by the former. This tank or reservoir is made of cast iron and measures 52ft. 6in. in length, 25ft. in width, and 2ft. 6in. deep. It is kept filled with water to a depth of about 20in., so that it contains some 13,650 gallons of water. The circulating water is distributed over the condenser tubes by means of a system

CONDENSING PLANT AT THE BERMONDSEY SUPPLY STATION

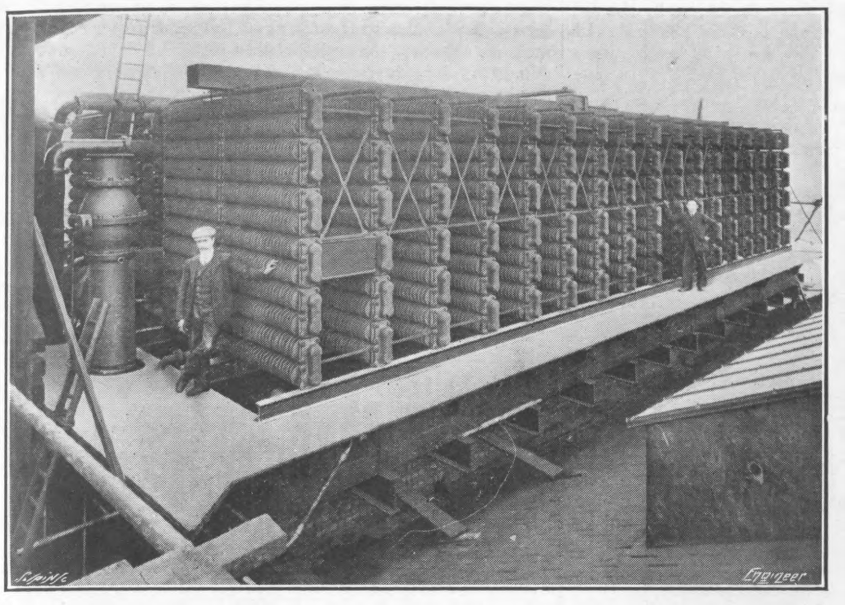


Fig. 2—THE CONDENSER

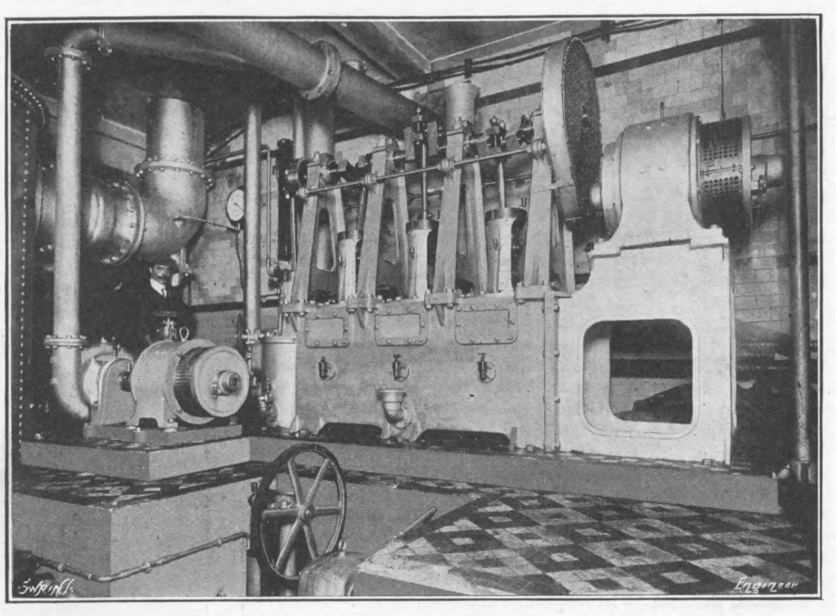


Fig. 3—THE PUMP-ROOM

which differs little, if at all, from that in common use.

The condenser consists of 812 of the excentrically corrugated tubes, arranged in thirty-four coils, forming two groups or batteries running the full length of the tank, with an intervening space for the exhaust main and connections.

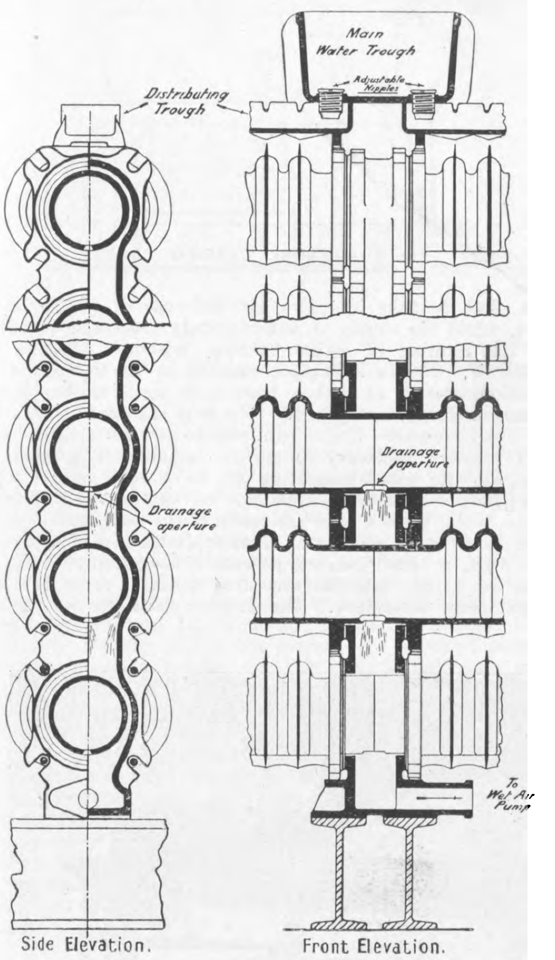
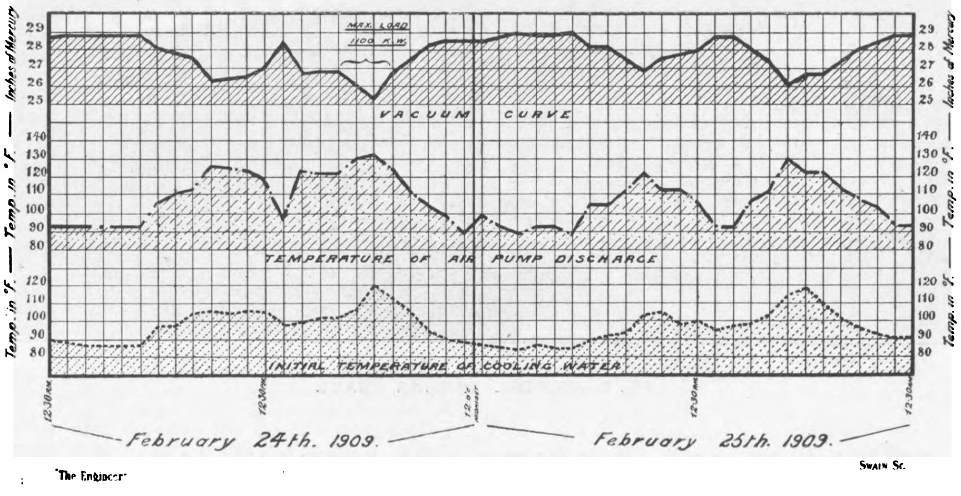


Fig. 4—CONDENSER TUBES

Each battery is carried by four lines of rolled steel joists resting upon supports within the tank. It will be observed from the drawing—Fig. 1—that the steam enters the condenser tubes at the bottom. At this point the condensing water is hottest. As the steam gradually finds its way up through the coils, it traverses tubes over which is flowing water which is less and less warm, until, in the top pipe, the coldest available water is flowing over it.



"The Engineer" Swain Sc.

Fig. 5—CURVES SHOWING THE WORKING OF THE CONSUMMATE CONDENSER

It might have been thought that, as each horizontal condenser tube has an opening leading into the central vertical drainage pipe, there would be short-circuiting, and that uncondensed steam would find its way into this pipe, and away direct to the dry air pump. This, however, does not happen, or not to a great extent at any rate, for the steam certainly traverses succeeding rows of horizontal tubes, as can be readily told by the feel.

The exhaust steam is taken away from the engines in a 20in. main, which, first of all, is led to an oil separator of the baffle type. To the outlet from the separator is coupled a stop valve, and from this a main is taken up from the engine-house floor to the roof, on which is fitted the condenser—see Figs. 1 and 2. Here it terminates in an automatic relief valve of the direct lift balanced water-sealed type. A branch pipe is led from it to a riveted steel receiver, which is fixed between the two batteries of coils. Each opposite pair of coils is connected by its lowest tube with the underside of this receiver by means of a breeches pipe. At the top of the condenser, and also between the two batteries of coils, an 8in. diameter cast iron vapour main is fixed, and to this the uppermost tube of each coil is connected. This vapour main is run down to the pump-room beside the exhaust rising main, and is coupled by means of a three branch pipe to the suction side of the dry air pumps.

The pump-room equipment comprises a set of motor-driven three-throw dry air pumps of the Edwards type—see Fig. 3—with a single wet air pump attached to the same bed-plate; a motor driven centrifugal pump for the circulating water, and a small motor-driven vacuum pump for exhausting the oil and grease from the separator. The dry air pumps are 12in. in diameter, and have a 10in. stroke, and run at about 378 revolutions per minute, being coupled by gearing to a 12 horse-power electric motor running at 800 revolutions per minute. The wet air pump dealing with the condensed water has a cylinder diameter of 10in. and a 6in. stroke. It is driven by a disc crank keyed to the outer end of the main pump crank shaft. The circulating pump is directly coupled to a 5 horse-power motor running at 800 revolutions per minute.

We are enabled to reproduce in Fig. 5 a curve compiled from figures obtained by Mr. Heenan during a forty-eight hours' test of this condensing plant. The vacuum at its highest point was just over 29in., and at its lowest about 25½in. At this point the condenser was overloaded to the extent of some 10 per cent. The actual rated capacity of the plant is 25,000 lb. of steam dealt with per hour. With this load the makers guaranteed a vacuum of 25in., and a hot well temperature of 128 deg. Fah., the cooling surface provided being at the rate of 1 square foot per pound of steam condensed.

SHIPBUILDING NOTES.

THE statement that several vessels are to be built on the Isherwood system of construction has directed attention again to the progress which this particular system is making in the favourable estimation of owners. It is now about two years since Mr. Isherwood introduced the design associated with his name, and in that time the total number of vessels built, or to be built, is already twenty, aggregating 70,000 tons.

THESE are remarkable figures when we consider the immense difficulty of effecting even moderate changes in the present methods of using material in the hull. The permanence of these methods is, indeed, astonishing. In the past, when such changes have been effected, there have usually been contributory causes which have served to explain, to a certain extent, the success which has attended them. Thus, when turret and trunk vessels were first built, their claims were supported by powerful firms, who made a speciality of their particular design. These vessels, moreover, do not represent any departure in principle from the usual methods of transverse shipbuilding. No practical attempt has been made to effect a decisive departure from the transverse disposition of the supports to the shell plating until the present, and when one finds so substantial a tonnage being built in such a comparatively short time, one is forced to the conclusion that, whatever structural merits the new system possesses over the old one, a substantial saving in weight must be effected. On no other ground can its preference by owners be explained, the cost of construction being practically the same as in the case of its transverse rival.

THE statement that Messrs. Lamport and Holt, of Liverpool, have purchased the iron sailing vessel Kentmere, built in 1883 by Potter and Son, Liverpool, and intend to use her as a coal depôt in the Straits of Magellan, reminds us of the wonderful resistance to decay offered by the iron manufactured thirty years or so ago. We know of many cases where the excellent condition of old iron ships undergoing survey has excited general remark. It is now an exceedingly common practice to specify those parts of a vessel especially liable to corrosion to be of iron—for example, the parts of the inner bottom under the boilers, bunker plating, and, in some cases, deck and stringer plates. It must not be forgotten, however, that the commodity now sold under the name of "iron" differs very considerably from the material used in the construction of iron vessels before the introduction of steel. The results of tests, more particularly the elongation now to be obtained in the case of "iron" specimens, provoke the suspicion that it may not differ very much in its structure from steel. It is, perhaps, dangerous to run counter to the very generally accepted view that modern iron resists corrosion better than mild steel, and yet it may be well to bear in mind that when iron is used, say, in a stringer plate, it is considerably thicker than the steel plate whose place it takes. At the same rate of corrosion the plate can thus remain longer in the vessel without requiring to be renewed, and frequency of renewal—without reference to initial thickness—is very often the standard by which the practical man judges of the capabilities of the material to withstand decay.

ONE of the notable launches of the month took place from Messrs. Palmer's yard at Jarrow, when the British torpedo-boat destroyer Viking was placed in the water. The dimensions of the vessel are 280ft. by 27ft. 3in. by 17ft., and she is propelled by Parsons turbines at a maximum speed of 33 knots—four knots more than the speed required for the destroyers recently placed. The boilers are of the Yarrow type, and, like many of the later destroyers, are adapted for oil fuel. The number of merchant vessels burning oil fuels in their boilers is, it may be remarked, steadily on the increase. Nearly all oil ships now use it, and the practice is very common in American vessels. In some cases the fuel oil is carried in deep tanks at the sides of the boilers, and in others in the double-bottom compartments.

THERE has been some considerable discussion lately, produced no doubt by a recent case of ship disappearance, on the stability of merchant steamers. A point that seems to escape the attention of some writers on the subject is that excessive rolling is not necessarily indicative of deficient stability but rather of a superfluity of it. When an ordinary cargo vessel is in the light condition she usually rolls very heavily, yet in that condition her initial stability is great, since the displacement is small, and the range is also great, due to the extent of side out of the water. The ship in this condition, with a large reserve of stability, may be represented popularly by a pendulum having a long length and a correspondingly great amplitude of vibration. It is rather unsatisfactory to reach conclusions on this subject from an observance of external conditions. The indispensable factors are a knowledge of the vessel's form and displacement, of the disposition and magnitude of the loads carried —and of the principles upon which the theory of stability is based.

A CORRESPONDENT raises the question of the effect of the recent revision of the Load Line Tables upon merchant ships. In the course cf his letter he writes:—"In these conditions, in order that our ships may be better able to meet the competition of foreign shipping, a little more than a year ago we wiped out by a stroke of the pen the legislation for which Plimsoll fought, and in the place of it set up the law of Mr. Lloyd George. It will interest some of your readers to know how the 'Lloyd George load line' was determined, and how it affects the safety of the ships and their crews." It may be pointed out as a mere matter of fact that the revision of freeboards actually took place in the early part of the year 1906, that the proposals had engaged the attention of the Board of Trade for a considerable time prior to that, and that, although they were legally authorised in the lifetime of the present Administration, it is probable that Mr. Lloyd George's predecessor had as much to do with them as he had. Apart from that, however, it is not correct to say that by a stroke of the pen the legislation for which Plimsoll fought was wiped out, for in many cases no reduction was made, and the alterations themselves were effected in consonance with the spirit and principles of the old Freeboard Tables. But, it may be asked, why were these alterations made? In the first place, the tables for assigning freeboard were framed in the year 1885, and provided for flush deck vessels of a certain standard of strength. When erections were fitted on these flush deck vessels, certain allowances were made in respect of these erections. Now, in 1885 the erections fitted were, for the most part, of small lengths and of light scantlings. Since then, however, much has happened. The vessels of the present day have embodied in them methods of construction which were not known in those early days. Ships are now more scientifically built, and, therefore, are stronger than they were. Deck erections, too, have been increased in length, and made strong and integral parts of the hull. Sometimes these strong erections extend over the whole length of the ship, and we have the strong shelter or awning deck vessel. It is surely obvious that conditions so changed were a sufficient warrant for the reconsideration that took place. Accordingly we find that the alterations actually made took effect on those cases to which we have referred—vessels with long erections, substantially constructed, the product of modern conditions of trade. The flush deck standard was still kept as the standard, but concessions were made to vessels having these strong superstructures; but, as before mentioned, there were many vessels which had their draught of water quite unchanged. As regards the effect of the alterations upon the safety of the ships and their crews, it may be said at once that up to the present no injurious effect is visible. Loss of life and property at sea has not been any more pronounced during the past three years than formerly, and the satisfactory experience of the Germans in respect to their reduced freeboards has thus been confirmed.

THE GASSING OF YARNS.

MOST large industries involve the use of some process which is open to objection from a hygienic point of view. In the textile industry the process known as "gassing" may be taken as an example, although in recent years remarkable improvements have been effected in the conditions under which the operatives have to work, as well as in the speed and quality of the material turned out. The term "gassing" is applied to the process of burning off the ends of fibres or "ooze" on the different kinds of yarns. Although the operation is not necessary with the yarns used for the production of the commoner classes of cotton fabrics, it is usual in the case of yarns intended for the manufacturing of lace goods, in order to give the yarns a firmer, smoother, and more lustrous finish. The operation has to be carried out without materially reducing the strength of the yarn, and necessarily involves a certain amount of discoloration of the latter, which, though unavoidable, has to be limited in extent and uniform. Coal gas, being generally available, is chiefly used for the operation, but other fuel, such as Mond gas, oil gas, acetylene gas, can be utilised. More recently a frame has been devised in which electricity furnishes the necessary heat for treating the yarns. Whichever process is used, a certain amount of dust is given off with the products of combustion, while the employment of gas, even under the best possible conditions, is generally attended by more or less leakage. In treating cotton the yarn is caused to pass rapidly one or more times over or near to a flame produced by burning a mixture of gas and air in various kinds of burners. In running the yarn from bobbins the speed of unwinding is limited by the tension which the material will stand in pulling round both bobbin and spindle. Formerly a yarn speed of from 180ft. to 230ft. per minute was usual, but speeds much higher are now possible with the improvements recently made in gassing frames, while the developments that have taken place in the design and construction of burners enable a considerable economy to be effected in the consumption of gas.

Exhaust ventilation for the removal of injurious fumes and dust is required under the Factory and Workshop Act wherever any process is carried on by which dust, gas, vapour or other impurity is generated and inhaled by the workers to an injurious extent. For this purpose it is necessary to apply the exhaust so that the dust or fumes shall be carried away at or near to the point of origin, and so prevent them from diffusing into the atmosphere breathed by the workers. In a method adopted in some factories with satisfaction, the air is drawn directly from the outside and conveyed to the gassing frames in channels underneath the floor. Branching out of the main channel there is a separate channel to the end of each gassing frame, and from this point the fresh air supply is taken forward by a sheet iron trunk. This trunk diminishes in size until it reaches the far end of the gassing frame. Air outlets are arranged alternately on each side of the trunk, and each has a controlling grid. This arrangement helps to secure an equal distribution of the entering air and avoids draughts. For cold weather steam radiators are provided to warm the entering air. The removal of the vitiated air is effected by means of fans in the roof. The chief objection to this arrangement is that the fumes and dust are not taken off near the point where they are formed. In another arrangement, which has been adopted in a mill, the air currents travel from the ceiling to the floor. Under each gassing frame there is an air trunk with openings of sufficient number, through which, by the aid of a mechanically-driven fan, a current is caused to draw the fumes and particles of dust from the breathing level. This method has the same defect as that referred to in the previously mentioned system.

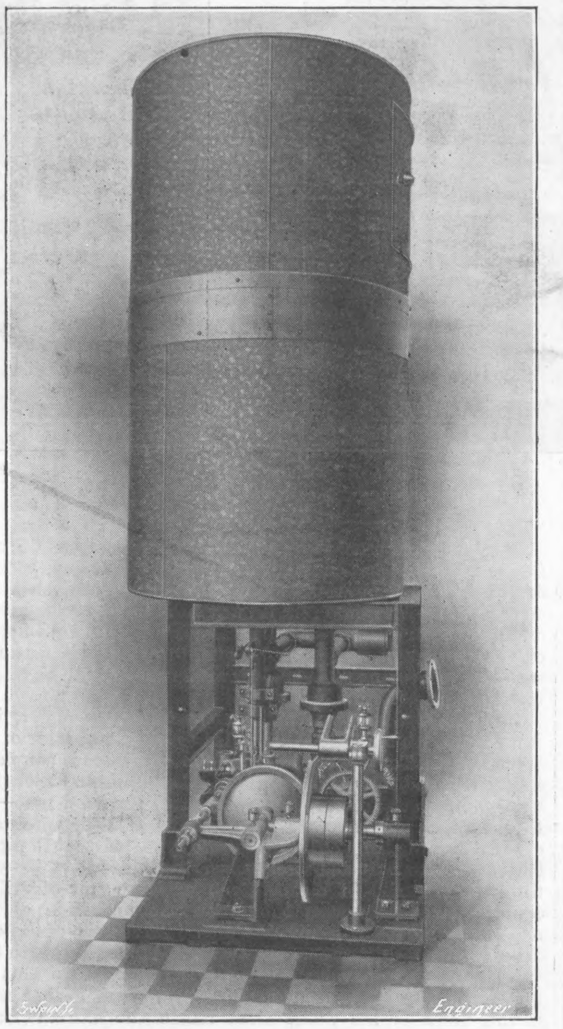


Fig. 1—ARUNDEL GAS REGULATOR

Mr. Verney, a Home-office inspector, recommends a system in which the exhaust is quite local, the dust and fumes being drawn off immediately on formation. Over each of the two rows of gas jets he provides a duct with adjustable slits on the under side. These ducts deliver into a reducing box and a down pipe at the end of each frame, and thence into a trunk, from which the air can be exhausted by means of a centrifugal fan. If special inlets for the pure air are required, similar ducts can be provided under the jets with slits on the upper sides. A current of fresh air would be induced through these inlet ducts by the action of the exhaust fan. If necessary, however, an impelling fan can be applied to the fresh air ducts. In all cases it is advisable that the air inlets should be under the frame and as large as possible, so that the incoming air will have a low velocity. Coal gas from the local supply mains is generally used for the burning off of the loose ends of the yarn. A difficulty encountered in the employment of the gas direct from the supply mains is introduced by the variations of pressure in the mains causing a non-uniform flame, and making it difficult to keep the work of equal quality. To obviate this makers of gassing frames have had to resort to means for delivering the gas, or a mixture of gas and air, at a constant pressure to the burners. One firm of gassing frame makers, Messrs. Arundel and Co., Stockport, makes an apparatus for supplying gas and air in definite proportions to the burners. We give an illustration of this plant in Fig. 1. It has separate positive blowers for the air and the gas. These are connected by a train of spur gear wheels, which can be changed to vary the relative speeds of the blowers, and hence the proportions of the air and gas. Above the blowers is a tank with separate water-sealed compartments for air and gas. The usual working position of this tank is at half lift, free to take in more air and gas or to give some out, while the supply is automatically regulated according to the number of lights burning without affecting the pressure; the tank being connected so as to operate the friction gearing in such a manner as to drive the blowers faster or slower as required. The tank is loaded to give the required pressure—7in. to 8in. water—so that at the frame the pressure necessary to get the amount of air and gas through the small measuring nozzle in each burner top is enough to be read on a gauge. So long as the mixture is reliable this gives a good indication of the heat, and it allows the flames to be regulated. This appliance is also applicable to oil gas or Mond gas, and permits of the pressure of the gas and air being regulated according to the "count" of the yarn under treatment. The makers claim for its use not only an economy in gas but also a higher speed of operation.

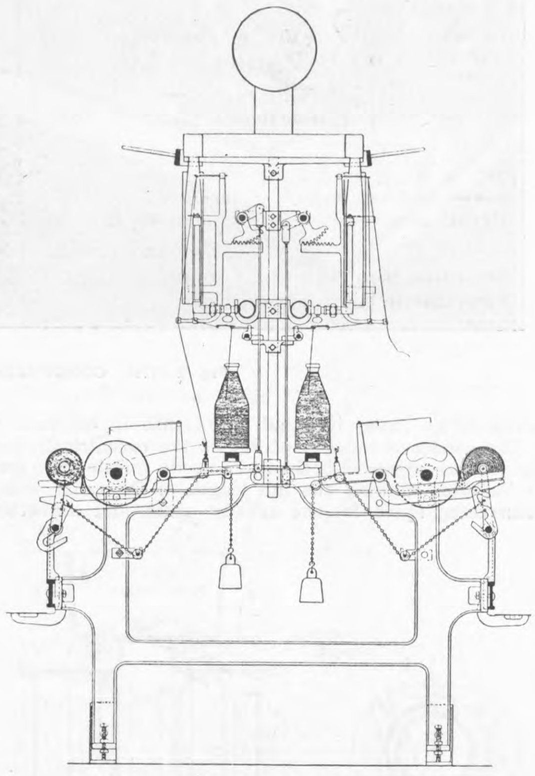


Fig. 3—ARUNDEL GASSING FRAME

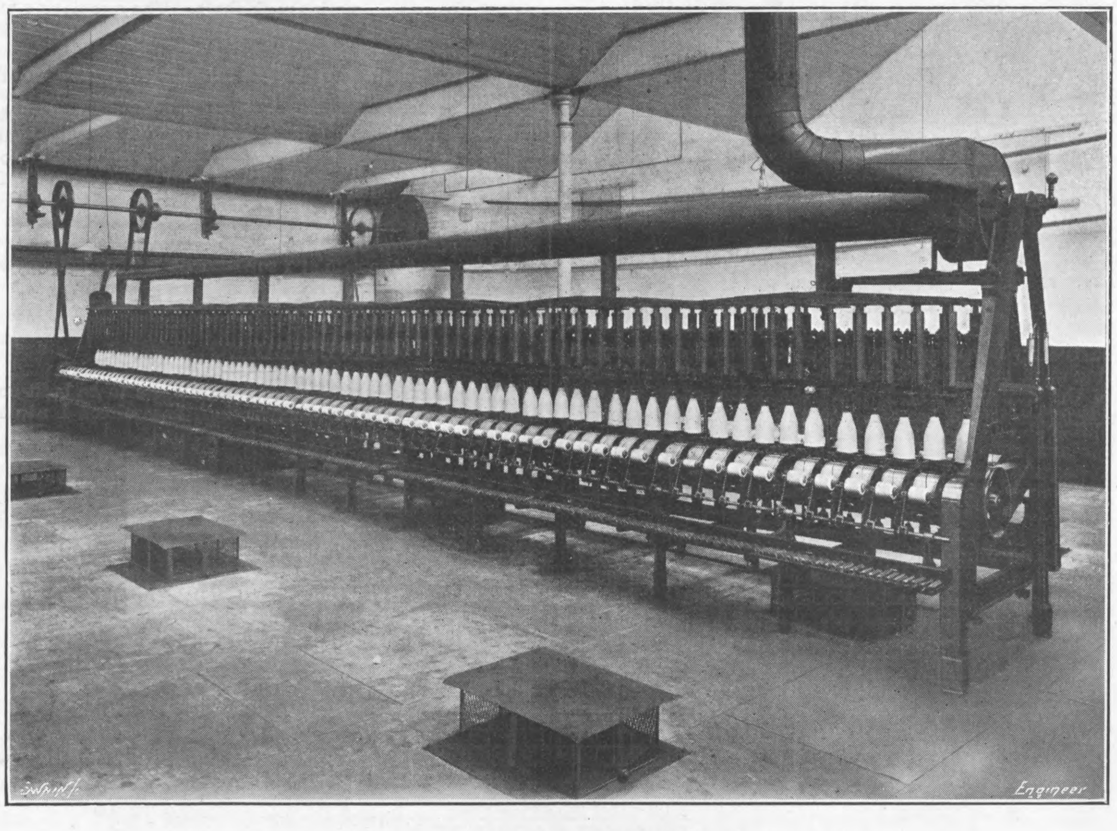
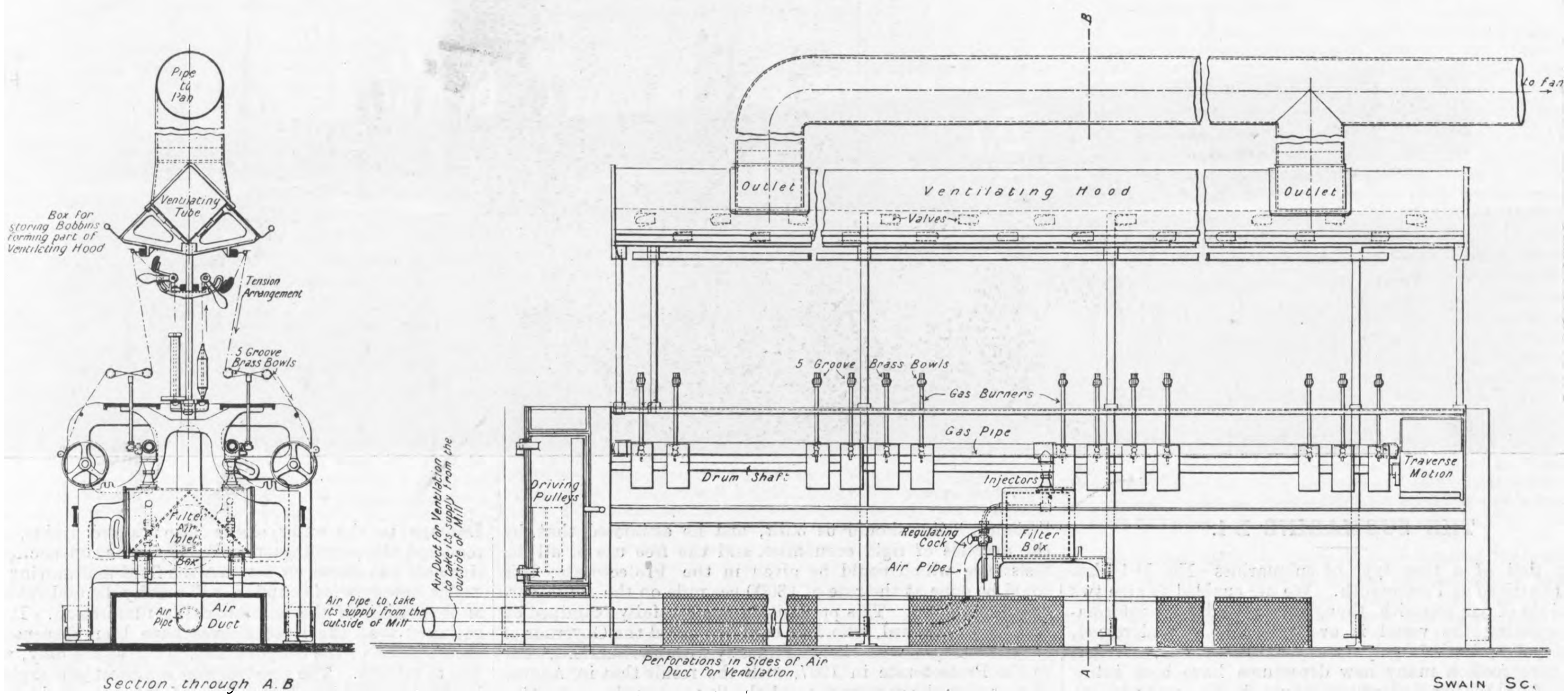


Fig. 2—ARUNDEL GASSING FRAME

In Figs. 2 and 3 we give illustrations of the most improved form of gassing frame made by Arundel and Co. In this machine yarn speeds of 700ft. and over are possible, and vertical burners are used. These consist of a vertical tube having a number of small holes or a long slit through which the gas and air mixture is forced and ignited. The burners are surrounded by a vertical split tube or combustion chamber, which is connected with a ventilating arrangement above. The mixture of air and gas is led along the frame on each side by pipes, from which connection to the burners is made by taps fitted with measuring nozzles. The yarn is guided upwards vertically through the flame, and its direction is then completely reversed, and it is claimed that this arrangement causes the burnt fibres to assist in singeing off those on the upper part of the yarn, with a more complete combustion of the dust produced during the process. It will be observed that the system of extraction of the products of combustion and burnt fibres is good, as the burners are surrounded by a current of air flowing upwards through the combustion chamber into the extraction shaft, which is, of course, provided with a fan. In the transverse sectional view will be seen the motion for moving the burner from the yarn, which acts simultaneously with the drawing of the spool from the drum.

The frame illustrated in Fig. 4 is arranged for the use of intensified gas, and represents the latest practice of Mr. Joseph Stubbs, Ancoats, Manchester. In this appliance the gas from the town's mains is intensified by means of a rotary blower to a pressure equal to a column of water 32in. high. The gas is conducted by the pipe shown through a regulating cock into the underside of an injector which is fixed in the air-box, and the proportions of air and gas are regulated by means of adjustable nozzles. The air is introduced at atmospheric pressure preferably from the outside of the building, and is drawn through the pipe which is connected to the filter-box. The latter is of triangular section, and is fitted with perforated metal plates to prevent the admission of dust or dirt into the burners. From the injector the mixture of air and gas in the correct proportions to ensure perfect combustion passes into the longitudinal main gas pipe to which the series of burners is attached. The burners are of the box pattern, with a series of narrow slits arranged transversely to the run of the yarn, and are each carried at the end of a piece of tubing, the other end of which fits into a gas cock. These cocks are mounted on swivel joints to enable the burners to be moved out of the way of the yarn to facilitate piecing in cases of breakage. The yarn passes backwards and forwards through the flame a number of times, sometimes as many as nine, depending upon the quality of the finish required. Ventilation is effected by means of the wrought iron canopy shown. This extends the whole length of the frame, and contains an inner sheet iron duct, which is connected at suitable distances by outlet branches to a flue from which the air is exhausted by a fan. Extending along the lower surface of the ventilating tube are numerous small flaps, shown in the illustration. These are stamped out so as to be easily regulated according to the distance they are situated from the exhaust branches. Extending along the floor underneath the frame throughout its whole length is a perforated duct, by which fresh air is admitted from the outer atmosphere to replace that exhausted by the fans. This air carries with it along the flue the particles of dust and fluff given off at the burners, the strength of the draught being just sufficient to prevent the objectionable matter from falling and becoming mixed with the air breathed by the operatives.



"The Engineer" Swain Sc.

Fig. 4—THE STUBBS GASSING FRAME

The ingenious attempt to apply heat generated by electricity to this class of work is due to a French inventor, the yarns being drawn through fine platinum tubes which are heated by the passage of a current of electricity through them. The dust and fluff produced in the process are drawn off in a downward direction. Although from a hygienic point of view this system approaches very closely to the ideal, the French machine has not yet found much favour in this country.

SCIENTIFIC EXHIBITION AT WESTMINSTER.—The model engineering exhibition which opens at the Royal Horticultural Hall, Westminster, S.W., on Friday, October 15th, will contain a number of model aeroplanes on view, including the machine designed by Mr. G. P. Smith which won the gold medal in the recent contest at Wembley Park. Working model steam and electric railways, electric clocks, light machine tools, model motor boats, a model engineers' workshop in operation, and a working demonstration of wireless telegraphy by the latest Marconi apparatus, will form some of the other exhibits, while we understand that in the competitions for engineering and electrical model making over a hundred entries have been received. The exhibition will remain open for eight days, from 12 noon till 10 p.m., closing on Saturday, October 23rd.

LETTERS TO THE EDITOR.

(We do not hold ourselves responsible for the opinions of our correspondents.)

DRAWING AN ELLIPSE.

SIR,—In your issue of 10th September, 1909, page 278, Mr. Merry del Val gives a description of the drawing an ellipse whose axes are as 16 : 24, and he claims that "the operation is short and very accurate."

I cannot agree with this statement, as will be seen from Fig. 1, which is a repetition of part of Mr. Merry del Val's figure with the same letters written on corresponding points. y is the centre of the arc of a circle described with the radius N y = 16.

Your correspondent says that this arc will accurately join the point N. This, however, is not true, because in order to make the two circles join accurately without a kink it is necessary that the point where the two circles meet must lie on one straight line with the two centres of the circles—that means, the three points N F y should lie in one line, which, however, is not the case with Mr. Merry del Val's construction. The result is that the large arc cuts the small circle actually in two points N and N′. The further result of this construction is that the small axis of the ellipse actually becomes smaller than 16. This is proved by Mr. Merry del Val's figure.

The inaccuracies mentioned are, however, very small indeed, and they would not in themselves offer sufficient ground for criticism if they were outbalanced by the simplicity of the construction.

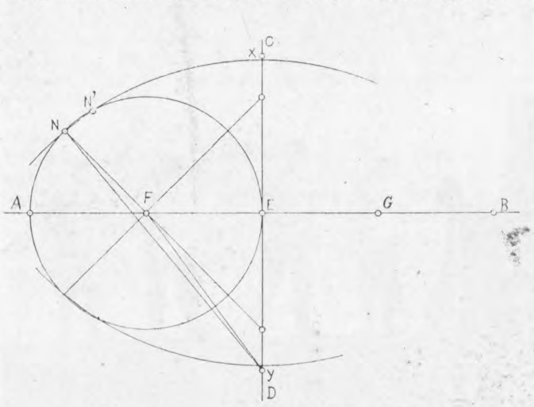


Fig. 1

My point, however, is that there is no reason for sacrificing accuracy if an actually accurate solution can be found which at the same time is even much simpler than the complicated inaccurate one.

Fig. 2 shows this correct construction. I have taken the two axes as 12″ and 8″ respectively, that is the same ratio as is assumed by your correspondent.

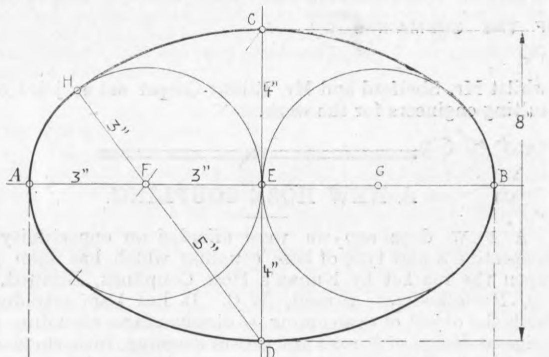


Fig. 2

Now, the construction is as follows:—

(1) Draw the two axes A B = 12″ and C D = 8″ intersected at E.

(2) Divide A E and E B into two equal parts at F and G, and with these two points as centres describe two circles with A F = G B as radius.

(3) With C and D as centres describe two arcs of circles which will accurately join the two smaller circles, thus finishing the required ellipse.

In order to prove that this construction is correct, I have drawn the line D F until it cuts the small circle round F at the point H. Thus we have H F = F E = 3″. E D = 4″, and since F E D is a rectangular triangle, the distance F D will be

$$FD = \sqrt{3^2 + 4^2} = \sqrt{25} = 5''.$$

Therefore H D = H F + F D = 3″ + 5″ = 8″ = C D.

That means the point H must lie on the circle described, with D as centre and C D as radius. At the same time H lies in one straight line with F and D, the centres of the two respective circles, and is, therefore, the point at which they touch each other.

I should like to mention that this construction, of course, only holds good when the ratio of the two axes is 2 : 3. Moreover, the combination of the two arcs of two circles is only an approximation of the ellipse in the true mathematical sense.

Stafford, September 24th. M. KLOSS, Dr.-Ing., M.I.E.E.

BRITISH LOCOMOTIVE PRACTICE OF TO-DAY.

SIR,—Mr. Dauncey will excuse me, but Mr. Webb's experiment of 1897 was not so absurd as it appeared to be. Inferentially, your correspondent himself admits that the boiler, which was too small for the simple, was large enough for the compound. That admission implies that the compound saved steam. Therefore, it seems to me that the whole question of compounding resolves itself into this: should the economy in steam be direct or should it be merely relative? In other words, should the aim be to save coal direct, or should it be to increase the tractive force? It may be said that there would be a saving in coal in either case, but in the one case it might mean that, for a given load, an engine would require a pilot, and in the other no assistance. This is a matter which can only—and rightly—be settled by locomotive engineers themselves. At the same time, Mr. Riekie's plea for augmented cylinder capacity suggests what to my way of thinking is the better alternative. I believe, however, that superheating will be found to be preferable to compounding.

The performance by the altered Webb compound, Alfred the Great, quoted in my previous letter, has never, so far as I am aware, been surpassed by that of any 4-4-0 simple engine of like weight. We now often hear of 400-ton trains, but this one weighed 464 tons empty. Some details of the uphill running with this huge load may be of interest. The engine ascended the bank out of Rugby at a steadily increasing speed. The first mile was covered in a little over 3 min., the next two in 3 min. 39 sec. Before Hilsby tunnel was entered, a speed of 40 miles per hour had been attained, and the rate was still tending to rise. The pace on emerging from the tunnel rapidly increased until it reached 70 miles an hour, which was steadily maintained to the beginning of the 7-mile rise to Roade, the last three miles of which are at 1 in 326, and on which bit the speed dropped to 52.8. A rapid descent was made on the succeeding downhill stretch. At Bletchley the speed was 52.8, which had increased to 54.2 at Leighton, and to 56.3 on the easier grade beyond the last-named station. On the last stretch at 1 in 330, the speed fell successively to 53, 50, and finally to 47.4, at which it steadily kept mile after mile to the summit. Said Mr. Rous-Marten: "Such a performance with one engine and so huge a load I have never before recorded in all my experience." The 15⅛ miles of upgrade, Bletchley to Tring, were covered in 17 min. 58 sec.

London, September 25th. F. W. BREWER.

DEFLECTION DUE TO SHEAR.

SIR,—In your current issue Mr. W. C. Popplewell gives a method of calculating the deflection of a beam due to shear, which is an extension of Professor Perry's method for simple sections. May I point out that this extension, by graphical means, to sections other than of simple geometrical form, may be found in Professor Morley's "Strength of Materials," pp. 229-231.

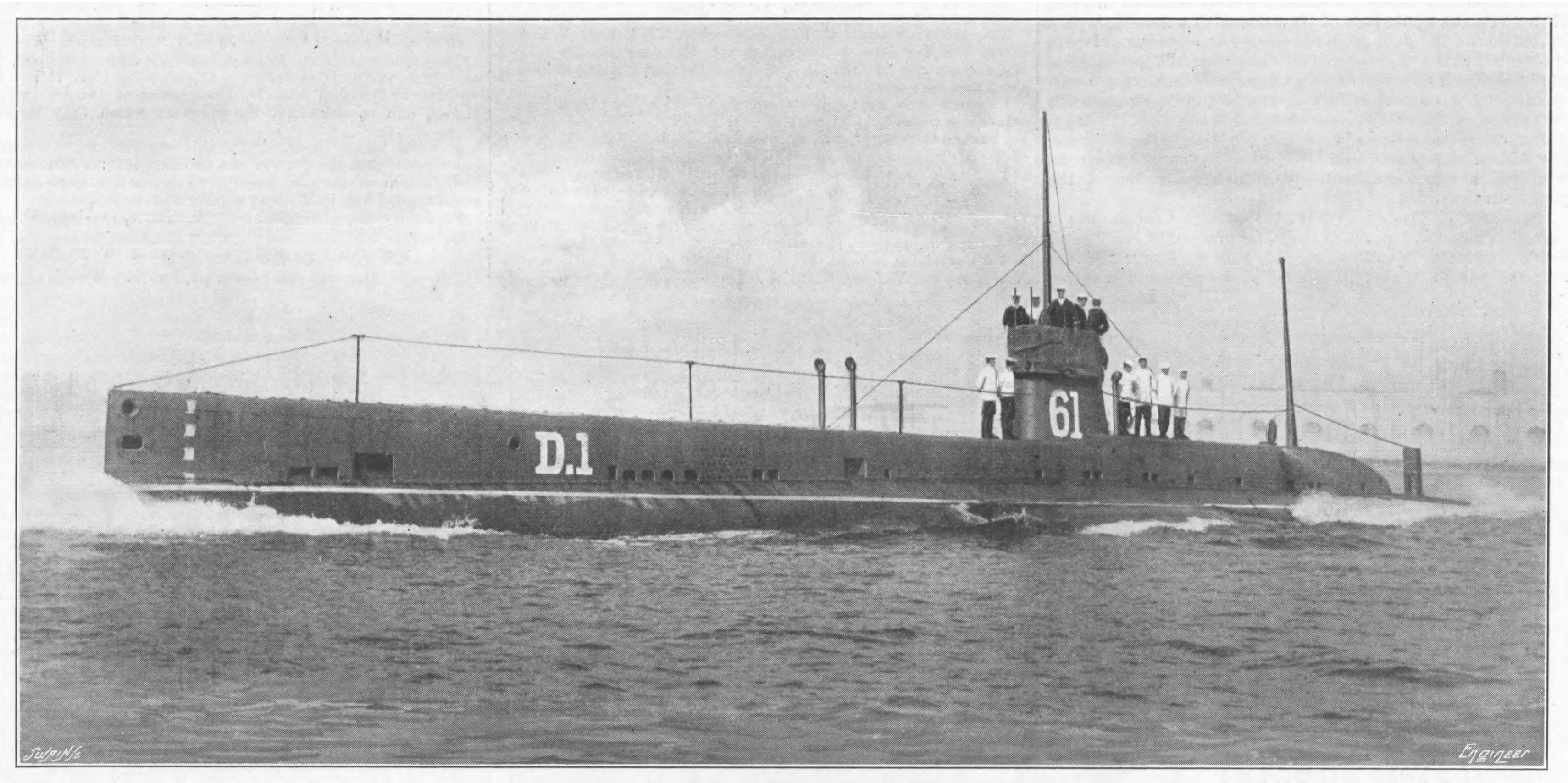
Professor Morley recommends finding the ordinates which are proportional to the moments of the various areas by a modulus figure; this is, of course, much better than by cutting out a number of strips of cardboard. It would, for example, be rather difficult to find the c.g. of strips 5 and 6—Fig. 6 in Mr. Popplewell's article—by balancing. DOUGLAS GILLESPIE.

Westminster, September 27th.

IT appears from a report by H.M. Consul-General at Zanzibar that it has been decided to improve the water supply of the town of Zanzibar. The existing aqueduct is to be replaced by iron pipes, and a tower is to be erected at a short distance from the town into which the water can be pumped, and from which it can be carried by gravitation into all parts of the town. It is proposed to carry this scheme, which is estimated to cost £16,000, into effect when opportunity occurs.

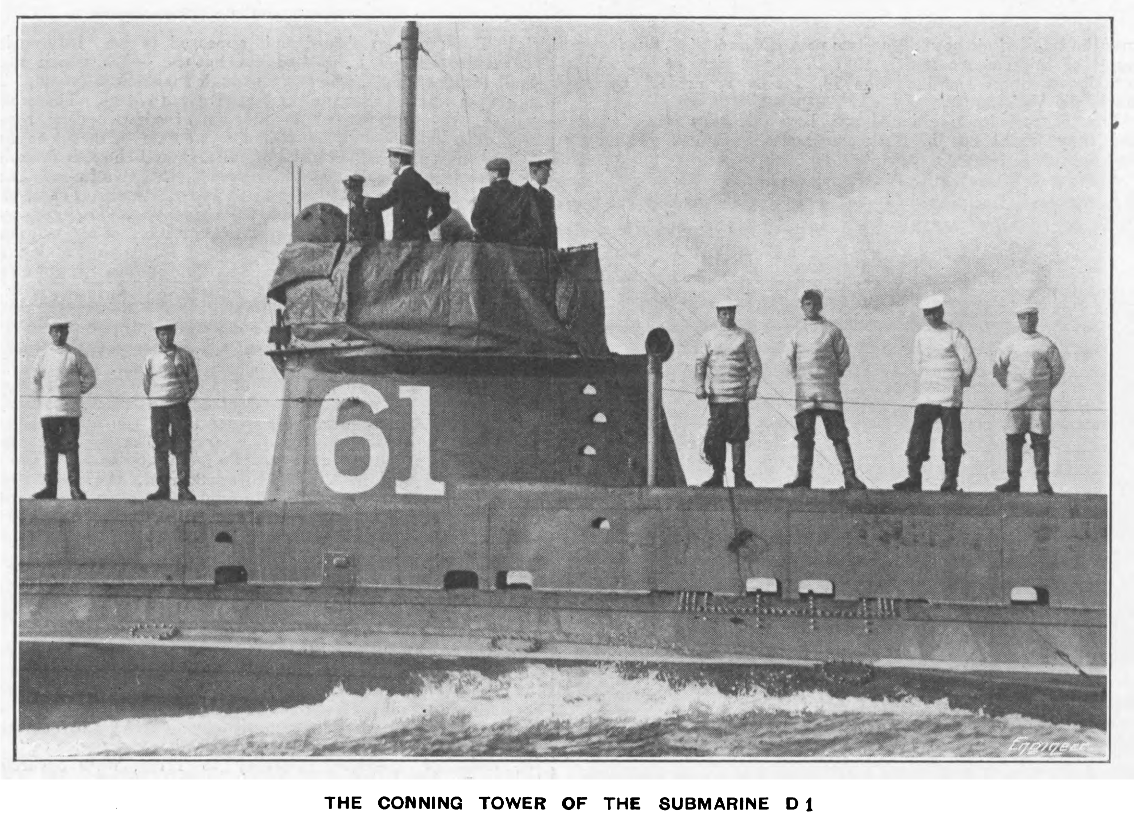
THE BRITISH SUBMARINE D1

VICKERS, SONS, AND MAXIM, LIMITED, BARROW, BUILDERS



THE SUBMARINE D 1.

THE first of a new type of submarines—No. D 1—has recently arrived at Portsmouth. We are enabled to give two engravings of her herewith, though but little definite information regarding the vessel is available. It is understood, however, that she is largely an experimental craft, and that in her construction many new departures have been introduced. She has two propellers driven by two separate sets of engines. Her surface speed is reported to be about 16 knots, and her submerged speed nearly 10. It is anticipated that her radius of action will be considerably in excess of that of the "C" class of submarine. She is provided with four torpedo tubes—two forward and two aft. She was built by Vickers, Sons and Maxim, Limited, at Barrow.



THE CONNING TOWER OF THE SUBMARINE D 1

THE BARO KANO RAILWAY.

IN our issue of September 17th we published an account of the constitution of the Baro Kano Railway in Nigeria, and we are now indebted to Mr. Frederic Shelford for a few historical notes about the line which make the account complete.

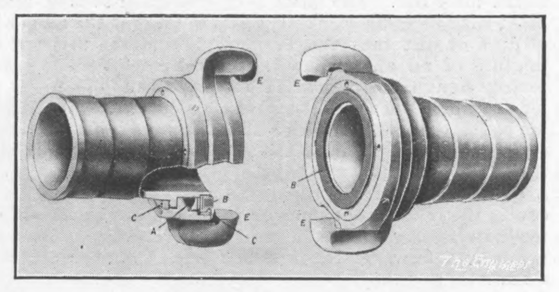
The proposals for the construction of a line joining Baro and Kano, *vid* Bida, Zungeru and Zaria, are now several years old, and in 1903 and 1904, at the request of the Government, a survey was made, and a very long report was drawn up by the late Sir Benjamin Baker and Mr. Shelford, dealing particularly with the comparative advantages and disadvantages of a 3ft. 6in. gauge line, and a 2ft. 6in. gauge line. The cost of either was, however, considered too great, and nothing was done. In 1906 the project came again before the Government, and Mr. Frederic Shelford then suggested that a 3ft. 6in. "pioneer" line should be built, and he estimated that, by the exercise of rigid economies, and the free use of all the assistance which could be given in the Protectorate, this could be done at the rate of £3000 per mile on the route surveyed in 1903-4. This proposition was carefully examined by Sir Percy Girouard, who had been appointed the Governor of Northern Nigeria, and he, in company with Mr. Shelford, went to the Protectorate in 1907, with the result that in August of that year the construction of the line was authorised. The actual supervision of the work has been carried out in the colony, whilst Mr. Shelford and Mr. Elliott-Cooper act as joint consulting engineers for the work.

A NEW HOSE COUPLING.

A FEW days ago we were afforded an opportunity of inspecting a new type of hose coupling which has been put upon the market by Nunan's Hose Couplings, Limited, of 10, Norfolk-street, Strand, W.C. It has been introduced with the object of overcoming a disadvantage attending the original design of Nunan and Stoves coupling, hitherto manufactured by this firm. In order to enable the hose pipe to free itself from twists when the water is turned on, the old type of coupling had two concentric sleeves, the outer sleeve, to which the hose pipe was fastened, being free to revolve. Thus as soon as the water was turned on, the pressure, acting on the twisted portions of the pipe, caused the loose sleeves to revolve, and in this way the pipe automatically straightened itself.

Experience has shown, however, that in the event of these outer sleeves becoming bent, owing, say, to the coupling receiving a blow, these loose sleeves would not revolve, with the result that the pipe would no longer untwist itself. Damage to the outer sleeve also caused leakage, which rendered the couplings unsuitable for use on suction pipes, since air was drawn in between the fixed and moving sleeves.

The new type of coupling will readily be understood from an inspection of the accompanying illustration. It will be gathered that the loose sleeves have been dispensed with, each portion of the coupling having one sleeve only, which is free to revolve. The construction is almost self-explanatory. In the illustration A is a ring of ordinary packing, which makes a water-tight joint between the stationary collars and revolving sleeves. B and B^1 are rubber rings which are clamped together by means of the lugs E, which fit on to projections round the circumference of the collars, as in the original design. A feature about these couplings worthy of mention is that when joining the two halves together no spanners are required, the clamping being carried out by hand. By removing the rings C C the couplings can be taken to pieces and new packing can be put in, or any damaged portion can be replaced without removing the hose pipes from the revolving sleeves. Both ends of the coupling are identical, so that it is unnecessary to pay attention to which ends of the pipes are brought together.



HOSE COUPLING

We have seen these couplings tested under a water pressure of 100 lb. and the joints were quite tight. The pipes were intentionally twisted, but as soon as the water was turned on the sleeves revolved and the pipes became perfectly straight. When the pipes were under pressure the collars of the couplings could be turned quite easily by hand. We are informed that this new type of coupling is equally satisfactory when used on suction pipes.

METEOROLOGICAL COMMITTEE.—The fourth annual report of the Meteorological Committee, which was published at the beginning of the past month, affords interesting evidence of another sphere of usefulness to which wireless telegraphy may be applied. It seems that messages sent by this system are proving of great value to our weather prophets, and there is little doubt that when practically every ship carries a wireless installation, and more shore stations have been erected, the daily weather charts will be much more complete and accurate. Since the beginning of the present year many wireless messages relating to the weather have been received from Atlantic liners, no less than 1219 communications having been transmitted during the first three months. It is unfortunate, however, that a great number of these messages are not transmitted direct to land stations, but are collected by the fast liners and then re-transmitted. This system obviously causes delay, so that valuable data that would prove useful to our weather prophets is often wasted through not being sent direct. So far as the wireless communication is concerned accuracy appears to be all that could be desired, but it is an unfortunate fact that the same cannot always be said as regards the observations which are carried out at sea. A large number of ships carry aneroid barometers only, with the result that it is frequently difficult to bring their pressure observations into correspondence with those of other ships and on shore stations. This report brings clearly forward another argument in favour of increasing wireless equipments on land as well as at sea.

CATALOGUES.

Carburation, Limited, Bryon House, 25, Mount Pleasant, Rosebery-avenue.—This is a neat little booklet which contains a simple and concise explanation of the carburetter.

Crosby Steam Gage and Valve Company, 147, Queen Victoria-street, E.C.—This is a pamphlet giving a concise comparison of the optical and pencil lever indicators as used on gas engines.

American Locomotive Company, 26, Victoria-street, London, S.W.—This is an interesting publication on articulated compound locomotives, being a paper read by Mr. C. J. Mellin before the American Society of Mechanical Engineers, New York.

John C. Fuller and Son, Woodland Works, Bow, London.—From this firm we have received a pamphlet dealing with the Fuller electric geyser for giving an instantaneous supply of hot water for baths, lavatories, and all domestic, trade, and professional purposes.

Spagnoletti, Limited, 102, Charing-cross-road, London.—A well got up pamphlet to hand from this firm has reference to the "Therol" patented electric water heater. This apparatus is quite new, and opens up a fresh field for the consumption of electric current. The pamphlet describes the apparatus in a clear and concise manner.

The Hudson Economiser Company, Limited, Gloucester House, 2, Bishopsgate-street Without, London, E.C.—This company's new sectional catalogue "C" has reached us. It deals with heating and drying with exhaust steam, and the production of vacuum without the expense of water. It is an interesting and well illustrated publication.

The General Electric Company, Limited, 71, Queen Victoria-street, London, E.C.—Some literature has reached us having reference to Osram lamps. A tasteful little pamphlet contains illustrations of some large buildings which are lighted with Osram lamps. Prices and other particulars of interest to buyers are also given. Another little booklet sets forth the advantages of Osram lamps, and gives testimonials from users.

Laurence, Scott and Co., Limited, Gothic Works, Norwich.—List No. M 40, which has been sent to us by this firm, has reference to adjustable speed motors. The motors dealt with are generally called variable speed machines, but the firm prefers to use the word adjustable, as the word variable also applies to series wound motors, in which the speed varies automatically with the power. The list has been compiled particularly for the use of machine tool makers, the firm having specialised for some years in adjustable speed motors for direct-driven tools.

William Geipel and Co., Vulcan Works, 72a, St. Thomas-street, London, S.E.—From this firm we have received a price list of Okonite and Manson insulating tapes, also sample packets of these tapes. The Okonite tape is intended to take the place of the ordinary Para rubber strip, one of its principal features being its low cost. The Manson tape is for protecting joints, and is used over the Okonite or rubber tapes. From the same firm we have also received a pamphlet dealing with Herion carbons for arc lamps and welding carbons for direct and alternating current.

The Electrical and Engineering Supplies Company, Limited, 36 and 37, Upper Thames-street, E.C.—This is a well got up catalogue dealing with "Lloyd" dynamos and motors, and gives prices and other particulars concerning the efficiency, weight, and so forth. Prices and other particulars relating to starters and shunt regulators are also given. The catalogue contains illustrations of complete machines of various types, connection and dimension diagrams, and all possible particulars. The special features claimed for these machines are high efficiency, light weight, small floor space, and good appearance.

LAUNCHES AND TRIAL TRIPS.

Floating dock; built by Swan, Hunter and Wigham Richardson, Limited; to the order of the Penarth Shipbuilding and Repairing Company; dimensions, 382ft. by 72ft.; the pumping machinery, consisting of four centrifugal pumps and engines, was constructed by Gwynnes, Limited; launch, September 2nd.

Lancer, steel screw steamer; built by the Tyne Iron Shipbuilding Company; to the order of Fisher Renwick and Co.; dimensions, 240ft. by 34ft. by 24ft.; engines, triple-expansion, 18in., 30in., 49in. by 33in. stroke; pressure 180 lb.; constructed by the North-Eastern Marine Engineering Company; trial trip, recently.

Belgique, steel screw steamer; built by Wood, Skinner and Co., Limited; to the order of Société Anonyme Baltique; engines, triple-expansion, 20in., 33in., 54in. by 36in. stroke; pressure 180 lb.; constructed by the North-Eastern Marine Engineering Company, Limited; trial trip, recently.

THE IRON, COAL, AND GENERAL TRADES OF BIRMINGHAM, WOLVERHAMPTON, AND OTHER DISTRICTS.

(*From our own Correspondent.*)

Pig Iron and Prices.

There is some recovery of the iron market this week, due to outside influences. Ironmasters welcome the improvement in the German pig iron trade, accompanied by an advance of 1s. per ton in German prices. American buying of British pig iron, judging by reports from the Northern iron markets, has also to some extent already begun, and increasing purchases are looked for as demand in America overtakes the supply and prices on that side rise to a point at which it will bring importers to order material from our furnaces. All this is very important, and excites Birmingham ironmasters this week to believe that there will soon be again an active pig iron buying movement on the part of local consumers on the Birmingham Exchange, and that prices will again advance. A rather better tone may therefore be reported. Some sellers of pig iron will not accept fresh contracts except subject to higher rates. Deliveries, however, under contracts already on the books are not as good as furnace owners could wish—a circumstance which argues unmistakably the continued lack of vigour in the manufactured iron trade and in the other consuming industries of the district, such as engineering, ironfounding, &c. Some furnace owners are, however, more fortunately situated in respect to deliveries than others. Prices are quoted: Staffordshire common, 47s. to 48s.; part-mine, 50s. 6d. to 51s. 6d.; best all-mine forge, 85s.; foundry, 90s.; cold-blast, 115s.; Northamptonshire, 49s. to 50s.; Derbyshire, 50s. to 51s.; North Staffordshire forge, 51s. 6d. to 52s. 6d.; best, 58s. to 59s.

Finished Iron.

There is not much new business available for finished ironmasters, and this department of the market has still not responded to the rise in raw materials. In this respect the market must be reported as unimproved, and so far there appears little prospect of betterment. Makers of the best qualities of bars register a regular demand, but orders in the second and third-class bar trade are of anything but a pleasing character, whether size or price is considered. A good turnover of marked bars is being made at the £8 standard, with £8 12s. 6d. as the Earl of Dudley's price, and £7 as the figure for second grade iron. North Staffordshire "crown" bars remain at £6 10s. at the ports. The usual figure for merchant bars is now £6 2s. 6d., and in some cases £6 5s. is asked, but this latter figure is an outside price. Common bars are £5 17s. 6d. to £6 per ton. The hoop department is rather quiet, and there are general complaints of a want of specifications. Values stand at £6 15s. Gas tube strips are still £6 5s. to £6 7s. 6d. nominal.

Black and White Sheets.

The black and white (galvanised) sheet iron industry is so very important to this district that it is a matter for great satisfaction that the revival which the white branch has recently shown, following upon the late suicidal outbreak of unrestricted internal competition, continues. Excellent accounts are brought to 'Change now week by week of this branch, and to-day (Thursday) in Birmingham was no exception. Leading makers reported themselves full of orders, mainly for shipment, and with every prospect of maintained complete activity up to the end of the year. Prices have recovered from the late excessive minimum in sympathy with the big demand. Some firms are asking £11 10s. for 24 gauge corrugated sheets f.o.b., but the general quotation is £11 5s. for the commonest qualities; £11 is said by buyers to be ruling, but the figure is by no means general. Black sheets are £7 2s. 6d. to £7 5s. for doubles, £7 to £7 2s. 6d. for singles, and £7 15s. to £7 17s. 6d. for lattens.

Steel Trade.

Engineering angles are quoted £5 17s. 6d. to £6; girder plates, £6 to £6 5s.; joists, £5 10s. to £5 15s.; and mild bars £6 7s. 6d. to £6 17s. 6d. Raw steel is relatively in a better position than manufactured steel, and demand is quite brisk, with satisfactory prices. Bessemer bars and billets are £4 15s. delivered in the Birmingham district, and Siemens sorts £4 17s. 6d. per ton.

NOTES FROM LANCASHIRE.

(*From our own Correspondent.*)

Manchester, Thursday.

An Interesting Month.

The course of pig iron during the past month has been interesting, the close showing all round higher prices, though much of this is attributable to speculation and shipments, which have been fairly good from all ports. Speaking generally, however, there has been a fair demand, though locally it has been scarcely so good as in the preceding month of August. In the early part of September there were few changes to record, though there was a firmness which presaged the advances which have subsequently taken place. Lincolnshire No. 3 foundry for prompt delivery is 1s. to 1s. 6d. per ton higher, while for the next year's delivery 1s. 6d. per ton more is being asked. Staffordshire has enjoyed fair vogue and is about 6d. per ton higher on the month. Middlesbrough brands under speculative influences and heavy shipments have advanced about 1s. per ton; Scotch has also gone up in the same ratio, while so far as Dalmellington is concerned in this centre, it is "off the map." Forward prospects in this department tend to higher prices. Hematite in sympathy with other classes of iron has also participated in the upward movement to even a greater extent. West Coast is 1s. to 2s. more, with little offering for forward delivery. Scotch is 1s. 6d. to 2s higher; while East Coast, in conjunction with foundry iron, is about 2s. more money. Tuesday's Iron Exchange was fairly well attended, and current prices will be found in the quotations given below.

Finished Iron and Steel.

Have been fairly steady throughout the month, and there has been a scarcity of foreign billets.

Copper, Lead, and Tin.

In manufactured there has been a drooping tendency on the whole, but in common with the raw metal there is an upward movement at the close. There was a reduction in sheets, but this has been recovered. Tubes also have been variable and have been advanced during the week ⅛d. per pound. Lead: Sheet closes a shade dearer. Tin: English ingots have advanced about £4 per ton on the month.

Quotations.

Lincolnshire, No. 3 foundry, 56s.; Staffordshire, 54s.; Derbyshire, 55s.; Middlesbrough, open brands, 61s. 4d. Scotch: Gartsherrie, 62s. to 62s. 6d.; Glengarnock, 61s. 6d.; Eglinton, 60s. to 60s. 6d., delivered Manchester. West Coast hematite, 63s. 6d.; East Coast ditto, 60s. to 60s. 6d., both f.o.t. Delivered Heysham: Gartsherrie, 60s. to 60s. 6d.; Glengarnock, 59s. 6d.; Eglinton, 58s. to 58s. 6d. Delivered Preston: Gartsherrie, 61s. to 61s. 6d.; Glengarnock, 60s. 6d.; Eglinton, 59s. to 59s. 6d. Finished iron: Bars, £6 10s.; hoops, £7 12s. 6d.; sheets, £7 15s. to £8. Steel: Bars, £6 2s. 6d. to £6 5s.; Lancashire hoops, £7 5s.; Staffordshire ditto, £6 17s. 6d. to £7; sheets, £7 17s. 6d. to £8; boiler plates, £7 5s. to £7 7s. 6d.; plates for tank, girder, and bridge work, £6 5s. to £6 7s. 6d.; English billets, £4 12s. 6d. to £4 15s.; foreign ditto, £4 10s. to £4 12s. 6d.; cold-drawn steel, £9 10s. to £9 15s. Copper: Sheets, £72; tough ingot, £62 10s.; best selected, £62 10s. Copper tubes, 8½d.; brass tubes, 6¾d.; condenser, 7¾d.; rolled brass, 6¼d.; brass wire, 6½d.; brass turning rods, 6½d.; yellow metal, 6d. per lb. Sheet lead, £17 per ton. English tin ingots, £138 to £138 10s. per ton.

The Lancashire Coal Trade.

There has been no new feature to note. Trading has been on a rather quiet scale, though there has been a hardening tendency in slack and steam coal generally. Best sorts of domestic fuel continue scarce, but apparently the course of advancing on the 1st of October to winter prices is not to be observed this year, but probably November will see some move in this direction. Coke has been advanced 1s. per ton in Lancashire, Yorkshire, and Durham.

Barrow-in-Furness, Thursday.

Hematites.

The market for hematite iron is, generally speaking, steady, but while there is a falling off in some of the branches of trade there are increases in others, and particularly so in the consumption of local makes of steel. There is, however, a reduction in the make of iron brought about by the stoppage of the Distington Ironworks through an explosion a few days ago. This means that at the moment 3000 tons less of iron is being put on the market, and as a consequence prices have been advanced. There is, however, some compensation in the fact that an additional furnace has been put in blast at the Maryport Works of the West Cumberland Combine; but before the explosion at Distington it had been arranged to increase the production of the Combine plant. It is now probable that, at any rate, three furnaces belonging to other companies will be started at an early date. If not there will be a scarcity of iron in the district, and as a consequence prices will show a further advance. Mixed Bessemer numbers are at 62s. 6d per ton net f.o.b. Special hematites, in which a good business is being done, are at 65s. to 66s. 6d., and warrant iron is at 61s. 6d. net cash sellers, and business has been done during the week in warrants, three months delivery, at 63s. The general belief is that prices will advance in the near future. Sales of ferro-manganese, charcoal, and scrap iron are fairly well maintained. Iron ore is in moderate request at 12s., 14s. 6d., and 18s. per ton net at mines. Foreign ores also remain at the higher prices ruling of late.

Steel.

The steel trade is only employed in the Bessemer department, and the main feature of the output is steel rails, orders for which are sufficiently large to ensure practically full employment; but the demand in the open market is not large, and there is no guarantee of a continuance of orders. Heavy sections are at £5 5s. per ton net f.o.b. Merchant steel is in poor demand. There is nothing being done in shipbuilding material.

Shipping and Coal.

The shipments of iron and steel from West Coast ports last week amounted to 8024 tons—iron 3445 tons and steel 4579 tons—as against 9395 tons in the corresponding week of last year, a decrease of 1371 tons. For the year to date the shipments aggregate at 447,127 tons, against 363,568 tons for the corresponding period of last year, an increase of 83,559 tons. Coal and coke quiet at steady prices.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

The Steam Coal Trade.

The demand for steam coal for export still keeps active, but there are signs of the approaching end, and the demand is such that the time yet to elapse before the close of the season will see the fulfilment of all the pressing orders. This is rather a disappointment to some colliery owners who have not been able to take advantage of this season owing to irregularity of work, and rather indicates that the call at the present season has not been so large in volume as previously. The prices now ruling are a little easier for forward delivery, ranging from 9s. to 9s. 3d. per ton. The supplies forwarded to continental ports *in toto* are not considered to have been as much as normal, probably owing somewhat to the unsettlement in Sweden, though this synchronised with the disturbance in the English coalfield through the operation of the Eight Hours Act, demand and supply being thus pretty evenly balanced.

House Coal Steady—Gas Coal Brisk.

The advance in house coal referred to last week has not, at the time of writing, actually been notified, but it is taken for granted it will be made to-day. The rates which have been current for a considerable time are 11s. 6d. to 13s. per ton for best Barnsley, and 10s. to 11s. per ton for secondary grades. The activity already noted in the call for gas coal by gas companies and Corporation gas departments is more marked this week. All the gas coal contracts may now be considered completed, and the reduction on last year's prices is from 6d. to 1s. per ton. Latterly, coalowners have been disposed to stand out for less reduction.

Small Coal in Brisk Request—Coke again Advanced.

Activity pervades the market for small coal, a large tonnage leaving the district under contract. Best slack is in most request, quotations for the sorts sent to Lancashire and Yorkshire textile localities continuing firm at from 4s. 6d. to 5s. 6d. per ton. Coke is still advancing in value, best washed now making 11s. 6d. to 12s. per ton, and unwashed from 11s. to 11s. 6d. per ton. The rise in prices is owing to shortage in the supply of coking fuel, as well as to the advance in iron prices.

The Iron Market—Small Business, but Values Maintained.

The pig iron market remains pretty much as reported last week. Makers are not pressing sales, being well furnished with contracts, and therefore able to stand out for the advances recently established. In hematites, though official quotations remain unaltered, the firm tendency noted last week is maintained. Quotations:—West Coast hematites, 68s. to 70s. per ton; East Coast, 65s. to 67s. per ton net, delivered in Sheffield and Rotherham. Lincolnshire, No. 3 foundry, 52s. 6d. per ton; No. 4 foundry, 51s. 6d. per ton; No. 4 forge, 51s. 6d. per ton; No. 5 forge, mottled and white, 51s. 6d. per ton; basic, 52s. 6d. per ton, all net, delivered in Sheffield and Rotherham. Derbyshire, No. 3 foundry, 52s. per ton; No. 4 forge, 50s. 6d. per ton, both net, delivered in Sheffield and Rotherham.

Finished Iron, &c.

No change to report. Makers of bar iron are very slack, with no immediate prospect of any revival in business. Bars continue at £6 10s. per ton; hoops, £7 10s. per ton; sheets, £8 10s. per ton. Other departments of the finished iron trade are also indifferently employed.

The Heavy Industries.

Since last week an order of considerable magnitude has been received for shells from a foreign Government. Further orders for projectiles are not coming forward as freely as could be desired. Some firms are fairly busy in heavy forgings for the new orders in torpedo boats, and inquiries are also being received rather more frequently from shipbuilders on the East Coast. Whether these, however, are for speculative building or actual requirements is at present unknown. The demand for railway material still keeps flat, both on home and foreign account.

NORTH OF ENGLAND.

(*From our own Correspondent.*)

Cleveland Pig Iron.

The chief influences affecting our Cleveland pig iron market at present come from the United States, where the revival of business is very pronounced, and prospects of better things are excellent. The speculators in Cleveland warrants are operating mainly on the strength of there being a large business done again by American consumers in Cleveland iron, and certainly the tendency seems to lie that way, for already the demand for American pig iron is almost equal to the production, which is on a larger scale than was ever before known. It would seem as if consumers on the other side of the Atlantic were getting short of pig iron and other raw materials, for they have lately been inquiring rather freely, not only for Cleveland and hematite iron, but also for scrap steel and spiegel, though so far only one order for Cleveland iron has been secured, and that, it is believed, was taken by a London house, for neither the Cleveland nor Scotch traders seem to know anything of it. The 3000 tons of scrap steel has been shipped from the Tees to the States, and another similar order has been placed. Further business in spiegel has been done on American account. The latest advices from the States are that an unprecedented buying movement both for prompt and next year is in progress. Scrap metal especially is in demand, and more of this than of pig iron is likely to be taken on account of the duty being lower. Basic pig iron is being largely bought for delivery over the whole of next year. Such intelligence as this has considerably strengthened the warrant market here, and speculators are in a hurry to operate, as in all probability prices will rise so as to leave them with a good margin of profit. It is due to these good reports that the unsatisfactory local statistics fail to have a detrimental influence upon the market; in fact, traders seem to ignore them completely, and the price of Cleveland warrants is higher than has been reported at any time since September of last year, having risen more than 1s. within the last week, and the 52s. 8d. paid on Tuesday was no less than 6s. 8½d. per ton above the minimum of the current year, which was 45s. 11½d. in March last. A fair business has been done in warrants at 52s. 5d. cash buyers. Makers' iron has not advanced to the same extent as warrants, most of the business being done this week at 52s. for No. 3 for prompt f.o.b. delivery, but when named brands were required 52s. 6d. had to be paid. No. 1 has been at 54s. 3d.; No. 4 foundry at 50s. 6d.; No. 4 forge at 50s.; mottled at 49s. 6d.; and white at 49s., all for prompt delivery. For forward delivery, say up to the end of March, 9d. to 1s. more per ton was quoted, but makers have not seemed in any great hurry to sell ahead, seeing that the tendency in prices is generally upward and the outlook mostly favourable.

Hematite Pig Iron.

During the present week few orders have been placed for East Coast hematite pig iron, but that is of small moment, as most of the producers have satisfactory order-books, and have no need to press iron on the market for sale. The outlook is favourable, and one cannot expect anything but improving trade, seeing how much better the shipbuilding industry has become. The plate makers have already bought heavily from hematite producers, and must continue to purchase more freely than has been the case for the past two years. More orders for new vessels will be forthcoming, because there is brisker employment for steamers, the ranks of "laid up" vessels is steadily being depleted, and rates of freight are increasing in several trades. Some business men predict that before long we shall find the shipping available too small to satisfy requirements. The hematite market is also being favourably influenced by the inquiries that are being received from American buyers. The quotation for mixed numbers, early delivery, is maintained at 59s. per ton, with 60s. for delivery over the last quarter of the year and 62s. 6d. for the first quarter of 1910. No. 1, for prompt delivery, is at 59s. 6d., and hematite forge at 58s. 6d. Ironmasters are not buying ore freely, but then there is no necessity, for they have already covered their requirements for a considerable time ahead. Prices are practically nominal, the prompt c.i.f. delivery price being 17s. per ton, and merchants are not inclined to quote for next year's deliveries Coke is not cheaper, nor is it likely to be, notwithstanding that German manufacturers are competing keenly in neutral markets. They have large stocks of coke which they are anxious to get rid of, even at prices which involve a loss. Thus, they are said to have secured an order for 150,000 tons of coke for blast furnaces at Tampico, in Mexico, at a price which will leave no more than 9s. per ton f.o.b., that being little more than half the figures that Durham coke manufacturers are quoting and adhering to. The general quotation for average Durham furnace coke is 17s. per ton delivered at Middlesbrough.

Pig Iron Stocks and Shipments.

Notwithstanding that trade is better the stock of Cleveland pig iron in Connal's public stores continues to increase rapidly, but this has no detrimental influence upon the market. The total quantity held yesterday was 312,050 tons, an increase for the month of 23,748 tons. Exports of pig iron from the Cleveland district are anything but satisfactory this month, especially on oversea account. Up to Wednesday night the shipments were 85,257 tons, as compared with 103,145 tons in August, 1909; 98,252 tons in September, 1908; and 118,181 tons in September, 1907, all to 29th.

Realised Prices of Manufactured Iron.

It has been officially reported to the Board of Conciliation and Arbitration for the Manufactured Iron Trade of the North of England that the average price realised by the producers for the finished iron delivered during July-August was £6 6s. 8.16d. per ton, or 1d. more than was reported for the previous two months. Wages for October and November, in accordance with the sliding scale, will remain the same as in August-September. The rate for puddling is now 8s. 3d. per ton, or 1s. per ton less than in the latter half of 1907, which was the highest in the last revival. The average price of the two months under notice is about 10s. 1d. per ton less than in the last period of good trade, and the price has dropped 6s. 9½d. this year. The average realised for iron rails was £5 1s. 3.23d.; for iron plates, £5 16s. 8 82d.; for iron bars, £6 9s. 1.35d.; and for angles, £6 17s. 2.61d. Compared with the previous two months, rails have fallen 10s. 11d. and plates 1s. 9½d.; but iron bars are up 1s. 5½d. and iron angles 2s. 6d. per ton. The best feature of the return is the considerable increase in the deliveries of shipbuilding material, which bears out the reports of the improvement in the shipbuilding industry. In the May-June two months plates formed 13.62 of the production, but in the last two months they had increased to nearly 22 per cent., while angles had risen from 5.61 to 6.82. The deliveries showed an increase of about 20 per cent., which must be accounted satisfactory.

Manufactured Iron and Steel.

The various branches of steel making are showing considerable improvement, and work is more plentiful generally, but no changes in prices have been made this week. Heavy steel rails are at £5 5s. per ton net f.o.b.; steel ship plates at £6; iron ship plates, £6; steel ship angles, £6 7s. 6d.; steel bars, £6 5s.; steel hoops, £6 5s.; steel strip, £6 2s. 6d., all less 2½ per cent. f.o.t.

Coal and Coke.

The coal trade is rather dull this week, and few consumers are disposed to buy for delivery much ahead, there being some idea that prices will shortly be more favourable to consumers, with the exception of those for gas coals. This is the best season for the last named, and sellers are realising fully 11s. per ton for early f.o.b. deliveries, with 10s. to 10s. 3d. for seconds. Most producers ask more for forward delivery, but it is reported that a contract for 200,000 tons has been arranged for shipment over next year at a price which is calculated to leave no more than 11s. per ton f.o.b. Bunker coals are somewhat easier in price, being obtainable at 9s. per ton f o.b. Tyne Dock. Coking coals are strong at 9s. 6d. to 10s. per ton, and foundry coke is generally quoted 17s. 6d. to 18s. per ton f.o.b.

NOTES FROM SCOTLAND.

(*From our own Correspondent.*)

The General Trade Outlook.

THE improvement in home business is almost everywhere slow. Apart from the placing of some additional shipbuilding contracts, mainly on the lower reaches of the Clyde, there does not appear to have been any great accession of orders since last report. It is notable that the upward movement in the market for raw iron proceeds almost exclusively on the strength of American prospects. Inland business is disappointing, except in hematite, sales of which have been good, and the foreign shipments of Scotch pig iron are so far much short of what might have been expected, looking to the statements that are in circulation as to the large business done in pig iron.

The Iron Market.

A further advance has taken place in the prices of pig iron warrants, the stimulus being speculative, and arising out of the reports in circulation that America is likely to require considerable supplies from this side, mainly of hematite iron. A large business was done in hematite warrants at the end of last week, when the prices made a fresh upward movement. The iron market was closed on Monday, which was observed as the Glasgow autumn holiday, but the pig iron market was strong at the opening on Tuesday, when some further rise took place in prices. Business has been done in Cleveland warrants from 51s. 9d. to 52s. 6d. cash, 52s. to 52s. 9d. one month, and 52s. 6d. to 53s. 3d. three months. Transactions are also recorded at 52s. 0½d. to 52s. 4½d. for delivery in five days, 52s. 4½d. and 52s 5½d. for 9th November, 52s. 6d. ten days, and 52s. 8d. twenty days.

Scotch Makers' Iron.

There have been some changes in the blast furnaces. One furnace has been taken off ordinary Monkland iron and two off Clyde, while an additional furnace has been placed on hematite at the Wishaw Works of the Glasgow Iron Company, and another on hematite at the Clyde Ironworks. There are now 40 furnaces making hematite, 36 ordinary and 5 basic iron, the total of 81 furnaces now in operation in Scotland comparing with 82 last week and 75 at this time last year. It is reported that there has been a good demand for the special brands of Scotch makers' iron for export, and the sales effected have been on a considerable scale. Makers' prices are again higher. At Glasgow, f.a.s., Monkland No. 1 is quoted 58s. 6d.; No. 3, 56s. 6d.; Carnbroe, No. 1, 60s. 6d.; No. 3, 57s. 6d.; Clyde, No. 1, 63s.; No. 3, 58s.; Gartsherrie and Calder, Nos. 1, 63s. 6d.; Nos. 3, 58s. 6d.; Langloan, No. 1, 64s.; No. 3, 59s.; Summerlee, No. 1, 65s.; No. 3, 59s. 6d.; Coltness, No. 1, 90s.; No. 3, 59s. 6d.; Eglinton, at Ardrossan or Troon, No. 1, 58s. 6d.; No. 3, 56s. 6d.; Glengarnock, at Ardrossan, No. 1, 65s.; No. 3, 59s. 6d.; Shotts, at Leith, No. 1, 63s.; No. 3, 58s.; Carron, at Grangemouth, No. 1, 65s.; No. 3, 59s.

Hematite Ore and Pig Iron.

The imports of hematite ore into the Clyde continue on an extensive scale, and now amount since the beginning of the year to upwards of 800,000 tons, being about 100,000 tons more than in the corresponding nine months of 1908. The hematite market has had a stronger tendency. Business has been done in our market in Cumberland hematite warrants at 61s. 9d. for delivery in twelve days, and at 63s. three months. The Scotch makers have been reported as quoting 65s., and it was stated that in some cases they were practically out of the market, but merchants are quoting 62s. for delivery at the West of Scotland steel works. The output of hematite in Scotland has been increased since last report to the extent of about 700 tons extra per week, and now amounts to 14,000 tons weekly, being at the rate of 720,000 tons per annum.

Finished Iron.

An official examination of the books of the makers of finished iron in Scotland during July and August show that the average net price realised at the works was £5 16s. 4.64d. per ton. This price does not admit of any change in the wages of workmen during the next two months—October and November. There is still much room for improvement in this department of the iron trade, the work coming to hand being insufficient to keep machinery in anything like full and steady employment. The work obtained is, with regard to a great portion of it, subject to keen competition.

The Steel Trade.

Some steelmakers report that specifications for heavy work are coming to hand a little more freely, and the fresh inquiries are more encouraging and suggestive of fuller employment ere long.

Clyde Shipbuilding.

The output of new shipping on the Clyde during December, which includes H.M.S. Glasgow, launched from the Fairfield yard on Thursday, is the largest that has taken place in any month this year. The figures are 47,570 tons, and compare with 22,000 tons in September, 1908. The output for the nine months is 257,609 tons, compared with 245,102 in the same period of 1908, and with 458,351 in 1907. The largest nine months' output on record was that of 1906, which reached 462,277 tons. Some good orders have been received within the last few days, and a large share of these have gone to Port-Glasgow.

The Coal Trade.

The coal shipments at Scottish ports have shown a considerable improvement, and the inquiry is fair both for home use and export, but heavy outputs are not easily cleared away. There is practically no change in prices.

WALES AND ADJOINING COUNTIES.

(*From our own Correspondent.*)

Last Week's Coal Trade at Cardiff.

LAST week was a disappointing one. Sellers were prepared to see higher prices, and coal—the best steam—had remained so long ranging from 17s. 6d. to 17s. 9d. as to become monotonous and wearisome. One could not hear even of a stray cargo at 18s., and the hope of some authorities that quotations would ascend into the eighteenth scale was not realised; 17s. 6d. to 17s. 9d. for best; seconds, from 16s. to 17s.; drys not very firm; slight abatements 1½d. or 3d.; such were the salient features, and a drooping tendency with smalls; and throughout the week tonnage came in very fairly and permitted easy despatch.

Latest Quotations.

A steady tone observable, market showing improvement. Best large steam, 17s. 6d. to 17s. 9d.; best seconds, 16s. to 17s.; ordinary seconds, 15s. to 15s. 6d.; best drys, 16s. 3d. to 17s.; ordinary drys, 14s. to 14s. 3d.; best washed nuts, 14s. to 15s.; seconds, 13s. to 13s. 6d.; best washed peas, 12s. 6d. to 13s.; seconds, 11s. to 12s.; very best smalls, 8s. 6d. to 9s. 3d.; best ordinaries, 6s. 9d. to 7s. 3d.; inferior sorts, 6s. to 6s. 6d.; best Monmouthshire black vein, 15s. 3d. to 15s. 9d.; ordinary Western Valleys, 14s. 6d. to 15s.; best Eastern Valleys, 13s. to 13s. 6d.; seconds, 12s. 6d. to 13s. Bituminous coal: Very best households, 17s. to 18s.; best ordinaries, 15s. to 16s.; No. 3 Rhondda, large, 17s. 3d. to 17s. 6d.; brush, 13s. 6d. to 13s. 9d.; smalls, 10s. to 10s. 6d.; No. 2 Rhondda, large, 12s. 3d. to 12s. 6d.; through, 9s. 6d. to 10s. 3d.; smalls, 7s. to 7s. 6d. Patent fuel, 15s. to 15s. 6d. Pitwood, 19s. 3d. to 19s. 9d. Coke: 24s. 6d. to 28s. for special foundry, and other sorts 19s. to 22s.; furnace, 17s. 3d. to 18s.

Newport Coal.

A better tonnage noted, and steadier tone, but no improvement in prices. Stocks are in some quarters in excess of needs. Latest prices:—Best Newport black vein, large, 15s. to 15s. 6d.; Western Valleys, 14s. 3d. to 14s. 9d.; other sorts, 12s. 3d. to 12s. 6d.; best smalls, 6s. 9d. to 7s.; seconds, 6s. 3d. to 6s. 6d.; inferiors, 5s. 9d. to 6s. Bituminous coal:—Best house coal, 15s. to 15s. 6d.; seconds, 14s. to 14s. 6d. Patent fuel, 15s. to 15s. 6d. Coke: Foundry, 18s. 6d. to 19s.; furnace, 17s. to 17s. 6d. Pitwood, 19s. 3d. to 19s. 9d., less 2½, in 30 days on all coal.

Swansea.

Anthracite is in fair demand, but the market showed no alteration, and, the tonnage coming in freely, easiness was the characteristic. Prices maintained, best very firm; beans slight reduction. Latest:—Best malting hand-picked, 24s. to 24s. 6d. net; seconds, 21s. 6d. to 22s. 6d.; big vein, 18s. to 20s., less 2½; red vein, 12s. 6d. to 12s. 9d., less 2½; machine-made cobbles, 23s. 6d. to 24s. net; Paris nuts, 25s. to 26s. net; French nuts, 25s. to 26s. net; German nuts, 25s. to 26s. net; beans, 17s. 6d. to 18s. 6d. net; machine-made large peas, 11s. 6d. to 12s. 6d. net; fine peas, 10s. 6d. to 11s. 6d. net; rubbly culm, 5s. 6d. to 5s. 9d., less 2½; duff, 3s. to 3s. 3d. net. Other coals: Best large steam, 17s. to 18s., less 2½; seconds, 14s. 6d. to 15s., less 2½; bunkers, 9s. 9d. to 10s. 6d., less 2½; smalls, 7s. 6d. to 9s. 6d., less 2½. Bituminous coal: No. 3 Rhondda, 18s. to 18s. 6d., less 2½; through, 14s. 9d. to 15s. 6d., less 2½; small, 10s. 6d. to 11s., less 2½. Patent fuel, 13s. 6d. to 14s., less 2½. Swansea has been busy in shipping pig iron to Rio Grande, and 300 tons tin-plate to Norway.

New Company in Swansea District.

New works are projected in the Swansea district by the Columbian Fireproofing Syndicate, which are expected to employ about 300 men.

The Belgian Coal Contracts.

The fact that most of these have gone elsewhere has caused little surprise. The uneasiness in the labour market, the eight hours difficulty, the late circular by coalowners—now withdrawn—and other vexed questions left little encouragement to quote forward prices when the North of England and Germany were prepared to give inducements, and there was no strike fear ahead, so for this season Wales has not obtained these coal contracts, which have gone to coalowners in Belgium and Germany.

Anthracite Developments.

It has been officially stated that Sir Griffith Thomas has sold his Oullwyn and Malsmarthog collieries to Mr. Evans-Bevan, of Neath. This firm will now have practically the government of the whole of the Dulas anthracite collieries in the upper district of the Dulas Valley, with an output of 2000 tons per day. They cover an extent of 5½ miles by 1¼ miles.

Advance of Wages to Ironworkers.

At the meeting last week of the sliding scale, held at Abergavenny, it was decided that the examination of books justified an advance of ½ per cent., which would accordingly be carried out on and from the 1st of October.

Is Blasting in Collieries Safe?

At a meeting of the South Wales and Monmouthshire branch of the Colliery Managers' Association held at Port Talbot the notification of the resignation of the secretary, Mr. Griffiths, was received with regret. The chairman, Mr. Richards, added that the names of four applicants had been received, and it was agreed that balloting should take place by the next meeting. The candidates are:—Mr. Keen, Staples, Llanelly; Mr. Rogers, Blaengarw; Mr. Phillips, Swansea. At the meeting Mr. Keen read a paper on the subject of colliery working without blasting. At Wattstown and Risca collieries they had an output of one million tons, and they had not fired a shot for five years at Risca, nor for over three years at Wattstown. This was not stated to condemn blasting, but to show how they managed at some collieries.

Iron and Steel.

There is still an absence of any hopeful news regarding these trades, but the slight advance in wages notified is considered promising.

Tin-plate.

The shipments of tin-plate last week again reached a high total—93,437 boxes. Receipts from the works were 91,983 boxes, and stocks now consist of 118,683 boxes. Latest quotations:—C. A. roofing sheets, £8 10s. to £8 15s. per ton; big sheets for galvanising, £8 10s. per ton; finished black plates, £8 10s.; galvanised sheets, 24 g., £11 to £11 5s. per ton; block tin, £140 15s. cash, and £141 17s. 6d. three months. Other quotations:—Copper, £59 5s. cash, £60 1s. 3d. three months. Lead: English, £13 12s. 6d. Spanish spelter, £23 5s. Silver, 23⅝d. per oz. Rubio ore. 16s. 3d. to 16s. 9d. The latest quotations of iron and steel are as follows:—Swansea: Hematite, mixed numbers, 62s. cash and month; Middlesbrough, 52s. 4d. cash, 53s. 7d. month. Scotch, 58s. 4½d. cash and month. Welsh hematite, 66s. to 67s. d.d. East Coast hematite, 65s. to 66s. c.i.f. Steel bars, £4 12s. 6d. to £4 15s. per ton, Siemens; £4 10s. to £4 12s. 6d., Bessemer.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

MR. W. H. BOOTH, artesian and steam engineer, has moved to Caxton House (West Block), Westminster, S.W.

WALLACH BROTHERS, Limited, have removed their works and warehouse from 50, Tenter-street South, Goodman's Fields, Whitechapel, E., to 20, Holywell-row, Finsbury, E.C.

THE Adnil Electric Company, Limited (late Marples, Leach and Co., Limited), have appointed Mr. J. B. Chambers engineer and representative for the Yorkshire district. Mr. Chambers' address is 76, Hill Top Mount, Roundhay-road, Leeds.

A SPECIAL general meeting of the trustees of the Harbour of Dundee was held on the 21st September, 1909, at which the trustees appointed Mr. John Hannay Thompson, M. Inst. C.E., the engineer, as general manager of the Harbour of Dundee, with control over all affairs of the harbour and the Tay ferries, and all other undertakings of the Trust.

MESSRS. TYLER AND FREEMAN, of 20, New Bridge-street, London, E.C., ask us to state that while re-arranging and extending their offices they are making up a fresh file of catalogues, and that they would be much obliged if all manufacturers of electrical and mechanical apparatus and machinery of all kinds would send them complete copies of their catalogues, with prices and discounts.

THE Home-office has issued the report of Major A. Cooper Key, Chief Inspector of Explosives, on the explosion at the Blackbeck Gunpowder Factory, near Ulverston, by which two workmen lost their lives. The two men were engaged in corning or granulating gunpowder, and the inspector explains that in this work cakes are passed by means of a wooden hopper between a pair of gun-metal toothed rollers known as crackers. When passing the cake through the crackers a piece will sometimes "flirt" or "play" on to the rolls, and the workmen are accustomed in such cases to turn the piece with a strip of copper. When clearing the debris a piece of copper was found showing distinct marks of the teeth of the cracker rolls. The inspector has little doubt that with this strip the true explanation of the accident has been found. In future strips of ash or sycamore will be used for this purpose instead of copper.

CONTRACTS.—The Mirrlees Watson Company, Limited, has recently secured contracts for low-level counter-current jet-condensing plants for the Niddrie and Bonhar Coal Company, Limited; the Fife Coal Company, Limited, Mary pit, and the Fife Coal Company, Limited, Kinglassie pit, as well as for a surface-condensing plant for the Aktiebolaget de Lavals Angturbin, Stockholm; for a barometric condensing plant from Okura and Co., for Formosa; and for two sets of large three-throw air pumps from Henry Tate and Sons, Limited, Silvertown, E.—Schmidt's Superheating Company, Limited, has during the last six months received orders for fitting its patented superheater to forty-three separate vessels, having a combined indicated horse-power of 22,650.—Reavell and Co., Limited, have received orders for an electrically driven compressor for the borough of Rotherham for supplying air to the various pneumatic sewage ejectors in the borough, and for a large machine of the quadruplex double-ended type, to the order of the General Post-office, for pneumatic despatch at the Central Post-office.

NOTES FROM GERMANY, FRANCE, BELGIUM, &c.

(*From our own Correspondent.*)

More Firmness in Rheinland-Westphalia.

In most departments of the iron and steel industry stiffness has increased since last week, and more life is shown, dealers and consumers purchasing rather largely at the present low prices. For sales to Holland, Denmark, and Sweden higher rates are already quoted, and they are generally paid, though somewhat reluctantly. Inland quotations are the same as before, but the increasing number of orders has caused prices to become very stiff. After the hand-to-mouth business that has been done for so long, it is quite a relief to hear of sales having been effected up to the end of March, 1910. Owing to renewed difficulties the negotiations concerning the forming of a German Plate Syndicate have now been finally broken off. All the works belonging to the Steel Convention, also the Silesian works, have resolved to hold back with sales of bars for 1910 till after the 30th inst., so as to be able to carry higher prices.

Iron and Steel in Silesia.

The fair amount of orders and the improving inquiry of late experienced have caused the minimum quotations for pig iron to be raised M. 1 p.t. All concerns are reported to be well occupied.

German Steel Convention.

At the recent general meeting it was stated that orders booked on September 10th exceeded those of the same time last year by 550,000 t. In semi-finished steel and in sectional iron a good demand is experienced; deliveries in the last-named article from January to August of present year were 193,000 t. higher than in the same period in 1908. In heavy rails a moderate business is being done.

Coal in Germany.

In Rheinland-Westphalia engine fuel is complained of as being still but moderately called for. Shipments to the Upper Rhine have been comparatively heavy. Deliveries, generally, have been about the same as in last month; small nuts remain in weak request. There has been rather less done in gas coal this month than last; briquettes continue in fair demand. A steady business was experienced on the Silesian coal market. The cokeries are also reported to be in active work.

No Change in Austria-Hungary.

A moderately firm tone prevails in the iron and steel industry. Sales of the United Austrian Ironworks in August of present year were as under:—

	1909.		1903.		
	q.		q.		q.
Bars, sectional iron ..	293,037	..	305,072	−	12,035
Girders	130,028	..	141,800	−	11,772
Heavy plates	40,993	..	40.893	+	100
Rails	55,433	..	144,222	−	88,789
	Since January 1st.				
Bars, sectional iron ..	2,122,512	..	2,522,420	−	399,908
Girders	900,236	..	904,599	−	4,363
Heavy plates	368,171	..	367,337	+	334
Rails	697,342	..	792,181	−	94,839

A falling off is shown in the demand for nearly all articles as compared with the same month last year. Increasing inquiry was reported for gas coal on the Austro-Hungarian market.

The Belgian Iron Market.

The upward tendency continues. Pig iron shows more strength, and the number of orders increases. Luxemburg ironworks are stated to have secured contracts for basic at 60f. p.t., foundry pig at 64f. p.t. free place of consumption. Of forty-four existing blast furnaces, thirty-seven only were in blow in the beginning of September, with a daily output of 4952 t. In August of the present year the output was 147,060 t., as compared with 101,430 t. in the same month the year before. Total output during the first eight months of present year was 1,034,650 t., as against 782,700 t. during the same period the year before. The manufactured iron market has stiffened a little, and better prices were realised in a few instances, but German competitors are met everywhere, at home as well as abroad. Since the beginning of August merchant bars have advanced 2.50f. p.t. Both rails and girders have shown increasing firmness. No change of importance has taken place on the Belgian coal market; briquettes are tending downwards, but coal is strong. At the tenderings for coal for the State Railways, which took place on the 22nd inst., existing prices were generally maintained; inland pits have been fortunate in obtaining the greater part of the contracts.

AMERICAN NOTES.

(*From our own Correspondent.*)

New York, September 22nd.

One of the most active branches of the steel industry at the present time is that of pipe-making. All pipe foundries have expanded their capacity, the United States Cast and Foundry Company having doubled their capacity in eight weeks. This company has just purchased 18,000 tons of pipe iron to cover contracts on hand. Another big pipe concern is in the market for 20,000 tons for delivery during the first quarter of next year. There are about 60,000 tons of pig iron at the various Valley furnaces, and buyers are now endeavouring to purchase every ton of it. Stocks of basic pig have been cleared up and orders for Bessemer pig are now being placed for delivery next year. There are numerous inquiries for foundry iron, and if they result in sales foundry capacity for this year will be pretty well sold up. Such extensive ordering is, however, improbable, because of the unwillingness of pig iron makers to contract for future delivery at any concessions from present prices. The sheet manufacturers are better sold up than they have been for two years. Much corrugated sheet is being used in construction, and the demands for sheet for various other purposes is constantly expanded. The tin plate mills will show for September an increase of 20 per cent. over August. The bar mills are similarly active, but their orders are very largely for immediate delivery, while the sheet mills are booking orders for next year's delivery. The tube branch has become quite active because of the rush of orders for engines and boilers. The locomotive builders are at last on full time and they are piling up business at a rapid rate. The National Tube Works report a heavy accumulation of orders during this month. The builders of pipe lines for oil gas and water are now contemplating the placing of orders for pipe for enterprises which cannot be undertaken before next spring, excepting in certain localities, as Oklahoma and Texas. Plans are now being laid by various large interests for the starting of large enterprises involving railroad building, warehouse building, pipe line construction, and other great works that will absorb a volume of supplies that can only be guessed at. For the first sixteen days of September the exports from Atlantic ports amounted to 9800 tons. The usual supplies of tin are arriving and spot price is 30.25.

The development of copper mining is attracting more attention and more capital than at any time in the history of copper. Quite an amount of productive capacity will be brought within reach of the markets and the world during the coming twelve months. The latest developments in Alaska are full of encouragement. The main condition confronting those who have the development of the copper fields in hand is the construction of railroads, and this vital problem is receiving the earnest consideration of some of the foremost capitalists of America.

BRITISH PATENT SPECIFICATIONS.

When an invention is communicated from abroad the name and address of the Communicator is printed in italics.

When the abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent-office Sale Branch, 25, Southampton-buildings, Chancery-lane, London, W.C., at 8d. each.

The first date given is the date of application; the second date at the end of the abridgment is the date of the advertisement of the acceptance of the complete specification.

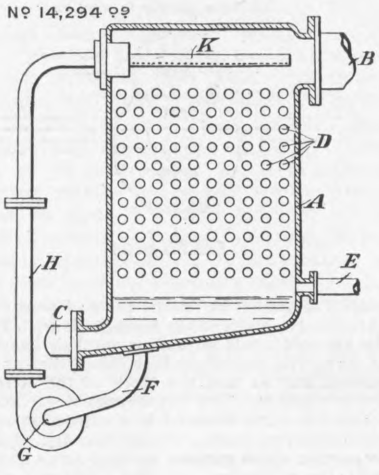
Any person may on any of the grounds mentioned in the Acts, within two months of the date given at the end of the abridgment, give notice at the Patent-office of opposition to the grant of a Patent.

STEAM GENERATORS.

14,294. July 1st, 1908.—Improvements in or relating to Surface Condensers, Edward Shaw, of Clayton Croft, Dartford Heath, Kent.

According to this invention, in order to avoid the possibility of the cooling surface becoming coated with a layer of water whose outer skin or surface, against which the steam to be condensed impinges, is considerably hotter than the surface which is in contact with the cooling surfaces, and with the object of obtaining sufficient movement of the water to ensure rapid transfer of heat from the steam to the cool surface, the water of condensation is caused to flow, as by pumping, in sheets over the condensing surfaces. The accompanying engraving illustrates a surface-condenser casing A with steam inlet B, outlet C for water of condensation, circulating water tubes D, and outlet E for air. Condensation water is drawn through a suction pipe F from the lower part of the casing by means of a centrifugal or other pump G, and delivered through a pipe H to perforated pipes K arranged at the upper part of the casing above the tubes over the condensing surfaces of which it flows.—*September 8th*, 1909.

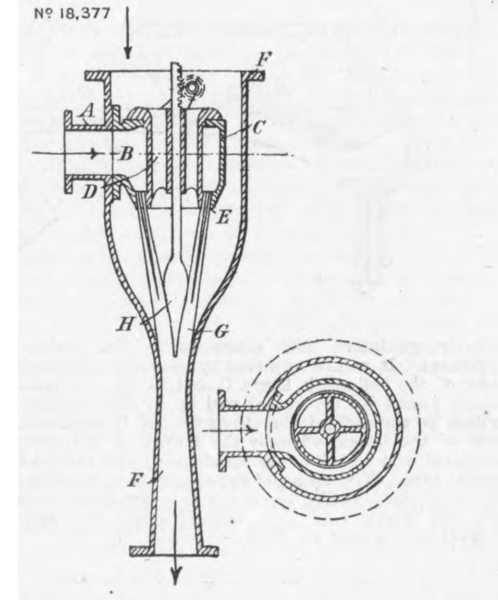
Nº 14,294 99



18,377. September 1st, 1908.—Improvements relating to Jet Condensers, *Otto Kolb, of 7, Sudenstrasse, Karlsruhe, Germany.*

The working of this condenser is as follows:—The cooling water introduced under pressure through the branch A into the conduit B of the inlet nozzle C, D, escapes from the nozzle through the slot E in the shape of hollow cylinders or hollow cones, also under pressure, and with a corresponding velocity. It then comes into contact with the steam supplied to the condenser at F. Owing to the construction and arrangement of the nozzle C, D, the steam can come into contact with the water escaping from it, both inside and outside, so that a large area of contact for the steam is obtained. Owing to the cooling water escaping from the slot E and exercising a strong suction on the steam, the contact between steam and water will be a very thorough one, so that perfect condensation will be obtained. At the same time, owing to the strong sucking action of the cooling water, a high vacuum is produced, the air present being entirely carried away. The mixture of air, condensed vapour, and cooling water, formed in the condenser, passes then into the outlet branch F through the annular nozzle or its slot G, formed by the condenser casing and the part H, and escapes from the outlet branch F in the shape of a continuous stream. By means of the part H, the mixture jet passing through the second nozzle is properly and correctly guided, so that any disturbance in the discharge of the mixture which might have the injurious effect on the vacuum in the condenser is avoided.—*September 8th*, 1909.

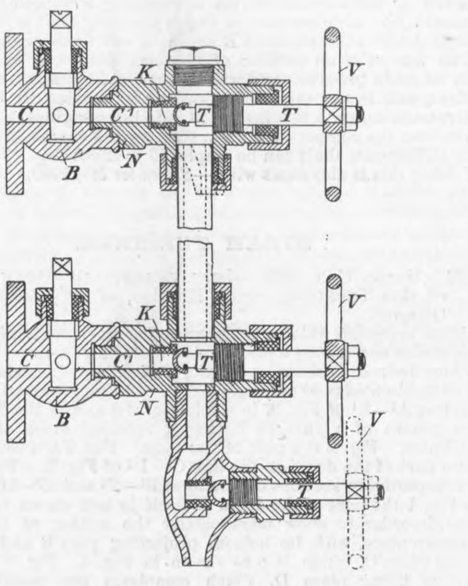
Nº 18,377



21,501. October 10th, 1908.—Improvements in Gauge Glass Fittings for Steam Boilers and the like, *Friedrich Vomhof, of 44, Untere Friedrichstrasse, and Robert Pries, of 34, Schulstrasse, both of Weidenau, Germany.*

For the purpose of controlling the water level and disconnecting the gauge from the boiler at any moment, a cock body B is mounted between the gauge head and the boiler and secured to the latter by means of a flange. Into the screw-threaded portion of the cock casing B a water gauge head N is screwed. The latter is provided, in line with the passage C, with a passage C^1, in which an easily interchangeable steel valve seat K is mounted, which can be closed by a conical valve removably connected to a spindle T provided with a hand wheel V. The joint between the cock casing and the spindle T is rendered air-tight by means of a stuffing-box.—*September 8th*, 1909.

Nº 21,501.

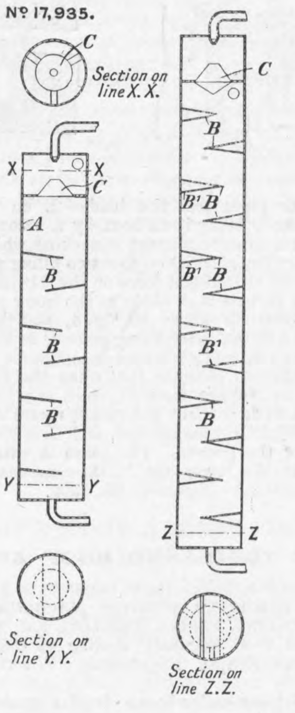


INTERNAL-COMBUSTION ENGINES.

17,935. August 26th, 1908.—Improvements in Carburetters, Joseph Gurdon Leycester Stephenson, Civil Engineer, of 33A, The Broadway, Hammersmith.

The carburetter shown on the right embodies the improvements according to this invention. The hydrocarbon and air are admitted in two streams opposite in direction. The hydrocarbon is spread by the cone C, falls on to the plates B B in succession, and flows off from the edges of such plates in a thin sheet which is met by the incoming stream of air so that the latter becomes thoroughly saturated. The height is so chosen as to ensure complete impregnation of the air, and will vary according to the density of the hydrocarbon employed, the rapidity with which the gas has to be generated, and other circumstances, as is readily understood. The carburetter may be provided with the usual means for retaining any unvaporised liquid that might otherwise be carried away by the outflowing gas. In the construction shown on the left the air under certain circumstances is liable to collect in the angle formed by the underside of plates B and the walls of the cylinder A, and to create a certain amount of back pressure which somewhat impedes the operation of the apparatus. In order to obviate this disadvantage the stay-plates B B^1 shown on the right are provided, which make the channel between the several plates B B of uniform, or practically uniform, height throughout, so that a quiet, uniform current of air flows upwards through the liquid.—*September 8th*, 1909.

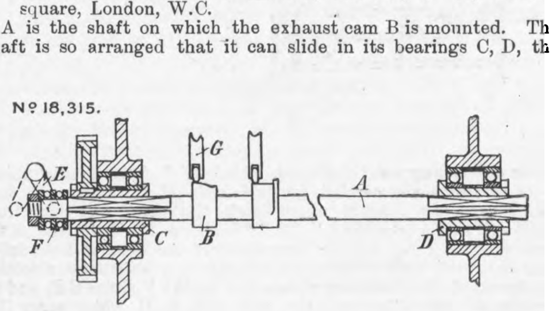
Nº 17,935.



18,315. September 1st, 1908.—Improvements in and relating to Valve Gearing for Internal Combustion Engines, Oscar Charles Selbach, of 28, Russell-square, London, W.C., and the Etablissements Selbach, Limited, of 28, Russell-square, London, W.C.

A is the shaft on which the exhaust cam B is mounted. The shaft is so arranged that it can slide in its bearings C, D, the movement being conveniently controlled by a lever E connected to a double ball-thrust washer F on one end of the shaft A. Each cam B is of sufficient width to remain in contact with its valve tappet G whatever the position of the cam shaft A. The inlet cams H are cylindrical, that is to say, all cross sections at right angles to the axis are similar and similarly placed; but the

Nº 18,315.

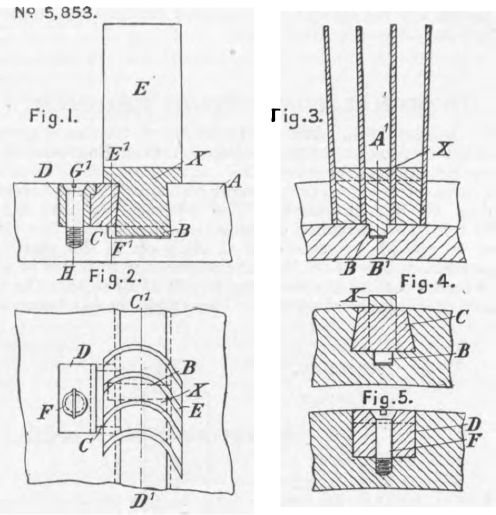


exhaust cams B are helical, that is to say, any two cross sections at right angles to the axis are similar, but are turned through an angle proportional to the distance between the sections. It will be seen that the setting of the inlet valves is not altered by sliding the cam shaft A longitudinally, but that the opening and closing of the exhaust valves is gradually advanced or retarded according to the direction in which the cam shaft is moved. By shaping the exhaust cams B as above set forth with a suitable pitch the extreme position of the cam shaft A in one direction can be made to correspond with the normal timing of the exhaust valves, and in the other direction to the opening of the exhaust valves according to this invention. In large engines it is necessary to relieve the compression when starting the engine by hand, and the sliding cam shaft can be employed to effect this. The method of doing this is also dealt with.—*September 8th*, 1909.

STEAM TURBINES.

5853. March 11th, 1909.—Improvements in Steam Turbines or Gas Turbines, James Howden, of 195, Scotland-street, Glasgow.

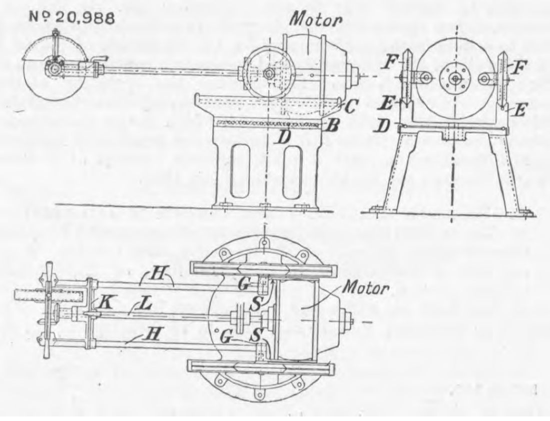
This invention relates to improved arrangements which permit the blades and distance pieces to be uniformly secured accurately in the desired position or at the desired angle in relation to the fixed guide blades or nozzles. Fig. 1 is a longitudinal section on the line A^1—B^1 of Fig. 3, in the line of the axis of the drum across one groove of a turbine having a rotating drum of moderate thickness. Fig. 2 is a plan of the same. Fig. 3 is a section of the same part of the drum on the line C^1 - D^1 of Fig. 2. Figs. 4 and 5 are respectively sections on the lines E^1—F^1 and G^1—H^1 of Fig. 1. In Fig. 1 the part of the drum A itself is not shown in sectional lines, in order to show more clearly the section of the stopper distance piece, with its bottom projecting part B and the inner filling piece C, which is also shown in Fig. 4. Fig. 5 shows the outside filling piece D, which completes the security of the stopper distance piece and the blades E on each side of the stopper, the piece D being itself held by a screw-threaded pin F fixed to the drum so as to prevent it slacking while the turbine is at work. This outer piece D of the two filling pieces C, D, bears no strain from the centrifugal force on the blades E and distance pieces when the turbine is at work, as the inner piece C is secured by its own dovetail as shown in Fig. 4, and therefore the small projection shown in the outer filling piece D in Fig. 1 may be dispensed with. If retained, it serves as a double security. These illustrations suffice to indicate that when the filling pieces C, D, are removed the stopper distance piece can be put in by being first put down a little towards the vacant recess with its lower projection in the slightly tapered slot, and then pushed against the opposite side of the groove. The piece is withdrawn by being brought back in the lower slot in the same manner. There are five other illustrations.—*September 8th*, 1909.


Nº 5,853.

MACHINE TOOLS AND SHOP APPLIANCES.

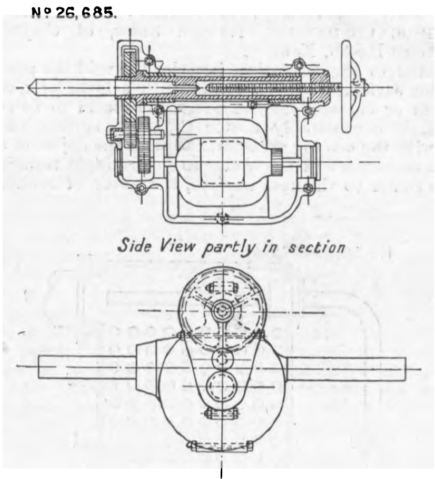
20,988. October 5th, 1908.—Improvements in Adjustable Non-portable Electrically-driven Machines for Grinding, Sawing, Milling, Boring, Drilling, and the like, George Robson and Fred Marshall, trading as George Robson and Co., of the Eclipse Engineering Works, Napier-street, Sheffield.

On the top of the circular base a circular grooved pathway B is provided on which is mounted a revolving head C provided with a corresponding grooved pathway on its under side. Between these grooves the requisite number of balls D are placed. The upper part of this revolving head carries two V-shaped slides E E parallel to each other, and a sufficient distance apart to allow of their supporting two V-shaped wheels F F from the trunnions G G, of which are carried two side rods H H, their rear ends being fixed to a bracket which carries the motor, and their front ends carrying a crosshead K, which supports the front end of the driving spindle L. By this arrangement the driving mechanism can be moved backwards and forwards in a horizontal direction by means of the V-shaped wheels F F on the V slides E E, and by reason of the motor and the side rods H H which carry the driving spindle L being supported on the trunnions G G of the V-shaped wheels, the driving spindle can be elevated or depressed to any required angle within a range of 45 deg. above or below the horizontal, and by reason of the circular ball bearings D on which the revolving head C is carried the whole of the driving apparatus can be turned so as to act radially through the whole circumference of a circle. When not required to turn, means are provided for securing the revolving head C to the circular base.—*September 8th*, 1909.


Nº 20,988

26,685. December 9th, 1908.—Improvements in and relating to Portable Electrically Driven Drilling Machines, Siemens Brothers Dynamo Works, Limited, of York Mansions, York-street, Westminster.

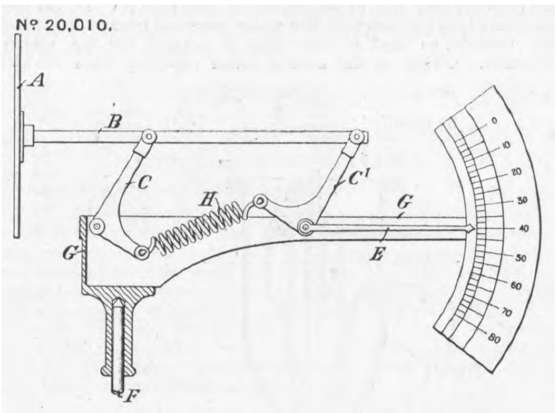
This invention relates to improvements in portable drilling machines of the kind which are driven by an incorporated electric motor situated alongside the drill driving spindle, and which are fitted either with screw arrangements for feeding the drills forwards as the holes become deeper or with a breast plate for the same purpose. These improvements consist, first, in dividing the machine framework into two parts in a plane which cuts the axis lines of the shafts of both motor, drill driving spindle and countershaft, these shafts being arranged in the framework in such positions as to make this possible. In this manner all the moving parts are readily accessible for the purposes of repair or examination, and when the two parts of the framework are bolted together all the shafts are held firmly in position in their bearings, so that they cannot move with respect to each other when the machine is roughly handled, and so that the teeth of the spur wheels are kept in proper register. The improvements further consist in combining with the above referred to construction arrangements which are in themselves known, wherein the drill driving spindle has a hollow portion which encloses the feed screw and is encircled on the outside by a bearing. In this manner a large area of bearing surface can be obtained for the driving spindle, and the bearings of the drill driving spindle can be placed at a considerable distance apart, and thus a stronger and more reliable machine can be obtained.—*September 8th*, 1909.


Nº 26,685.

TESTING AND MEASURING INSTRUMENTS.

20,010. September 23rd, 1908.—Improvements in the Determination of Wind Velocity, Sir Hiram Stevens Maxim, of Thurlow Park, Norwood-road, West Norwood, Surrey.

This apparatus comprises a disc or plate A of suitable size connected on its axis to a rod B to which two bell-crank levers C and C^1 are attached, the bell-crank levers C and C^1 being pivoted to the frame G in such a manner that the cranks, not connected with the aforesaid rod, point one towards the other, as shown. These two cranks are joined by a spiral spring H, whilst one of the levers has a pointer E connected thereto which moves over the face of a suitably graduated dial connected to the casing G of the apparatus. It will be seen that by the before-mentioned arrangement of the bell-crank levers C and C^1 the movement of the cranks joined by the spring will be in opposite direction when motion is transmitted thereto by the rod B connecting the other ends of the levers, whereby the tension of the spring will be increased and so allow the spacings on the dial to be approximately even. The casing of the apparatus is suitably pivoted on the rod F, for instance, to allow it to rotate under the influence of the dial which acts as a vane to bring the aforesaid plate immediately against the wind.—*September 8th*, 1909.


Nº 20,010.

SELECTED AMERICAN PATENTS.

From the United States Patent-office Official Gazette.

932,945. Annealing Furnace with Inlet sealed by Steam, *C. C. Baldwin, Perth, Amboy, N.J., assignor to Standard Underground Cable Company, Pittsburg, Pa., a Corporation of Pennsylvania.—Filed July 3rd*, 1909.

An annealing furnace having a heated retort, an inlet mouthpiece extended downward from the inlet of the retort and open to the atmosphere, a conveyor arranged and operating through the inlet mouthpiece and the retort to carry the metallic articles for annealing through the same, means for wetting the said articles with water when placed upon the conveyor, a mouthpiece extended downward from the outlet end of the retort, and a tank with liquid covering such mouthpiece, the air being excluded from the retort and the inlet mouthpiece by steam generated from the moisture upon the articles. There are six claims.

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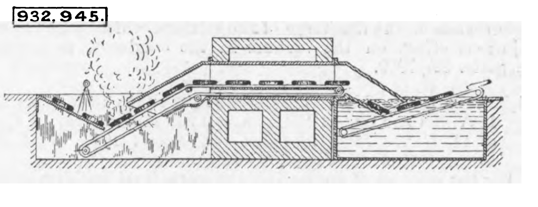
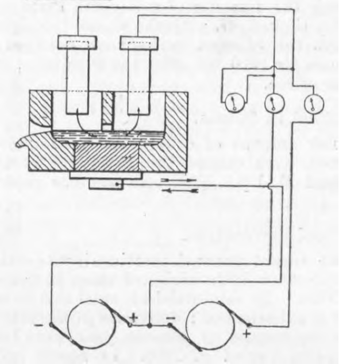


932,835. Electric Furnace, *J. B. Trillon, St. Jeoire, France, assignor to himself and La Société Electrochimique du Giffre, St. Jeoire, France.—Filed July 6th*, 1907.

An electric furnace comprising at least two independently adjustable electrodes of opposite polarity, and in which the sole conducting bath forms a part of the generating circuit and at least two hearths are formed, with a third conductor between the sole and a selected point of the generating circuit to allow of the return of the electric current wholly or partly through the third conductor.—There is only one claim.

932,835.


930,401. Feed-water Filter.—*R. C. Monteagle, Winchester Mass.—Filed November 2nd*, 1908.

The drawing makes this invention clear without much description. Perforated pipes are arranged as shown. The pipes are wrapped in filter towelling. One head can be taken off and the pipes withdrawn. While the change is being effected the feed can be sent direct into the boiler. There are nine claims.

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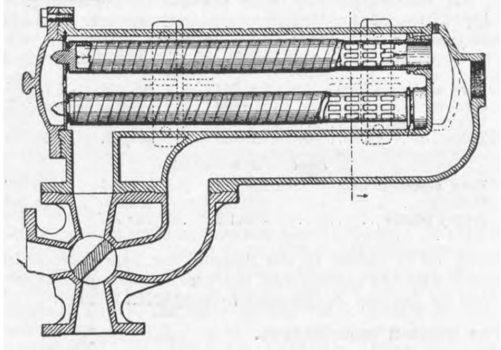
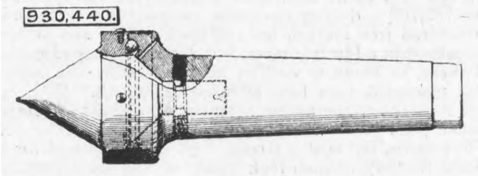


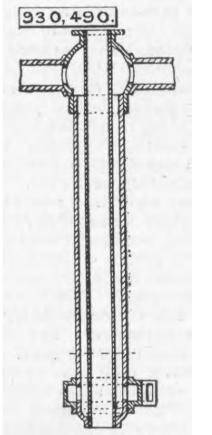
930,440. Lathe Centre.—*C. S. Totten, Pittsfield, Mass.—Filed May 13th*, 1908.

930,440.


The centre is fitted with ball bearings, and rotates with the work instead of the work rotating on it. There are two claims.

930,490. Method of Producing Rods, Tubes, Wires, &c., Direct from Molten Metal.—*A. H. Pehrson, Central-palatset, Stockholm, Sweden.—Filed December 1st*, 1908.

There are three complicated claims, which simply mean that the cooling water flowing down the annular space passes out through a reaction turbine nozzle, and so causes the rotation of the apparatus, the molten metal, by centrifugal force, lining the internal tube.

930,490.


A consular report for the year 1908 on the trade and commerce of the consular district of Rosario states that the construction of railway extensions and works is unprecedented, and promises to last for some time. The existing companies, in view of competition from new lines under construction, have been and are undertaking considerable expenditure, so as to be in a position to compete for the ever-increasing passenger traffic. Rosario will shortly be connected with the capital, Buenos Ayres, by five different lines of railways. There is little doubt that the present exceptionally flourishing condition of the country has been largely brought about by the railway companies' large expenditure for expropriations of lands for new lines, extensions, works, and improvements.

SOME RECENT LOCOMOTIVE PERFORMANCES ON THE NORTHERN RAILWAY OF FRANCE.

By J. T. BURTON-ALEXANDER.

The locomotive work on the Northern Railway of France is always interesting, and this summer I had the occasion to enjoy some remarkable performances with the new 4–6–0 passenger engines illustrated and described in The Engineer of June 4th. I need hardly describe the gradients of the main lines. The articles of the late Mr. Rous-Marten have rendered them familiar to your readers. As with him, all my notes are the result of personal observations, and the loading of the trains is official, and in every case exclusive of the engine and tender. I shall not try to make comparisons or draw conclusions, but with, I hope, equal impartiality record what I have observed. I can only take him as my model, and strive as best I can to continue on the same lines.

The chief work that I had this summer in the way of locomotive novelty was with the 4–6–0 passenger engines. These engines were built for a specific purpose—heavy fast trains with frequent stops. They were not built for the fastest *rapides*, and they are exclusively in the *roulement*, or, as we should say, in the link of these slower trains. I may add that these engines so closely approach the classification of mixed traffic engines that, to prevent their being used for the fast, heavy coal trains now worked by the small 4–6–0 engines with a similar diameter of driving wheels, the Locomotive Department has purposely not fitted them with the vacuum brake—that in use for the goods trains. The axle loading weight was a great cause of difficulty, and is the real reason of the adoption of such small wheels as 69in. To reduce to a minimum the effects of back pressure, the steam ports and ways have been entirely re-designed, and drawings to be given later will show. The tenders of these engines are of a novel design, and will also be illustrated. The advantages are considerable; the coal is always to hand for the fireman, who has never to climb over the tender to shovel it forward, while the footplate is rendered less dusty. This is a great point for the eyes of the men, especially with briquettes.

Before turning to the actual performances I should like to explain that any slight deceleration, more apparent than real, is due to the new junction after St. Dennis for the four roads towards Chantilly, as all facing junctions must be crossed at a speed not exceeding the average running speed of the train. This is a considerable handicap to the ascent of the bank to Survilliers, as compared with former times.

It was considered that the best tests of these 4–6–0 engines would be on the very trains they were not built for, so I shall choose two runs, one to Calais on the 9.50 boat train, a very heavy, fast *rapide*, and the other at an over 60 miles an hour booked speed on a train that nominally has a moderate load, but on this occasion had it increased—the Nord express.

On the 9.50 Calais boat express our load was eleven coaches, weighing 315 tons, which pulled very heavily owing to some foreign six-wheeled stock being in the train, and the weather was cold, misty, and a drizzling rain at times, with a side wind. This train is allowed 113 min. to Abbeville, 109½ miles, and 84 min. on to Calais for the 77 miles. We started sharp to time, and gained speed so rapidly that 2½ miles from the start we were already doing 55 miles an hour, and St. Dennis, 3¾ miles, was passed in 5 min. 45 sec., at the regulation speed of 58 miles an hour; on the long climb to Survilliers the speed varied between 55 and a minimum of 51¼ miles an hour, with the regulator wide open, and an admission of 55 to 58 and 68 per cent. in the high-pressure and low-pressure cylinders respectively. While climbing the bank steam was easily maintained, and the water level did not vary to any degree. Survilliers—18¾ miles—was passed in 22 min. 25 sec., and our speed rose very rapidly to 70 miles an hour, when we shut off to pass Chantilly; after this our speed again reached 70 miles an hour, when the Creil slack to 50 miles an hour for the junction to St. Quentin slowed us again. However, we passed this station, 31¾ miles, in 34 min. 13 sec., and on the easy gradients to Clermont attained 63.7 miles an hour; up the hill to Gannes, 54½ miles, which we passed in 58 min. 28 sec., our speed never went below 55.8 miles an hour, with an admission of 52 and 65 per cent. respectively, the regulator being wide open. As we were slightly early, a very steady descent to Amiens followed, though at Ailly-Noye a special speed restriction of 50 miles an hour was in force for 1¼ miles; at Longueau we observed a most cautious slack, and we passed Amiens, 81¾ miles, in 84 min. 13 sec., at exactly the regulation speed of 25 miles an hour. We gained speed rapidly once passed St. Rock, and maintained a steady rate of 63 to 66 miles an hour up to Abbeville, where we stopped in 112 min. 35 sec., after having shut off steam some distance outside and running in exceedingly cautiously to the water crane. The start from Abbeville was very smart, though on a curve, and our speed had reached 1½ miles from the start 40, 2½ miles 51¼, and at 6 miles, including a short rise of 1 in 200, 58.7 miles an hour. Continuing on the level, at a speed of between 65.1 and 62 miles an hour, we passed Etaples, 32½ miles from Abbeville, in 32 min. 15 sec. The bank after Dannes-Camiers was smartly ascended at a minimum speed of 47.5 miles an hour, the admission being 55 and 68 per cent. respectively; a smart descent followed, but a signal "slow" before the Boulogne junction reduced our speed to 30 miles an hour, and we passed the Tintilleries station, 50 miles, in 50 min. 10 sec. Our speed in the tunnel up the 1 in 125 never fell below 40 miles an hour, and as we were early, no special effort was made till the Caffiers bank was reached. We began this long bank at 57 miles an hour, instead of 70, as is usually the case, which had only decreased to 42.6 miles an hour at the top, the admission being 58 and 68 per cent. at the end, with, I need hardly say, the regulator full open, which is its normal position when climbing any bank. We dropped down the corresponding descent to Calais with steam shut off, never quite touching 60 miles an hour, and in spite of taking 6 min. from Fontinettes to Calais Pier—3 miles—we stopped in 82 min. 50 sec., 1 min. early, with nothing deducted for the Boulogne slack. The object of the run was to see if these engines could keep the *rapide* booking, and this run shows how easily and with what a curiously even speed we made the run, and with what an entire absence of high downhill speeds.

The other train I will give in detail is even harder, for here the booking is over 60 miles an hour—Paris-St. Quentin, 96 miles, in 95 min. As I have said, the normal load is 250 tons, but owing to heavy passenger traffic we had an extra coach, making eight coaches, or a load of 287 tons. The weather again was unfavourable, heavy showers of rain and a strong side wind.

Starting very smartly, we passed St. Dennis in 5 min. 30 sec. at exactly 60 miles an hour, which had risen at the foot of the bank to 61.4; however, at kilometre post 12 a distant signal at danger forced us to shut the regulator, and before we saw the home signal was clear our speed had fallen to 50 miles an hour. Starting away with the regulator wide open, and 58 and 68 per cent. admission respectively in the high-pressure and low-pressure cylinders, which gave a low-pressure receiver pressure of 56 lb. per square inch, our speed rapidly increased, till at Louvres it had again touched 60, while the absolute minimum to the top of the bank was 57.7 miles an hour. Survilliers was passed in 20 min. 35 sec., at least 30 sec. having been lost by the signal check, and we soon attained the legal maximum speed of 74.4 miles an hour. We passed Chantilly, with the regulator shut, at 59.1 miles an hour, but before Creil our speed had again reached 74.4. This station was passed in 31 min. 50 sec. at 37.3 miles an hour, but recovering rapidly our speed, we maintained a speed of between 65 and 67.1 miles an hour up to Compiègne, 52½ miles, which we passed in 51 min. 30 sec. at 55 miles an hour, a speed required by the position of the station. In the first hour we covered exactly 61¼ miles, and were well on time; but before Noyon signals brought our speed down to 25 miles an hour, for a goods train that was being shunted there, and caused us at least two minutes' delay; gaining speed rapidly, we maintained a rate of 68 to 70 miles an hour, and passed kilometre post 129 in 78 min. 50 sec. Owing to bridge renewals in Tergnier Station itself our speed was reduced to 12 miles an hour at the very beginning of the 9-mile bank of 1 in 333, and we only passed this station, 81¾ miles, in 80 min. 50 sec.; so well, however, did we get away that our speed rose steadily up the bank till at the top we were doing 62.1 miles an hour. We came into St. Quentin Station very steadily, where we stopped in 96 min. 30 sec. gross, 91 min. net, or a speed of 63.3 miles an hour. The subsequent ascent of 1 in 200 to Bussigny was climbed at a minimum of 57.7—curiously enough, the same speed as to Survilliers. These two runs show what these passenger engines can do, and I must say at no time did our steam pressure vary or the water level drop, even on this last run. On both occasions the engine was 3.524, and her driver and fireman, especially the latter, were noticeably efficient. On other occasions the work has been noteworthy with various engines of this class, and I will give shortly some of the most striking. With a load of 184 tons we attacked the Caffiers bank, from the Calais side, at a speed of 53.4 miles an hour, which rose steadily to 56.2 at the top, while after Hesdigneul, with the same train, our speed rose on the bank of 1 in 140, and 1 in 133 to exactly 60 miles an hour at the top.

With another engine and a load of nine coaches weighing 295 tons and steam-heated, we passed Gannes from Amiens in 30 min. 10 sec., the final 4.7 miles being covered in 4 min. 35 sec. With the slightly lighter load of 283 tons, composed, however, of ten coaches, in spite of a slow in the middle of the climb up to Gannes, our speed at the top was 60.1 miles an hour. With the same train, though we were stopped after Chantilly on the 1 in 200, our speed at the end of the gradient, 6 kiloms. from the start, was 47.7 miles an hour. I merely record such facts as I have observed.

I think that the following run with a load of twelve coaches, weighing 293 tons, and one of the second class of compounds built in 1895, is worthy of attention. This engine, 2.151, weighs only 49 tons, and has a total heating surface of 1620 square feet, with a grate area of 21.39 square feet. The weather was nasty, mist and rain, while the booking of the train from Paris to Longueau in 90 min. for the 78.3 miles, represents a speed of 52.2 miles an hour. The start was sluggish, St. Dennis being passed in 7 min. 40 sec.; hence, however, the work was very different; up the long bank to Survilliers our speed, which was 52 miles an hour at the foot, varied between that and 50, the absolute minimum being 48 miles an hour, and Survilliers was passed in 25 min. 25 sec., Creil in 37 min. 10 sec., and Gannes in 63 min. 55 sec., our speed up the bank being maintained at a minimum of 50.9 miles an hour. The descent was run easily, and we stopped in Longueau in 87 min. 30 sec., exactly to time, having made up a late start, which represents a speed of 54.3 miles an hour. Considering the weight of the engine, weight of the train, and the gradients, the performance is noteworthy.

I had also some interesting work with the big 4–4–2 express engines. After having done the 9.50 with the new 4–6–0, I wished to do it with a 4–4–2, with the same end in view—to run to time. We had No. 2.669, an engine that had done 250,000 miles before heavy boiler repairs, and the load was 11 coaches, weighing 323 tons. We passed St. Dennis in 6 min. 5 sec., Survilliers in 22 min. 10 sec., at a minimum speed of 52 miles an hour; Creil in 33 min. 15 sec., Gannes in 58 min. 35 sec., the minimum speed being 55.5 miles an hour; Amiens in 83 min., and stopped at Abbeville in 112 min. This is curiously similar to the work of 3.524, especially as up all the hills the engine was worked with the same admission as with the 4–6–0. Starting again, we passed Etaples in 32 min. 25 sec., and Boulogne Tintilleries in 49 min. 10 sec., without any check, our speed up the bank beyond Dannes-Camiers being 48 miles per hour. A re-laying slow hindered the climb of the Caffiers bank, and we only commenced this climb at 53 miles an hour, finishing it at a minimum of 41. After descending without steam we stopped on Calais Pier 1½ min. early, in 82 min. 20 sec.

With another of this class, and the light load of 248 tons, we started so smartly from Boulogne Central that our speed to the top of the bank beyond Neufchâtel never fell below 49 miles an hour, and we passed Etaples, 16.8 miles, in 18 min. 35 sec. after easing down.

On the same occasion we experienced a long re-laying slow at La Faloise, but so smartly did we get away that we went over the top of the bank beyond Gannes at 63.7 miles an hour. Further examples would be merely repetition of such and similar work; but on a surprise visit, with 2.670 and a load of 285 tons, we climbed the Survilliers bank at a minimum of 59.1 miles an hour, while the minimum speed to Gannes was 61.2. This run was not done recently, and no one knew I was going.

I had also the opportunity of a run with a load of forty-six wagons, weighing 900 tons, with one of the tank goods engines 0–6–2–2–6–0. These engines are entirely different from the Malet engines, and are provided with a central single girder, on which is fixed boiler, draught gear, and water tanks. This arrangement enables high speeds without oscillation, and renders the bogies perfectly free to follow the curvature of the line without any pull on them. On the long gradients of 1 in 100 from Valenciennes our speed varied between 11.8 and 12.6 miles an hour, while on a gradient of 1 in 83 our speed was 9.3; this increased to 10.7 within half a mile on admitting live steam to the low-pressure cylinders, the low-pressure receiver pressure being 98 lb. per square inch, and the engine maintained her steam pressure and water level. On the official trials of these engines the trial engine ran from Paris on a passenger train, attaining a speed of 56 miles an hour, and returned with a coal train of 1000 tons over gradients of 1 in 100 and worse. These engines are so satisfactory that the Grande Ceinture Company is having some built for its heavy goods traffic.

Speaking generally, the express passenger engines are worked, as far as possible, with the regulator wide open and an admission of 42 and 65 per cent. in the high-pressure and low-pressure cylinder as a minimum, increased to 58 and 60 and 68 and 70 per cent. on the banks; point to point time is kept exceedingly well, and in case of lateness the time is made up as far as possible without exceeding the maximum speed of 74.4 miles an hour. The coal consumption, from figures I saw put up outside The Paris round-house for the men's information, would average between 30.6 lb. per mile and 36.28 for the engines in the heaviest passenger service. The smoke-box vacua are fairly high, but the temperatures are not abnormal, and there is practically no spark-throwing.

The Nord have now engines in every way suited for the heavy, fast, stopping trains. I do not think the express engines have been overlooked, and when the present 4–4–2 engines are mastered there will, no doubt, be ready engines which will be as successful as their forebears.

I must thank M. du Bousquet and his coadjutors, including MM. Rodrigues and Koecklin for their kindness in affording facilities and giving blue-prints and information. I was accompanied by Mr. Rudloff, chef mécanicien principale, in all my runs with the 4–6–0 engines. I take this opportunity of thanking him also.

SWING BRIDGE ACROSS THE WEAVER NAVIGATION.

A new swing bridge has recently been erected across the Weaver Navigation at Winnington, near Northwich, by the engineer to this waterway, Mr. J. A. Saner, M. Inst. C.E. The structure is chiefly noteworthy on account of the novel arrangement of the ball-bearing pivot on which it is caused to swing. It should be mentioned that at this place there are two portions of the river Weaver, namely, the flood watercourse and the navigable channel, the latter being an artificial cutting made as an improvement early in the last century. The flood watercourse is spanned by a permanent stone arch of considerable age which replaced a still more ancient structure, and in the neighbourhood of this bridge a skirmish known as the Battle of Winnington Bridge is reported to have been fought between the Royalists and Parliamentarians in 1659.

The old swing bridge recently replaced by the new structure was of later construction, and was built to carry the road traffic across the navigable cutting, some 200 yards away from the stone arch. It was worked by hand, and originally gave only about 25ft. of clear waterway, but about thirty years ago was lengthened to give a 40ft. clear waterway. It was sufficiently strong to allow a rolling load of 8 tons to pass over it, but by giving notice, in order to allow time for packings and supports to be put in the river, heavier loads could be carried. Owing to the increase in heavy motor traffic of all kinds, these temporary supports had to be resorted to with increasing frequency, and as a certain amount of straining of the bridge resulted, the structure deteriorated rapidly, until it became necessary to forbid loads of more than 4 tons to pass over. Considerable inconvenience was thus caused to the owners of heavy vehicles using the bridge, and owing to the fact that the Weaver Trustees were not liable to provide a bridge which was more than equal to the requirements of ordinary traffic, the county and rural councils were asked to contribute towards the expense of building an entirely new structure. This, after some negotiations, they agreed to do.

The old bridge had a roadway about 12ft. 6in. in width only, and a waterway of 40ft. The roadway was of planking, supported on iron girders, and had been much damaged by passing craft, in addition to being distorted

SWING BRIDGE AT WINNINGTON

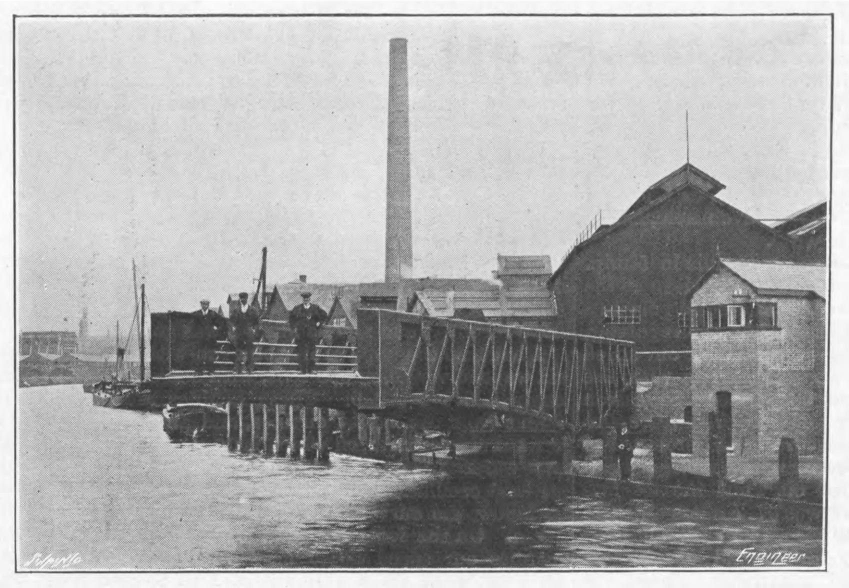


Fig. 1—BRIDGE OPENING

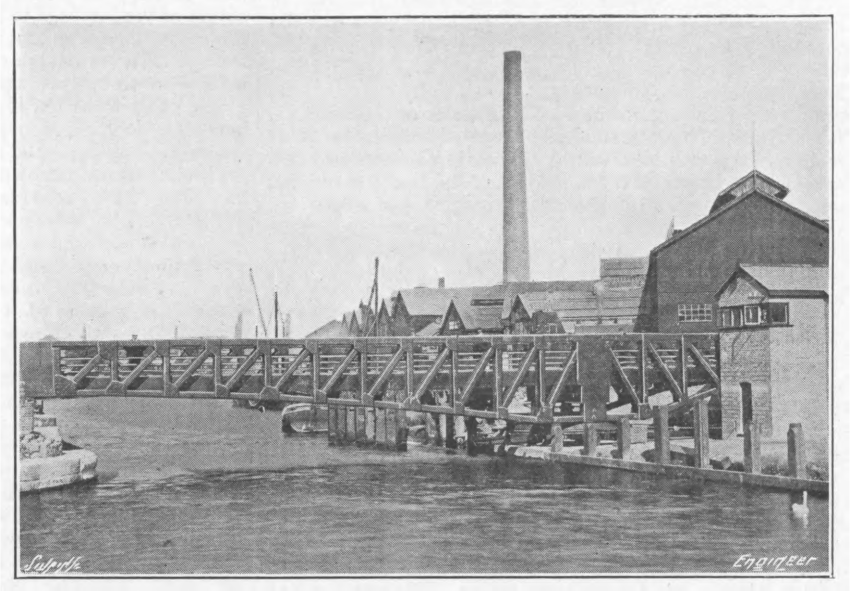


Fig. 2—BRIDGE CLOSED

by heavy loads. It was therefore decided in September last year to commence the construction of the new bridge, and although there was considerable delay with the foundations, not only on account of the structural difficulties, but also because of frost and bad weather, the work was so far complete as to enable the bridge to be used on July 18th last.

The new bridge, illustrated in Figs. 1 to 8 on this and the opposite page, has a clear waterway of 55ft., and a clear roadway of 13ft. 6in., and is of sufficient strength to carry a rolling load of 20 tons on four wheels. The girders are 108ft. long, and consist of steel H and U sections, forming an N type of girder, with a horizontal upper boom and a doubly curved lower boom. The flooring consists of creosoted wood blocks laid on asphalt, which in turn rests on trough flooring supplied by Dorman, Long and Co., Limited. In order to facilitate the balancing of the two halves of the bridge, the nose or long end has arched plates riveted between the troughs, as shown in Fig. 8, for lightness, while the tail or short end has the troughs filled with concrete, and towards the extreme end with specially made cast iron blocks. There is a stiff stringer plate running throughout, taking the weight of the floor and load between the main verticals. The whole weight of about 150 tons is carried on two transverse rolled joists of the largest obtainable section, viz., 2ft. 5½in. by 12in., and weighing 177 lb. per lineal foot. Midway between these girders is a cast steel saddle, clearly shown in Fig. 6, which in turn rests on a Hoffman ball-bearing placed on the top of a cast iron pillar. Interest attaches to the ball-bearing pivot on account of its proportions. There are 40 balls, each 2¼in. in diameter, in two rings which run in independent ball races of circular section resting on a Λ shaped ring, which is intended to ensure an equal bearing throughout. The whole of the above rests on a cup-and-ball casting to allow for oscillation. The latter is limited in extent by means of six steadying rollers on the concrete, which only come into operation when the movement exceeds a certain amount. The cast iron pillar referred to above rests on a cube of concrete carried down in a timbered sump 17ft. below ordinary water-level. The floor of the turning pit is also of concrete stiffened with expanded metal, and the circular retaining wall of the bridge pit, as well as the new portions of the nose-end abutments, are of Staffordshire blue brick.

The bridge is swung by means of a 30 horse-power electric motor, actuating a vertical drum through a worm and worm wheel, as shown in Fig. 7, the wire rope connections being fastened to a circular girder fixed to the bottom of the main girders, which also carries an inverted rail over the fixed steadying rollers. The current for operating the motor is obtained from the mains of the Northwich Electric Supply Company. For one complete operation of opening and closing through 95 deg. the power absorbed amounts to no more than 0.14 B.T.U., and the time occupied is about 45 sec. The safety gates, Fig. 5, at each end of the bridge are opened and closed by hand, each pair being coupled together by means of an underground shaft, so that by taking hold of one gate the man closes the pair. There is only one pair of wedges, and these are placed at the tail end. As will be observed from Fig. 3, they are operated by means of an electric motor supplied by Mather and Platt, Limited. This motor, which is of 5 horse-power, acts through a right and left-hand screw, which opens and closes two pairs of arms arranged like toggles. When these are opened the wedges are withdrawn, and when closed the wedges are pushed home. This arrangement has the advantage that as the toggles approach each other the ratio of the leverage is increased and the greatest force is exerted exactly when required, either when opening or closing. The chief difficulties in connection with the design of the bridge were to obtain a reasonably good foundation and to cause as little diversion of the road as possible while improving the approaches, especially on the Barnton side. The work was carried out without necessitating the employment of a temporary bridge, the old stone abutment being made use of. The cost complete has not exceeded £4000. The drawings were made in the office of the Weaver engineer, Mr. Saner, and the whole of the work, except the electric motor and ball bearings, was carried out in the Weaver Navigation repair yard by the engineer's staff.

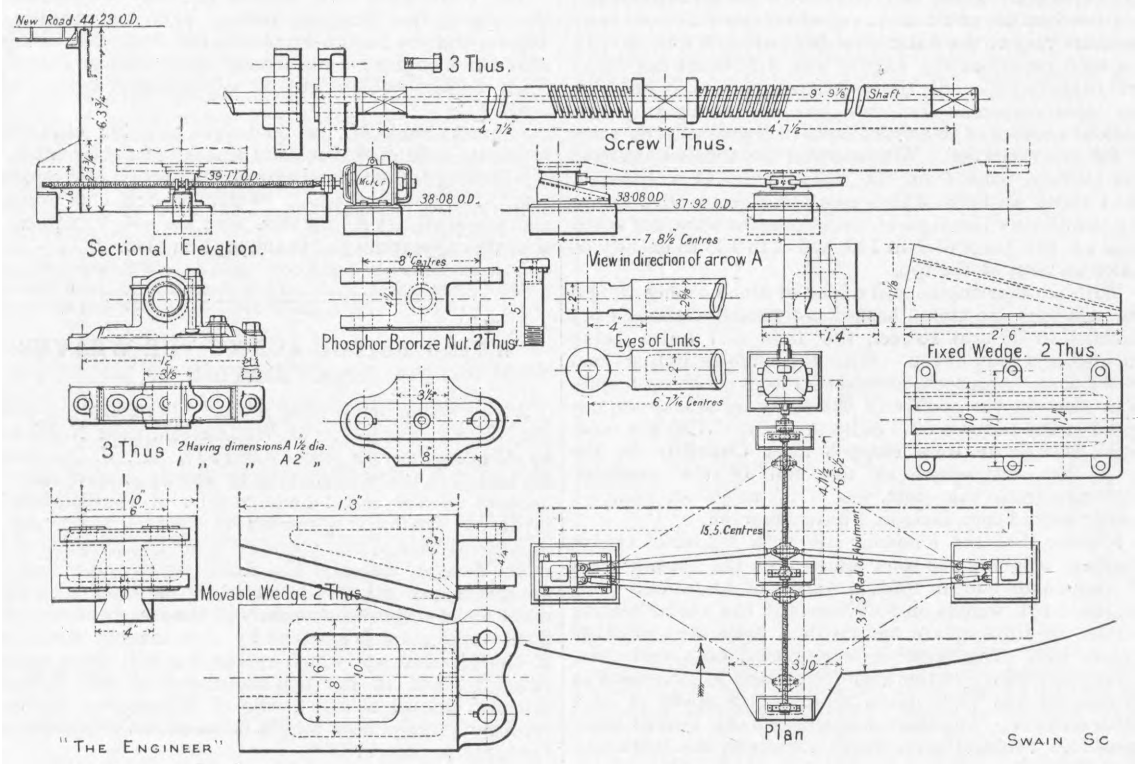


Fig. 3—DETAILS OF THE WEDGE MECHANISM

IRON AND STEEL INSTITUTE.

No. II.*

Sir Hugh Bell, the president, occupied the chair at the second day's meeting of the Iron and Steel Institute, held in the hall of the Institution of Civil Engineers on September 29th. The first business before the conference was the presentation of the Carnegie gold medal, which had been awarded to M. A. M. Portevin. The President, in making the presentation, said that M. Portevin had been educated at the Central School of Arts and Manufactures at Paris, and had made a special study of the properties and characteristics of alloy steels. In the Carnegie Research Memoir submitted by him to the Institute, he gave results of further investigation of the properties of numerous special alloys, with the object of ascertaining the influence of the various elements added to steel.

M. Portevin, speaking in French, gracefully acknowledged the distinction which had been conferred upon him, adding that his work had been carried out in association with M. Le Chatelier and Professor Guillet.

The papers first taken for discussion were those by Mr. Greville Jones on "Uniform Moisture in Blast," and "The Fuel Economy of Dry Blast, as Indicated by Calculations from Empirical Data," by Mr. R. S. Moore. The first we give below in abstract, and the second in full.

Uniform Moisture in Blast.

These experiments, which were intended to show the effect of uniform moisture in blast, were carried out at Clarence Ironworks during this year, were the outcome of several interviews which the author had with Mr. R. S. Moore on the question of the uniformity of blast as supplied to blast furnaces, as it was considered, after careful study of the various discussions by several eminent persons on Mr. Gayley's paper on "Dry Air," that there was still some element of doubt as to whether the principal saving in fuel was due to the uniformity of blast or to its dryness. As soon as the matter was placed by the author before Sir Hugh Bell, he readily consented for the experiment to be carried out on the lines proposed by Mr. Moore, the latter having as a matter of fact, provisionally protected the idea of extracting the peaks or high percentage of moisture from the air during the summer months, and keeping the moisture constant by the addition of steam, if found necessary, during the winter months.

After due consideration, it was decided that it would be advisable to carry out the experiment at No. 9 furnace on the "New Side," for the following reasons:—(1) No. 10 furnace (working alongside No. 9 furnace) was of the same dimensions, and (2) both furnaces were worked by separate blowing engines, and supplied with the same quantity of air; (3) each furnace had four stoves of the same size; (4) both furnaces received their common supply of ironstone, limestone, and coke from the same source; (5) they were both new furnaces, built in 1908, and blown as follows:—No. 9, September 17th; No. 10, June 9th; (6) each furnace was burdened for foundry iron, and carried the same total load. The silicon in the iron was required to be between 2.50 per cent. and 3 per cent.

The experiment was continued for four weeks, the first week being occupied in increasing the moisture up to the desired quantity. As careful observations had been made with wet and dry bulbs outside the engine-house prior to the commencement of the experiment, it was agreed that it would be better not to exceed four grains of moisture in the aggregate.

The procedure was to connect up to the cold blast main and steam pipe from the main boiler plant, and fit it with a calibrated steam valve, so arranged that, for a minute movement of the valve, a certain quantity of steam would be admitted, representing so many grains. A pipe was also connected from the cold blast main into a wooden case, where a wet and dry bulb was hung, with, in addition, an ordinary hair hygrometer, the instrument having previously been calibrated. There was also a connection from the hot blast main to a wet and dry bulb, which gave an additional check. As a further check upon these instruments, the head chemist of the works (Mr. Weldon Hanson) very carefully took samples of both hot and cold blasts gravimetrically for five hours each day. The gases were also taken daily over the same period.

Diagrams, which we do not reproduce, are given showing the results obtained, which are indicated by the following curves:—No. 1. First line gives the records taken by the hair hygrometer—hot blast; No. 2 shows to what extent the steam valve was open; No. 3 gives records of air outside engine-house; Nos. 4 and 5 show the silicon and sulphur respectively. Readings were taken every fifteen minutes from February 11th at 2.30 p.m. to 2.30 p.m. on February 12th, and subsequent readings every thirty minutes until the experiment was completed.

The following are the author's observations on the experiment:—As to the working of No. 9 furnace, no appreciable

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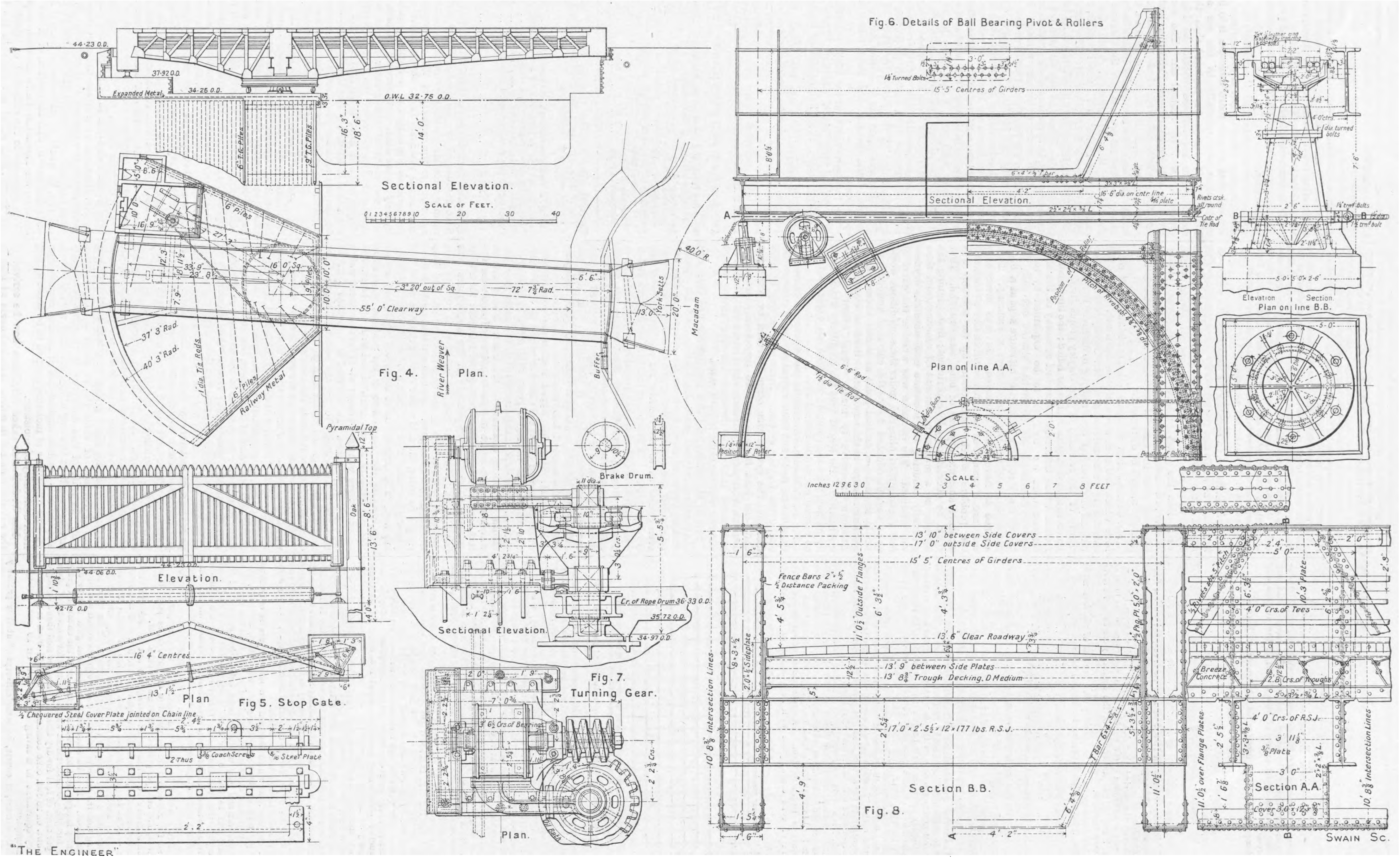
* No. I. appeared October 1st.

SWING BRIDGE OVER THE WEAVER NAVIGATION AT WINNINGTON

MR. J. A. SANER, M. INST. C.E., NORTHWICH, ENGINEER

(For description see page 359)


Sectional Elevation.
Scale of Feet.
44·23 O.D.
37·92 O.D.
34·25 O.D.
Expanded Metal
O.W.L. 32·75 O.D.
16' 3"
18' 6"
14' 0"
6" T.G. Piles
9" T.G. Piles
Fig. 4.
Plan.
River Weaver
6 Piles
6' Piles
Railway Metal
1" dia. Tie Rods
37' 3" Rad.
40' 3" Rad.
55' 0" Clearway
3° 20' out of Sq.
72' 7¾" Rad.
10' 0"
16' 0" Sq.
Buffer
York Setts
Macadam
40' 0" R.
20' 0"
13' 0"
Pyramidal Top
Oak
8' 6"
13' 6"
Elevation.
44·06 O.D.
42·12 O.D.
16' 4" Centres
13' 1½"
Plan
Fig 5. Stop Gate.
½" Chequered Steel Cover Plate jointed on Chain line
2 Thus
⅜" Coach Screws
5/16" Steel Plate
2' 2"
Brake Drum.
Cr. of Rope Drum 36·33 O.D.
35·72 O.D.
34·97 O.D.
Sectional Elevation.
Fig. 7.
Turning Gear.
3' 6⅛" Crs. of Bearings
Oil Bath
Plan.
Fig. 6. Details of Ball Bearing Pivot & Rollers
1⅛" Turned Bolts
15' 5" Centres of Girders
Sectional Elevation.
16' 6" dia. on centr line
Rivets csk. all round
Cntr. of Tie Rod
Plan on line A.A.
6' 6" Rad.
1½" dia. Tie Rod
Position of Roller
Pitch of Rivets
Scale.
Inches 12 9 6 3 0 1 2 3 4 5 6 7 8 Feet
Elevation
Section.
Plan on line B.B.
5' 0"
4' 0" Crs.
1" dia. turned bolts
1⅛" trnd. Bolts
13' 10" between Side Covers
17' 0" outside Side Covers
15' 5" Centres of Girders
Fence Bars 2" × ½"
½" Distance Packing
11' 0½" Outside Flanges
13' 6" Clear Roadway
13' 9" between Side Plates
13' 8⅝" Trough Decking, D Medium
17' 0" × 2' 5½" × 12" × 177 lbs. R.S.J.
10' 8⅝" Intersection Lines
2' 0" × ½" Sideplate
T Bar 6 × 4 × ⅝
Section B.B.
Fig. 8.
4' 2"
Breeze Concrete
4' 0" Crs. of Tees
10' 3" Plate
2' 8" Crs. of Troughs
4' 0" Crs. of R.S.J.
⅜" Plate
11' 0½" over Flange Plates
Section A.A.
Cover 3' 0" × ½"
Swain Sc.
"The Engineer"

difference was found. The average analyses of the pig iron were:—

Before experiment.

	Per cent.
Silicon	2.97
Sulphur	0.037

During experiment.

Silicon	2.76
Sulphur	0.036

showing a reduction of 0.21 per cent. in the silicon, and 0.001 per cent. in the sulphur, the latter of which is of no account, and may be due to the slight excess of lime shown in the average slag analysis.

Comparing similar figures for No. 10 furnace, we have—

Before experiment.

	Per cent.
Silicon	2.89
Sulphur	0.045

During experiment.

Silicon	2.81
Sulphur	0.040

Taking the records for Nos. 9 and 10 furnaces, the author finds that during the experiment No. 9 had eleven slips and No. 10 seven slips.

During the period that No. 9 furnace had uniform blast, no alteration was made in the burdens or temperatures of the blast at Nos. 9 and 10, and the speeds of the engines were kept the same on both furnaces.

Coke consumption.—The quantity used per ton of pig iron made at No. 9 furnace (no deduction for breeze) was—

	Cwt.
4 weeks previous to experiment	21.98
4 „ during „	22.08
4 „ after „	21.86

At No. 10 furnace the results were as follows:—

	Cwt.
4 weeks previous to experiment	22.06
4 „ during „	22.20
4 „ after „	21.80

FUEL ECONOMY OF DRY BLAST, AS INDICATED FROM CALCULATIONS OF EMPIRICAL DATA.

The author was associated with Mr. Greville Jones in making a test to determine the effect of uniform moisture. The results of the test points strongly to the fact that the great heat saving of the Gayley dry blast must be due to its dryness. The theoretical explanations on this basis have not been supported by any actual experimental proof, and they have apparently been as much rejected as accepted. The principal experimental proof which is lacking is data on the saving of fuel to be secured by adding heat to the bosh. In studying the conclusions suggested by the test, it occurred to the author that this hiatus is supplied by the results of experience with the Neilson hot blast.

Fig. 1 is a curve representing the relation between temperature of hot blast and coke saved based on cold-blast requirements, the data for the points from which this curve is plotted being taken from Sir Lowthian Bell's book on "The Principles of the Manufacture of Iron and Steel." A curve which represents the variations of coke consumption with heat added to the blast also represents the combined effect of all physical and chemical changes taking place in the blast furnace, whether the heat changes have to do with carbon-monoxide reduction, the carbon reduction, or the heat absorbed by the iron, the slag, or by heating stock. It is therefore a curve of practice rather than of theory, in so far as it is accurately plotted. It is evident from the slope of the initial portion of the curve that a saving of 1 cwt. of coke is obtained for approximately each 100 deg. Fah. increase of blast temperature. The heat added in the blast per 100 deg. per ton of iron is 276,000 British thermal units. 154,000 British thermal units are required per ton of iron to disintegrate 1 grain of moisture per cubic foot in the blast. This heat is therefore equivalent to $154{,}000 \div 276{,}000 = 0.56$ cwt. on the initial portion of the curve.

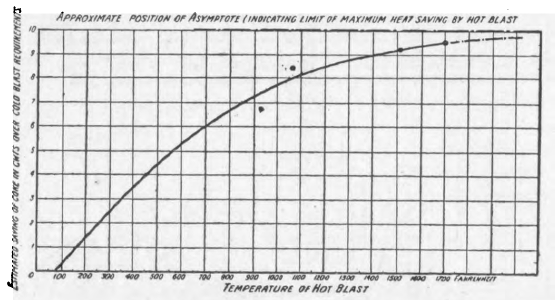


Fig. 1—Relation between Temperature and Saving of Fuel

But the saving in the upper portion of the curve is less than $\frac{1}{2}$ cwt. per 100 deg. Fah., and the question now arises, what portion of the curve applies to the heat necessary to disintegrate moisture? It is a well-known fact that for the economical reduction of iron oxide in the blast furnace, as large a proportion as possible must be reduced by carbon monoxide. Now, as this reduction occurs most readily at about 1100 deg., and decreases rapidly at higher temperatures, and as the temperature of the stock entering the furnace soon approaches this point, it follows that a limit to the amount of heat which should escape in the gases rising from the bosh is soon reached. It was pointed out by Sir Lowthian Bell years ago that the economy of the Neilson hot blast was due to the fact that adding heat to the blast enabled it to supply much of the heat necessary in the bosh to melt the iron and slag. The heat which was thus absorbed did not have to pass through the upper carbon-monoxide reducing zone, thereby heating it and retarding the reduction.

Now, the heat which the iron and slag require is only about 18 per cent. of the total; it appears self-evident, therefore, that the fewer heat units which are added to the blast the easier it is for the iron and slag to absorb them before they pass out of the bosh; but as the 18 per cent. is approached more and more escape to the reduction zone. Therefore, removing the moisture before it enters the furnace is equivalent to utilising all the heat necessary to disintegrate it in melting the iron and fusing the slag. The economy to be expected from low moisture alone is therefore that represented by the initial portions of the curve, or 1 cwt. of coke for 100 deg. Fah. temperature of blast, or, as pointed out before, 0.56 cwt. per grain of moisture per cubic foot.

If 5 grains be taken as the average amount of moisture which can be eliminated, this would be equivalent to $5 \times 0.56 = 2.8$ cwt.; $2.8 \div 20 = 14$ per cent. of 20 cwt. per ton of iron. About 2 grains of moisture were added to secure uniformity, and no gain or loss was found except a very slight lowering of the silica, indicating that the harmful effect of the two grains added was almost neutralised. If it be assumed that the heat gain due to uniformity is equivalent to one-half of this, or to the effect of 1 grain, the foregoing considerations would account for a saving of about 17 per cent. of fuel for dry blast. It may be said that a saving of 2.8 cwt. on 28 cwt. coke consumption on cold blast is not necessarily equivalent to a saving of 2.8 cwt. on 20 cwt. hot-blast consumption.

There must, of course, be some difference, but it is probably very slight, because while under cold-blast consumption 40 per cent. more coke is burned than under hot blast, 50 per cent. more ore is contained in the furnace under hot-blast conditions. Therefore, while there is less carbon monoxide generated, it acts on 50 per cent. more ore, and under better conditions of efficiency, namely, lower temperature. The rate of increase of ore volume to coke volume is also approximately twice as great per cwt. of coke decrease at 20 cwt. hot-blast consumption as at 28 cwt. cold-blast consumption. The coke-saving in the two cases should therefore be very closely similar.

The author regrets that, in the limited time at his disposal, he has been unable to get reliable and full data for more points for the curve. The data are difficult to find, because all the figures for the curve must be for one furnace, operating in each case under the same conditions of ore, fuel, and fluxes. As it is, he trusts there is sufficient to allow of the present contribution finding acceptance as another interesting chapter of the story of the development of the Gayley dry-air blast.

Mr. J. E. Stead, in opening the discussion, to which he intimated he would also contribute by correspondence with regard to the calculations, said he would like to ask Mr. Jones what was the actual amount of steam which went into the blast furnace over the whole period. The actual increase in coke was slight, as would be expected from increase of moisture, so little indeed that it might almost be disregarded.

Mr. Cosmo Johns welcomed the contribution of solid facts which had been given to the Institute. Since the astonishing pronouncement of Mr. Gayley, every metallurgical engineer had been seeking to discover the correct theory of the economy of the Gayley proposition. The theoretical investigator had so far failed; the fundamental factors which determined the fuel economy of the blast furnace were too complex to be explained by mere *a priori* reasoning, Mr. Moore had started out with the theory that a medium amount of moisture kept at a fixed percentage might of itself be a source of economy. That seemed to have been disproved. It was clear that moisture, if present at all, must result in loss of fuel, and the problem which then came up for solution was whether absolute dryness of blast was essential. That could be decided only by experiment; first, running the furnace on a maximum amount of moisture, and then gradually reducing the moisture until absolute dryness was attained. The question was whether the curve of fuel consumption obtained under these conditions would be a smooth one and follow the curve of humidity, or would there be a critical point at which there was a marked change in the conditions. Such an experiment, although expensive to make, would afford valuable information. He feared that the conditions which arose in practice were too complex for such an experiment to be carried out in the laboratory.

Mr. E. P. Martin, referring to the experience gained at Cardiff, said there had been a great saving in coke by the use of the Gayley system. There was at one time an idea that the system was being favoured by being put upon the best furnace, and an opportunity arose for deciding that point by testing the system on what was considered the worst furnace, but the saving which resulted was the same in both cases.

Mr. E. H. Saniter said that the question had been one of exceeding interest since Mr. Gayley read his epoch-making paper in New York on the subject of the dry blast. Mr. Jones had added to the knowledge which had been gained as to the reasons for the economy of the Gayley system. It seemed to him that when more steam was put into the blast it was possible to calculate from the extra steam passed through the furnace how much coke had been used to desiccate that steam. In that way the absolute value of uniformity might be arrived at, and one disputed point settled. It seemed to him that the value of uniformity could be investigated quite independently of the value of less moisture.

Mr. J. H. Harrison hoped that more experiments would be carried out at the Clarence works, as the subject was capable of having a great deal more light thrown upon it. The experiments recorded in the paper gave the results of adding moisture to the blast. The 4 grains, which was the figure of moisture decided upon for the test, was a rather high percentage of moisture for a time of year when the temperature of the atmosphere was fairly high. Would it not be possible to reduce the moisture down to 2 to $2\frac{1}{2}$ grains per cubic foot, and keep it constant at that figure. He believed that could be done simply by using the cold water coming into the works and passing the blast through before it went to the blowing engines. The experiment he suggested would be another step towards the elucidation of the problem why there was a saving of 17 per cent. of fuel with dry blast. At 4 grains there was no saving; at $1\frac{1}{4}$ grains there was a saving of 17 per cent. It occurred to him that it might be a useful experiment to try the result of keeping the moisture at two grains rather than go to the considerable expense of further reducing the moisture.

Mr. A. Reese said that it was the experience of every man who had operated the blast furnace that to increase the moisture in the blast, whether by means of blowing in steam or by unintentional means, interfered with the economical operation of the furnace, the fuel consumption being increased. An increase of the moisture in the blast would naturally give poorer results than working with ordinary atmospheric moisture, but these experiments were a case where the results were as good after increasing the percentage of moisture as before. That would seem to point to some clear benefit arising from uniformity of moisture. There were one or two curious facts in connection with the operation of the Gayley process at Cardiff and South Chicago. At Cardiff an average of $2\frac{1}{2}$ grains of moisture were removed from the blast, reducing the moisture to 1 grain per cubic foot; whereas at South Chicago something like 6 grains were taken out, reducing the percentage of moisture to about 1.75 per cubic foot. In spite of this difference in practice, practically similar results in the way of fuel economy were obtained, and the only possible explanation of similar results from varying conditions of moisture seemed to be those arising from uniformity of moisture.

Mr. W. J. Foster asked Mr. Jones how he arrived at the calories required to reduce sufficient oxide of iron to make one ton of pig. He gave the total calories as 88,795. That calculation was, no doubt, based on Sir Lowthian Bell's principle of calculating the efficiency of the blast furnace. He would like to refer to two papers he had himself presented to the Institute in 1902 and 1904, and to a paper read before the Staffordshire Iron and Steel Institute, in which he gave a diagram showing, theoretically and practically, what could be expected by eliminating the moisture from the blast, and also how to account for the saving due to hot blast.

Mr. L. Sterne said he had just received a cablegram from Mr. Gayley which he would ask the Secretary to read to the meeting.

The Secretary then read the cablegram, which was to the following effect:—Mr. Greville Jones' experiments showed that he put more moisture into his blast with steam than was normally in the air at the time. Therefore it was to be expected that the coke consumption on the furnace should be higher than it previously was on normal air. The month selected for the experiments was February, and the charts for the month showed that normal air moisture was very uniform. It could not be said, therefore, that in the experiment the uniformity of moisture was increased to any marked extent, and had the summer months been chosen for the experiments, when the atmospheric moisture was higher and more irregular, more valuable data might have been obtained. The experiments indicated that uniformly high moisture was no better than irregular moisture. Slightly lower uniform low moisture, and providing supply to engines of air uniform in temperature gave the best economic results, through the concentration of heat in the hearth, and uniform descent of uniform material into the hearth. The paper by Mr. Moore showed that extraction of moisture had an equivalent heat value in the furnace. The paper showed a saving of practically 14 per cent. in coke consumption on elimination of 5 grains of moisture. This was based on temperature equivalents with use of hot blast up to 900 deg. F. It was further shown that on the principle of the saving in coke consumption being lessened as temperature of hot blast increased, so also the saving in coke consumption would be lessened in a certain proportion by the use of dry blast, due to the better operation of the furnace. This latter was again due to greater heat concentration in bottom of the furnace, and from more perfect general operations.

Mr. L. Sterne said that the tables exhibited on the wall gave results from actual practice. These tables are reproduced below. These figures and the figures in the paper illustrated the great advantages to be derived commercially from the use of dry air blast. Every ironmaster could readily calculate for himself the relative costs and profits according to the capacity of the ore treated and cost of coke in the district. If by the adoption of the Gayley dry air blast the output of a furnace could be increased by only 15 per cent., a conservative figure, there was not only the profit of the greater output with its many collateral advantages, but the decreased cost of the entire output had also to be taken into account. It was easy to show that independently of the building, the entire outlay for the dry air blast plant could be recouped within from eighteen to twenty-four months. In the United States the system had already been adopted for furnaces requiring above 1,000,000 cubic feet of air per minute, a result mainly due to the investigation made by the Committee of the United States Steel Corporation. Mr. Gayley had devoted many years of hard work and considerable capital to the perfection of his system, and to him alone belonged the credit of an invention which in its practical application had made the greatest single advance in the iron industry since the introduction of the hot blast.

Table I.—*Gayley's Dry Air Blast Plant, Erected* 1907, *at Dowlais Cardiff Works.*

Period.	Weekly production.	Coke per ton of iron.
	Tons.	lb.
Average of first 50 weeks of blast (natural air)	2001	2278
With dry blast, and operated for increase of output (average of four weeks)	2286	1857
Advantage of dry air for increased output		Per cent.
Increase of output	—	26·4
Decrease of coke	—	13·4
Advantage of dry air in relation to coke consumption—		
Increase of output	—	14·1
Decrease in coke	—	18·4

Table II.—*Dry Air Blast* (*Gayley's Patent Process*). *Saving by Use of Dry Air, being Statistics Compiled by a Committee of the United States Steel Corporation.*

	$		s.	d.
Saving in limestone through less coke used	0·05	=	0	$2\frac{1}{2}$
Saving in flue dust in iron used for steel making	0·04	=	0	2
Through increased regularity of metal	0·05	=	0	$2\frac{1}{2}$
Duration of lining increased by 30 per cent.	0·06	=	0	3
Counting 10 per cent. increased production	0·10	=	0	5
Total	0·30	=	1	3

In reply to a question Mr. Reese stated that the United States Steel Corporation now had three furnaces in operation on the Gayley system at South Chicago, and were building a dry air blast plant for three more furnaces. He was informed that arrangements had been made for twenty furnaces to be run on dry blast at the various works of the Corporation.

Mr. Greville Jones, replying on the discussion, said they would endeavour to carry out the suggestion made by Mr. Harrison of a lower uniform moisture, although the experiment was somewhat difficult. With regard to what had been said as to the method of calculating the calories, he would be interested to learn if Mr. Foster had anything new in that connection, or if his figures, calculated on Sir Lowthian Bell's method, required revision. With reference to the reduction of labour mentioned by Mr. Sterne, that would not apply in the Cleveland district, where the rate was per ton of iron made. Something had been said as to the growing application of the dry air blast, and he would point out that it was having a wider application in Canada than in the United States.

Sir Hugh Bell, in moving a vote of thanks to the authors of the two papers, said that the discussion pointed to the fact that the definite explanation of the economies of the dry air blast was still postponed. It was neither an easy nor a cheap matter to experiment with a blast furnace, but he could not help feeling that the observations which fell from Mr. Reese pointed to the desirability of further experiments, and Messrs. Bell Brothers would be glad to put the furnace at the disposal of Mr. Jones and Mr. Moore. The results obtained in South Wales and elsewhere indicated that in many cases the Gayley system had enabled economies to be effected, and ironmasters would continue the research with the view to obtaining the final solution of the problems involved.

The vote of thanks to the authors was carried by acclamation.

The next papers taken were those by Mr. F. J. R. Carulla on "Artificial Magnetic Oxide of Iron," and by Dr. J. Newton Friend on "The Corrosion of Iron," both of which we give below, the first in abstract the second in full.

Artificial Magnetic Oxide of Iron.

One more process, it would seem, must be added to the number of those that have had their inception in England, but which have been developed abroad. The Wülfling process, introduced from Germany, for the manufacture of a blue-black oxide of iron colour from ferrous liquors of which an account was given to this Institute at the recent Vienna meeting,[*] finds its parallel in a discovery of Dr. William Gregory which appears to have been lost sight of. It, however, in no way detracts from the merit of Dr. Wülfling nor from the value of the existing patents.

Gregory observed,[†] that when a solution of protosulphate of iron is divided into two equal parts, one of which is peroxidised, then mixed with the other, and precipitated by ammonia at a boiling heat, a black oxide is obtained, which does not attract oxygen in drying, and is highly magnetic. Its composition, he continues, must be $2FeO + Fe_2O_3$; as the two solutions contain equal quantities of iron; and suggests that it may occur native as a variety of magnetic iron ore.

The above observation of Gregory's is not usually to be found in the small handbooks of chemistry excepting his own, wherein he has the following paragraph worthy of quotation in full:—

"*Magnetic oxide of iron.*—This oxide is the native magnet or loadstone, which is a heavy black mineral strongly attracting iron filings or steel. It is believed to be composed of protoxide and peroxide, and the native magnet is generally supposed to be $Fe_3O_4 = FeO + Fe_2O_3$. There is reason, however, to believe that another kind of magnetic oxide exists, which is $Fe_4O_5 = 2FeO + Fe_2O_3$. At all events, both of these compounds may be formed artificially, and both are magnetic, as well as permanent, not absorbing oxygen or passing into peroxide. To prepare the former, take two parts of green vitriol; dissolve it in water, and convert it into persulphate by boiling with nitric acid; then mix the solution with the solution of one part of the unaltered green vitriol, and precipitate the hot liquid by ammonia. A green precipitate falls, which is to be washed and dried. The second magnetic oxide is prepared in the same way, only converting into persulphate one part of green vitriol instead of two parts. The precipitate is black if made in the liquid while hot. It is evident that in the latter case the quantity of iron, in the forms of protoxide and of peroxide, will be equal; in the former the quantity of iron in the peroxide will be double that in the protoxide, so as to yield the above formulæ."[‡]

The author then discusses the process, and concludes by recapitulating the points he desires to emphasise. These are:—First, that to William Gregory, of Edinburgh, must be assigned the discovery of the artificial production of magnetic oxide of iron. Of this there can be no doubt, as what seems to be the earliest notice of it is found in a book of which Liebig was co-editor and Gregory gets full credit for it. Secondly, that there are grounds for believing that magnetic oxide of iron made by the above process is either Fe_3O_4 or Fe_4O_5, and that any variation from these formulæ is due to admixture of Fe_2O_3. Thirdly, that to say whether the main portion of any sample is Fe_3O_4 or Fe_4O_5 is not a matter that can be asserted with certainty, although there are indications that two distinct bodies exist in different samples, one of these being most difficult of solution. This is a matter well worthy the attention of some competent investigator to whom the subject may appeal. Fourthly, that notwithstanding those difficulties that all beginners are sure to encounter, the product is difficult to spoil in the making, except as regards colour, and the operator can soon attain to the production of a commercially uniform article. Finally, it may be added that the protective character of this magnetic oxide of iron is most marked. Just as the Bower Barff coating and the film on Russian sheet iron, both magnetic, afford protection to iron surfaces, so does this product when laid on in the form of paint.

The Corrosion of Iron.

It is well known that iron readily corrodes when exposed to the action of liquid water and air at ordinary temperatures. At first this was regarded as a simple case of oxidation, similar to that which obtains when iron is heated in air. We now know, however, that the reaction is more complex, and several theories have been suggested by way of explanation. Of these there are two only which merit consideration here, for the others have already been proved to be untenable.[§] These are what are known as the acid and electrolytic theories respectively.

According to the former, as its name implies, pure water, oxygen, and iron may remain in contact with one another for an indefinite period without the formation of rust. The presence of a trace of some acid to act as catalyser is absolutely essential if oxidation of the metal is to begin. As carbonic acid is very prevalent in natural air and water, we may assume that, in all ordinary cases of rusting, it is this acid which acts as the catalyser, by attacking a portion of the iron, forming ferrous carbonate, $FeCO_3$, or perhaps the soluble ferrous hydrogen carbonate, $FeH_2(CO_3)_2$. This is then converted into rust by the oxygen of the air with the simultaneous liberation of carbon dioxide, which is now free to attack a fresh portion of the iron. We thus see that an infinitesimal amount of carbon dioxide in the presence of water and oxygen would be capable of converting an indefinite amount of iron into rust.

I may, perhaps, at this point be allowed to take exception to Dr. William H. Walker's recent statement[||] that I am a supporter of the so-called "carbonic acid theory of corrosion." This theory implies that carbonic acid is the only acid which can or does effect the corrosion of iron, whereas it should be well known that any acid capable of attacking iron is also effective.[¶] In my previous paper, already referred to, carbonic acid was cited for the reason given above. It is to the general "acid theory of corrosion" that the results of numerous experiments compel me to adhere, and the importance of bearing this distinction in mind has already been emphasised by Dr. Gerald T. Moody in a letter to *Nature* of March 7th, 1907.

According to the electrolytic theory of corrosion, on the other hand, the presence of an acid, even in traces, is not essential to the oxidation of the iron, liquid water and oxygen alone being necessary. It is assumed that pure water is ionised to a small but definite extent, and that when a strip of iron comes in contact with it positively charged iron ions are sent out into the water. Hydrogen ions simultaneously leave the liquid, which latter now becomes virtually a solution of ferrous hydroxide in water. Thus:

$$Fe + 2H^{\cdot} + 2OH' = Fe^{\cdot\cdot} + 2OH' + H_2.$$

Addition of oxygen now causes the ferrous iron to assume the ferric condition, and rust appears.

It might appear at first sight that to decide between the two theories would be a matter of great simplicity, for the presence of an acid can readily be detected by means of certain reagents such as litmus and methyl orange. But further consideration shows that such is not the case. It has already been pointed out that, according to the acid theory, a single molecule of acid is sufficient to start the process of rusting, and certainly in practice a very small number would be able to produce a visible effect in a few hours. Remembering that several million molecules of an acid could be placed side by side in a line less than one centimetre in length, it will be clear that millions upon millions of such molecules would be necessary to respond to a colour test gauged by the naked eye. Hence such a method breaks down at once. We are bound, therefore, to arrive at our conclusions in a more or less indirect manner, and hence arises so much uncertainty. In my previous paper[*] I have given a detailed account of experiments performed in two glass bulbs connected together internally, but hermetically sealed from the air. One bulb contained sodium hydroxide, and pure CO_2 free water was distilled from it on to a strip of pure iron in the second bulb. It is a noteworthy fact that, when the water was distilled from the $\frac{1}{30}$-normal sodium hydroxide solution, the iron readily rusted, but when the alkalinity was normal, no rusting took place, save at the edges in contact with the glass. This freedom from rust in the latter case is attributed by the advocates of the electrolytic theory of corrosion to the solution, by the distilled water, of some of the alkali from the glass, whereby the number of hydroxyl ions was increased, and the number of hydrogen ions proportionately reduced. But if such was the case, the same source of alkalinity should have prevented the formation of rust, when the $\frac{1}{30}$-normal sodium hydroxide solution was used. But it did not, and the explanation is thus seen to break down.

According to the acid theory, on the other hand, a ready explanation is forthcoming. It need not, however, be repeated here, as it has already received full treatment in the paper referred to.[†]

Again, in all experiments hitherto published, in which iron is said to rust in contact with pure oxygen and water, it is easy to show that sufficient precautions have not been taken to make the removal of all traces of acid an absolute certainty. Thus Tilden[‡] overlooks the fact that barium hydroxide has a very definite equilibrium pressure of carbon dioxide. He also assumes that, by merely warming an exhausted glass tube, every trace of adherent air can be removed from its surface. But numerous researches of recent date have shown that such is far from being the case. The experiments of Dunstan, Jowett, and Goulding[§] are open to similar criticism.

My experiments show, however, that when all the necessary precautions are taken, corrosion does not take place. It seems to me, therefore, that the balance of evidence is decidedly in favour of the acid theory. In the paper already referred to, after quoting my statement "that the electrolytic theory of corrosion is untenable," Dr. Walker remarks that "if Dr. Friend's observation be correct, which the author does not admit—namely, that this small amount of carbonic acid is necessary to the solution of the iron—this fact does not contradict the electrolytic theory, but can best be explained, and in truth can be explained only, by the use of the electrolytic theory." It is clear that Dr. Walker fails to distinguish between "the electrolytic theory of corrosion" and what is generally understood by the "electrolytic theory" in its wider application. As we have already seen, the former is based on the assumption that water is ionised to a sufficient extent to cause the corrosion of iron in the presence of oxygen, even though no trace of acid is present. My conclusion is that an acid must be present. But I agree with Dr. Walker when he says that the acid theory of rusting is in harmony with the "electrolytic theory," where by that expression he refers to the theory as enunciated by Arrhenius in its widest sense. The criticism is thus seen to be based on a misunderstanding, and falls to the ground.

It may be well to call attention at this juncture to the fact that the ionisation of water, which forms the base of the electrolytic theory of corrosion, is purely an assumption for which we have no definite proof. Kohlrausch showed many years ago that water offers the greater resistance to the passage of an electric current the more carefully it is purified. A limiting value can, however, be reached, below which the conductivity cannot be reduced. Kohlrausch and Heydweiller[||] distilled water repeatedly in platinum vessels in vacuo, and determined the conductivity as soon as the water was condensed. At 18 deg. Cent. the value was $0{\cdot}0384 \times 10^{-6}$ ohms per centimetre, from which we calculate the ionic concentration to be 0.78×10^{-7} gramme ions per litre.[¶] It is noteworthy that simple contact with air raised its conductivity tenfold in a very short time.[**]

Now although this water was undoubtedly the purest which has ever been obtained, we have no proof that it was absolutely pure. Not a few chemists maintain that if absolutely pure water could be obtained it would be found to be incapable of conducting an electric current—in other words, that it would be incapable of ionisation. Leduc[††] has drawn attention to the extreme difficulty of removing every trace of dissolved gases from water by boiling, and a very few molecules of carbon dioxide would be ample to give to an absolutely non-conducting specimen of water the minute conductivity observed by Kohlrausch and Heydweiller; so that their results may simply be a measure of the extent to which the dissolved gases remain in solution under the special conditions of the experiments. If such is really the case the electrolytic theory of corrosion becomes a myth, whereas the acid theory is unaffected by it.

In this connection I should like to draw attention to the fact that, whilst Dr. Walker's ferroxyl is undoubtedly a useful reagent when rightly used, no experiments with ferroxyl in actual contact with metallic iron can be quoted as deciding between the acid and electrolytic theories of corrosion, for its constituents are complex organic bodies which it is impossible to prepare in an absolutely neutral condition.

From the preceding remarks it will be clear that the whole question resolves itself into this: Is pure water sufficiently active to effect the corrosion of pure iron in the presence of oxygen alone at ordinary temperatures, or is it not? Dr. Walker supplies the answer most decidedly in the affirmative, but my experiments lead me to an opposite conclusion. But either view is in harmony with the electrolytic theory of ionisation as we now know it, and the solution of the problem is one of theoretical rather than practical value.

Professor Thomas Turner said that he used to prepare magnetic oxide of iron by the Gregory process, and in order to show its magnetic properties the specially prepared precipitate was poured into water in a glass. The magnetic oxide was attracted by a magnet, and adhered to the side of the glass. It was found that the properties of the salts could be varied somewhat widely while still obtaining a magnetic product. That was in accordance with experience gained with iron ores in the Lake Superior district, where the ores gradually passed from a perfectly pure hematite to a perfectly pure magnetite, but so long as there was any ferrous oxide the ores were generally magnetic.

Mr. Carulla said that it was true, as Professor Turner had said, that no matter in what proportions the precipitate was made it remained magnetic. Dr. Wülfing had sent him a very interesting account of his theory, and he would deal with that subject in the journal of the Institute.

The President said that many questions of interest arose in connection with the corrosion of iron, particularly in connection with constructive work. Anything, which like the magnetic oxide discussed in Mr. Carulla's paper, rendered iron less exposed to attack by the atmosphere, deserved careful consideration. It was for that reason that Dr. Friend's paper had been taken with that by Mr. Carulla.

A cordial vote of thanks was accorded to the authors of the papers, and this concluded the sitting for the day.

VISITS TO WORKS.

The programme of visits for the day included the National Physical Laboratory. Those who made the journey to Teddington—and if the number was much smaller than had been anticipated the blame must be assigned to the deplorable climatic conditions—had quite an interesting visit. Important additions are at present being made to the plant at the National Physical Laboratory. Readers of The Engineer are familiar with what has been done through the initial munificence of Mr. Yarrow to install an experimental tank for research work in naval architecture. The tank is now under construction at Teddington by Messrs. Dick, Kerr and Co. The whole of the excavation has been completed, and considerable progress has been made with the concrete work. It is hoped that another six months will see the completion of the contract. It will be remembered that Dr. Glazebrook made a visit of inspection to some of the recently constructed European tanks, and in the design of the Teddington tank the experience gained elsewhere has been freely drawn upon in order that the best points of existing practice should be embodied. The section adopted is that of the Uebigau tank, described in The Engineer of September 18th, 1908, but there is considerable variation in detail. The site selected for the tank necessitated the demolition of the tower on which Dr. Stanton has carried out his experiments on wind pressure, the results of which had been communicated to the Institution of Civil Engineers. These experiments are, however, to be continued and enlarged in scope, and for this purpose two towers are under construction on sites adjoining the tank house, and in a situation exposed to the prevailing western winds. The height of the towers has been fixed at 60ft., and, indeed, the erection of one is now completed, while in the case of the second tower the foundations are in, and about a third of the superstructure erected. The chief feature of the aeronautical plant now being installed is the great whirling table of 60ft. diameter, which is to be employed for testing the relative efficiency of different forms of propellers. The building in which the table is to be housed is completed, and arrangements have been made for the most ample clearance for the whirling tests. The experimental channel for air resistance work is being enlarged, and a test bed is being prepared for carrying out tests on motors designed for aeronautical service. In the same department an investigation is in progress for the Post-office on the tensile strength of long lengths of copper wires at varying temperatures. Lengths of 50ft. are at present being tested, the load being applied by water from the mains admitted to a straining cylinder which produces a maximum pressure of 1500 lb. Provision is made for taking five stress-strain diagrams simultaneously at intervals of 10ft. The resistance of welded joints in iron and steel to direct alternating and impact stresses has also been the subject of research in the engineering department.

In the thermometry department Dr. Harker exhibited to the members of the Institute the new type of carbon furnace for very high temperatures. In the furnace just completed the carbon tube is retained as a lining only, the heat being supplied by current in a graphite spiral, insulated from the central tube. In the first furnace of this type constructed the graphite spiral was fixed horizontally, but in the new furnace this is disposed vertically. In this furnace pyrometers can be tested up to 1400 deg. Cent., and it will be possible in the future to obtain a maximum temperature of 2000 deg. Cent. The enlarged room in which these furnaces are installed is a useful addition to the resources of the laboratory, and in view of the extra power now required for the work a motor alternator is about to be put in service. This will be arranged to run at extra high frequency, 160 to 200 cycles, for electric furnace requirements. Much interesting work bearing on iron and steel problems is in progress in the alloys research department under the superintendence of Dr. Rosenhain. The special investigation in hand, of which some results have already been submitted, is the investigation of the alloys of copper and aluminium with manganese, nickel, and zinc. The eutectic alloys research work has for its object the determination of the composition of binary and ternary eutectics. Attention has been devoted to the crystalline structure and mode of solidification of these alloys. In the electrotechnical department visitors had an opportunity of learning something of the work in progress in connection with the recently installed electrostatic wattmeter. This instrument, which was constructed in the laboratory from the design of Mr. Paterson and Mr. Rayner, is to be employed for the testing of commercial instruments. In the metrology department the fifty meter comparator has been installed, and will be employed for the accurate measurement of tapes or wires on the flat or in catenary. The preparations for the installation in the electrical department of the Lorenz apparatus, under construction by Messrs. Armstrong, Whitworth and Co., are now in a forward state.

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[*] *Journal* of the Iron and Steel Institute, 1907, No. III. p. 204.

[†] "Elements of Chemistry," by Edward Turner, seventh edition, edited by Justus Liebig and William Gregory, London, 1842, p. 431.

[‡] "A Handbook of Inorganic Chemistry," by Wm. Gregory, third edition, 1853, p. 214.

[§] See Friend, *Journal* of the Iron and Steel Institute, 1908, No. II., page 5.

[||] *Journal* of the Iron and Steel Institute, 1909, No. I., page 69.

[¶] Such powerful oxidisers as chromic acid are exceptional in their behaviour, however, as they render the iron passive. (See Friend, *op. cit.*, page 9.)

[*] *Op. cit.*, page 13.

[†] *Op. cit.*, page 15.

[‡] "Transactions" of the Chemical Society, 1908, Vol. xciii., page 1356.

[§] *Ibid*, 1905, Vol lxxxvii., page 1548.

[||] "Zeitschrift für physikalische Chemie," 1894, Vol. xiv., page 317; "Wied. Ann.," 1894, Vol. liii., page 209.

[¶] Nernst, "Theoretical Chemistry," translated by Lehfeldt, 1904, page 509.

[**] Kohlrausch, "Zeitschrift für physikalische Chemie," 1902, Vol. xlii., page 183.

[††] *Comptes Rendus*, Vol. cxlii., page 149.

Another visit arranged was to the works of D. Napier and Son, Limited, at Acton. These workshops consist of two main buildings, the machine shop and the fitting shop. The former is a single-floor building, with a floor area of approximately 6000 square yards. The machines are principally semi-automatic. It is divided into sections where boring, drilling, milling, turning, grinding, &c., are carried on, the processes being kept as distinct as possible. The machines are driven from line shafting by electric motors placed in the roof. The fitting shop is also a single-floor building, and has an area of 4400 square yards. It contains departments in which the engines, gear boxes, rear axles, and the complete chassis are erected. There is, in addition, a stores for finished parts, which is partitioned off. This shop also contains machines for cutting spur and bevel gears, hobbing, spiral gear cutting, bevel planing, and other machines.

The works of the Mitchell Motor Company is in Wardour-street, Soho. It contains over 70,000ft. of superficial area devoted entirely to industrial purposes. The garage can contain 500 cars, any of which can be immediately withdrawn at will. The works are equipped for the manufacture of motor car parts, and any piece of mechanism can be reproduced. The tools, which are all driven electrically, include bevel gear automatic planers, spur gear milling machines, automatic turret lathes, and high-speed lathes of various sizes. The establishment is, we understand, fully occupied in carrying out repairs, &c.

Another visit was to Lambeth Palace, and still another to Doulton's potteries in Lambeth. This business was started by Mr. John Doulton, senior, in 1815. He established a small pottery in Vauxhall Walk. In 1826 the works were removed to High-street, Lambeth. For many years only ordinary stoneware for household use was manufactured, but towards the middle of the century the making of stoneware for sanitary purposes was undertaken. Factories were built at Lambeth, St. Helens, Rowley Regis, and Smethwick for the manufacture of drain pipes, gullies, &c. Terra-cotta work followed, and later on the celebrated Doulton art ware. In 1877 works in Staffordshire were opened for the manufacture of all kinds of china and fine earthenware.

Other visits arranged for this day were to the Royal Small Arms Factory at Enfield and to the Mint. Our readers are already familiar with both these institutions.

Finally, there was a visit to the works of the Power Plant Company, Limited, at West Drayton. These works were established some four years ago for the exclusive manufacture of machine cut double helical gear wheels. The chief feature of these gears is the staggering of the teeth. Before the company started to work such wheels could only be obtained from the Continent. The machines on which the gears are cut are ingenious and interesting. Both the shape of the tooth and the helix are generated automatically for right-hand and left-hand teeth in one operation, and all sizes of wheels of the same pitch are cut by the same tools. The plant consists of a suction gas plant installation and three-phase alternating-current distribution. The gear-cutting machines are driven by multi-speed three-phase motors. Wheels from 1in. up to 10ft. in diameter can be produced, besides complete reduction gears in cases. A plant for making the special cutting tools is also installed.

It may be said of all the visits that they were very sparsely attended, and some of them—for example, that to the Small Arms Factory—were practically neglected altogether.

In the evening members and ladies accompanying them were entertained to dinner at the Trocadero Restaurant. Sir Hugh Bell was in the chair—and was supported by many distinguished guests.

AERONAUTICAL ENGINES IN PARIS.

No. II.*

It is probable that the exhibition in the Grand Palais offered a greater diversity of forms and types of petrol engines than had been seen at any previous show. This is to be explained by the fact that there are, as yet, no settled ideas about aeronautical motor design, and as the new branch of the engineering industry is "feeling its way" every engine builder with ideas of his own is bringing them forward in the hope that he will satisfy the requirements of aviators. Thus in the Cote engine, manufactured by Prini and Berthaud, we see a revival of the two-cycle principle which, despite its presentation in many ingenious and apparently practical forms, has never made any headway in the sister branch of automobilism. In aeronautics its claims, when based upon lightness for a given power, are likely to receive closer consideration. In the illustration of the Prini and Berthaud engine published last week—page 346—two of the four cylinders are shown with the copper water jacket casings removed. This explanation is necessary because the engine, in its incomplete state, presents a somewhat curious appearance. The feature of the Cote engine, by which name it is more commonly known, is the compression of two charges of gas by one upward stroke of the piston. The cylinder is bored to two diameters, the upper one for the piston and the lower one for the plunger, which practically forms part of the piston. The bottom of the plunger is flanged out to the larger diameter of the cylinder, whereby a circular chamber is formed around the plunger when at the end of the downward stroke. In this position ports in the cylinder walls are uncovered by the piston, through which the burnt gases are driven out by the incoming charge. At the same time a charge of gas has been drawn into the cylindrical chamber around the plunger. On the upward stroke the charge in the upper cylinder is compressed, and the gas in the lower part is driven by the plunger into an oval chamber partly observable on the opposite side of the engine shown in the illustration, whence it passes into the next cylinder at the end of the explosion stroke. It is claimed that this system overcomes the objection frequently urged against two-cycle engines of sluggishness in filling the cylinders when running at any high speed. In official trials the 100 by 110 four-cylinder Cote engine has developed 50·8 horse-power at 1464 revolutions per minute, with a total weight in running order of 202 lb.

Of Farcot engines two distinct types have been designed for aeroplanes, one having two horizontal cylinders opposed with pistons actuating the same crank shaft, and said to develop 25 horse-power, with a total weight of 110 lb. It is of the same class as the Dutheuil-Chalmers and the Darracq, built for Santos Dumont. The horizontal engine with opposed cylinders is in many quarters regarded with special favour for monoplanes. The other Farcot engine has six cylinders arranged fan shape around the upper part of a circular crank case. They are air cooled, and the induction and exhaust valves are concentric, like the Panhard. The engine is enclosed in a sheet steel case, and air is driven through it by a fan. The Beck rotary motor, of which we published an illustration on page 343, is built up of two circular plates pressed out near the periphery in an annular corrugation, so that when the plates are bolted together the semi-circular corrugations form a circular cylinder. In this cylinder are fixed four rings drilled near the edges with a series of small holes. Inside the ring is a narrow sleeve actuated by a lever and cam at the back of the motor. As this sleeve slides in the ring it uncovers the two series of holes alternately. The holes are in communication with a pipe divided internally, one part for the admission of gas and the other for the exhaust. When, therefore, the sleeve moves one way it uncovers the holes, putting the induction pipe into communication with the cylinder, and in the other direction it closes the holes and opens those in communication with the exhaust pipe. The explosion drives the two pistons apart, and by a double system of connecting-rods arranged to give an angular thrust on the shaft the motor itself is driven round. No special arrangement is made for cooling, as it is claimed that the rotation of the engine is quite sufficient to radiate the heat from the smooth surface of the annular cylinder. The makers state that they build the engine with a number of pistons corresponding with the power to be developed. It does not, however, appear to have run except in laboratory tests. The rotary engine of Colonel Renard, illustrated on pages 342 and 343, was exhibited in the retrospective section, and was an experimental motor built many years ago. In principle it is very much the same as the Gnome already described, the pistons giving a slightly angular thrust on a plate on the shaft for the driving round of the engine. Nothing, however, was ever done with the Renard engine, and it is significant of the special conditions created by the science of mechanical flight that an engine on the same principle should now be meeting with a certain measure of success.

Among other engines the Brouhot—page 346—is a characteristic example of a type of motor built by an automobile maker who refuses to go to the extent of weight reduction adopted by firms who are giving special attention to aeronautical engines. Whether there will be a reaction against excessive weight cutting remains to be seen, but meanwhile the Brouhot is interesting as illustrating once more the tendency of engine builders to multiply cylinders and group them in pairs of four set at an angle for the sake of shortening the crank shaft, simplifying parts and securing a better balance. A commendable feature of the Brouhot engine is the use of vertical valves. The engine develops 60 horse-power, and was reported to weigh about 300 lb. The De Dion engine for aeroplanes —page 343—is also of the eight-cylinder type arranged in much the same fashion.

While it is obviously desirable to employ a thoroughly reliable air-cooled engine for aeroplanes, it is noteworthy that three-fourths of the makers exhibited engines with water jackets. Only three air-cooled engines have been employed on aeroplanes, including the Gnome, which is, of course, cooled in a highly efficient manner by the rotation of the cylinders. It is true that in the case of engines with water jackets the water is carried in a very small radiator which does not represent any appreciable weight, but, while this may be satisfactory for short flights, it will certainly be necessary to employ tanks when the aeroplane has developed sufficiently to undertake long journeys, or else the air-cooled engine will have to be perfected. Some of the radiators are ingeniously contrived for weight reduction. In the Gregoire-Gyp—page 343 —the radiator consists of a short copper tube extending out each side of the water jacket casing, and connected with a tube above by smaller tubes, as well as by a vertical tube from the cylinder head. In the Demoiselle of Santos-Dumont there is a small tin "collector" at each edge of the aeroplane connected by a considerable number of small rubber tubes. In a word, all types of engines are being more or less successfully employed on aeroplanes — water-cooled, air-cooled, vertical, V-shaped, horizontal and rotary—and the final selection will be a survival of the fittest. It is to be remarked, too, that the fashion of keying the propeller direct on the crank shaft on a monoplane has directed attention to comparatively long-stroke engines, as experience has shown that fairly large propellers running at a comparatively low speed are more efficient than the small high-speed propellers formerly employed on the majority of machines, and thus most of the engines run at 1000 or 1100 revolutions per minute. One of the few exceptions is the Renault—page 342—where the propeller is keyed on the camshaft, whereby the speed is reduced one half.

As regards aeroplane construction there is a good deal of similarity in general principles and plenty of diversity in matters of detail. If we except the machines which are purely experimental and have never flown—and there were quite a number of them at the Salon—all the aeroplanes are derived from the original machines built by Wright, Farman, Voisin, Blériot and Levavasseur. They are modified according to the more or less ingenious ideas of inventors, but no one has yet done anything with machines differing essentially from the well-known biplane and mono-plane types. In the Farman machine the method of assembling is that adopted by quite a number of makers. The vertical struts are of a flattened oval section, and are fastened to the horizontal members by aluminium connections, through which pass pins held by small nuts—see Fig. 1. In some cases the end of the pin is drilled to receive the end of the wire stay, and in others the nut is screwed down on a piece of sheet steel in which holes are made for the same purpose. The wooden girder frame is stayed diagonally and horizontally by piano wire. Special care has to be taken to prevent the wires from slipping out of their connections. A small soft copper tube is usually slipped over the wire before the end is passed through the eyelet, and the wire is then threaded back again through the copper tube, which is pushed down close to the connection and squeezed with pliers, after which the end is turned over. The wires are kept taut by a tube screwing on right and left-hand threaded stems attached to the wires in the manner already described. The Farman machine is controlled by two small ailerons placed at the rear of the upper main plane, and by an elevating plane which turns horizontally on a steel tube. They are all actuated by one lever, a forward movement inclining the elevating plane, while a lateral movement raises and lowers the ailerons. The vertical rudder at the rear is operated by a foot lever.

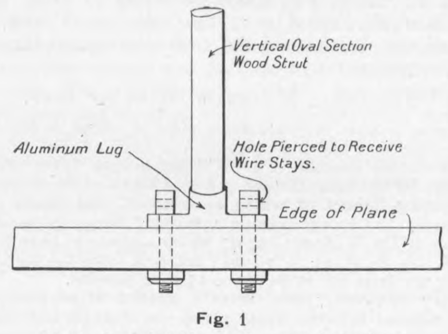
Vertical Oval Section Wood Strut
Aluminum Lug
Hole Pierced to Receive Wire Stays.
Edge of Plane

Fig. 1

Method of Jointing.—Farman Aeroplane

The Demoiselle of Santos Dumont is particularly interesting, because it is the outcome of a conviction that a small and portable aeroplane could be built capable of carrying a man of even more than average weight. Santos Dumont has repeatedly shown this to be possible by flying quite long distances and carrying dead weight to make up for his own deficiency in this respect, and the speeds at which he travelled were stated to be from 45 to 50 miles an hour. With such a small sustaining surface it is essential to fly at a high speed in order to carry weight. The merit of Santos Dumont's experiments lies in the fact that he has fixed upon fairly exact proportions of an aeroplane for carrying a man, although with sufficient margin to enable him to carry enough fuel for long periods. A comparison between the Demoiselle and the big machines is striking, and suggests the question whether after all the latter will not have eventually to be refined down. The construction of the Demoiselle is light, not to say flimsy. The triangular section frame is of bamboo, and is stayed vertically and laterally by light flattened oval metal tubes. The upper bamboo terminates in a steel lug clamped down by bolts, and to this lug is welded by the oxy-acetylene process two square tubes, which receive the square front members of the main plane—Fig. 2. To the top of the lug is fixed the horizontal engine, of which we have already given a description. The planes are stayed by wires to the ends of the tubular axle carrying the wheels. Behind the pilot's seat, inside the triangular body, is a hinged vertical rod connected by wires with the rear ends of the planes, so that as the pilot bends one way or the other it flexes the planes in the required direction. It is difficult to imagine how anything smaller and lighter in the way of practical aeroplanes can be built. Santos Dumont stated that he intended to let his patents drop, so that anyone could manufacture this machine; but since then complications appear to have arisen, and the automobile firm of Clément-Bayard is arranging to manufacture the aeroplane in considerable quantities.

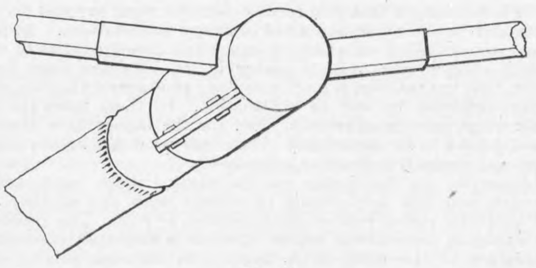

Fig. 2

Lug made out of a strip of sheet steel clamped on end of bamboo frame to receive square section members supporting planes. The square tubes are welded on the strip by the oxy-acetylene process

Santos-Dumont Monoplane

Extreme rigidity is the feature of the Vendome monoplane, which has a long solid body of square section forking out in front to receive the pilot's seat and the mechanism. This is an Anzani two-cylinder engine. The front of the machine is supported on a large vertical semicircular frame, which is connected with the main frame by long wooden struts. The semicircular frame carries the wheels. The planes are supported by wires to two triangular standards, one above the main frame and the other immediately under the pilot's seat. Stability is obtained by manœuvring two small triangular planes forming part of, and overlapping, the main planes. They are raised by a lever actuating wires, and are otherwise kept down by spiral springs. The machine is assembled throughout by steel plates and bolts, and in its construction strength and rigidity have been aimed at rather than lightness. We have not heard of the Vendome apparatus being successful in actual flight.

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* No. I. appeared October 1st.

The Fernandez biplane is assembled by tubular joints, each consisting of two steel tubes welded at right angles. In the Koechlin monoplane the body is in the form of a wooden shell, apparently made of very thin sheets of mahogany similar to the Antoinette. The members carrying the planes are fixed to the body by metal plates, and are stayed as usual by vertical standards. The idea of employing a shell is to diminish the wind resistance, which is very considerable when aeroplanes are travelling at high speeds, but it seems probable that the stays and struts would offer more resistance than the longitudinal body which is in a line with the engine and pilot. The Koechlin engine is carried on a wooden frame bolted to the flat front end of the body. The machine is supported on a tubular frame for the wheels. The Gregoire-Gyp monoplane is a nicely designed machine, with girder-built wood body tapering to the rear, and supported on a tubular frame with wheels. The members, which are apparently of mahogany of very light section, are mortised, and, where necessary, secured by plates. A feature of this machine is the method of flexing the planes. They are carried on a large diameter tube, through which passes a shaft extending to the extremities of the planes. A contrary motion is given to the planes by a pinion gearing on two wheels at the ends of the shafts, the pinion being actuated by a horizontal rod and wheel in front of the pilot. When the wheel is turned one plane is depressed and the other raised, and on moving the wheel vertically both planes are inclined simultaneously. In accordance with the usual monoplane practice the four-cylinder vertical engine, to which we have already referred, is placed in front of the machine, and the propeller is keyed on the crank shaft; but instead of starting the engine by turning round the propeller, this is done from the pilot's seat by a starting handle. The only machine which is built up of steel tubes welded by the oxy-acetylene process is the R. E. P., manufactured by M. R. Esnault Peleterie, who was one of the originators of the monoplane. The inventor has accomplished some remarkable flights with this machine, but it has not taken part in any of the competitions held during the present year. M. Esnault Peleterie is one of the very few makers who still adhere to the high-speed engine with small four-blade propeller. The engine has seven air-cooled cylinders grouped round the upper part of the crank case. The ends of the planes are flexed by a steering column extending below the machine. The Lioré monoplane has two propellers driven by chains, and carried on a tubular frame fixed to the end of the bod,y as well as to the front members of the planes.

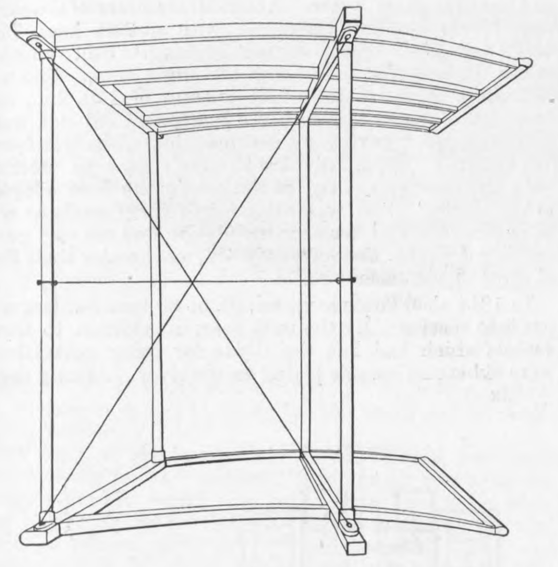


Fig. 3
Method of assembling a biplane
Sketch view of one girder

Apart from the extraordinary apparatus of Messrs. Aimé and Salmson, consisting of a plane slightly curved upwards and a lower plane of semicircular form, the curious multiplane of De Dion-Bouton, and the helicopter of Vuitton-Hubert, the majority of the apparatus shows, as we have said, a great similarity in biplane and monoplane design, the differences being principally in the curves and the methods of supporting and flexing the planes. Each maker employs a wood which suits him best, but hard pine wood is being used more and more, on account of its lightness and resistance to compression. The advantage claimed for wood is that in the event of damage when alighting, repairs can be carried out easily and cheaply, while steel tubes would be much more difficult to repair. The main biplane—Fig. 3—is of girder construction, and is built up of four horizontal members of rectangular section, being rounded in front where the fabric is drawn over and laced. The horizontal members are connected by vertical struts of flat oval section, and attached either by lugs, in the way already described, or by tubes. The main members and vertical struts are stayed diagonally and horizontally by piano wire. The bodies of biplanes are also usually constructed upon the girder principle, but in monoplanes they are more often given a triangular form. In both cases the parts are mortised and riveted and stayed by wires. Between each pair of vertical struts there are three or four traverse pieces, usually in the form of laths slightly curved and extending behind the rear members. These are covered by a light rubber solutioned fabric similar to that employed for balloons, and is supplied by all the pneumatic tire firms who are making a special feature of this material. In monoplanes a much more rigid construction has to be given to the planes. The traverse pieces are made of two thin wood strips curved to the desired shape and separated by blocks to which they are riveted—Fig. 4.

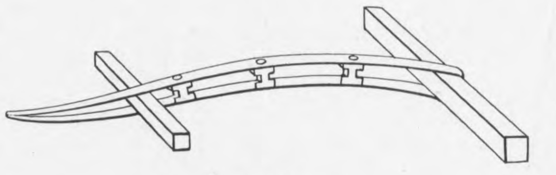


Fig. 4
Sketch showing one of the traverse pieces holding the main members of a monoplane

The main member, which forms the chief support of the frame, is held and riveted between the ends of the traverse pieces, and at about two-thirds of its length a lighter member is assembled in the same way. This skeleton structure is covered both sides by rubber solutioned fabric. All the French machines are mounted on small pneumatic tired wheels to allow of their starting without any special device, but as the wheels have a tendency to break when alighting with a shock, Farman has combined the wheels with skates or runners, that is to say, the machine is supported by the wheels under normal load, but when subjected to a shock the frame carrying the wheels rises against the pressure of damping springs, and the shock is then taken up by the runners. All the wheels are fitted with some spring device for taking up shocks.

For dirigible balloon construction special sections of wood are supplied, having a diameter of 4in. or more. Pine wood is planed in the direction of the grain to a semicircular section, and on the flat side it is hollowed out like a bamboo, leaving solid partitions between each chamber. Along the edges deep grooves are cut, into which are inserted thin tongues of hard wood. Two lengths are assembled in this way, constituting a very stiff member, about 65 per cent. lighther than solid wood of the same diameter. To join up these large sections the cylindrical members are tied by strips of canvas wound round several times in glue and then varnished, while in cases where flat pieces are joined to round members a hard wood strip is bent round the cylindrical part and riveted down on the flat piece—Fig. 5. Wood is also likely to be used exclusively for propellers now that the disaster to the République has shown the risks of employing metal for this purpose. The propellers are sometimes cut out of one piece of wood, and in others they are built up and covered with canvas. In this connection it may be remarked that the French War Department has decided to carry out important modifications to the new dirigible balloons, notably in replacing the metal propellers with wood propellers, and fitting two engines which may be run together or independently.

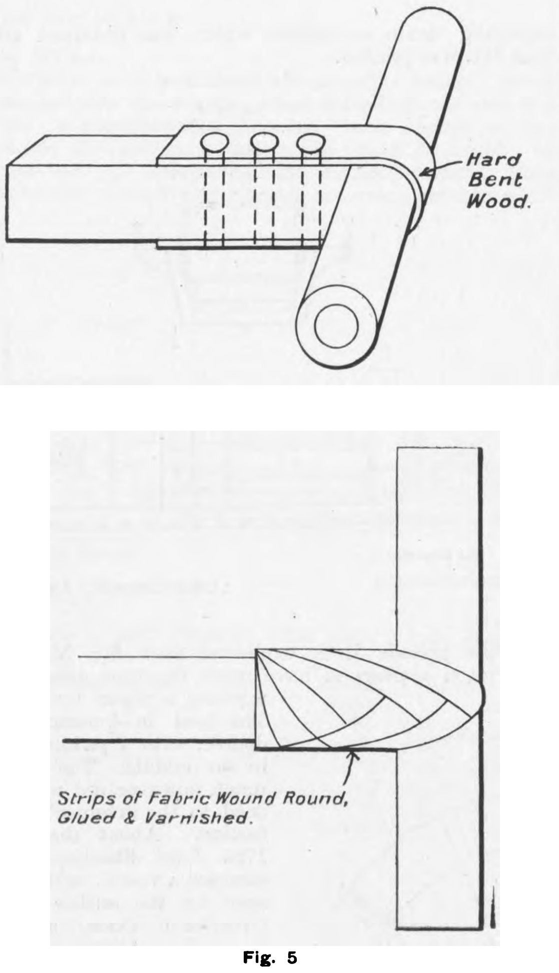


Fig. 5
Two methods of making joints where wood of large hollow sections is employed

SUPERHEATED STEAM LOCOMOTIVE, SAN PAULO (BRAZILIAN) RAILWAY.

The illustrations on page 370 show a 2-8-0 or Consolidation type locomotive with six-wheeled tender, of which ten are being constructed for the San Paulo (Brazilian) Railway at the Atlas Works of the North British Locomotive Company, Limited, Glasgow, to the specification of Mr. D. M. Fox, consulting engineer to the company.

These engines are fitted with Schmidt's superheaters of the latest form, designed to superheat the steam to a temperature of 670 deg. Fah. In this arrangement the ordinary small tubes at the upper part of the boiler are replaced by twenty-one large tubes 4⅞in. inside diameter. These tubes contain the superheating elements, each group of which consists of four tubes 1⅜in. external diameter, equally spaced within the large tubes, and connected at their fire-box ends to form a single continuous or "double-looped" passage. At the smoke-box ends the superheater elements are connected to the steam collector, which is fixed to the smoke-box tube plate, in communication with the main steam pipe from the regulator. The collector casting is so divided that the saturated steam, which enters it from the boiler, must pass through the superheater tubes before reaching the cylinders. The degree of superheat is regulated by a damper in the smoke-box, which is ordinarily worked automatically by means of a small steam cylinder on the smoke-box, with suitable gearing to the damper shaft. The damper cylinder takes steam by a small pipe from the steam chest while the regulator is open, the damper closing by a counterweight when the regulator is closed. The damper cylinder is seen on the left-hand side of the smoke-box in the upper view. Provision is also made for varying the position of the damper by hand from the driver's cab.

A mercury pyrometer is placed on the collector casting, with a capillary tube connection to a temperature gauge in the cab.

For tube-cleaning purposes the engines are equipped with the "Ramoneur" hot-air apparatus, taking steam from a cock on the fire-box. The cylinders are outside the frames, with piston valves on top. The latter are of Dr. Schmidt's special design for superheated steam with trick ports, and arranged for inside admission.

Lubrication of valves and pistons is effected by means of a Wakefield's mechanical lubricator of one gallon capacity, with six feeds operated by the valve spindle on the left-hand side of the engine, as shown in the lower view. Each cylinder is fitted with a by-pass valve for the purpose of equalising the pressure between the two ends of the cylinder when drifting with the steam shut off. The by-pass is opened by hand from the cab immediately after closing the regulator. Pressure relief valves are fitted to each end of the cylinders, and a snifting valve to each steam chest. The valve gear is of the Walschaerts' type, with steam reversing gear. The boiler is of the Belpaire type, and, except as regards arrangement of tubes, is interchangeable with the boilers in this company's latest heavy 4-6-0 passenger engines built by the same makers. The boiler and cylinders are clothed with asbestos mattresses covered with planished steel sheets and finished with bright brass bands and mouldings, and brass covers for the dome and safety valves; the latter are of the Wilson-Klotz type, four valves in all arranged in pairs. The automatic vacuum brake is fitted to operate on both engine and tender, with connections to the train. The boiler is fed by two Körting's injectors, Nos. 8 and 10. All the coupled-wheel spring links are fitted with Spencer's supplementary india-rubber pads in cases.

The following are the principal particulars:—

Gauge of railway	5ft. 3in.
Heating surface—	
Fire-box	154 sq. ft.
Tubes	1410 sq. ft.
Superheater	376 sq. ft.
Total	1940 sq. ft.
Grate area	28.5 sq. ft.
Working pressure	200 lb. per sq. in.
Diameter of cylinders	21½in.
Stroke of cylinders	26in.
Diameter of piston valves	8in.
,, driving wheels	4ft. 6in.
,, truck wheels	3ft.
Wheel base of engine, fixed	16ft. 3in.
,, ,, total	24ft.
,, engine and tender	47ft. 5⅜in.
Boiler—	
Height of centre above rails	8ft. 6in.
Diameter of barrel	5ft. 4¾in.
Length between tube-plates	14ft. 1$\frac{1}{16}$in.
Fire-box shell, length outside	8ft. 4in.
Inner fire-box	Copper
,, stays	Copper
Tubes—	
Ordinary, number	128
External diameter	2⅛in.
Material	Brass
Large, number	21
External diameter	5¼in.
Material	Steel
Weight on driving wheels in working order	66 tons 6 cwt.
,, truck wheels in working order	8 tons 9 cwt.
,, total	74 tons 15 cwt.
Tender.	
Tank capacity	3000 gallons
Fuel	4 tons coal
Diameter of wheels	3ft. 1in.
Wheel base	1ft. 7 6in.
Weight in working order	35 tons 3 cwt

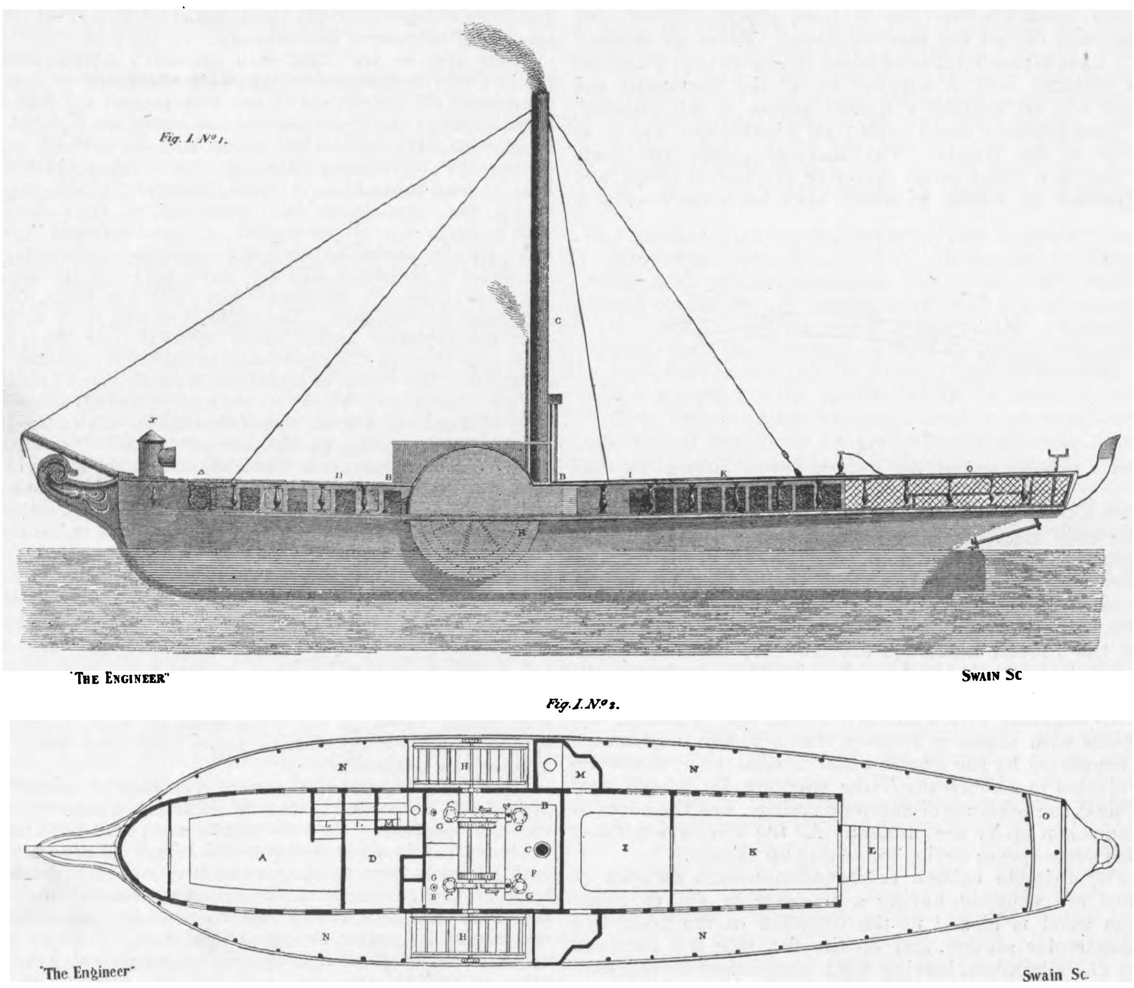
The National Electrical Manufacturers' Association.—The next Committee meeting of this Association will be held on Tuesday, October 12th, at Balfour House, Finsbury-pavement, E.C., at 2.30.

The Incorporated Association of Municipal and County Engineers.—A South Wales district meeting will be held at Cardiff on Saturday, the 16th inst. The members will assemble at the City Hall at 12.30 and will afterwards inspect the new City Hall buildings. In the afternoon a tour of inspection will be made, and the Western District outfall sewerage works, the pumping station, Penarth-road, the pipe arch over river Ely, and the reservoir sewer and sea outfall at Lavernock will be visited.

A Farewell Dinner.—On Wednesday, the 29th ult., a farewell dinner was given at the Midland Hotel, Manchester, in honour of Mr. K. K. von Krogh, who has resigned his position with the British Westinghouse Company, to engage in consulting engineering work in Norway, his native country. Mr. Newcomb Carlton, managing director of the British Westinghouse Company, acted as toast master. The general manager of works, the general sales manager, and some twenty-five other prominent members of the staff were present. The chairman, in a eulogistic speech, paid tribute to the excellent work accomplished by Mr. Krogh, and said that if consulting engineering should not prove as attractive or lucrative as anticipated, he would always be welcomed back at Trafford Park.

THE EARLY HISTORY OF STEAM NAVIGATION.

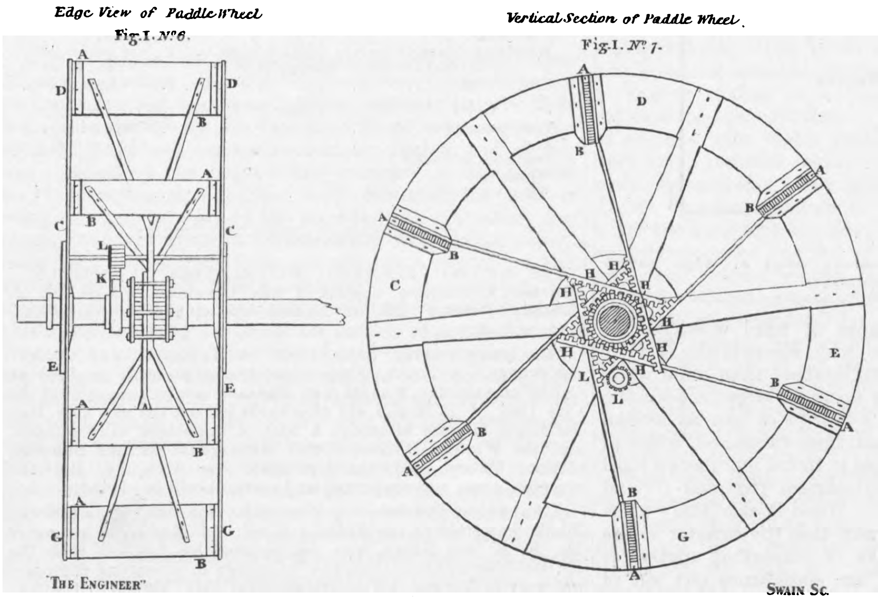
We have recently had courteously brought to our notice by Engineer-Commander G. T. Simmonds, R.N. (Ret.), a most interesting little volume entitled "A Practical Treatise on Propelling Vessels by Steam, &c." It was written by a civil engineer of the name of Robertson Buchanan, and was published in Glasgow in the year 1816. We feel sure that a few extracts from this book will be of interest to those of our readers—and we believe them to be many—who are interested in the historical aspect of their profession.



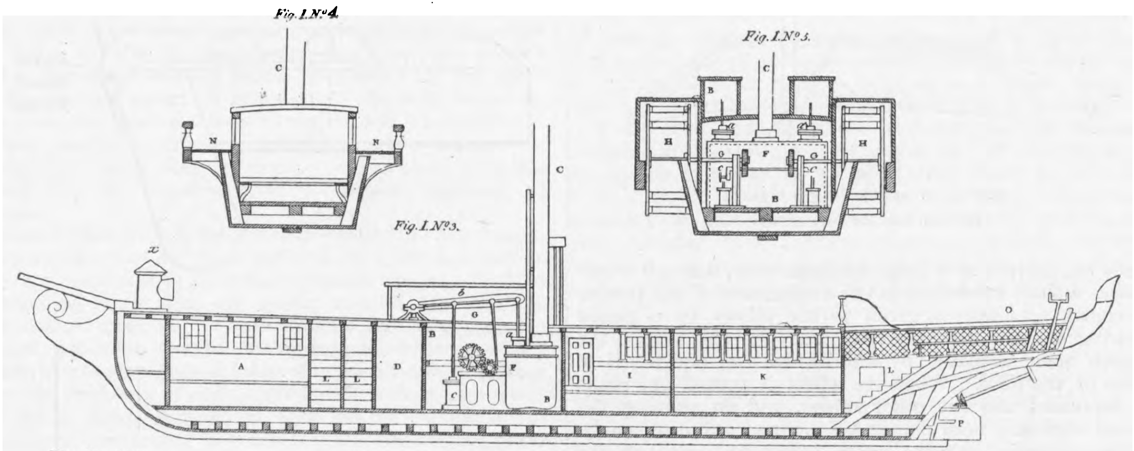
ELEVATION AND PLAN OF BOAT G

It is pointed out at the beginning of the preface to the work that navigation by steam "having been more early introduced and carried to greater extent on the Clyde than on any other river in Europe," more attention is devoted to the boats plying on that river than to any others. And then the author goes on to prophesy. "Calculating," he says, "from the progress which has already been made in navigation by steam, it is reasonable to suppose that it will rapidly extend not only in those countries where it already exists, but that its benefits will be speedily experienced in every civilised nation." Surely no prophecy of modern times has had more complete fulfilment.

Mr. Buchanan divides his book into an introduction, eight parts, and an appendix. The first part deals particularly with the peculiarities of the Clyde navigation and with an account of the various steamboats which had been employed on that river. Incidentally, "for the use of those who have not previously paid attention to the subject of the steam engine," the author introduced "a popular account and description of that useful invention." The second part contains "descriptions of various modes which have been at different periods proposed or tried for propelling vessels." Part III. deals with the steam navigation on other rivers in Great Britain and Ireland. Part IV. contains a short account of the steamboats then in use in America, and the fifth part makes mention of the vessels propelled by means of machinery driven by "cattle" which were employed in that country. Part VI. deals with subjects relating to naval architecture; Part VII. contains "miscellaneous observations," while in Part VIII. is given some additional information regarding steam navigation which was obtained after Part III. was printed.



METHOD OF ADJUSTING PADDLE-WHEEL FLOATS



LONGITUDINAL AND CROSS SECTIONS OF BOAT G

In the preface it is explained that Mr. Miller of Dalswinton appears to have made the first attempt at working a vessel by steam. The boat in question was double, with a paddle-wheel in the middle. The experiment, however, did not succeed to the inventor's satisfaction. About the year 1795 Lord Stanhope constructed a vessel, which was seen by the author in the Greenland Dock, and in which the paddles were made in imitation of the feet of a duck, and were placed under the quarters. Reference is then made to the boat tried by Mr. Symington in 1801 on the Forth and Clyde Inland Navigation. In 1807 came Fulton's boat in America, and not till 1812 was the Comet put to work on the Clyde. Soon after this a steamboat was running on the Avon at Bristol, and in 1813 a steamer began to ply on the Yare from Yarmouth to Norwich.

In the beginning of Part I. reference is made to some early attempts at mechanical propulsion without the use of steam. A Monsieur Duquet appears to have tried revolving oars in 1699. A Monsieur Camus in 1703 proposed to work oars by machinery in three different ways, while M. Martinot, in the year 1763, suggested the union in one oar of the properties of many. Daniel Bernouilli proposed the use of inclined planes immersed in the water, parallel to the sides of the vessel, which, turning in a collar, were moved in a plane perpendicular to the keel. It is explained, however, that as none of these modes were ever brought into practice, it is needless to enter further into their detail.

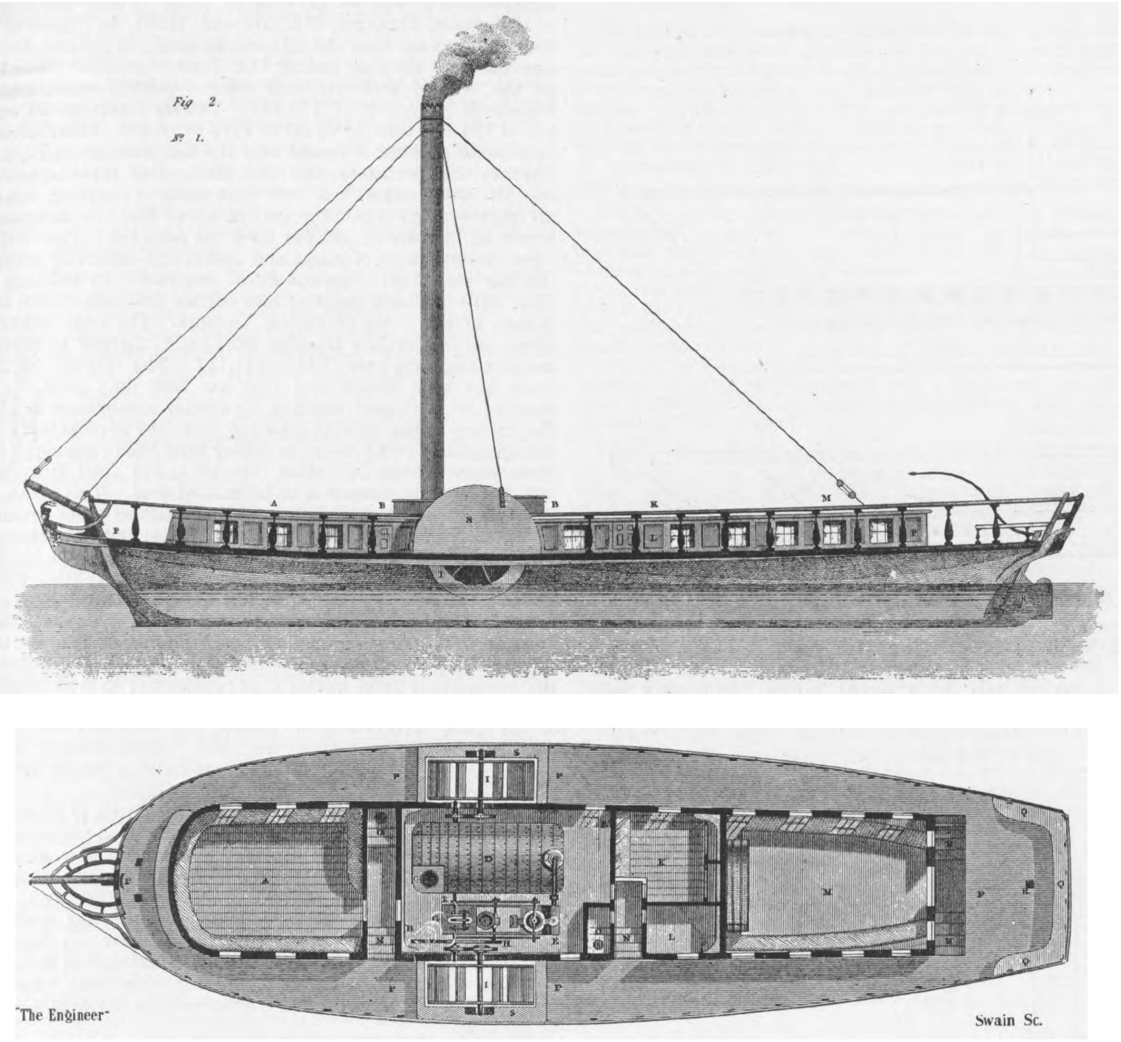
Mr. Buchanan then proceeds to discuss the peculiarities of the river Clyde, and to refer to the steamboats at work on it. It is explained that the river at Glasgow was only 140ft. wide, and that its width increased by from 4ft. to 5ft. for every quarter of a mile The neap tides were at most 3½ft. and the spring tides about 5½ft. Vessels drawing 9½ft. of water could go at ordinary spring tides up to Glasgow. The speed of the current varied from 2½ to 4 miles, and was strongest on the ebb. There were many shallows on the river, and at Bowling Bay, 10 miles below the city, there was one part of the stream, the depth of which "was not, until of late, known to be greater than from 1ft. 6in. to 2ft. 8in. during dry season." This, however, was increased to about 3ft. by the formation of stone dykes.

Symington's boat tried in 1801 on the Forth and Clyde inland navigation was "laid aside, among other reasons, on account of the injury it threatened the banks of the canal by the agitation of the water." Then "the first attempt, on any scale worthy of notice at navigation by steam, on the river Clyde was in the year 1812." This boat Mr. Buchanan designates by the letter A. It was of about 40ft. keel and 10½ft. beam, and had a steam engine of "only 3 horses' power." This boat was apparently at work for something over two years, and was then superseded. In March, 1813, another boat he calls B was got to work. She was 58ft. long on the deck, and had an 11ft. beam. Her power was that of 10 horses, and she was successful for a time and remunerative to her owner, but she also was superseded by vessels of greater speed and less draught of water. About Midsummer of the same year (1813) another vessel, C, with a 70ft. keel, 75ft. deck, and 13ft. beam, started running. Still another vessel, D, was first tried about the same time. She was 69ft. from stem to stern, had a beam of 15ft. 2in., and drew 4ft. of water. At first the machinery did not work very well, but "having got new machinery, she was found last summer [apparently 1814] with regard to steering well, and moving swiftly, on the whole the best adapted to the Clyde." She was intended to carry goods as well as passengers, and her accommodation was not very good, and her draught, although only 4ft., was greater than that of some of the other vessels.

In 1814 also, another vessel, E, of 80 tons burden, was put into service. By the next year, in addition to three vessels which had left the Clyde for other ports, there were six steam vessels plying on the river. Among these there was one with a keel about 90ft. long and a 17ft. beam, its engine being of "24 horses' power." Still another, of about the same burden, had an engine of "30 horses' power."

Another boat, G, was constructed so as to draw as little water as possible, on account of the numerous shoals in the river. This vessel, with the usual complement of passengers, had a draught of only 3ft. 6in. With the object of making her as light as possible, however, "the engine was made of too small power, being only that of 8 horses; yet notwithstanding this she makes the average voyage [Glasgow to Greenock, about 26 miles] within one quarter of an hour of the speediest vessel yet constructed, and which has an engine of 14 horses' power." It may be mentioned that the distance between the two points had been accomplished in 2¼ hours, the tide being favourable, but the voyage being made against a moderate head breeze. The reason given for the performance of the lower powered as against the higher powered boat is that the construction and workmanship of the engines of the former were superior—she had "two engines of four horses' power each." It appears highly probable also, in the light of later knowledge, that the method of computing the horse-power in the various cases may have been faulty. Particular interest attaches to these two boats E and G in that engravings of them are given, and these we are enabled to reproduce. Taking the latter first, as it is dealt with first by the author, Fig. 1, No. 1, is an elevation or side view showing one of the paddle wheels. Fig. 1, No. 2, is a longitudinal horizontal section. Fig. 1, No. 3, is a longitudinal vertical section showing the interior of the cabins and machinery; while Fig. 1, Nos. 4 and 5, are transverse sections. We have adhered to the author's numbering and descriptions. A general reference to the letters on these various figures is given as follows:—A, the fore cabin; B B, space for the machinery;

C, the iron chimney serving also as a mast; D, the steward's room; F, the boiler, which contains the cylinder of the two steam engines; G G, the steam engines;* *a a* the cylinder; *b b*, the beams; *c c*, the air pumps; H H, the paddle-wheels; † I, the ladies' cabin; K, the principal cabin; L, L, L, stairs to the cabin; M, M, water-closets; N, N, gangways; O, O, seats at the stern and on deck; P, the rudder.



ELEVATION AND PLAN OF THE BOAT E

As even at this early date inconvenience had been found owing to the "paddles" being much deeper in the water when the vessel was laden than they were when she was light, and the difficulty had been met by the contrivance shown in Fig. 1, Nos. 6 and 7. The two "paddles," A B, A B, instead of being fixed to the shrouding, C D E G, of the paddle-wheel, were made to slide inwards and outwards between guides by means of a rack, H H H, and connected to each "paddle." This rack was worked by a toothed wheel, I, movable round the axle of the paddle-wheel. Attached to the toothed wheel was a toothed segment, K, meshing with which was a pinion, L, fixed on a spindle, M N, which turned at each end in bushes fixed to the arms of the paddle-wheel. All that was necessary in order to make the "paddles" work more or less deeply in the water was, when the paddle-wheels were at rest, "to turn, by a key or wrench, the spindle, M N, which, by means of the intermediate parts above described, causes the paddles to recede from, or approach to, the centre of the wheel."

The boat E is shown in the engravings Fig. 2, Nos. 1 to 5. In this case, again, a list of reference letters is given, which are as follows:—A, the fore or second cabin; B B, space for the machinery; C, the iron chimney, serving also as a mast; D, the boiler; E E, the steam engine; G, the crank; H, the fly-wheel; I I, the paddle-wheels; K, ladies' cabin; L, steward's room; M, principal cabin; N N, stairs to the cabins; O O, water-closet; P P, gangway; Q Q Q, seats at stern and on deck; R, the rudder; and S, covering of paddle-wheels.

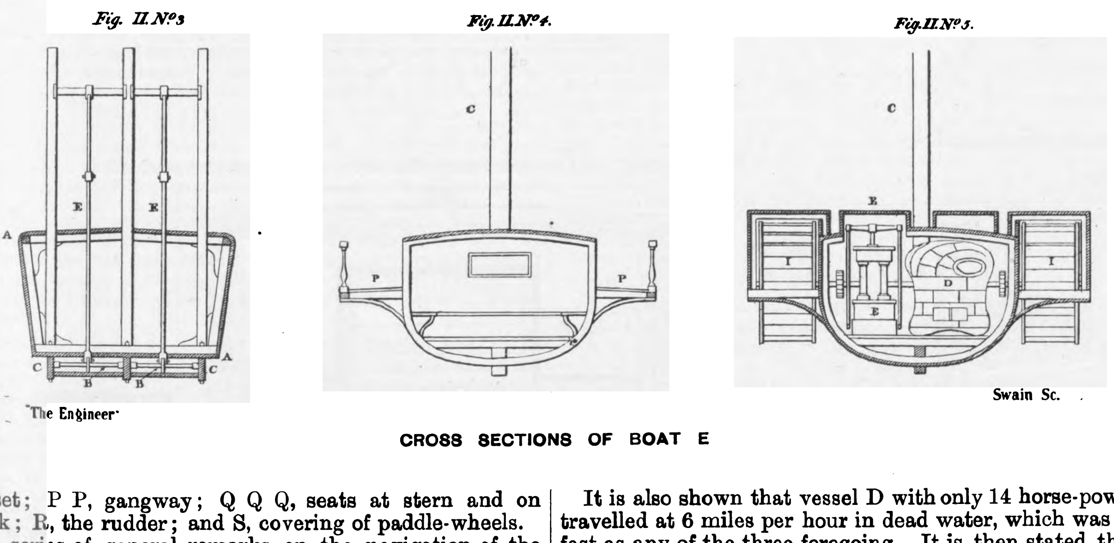


Fig. II. No 3. Fig. II. No 4. Fig. II. No 5.

CROSS SECTIONS OF BOAT E

A series of general remarks on the navigation of the Clyde follows next, and they sound very quaint in the light of the experience of to-day. Thus it is stated that the steamboats of that day were less easily turned than vessels propelled by sails. "Even," adds the author, "common oars act so far out from the side of the vessel that they have much more power to bring her round than the wheels of a steamboat can possibly have." It is remarked also that a boiler when placed on one side of a vessel is objectionable, because "any change of the quantity of water in it causes the vessel to heel." In steamboat "G," it is pointed out, the boiler extends from side to side of the vessel, "which is a much better mode."

Reference is also made to three other Clyde boats as follows:—

Vessel.	Length of keel. ft.	Beam. ft.	Burden. (tons).	Horse-power of engine.
H	... 65	... 18	... 90	... —
I	... 85	... 16	... —	... 24
K	about 90	... 16	... —	... 32

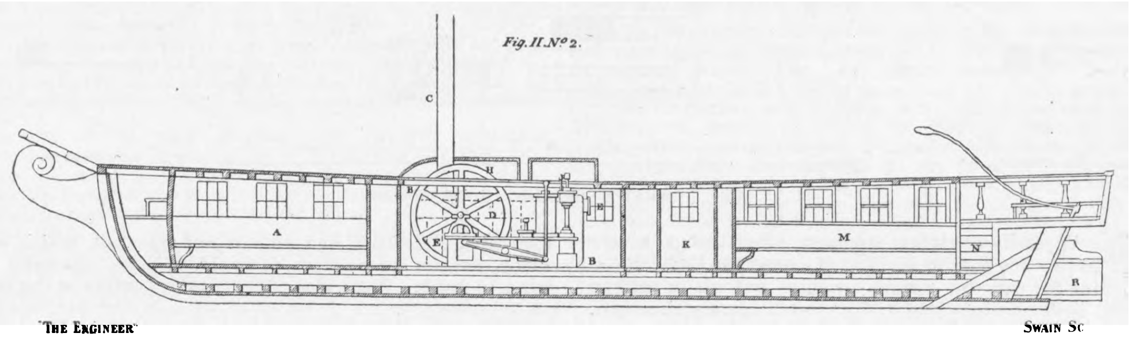
It is also shown that vessel D with only 14 horse-power travelled at 6 miles per hour in dead water, which was as fast as any of the three foregoing. It is then stated that it is not surprising that the increase of velocity had not been proportional to the increase in power, since "the resistance to which a boat is subject increases not in an arithmetical proportion (as 1, 2, 3, 4, 5, &c.), but in a geometrical proportion, viz., as the squares of velocity (as 1, 4, 9, 16, 25). In other words, to make the same vessel move with ten times a given velocity requires one hundred times the power."

The details given of the cost of the steamboat G are interesting:—

	£.
The hull	700
Steam engine, and all other machinery. cost £1000, about £700 of which went for the steam engine. The rest of the sum, about £300, was laid out for the paddle-wheels and connecting machinery	1000
Joiners' work...	200
Upholsterers' work	70
	1970
Contingent expenses	330
Total	2300

Details of coal consumption are also given. It is remarked that in a boat there is greater waste of fuel than in the case of a shore engine. One of the boats with an engine of 33 horse-power required 3 tons 12 cwt. from Glasgow to Gourock—fully 29 miles—and back to Glasgow. Another of 15 horse-power, and still another of 8 horse-power, took each the same quantity, viz., from Glasgow to Greenock—26 miles—and back to Glasgow, 1 ton 4 cwt.

The part of the volume devoted to various systems of propulsion which have been tried is full of interest. Space, however, will not permit of our doing more than briefly to refer to one or two of these. Fig. 3, Nos. 1 and 2, show a method "reduced to practice" by Mr. James Linaker. In this the water was drawn in through the front of tubes extending the full length of the vessel below the water-line, and expelled at the rear. The following key is given of the drawing:—A A, the boat; B B, the trunk pistons: C C, the trunks; D D, the trunk piston-rods; E E, levers connected with these piston-rods, and to which motion is communicated from the steam engine K by G G, the rods; and H, the tumbler. The method of working is self-evident. A second plan of Mr. Linaker's is shown in Fig. 4, Nos. 1 and 2. In these A A, show the boat; B B, the steam engine; C C, the boiler formed of wood to contain water and steam, with iron flues to contain the fire; D D, an iron chimney; E E, a large cylinder, connected with two horizontal trunks; I I and M M have valves in them and form a large double pump, the piston F of which, being moved by the steam engine, will, on its ascent, supposing the air previously expelled, draw water at the valve G in the trunk M M, and force water out of the valve H of the trunk I I; again, the descent of the piston F will draw water by the valve K in the horizontal trunk I I, and force out water at the valve in the trunk M M. "By means of this alternate expulsion of the water from the trunks the boat is propelled." "Experiments," continues the author, "have been made on a kind of screw; but this, I believe, after a trial on a considerable scale in America, was rejected. Some mechanics, however, still think favourably of it, and suppose that if a screw of only one revolution were used it would be better than where a longer thread is employed."‡ He also explains a method he had devised for making the floats of a paddle-wheel always act in a vertical direction. A curious suggestion is also alluded to. It is that of using a number of things resembling umbrellas, which would fold together when pushed forward, and expand when drawn backward in the water, and thereby propel the vessel. He, however, remarks that it is obvious to any mechanic that there is little hope of rendering this or any other such folding and unfolding or hinged machinery sufficiently strong and durable to answer the proposed end.



LONGITUDINAL SECTION OF BOAT E

Part III., devoted to the navigation on rivers other than the Clyde, is of four pages only. It appears that at the date of writing there were three steamers on the Forth, two on the Tay, one on the Avon, one on the Severn, three on the Thames, one on the Trent, three on the Tyne, one on the Mersey, and only one in all Ireland!

Part IV. deals with navigation by steam in America. Reference is made to Fulton's boat, and to the first steam frigate ever built—Fulton the First—carrying 32 long 18-pounders, and to another steam frigate, 300ft. long and 200ft. (!) beam, which carried 44 guns, four of which were 100-pounders!

In Part V. a brief illustrated description is given of a boat propelled by cattle, the "cattle" being actually horses or mules; from eight to thirteen of them. Fig. 14, Nos. 1 to 4, shows this boat and its mechanism. The boat was double, and had a paddle-wheel placed in the middle. The horses or mules worked in a gin on the deck, and, by means of toothed wheel-work, communicated motion to the paddle. A B C is the horse course; D E a large bevel wheel which drove the pinions G G; H H were spur wheels attached to the pinions G G, which worked on studs, and communicated motion to the pinions I I, and which were coupled to the axle of the paddle-wheel K.

Part VI. is devoted to various subjects dealing with the theory and practice of naval architecture, and is too lengthy to attempt an abstract of it. It must suffice to say that it treats largely of the resistance of bodies in the water, and discusses numerous trials very similar to those now carried out in experimental tanks.

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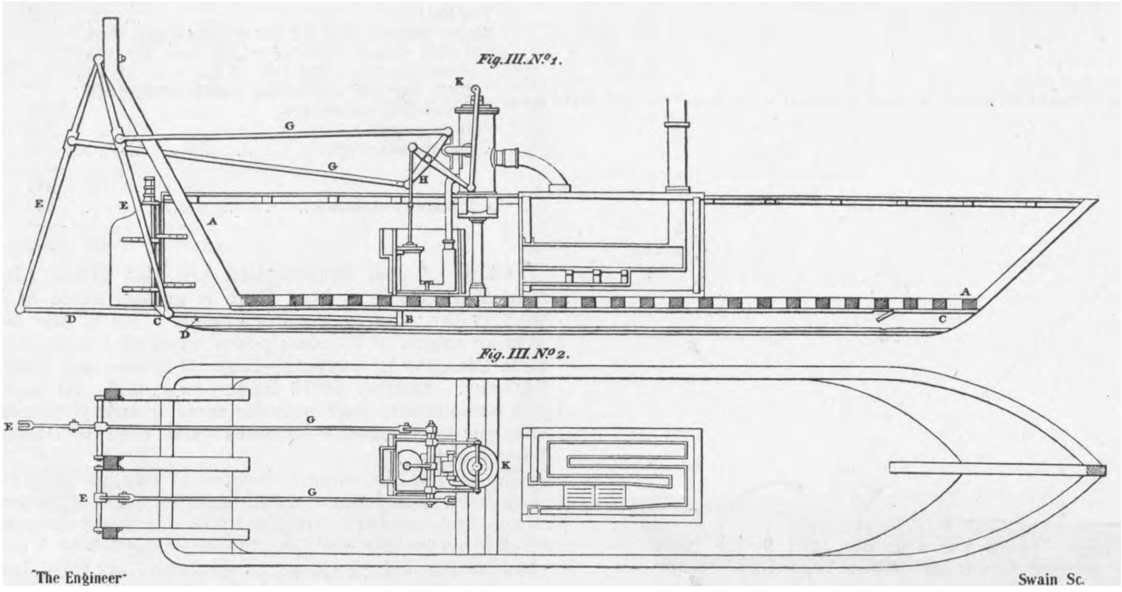
* These engines made 45 strokes a minute, and the length of the stroke was 22in.

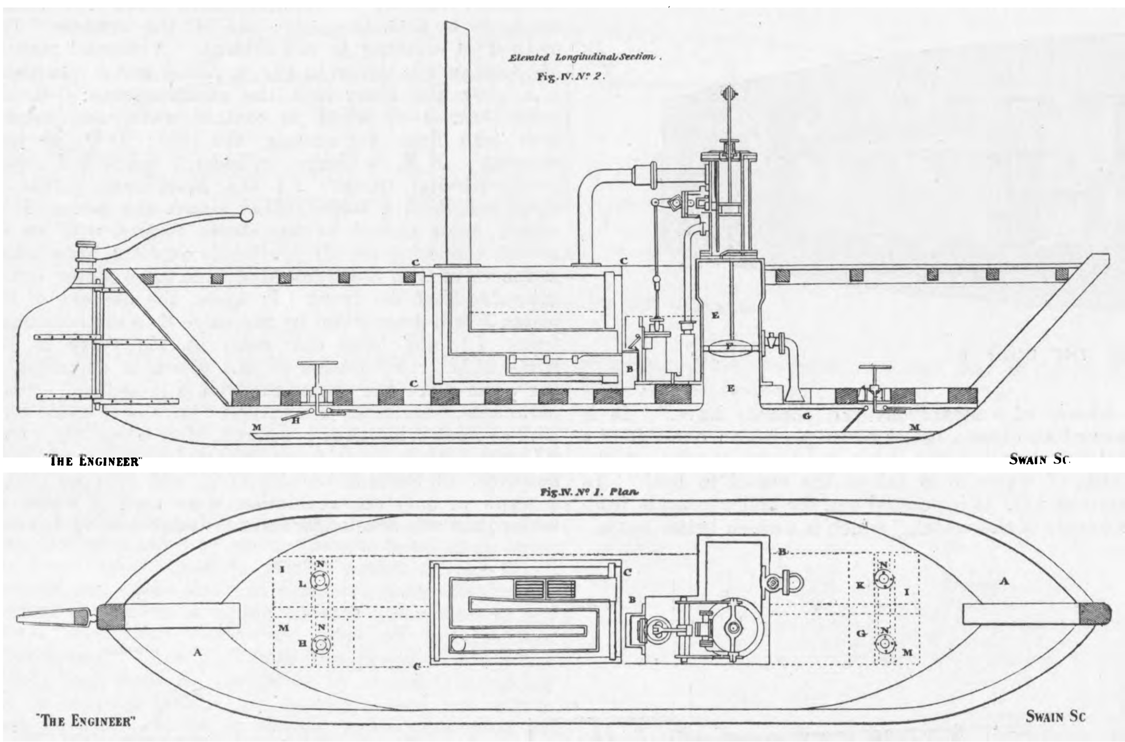
† The paddles were 9ft. in diameter and 2ft. 11in. wide. They had ten paddles and made 30 revolutions per minute; 14.1ft. per second, or nearly 10 miles per hour.

Parts VII. and VIII. do not call for any special remark, saving that they are interesting from the historical point of view, as further particulars of some early steamboats are given.

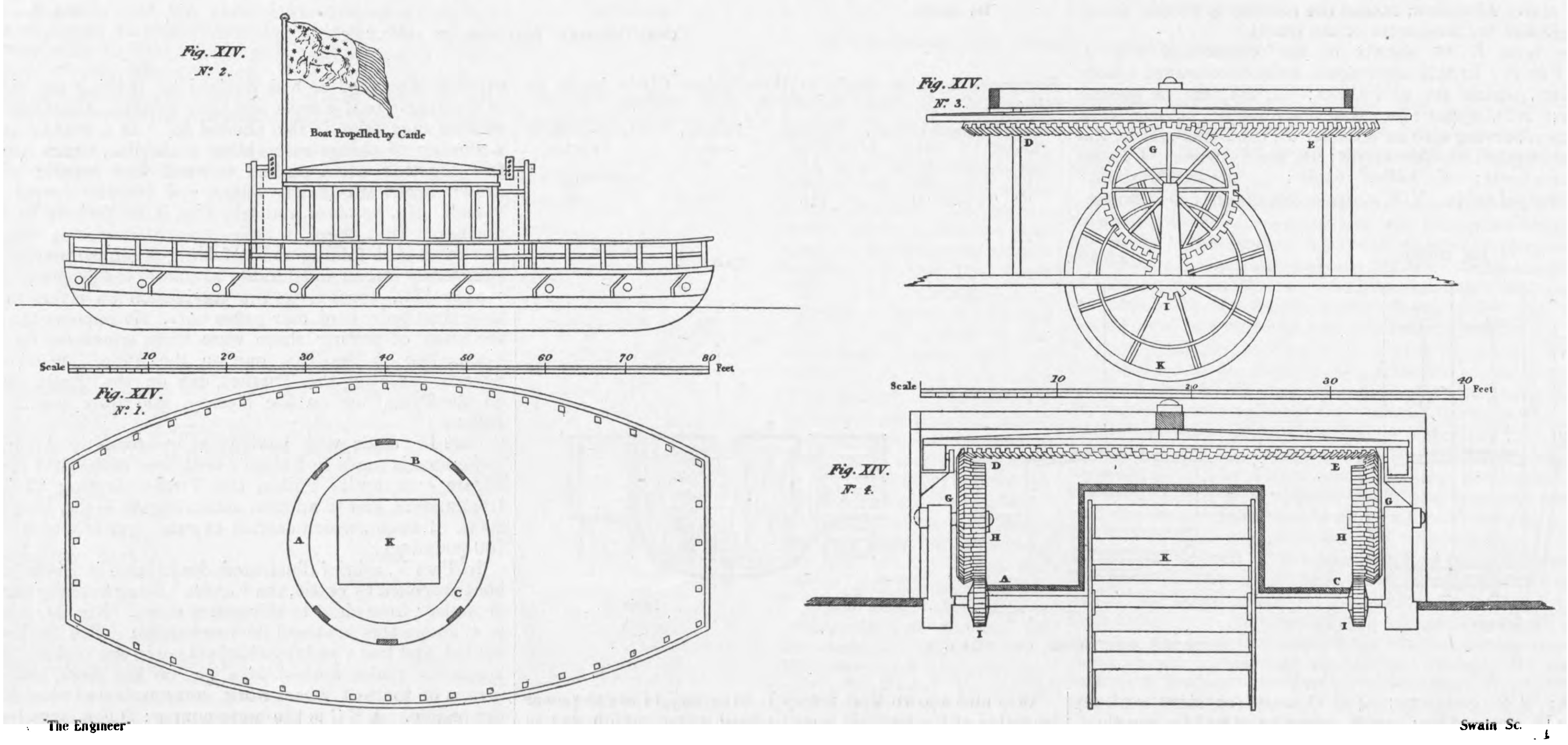


MR. LINAKER'S FIRST SUGGESTION

The Appendix contains, amongst other things, a reference to the suggestion in 1737 of Jonathan Hulls for "a machine for carrying vessels or ships out of, or into any harbour, port, or river against wind or tide, or in a calm."



MR. LINAKER'S SECOND SUGGESTION



AMERICAN CATTLE WORKED BOAT

The book, though by no means an exhaustive treatise on its subject, is full of interest from beginning to end.

SOUTH STAFFORDSHIRE MINES DRAINAGE.

THE South Staffordshire Mines Drainage Commissioners are proceeding steadily with their important task of unwatering the Midland mines, and thereby preventing one of the chief English coalfields from being drowned out. Year by year this undertaking goes on with its useful work in the face of serious and, as it would almost sometimes seem, increasing difficulties, and year in and year out, coal is won which, but for its exertions, it would be quite impossible to bring to bank. Some idea of the gigantic nature of the task which the Commission has to face will be gathered from the fact that in the Tipton district forty-two tons of water have been raised during the past financial year for every ton of mineral. The volume of water dealt with by the Commissioners during the year has been 15½ million tons, against nearly 17 million tons last year, and 15 million tons in the previous year. It is satisfactory to find from the Commissioners' annual reports that the improved machinery and plant of late installed have proved a success, and have effected considerable economies in working costs. From the report of the general manager, Mr. Edmund Howl, we gather as to general drainage that the mineral assessed for general drainage rates for the year ending 31st December, 1908, included in the annual accounts, has been 2,506,559 tons, which represents a revenue of £10,443. This is a decrease in output of 124,676 tons, or equal to £519 in value. This decrease in mineral assessed is spread over the four districts of Tipton, Oldbury, Kingswinford, and Old Hill. Bad trade is doubtless the chief cause, but now that trade is reviving again, an improvement once more may be hoped for. In last year's report an increase of 127,044 tons was recorded. The outlay upon maintenance of works and steam and electrical pumping has been £1815, against £2167 last year. In addition to this, £219 has been spent on new surface drainage works, and placed to the debit of capital account. The total amount spent on new surface drainage works and charged to capital account since the year 1898 is £14,111. The interest of the loans has been £2855, and this has been duly paid. On account of decreased revenue, by special arrangements with the lenders of the general drainage loan, the covenants fixing the amount of principal to be repaid have been suspended for three years ending December 31st, 1911, and until that date only the surplus revenue is to be handed over. This arrangement will doubtless afford the Commissioners some amount of much-needed financial relief for a time; but the arrangement does not apply to the loan of £15,000 from the Public Works Loan Commissioners, dated September 8th, 1899. During the year ending June 30th last 75 per cent. of the covenanted amount was paid off in respect of the loans affected by the new arrangement and the full amount for the £15,000 loan—the total repayment being £3061. As regards the expenditure upon works, it is satisfactory to find that a distinct advance has been made in obtaining the assistance of the local authorities in keeping the streams free from obstruction. During the year the Commissioners have carried out joint work with three corporations, eleven urban district councils, and two rural district councils.

With regard to the Tipton district, the output of minerals during the year has been 463,559 tons, which, at the amount per ton fixed by the Arbitrators' award, gives a rate of £14,746. This has been amended by the Chancery allowance for pumping to £14,584, being a decrease of £1086 upon last year. The surplus of revenue, after providing for working expenses, is £1553, as against £195 last year. A further £4000 on account of the Tipton District Engineering Scheme—which is proceeding very satisfactorily—has been received from the Public Works Loan Commissioners, making a total of £85,000.

With reference to the Old Hill district, the assessments amount to £8152, against £8985 last year, and £8388 in 1907. The expenditure on working account has been £6598, as compared with £7953 last year.

THE QUEBEC BRIDGE studies have progressed far enough to lead to a decision to request tenders on both cantilever and suspension types of structures. The centre span is to be reduced from 1800ft. to 1715ft. by constructing a pier 100ft. further out from the north shore than the present river pier. The bridge will be 85ft. wide and 150ft. above high tide for 600ft.

BLACKPOOL AVIATION WEEK.—Satisfactory progress has been made this week with the preliminary arrangements for the above fixture, which will be held during the week commencing October 18th, under the joint auspices of the Blackpool Corporation and the Aero Club. The site for the trials is a flat piece of land at South Shore belonging to the Blackpool Golf Club. The bunkers are being removed and the course laid out by the Borough Surveyor, Mr. Brodie. Grand stands to accommodate thousands of visitors and houses to shelter the aeroplanes are in progress of erection. The prize list is an attractive one, and the competitions will include long-distance flying, high speed, height, and passenger carrying, while special prizes are offered for British machines and for slow flying. The entry list up to date includes the names of Henry Farman (Farman biplane), Rougier (Voisin biplane), Paulhan (Voisin biplane), Baratreux (Wright biplane), Sanchez-Besa (biplane), Emilio Edwardes, Dufour, and Defier. There are three other continental aviators with whom negotiations are virtually complete, namely:—Leblanc, De Riche, and Deutrix.

RAILWAY MATTERS.

THE New South Wales Railway Commissioners, it is reported, have decided to electrify the remaining 43½ miles of suburban steam lines running out of Sydney. A total of 146 miles of single track have been electrified during the last nine years, and the return on the capital invested is now nearly 6 per cent.

THE Great Eastern Railway Company has practically closed its stations at Theobald's Grove, Forty Hill, and Churchbury, and has withdrawn its clerical staff from those places. Cheshunt will for the future deal with traffic for Theobald's Grove and Forty Hill, and Lower Edmonton with that for Churchbury.

WE hear that the Rio de Janeiro Tramway, Light, and Power Company has opened a new sub-station at Meyer for supplying electricity to the new Caxomby tramway system and for general use. Another sub-station is being erected at Cascadura, and a supply is to be given to the cotton mills at Bangu and the military town of Sapopemba.

THE announcement is made by the Nicaraguan Government that work is shortly to be resumed on the Railway between San Miguelilo, on Lake Nicaragua, in Nicaragua, and Monkey Point on the Atlantic coast of that country. Of the £2,250,000 recently borrowed by Nicaragua, £430,000 will be used for the railroad. It will be 118 miles long—3½ miles already have been constructed.

THE extensions to the Johannesburg tramways, which are to be undertaken forthwith, include the following works:—Extend Fordsburg tramway to station, £6410; Bezuidenhout Valley line to south side, £6500; extend Parktown West line to Rosebank terminus, £13,836; duplicate Parktown line from Ridge to Zoo, £3800; extend Auckland Park line to Helville, £6800; and extend Newtown line to Brixton, £19,295.

THE construction in the Departments of the Rhône and Loire of an important series of narrow-gauge light railways of a total length of 80 miles, linking up various industrial centres in the mountainous and isolated country between Lyons, Roanne, and Saint Etienne is about to be begun, the Government having approved the scheme. The estimated cost to the Department of the Rhône is £328,100, to be raised by means of a 3¾ per cent. loan.

THE Board of Trade have recently confirmed the following Order made by the Light Railway Commissioners:—Padstow, Bedruthan, and Mawgan Light Railway (Extension of Time) Order, 1909, reviving the powers granted and extending the period limited by the Padstow and Mawgan Light Railway Orders of 1903 and of 1905, for the compulsory purchase of lands, and extending the period limited by those Orders for the completion of the railway and works thereby authorised.

IN the House of Commons recently Mr. Joynson Hicks asked whether the Home-office would consider the question of compelling tramway authorities to fix on their cars a device for making a continuous noise when the speed exceeds a certain limit, as was now done in the case of motor omnibuses. Mr. Masterman replied that the question was under consideration, but the application of the device to tramcars presented special difficulties, owing to the varying limits of speeds authorised for tramways. Mr. Myer asked if Mr. Masterman was aware that some of the cars on the Thames Embankment travelled at a speed of over 20 miles per hour, but no answer was given.

THE rack-and-pinion railway from Chamonix to the Montanvert, overlooking the Mer de Glace, though opened for traffic in 1907, was only finally completed in May, 1909, as up to that time it stopped short at the top and passengers were compelled to get out and walk for the last part of the climb. The line ascends in two sharp zigzags, with an average gradient of 1 in 6 and a maximum of 1 in 4½. The engines, of Swiss construction, from the well-known works at Winterthur, are fitted with four separate and independent brakes, operated by different means, including a steam brake, which comes into action automatically whenever the engine speed exceeds 5½ miles an hour, so that any risk of an accident on the steep incline is very remote.

EXPERIMENTS are being carried on in Berlin with a new type of electrically driven motor omnibuses. When fully charged, these vehicles can carry thirty-six passengers a distance of over 60 miles at an average speed of 12½ miles per hour, but, inasmuch as the working expenses are very heavy, it is considered that they would be run at a profit only on lines with plenty of short distance traffic. A special feature of the past year was the first introduction into German South-West Africa of a 45 horse-power passenger car by the German Imperial Colonial-office. All four wheels are driven, and in the course of a lengthy trial trip of nearly 1000 miles over hilly country and through deep sand the vehicle proved to be thoroughly efficient. The military authorities have placed somewhat extensive orders for various makes of motor cars.

IN order to cope with the contemplated increase in the train service on that section of the London and Brighton Railway consequent on the electrification of the South London line, it has been arranged, with the sanction of the Board of Trade, to use one of the two "up" lines for "down" working for a distance of 1½ miles during the "rush" hours in the evening, when additional facilities are required for the dispatch of trains from London Bridge. This arrangement of alternate line working will also enable the company promptly to clear the terminus of empty trains after business hours in the morning. The Brighton Railway are to be congratulated on their efforts to solve a difficulty which is experienced by all suburban lines carrying a large traffic within a limited period of time, when the flow of traffic is towards London in the morning and in the reverse direction in the evening.

IN connection with the adoption of automatic signalling on the Metropolitan Railway it has been found advisable to remodel the arrangement of running roads at Aldgate station. Formerly the through roads ran through the centre of the station, and on the other side of each platform was a terminal bay. This plan, though fairly convenient, naturally caused considerable fouling of the roads when the bays were used, which was very frequently. Hence the former through roads have been made terminal bays and the through circle trains take the outermost set of rails in each direction, which have been transformed from terminal lines to through roads, arriving at what may be termed the wrong side of the platform. With the sliding doors under the control of the staff, there is not the danger that there is connected with the closing of the ordinary swing doors when the train is leaving the platform on the wrong side, as in the case of all island platforms.

PROGRESS is being made with the projected rack-and-pinion railway from Le Fayet to the Aiguille du Goûter *viâ* the Col de Voza and Mont Lachat, which it is proposed eventually to prolong to the summit of Mont Blanc itself, and the Le Fayet-Col de Voza section was opened for traffic last July. The next sections to be undertaken are from the Col de Voza to Mont Lachat and the Tête Rousse—10,380ft.—but the real difficulties of the undertaking will begin with the last section, from the Tête Rousse to the Aiguille du Goûter, 12,600ft. high, the provisional terminus of the line. This section of about a mile and a-third will require tunnelling throughout its length. It is calculated that the journey from Le Fayet to the Aiguille du Goûter will take about four hours, and as the summit is only an easy five hours there and back from the Aiguille it will thus be possible to make the ascent of Mont Blanc from Le Fayet and return in fourteen hours. As for the Aiguille du Goûter-Mont Blanc section, long and laborious preliminary surveys and soundings of the sub-glacial soil will be necessary before even a beginning can be made of this project.

NOTES AND MEMORANDA.

A HYDRAULIC dredge reclaiming land at Bombay, India, recently dredged a channel through stiff blue clay 300ft. wide, 21ft. deep, and 1000ft. long in 85 working hours, the average rate of discharge being 2700 cubic yards per hour.

AN excess of phosphorus in bronze causes pin-holes in the casting. The ideal condition in the use of phosphorus is when just the right amount is added to the bronze to remove the oxide present in it, and a small quantity only is needed for this purpose. Owing to the fact that the quantity of oxide in copper or bronze is always variable (depending upon the manner of melting, &c.), the amount of phosphorus to be introduced can only be approximated. The same rule holds true of all deoxidising agents.

OWING to the careful adjustment and regulation of temperature necessary in bacteriological incubators, a new incubator has recently been built which will be heated by electricity, and which it is expected will thus overcome the difficulties with gas-heated incubators. Incandescent lamps are used in the new heater to maintain the required temperature. A new mercury regulator controls the lamps. The instrument was tested quite recently for a run of forty-five days, and the variations in temperature during this time were practically nothing. The incubator is formed with a triple wall, providing a water jacket and an air space, and is covered with asbestos finished in white enamel.

GREAT progress has been made by Argentina during the last few years. This progress is partly the outcome of her rapid agricultural development, though only 15,830,000 of 295,050,700 hectares of land are under cultivation. But the cultivated surface increases each year tremendously. Last year, for instance, not less than 1,213,000 hectares of land, or as much as one-half of the total surface of Belgium, were brought under cultivation. Among others there were produced 5,238 000 metre-tons of wheat and 1,100,000 metre-tons of linseed. The export in agricultural products alone was over 1 milliard of shillings, of live stock 468,522,000. The total imports amounted to 1,102,000,000 marks; of this there was taken up by agricultural machines and implements 16,784,000 marks, by seeds for sowing purposes 15,473,000, and by live stock 7,198,000 marks.

DURING the eight months ending August 31st Great Britain exported iron and steel and manufactures thereof to the value of nearly twenty-four and three-quarter millions; other metals, five and a-half millions; cutlery, hardware, &c., nearly three and a-half millions; machinery, over eighteen and three-quarter millions; and ships, four millions. Our exports of iron and steel and manufactures thereof for August amounted to £2,944,430; of other metals, to £719,712; of cutlery, hardware, &c., to £426,059; of machinery, to £2,228,672; and of ships, to £358,509. The total British exports for August amounted to £32,114,700. The total value of exports from the United Kingdom during the eight months ending August 31st was £244,536,290. The most notable increase among engineering exports during August were those concerning various metals, cutlery, &c., and ships, with an aggregate advance of £128,872 over the corresponding month of last year.

ELECTRICITY has once more been enlisted in the service of business, an invention having been perfected which will make the tampering with all forms of credit notes, and many other documents, impossible. A glass-topped desk is provided with an aluminium plate. Beneath this are a couple of electric batteries, a rheostat, condensers and resistances connected with the aluminium plate. The circuit is completed by a stylographic pen, connected by an ordinary flexible cord to the batteries. The cheque or other document is placed on the aluminium plate, which is then written over with the stylus, with the result that a series of small sparks are seen to burn tiny holes in the paper or parchment, leaving the words traced out in brown—the tiny carbonised dots. Such a document cannot be tampered with, and if only the apparatus answers well in practice, these little glass desks, with their appurtenances, should soon be seen in every bank and business office. It is only in accordance with the fitness of things that this invention is due to a Parsee gentleman, for Parsees are almost as intimately connected with banking as were the olden Lombards.

ACCORDING to the *Engineering Record*, insulation joints in steel water pipe are to be built into the two 30in. lines which will carry the Little River supply of Springfield, Mass., under the Connecticut River, in order to prevent a flow of electric current through the crossing. A joint of wood stave pipe will be introduced in each pipe at each end. The castings for the ends of the joints, between each pair of which there is a gap of 3ft., are flanged to connect with the regular 30in. pipe. The interior diameter of each casting is 30in.; the outside surface, for a distance of 15in. from each end, is turned to a circle precisely 33in. in diameter except for three beads which are allowed to project above the rest of the surface. Cypress staves, 5ft. 6in. long and varying in thickness from 2in. at the ends to 4in. at the middle, lap over the ends of each casting a distance of 15in. and form a 3ft. length of wood stave pipe between the metal parts of the line. Eight welded hoops of 1in. by 4in. steel band the staves together, bringing the wood to a tight fit around the ends of the castings and causing the beads to sink into the staves and thus hold them in place.

THE *Industria* of Milan gives the following particulars respecting the imports and exports of automobiles and of bicycles into and from Italy. The imports of automobiles have fallen off during the last few years. From 931 in 1906, the number decreased to 725 in 1907, and to 348 in 1908, with a declared value of 4,854,470 lire. On the other hand, the exports have risen from 899 automobiles in 1906 to 1283 in 1907, and to 1629 in 1908, with a declared value of 28,236,765 lire. The countries they were sent to are France, the United Kingdom, Switzerland, Austria-Hungary, Germany and countries out of Europe. But the production of bicycles is below the demand. In 1908 the importation of bicycles and of parts of bicycles showed a marked increase; indeed, the former rose from 4502 in 1907, value 870,060 lire, to 7719, valued at 1,433,270 lire, and in "parts" the increase was from 7815 quintals, for about 4,000,000 lire, to 10,488 quintals, valued at 5,244,000 lire. Bicycles and their "parts" came chiefly from Germany, which supplied about half, from the United Kingdom, France, United States, and Switzerland. The export of bicycles is far less important, and was only 648, valued at 125,120 lire in 1908.

A NEW method has recently been suggested for the absolute measurement of resistance. A revolving coil, or two such coils, are to be so disposed in the magnetic field of a pair of fixed coils as to yield an E.M.F. which can be compared, by means of a differential galvanometer, with the fall of potential through a fixed resistance, and so give the absolute value of the resistance. The advantage of this method would be that the E.M.F. generated could be a thousand times greater than in a Lorenz apparatus, while the thermoelectric forces at the sliding contacts would be considerably less; for a revolving coil cuts the lines of force four times in each revolution, and two coils of only 125 turns each would therefore generate a thousand times the E.M.F. produced by a disc, supposing the field and speed the same, and the area of the coils equal to that of the disc. The thermoelectric forces due to the brushes would be less, because the commutator could be much smaller than the disc. The method of securing this result is not quite so simple as in the Lorenz experiment, but it seems to be free from any serious difficulty. An apparatus of this kind is being constructed at the Bureau of Standards, Washington.

MISCELLANEA.

THE Manhattan Bridge across the East River between Manhattan and Brooklyn, which is now almost finished, has been investigated by Mr. Ralph Modjeski at the request of the Board of Estimate and Apportionment of New York and pronounced "carefully designed and when completed amply strong to carry the heaviest traffic which may be placed upon it in the near future, as well as any reasonable additional increase in the weight of properly regulated traffic it may be called upon to carry for many years to come."

ACCORDING to the *Engineering and Mining Journal* the first pig iron in the United States made in the electric furnace, which has been put on the market commercially, comes from the plant at Héroult, in Shasta County, California. This plant uses furnaces of the Héroult type, and electric power is furnished by the Pitt River. The first regular shipment was 20 tons of pig iron delivered in Redding. The electric furnace in operation is turning out about 25 tons of iron daily, and delivering it at a cost less than the present price in California. Some few changes have still to be made before the process will be considered completely successful.

SOMETHING is at last being done by the municipality to improve the lighting of Salonica. The electricity will be supplied by the dynamos which drive the electric trams. The wires will be carried overhead, and for this purpose 211 tapering trellis-pattern standards of Belgian iron of an average weight of 1760 lb. are to be used. Private consumers still seem to be deterred by the tariff—70 c. per kilowatt—though this compares favourably with some European rates. So far three theatres and a big flour mill are the only instances of private electric installations. Three of the four main arteries of Salonica will shortly be lighted by electricity, as well as one or more of the principal cafés.

SCIENTISTS now have placed at their disposal the highest meteorological and astronomical observatory on the American continent. It is situated on the top of Mount Whitney, California, 14,000ft. above sea level. Realising the value for effective and progressive astronomical and meteorological work of an observatory far above the clouds and free from dust and smoke near great cities, the Smithsonian Institution decided to build a suitable laboratory on Mount Whitney. Now that the observatory is opened it will be used by scientists of the Smithsonian Institution and by others to make observations. The Smithsonian Institution will permit the building to be used by any scientist gratuitously.

WRITING from Berdiansk, in the consular district of Odessa, the British Vice-Consul reports that there are really no new openings for British trade, seeing that there is no direct line of steamers with British ports. British goods required by shopkeepers come from Odessa. Sections for reaper and mower knives come from the United Kingdom and America, and the principal makers send their representatives to take orders from the agricultural machine manufacturers. The special steel plates for plough breasts have hitherto come from Germany, but Russian works are now offering them, and the demand for the foreign article must cease. There is no reason why British makers should not do a trade in self-binding reapers if they can compete in price with the Americans.

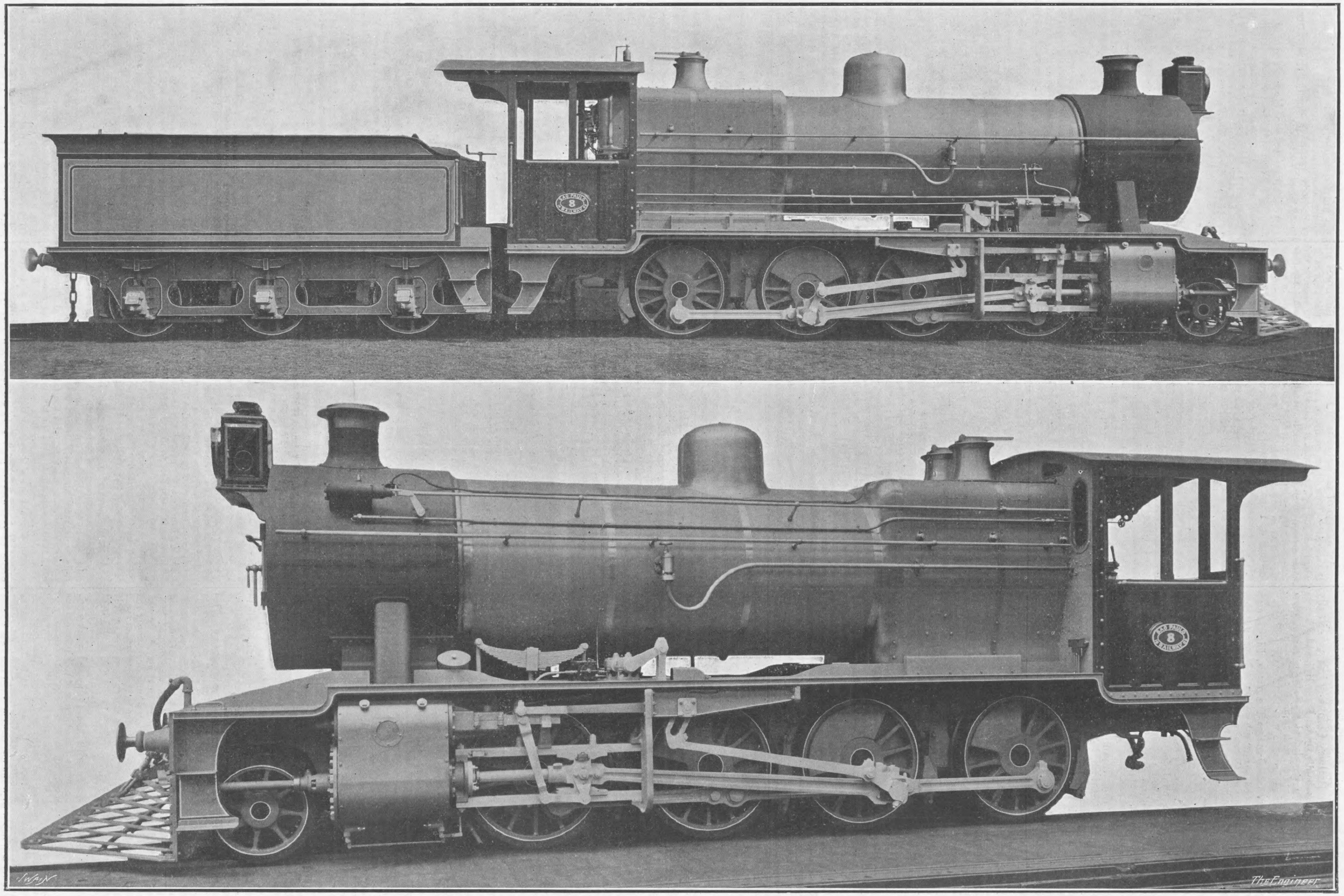
IN view of the serious delays occasioned in the ordinary telegraph service during the severe magnetic storm on September 25th, it is interesting to find Mr. W. H. Eccles writing to the *Electrician* to say that although he was working a wireless telegraphy station in Surrey between the hours of 2.30 and 4 p.m. on that day he did not know that a storm was in progress, so entirely absent was any sign of unusual disturbance. The disturbances set up in ordinary wire telegraphs are, of course, due to induction caused by the fluctuations of the magnetic field enclosed by the telegraph circuit, which consists of the overhead wire and the earth return. In wireless telegraphy there is no such circuit, the message being transmitted by waves in the ether, and, apparently, these are not affected by magnetic storms.

A COMBINATION girder and arch bridge has recently been built near Saybrook Junction, Conn., for an electric railway carrying large cars, which, when loaded, weigh about 50 tons. It is on a long 2 per cent. incline, and, in order not to increase the gradient and raise the bank on each side of it, a flat arch of reinforced concrete, only 8in. thick at the crown, was adopted. The clear span is 30ft., with a rise of 2ft. 8in. Instead of solid abutments, two diagonal reinforced concrete struts are run down to a skewback 25ft. back of the springing line, and support is provided at the springing by a transverse girder, carried by two piers. The track on each side of the arch is carried, directly above the diagonal struts, by reinforced concrete girder spans, supported by the piers at the springing line and by another set rising from the skewback footings.

WE understand, states *Electrical Engineering*, that a change of considerable importance has been decided upon by the postal authorities in reference to the future control of electrical engineering arrangements of the North Midland district. For many years Nottingham has formed the headquarters of a widely scattered area, including parts of Yorkshire and Staffordshire, and the whole of the counties of Nottingham, Lincolnshire, Leicestershire, Derbyshire, and Rutlandshire. After December 1st this territory will be absorbed by the Leeds and Birmingham districts, opportunity being afforded to the existing staffs at Nottingham of transferring to other centres of administration. The change is coincident with the approaching retirement under the age limit of Mr. T. J. West, the present electrical superintendent.

NAPLES, deservedly renowned for its beauty, still, states the *Electrical Engineer*, undeservedly retains its notoriety for the *dolce far niente* of its *lazzaroni*. As a matter of fact, modern Naples is one of the most industrious of old-world cities, largely because its wideawake Edils have known how to spend judiciously and offer all kinds of valuable concessions for the development of the manufacturing quarter in the plains. Another manifestation of their enterprise is seen in the hydro-electric scheme, which will utilise the wasted powers of the Volturno River. The dam will be built high up the river and water conducted to the generating station, 50 miles from Naples, by means of sluices. Turbines will drive the three-phase generators, the current will be stepped up from 5000 to 45,000 volts, and it is expected to be able to transmit 16,000 horse-power. In this way a fresh impetus will be given to the industrial suburb of Naples, while the citizens themselves will also benefit by power being made available for domestic purposes.

LAST year, according to the Home-office returns, the electric coal cutters in use increased from 643 to 737, while the compressed-air machines moved from 850 to 922. The electric coal cutter has made the greatest strides in Scotland; *per contra*, it is hardly known in South Wales, where hand work is almost exclusively used. When it is remembered that only 5 per cent. of our coal output is machine-cut, the vastness of the field open to electricity may be realised. At present compressed air is supposed to be safer than electricity, especially in mines liable to fire-damp. But with proper precautions electricity can be made perfectly safe, and in any case the value of electric power for driving air compressors is admitted. As a sequel to the growing use of machinery in mines comes the recommendation of a Royal Commission that there should be more Home-office inspectors, and that while the qualifications of the existing inspectors should be, if possible, increased, a new class of assistant should be created. These are to be men with thorough practical experience in pit work, and chosen by competitive examination.



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(For description see page 365)

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TO CORRESPONDENTS.

☞ *In order to avoid trouble and confusion we find it necessary to inform correspondents that letters of inquiry addressed to the public, and intended for insertion in this column, must in all cases be accompanied by a large envelope legibly directed by the writer to himself, and stamped, in order that answers received by us may be forwarded to their destination. No notice can be taken of communications which do not comply with these instructions.*

☞ *All letters intended for insertion in* The Engineer, *or containing questions, should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

☞ *We cannot undertake to return drawings or manuscripts; we must, therefore, request correspondents to keep copies.*

REPLIES.

T. H. B.—Your letter has been forwarded.

A. P. (Barry Dock).—The Admiralty will not permit the publication of drawings, and we are therefore unable to help you.

A. T. (Dundee).—We have no knowledge of the work of the school in question, and are therefore unable to express an opinion.

B. H. (Norwich).—The qualifications are plenty of experience, plenty of common sense, and much steadiness. Write to some of the insurance companies and tell them you want a berth.

G. J. (Hammersmith).—See "Steam Boilers: Their Management on Land and Sea," by Peattie—a small book—or Hutton's "Steam Boiler Construction," a larger and more expensive book.

G. A. H.—We cannot recall even having seen a book which would meet your friend's wants. The only thing would be to consult some good works on shipbuilding and marine engines. See, for example, Sothern's "Verbal Notes and Sketches," and Holms' "Practical Shipbuilding."

F. B. (London).—What you want is not easily obtained anywhere, and is now-a-days practically impossible in London, where only one big marine engineering works remains, viz., The Thames Ironworks Shipbuilding and Engineering Company, Limited. Your best chance will be to try the Tyne, Clyde, or Wear, and you will almost certainly have to pay a premium. On the Tyne try Hawthorne, Leslie and Co., Limited, Sir W. G. Armstrong, Whitworth and Co., Limited, Walker, and Wallsend Slipway and Engineering Company, Limited. On the Clyde there are many firms: Fairfield Shipbuilding and Engineering Company, Limited, David and William Henderson, A. and J. Inglis, Denny Bros., London and Glasgow Engineering Company, and so on. On the Wear are Wm. Doxford and Sons, Limited, and the North-Eastern Marine Engineering Company, Limited. It is hardly likely that any firm will guarantee any one a good salary at the end of his time.

INQUIRIES.

"MARCHANT" PATENT PROPELLER LUBRICATOR.

Sir,—Can any of your readers give me the name and address of the makers of the "Marchant" patent propeller lubricator? S. I. K.
October 4th.

ADDRESS WANTED.

Sir,—Some time ago a Mr. A. P. Fleming circularised me, asking for particulars of the engineering school here. I prepared a reply, but unfortunately lost his address. I would be grateful if you or any of your readers could give it to me. C. W. L. Alexander.
Engineering Department, Queen's College,
Cork, September 28th.

MEETINGS NEXT WEEK.

The Junior Institution of Engineers.—Friday, October 15th, at 7 p.m. Visit to the Model Engineer Exhibition, Horticultural Hall, Westminster.

The Association of Engineers-in-Charge.—Wednesday, October 13th, at St. Bride's Institute, Bride-lane, Fleet-street, E.C. Prof. Henry Adams will deliver his Presidential Address, "Standardisation."

The Institution of Mechanical Engineers: Graduates Association.—Monday, October 11th, at 8 p.m. Paper, "Invention and Industrial Progress: with a Treatise on the British Patent System," by Mr. J. E. S. Lockwood.

The Institution of Mechanical Engineers.—Friday, October 15th, at 8 p.m., in the Institution House, Storey's Gate, St. James's Park, Westminster, S.W. Monthly general meeting. Paper, "Heat Transmission," by Professor W. E. Dalby, of London.

The Incorporated Institution of Automobile Engineers.—Wednesday, October 13th, at 8 p.m., at the Institution of Mechanical Engineers, Storey's-gate, St. James's Park, S.W. Dr. H. S. Hele-Shaw, F.R.S., M. Inst. C.E., will deliver his Presidential Address, "Aerial Automobilism."

THE ENGINEER.

OCTOBER 8, 1909.

The Life of Permanent Way.

During the last meeting of the Iron and Steel Institute Mr. R. Price-Williams read a paper on "The Serviceable Life and Cost of Renewals of Permanent Way on British Railways," which is very full of interest. It will be remembered that Mr. Price-Williams not long since read a paper on the cost of the maintenance of locomotives on different railways which was full of figures, to say the least startling. The present paper may be taken as supplementing the first. It would be impossible within reasonable limits and without being tedious to follow Mr. Price-Williams through all his figures; for our purpose it will suffice to concentrate attention on a selected few. All his information has been acquired from the Board of Trade returns, which again have been supplied by the railway companies. There were in 1907 about 23,000 miles open for traffic in the United Kingdom; some 13,500 miles are double and more. Of single lines there are 10,250 miles, while sidings represent 14,000—an astounding mileage. The total annual cost of maintenance works out at £11,000,000, or nearly 15 per cent. to the total working expenses, which are now about 63 per cent. of the total receipts. The 15 per cent. represents the total renewal in ten years of 5039 miles of permanent way. That is to say, that every year 504 miles are completely worn out and must be renewed. In terms used by actuaries, this represents the death-rate on which, if insurance were possible, the premium rate would have to be fixed. It must be kept fully in view that under the heading "permanent way" Mr. Price-Williams includes all the machinery and appliances, apart from engines and rolling stock, required for the safe conduct of traffic, as, for example, signals of all kinds and mechanism for working points. These are general statements, and we now proceed to consider particulars.

As we have said, we must narrow our field of view. We shall speak, therefore, mainly of two lines, which stand at opposite ends of the scale. The London, Brighton and South Coast Railway has cost during the last ten years more than other lines, the expenditure averaging £418.18 per mile. In marked contrast is the North British, with £190.8 per mile. The cost on the former railway was therefore £227.38 per mile greater than the cost on the latter. To account for this enormous difference we turn to the relative traffic, and we find that the tonnage of goods and minerals is just twice as great on the Scotch as it is on the English line. The North British is not an easy line to work, neither is the London, Brighton and South Coast. Mr. Price-Williams contents himself with putting forward figures. He does not attempt to give a reason for the disparity. Nor is this an isolated case. On the contrary. Thus, on the London and North-Western, the goods and minerals work out at 26,493 tons per mile, and the cost of renewals is very nearly £336 per mile. But on the North-Eastern the traffic is 36,000 tons, while the expenditure is only a trifle over £236 per mile. There is ample evidence that goods and mineral traffic has little or no effect on permanent way, and that it is passenger traffic which is answerable for the heavy outlay. Now, the maximum weight for each axle is probably not greater with passenger than it is with mineral stock, but it is fairly certain that for "goods" traffic it is. A 10-ton four-wheeled coal wagon fully loaded represents 16 tons, or, say, four tons per wheel; but the same wagon, nominally, with, say, two tons of farm produce, has only two tons per wheel. On the other hand, the total weight of a modern corridor coach is little affected by the presence or absence of passengers. But quite apart from the weight we have speed, and it has always been known that the wear and tear of permanent way is enormously increased by high speeds. Very few goods engines have axle loads as great as those quite common with express locomotives. The first have six or eight wheels coupled; with 15 tons per axle we have 45 and 60 tons respectively—maximum dimensions for goods and mineral engines in this country. But 18 tons per axle and more are quite usual for passenger locomotives. Again, the speeds of mineral and goods trains are low; that of passenger engines becomes daily greater and greater. Further, as Mr. Price-Williams points out, the wear and tear of crossings and frogs is enormously augmented by the smashing blows delivered to them by trains running at great velocities; and we have probably in addition the great lateral stiffness of a close buffered train as certain to exert stresses on curves, from which the rails are exempt with loose-coupled go-as-you-please wagons.

It is, we think, impossible to read Mr. Price-Williams' paper without arriving at the belief that high speed costs a great deal more than it is the custom to take for granted. The question arises, how can the enormous outlay on permanent way be reduced? Mr. Price-Williams sets himself to suggest one way, which consists in softening what we may term the asperities of the road. The vehicles and the track are two independent parts of the same machine—just as much as the V's under the table and the grooves on the bed of a planing machine. Each vehicle is subjected to two disturbing forces, the one vertical, the other horizontal. The first can be reduced by keeping the rail tables level. Concerning the latter, Mr. Price-Williams said:—"Permanent way has certainly been greatly improved and better maintained, and renewed with stronger and better materials, but on those portions of the main lines where there are junctions, and at all intermediate stations over which trains pass at high speeds without stopping, there are the knife-edged facing points and the main line rail crossings, more especially those known as the obtuse or diamond crossings, at all of which there is a gap in the main line rail, and they are all of the primitive types of crossing and switches as at the time Sir John Hawkshaw alluded to the permanent way in 1866. It is notoriously the fact that at these main line junctions and crossings, as the published records testify, some of the most terrible railway accidents have occurred. The recent very calamitous accident at Salisbury and Shrewsbury junctions have since directed attention to the great defects and risks at junctions when trains are travelling at the high speed now attained, and to the need in such places for curves of greater radius, but that involves the adoption of longer and much more attenuated knife-edges, facing points or switch tongues, sharper-angled crossings, and bigger gaps in the main lines." He went on to say that a method has been devised for dispensing with the gap in the main line, and rolling much stronger and larger tapered facing points, for which he hopes great things.

The second method of reducing wear and tear is to try and improve rolling stock. It does not appear that there is any insuperable objection to the use of wheels which, while on the same axle, can roll independently round curves. Difficulties which presented themselves while machinery and materials lacked their present excellence have disappeared. Such wheels would beyond all question diminish the wear of rails. But leaving this on one side, we may ask if it is quite certain that all existing rolling stock represents the easiest running type that it is possible to devise. Endless experiments have been carried out to ascertain train resistance. We cannot call to mind one which was intended to settle the relative merits of different designs and types in getting round curves. It is impossible to believe that all the coaches in a train run with equal freedom. A little careful experimenting might supply a large quantity of useful information.

On one most vital point Mr. Price-Williams' figures help us not at all. We refer to the effect of engines alone on the roads. Is there, for example, any special feature about the North British engines which makes them less destructive than the London and Brighton locomotives? Here is a subject far better worth discussion than the relative economy of simple and compound engines. It is an open secret that from the earliest days of railways locomotives have been scrapped because, while otherwise admirable, they were specially destructive to the permanent way. We may remark incidentally that the relations existing between the road and the locomotive are seldom, if ever, mentioned in any discussion, or in any books. It seems to be taken for granted that all engines will perform equally well, provided the weight on any axle does not exceed about 18 tons. It may be regarded as proved by many years of experience that the destruction of permanent way is greatest when the resistance as a vehicle of an engine is a maximum. The two things are inextricably mixed, but the fact has never really been brought into that prominence which it deserves. We need scarcely add that neither we ourselves nor Mr. Price-Williams have done much more than touch the edge of a subject of the utmost importance to railway shareholders. We shall have more to say about it. We hope that Mr. Price-Williams has the like intention.

Admiralty Destroyer Policy.

To the man in the street who takes an intelligent interest in naval matters the variations which have taken place in the designs of our latest destroyers must be, to say the least, puzzling. In the early days of the introduction of the destroyer they were looked upon as pets or nuisances to be nursed or anathemised according to the temper and inclination of the admiral in command. With time and experience came the desire to extend their sphere, and they were accordingly used more and more to accompany the fleet. It is ancient history how they were found unequal to the strain of continual buffeting in bad weather, and how the River class, with slower nominal speed but equal sea speed to the previous boats, came into being as the first of the ocean-going classes of modern destroyers. So far the development was perfectly natural, and followed a normal course, but subsequent classes have followed anything but the same road, and can only be explained by the assumption that the Admiralty have in turn become—to borrow a colloquialism from present-day affairs not connected either with the Navy or engineering—whole-hoggers and little-piggers. In the Tribal class the Admiralty went the whole hog. From the 25½ knots of the River class the speed was increased to 33, the displacement nearly doubled, and the cost more than doubled. Turbines and oil fuel made this result possible; but, in point of armament, they were practically no better than the River class.

Having achieved this remarkable result, the Admiralty appear to have come to the conclusion that the cost was not commensurate with the speed, and doubtless with the eagle eye of the Treasury upon them, set themselves the task of obtaining a cheaper class of boat. In the meantime, too, doubts had arisen as to the adequacy of the then provision for stocks and supplies of oil fuel, and as a precautionary measure the new boats were designed for coal burning. It is thought by some that if reduction in cost were necessary, some reduction in displacement should have been made, as at one time seemed likely, whereas all the saving appears to have been effected on the machinery. The reversion to coal no doubt accounts for some of the loss in speed, probably at least a knot; but if £140,000 were too high price to pay for 33 knots, it would seem that £100,000 is an even higher figure to pay for 27 knots. Eventually sixteen boats were ordered under last year's programme at this latter speed. In the twenty boats recently ordered under this year's programme, the speed has been increased to 29 knots, while the fears as to the supply and storage of liquid fuel appeared to have been allayed, for the new boats are to burn oil. Their nominal power is only slightly below that of the Tribal class. We say nominal power advisedly, for the turbine is capable of a very large overload, and, in fact, the vessels of the Tribal class very considerably exceed their nominal power, in some cases by nearly 50 per cent. Unless, therefore, advantage is to be taken of the results of the trials of the Tribal class, and the size of turbines and heating surface of the boilers be reduced in proportion, it looks as if the Admiralty intend in their latest boats to have at least 2 knots in reserve. The question of the speed of destroyers is one that must be looked at from the point of view of the fleet, for the functions of the modern destroyer have been extended beyond its original scope so that it has now to do duty as a scout as well as its primary duty of seeking out and destroying the enemy's torpedo boats, and of acting in flotilla as a screen to the battle fleet to ward off torpedo attacks. It is an axiom of naval policy that if you develop one arm of the fleet all the others must progress with it, and the increase in speed of our latest battleships and cruiser battleships has made increase in speed of the destroyer inevitable. We are now about to embark on the construction of an improved Invincible which will have a speed of 29 knots. If this type becomes general, no destroyer of less speed than 32 knots will be of any use as an ocean-going destroyer to accompany the fleet. Probably even a margin of 3 knots is not sufficient, for a vessel of 20,000 tons has an enormous superiority over one of 1000 tons in maintaining speed in a seaway. We cannot have our cake and eat it. If we must build these enormous cruiser battleships with unprecedented speed—we instinctively drop into the phraseology of the non-technical daily Press—it is no use our crying out that destroyers are costing too much. Where this policy is likely to lead to in cost we can form an opinion from the Swift, which for a speed of 36 knots is to cost a quarter of a million. There is a further consideration that as the speed is increased, unless the displacement rises very largely it is impossible to maintain a reasonable radius of action. The weight of hull and machinery becomes such that very little of the displacement is left for fuel. In the case of the Swift the quantity of fuel carried is given in the Navy Estimates as 180 tons. For a vessel that can burn at full speed 30 tons an hour this fuel stowage appears ridiculously inadequate.

The difficulties in getting a satisfactory solution to the problem of building a vessel to fill the double *rôle* ocean-going destroyer and scout are very great, and if in addition small cost is required, the solution becomes impossible. The endeavour to find one probably accounts for the vacillation to be found in the boats ordered in last year's and this year's programme. One is led to ask whether too much is not being expected from these craft, and whether it would not be better to abandon the idea of making them sufficiently large and of sufficient speed to be able to go anywhere and keep up with a fleet, and to return to the original ideal of a destroyer, pure and simple, as exemplified in the River class. The work of scouting would have to be relegated to vessels specially fitted for it. In any case it seems probable that the smaller destroyers, if steaming with a fleet, would no more hamper its movements than larger vessels, such as the Tribal class, which by their limited fuel capacity would require to stop more frequently to fill their tanks or bunkers.

Unskilled Labour.

With the fall of the leaf comes the season of unemployment. Already the daily papers are beginning to wring our hearts with prophecies of approaching distress. We are told that the out-of-work committees have even at this early date enrolled a larger number of names than ever before, and the curt language of the posters announces the horrors of the approaching winter. It is time then to try and get some clear ideas of the problem before us, for a little later it will be difficult to look at the matter as calmly and as coolly as we can now; sentiment and sympathy are bound to distort our vision to a certain extent when actual starvation and misery are knocking at our doors. Obviously, we cannot in the space of a column offer anything like a general view of the whole enormous subject of unemployment, and we propose therefore to take only a very small portion of it, and endeavour to see, at least, that part clearly. The portion we bring into the field of vision is unskilled labour.

If we could begin with a definition we should do so. Could we say what unskilled labour is, the ease of discussing it would be enormously increased. But definition is impossible. As a matter of fact there is no labour wholly unskilled, and the term implies nothing more nor less than the lower kinds of handicraft. Sweeping a crossing or selling street toys—refuges of the distressed—appear to be unskilled, but let us who have never tried them endeavour to make a living by either, and we shall find that even crafts so low require some knack, some little turn of skill, which can only be acquired by a few days of apprenticeship. The fact is that labour fills an extraordinary long gamut, extending from the highly skilled art and craft of an Armstrong, Maudslay, or a Leighton to the very low occupation of a dustman. Many people rail against the lower occupations—the occupations that are known vaguely as unskilled. But it is to be doubted if society will ever be conducted without them. Science and invention apparently reduce them, but actually they do nothing of the kind except for a time, for by as much as they cut off from the lower end of the labour scale they add to the upper, and the distance between the highest and the lowest remains much as it was. Indeed, if anything, every advance of science tends to carry the scale below the line as much as it takes it above it. Extraordinary intelligence is required to devise a new automatic machine, and a high standard of skill is required to carry out the invention. But once perfected, the machine does what was formerly done by sleight of hand, and a highly skilled workman is no longer required. Much manual dexterity was at one time exercised in the wrapping up of little parcels, matches, or chocolates for example. To-day machines do the same thing. Automatic machine tools, it is admitted now, though it was once stoutly denied, do not demand that degree of intelligence that the simple lathe required; and daily there are being added to workshops small appliances, height gauges, jigs and rigs, and so on, which all reduce the demand upon ability. Even the degree of dexterity that was required to avoid the loss of fingers or limbs in certain classes of work is being cancelled by the endeavours of the Home-office, which insists on the multiplication of protective devices. On all hands science is working to reduce skill, not to increase it, and whilst we are adding enormously to mental ability at one end of the scale we are reducing at the other the value of manual dexterity. To discuss whether this is good or ill is fruitless; the tide will sweep us off our legs in any case. Science and invention will and must increase, and manual skill and the old mechanic intelligence must decrease. Hence we are always adding to the lower little-skilled classes of society, and we desire to make it quite clear that it is the advance of science and invention that is responsible for this condition of affairs, and to remove the odium which many people attach to the epithet unskilled. The unskilled man is the outcome of circumstances.

So far the picture appears wholly bad, but there is luckily another and a brighter side to it. At the risk of hurting the feelings of those admirable people who believe that any work is worth doing for its own sake, we shall assert that the average workman works to make a living and for no other reason. He does not work because he feels that if he were not occupied the football field or the public-house would irresistibly attract him, and it is certain that the poetic warnings of Dr. Watts do not appeal to him. He works because he wants to eat, drink, clothe, house himself, and enjoy his leisure, and the bright side of automatic machinery is that the unskilled workman is now-a-days by its help able to earn more under more pleasant conditions than his predecessors did. Science has removed many detestable occupations. It has, indeed, reduced enormously the sum total of manual skill required, but it has also added enormously to the general welfare of the lower labouring classes.

Unskilled, rather unintelligent, labour of this kind is absolutely essential to industries. We cannot do without it, and when people urge the desirability of giving a higher training to all sorts and conditions of labour they either overlook or shut their eyes to the fact that suitable occupation could not be found for a world of all highly trained artisans. Some must inevitably sink back to the lower grades of occupation. We could not do with a labour army composed wholly of non-commissioned officers. Some must command, some must take higher positions, some lower. Some must perform the unskilled, unintellectual labour, and their number must always be great. But, we wish it to be remarked here that, although much of the work that has to be done in the world requires the exercise of but little intellect, it does not follow that the workman must be unintelligent. That is obviously a conclusion not justified by the premises. As far as his work is concerned much intelligence is indeed not required, but intelligence gives him the ability to rise if opportunity offers, as it must of necessity to some men, and above all it gives him the power of enjoying his leisure. That is an extremely important thing, for after all is said and done the object of the government of a country is to increase its happiness—nothing more nor less.

One might imagine that the fact we are enforcing is too obvious to need labouring; experience, however, shows that the contrary is the case. Because a great proportion of the unemployed is composed of unskilled labour, it is presumed that if we could reduce the amount of such labour we should reduce the amount of unemployment. The Lord Mayor, to take a case, appealing in our correspondence columns this week for a very admirable body—the National Institution of Apprenticeship—writes:—"Its value cannot easily be overestimated, especially as it tends to diminish the number of the unemployed, who are nearly all unskilled." There can, we think, be no doubt that in the writer's mind was the thought: "If these men were skilled they would not be out of work." It would, we submit, be just as reasonable to say that if they could all play the piano they would never lack employment. The fact is that much skill or little skill has little or nothing to do with the state of the labour market. Trade is influenced by matters over which labour has very little control. Great political events, the success or failure of a harvest, even the general state of the weather, are far more influential. Moreover, as we have endeavoured to prove, so-called unskilled labour is an essential part of industrial economics; it cannot be done without. We catch colds through our feet, but no one suggests as a prevention against colds that we should cut our legs off at the ankles. Yet the proposal to cut off unskilled labour to avoid the ills of unemployment is on a par with that proposition.

OBITUARY.

PETER SAMSON.

We have to record with regret the death, at the age of sixty-seven, of Mr. Peter Samson, who was for very many years in the service of the Board of Trade, and from which he only resigned some nine months ago.

Mr. Samson was born at New Glasgow, Nova Scotia, in 1842, but at an early age went to Scotland, and when fifteen years old was apprenticed to a firm at Glasgow, which has since become the Fairfield Shipbuilding Company, but which at that time bore the name of Randolph Elder and Co. When he entered it the firm were engineers and engine builders only; but before his time was up the business of shipbuilding had been undertaken, so that some of Mr. Samson's earliest experiences were connected with this branch of his profession. His knowledge of the subject was doubtless increased during a short term of service, after he left Randolph Elder and Co., with Simons and Co., of Renfrew.

At the age of twenty-one, that is to say, in 1863, Mr. Samson entered the Navy, and served in it in various capacities until 1870. In 1864 he became second assistant engineer on H.M.S. Assurance, which was at that time engaged as a fishery cruiser off the coast of Scotland, but which was some months afterwards despatched to the Mediterannean, and later on to the West Coast of Africa as a guard ship to prevent slave running. His next ship was the Northumberland, in which he served for two years, joining her first as first-class Assistant Engineer, and leaving as Engineer, having passed his examination for that rank while on board her. The Northumberland was one of the largest ironclads of her time, and was capable of a speed of over 14 knots, though her boilers only worked at a pressure of 30 lb. per square inch.

Whilst on this vessel he assisted in the towing of the first Bermuda Dock from London to Madeira. The Northumberland and the Agincourt were both engaged in this work, the latter towing ahead in front of the former, which was made fast to the dock. Behind the dock itself was a small paddle steamer to assist in keeping the tow on its course. Such a towing feat had probably never been attempted before, and it must have caused the engineers of the two warships no inconsiderable amount of anxiety.

In 1870, taking advantage of some newly issued regulations in the Navy regarding retirement on allowances, Mr. Samson, who was then only twenty-eight years of age, resigned his post, and two years later entered the service of the Board of Trade, which had recently taken over the business of measuring the tonnage of merchant vessels—a work which had up to then been carried out by Customs officials. It was to help in this additional work that Mr. Samson was engaged as assistant surveyor. From this time till January of the present year he remained with the Board, going gradually up towards the chief position. At first he was stationed at Newcastle-on-Tyne, but after only about a year there he was called to London to become assistant to Mr. T. W. Traill, who was Engineer-Surveyor in Chief to the Board. The association continued till January, 1896, when Mr. Traill retired, and Mr. Samson was appointed in his place. Of him it may be said that he filled the position with distinction. Owing to having exceeded the age limit, he should in reality have retired two years before he did; but so anxious were the authorities to retain his service as long as possible, that they pressed him to continue in office, which he did, as above stated, till January of this year. As a reward for his labours he was made a Companion of the Imperial Service Order.

To attempt to give any detailed account of Mr. Samson's work while at the Board of Trade would be impossible, but some little idea of its interest can be imagined when the vast strides made in engineering and shipbuilding during his period of office are remembered. With all of these he kept in close touch. When he commenced his career things were very much as they had been for fifty years before, but during his working lifetime the progress was prodigious. Steam pressures had gone up, in some cases, ten-fold; the turbine had made its appearance, and the combination of reciprocating and turbine engines had been successfully tried. It is understood that he thought highly of this arrangement. With each advance it was his duty to keep himself fully conversant; and to our knowledge he did so. It is worthy of note that, when still an apprentice, he helped to construct the first compound engines fitted to a British warship—the Constance.

Mr. Samson was a member of the Institution of Naval Architects and of the Institution of Engineers and Shipbuilders of Scotland. He served on the Committee appointed by the Admiralty in 1892 to consider the designs of engines and boilers for the Royal Navy, and also on the Committee for the Standardisation of Materials for Ships and Boilers.

Mr. Samson's position at the Board of Trade is filled by Mr. Alexander Boyle, who has been connected with the department for over twenty-five years.

THE PEAT DEPOSITS OF MAINE.

A recently issued bulletin—No. 376—of the United States Geological Survey deals with the peat deposits of Maine, and contains an account of the field studies made by Mr. E. S. Bastin, an officer of the Survey, and some remarks on the origin and uses of peat by Professor C. A. Davis. Mr. Bastin's report is of more or less local interest, but many of our readers will, we think, follow Professor Davis's remarks with attention, as they contain much which is as applicable to the peat formations of this country as it is to those of the United States and elsewhere.

In passing, however, we may note that the question of fuel—and it is in this connection that the report chiefly deals with the subject—is of acute interest to the New England States. In the early settlement days the ravages on the timber supply of the country were carried on in a fashion pre-supposing an inexhaustible reserve; coal is found in but limited quantities, and in recent years careful organisation in the coal trade has eliminated competition, with results affecting, of course, the consumer. A general strike of the miners in 1902, and a consequent increase in the price of coal, attracted attention to the use of peat as a fuel, and attempts were made to deal with the supply of this substance commercially, when the speedy termination of the strike also brought an end to public interest in the matter.

Professor Davis first describes the nature of peat, and the general conditions favourable to its formation. In texture and colour peat shows many variations, due largely to differences in the original vegetable matter from which it was formed. When dry it may be fibrous or compact and structureless, while its colour varies from light to dark brown and black. The conditions essential for its formation may be briefly stated as a restricted access of air and an abundance of water; the former impedes the growth of the fungi and bacteria producing decay, while the latter is necessary for profusion of plant growth. The partial decomposition of the vegetable tissues which is necessary for the production of peat involves the liberation of certain gases and the occurrence of many complex chemical changes, and this, of course, if carried on too quickly or too far, will prevent the formation of peat, an analogy being afforded by the mode of production of wood charcoal by artificial means. Hence arises the necessity for restriction in the matter of air supply, for it is known that the decay-producing organisms flourish best in the presence of air and moisture. Where both moisture and air are abundant, as in certain moist woodlands, the plant remains soon decay, and even the woody fibre quickly becomes part of the soil. It is thus apparent that the water acts more or less as a preservative, as it excludes the air to the required extent and thus permits the vegetable matter to accumulate without total decay.

Two principal kinds of peat formation are recognised. In the first the accumulation is the result of the gradual filling of ponds and lakes with the vegetable remains of the aquatic plants which grow in them. The second type originates in some badly drained damp depression, and is comprised of the remains of plants quite different in character from those forming the first kind of deposit. In some cases deposits are found showing all the characteristics of the former type in their lower strata, while in the upper regions these give place to the signs recognised as indicating an origin of the second kind. Such deposits, it is stated, owe their structure to the silting up of a lake, as in the first method, until the conditions were suitable for the growth, on the now boggy surface, of the plants adapted to the second mode of formation.

Minor deposits of peat are found in the salt marshes which border some regions of the Maine coast, and, in connection with the formation of these, the report contains an interesting explanation recalling Darwin's theory of the formation of coral islands. The salt marshes may be regarded as poorly drained shallow basins, which at frequent intervals are submerged under salt water. Salt in excess in the soil being fatally poisonous to most plants, the flora of such marshes differs greatly from that of the neighbouring regions, and even in the condition of peat can be readily recognised as having grown under different circumstances. It is found in these marshes that the structure of the plants becomes more complex as the length of time during which they are under the salt water decreases. Hence it might be expected in a peat deposit of this class that a gradual passage from salt water to fresh water plants would be observed, the progression keeping pace with the increasing thickness of the deposit. It is, however, stated that these bogs show well differentiated layers formed below of fresh marsh peat and above of salt marsh peat. Again, the layers of salt peat are frequently found to be of relatively great thickness, though formed throughout of the remains of plants which cannot live at the depths at which their remains are found. These circumstances are explained by the slow subsidence of a coast originally bordered by fresh water deposits of peat, the growth of the salt peat keeping pace with the sinking. In some cases a layer of salt peat is found beneath the stratum of fresh, indicating, it is thought, a slight uplifting of the shore previous to its subsidence. The buried beds of fresh marsh peat found in the littoral regions can, it is stated, be used for fuel, but the salt marsh peat is usually too full of silt and mud for this purpose.

Passing next to the uses of peat, the report first briefly considers the commercial aspect of the successful utilisation of a deposit of this substance. In this connection the opinion is expressed that former failures in the working of the peat deposits of the United States have been due, not to inherent difficulties in the necessary operations, but to the neglect of elementary economic principles, and the remarks made on this view of the question are intended as a brief guide and warning to future exploitation. In treating peat to prepare it as a fuel it is stated that as it comes from the bog it contains as much as 85 to 95 per cent. of water. Hence its preparation for the market involves principally the removal of the water quickly and cheaply and a reduction in its bulk.

Omitting the cut peat used for domestic purposes in Ireland and elsewhere, we find five methods of treatment enumerated whereby peat may be rendered a commercial commodity as a source of heat. These are machine peat, briquetted peat, peat powder, peat coke and charcoal, and peat gas. For the production of machine peat, the raw material is macerated in machines so that the coarse portions are broken up, and certain colloidal constituents set free, whereby the mass is finally cemented together when moulded and dried, the latter process being carried out in the open air.

Briquetted peat is formed by air-drying until the moisture is reduced to 40 or 50 per cent., then grinding and screening and artificially drying to 15 per cent. of moisture, when the powder thus formed is pressed into suitably sized blocks, as in the case of briquetted coal. The report states that near London, Ontario, an improved process of briquetting is carried out, consisting of lightly harrowing the surface of the bog, and after a few hours' exposure to the sun's heat, removing the dust formed on the surface by means of a collector constructed on the principle of the vacuum cleaner. Under this heading the wet carbonising process introduced by Ekenberg is described. In this method the wet peat is heated in closed retorts along with additional water to a temperature of about 300 deg. Fah., corresponding to a pressure of about 50 lb. per square inch. When thus treated peat loses its structure and becomes black and amorphous. The remaining water is then readily removed from it by pressure, and the residue briquetted and dried. It is stated that the briquettes from this process are very solid, and in appearance, weight, and calorific value resemble coal.

Peat powder is said to be an economical form in which to burn this fuel, as the combustion can be rendered very complete, little or no smoke being developed. The preparation of the peat required for this process is simple. On being cut from the bog it is allowed to remain on the surface throughout the winter until it is disintegrated and partially air dried. It is then further dried artificially and pulverised, when it is ready for use in burners specially designed for the purpose and supplied with a variable blast.

To increase the fuel value of peat, and to decrease the cost of transportation, it is sometimes converted into coke or charcoal. This process had a very early origin, and has passed through various stages in its evolution from the primitive method of coking in heaps covered with earth and sods to the Ziegler process carried on in Germany and Russia, in which not only is it claimed that the product is in everyway comparable with charcoal, but that valuable by-products are secured. The apparatus employed in this treatment consists of a vertical cast iron retort lined with firebrick, and provided with flues and air-tight openings. A double firebrick wall with flue spaces between surrounds the retort. Fire-boxes at the base are provided for initial heating of the apparatus, but it is found possible to secure continuity in the process of coking by using the lighter and non-condensible gases driven off from the peat for heating the retort. The waste gases are afterwards led to driers, where the peat is dried before being placed in the retorts. Two qualities of coke are produced simultaneously by this method. The first quality is heavy and hard, and is said to be adapted to all the uses to which charcoal is put, such as the smelting and refining of metals. The second quality is less thoroughly coked, and is said to make excellent fuel for steam raising purposes.

It is claimed that 30 to 33 per cent. of the first quality of coke is obtained, while the second sort represents 45 to 50 per cent. of the original weight of the dry peat. A large proportion of the remaining constituents is recovered as by-products, and it is stated that the profits in this direction are alone sufficient to secure commercial success for the process. Among these by-products may be mentioned methyl alcohol, ammonium compounds, acetic acid, illuminating and lubricating oils, paraffin wax, phenol, and asphalt. As already stated, the non-condensible gases are combustible, and can be used for heating or motive power.

Gas producers, either of the pressure or down-draught type, have, continues the report, for some time past been used successfully in Sweden and Germany with peat as fuel, the calorific value of the gas thus generated comparing favourably with that derived from bituminous coal. We reproduce in the accompanying table a selection from the data on this subject given in the report :—

Calorific Value of Producer Gas.

Fuel.	Locality.	Type of producer.	B.T.U. per cu. ft.
Peat	Sweden	Koerting..	132
,, ...	Nymphenburg ..	Luther	114
,, ...	Stockton..	Mond	145
,, ...	Winnington	,, ...	152
Coal	Indiana	—	147
,, ...	Illinois	—	143
,, ...	Ohio	—	157
Lignite	N. Dakota	—	161

The gas obtained from a peat gas producer is, it is pointed out, suitable either for use in internal combustion engines or for external firing, and is especially valuable for some metallurgical operations, as it is usually lower in sulphur than ordinary coal producer gas. In concluding the remarks on the use of peat as a fuel reference is made to the analyses at the end of the book. Here will be found particulars of sixty-nine samples of peat, the details tabulated including volatile combustibles, fixed carbon ash, sulphur, nitrogen, and thermal value. In connection with the last we notice that the figures given range from 3600 to 10,500 British thermal units. These figures, however, appear to be exceptional cases, occurring only once each, and the great majority of determinations give about 9000. When comparing these figures with those obtained from coal, it is pointed out that peat, when used for external firing, does not clinker nor give off black smoke or sulphurous gases. The ash remaining is powdery and light, and of small bulk.

In addition to the recovery of the chemical by-products, which, as already mentioned, forms a profitable part of the coking of peat, there are several other industries which depend on a supply of peat as a source of operations. These the report next considers, and will be briefly enumerated here.

The first of these commercial applications of peat is the production of ethyl alcohol. This process is still in the experimental stage. As a by-product from the peat gas producer a large part of the combined nitrogen of the peat can be recovered as ammonium compounds, and in a new process devised by Frank and Caro, in Germany, the manufacture of ammonium sulphate in this way is rendered commercially possible.

The production of nitrates by inoculating with nitrifying organisms a bed of peat sprinkled with ammonium sulphate is reported to be possible, and is at present being experimented with in Europe.

Peat containing much fibrous matter can be utilised for the production of paper. There is at present a factory in America, believed to be the only one in existence, which produces paper made from this source ; but it is stated that owing to the difficulty experienced in bleaching and the weak fibrous structure of peat, it is possible at present to use it only in the production of dark-coloured cardboard. Paper and pasteboard have, however, been manufactured from mixtures of peat fibre and wood pulp.

Woven fabrics, artificial wood, mattresses and sanitary appliances are also mentioned as being among the various goods producible from peat. For weaving purposes the stronger fibres are selected and cleansed, then treated to render them pliable. Successful use has been made of the material thus produced for blankets, &c., for horses and other live stock. In this connection there is reported to be a growing demand for certain sedges found in moss bogs, the material derived being ultimately incorporated as an adulterant in silk fabrics. A material called "heloxyl," made by compressing and hardening fibrous peat, is said to be light, waterproof, an insulator of both sound and heat, and readily glued, nailed, and painted. It can be used to replace wood for many purposes, can be moulded and can be rendered fireproof by the introduction of certain mineral matter.

Moss peat selected and cleansed forms a convenient material for the manufacture of mattresses ; being absorbent, deodorising, and antiseptic, it can also be applied as a surgical dressing. These same properties render the more fibrous kinds of peat a most suitable material for the bedding of stock, and the small cost of production should make this an important branch in the peat industry. As a material for packing fragile and perishable articles, and as a "filler" or diluent in artificial manures, peat has already extensive use and requires but little preparation for the market.

The uses of peat in agriculture are therefore varied, and in addition to those already mentioned the report deals with the utilisation of a peaty soil for crop-raising. Although such soils generally need mineral fertilisers, it is stated that in some parts of the country peat soils are the most productive of all, the crops raised being chiefly vegetables, such as celery, cabbage, &c. The black thoroughly decomposed type of peat deposit seems to be the only one adapted for crops. We give below a table abstracting the report showing typical analyses of peat specimens from Maine.

Typical Analyses of Peat Specimens from Maine.

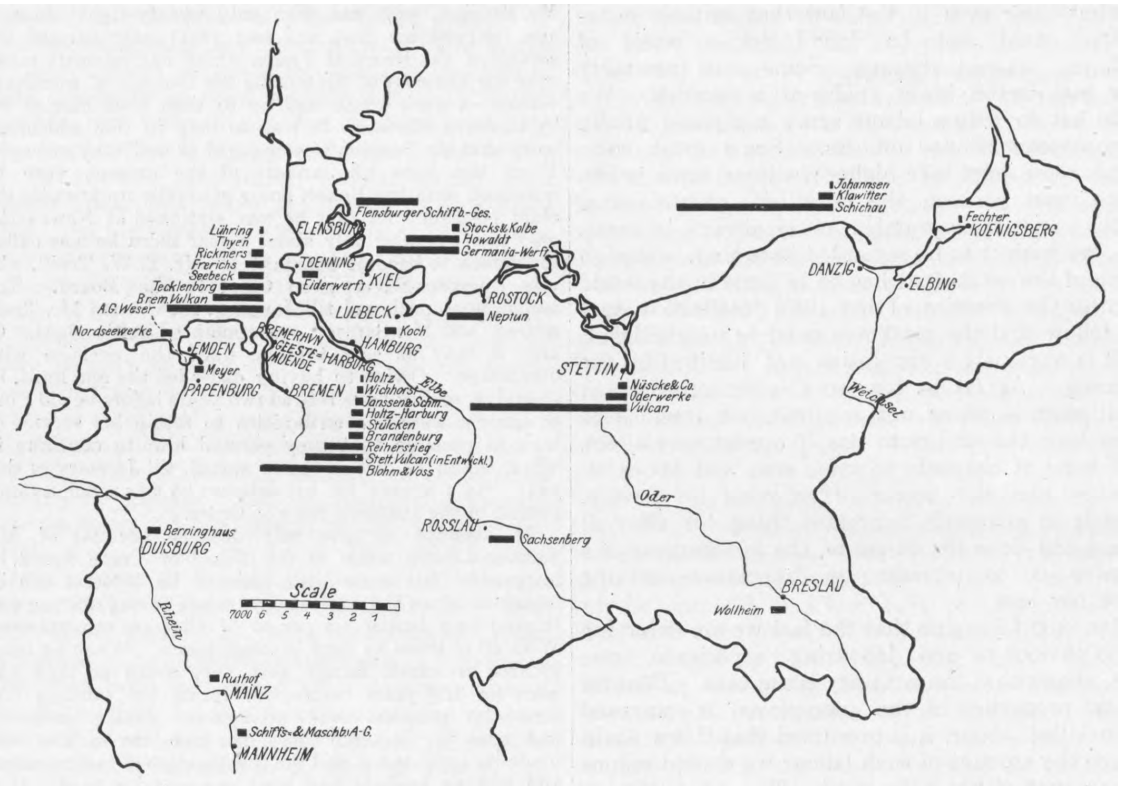
Volatile combustible matter.	Fixed carbon.	Ash.	Sulphur.	Nitrogen.	Calorific value, B.T.U.
56.01	31.30	12.69	0.59	1.78	8746
51.46	26.03	22.51	0.18	1.15	7308
61.67	31.41	6.92	0.10	0.77	9009
63.06	31.21	5.73	0.36	2.09	9630

North of England Institute of Mining and Mechanical Engineers.—A general meeting of the members of the North of England Institute of Mining and Mechanical Engineers will be held in the Wood Memorial Hall, Newcastle-upon-Tyne, at two o'clock on Saturday, October 9th. The following paper will be open for discussion :—"Electricity in Coal Mines," by Mr. Robert Nelson. The following paper will be read or taken as read :—"Automatic Cage Tub-stops," by Mr. T. Campbell Futers. A new patented combined pedestal for colliery tubs, rollers, shafting, &c., will be exhibited and described.

GERMAN SHIPYARDS.

No. I.

In our issue of September 25th of last year we gave a description of one of the largest and best known of the German shipyards, the Stettiner Maschinenbau Aktien-Gesellschaft Vulcan, of Bredow, near Stettin. We now purpose describing other large private yards of the same country in a series of articles.



"The Engineer" Swain Sc.

Fig. 1—THE POSITION AND SIZE OF GERMAN SHIPYARDS

For convenience, we shall first give a general idea of the positions, number and sizes of the German shipyards by means of the map—Fig. 1—and the annexed table. From these the boat and yacht-building and a few other small yards that are concerned mostly in wooden shipbuilding are omitted.

The bars drawn opposite the names of the various shipyards give a graphic representation of the average number of workmen employed in each yard in accordance with a scale drawn on the figure, while further particulars are given in the table below.

Name of the shipyard.	Area in acres.	Average number of workmen.	Nominal working capital.	Number of building slips.	Length of the largest vessel built.	Greatest I.H.P. single engine	Central power station of the yard.
I.—On the Ems.			£		ft.		I.H.P.
1. Nordseewerke, Emden	49·4	600	255,000	1	—	1,000 K	540
2. Jos. L. Meyer, Papenburg	64·3	380	—	6	197	1,100 K	230
II.—On the Weser.							
3. Aktien Gesellschaft "Weser," Bremen	150·7	4300	484,500	5	591	9,000 K 560 T	2900
4. Bremer "Vulkan," Vegesack...	81·5	2300	596,700	6	426	3,700 K	3000
5. Joh. C. Tecklenborg A.G., Geestemünde	51·9	2300	392,700	6	607	7,000 K	2500
6. G. Seebeck A.G., Bremerhaven-Geestemünde	18·0	1100	224,400	5	328	2,500 K	700
7. J. Frerichs and Co. A.G., Osterholz-Scharmbeck and Einswarden	58·8	800	204,000	5	236	—	800
8. Rickmers Reismühlen Reederei and Schiffbau A.G., Bremerhaven	24·7	500		3	—	Engines not built	100
9. S. H. Thyen, Brake i. Oldenbg.	4·9	120	—	2	197	Engines not built	50
10. C. Lühring, Kirchhammelwarden i. Oldenbg.	2·7	120	—	4	—	—	—
III.—On the Elbe.							
11. Blohm and Voss, Kommandit Ges. auf Act., Hamburg	69·2	5000	816,000	8	560	K and T	—
12. Stettiner Maschinb. A.G. "Vulcan," Branch Establishment at Hamburg	58·0	Work not yet begun	See Stettin	3	—	—	—
13. Reiherstieg, Schiffswerfte and Maschinenfabrik, Hamburg ...	12·4	1700	244,800	2	440	4,000 K	800
14. Heinrich Brandenburg, Hamburg...	3·5	600	—	6	122	600 K	220
15. H. C. Stülcken Söhne, Hamburg	4·4	600	—	7	148	5 0 K	170
16. R. Holtz, Harburg and Hamburg	9·9	600	153,000	4	246	—	190
17. Schiffswerft and Maschinfabrik, vormals Janssen and Schmilinsky, A.G., Hamburg	2·0	320	20,400	7	148	650 K	140
18. J. H. N. Wichhorst, Hamburg	2·7	250	—	4	—	500 K	140
IV.—Schleswig-Holstein.							
19. Eiderwerft A.G., Tönning	21·7	312	510,000	5	305	1,500 K	600
20. Fried. Krupp A.G. Germaniawerft, Kiel	58·0	3500	1,377,000	12	486	—	3000
21. Howaldtswerke, Kiel	180·4	2300	499,800	9	407	7,000 K	800
22. Stocks and Kolbe, Kiel	12·4	280	—	9	171	—	100
23. Flensburger Schiffsbau Gesellsch., Flensburg	44·2	2200	440,880	8	453	3,000 K	2000
V.—Other Baltic Sea Shipyards.							
24. Schiffswerft von Henry Koch, Lübeck...	21·7	500	67,830	4	312	1,900 K	—
25. A. G. Neptun, Rostock i. Mecklenbg.	26·4	1600	209,100	5	394	2,400 K	1150
26. Stettiner Maschinenbau A.G. "Vulcan," Stettin	70·4	6000–8000	877,200	7	705	22,500 K	3900
27. Stettiner Oderwerke A.G., Stettin	23·0	900	55,080	8	295	1,500 T K	600
28. Nuscke and Co., A.G. Stettin	5·9	350	51,000	5	295	950 K	700
29. F. Schichau, Danzig and Elbing	190·3	7000–8000	—	D 6 E 9	581	24,000 K	6400
30. J. W. Klawitter, Danzig	13·1	600	—	4	295	—	600
31. Danziger Schiffswerft and Maschinbauanstalt Johannsen and Co., Danzig	3·2	100	—	2	197	60 K	—
32. Gustav Fechter, Königsberg	6·2	100	—	4	230	—	50
VI.—Inland Establishments.							
33 Schiffs und Maschinenbau A.G., Mannheim	12·8	400	40,800	2	—	450 K	180
34. Chr. Ruthoff, at Kastel, near Mannheim	8·6	400	—	5	295	1,300 K	—
35. Gebr. Sachsenberg, at Rosslau on the Elbe...	66·0	1000	142,800	5	250	2,000 K	680
36. Gebr. Sachsenberg, Branch Establishment in Köln-Deutz ...	—	—	—	2	272	—	140
37. Schaubach and Graemer, at Coblenz	—	—	—	—	—	—	—
38. Ewald Berninghaus, at Duisburg	—	550	—	3	299	1,500 K	—
39. Union A.G., at Dortmund	—	—	—	—	—	—	—
40. Dresdner Maschinfabrik and Schiffswerft, at Uebigau	21·7	1000	163,200	5	305	1,500 K	600
41. Gebr. Wiemann, at Brandenburg on the Havel...	—	350	—	—	—	—	—
42. F. Lemm, at Boizenburg	—	—	—	—	—	—	—
43. J. G. Hitzler, at Lauenburg	—	—	—	—	—	—	—
44. Cäsar Wollheim, at Cosel, near Breslau	37·0	650	—	20	213	800 K	300
45. H. Pauksch A.G., at Landsberg on the Warthe	—	—	—	—	—	—	—

K = Reciprocating engine. T = Steam turbine.

Of the firms enumerated, the following six build war vessels of every description, as well as merchant vessels :—

(1) The Aktien-Gesellschaft "Weser," Bremen.
(2) Blohm and Voss, Hamburg.

(3) The Friedrich Krupp Aktien-Gesellschaft "Germania," Kiel.
(4) The Howaldtswerke, Kiel.
(5) The Stettiner Maschinenbau Aktien-Gesellschaft, Stettin.
(6) The works of F. Schichau, at Dantzig and Elbing.

Smaller vessels, such as tenders, tugs, and surveying craft for the navy have also been built by the following firms:—

(1) Jos. L. Meyer, Papenburg.
(2) Joh. C. Tecklenborg, Geestemünde.
(3) S. Seebeck Aktien-Gesellschaft, Bremerhaven.
(4) Gebrüder Sachsenberg, Rosslau-on-the-Elbe.
(5) The Dresdner Maschinenfabrik und Schiffswerft, Uebigau.

The total area of the German private shipyards is 1480 acres, the number of workmen employed in them being about 70,000. In addition, there are three Government dockyards—in Wilhelmshaven, Kiel, and Dantzig—employing about 20,000 workmen. It is difficult to make a distinction between the builders of sea-going and inland navigation vessels respectively, as several of the small yards situated near the sea lay themselves out principally for the construction of canal, river, and harbour craft, while others that are far inland on the upper reaches of the rivers build small sea-going vessels, such as steam trawlers, tugs, and the like. Contrary to the custom in England, where many firms carry on shipbuilding alone, almost all the German shipyards build their own engines and boilers. Exceptions to this rule are to be found in some of the small yards and among the larger ones in those of Rickmers, of Bremerhaven, and Henry Koch, of Lübeck, the latter, however, building their own boilers. As regards the woodwork and outfit, the practice in the different shipyards varies very considerably, some firms working up the raw material through the various stages into the finished product in the cabins, while others buy their furniture, and even have whole cabin arrangements supplied and built into their vessels by outside firms. In like manner, some of the yards make their own steering gears, winches, sidelights, &c., and do their own rigging and upholstering, while others obtain all these accessories ready made, and either fit them up on board themselves or have them fitted up by other firms.

The case is much the same in the engine-building department. Most of the firms have their own iron and brass foundries, some of them being able to cast propeller blades of the largest size. A few also have steel foundries where they are able to deal with the heaviest stern frames and rudders likely to be required. Others again, including some of the largest, order all their castings from outside and only finish them in their engineering shops. With large forgings the case is much the same, many firms making everything up to the crank shafts, while others buy almost all the larger parts, including finished boiler ends and shell plates bent to shape. The same may be said regarding the auxiliary engines and other such apparatus; large heating and refrigerating plants and electrical installations, however, being almost always obtained ready made, and even their fitting and mounting entrusted to other firms.

In addition to the construction of new vessels and their machinery, most of the German yards engage largely in repair and maintenance work, for which they make provision with the necessary docks and slips. Many of the shipyards in the large seaports make repairs their principal business, and only take new work in order to keep a considerable staff of workmen always ready for emergencies. It thus comes about that the statistics available as to vessels under construction often give a rather incomplete indication of the work in progress.

In contradistinction to the specialisation which for the most part characterises English undertakings of this kind, it is the practice of many of the German shipyards to lay themselves out for dealing with both large and small orders, so that ocean liners and barges, battleships, and small river vessels, may be seen under construction side by side. This is, in general, not altogether advantageous, and the English method of specialisation unquestionably gives better economical results. The German yards, however, are obliged to take a good deal of unprofitable work in order to keep their men and machinery employed. Moreover, it is, in Germany, impossible for a yard to confine itself to the construction of war vessels, since the Government is not in a position to give continuous employment to even the few private yards that participate in naval work.

Before we proceed to describe the larger yards in detail, we may observe that since 1900 these have, one after another, almost all adopted comprehensive arrangements of large building-slip cranes. The reason of this is that they have come to see that the transport of materials to the slips and the erection of the various parts of the structure of a vessel account for a large proportion of the wages paid for steelwork, a reduction of which makes itself in a considerable degree apparent in cheapening the cost of construction of the hull; and, again, that the constant scarcity of workmen during the recent years of plenty made it necessary to substitute mechanical for hand labour in order to cope with the work. The general character and capabilities of the different crane arrangements will be gathered from the description of the individual yards which we shall give in the following series of articles.

A NEW AUTOMATIC CARBURETTER.

Much work and time have recently been devoted by motor car engineers and others to the satisfactory solution of the problems connected with the design of an automatic carburetter. The difficulty to be faced is the provision of means whereby the engine may receive the mixture of air and vaporised petrol in suitable proportions at all speeds. It seems to have become axiomatic to regard a constant ratio of air and petrol as the most suitable over a wide range of speeds, the exact ratio being in each case dependent on the design of the engine and other varying considerations. It is, however, universally acknowledged that at low speeds it is desirable to have a slightly richer mixture than that which has been settled on as the constant proportion for higher speeds. A carburettter which, it is claimed, fulfils these conditions has recently been designed, and is now being manufactured by Wadkin and Co., North Evington, Leicester. We are now enabled to give an account of this carburetter, which is known as the Polyrhoë, and to show its performance, as far as its control of the mixture is concerned, by means of a curve.

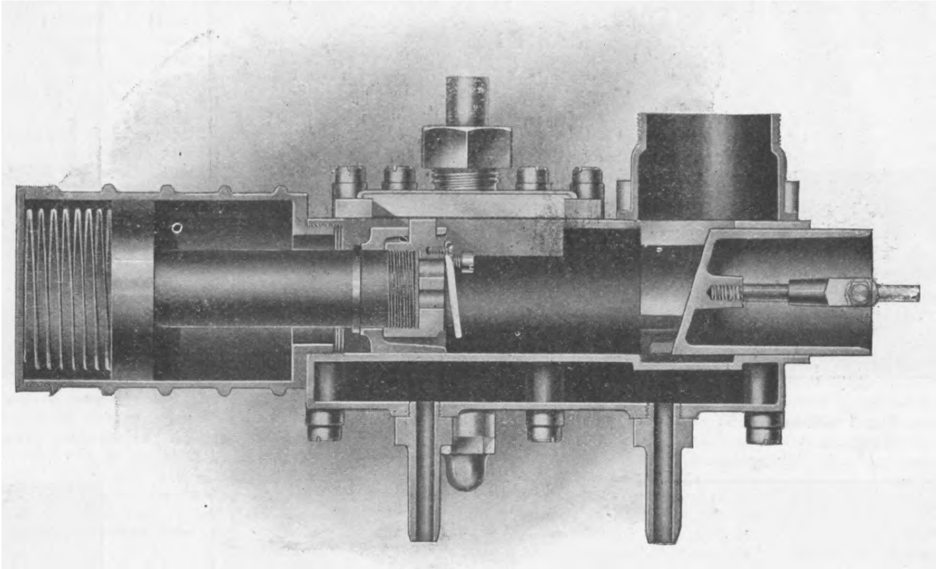


Fig. 1—SECTION OF THE CARBURETTER

As in other designs of automatic carburetters, reliance is placed on the varying suction to control the air admission at different speeds. At the same time provision is made for what is virtually an increase in the area of the petrol-jet opening, and in this, the makers claim, lies the chief advantage of the design. A reference to the engravings will show that the construction of this carburetter includes in one body a float chamber, a mixing chamber, and a throttle valve. It is, of course, the details connected with the mixing chamber that attract particular attention. This chamber has a circular cross section, and in it a piston works. The piston-rod carries at its other end a second and larger piston which works in a cylinder screwed to the mixing chamber. This mixing chamber is in communication with the atmosphere by a longitudinal rectangular opening. Along one of the walls of this opening are disposed a number of very fine holes constructed in a manner to be described later. These holes communicate with the float chamber and have their mouths, in the wall of the rectangular slot, covered or uncovered as may be necessary by a projecting piece carried on the mixing chamber piston. Provision is made for the circulation of hot water beneath the mixing chamber. It will be seen that the piston element will, when the suction increases, move to the left—as it is represented in the engraving—its return being controlled by a spiral spring placed behind the larger piston.

It is, therefore, evident that with the increased suction of the higher speeds the number of petrol jets uncovered in the wall of the mixing chamber increases, while at the same time the air opening also increases in an equal ratio. The particular ratio of air opening to petrol opening is controllable by a slide which alters the breadth of the air port, thus regulating the air supply while the petrol is kept constant.

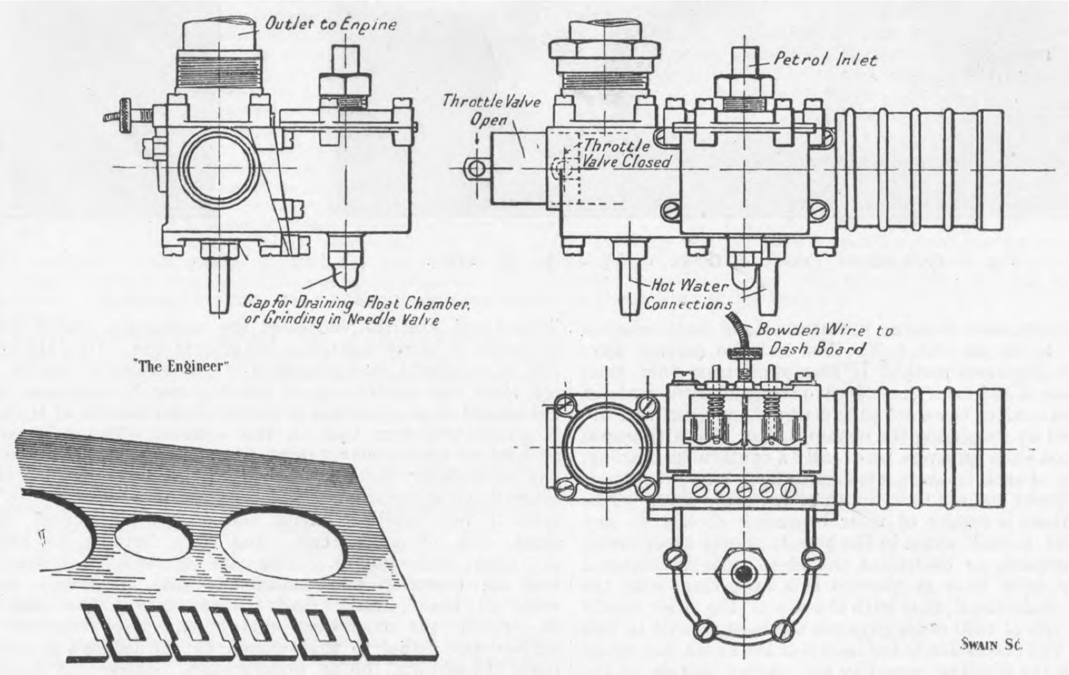


Fig. 2—THE POLYRHOE CARBURETTER

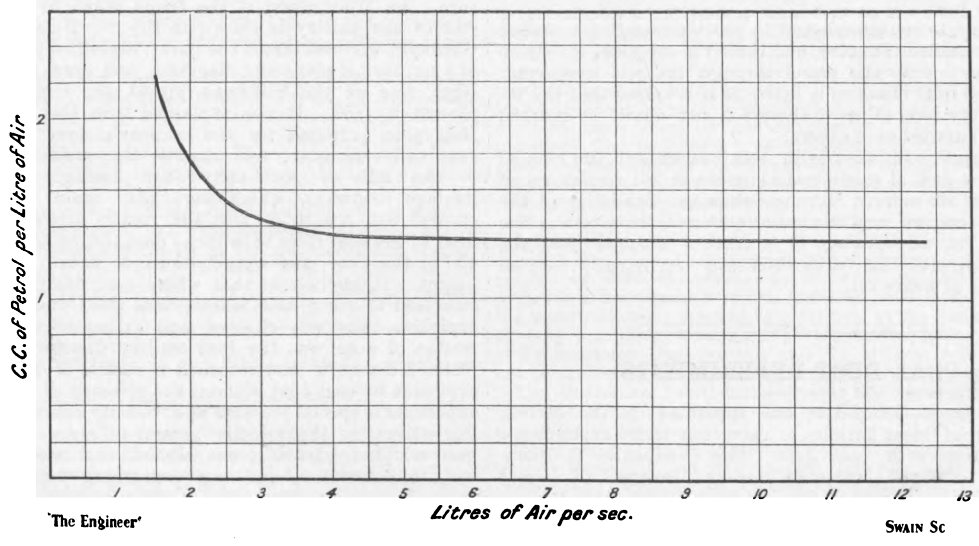


Fig. 3—PROPORTION OF AIR AND PETROL

It is intended that this slide should be used during actual running to alter the richness of the mixture to suit varying conditions—atmospheric and otherwise, and for this purpose it is controlled from the dashboard by means of a Bowden wire and a graduated dial plate.

It is obvious that the construction of the petrol jets requires

EXPERIMENTS WITH EXPLOSIONS OF COAL DUST

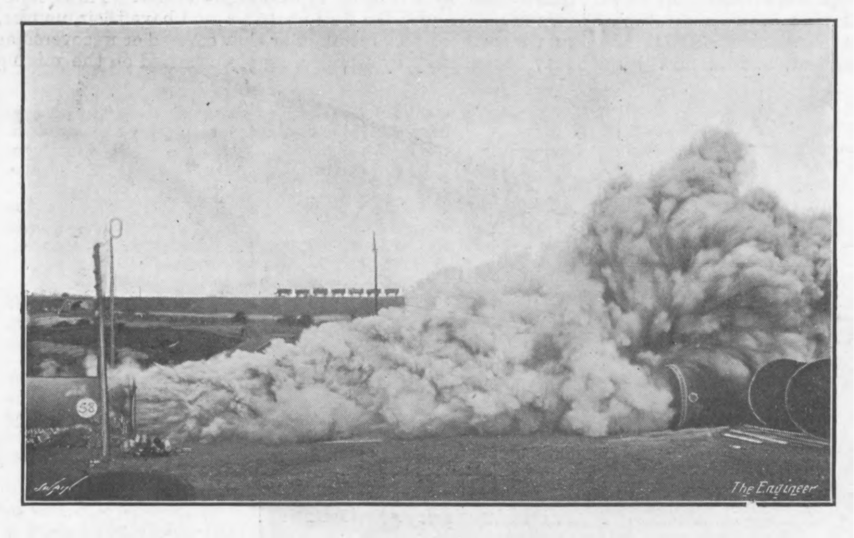


Fig. 1—COAL DUST BLOWN FROM MOUTH OF DOWNCAST

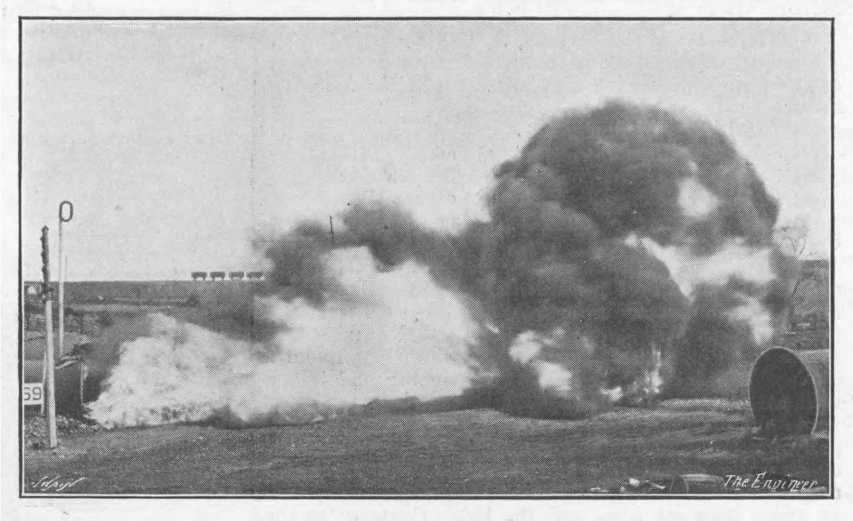


Fig. 2—EXPLOSION FROM A COAL DUST ZONE OF 350ft.

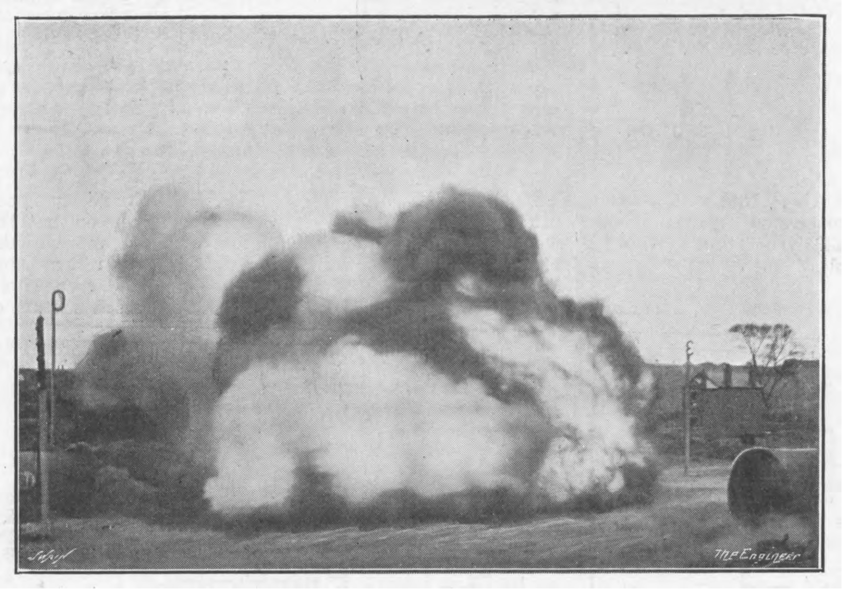


Fig. 3—EXPLOSION FROM A COAL DUST ZONE OF 275ft.

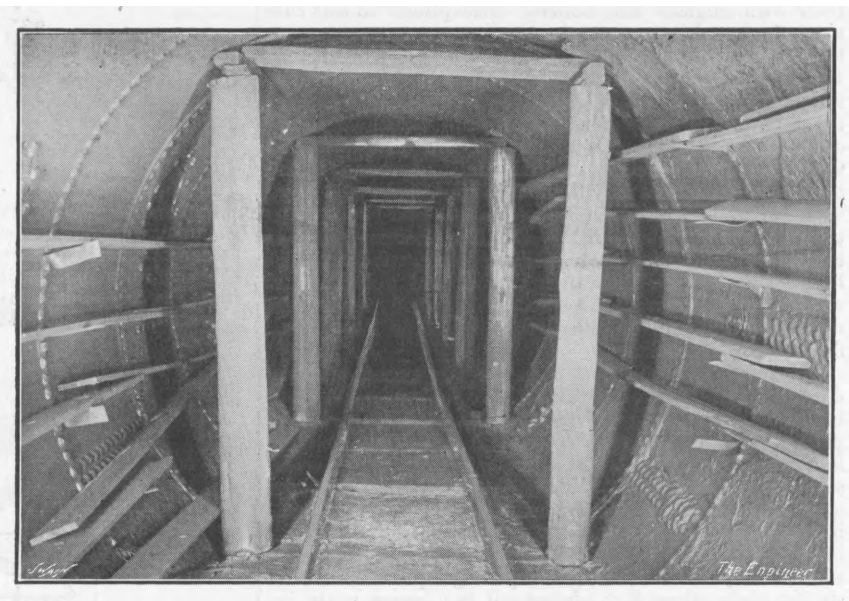


Fig. 4—INTERIOR OF MAIN INTAKE

particular care, since extreme minuteness and uniformity in size have to be secured. To this end the makers have adopted an ingenious method in stamping, from thin brass sheet, plates of the form illustrated on an enlarged scale in Fig. 2. Several of these are then clamped together, and are so arranged by staggering the openings that the withdrawal of the piston slide uncovers practically a continuous opening.

The area of each of these jets is extremely small, being, it is stated, about one ten-thousandth of a square inch. This being so, there is danger of their becoming choked by any solid matter carried along in the petrol. Some experiments were undertaken to determine the most suitable material to employ as a filter to prevent this occurring, with the result, we understand, that with the use of the filter finally adopted a run of 4500 miles gave not the least trouble in this respect. The effects due to the inertia of the liquid fuel which are seen in the flooding caused by the sudden closing of the throttle, and in the hindrance to quick starting caused by the supply of a weak mixture, are said to be absent in this carburetter, the reason given being the influence of the fine jets and the fine passages leading to them. In the curve shown in Fig. 3 the cubic centimetres of petrol per litre of air are shown plotted against the litres of air drawn into the cylinders per second. After the point 4 on the scale of abscissæ it will be seen that the curve is straight and very nearly horizontal, and that at low speeds the mixture is richer in petrol than at others, thus facilitating starting and acceleration under load.

It is found to be unnecessary to provide means for sealing the jets not called into play, and that it is sufficient to rely on the suction to draw the petrol through the jets uncovered. A simplified float chamber is fitted, as it is stated that the influence of the level of petrol therein is not nearly so marked in this carburetter as in others.

The makers claim that with this carburetter the ease of tuning it up and of starting the engines in all conditions of the weather are marked features, while the flexibility of the engine is increased, and the power obtained therefrom is the maximum at all speeds. It is further claimed that the engine fitted with this carburetter will run equally well on either light or heavy oil.

COAL DUST EXPERIMENTS.

LAST year a Committee was appointed by the Mining Association of Great Britain to carry out some experiments in connection with coal dust. The Committee is representative of the various mining centres of Great Britain, and consists of Sir Lindsay Wood and Messrs. W. E. Garford, C. Pilkington, J. F. Forgie, and W. W. Wood. The main object of these experiments was to demonstrate to as many as possible connected with the practical working of coal mines that coal dust without the presence of any inflammable gas forms an explosive mixture with air, and that if this mixture be ignited by any means, the destructive effects are equal to, if not greater than, those produced in a firedamp explosion. In addition, tests have been made on the various remedies or preventives that have been suggested. Over 600 people, including representatives from France and America, witnessed the explosions, which were successful in thirty-eight cases out of forty-one. On July 19th last a successful demonstration of the explosive nature of coal dust was carried out at Altofts, near Nottingham, for the benefit of the members of the German Institute of Mining Engineers who were then in this country. The party was afforded an opportunity of inspecting the experimental station and of walking through the gallery in order to view the internal arrangements. Its similarity to a roadway in a mine is very marked, having the same cross section, the same size of props, bars, and tubs holding 10 cwt., as used underground. The air current was similar both in quantity and velocity to that commonly met with on main intake roads in a mine. The shelves on which the coal dust was spread also presented a surface area equal to that offered by the ledges and interstices of pack, &c., on an underground roadway. A length of 367ft. of the main intake was spread with coal dust, 1 lb. being used per running foot of the gallery, or per 4ft. cubic feet of gallery space. Having viewed the fan, engine, and pulveriser of the dust used in the experiments, the visitors were shown the firing station and the instruments designed for recording the pressure and velocity of the explosions. Then the party adjourned to a safe distance from the tube to witness the experiment. A flame about 170ft. long shot out of the open end of the tube, and there were manifest signs of the setting-up of great internal pressure. An illustration of the flame taken at the downcast end of the gallery is shown in Fig. 3. Subsequently, Mr. Garforth, who conducted the party, explained the significance of a number of plans and diagrams, and drew attention to a large plan of the Silkstone pit at the time of the explosion in 1886. It was explained that this was the identical plan prepared for the coroner's jury who investigated that disaster, and showed the position and extent of the falls of roof and other damage. The main haulage roadways, which were also main intakes, were covered with coal dust, and the return airways and roads near to the coal faces with stone dust, owing to the fact that 4ft. of the roof was ripped down to make the necessary height. It was noticed that where coal dust was found destruction followed, and where stone dust predominated the explosive blast was checked and extinguished. This, it is worthy of note, was the first colliery disaster on record at which a coroner's jury returned a verdict of death from an explosion of coal dust without the presence of gas. In these experiments special pressure and velocity recorders are used. For estimating the velocity several different methods have been adopted, because it was felt that this was an important fact to determine, and one concerning which the usual methods of registration could easily give misleading results. A very good means of registration of the speed of the flame projected from the mouth of the gallery, as well as of the maximum length of that flame, has been obtained by means a special type of cinematograph machine.

In addition to the main experiments upon the explosive nature of coal dust, the fact that coals differ so widely in their composition and properties have rendered exhaustive laboratory tests necessary in order to institute a comparison between one coal and another, regarding their liability to form dangerous dusts or otherwise. For this purpose a laboratory has been built as part of the experimental station, and several different lines of research are in course of investigation. The gallery at Altofts is constructed of boiler shells, 7ft. 6in. and 6ft. in diameter, and in some of the experiments carried out last year the gallery attained a length of 1083ft. For the experiments described the total length is 895ft. It is divided into two parts, a main intake, in which the actual explosion is produced, 7ft. 6in. in diameter and 600ft. long, and a return airway 6ft. in diameter and 295ft. long. This return airway leads to a fan, which produces a ventilating current, such as is commonly met with in a mine. Safety valves are provided to relieve the pressure set up by the explosions. The boiler shells forming the gallery are further strengthened by strong hoops of T iron and continuous rings of $\frac{3}{4}$in. iron chains. An illustration of the interior of the main intake showing the position of props, bars, and shelves, is shown in Fig. 4. Close to the engine-house, where the fan is erected, is another house containing the pulveriser. In order to render the conditions as nearly alike as possible in each experiment, the requisite amount of coal dust is ground from the nut coal previous to each explosion by means of the pulveriser. The size of the particles is based upon samples taken from the highest parts of roadways in the mine. The delicacy of the instruments in use may be gauged when it is stated that microscopical examination of the coal dust used has enabled the size of the dust particles to be measured to $\frac{1}{1000}$ part of an inch. The instruments now in use enable the velocity of the explosive blast to be measured to $\frac{1}{2000}$ part of a second, the pressure to a fraction of a pound per square inch, and the period of duration of pressure to $\frac{1}{3000}$ part of a second.

In an experiment carried out on July 2nd a maximum pressure of 113 lb. per square inch was recorded. In the case of the explosion which we have particularly referred to, and which is illustrated in Fig. 3, a maximum pressure of 65 lb. per square inch was reached. After the coal has been ground it is spread on narrow shelves running on both sides of the gallery. The coal having been spread, it is raised in suspension in the air current either by the firing of a small cannon or by merely mechanical action of the air current, and whilst in suspension it is ignited by the flame from a large cannon which is charged with the blasting powder, and represents in its effect a blow-out shot, such as has been the case of the majority of the great colliery disasters. The experiments involving the use of remedial measures are similar in nature. The explosion of the coal dust is obtained in the same manner, but the disposition of the lengths strewed with coal dust is so arranged that the flame of the explosion encounters in its passage zones of watering, stone dust, carbonate dust, or lengths of gallery clear of dust, called dustless zones. The effects of such measures in checking the velocity and reducing the pressure of the explosion are recorded automatically. The Altofts gallery is on a natural scale, and is the largest, both in sectional area and in length, that has ever been used either in this country or abroad for such work. The practical results obtained have amply demonstrated that very little information of practical value giving reliable data can be obtained in galleries on a reduced or miniature scale, because small experimental galleries could never reproduce the same conditions on the surface as exist in the mine. Further, the dust could not be distributed by hand inside the gallery, and people could not walk through the gallery and see its actual state both before and after the explosion. The experience gained from these experiments has served to reinforce the hope that in stone dust an effective remedy has been secured. In August of last year an experiment was made with the standard length of coal dust, viz., 367ft., the resultant flame of which was extinguished by 317ft. of a stone dust zone at one end of the gallery. In the following September the standard length of coal dust zone was sandwiched between two stone dust zones of 210ft. each, which effectually extinguished the flame in both directions. Our illustration, Fig. 1, gives a view taken at the downcast end, and shows a cloud of dust emitted from the open end of the gallery. In this experiment coal dust was placed for 50ft. near the mouth of the tube, and stone dust for the next 100ft. A coal dust zone of 275ft. was then fired, and the flame from this 275ft. penetrated only 54ft. into the stone dust zone, and did not ignite the 50ft. of coal dust at the open end of the gallery. Fig. 2 shows an explosion from a coal dust zone of 350ft., when the flame shot out from the mouth of the gallery for a distance of 98ft.

The experiments are still in progress, and on September 23rd and 24th and on subsequent dates some important demonstrations were given at Altofts.

THE STATUS OF THE ENGINEERING PROFESSION.*

In depicting the difficulties which the professional engineer has to contend with, the author remarked that although the science of engineering entered very largely into modern civilisation, the position of engineers at the present day was far from satisfactory, and would not improve until definite steps were taken to secure for them that recognition which is accorded to members of other professions. The term "engineer" was, he said, too loosely applied, and was often used by those who had no proper claim to be so described. Every branch of the profession, civil, mechanical, and electrical, was equally concerned, and they should unite to overcome the obstacles by which they are handicapped; some of these difficulties being stated as follows:—

Overcrowding of the profession.—That was due to the constant influx of men lacking sufficient scientific training, who had no great love for their work, but were apparently tempted by the ease with which a footing might be gained.

Misuse of the term engineer.—This word was seen tacked on to almost every industry, and unfortunately it had gone on for so long that the only remedy would be to find a new word with which to designate members of the profession, unless means could be devised for restraining the use of the old title by unauthorised persons.

Multiplication of societies.—The tendency of the present day was all towards an increase in the number of engineering societies; but, although such associations did good work, it was a mistaken policy to allow members to use the initials of societies other than the three principal institutions as a distinguishing mark.

Advertisement.—Engineering businesses cannot refrain from advertising, but no professional man should be allowed to do so, whether he were a consulting engineer or the manager of a business concern.

General.—In the absence of any legal status, it was difficult to establish a scale of fees, and so to prevent cutting of prices. Consultants were also unfairly hampered by manufacturers who gave advice, naturally biassed, on engineering matters, and prepared estimates and drawings free of charge, in order to secure work for the firms with which they were connected.

Having sketched the chief hindrances to the advancement of the profession, the author proceeded to outline a scheme for their removal. In the first place, he advocated the election of a "Central Organising Body," from members of the three most important Institutions, those of the Civil, Mechanical, and Electrical Engineers respectively. Such a body should be equally representative of each Institution, and for this purpose each should be placed on the same footing, since as far as the scientific training of their members was concerned there was no material difference. The "Central Body," when complete, should endeavour to obtain recognition as a legalised corporation by Act of Parliament, and should have supreme organising and judicial powers in all matters relating to the profession. They should also have power to appoint committees to deal with special subjects. The points to which they should first apply their energies should be (i.) registration; (ii.) education; (iii.) minimum fees; (iv.) organising funds to aid invention and research. An effort should then be made to formulate schemes for the establishment of an information bureau for engineers and the institution of a benevolent fund. In conclusion, it was remarked that every effort should be made to arouse interest in this important question of reform, because delay would only tend to make the problem more complex.

The author of this essay has been awarded the Status Prize for 1909, offered by the Society of Engineers for the best paper submitted on the above subject. It should be noted that this prize is open for competition during the next four years, full particulars being obtainable from the Secretary.

Hydro-electrical Developments and Engineering.—In a short notice of a book by Mr. F. Koester bearing this title, which appeared in our issue of September 24th, it was stated that the book was published by D. Van Nostrand and Co., of New York. We are asked by Messrs. Constable and Co., Limited, of 10, Orange-street, Leicester-square, to say that they are joint publishers of this work and sole publishers of it in England.

An Oil Engine Ignition Plug.—We have received from Mr. R. S. Lovelace, of Henstridge, Somerset, an ignition plug for oil engines which appears to have good features. It has been designed with the object of preventing carbonisation at the point, and this is effected by making the earthed electrode in the form of a cap enclosing the porcelain point. The flash takes place in the cap, and is reflected back through the annulus over the porcelain, burning off the carbonaceous deposit. Mr. Lovelace has sent us a plug that has been in use for some time, and it shows very clearly the sort of effect that takes place. The form of the spark is distinctly good.

Foreign and Welsh Coalowners.—Attention is being called to the alleged "dirty filling" of coal trucks at Welsh collieries, and it is stated that sufficient care is not exercised in sorting the rubbish and shale from small coal when placed on the truck. On the part of coalowners, it is urged that as a new agreement will have to be signed before March, it is essential that the coal should be thoroughly true to its description, and when cases are cited that contracts that should have come to Wales have gone to Germany, it has become of the first importance to see that this is done. It is suggested that a system of rewards and punishments would answer better if recourse was had in the interests of the colliers themselves, who would make strenuous efforts to keep the quality of their coal up to the mark if a few pence per ton more could be given, according to the quality. This would tell better than giving bonuses to the men or awarding prizes for the best.

LETTERS TO THE EDITOR.

(We do not hold ourselves responsible for the opinions of our correspondents.)

BRITISH LOCOMOTIVE PRACTICE OF TO-DAY.

Sir,—I was pleased to learn from Mr. Dearberg's letter that he was able to understand that my compound system was practically a simple engine with 19in. high-pressure cylinders and additional low-pressure cylinders. I agree that it would be a difficult matter to arrange for cylinders 30in. in diameter; every increase in diameter over that of 19in. would, however, be a gain in power. The largest possible low-pressure cylinders should therefore be used. Let us assume that 24in. is the largest which could be fitted. The simple engine could then have two such cylinders added, making the engine the equivalent to a simple one with two high-pressure cylinders of this large diameter. Mr. Dearberg appears to think that the exhaust from such an engine would not work a toy. Is he not getting a little confused, for in his previous letter he states the engine would slip the wheels. Why he should refer to a 15 per cent. cut-off in the high-pressure cylinders of a compound system I am unable to say, especially as I have already pointed out that the cut-off in my system was fixed for 30 per cent, no matter what the condition of work might be. He refers to the success of the De Glehn type of compound engine using a late cut-off in the high-pressure cylinders, but the weight of steam used when cutting off at 60 per cent. of the stroke of the piston of a 15in. high-pressure cylinder of a De Glehn engine is much the same as cutting off at about 30 per cent. of the stroke in a cylinder 19in. in diameter, with the advantage in favour of the latter in being able to pass all the available boiler steam through the large cylinders without converting it to simple, should the necessity arise. Mr. Dearberg also makes reference to a 60 per cent. cut-off with my system. I should wish him to understand that my system requires neither an excessively early nor late cut-off, and such as is now daily used in British locomotive practice.

Regarding the very early cut-off practised by the drivers of simple engines, curiously enough Mr. Dearberg reminds me that the piston has little leverage on the crank until one-fourth of the stroke. How does he reconcile this statement with the fact that drivers work their engines with the lever somewhere near mid position? I have not the slightest intention of calling into question the intelligence of British drivers, whose zeal to economise in fuel consumption compels them much against their will to cut off so early in the stroke, and so run up a heavy repair bill. Most drivers would prefer to cut off somewhere about 30 per cent. of the stroke of the piston, and would no doubt welcome the introduction of an engine which could be worked under all conditions at this cut-off. My own footplate experience is that any attempt to cut-off either much earlier or later brings about no gain.

I have referred to a compound engine with 24in. low-pressure cylinders as being equivalent to a simple one having two high-pressure cylinders of this large diameter. I was glad to find that Mr. Dearberg was alive to the impracticability of making use of such large high-pressure cylinders in a simple engine, and hope the lofty expression he makes use of may also be the means of convincing those who advocate the use of a subdivision of large cylinders for simple engine work the futility of such a step.

I should now like to make one more attempt to convince Mr. Dearberg of the great advantage which will follow the enhancing the cylinder capacity of the locomotive.

Let us assume that arrangements can be made for trials between a simple engine with 19in. by 26in. cylinders, a De Glehn compound engine with 15in. and 24in. low-pressure cylinders—I select this type of compound as being of greater power than any British compound locomotive—and a Riekie compound with 19in. and 24in. cylinders. Each engine to have the same boiler power and same adhesive weight. The compound engines to work compound only throughout the trials, which may be as varied as possible.

I feel sanguine that all practical men will agree with me that the most successful engine is likely to be the one which can make use of the boiler steam over the largest piston area. Let us begin with the simple engine, the boiler steam of which can be used on a piston having an area of 283in., the power bearing a relation to the weight of steam used.

Taking the De Glehn type of engine next, we find that the 15in. high-pressure cylinders cannot make use of the same weight of steam by 60 per cent., and although it has cylinders of the large capacity of 24in., it cannot make use of all the available steam over the large area of 452in. unless converted to simple. The result is the simple engine is able to hold its own in a test of power. Now let us take the compound engine with 19in. high-pressure cylinders. The whole of the available boiler steam can in this case not only be passed through the high-pressure cylinders similar to the simple engine, but also acts on a piston area of 452in., as against the simple engine which has an area of 283in. only. The result is the power of the latter is enhanced greatly in excess of that of the simple or De Glehn type of engine. Mr. Dearberg points out that the ton-mileage has not been reduced during the last twenty-five years. I can go back as far as forty years. Does it not occur to him that if the power of the locomotive can be greatly augmented to the extent of enabling a compound locomotive to haul heavier loads, the ton-mileage is likely to be reduced to the extent of relegating the simple engine to the scrap heap? John Riekie.

Argaith, Dumbreck, September 25th.

EXPERIMENTS WITH CENTRIFUGAL PUMPS.

Sir,—Referring to the letter of "F. H. S." in the September 10th issue of The Engineer, I beg now to reply to the points raised.

The experiments have been made with the object of proving justifiable the use of a parabolic formula for the lift of a centrifugal pump (see diagram, p. 207), and the results obtained from the specially made experiments, and in applying the formula to published results of the performance of other pumps, show that the formula is applicable to practice so far as trials yet made are concerned.

The writer's contention that the theoretical analysis, as set out, is incomplete, is admitted, but what he seems to have entirely missed is simply that all the losses so far considered are proportional to either u_1^2, v_1^2, or $u_1 v_1$, or proportional to the sums or differences of these quantities. He will recognise that the derivation of the formula has been necessarily abbreviated, but for a fuller discussion of the matter it will be well to refer to "Hydraulics"—Lea (pub. Arnold).

The velocity in the discharge pipe V_d is certainly proportional to "u_1," so that $V_d{}^2/2g$ is simply a constant times $\frac{u_1^2}{2g}$.

Further, the "centrifugal head," the meaning of which there appears to have been difficulty in understanding, is merely the head impressed on the water by its whirling in the wheel, and in the volute chamber around the axis of the wheel or impeller. Consider a pipe A B filled with water, and having its ends A and B sealed, and let it be rotated about an axis through A perpendicular to the axis of the tube A B. Calling the length of the tube R feet, the angular velocity of rotation w, and the weight of one cubic foot of water w lbs. (see pp. 303 and 335 "Hydraulics") the pressure on the end B would be equal to W $\frac{w^2 R^2}{2g}$ lb. per square foot.

The centrifugal head, then, is assumed to be proportional to u_1, and also to v_1—page 207, column 1 of article—and, further, the velocity of the water in the volute space is, no doubt, a junction of both u_1 and of v_1; then not only the variation of the centrifugal head, but also of the head lost in the volute, it is fair to assume, is also a quantity which involves u_1^2, v_1^2, and $u_1 v_1$.

Again, disc friction in the wheel is proportional to v_1^2 practically, and also the friction due to the relative motion of the water and the casing is dependent on the velocity in the casing, which is again of the form $k\, v_1\, n\, u_1$, and therefore the head lost by friction may be assumed proportional to $\left(\frac{k\, v_1\, n\, u_1}{2\, g}\right)^2$ . . . . . (4)

The head lost by friction in the pipe is again practically proportional to $V_d{}^2$, that is to u_1^2, so that all losses are expressible in the form $K\, u_1^2 + K_1\, v_1^2 + K_2\, u_1\, v_1$; and, since the centrifugal head varies also in a similar way, all quantities are of the same form. Consequently three constants only are required.

The main point, therefore, is that, if all the losses can be expressed as multiples of u_1^2, v_1^2, and $(u_1 v_1)$, however complicated the losses are actually, and however many terms are introduced, the final expression must obviously be of the form

$$h \times 2\, g = m\, v_1^2 + C\, v_1\, v_1 + K\, u_1^2 \quad . \quad . \quad . \quad (5)$$

from which the constants m, C, and K can be determined from the results of any three independent experiments on the pump, in which simultaneous readings of the lift, speed, and discharge have been noted.

The contention that the experimental value of these constants varies by as much as 50 per cent. is admitted, but it must be borne in mind that this is the most extreme variation obtained from the curves in the course of the solution of a very large number of equations obtained from points chosen quite at random—to give as severe a test as possible.

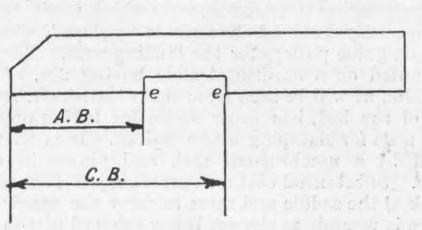
It is hardly claimed that the formula can be fixed when commencing the design of a new pump; it is put forward rather as an attempt to solve the problem: "What is the performance of a centrifugal pump under varying conditions of head, speed, and discharge?" The determination of the constants for any particular pump is a fairly simple matter, as three independent experiments give an approximate value, while a greater number of experiments will give a more exact value. As stated, the parabolic formula resulting takes into account the possible hydraulic and frictional losses in as complete a manner as possible, and the results of applying the expression are distinctly favourable from a practical point of view.

Seafield, Hants, October 4th. J. G. Davis.

DRAWING AN ELLIPSE.

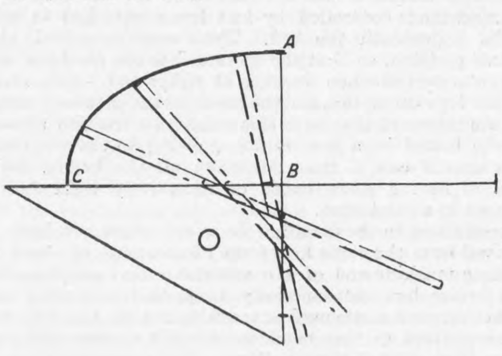
Sir,—Enclosed I describe what I believe is the only way to draw a true ellipse.

(1) Cut a piece of thin wood, say, $\frac{1}{16}$in. thick, as follows:—



A B = Half minor axis.
C B = Half major axis.

(2) Draw the two axes in position, and place a set square as shown; then, with pencil point on strip of wood at C, swing the wood from C to A, care being taken to keep the two edges *e e* to the set square all the time.



This gives one quarter of the ellipse, and by changing the set square and repeating the above movements the ellipse is completed. I have used this method many times, and it has always given satisfaction.

Sheffield, September 28th. D. B.

APPRENTICESHIP.

Sir,—Will you allow me, through your columns, to call attention to the valuable work which is being done by the National Institution of Apprenticeship, 39, York-place, Baker-street, in apprenticing boys and girls to trades in which skill is required, and to appeal to the public for contributions to enable the Council to continue to carry on and extend that important national work? Its value cannot be easily overestimated, especially as it tends to diminish the number of the unemployed, who are nearly all unskilled. The Institution is philanthropic and unsectarian, and is under the patronage of her Royal Highness the Princess Christian and his Grace the Duke of Devonshire, and is administered by a Council and several Committees.

The Council's report for 1908 shows that the Institution has great experience, and exercises a careful discrimination in the selection of trades and in the general management. The effective manner in which the arrangements for apprenticeships are conducted and the excellent results achieved were demonstrated at the largely attended meeting recently held at the Mansion House, at which I presided, when about 500 apprentices under the charge of the Institution were present, and 172 of them received prizes and certificates, which were distributed by Lord Avebury.

The Institution has indentured over 630 apprentices to good masters carrying on skilled trades, and those apprenticeships are supervised by the Council.

The number of boys and girls applying to be apprenticed is continually increasing, and now exceeds sixty per week, and at the present time a large number of boys who have served satisfactorily their probation are compelled to wait until the money is forthcoming to pay the premiums. For such purpose it is estimated that a sum of £13,000 will be required during the next twelve months, and the audited accounts show that the funds are now practically exhausted.

I shall be pleased to receive contributions on behalf of this excellent Institution, or they may be sent to the treasurer, the Right Hon. Lord Avebury, at 17, Lombard-street, London, E.C., or to the hon. secretary, Mr. J. S. Ballin, 5, Clarence-terrace, Regent's Park, N.W.

Mansion House, September 30th. G. Wyatt Truscott,
Lord Mayor.

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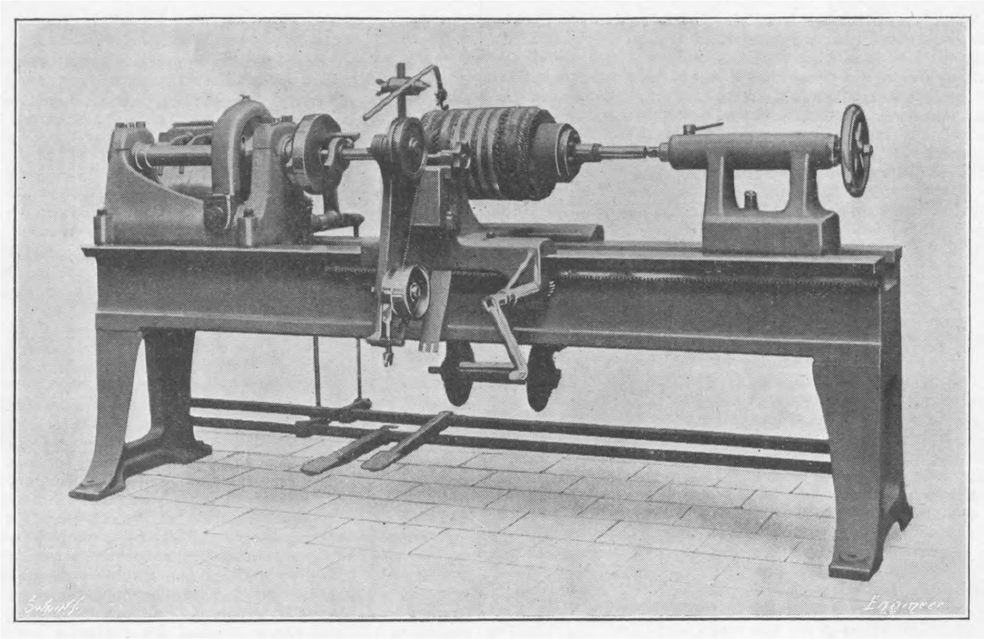
[*] Abstract of a paper read before the Society of Engineers on October 4th, by Mr. G. Allan Thomas

MACHINE FOR PUTTING BANDS ON ARMATURES

TANGYES LIMITED, BIRMINGHAM, ENGINEERS



A NEW MACHINE FOR BANDING ARMATURES.

A MACHINE, which has been specially designed for banding traction and other armatures up to 18in. in diameter and 4ft. 6in. long, has been brought to our notice by Tangyes, Limited, of Cornwall Works, Birmingham. It is shown in the accompanying illustration, from which it will be gathered that a specially-designed slide rest is employed, which carries leading on guide pulleys for the binding wire. These pulleys are mounted on a horizontal slide having 2in. of traverse. The saddle, as will be seen from the illustration, spans both shears of the bed, has taper strips for taking up wear, and locking nuts for clamping where desired. It is moved along the bed by a machine-cut rack and pinion in the usual manner. Substantial cast iron arms project downwards from the back of the saddle and serve to carry the spool on which the wire is wound, as shown, below the bed of the machine illustrated. The spool is arranged so that it will not revolve in the event of the wire breaking, the object of which is to avoid the wire becoming entangled. A hand brake is provided, so that the tension on the wire can be altered at will. It will also be gathered that there is a guide at the top of the machine, which is capable of adjustment in the horizontal and vertical planes.

Another feature to which attention should be called is that the machine is controlled by foot levers attached to square shafts underneath the bed. These can be moved to any desired position, so that the operator has the machine under complete control when working at either end. One lever is for the forward motion and the other for the backward motion. We are informed that with this machine a traction armature can be bound in a few minutes, owing to the fact that an even tension can be maintained on all the bands, and the risks of having slack bands or excessively tight ones are reduced to a minimum.

In addition to the machine described above, we have also received from the same firm some illustrations of a new coil-winding machine and of a commutator and grinding lathe. The former has been specially designed for winding heavy field coils, such as are used on traction motors, &c. The power is transmitted to this machine through a worm and worm-wheel from a set of three pulleys. The machine is provided with a counter, which records the number of turns put on or taken off any coil, so that it is always possible to tell the exact number of turns on a spool, which is a decided advantage. The commutator lathe has been specially designed for the purpose of turning and grinding commutators, the height of centres being 11in., and it will take armatures up to 16in. diameter and 4in. long.

A NEW TYPE OF STEAM REGULATOR VALVE.

THE mechanical effort required to open some designs of steam-regulating valves is at times excessive, and has led to frequent attempts to introduce devices whereby it may be minimised. This is especially so in the case of locomotives, where it has long been customary to supplement the main throttle valve with a small pilot valve, or to use valves of the double-beat type. These, while largely helping in the desired direction, are liable to further troubles and are more expensive to manufacture.

A valve which it is claimed satisfactorily overcomes these difficulties, while possessing many other advantages, has recently been designed and patented, and is now being constructed in this country by the Hulburd Engineering Company, Limited, of London. This valve, which is illustrated in the accompanying engravings, has been given the name of the "Servo," and has been designed for use in all cases in which the supply of steam has to be controlled. In particular it is designed for locomotive work, and we understand about one thousand engines have up to the present been fitted with it, including some belonging to one of the leading railways of this country, and to those of important continental and American railways. It has also been installed on board several steamships, among which, we believe, are some cruisers belonging to a foreign Power. In addition, its use on winding and hauling engines, and many other types of steam engines, is said to be attended with good results.

The construction of the valve will be seen in Fig. 1, where an example of an ordinary form of it is shown in the open position. The external casing of the valve, as shown, consists of a three-way casting, through which the steam flows from left to right. The upper limb is blanked off by a cover, and is machined on its inner surface for the reception of a steam-tight piston, the packing of which consists of an ordinary piston ring. An extension of this piston forms the valve itself, which is thus pressed against its seat by the pressure acting in the upper chamber, to which steam is admitted by the small hole on the left. In Fig. 2 is shown a development of the piston extension, which fits inside the valve seat. It will thus be seen that when the piston rises the steam passes through the valve first by way of the two longer passages, then, as the lift of the piston increases, all four openings are brought into use. These passages are cut with the peculiar profile shown, so as to secure a small opening at the beginning of admission, and thus in the case of locomotives to prevent slipping of the wheels as far as possible. Fig. 3 shows a curve, giving the area of the steam passage for different lifts of the valve, from which it will be seen that a 10 per cent. movement has to be made before the valve begins to open, while with a 45 per cent. movement the valve opening is only 5 per cent. of its maximum, after which the curve soon becomes a straight line. It is therefore possible to regulate the small areas, and consequently low speeds, very finely.

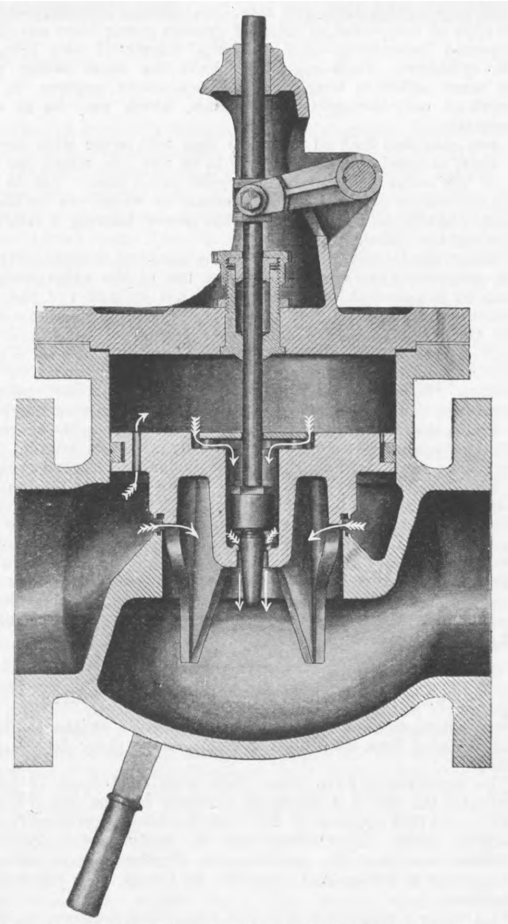


Fig 1—THE SERVO STEAM REGULATOR VALVE

The leading feature of the valve consists in the method employed to move and control the position of the piston. For this purpose a central cylindrical cup is formed on the piston, through the closed end of which a hole is bored. A spindle passing through a stuffing gland in the top cover carries a coned plug at its lower end, and this passes into the hole in the cup. There is no connection whatever made between this spindle and the piston, the small central plate shown in section being simply a cover. When it is desired to open the valve, the central spindle is raised from its seat in the cup by means of the handle shown. Steam thereupon passes from the upper chamber through the cup to the under side of the valve, and as the spindle lift is increased a time will arrive when the amount of steam leaving through the cup is greater than the amount entering the chamber through the small hole. When this takes place, the pressure in the chamber must obviously fall, and will continue to do so until the full pressure acting on the available portion of the underside of the piston is sufficient to overcome the reduced pressure on the upper side. The piston will now rise, and in consequence steam will be admitted through the openings already mentioned in the extension of the piston casting. When this takes place the steam in the chamber becomes compressed, and the pressure rises until the piston takes up a position which is dependent on the amount of opening past the spindle cone. It will now remain here, since a further rise would cause an increase of pressure in the chamber, thus giving a downward force, while if the piston fell, there would be an immediate reduction in pressure in the chamber, which would allow the full-pressure steam on the under side to act, and thus restore the piston to its former position. There is thus a definite position of the piston and valve for each definite position of spindle cone, and it is said that the former follows the movements of the latter as if it were rigidly connected to it.

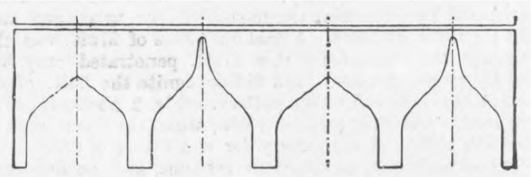


Fig. 2—DEVELOPMENT OF THE PISTON EXTENSION

It will thus be seen that the force required to open the valve is given almost entirely by the steam itself, the effort to open the small spindle valve alone requiring manual power.

There are said to be no signs of "hunting" or vibration of the valve, the friction of the packing ring and the special construction of the spindle valve preventing such an occurrence. So small is the force required to open the valve that a 16in. example made for a large warship can be operated by a small lever with one hand. This being so, it is sometimes deemed advisable to add a locking device to prevent accidental movement of the valve, although we are informed that in some installations, in particular those for locomotives, the friction of the packing glands is alone sufficient for this purpose.

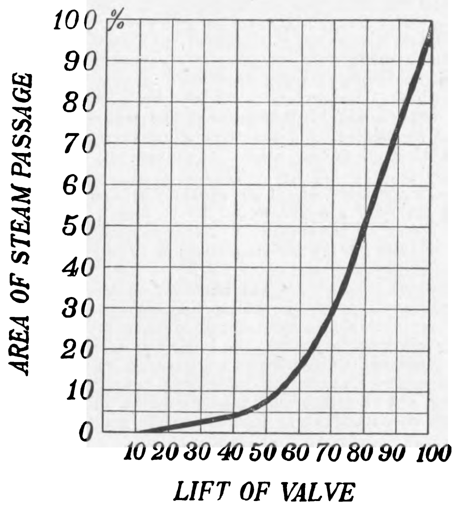


Fig. 3

In addition to the ease of manipulation, the rapidity of action, the tightness of shut-off, and the delicate control of the steam supply are said to be noticeable features of this valve. In connection with the last, the makers state that in a locomotive fitted with this valve the driver can easily secure an increase of pressure in the cylinders of 2 lb. at a time throughout the entire range at his command, an acquisition which must be highly advantageous under many circumstances. In Fig. 4 is shown a locomotive regulator valve of the "Servo" type. For this purpose the essential details are identical with those of the valve described above. The casing has, however, attached to it a casting on which are formed guides for a small crosshead to work in; this crosshead is carried at the end of the spindle rod, and is connected by links to the lever arm of the regulator rod. With this valve the usual "cow-horn" form of regulator handle is quite unnecessary, a small lever taking its place. From various considerations this valve, when applied to locomotives, is inverted, so that the weight of the piston, &c., acts counter to the steam in keeping the valve on its seat, but the working of the device is in no way altered thereby. We are informed that a modified design permits of the use of the valve in the upright position, and, at the same time, allows the spindle valve to be separated from the main valve and to be placed, say, in the cab of the engine or in any other handy position, thus decreasing the number of moving parts in the interior of the dome.

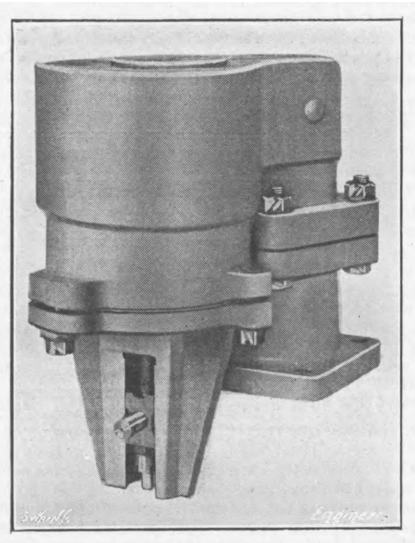


Fig. 4—SERVO LOCOMOTIVE REGULATOR VALVE

MICROSCOPY AND MACROSCOPY IN THE WORKSHOP AND FOUNDRY.

A LECTURE on this subject was delivered by Mr. J. E. Stead on September 11th before the Congress of the International Association for Testing Materials at Copenhagen.

Mr. Stead, after referring to the death since the last Congress of the pioneer of metallography, Dr. Sorby, said he would endeavour to show to what extent the pioneer work of patient workers in the past was being applied at the present time, and to give a few examples of cases in which Macroscopy and Microscopy had been found of great service to the steel maker and user. He had communicated with the greater number of metallurgical industries in Great Britain, and with the leading authorities in Europe and America, to ascertain the extent to which the microscope was actually in practical daily use. The responses were prompt and as full as could be expected. In some copper and brass factories the microscope had proved invaluable. Mr. Tomlinson, manager of the Broughton Copper Company, wrote that indirectly it was useful because one could, with its aid, detect in metals certain ill defects caused, for instance, by overheating, and this damage might be traced to some prior annealing or other heating operation. In the event of copper being heated in the presence of some reducing gas—to the detriment of copper—it was found the microstructure had a most characteristic appearance, and was easily distinguished from copper which had been spoiled by ordinary overheating. Also various brass alloys, including 70/30 mixture, yellow metal, &c., manganese bronze, electrolytic copper, rough copper, including several qualities, overheated brass, ordinary wrought brass, cast brass, &c., each had their characteristic appearance which experience rendered easy of recognition. Cases often arose when the expense and time taken by a chemical analysis had been saved, as the microscope afforded a rapid means of deciding approximately the composition of certain of the above metals and alloys.

The Royal Gun and Carriage Factories, Woolwich, reported that the microscopic examination of brass was a matter of daily routine. The microscope was used as an additional means of investigating failures, abnormal results from mechanical testing, and as a comparative method of examining structures due to varying composition and thermal treatment of the metals used in the manufacture, &c. of ordnance, carriage work, and gun mountings, projectiles, &c. The Consett Iron Company, Limited, wrote that the microscope was regularly used in all cases where ordinary analysis failed to yield satisfactory explanation and more extended research was necessary. The Wigan Coal and Iron Company, Limited, stated that in their works the microscope was regarded as a necessary adjunct to the chemical and metallurgical work in the laboratory. It was used, not as a regular routine accessory, but as occasion required, in investigating the structure of any particular material, principally steel. It was useful to confirm chemical analysis, or, in case the latter did not give sufficient explanation of the cause of any particular trouble or difficulty. In this respect it was valuable as a means of proving mechanical defects, such as overlaps, hair lines, pipes, segregates, &c. It was also used to decide whether material had been burnt or not, and to corroborate chemical analysis in distinguishing wrought iron from mild steel.

In the Crewe shops of the London and North-Western Railway it was found that by microscopical investigations it was possible to discover the qualities of metals even better than by either mechanical tests or chemical analysis within certain limits. Messrs. Thomas Firth and Sons, Limited, expressed the opinion that the warring between the doctors of the new science and the confusion in terminology discouraged practical men in the study and application to routine purposes of the investigations and researches of recent years. Before practical everyday use could be made of the microscope, the meaning of the terms and the reactions of the substances they represented must be learned by practical experiment and observation. When a store of elementary knowledge had been firmly acquired in this way, the microscope became to the steelmaker or hardener a most valuable instrument.

Messrs. D. Colville and Sons, Limited, reported that they found the microscope of very great assistance in everyday work. The employment of the microscope was indispensable for detecting the overheating of steel; checking its heat treatment; extent of deformation caused by shearing, bad and good; extent of segregation; amount of slag inclusions; amount and extent of work (rolling, forging, &c.); the extent of deformation caused by punching; and the structure of steel in its various stages of manufacture. In malleable iron the microscope was frequently used to show the amount, if any, of steel admixture. Frequent use was also made of the microscrope in the examination of other metals, such as copper, bronze, &c. The microscope was the only method of detecting electro-deposited copper from solid drawn copper. Messrs. Colville employed the Zeiss' complete installation of the Martens microscope, using arc light, but had found the Stead new form of workshop microscope very useful and handy.

Messrs. Vickers, Sons and Maxim, Limited, stated that the microscope was in constant use in connection with the heat treatment of the various alloy steels used in gun and armour plate manufacture, &c. It had been found to be most useful, both as a guide indicating correct heat treatment, and as a means of ascertaining whether the treatment ordered had actually been carried out. A metallurgical investigation laboratory had been in active operation for some years at the Sheffield works of the company, and in it the microscope had been very extensively used in researches bearing upon the special classes of steel whose manufacture had presented difficulties. Messrs. Cammell, Laird and Co., Limited, wrote from Sheffield that in special cases where the forging or casting was to be subjected to subsequent costly machining or complicated heat treatment a preliminary micro-examination was sometimes found useful; although even in those cases the examination of a large etched section by means of the hand magnifier was usually more successful. In the great majority of cases the microscope was employed, not to discover defects, but to investigate the origin and determine the particular stage at which they were produced. For the latter purpose microscopic methods were absolutely indispensable.

Those were typical examples of replies received from British manufacturers. There were few large industrial works where microscopic examination was not regarded as essential, and if works had not microscopic equipment, they obtained outside professional assistance. In every college and technical institution in Great Britain where metallurgy was taught students were instructed how to use the microscope for the purpose of obtaining knowledge of the structure of metals and alloys. He had obtained information from many well-known investigators of European and American fame who were interested in application of the microscope. The following was a brief summary of the information thus obtained. In regard to France Mr. Ph. Pellin had furnished a list of manufacturers, numbering seventy, in which the microscope had been found to be an adjunct to more efficient practice. Mr. Le Chatelier, whose admirable microscope was used throughout France, stated that considerable installations were in use at the works of De Dion-Bouton under the management of M. Guillet, at the works of Saint Jacques at Montlucon, and at the steel works at Creusot. Dr. Carl Benedicks stated that in Sweden up to the present time the microscope had been mainly used in connection with tool and special steels. Metallography, as a routine science, had not been employed to a great extent. Captain N. Beraieff communicated some very interesting information as to the use of the microscope for very many years by Anossoff, and later by Tschernoff, Rjechotarsky, and many of the steel works in Russia.

In Belgium, at the works of the Société Anonyme Fabrique Nationale d'Armes de Guerre and Société Anonyme des Ateliers Germain, the microscope was in regular use. At the first-named works the Chatelier microscope had been an indispensable necessity in the examination of all polishable metals, although for industrial purposes its use at present could only be said to be limited. La Société des Ateliers Germain reported that the microscope was of special service for the discovery of causes leading to fracture of metals used in motor car construction. In Spain, at the Trubix Gun Factory, the microscope was extensively applied to practical purposes for the examination of ordinary and special steels, alloys, brass, bronzes, &c. It was interesting to note that it had been suggested by Taller de Precision de Artilleria that in every test of brass for cartridges the micrographical investigations should be adopted.

In America Mr. Albert Sauveur stated that he had information of the use of the microscope in 134 large industrial concerns, 92 of which were steel works, 16 non-ferrous metallurgical plants, and 26 miscellaneous industries or concerns, such as railroad companies, &c. The application of the microscope was taught in 28 technical institutions. On the authority of Dr. Wust, very many works in Germany and other countries used the microscope as an aid to their work. Messrs. Dujardin stated that up to 1905 metallography had been but little adopted in German works, although at that time such eminent men as Professor Martens, Heyn, Dr. Wüst, Professor Friedrick, and Professor Tamman, possessed distinguished pupils who had acquired the theory and practice of metallography. Since that time steady but substantial progress had been made in its application. From 1906 to 1908 Messrs. Dujardin and Co., independent of other makers, had fitted up metallographical laboratories in seven large works and in three technical institutions, and others were now in progress. It was stated that although to-day the practical utility of metallography was no longer doubted by the theorist, it was unfortunately not the same with regard to engineers and managers of works. A large number of the latter had absolutely refused to credit the new methods of investigation with any degree of utility. In some works the metallographical laboratory was regarded by a section of the management as a scientific curiosity. Little by little these impressions were changing, and recognition was being accorded to the fact that metallography was capable of yielding practical results.

The method of auto-sulphur printing first discovered by Professor Heyn, and applied by him and by his assistant, Professor Bauer, and afterwards modified by Professor Baumann, if properly applied was most useful in foundry practice. This method had been more usually applied for the detection of local and axial segregation of sulphur in steel, but it was capable of showing approximately the amount of sulphur in cast iron. It was only necessary to file and polish sections or rough chips of cast metal, to press the flat surfaces on to pieces of bromide paper previously soaked in a 3 per cent. solution of sulphuric acid in water and allow them to remain in contact for one minute, after which they were removed from the paper, the acid washed out with water, the prints fixed in hypo-sulphite of soda, and then washed and dried. The brown stains remaining on the paper varied in intensity with the sulphur present in the iron. They were compared with standard stains prepared from metals with known contents of sulphur. Differences of 0.02 per cent. sulphur were quite easily detected in this way. Direct prints could also be obtained by contact on lantern bromide plates after saturating the films with the dilute sulphuric acid and removing the excess of acid with blotting paper, but in such case, pressure must be applied to the specimens after placing on the slides in order to get good impressions. On applying this process to complete sections of pig irons, the fact was revealed that in highly sulphurous material the sulphur was very irregularly distributed.

As phosphorus in cast iron existed in isolated masses of phospho-iron eutectic, and as the amount of these masses bore a close relation to the percentage of phosphorus present in the pig iron, an approximate estimate of that element actually present might be made by examining polished and etched sections of grey pig irons. The polish need not be more than that obtainable by use of fine emery paper. The etching was done with 20 per cent. nitric acid in water, and was continued until the surfaces of the metals appeared quite dark. On comparing the prepared specimens with similar sections of standard pigs it was not difficult to detect differences of 0.02 per cent. in hematite pig iron, and 0.5 per cent. in pig iron containing between 0.5 per cent. and 2.0 per cent. phosphorus. It was not so easy to apply the method to small foundry castings, as the eutectic usually was not evenly distributed, and appeared in reticulated form. It was easy to tell whether white irons were high or low in phosphorus, but the polishing was not so easily effected.

It was well known that the amount of combined carbon in steels could be estimated with a fair degree of accuracy by microscopic examination; it was almost as easy to estimate the amount of combined carbon in grey cast iron or in grey pig irons. The importance of this fact to the foundry foreman was very great for the following reasons:—(1) In examining pig irons of open fracture, if the combined carbon was found to be high, it was almost certain that the silicon would be low, probably 2 per cent. or under. If there was no combined carbon, it was almost as certain that the silicon would be high. This rule did not apply when considerable amounts of chromium or manganese were present, or when the cooling had been abnormally protracted. (2) In examining castings, if the combined carbon as pearlite occupied the whole ground mass, the iron would be as strong as it could be made permissibly with ability to machine readily. In proportion as the pearlite became less and less, the softer would be the iron, and the more easily would it machine. It was not difficult to detect what part in the structure was pearlite, for this constituent was stained brown on lightly etching with dilute etching reagents. When the intergraphitic spaces contained mixtures of pearlite and ferrite it was the rule to find the pearlite adjoining the phospho-iron eutectic, and the ferrite in juxtaposition with the plates of graphite. The microscope could also be used for identifying the nature of minute hard spots which appeared in castings.

The macro and micro-structure of steel castings was of great importance to the steel founder. He could readily locate segregations, and determine whether the sulphur was relatively high or low by the auto sulphur printing process. He could check the work done in the annealing furnace and determine by the examination of pieces cut from the casting whether the annealing temperature had been too high or too low, and whether or not the castings had been annealed. In foundry practice, where the facings of the moulds consist of a graphitic mixture, the outer envelope of the steel in contact with the mould itself was usually higher in carbon than the mass of the metal. When the annealing had been properly done, the envelope was completely decarburised, and the castings sheathed in a thin covering of carbonless iron or ferrite. This decarburised layer varied in thickness with the time and temperature, and with the percentage of carbon in the steel. In steels containing about 0.30 per cent. to 0.35 per cent. carbon, it was sometimes only 0.05 mm. in thickness when the castings were small, and as much as 1 mm. in large castings. In unannealed steels the ferrite envelope was almost invariably absent. The altered micro-structure of the mass of steel produced by annealing, as compared with the "casting structure," was usually sufficient to enable one to say whether the steel had been annealed, but not if the temperature of annealing had been excessive, and it was in such cases that the decarburised envelope had to be looked for. A thick ferrite envelope and a coarse triangular structure of the pearlite in the steel itself were indicative of annealing at excessive temperatures. The presence of granular pearlite indicated clear evidence of prolonged annealing at temperatures between 750 deg. Cent. and 650 deg. Cent., and steel in this condition was usually very soft. When the annealing was done by heating to between 850 deg. Cent. and 900 deg. Cent., and the steel was removed from the furnace and cooled in the air, the pearlite was nearly always of the lamellar variety.

It was now a common practice to improve the surfaces of defective steel castings by electrically melting and filling blow-holes with iron or steel. It was recognised in important work that the castings should be annealed after electric welding. Etching with 20 per cent. nitric acid after rough polishing would show at once whether electrically welded steel had been annealed or not, for, if not, the steel surrounding the weld always consisted of either martensite, troostite, or sorbite, and each of these gave a dark stain on application of the strong reagent, whilst the iron melted electrically and used to fill the cavities was always in the form of ferrite, and remained white after etching. This etching method was, therefore, most valuable, for it enabled the works inspector or engineer to determine on the finished work the areas welded, and whether or not the steel had been annealed after welding. Annealing not only changed the troostite, &c., into pearlite, but removed the strains set up by the excessive local heating.

In the manufacture of malleable castings the microscope was useful in determining to what extent decarburisation had taken place, and whether there was anything abnormal in the structure of the metal. The outer skin of both blackheart and white malleable castings was after normal annealing free from carbon. If the castings were very small and of very light sectional thickness they were frequently more or less completely decarburised and exceedingly soft and ductile The microscope enabled one to detect with absolute certainty the extent of the decarburisation. Occasionally one came across white-heart malleable castings covered with a brittle metallic skin, which peeled off on attempting to bend the metal. The skin contained the silicon of the metal oxidised to silica. In other cases the outer envelopes contained carbon, and this covered a layer of decarburised metal. For reasons not quite evident it was certain that during the annealing recarburisation to a slight extent occurred, but, whatever the cause might be, the microscope enabled one to readily detect the abnormal condition. There was no better means of controlling the workmen who were responsible for the proper case-hardening of iron and steel than by the use of the microscope. Sections of hardened case-hardened material after polishing and etching indicated with certainty the depth to which the carbon had penetrated the metal.

In the works, as in the laboratory, it was essential that the examination of metals should be made from every point of view. The simple polished surface should be carefully searched with a low power microscope to locate and determine whether or not there were any incipient cracks or defects, or if there were slag inclusions. Laps and unsoundness could often be detected in rolled and finished material at this stage. In the next step, the complete section, whether of a rail, plate, or axle, &c., should be pressed on properly prepared and acidulated gelatine silver bromide paper, and auto-sulphur prints obtained. These would show at once exactly where the sulphur was segregated and would enable one to determine with a fair degree of approximation what position a piece of steel occupied in the original ingot, and whether or not the material had been honeycombed or free from honeycomb. When the centre part of the complete section gave a very dense dark stain one was certain that the steel had come from the upper part of the ingot where axial segregation was at a maximum. If, on the other hand, the central axis yielded a stain slightly lighter than the stain afforded by the surrounding metal, it might be accepted that the section was steel which had come from a portion about one-third of the distance from the bottom to the top of the ingot. If the forged steel had been made from an ingot this could usually be detected in the polished section, for the honeycomb cavities contained segregates, and those could be readily detected by the auto-sulphur printing method, for they showed on the print as dark spots, and were always very sharply marked in outline in steel from the lower part of the ingot. In proportion to the distance from the bottom of the ingot the honeycomb segregations as a rule were at a greater and greater distance from the outside skin, and became more and more distributed throughout the central axis.

Having obtained auto-sulphur prints, sections might be immersed for about half a minute in 20 per cent. nitric acid, or for one minute in Heyn's cupric chloride reagent, the former when a rapid etching was required, and the latter when the operator wished to keep the specimen. Both reagents gave a dark coloration to the surface in the areas of highest phosphorus. Without exception, those stains corresponded exactly with the maximum sulphur stains given by the auto-sulphur prints. It might, therefore, be assumed as a law that where there was segregation of sulphur in steel, there was also a segregation of phosphorus. After etching with those reagents an approximate idea of the size of the crystalline grain might be obtained by examination with a low power microscope, or even with a strong pocket lens, and any unsoundness produced by lapping or piping would be clearly revealed. In steels which had been heat treated with the aim of obtaining the best possible structure it was important then that the specimen should be properly polished and etched with picric acid solution and examined under a higher power. The structure and character of pearlite would then be easily determined.

Many so-called mysterious failures of boiler and other structures had been explained by the use of the microscope. In most of them fracture had been proved to have been initiated by maltreatment of the steel when cold. The steel had been found to be crushed, the ferrite grained, flattened, and the metal made most tender. In four cases at least of boiler failure, maltreatment had proved to have been the cause.

The auto-sulphur prints obtained from sections of steel billets enabled the manufacturer readily to detect serious segregation, and the same method could be used for detecting segregation in the wire rods and even in the finished wire. It involved less labour and time to test the rods and wires than to prepare the larger sections from the steel billets. In making the tests it was only necessary to file down inch lengths of the rods or wires, so as to expose longitudinal axial sections, to polish on fine emery cloth, and then to take auto-sulphur prints in the manner previously described. The axial segregation, if any, was in that way recorded as a dark brown stain on the paper. The depth of the brown tint given by steel free from segregation varied with the sulphur, so that with a little practice it was easy to read the stains into approximate percentages of sulphur. The difference in the depths of the brown tints produced by experimenting with common and high-class material was very pronounced. The macro-structure yielded by a cupric reagent of Heyn, when applied on the surface of the polished sections, was a second method for readily detecting axial and local segregation. The importance of detecting pronounced axial segregation in wire rods was recognised, for when present it frequently caused the wires to break with a cup and cone fracture during the process of drawing.

The microscopic examination of wires also was useful, and particularly so in the case of wires and wire ropes which had failed during use and in the course of manufacture. It had been noticed that wires which contained definite proportions of fine micro strings of foreign matter, such as cinder oxides or sulphide of manganese, were incapable of standing the torsion test, and sometimes broke up during the pickling process after the wire rods had been "tempered."

The microscope was also useful in ascertaining whether or not the rods had been evenly tempered. It occasionally happened that high carbon rods—0.75 per cent. to 0·90 per cent. C—portions of the steel actually contained free martensite, or, as some called it, hardenite, and when martensite was present "drawing" was impossible. On polishing longitudinal sections and etching with picric acid in alcohol or other suitable reagent, the martensite remained white on a ground mass of troostite and sorbite.

Sometimes during use wire ropes employed for winding and for cable tram lines were subjected to violent friction, sufficient to heat the crowns of the wires to above the recalescent point, and this, followed by chilling, left the surface skin intensely hard. An examination under the microscope of wire so affected, after suitable etching, revealed the presence of martensite. When that brittle skin was formed, and the rope passed over a pulley in such a way as to produce considerable flexure, the hardened skin cracked, and the cracks, once formed, travelled through the wires, which then broke up, and the rope became useless for further work and had to be removed. Sometimes the pulley surfaces were not arranged to engage a sufficient surface of the ropes, and the pressure on the parts which did come in contact with the metal surfaces were subjected to excessive crushing, causing the steel to flow along the surface of the wire crowns. The same thing occurred when the diameter of the rope was too small for the work it had to do, or if the wires were too soft, the condition of the crown surfaces was in that way made exceedingly tender, and fine cracks then appeared, and complete fracture of the wires followed as a matter of course. The micro-examination of vertical longitudinal sections showed to what extent the surface layers had been crushed.

In conclusion, amateurs should be warned that, before forming any conclusions, they should operate upon and examine a large number of specimens cut from material which had been passed as satisfactory in every way, and which had given ideal service, otherwise they would not be able to say what was normal and what was abnormal. Much confusion and trouble had arisen on account of microscopists not having taken this precaution.

HOMERTON WORKHOUSE AND INFIRMARY.

ON Saturday, the 25th ult., the new Workhouse and Infirmary at Homerton, which has been built for the Guardians of the City of London Union, was formally opened by the Chairman of the Board, the Rev. Thomas Grear. Mr. John B. Wild, C.C., Chairman of the Amalgamation Committee, gave certain details as to cost. The buildings have been designed for the accommodation of 681 inmates and 63 officers, at a total cost of between £50,000 and £55,000, the average cost per bed being £154. A sum of £10,000 has also been expended in the renovation of the old buildings. The new buildings have been designed by Mr. Albert E. Pridmore, architect, and built by Mr. Albert Monk, of Lower Edmonton. The engineering work comprises the heating, hot-water service, electric lighting, laundry, and kitchen, and has all been carried out under the supervision of Mr. E. R. Dolby, M. Inst. C.E. (Dolby and Williamson), Westminster, as consulting engineer.

The plant requiring skilled attention has been centralised as much as possible. Sufficient steam can be generated in one boiler, and this effects all the work described above, with the exception of the electric lighting. The boiler-house contains two steam boilers for 80 lb. working pressure, and each 30ft. long by 8ft. diameter, built by Galloway, Limited, Manchester, also the feed pumps. All the water supplied to the boilers is previously softened. Steam is carried to two calorifiers in the basement, each of which is large enough to supply the whole of the heating and hot-water service, and a centrifugal pump driven by an electric motor is arranged in connection with each calorifier. The water is pumped into a ring main in a subway, and this supplies all the buildings except part of the old administration block, the receiving block, and the workshops. The water from the ring main passes directly into the hot water radiators in all the new blocks, and it also feeds hot water calorifiers, and gives up its heat to the hot water service. The hot water in the ring main acts solely as a vehicle for the heat, and is not drawn off for washing purposes. The old blocks are heated with low-pressure steam.

The laundry machinery comprises a steam engine, a number of rotary washers, and hydros for wringing the clothes, and a set of drying horses in a chamber warmed by air, which is heated by the exhaust steam from the engine, and delivered under pressure by a fan. The ironing-room contains two power mangles, a large Decoudun ironer for sheets, &c., and a small iron for dresses.

The kitchen contains a series of steam-heated boiling pans, beef-tea pot, milk steriliser, tea infuser, hot plate, bakers' ovens, and cooking ranges. A disinfector of large size is installed for dealing with infected goods, and a steriliser for treating instruments, &c , for the operating theatre.

Electric lighting is fitted in all the new blocks and parts of the old blocks, the current being obtained from the mains of the Hackney Borough Council. The lamps are chiefly of the Osram metallic type. All the chief rooms are wired upon more than one circuit, so as to prevent total extinction of the light in case of the melting of a fuse. There is also a complete service of telephones and electric bells, and two electric passenger lifts.

The whole of the heating and hot-water service work was carried out by Wenham and Waters, Limited, of Croydon; the boiler-house and laundry work by Thomas Bradford and Co., of Manchester and London; the water softener by William Boby, Limited, London; the electric lighting, telephones, and power by Lund Brothers, London; the kitchen work by McDowall, Steven and Co., London; and the electric lifts by J. G. Childs and Co., Willesden. Mr. Thomas Huckett acted as clerk of works.

THE TRAINING OF ELECTRICAL ENGINEERS.

AT the University of London on Wednesday, October 5th, Professor J. A. Fleming delivered a lecture on "Electrical Inventions and the Training of Electrical Engineers." The chair was taken by Mr. Wm. Mordey, President of the Institution of Electrical Engineers. The lecturer first reviewed the progress which has been made in the various branches of the electrical industry, and referred to the large number of useful devices which have been put into use. The achievements which electrical engineers had attained, he said, were not the result of common intelligence, but they were the outcome of very great perseverance. The electrical industry had grown to such an extent that those engaged in it were forced to specialise. Stress was laid on the fact, however, that, although specialisation is a necessity, it is highly essential that electrical engineers should acquire a good all-round knowledge before practising in one particular branch.

Advice was given as to the subjects which a student should thoroughly master if he is to become capable of understanding the machines and apparatus with which he will come into contact during his career, and which will help to place him in the position to grapple with the numerous problems that still remain unsolved.

Among other subjects which the lecturer urged students to study were mathematics, mechanics, and thermo dynamics. A knowlege of languages was also highly essential. But that which was most important was that students should combine scientific knowledge with business knowledge. An engineer's success not only depended on his familiarity with the theory and construction of engines and dynamos, but it was also largely dependent upon his business qualifications. Business instincts generally determined whether a given piece of work turned out a success or not; and an engineer should therefore acquire ability in the direction of finance, otherwise technical training was liable to prove of very little value.

One thing which the lecturer referred to is worthy of more than an ordinary amount of consideration on the part of those who contemplate entering the electrical or, in fact, any other branch of the engineering profession. He said that if he were asked what was the most essential thing that a young man should possess to enable him to become a successful engineer, he would reply, a good constitution. The engineering profession was exceptionally arduous. How arduous the calling is can only be appreciated by those who have gone through the requisite training, and who have attained some degree of success, and is probably never realised by any young man when he first enters it. The desire to become an engineer, as the lecturer intimated, frequently originates from the aspirer's love for model making, but this form of amusement differs very materially from the training and life work of a successful engineer, as many frequently find to their sorrow. If young men could only form some conception of the kind of constitution, the persevering and enduring powers which the work demands, it is highly probable that the profession would be far less crowded, and many less would attempt to mount the ladder which they can never climb.

Another thing to which Professor Fleming referred was that with the extensive use of electricity practically all engineers should know something about electrical engineering. It seems that as time goes on the qualifications of any class of engineer will be so extensive that what he is expected not to know will not amount to very much.

Stress was laid upon the necessity for diligent work in the laboratories of the universities and technical colleges, and to the desirability of scientific and commercial testing work being carried out. Students were also advised to visit various works and power stations whenever a chance presented itself, and if possible to go to America and the Continent, where large hydro-electric power stations may be seen and other things of educational value which are not to be found in our own country. Then, turning to the chances which properly trained electrical engineers have of distinguishing themselves and becoming shining lights in the electrical world, the lecturer first dealt with some of the recent notable inventions, and afterwards with some suggested inventions which are waiting for the necessary brains to develop.

In this connection attention was drawn to the recent work of the electrical engineers and the chemists with regard to the fertilisation of the soil. The question of how long Canada's soil would last without artificial fertilisation, the lecturer said, was a question of importance; but the problem of artificial fertilisation was one which the electrical engineers and chemists had solved. Some illustrations of very large water-driven electric power stations were put upon the screen, and attention was drawn to the fact that in order for this process of fertilisation to become practicable an abundance of water power was essential.

Mention was naturally made of the enormous strides which have been made in connection with wireless telegraphy, also of the many problems in this branch of electrical science which still await solution, and to the consequent field for the inventor which these problems open up. Here Professor Fleming put forward a suggestion which may prove of interest to our readers with inventive minds. He said that electrical engineers had discovered means of transmitting small currents without the aid of wires, and it was possible that as time went on someone would discover a means of transmitting large currents in the same manner. When this came to pass, if ever it did, electric traction would, he said, be considerably glorified, since overhead trolley wires and conduit systems would have no sphere of usefulness, and as the lecturer suggested, other vehicles could be supplied with power and paid for by meter. The possibilities of utilising the sun's heat and the employment of electricity for domestic heating purposes were also considered.

Lastly, Professor Fleming expressed the hope that the noisy petrol engines now used on motor omnibuses would some day be replaced by electric motors.

In proposing a vote of thanks, Mr. Mordey also gave some advice regarding the training of electrical engineers, and expressed his entire agreement with Professor Fleming's views concerning the necessity for students acquiring business as well as technical knowledge. He thought that a man who was not capable of preparing estimates, dealing with agreements, and so forth, had less chance of success than the man who possessed good technical and business qualifications.

THE MASTER CUTLER OF SHEFFIELD.—On Tuesday last, at the Sheffield Court House, Mr. Herbert Barber, of the firm of Daniel Doncaster and Sons, Limited, steel manufacturers and merchants, was duly installed Master Cutler for the ensuing year, in succession to Mr. Douglas Vickers, of Vickers, Sons and Maxim, Limited, the retiring Master. The Cutlers' Feast takes place on Thursday, the 21st October, when Sir Edward Grey, Bart., the Foreign Secretary, will be the chief guest.

LABOUR TROUBLES AT WELSH COLLIERIES.—There were fears of considerable trouble at Dowlais last week, the non-unionists, or non-paying miners to the Federation, being so many that the unionists refused to descend to work. This lasted for a day or two, but the unionists made energetic efforts to bring about a peaceful state, and, happily, work was fairly resumed on Tuesday morning. The night workmen went down on Monday night. There have been alleged breaches of contract at the Copper Pit, Swansea. Some little while ago summonses were issued against eighteen men of the Copper Pit, Morristown, and damages were claimed from each of £1. This week it was urged that a further breach of contract has been made by the same men, and damages of £5 from each are now claimed.

INSTITUTION OF MINING ELECTRICAL ENGINEERS.—A meeting of mining electrical engineers was held at the Royal Victoria Hotel, Sheffield, on Saturday last. A new society, under the above title, has been in course of formation for some months, and Saturday's gathering was one of the meetings preliminary to recognition of the Institution by the Board of Trade. The objects of the Institution are "to augment the safety and to promote the general advancement of electrical science in all its applications to the industry of mining, and generally to extend the experience, increase the efficiency, and elevate the status of those engaged in the profession." Membership is to be open to all mining and electrical engineers, mine officials, and students throughout the world. Several hundred members have already joined. There was a large attendance at Saturday's meeting, which was presided over by Mr. H. Maurice, M.I.E.E., who, in welcoming the members, said that considerable progress had been made since they last met. Numerous new members had been enrolled, and the Council had decided to place the Institution on a proper legal basis by having it incorporated under the Companies' Act. Articles of association had been drawn up. Provision had been made for the formation of a benevolent branch at a later stage, if this was deemed advisable. There were to be several classes of members. Honorary membership would be granted to gentlemen who had distinguished themselves by literary or scientific achievements, or had given such assistance to the Institution that the members desired to do honour to them. There would be honorary corresponding members, gentlemen abroad who would from time to time send to the Institution reports of mining electrical work done in other countries. Already gentlemen had consented to act for Germany and Austria. There would also be diploma members, ordinary members, associates, and students. The articles of association would be submitted to the Board of Trade, and it was anticipated that by the end of this month they would be accepted, and then arrangements would be made for the inaugural meeting of the Institution. A few weeks ago it was announced that the Home Secretary was going to appoint a small committee to revise the rules referring to electricity in mines. Formal application was made for representation on that committee, but the Home Secretary had replied that the constitution of the committee would not allow of representatives of that Institution being placed upon it. He would, however, be glad to receive information and suggestions, and it would be the business of the Institution to proceed in this way. It had been decided to form a committee to inquire into the causes of mining accidents and the means to be adopted to prevent them. That committee would draw up a report, which would be of considerable importance to mining electricians. An interesting discussion followed the president's address. The meeting subsequently proceeded to discuss the place for holding the opening meeting. A vote was taken, and London and Manchester were the places most favoured, but the Council is to take the opinion of members as to which place shall be definitely fixed upon.

THE IRON, COAL, AND GENERAL TRADES OF BIRMINGHAM, WOLVERHAMPTON, AND OTHER DISTRICTS.

(*From our own Correspondent.*)

Crude Iron Steady.

THE furnaces have been making good outputs of pig iron, and producers still quote at recent rates or a shade in advance. If American buying of British pig iron continues prices locally are likely further to go up. At present the general quotation is 47s. to 48s. for Staffordshire common forge, and 50s. 6d. to 51s. 6d. for part-mine. Best all-mine forge is still quoted 85s., and foundry 90s., with cold-air qualities at 115s. Midland descriptions are in moderate inquiry at 49s. to 50s. for Northamptons, and 50s. to 51s. for Derbyshires. North Staffordshire forge may be quoted 51s. 6d. to 52s. 6d.

Manufactured Iron.

Business continues quiet in manufactured iron, and quotations are weak. Marked bars are still £8, with Earl Dudley's brand £8 12s. 6d., and the second grade of the "list" houses £7. Unmarked bars are £6 2s. 6d. to £6 5s. For plain sheets (doubles) £7 2s. 6d. to £7 5s. is asked, with a small demand, but the galvanised sheet firms are still doing well with some of the principal foreign markets, and are quoting £11 5s. to £11 10s. It is stated, however, that some merchants who purchased freely a little time back when prices were much lower are now realising at about £11. Gas strip is quoted £6 5s. to £6 7s. 6d., rivet iron is £6 15s. to £7, and £7 is also asked for slit nail rods.

The Midland Iron and Steel Wages Board.

The accountants to the Midland Iron and Steel Wages Board have taken out the figures for July and August, and they certify the average net bi-monthly selling price to have been £6 2s. 9.53d. This, as usual, is ascertained by examining the returns of sales of iron made by the seventeen selected firms. The new average is not a sufficient change to alter wages, being a reduction upon the previous two months of only 1s. 0.80d. The wages for puddling therefore continue at 8s. 6d. per ton, and all other mill and forge wages remain unaltered from Monday, October 4th, until Saturday, December 4th. The sales were 31,492 tons, or a decline upon the previous two months of 2382 tons. The reduction was mainly in bars, which, although amounting to 20,340 tons, were less than two months ago by 2605 tons. This time bars constituted only 64·59 per cent. of the total sales, whereas last time they constituted 67·73 per cent. There was a slight decline also in angles and tees, and in plates and sheets; but in "hoops, strip, and miscellaneous," which amounted to 9440 tons, there was an improvement of 498 tons. For the previous two months this group formed 26·40 per cent. of the total sales, but in the new return the proportion has arisen to 29·97 per cent. The selling price of plates and sheets was £7 1s. 5·69d., or 5s. per ton less than in the previous return. This enormous drop, which was largely due to the break up of the Galvanised Iron Trade Association, is quite an exceptional occurrence, and has greatly affected the average net selling price of all descriptions. It makes the new net average of £6 2s. 9·53d. the lowest for ten years. The nearest figure to it was for September and October, 1904, when the net average went down to £6 3s. 9·1d., or a shilling higher than it is at present.

Steel in Moderate Demand.

There is a fairly good inquiry for structural steel for engineering purposes and prices are maintained. Mild steel bars are £6 7s. 6d. to £6 17s. 6d.; angles, £5 17s. 6d. to £6; and girder plates, £6 to £6 2s. 6d. Joists are quoted £5 10s. to £5 15s. There is more business in boiler plates than recently at about £7 5s. Semi-finished steel is again quiet, but quotations are kept nominally at £4 15s. for Bessemer, with half-a-crown more for Siemens.

NOTES FROM LANCASHIRE.

(*From our own Correspondent.*)

MANCHESTER, Thursday.

Quietude in Pig Iron.

AFTER the activity of a few weeks ago locally, the lull which has set in latterly has been somewhat accentuated by the lack of demand on spot. There was a very good attendance on the Iron Exchange on Tuesday, but business was by no means of corresponding proportions. On the one hand, the "Bulls" were in evidence with the usual stories of strong American demand, and these were backed up by rumours of the charter of a vessel on the West Coast to convey a cargo of hematite to Boston. On the other hand, the "Bears" were equally assertive that buyers were holding off, being certain that prices would drop in two or three weeks' time. The actual fact is that, speaking generally, prices are well maintained. Middlesbrough was a shade lower, but other sorts showed no change, and Scotch was exceedingly firm, Glengarnock being advanced 1s. per ton. Hematite ruled rather quiet. Forge iron was in buyers' favour.

Finished Iron and Steel.

Notwithstanding the increased price of fuel, there was no notice of any advance in bar iron. Steel and steel products were firm. Foreign billets continue scarce at full asking rates.

Copper, Lead, Tin.

There was little being done in manufactured stuff. There was no change in sheets, but tubes were lower, as also tough ingot and best selected ingots. Lead: Sheets remained unchanged. Tin: English ingots were a shade lower.

Quotations.

Lincolnshire, No. 3 foundry, 56s.; Staffordshire, 54s.; Derbyshire, 55s.; Middlesbrough, open brands, 61s. 4d. Scotch: Gartsherrie, 63s.; Glengarnock, 62s. 6d.; Eglinton, 60s. 6d., delivered Manchester. West Coast hematite, 63s. 6d.; East Coast ditto, 60s. 6d., both f.o.t. Delivered Heysham: Gartsherrie, 61s.; Glengarnock, 60s. 6d.; Eglinton, 58s. 6d. Delivered Preston: Gartsherrie, 62s.; Glengarnock, 61s. 6d.; Eglinton, 59s. 6d. Finished iron: Bars, £6 10s.; hoops, £7 12s. 6d.; sheets, £7 15s. to £8. Steel: Bars, £6 2s. 6d. to £6 5s.; Lancashire hoops, £7 5s.; Staffordshire ditto, £6 17s. 6d. to £7; sheets, £7 17s. 6d. to £8; boiler plates, £7 5s. to £7 7s. 6d.; plates for tank, girder, and bridge work, £6 5s. to £6 7s. 6d.; English billets, £4 12s. 6d. to £4 15s.; foreign ditto, £4 10s. to £4 12s. 6d.; cold-drawn steel, £9 10s. to £9 15s. Copper: Sheets, £72; tough ingot, £62; best selected, £62 per ton. Copper tubes, 8½d.; brass tubes, 7d.; condenser, 8d.; rolled brass, 6¼d.; brass wire, 6½d.; brass turning rods, 6½d.; yellow metal, 6d. per lb. Sheet lead, £17 per ton. English tin ingots, £138 per ton.

The Lancashire Coal Trade.

Last week's advance in slack and engine coal in the Manchester district has been followed by the rest of the Lancashire coalowners, who have advanced official quotations by 5d. per ton. How domestic coal will fare later on remains to be seen, but any advance will be received with very ill grace by the merchants in this district. On shipping account, demand is exceedingly quiet. Revised quotations are:—Best Lancashire for domestic purposes, 14s. 2d. to 15s. 8d.; seconds, 12s. 2d. to 13s. 2d.; common, 9s. 2d. to 11s.; best burgy, 10s. 6d. to 12s.; round furnace coal, 11s. 6d. to 12s.; best slack, 9s. 6d. to 10s. 6d.; medium, 9s. to 9s. 3d.; common, 8s. to 8s. 6d. at the pit. Coal for bunkering purposes, screened, 11s. to 11s. 6d.; unscreened, 10s. 6d., delivered Manchester Ship Canal.

BARROW-IN-FURNESS, Thursday.

Hematites.

The hematite iron market this week is reported dull and idle. The fact is that buyers have covered their wants well forward, and are not disposed to commit themselves further until some of their deliveries arranged for have been completed. Some of the business lately transacted is for delivery early in the year. On the other hand, makers have a sanguine idea of future prospects, and are not inclined to sell much metal for delivery in the early part of next year unless on a substantial advance in price. Mixed Bessemer numbers are at 62s. 6d. net f.o.b., and warrant iron sellers are nominally at 61s. 6d. net cash, buyers 61s. Special hematites are quoted at 64s. to 66s., according to specification, and some good orders have been booked. In ferro-manganese a fair business is being done, and the demand for spiegeleisen is well maintained. Charcoal iron represents a steady trade. There is a fair demand for scrap iron. Iron ore is in quiet request, and raisers are not working their pits to the fullest extent. There is, however, a fair trade in best classes of ore, which are quoted at 18s. per ton net at mines, while medium sorts are at 14s. 6d. and ordinary classes at 12s. Foreign ores are being imported to a large extent.

Steel.

The Bessemer plant at all the works in the district is practically fully employed. The output is chiefly rails, and the demand has for some time past been steady, as the present position of activity has been undisturbed for some months. Orders are not, however, largely held, but makers are nevertheless able to pick up as much trade as keeps them going. Heavy rails are still quoted at £5 5s. per ton. There is not much being done in merchant steel, but there are prospects of developments at some of the works and of the production later on of certain classes of steel not hitherto put on the market in this district.

Shipbuilding and Engineering.

Vickers, Sons and Maxim are the lowest tenderers for one of the four improved Bristols which are required by the Admiralty by private builders. They are at present at work in the building of H.M.S. Liverpool, of the same type. Much progress is being made with the completion of H.M.S. Vanguard, which is expected to go on her trials at the end of this month. Work is still quiet in the marine engineering shops.

Shipping and Coal.

Shipping of iron and steel from West Coast ports last week amounted to 18,154 tons—iron 4530 tons and steel 13,624 tons—as against 5033 tons in the corresponding period of last year, an increase of 13,121 tons. For the year to date the shipments aggregate at 465,281 tons, against 368,601 tons for the corresponding period of last year, an increase of 96,680 tons. Coal and coke quiet but steady.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

House and Gas Coal.

THERE has been no official advance in prices of house coal, as was confidently anticipated, but many of the collieries, with big order books, are declining to take orders except at the advance of 1s. per ton usually made at this time. The open weather we are experiencing, however, militates against a general rise, and other collieries not situated as those referred to, are, to use a phrase in the coal trade, "fitting" orders at September prices. These are 11s. 6d. to 13s. per ton for best Barnsley, and 10s. to 11s. per ton for secondary descriptions. The activity noted last week in the gas coal trade is fully maintained, and is certain to increase as the year advances.

Steam Coal—Export Season Approaching its Close.

The shipment season may be said to be now fast drawing to a close. The last consignment is said to have been made for delivery in St. Petersburg, and as the Baltic navigation comes gradually to an end, the trade, of course, will correspondingly attenuate. This decrease in shipment usually makes the market easier at this time of the year for industrial undertakings, and at present prices are easier than last week's quotations, the rates ruling for steam coal being now about 9s. per ton.

Small Coal and Coke—Both Firm.

A good trade generally in slacks, and the best grades of small coal particularly active. The requirements for the textile trades of Lancashire and Yorkshire are heavy, and all the output of small coal for the markets is readily absorbed. Rates are from 4s. 6d. to 5s. 6d. per ton. Coke continues on the up grade, best washed this week advancing again, while unwashed remains firm at former figures. Best washed, 12s. to 12s. 6d. per ton; unwashed, from 11s. to 11s. 6d. per ton.

The Iron Trade—Quiet Market.

Business very quiet all round. Makers, being well sold forward, do not press sales to induce brisker demand, and adhere firmly to their quotations. It is felt that this is the wisest course to follow in the present condition of trade and markets. Hematites are as formerly quoted:—West Coast, 68s. to 70s. per ton; East Coast, 65s. to 67s. per ton, both net, delivered in Sheffield and Rotherham. The Lincolnshire Ironmasters' Association met last Friday, but made no alteration in official quotations, which are:—Lincolnshire, No. 3 foundry, 52s. 6d. per ton; No. 4 foundry, 51s. 6d. per ton; No. 4 forge, 51s. 6d. per ton; No. 5 forge, mottled and white, 51s. 6d. per ton; basic, 52s. 6d. per ton, all net, delivered in Sheffield and Rotherham. Derbyshire, No. 3 foundry, 52s. per ton; No. 4 forge, 50s. 6d. per ton, both net, delivered in Sheffield and Rotherham. It is reported from the Derbyshire district that specialities in malleable iron are being better booked, and prices stiffening.

Bar Iron, &c.

The South Yorkshire Bar Iron Association met on Monday, but no change was made in prices. Although the price of pig iron has advanced fully 5s. per ton since the quotation of £6 10s. per ton for bars was fixed, it was not considered that the state of trade would justify any revision of rates at present. Makers are very short of work, not on account of lack of contracts, but of the indisposition of customers to take delivery of material contracted for as rapidly as could be wished. There is no improvement to report in other departments of the finished iron and allied trades. Hoops remain at £7 10s. per ton, and sheets at £8 10s. per ton.

The Heavy Trades.

Firms at the East End are at present engaged on the orders for armour plates given out some time ago. These, however, are rapidly being worked off, and the announcement this week of the First Lord of the Admiralty that further orders are to be given out in due course is received with feelings of hope that the actual giving out may soon take place. A few orders are stated to have been given out by the British Government in projectiles, chiefly, however, to replenish stores. Further work in this and other departments of military material would be exceedingly acceptable. Orders for tool steel, including high-speed, are reported to be more plentiful, though not in any great bulk. Several firms are fairly busy in this department.

NORTH OF ENGLAND.

(*From our own Correspondent.*)

Shipbuilding and Engineering.

THE position in the shipbuilding industry is steadily improving, and contracts for new vessels continue to be booked on a somewhat extensive scale, so that the yards in this district are more fully employed than they have been at any time since 1903, and what is more it may be stated that this state of affairs is likely to be maintained. The outlook for the winter is certainly more satisfactory than anyone ever expected it would be. The revival of the shipbuilding industry has also brought about with it a decided improvement in the marine engineering business, and most of the establishments are once more fairly well employed.

Cleveland Pig Iron.

Notwithstanding that the stocks of Cleveland pig iron in Connal's public stores are increasing at a very rapid rate, and that in the ordinary course dull trade and falling prices should be ruling, the situation is steadily becoming more favourable for the sellers of pig iron, and the unsatisfactory statistics have no detrimental influence, being practically ignored. Traders say the increase in stock will have a steadying effect, and doubtless prices would have advanced at a quicker rate than has been reported if the stock had been small and decreasing. Confidence is being restored, and traders take a very sanguine view of business and its prospects. This feeling is induced by the reports from the United States and also from Germany. The expectation of a large business being developed with the United States is the chief reason for the change for the better which is now appearing in the pig iron trade of the North of England. No. 3 Cleveland G.M.B. pig iron has risen to 52s. 6d. per ton for prompt f.o.b. delivery, and 53s. is asked for delivery up to the end of the year. Some producers will not entertain offers except at 6d. per ton more than these figures. The prompt price of No. 1 is 54s. 9d.; No. 4 foundry at 51s.; No. 4 forge at 50s. 6d.; mottled at 50s.; and white at 49s. 6d. Over the last three months Cleveland pig iron prices have risen 4s. 3d. per ton, and over the minimum of the year there is an advance of 6s. 9d. per ton.

American Order Forthcoming.

As has been already stated in these columns, much of the late upward movement in prices of Cleveland pig iron has been due to the anticipations regarding probable American requirements from this side of the Atlantic. Now the expectations have begun to materialise, and sellers in this district are securing orders from the States; thus there is greater reason for further improvement in prices. Several good contracts have been booked on American account this week by Teesside firms, not only for Cleveland pig iron, but also for hematite, steel scrap, and special descriptions of pig iron. The duties on iron having been reduced in the States, British producers can sooner compete than hitherto. Cargoes have been sold for delivery at Philadelphia, Baltimore, and Boston. There is some advantage in the way of freights; two years ago 7s. per ton was the general rate from Middlesbrough to Philadelphia, but it is reported that as little as 5s. 6d. has been accepted within the last few days. A steamer has been chartered to carry pig iron from the Tees to Boston at 6s. 3d. per ton. German pig iron is to be sent from Rotterdam to America. Very considerable sales have been made in this district of scrap steel for early despatch to the United States, and it is believed that this demand will be kept up. It is reported that locally made girders have been sold to the United States, but that is not a fact, though some have been sold to Canada.

Hematite Pig Iron.

Sales of East Coast hematite pig iron just now are rather slow, but that is not of much account, as the producers are very well off for orders for execution this year, and can afford to wait in face of the revival in shipbuilding. For mixed numbers some firms have raised their quotation to 59s. 3d. per ton for early delivery, but the general figure is 59s. per ton, a rise of 4s. during the last three months. The market is strengthened by the reports of inquiries from America for hematite, and, indeed, some has been sold to consumers in the States. Rubio ore continues to be quoted at 17s. per ton c.i.f. Middlesbrough, and a transaction at that is reported this week. Merchants will not yet quote for next year's delivery, as the Spanish mine owners still delay fixing the quotations for 1910. Furnace coke is becoming dearer; several ask 17s. 3d. delivered Middlesbrough, but 17s. is the regular quotation for early delivery.

Realised Price of Cleveland Pig Iron.

The accountants have reported that the average price realised by the ironmasters for the No. 3 Cleveland pig iron delivered during the third quarter of the year was 48s. 3.54d. per ton, that being 8.83d. per ton more than the price for the previous quarter, and there will be an advance, dating from 2nd inst., in blast furnacemen's wages of 1 per cent.; railway rates for the carriage of ironmaking materials will be raised 1 per cent. The average quoted rate for No. 3 over the third quarter was 50s. 0.78d. per ton.

Pig Iron Stocks.

At the close of September Connal's held 313,975 tons of Cleveland pig iron in their public stores, an increase for the month of 25,473 tons. The stock consisted of 291,806 tons of No. 3, 19,084 tons of No. 4 foundry, and 3085 tons of other iron undeliverable as standard. A year ago only 73,848 tons were held, or only about a fourth of the tonnage now held.

Pig Iron Shipments.

The September exports of pig iron from the Cleveland district must be characterised as unsatisfactory, for they only reached 96,883 tons, that being 16½ per cent. less than in August, 5 per cent. less than in September of last year, and 25 per cent. less than in September, 1907. The return even falls short of the September average of the last ten years, and that by 7¾ per cent. There has not been such a poor September since 1904. The large falling off was due to the curtailment of business with Germany, where trade has been even worse than in this country, and where there are enormous stocks of pig iron, which are offered at lower rates than Cleveland makers can afford to accept.

Manufactured Iron and Steel.

Improvement is generally reported in the finished iron and steel trades, producers speak more hopefully about the business, and the works are as a rule running more fully than they have been for two years past. No alterations in quotations have been announced this week, but the tendency of prices is decidedly upwards. The outlook is probably the most promising for the makers of plates and angles. The exports of manufactured iron and steel from Teesside last month were 48,004 tons, against 42,559 tons in September last year; while for the nine months they were 478,780 tons this year, against 446,739 tons in 1908. The chief deliveries were to Argentine, Canada, India, and South and East Africa.

Coal and Coke.

After a period of quietness, the steam coal trade somewhat unexpectedly shows improvement, and prices at the collieries have become stiffer, notwithstanding that second hands are underselling. Shippers are hastening to get coal away before the closing of the Baltic, and there is much activity at the shipping staiths and the docks on the Tyne and Wear. Best steam coal has risen again to 11s. per ton f.o b., and 11s. 3d. is likely to be asked next week. Best gas coal is strong at 11s. f.o b. Coking and bunker coals range between 9s. 6d. and 10s. The Mines Eight Hours Act, which comes into force in January in Durham and Northumberland, is expected to increase the cost of production, and higher prices for coal must be looked for on this score. It is probable that the three-shift system will be started if satisfactory arrangements can be made with the men.

NOTES FROM SCOTLAND.

(*From our own Correspondent.*)

General Trade Outlook.

THERE has been a quieter feeling in trade circles generally during the last few days. The upward movement in the iron and other markets appears to have spent itself for the time, some further impetus being necessary if it should be resumed. That a halt should take place in the advance in prices of raw material need not prove other than an advantage. Indeed, the rise in pig iron prices has recently been proving an embarrassment to manufacturers unable to secure a corresponding increase in the value of finished products. The harvest has been well secured in Scotland, and there has been a very marked increase in the price of wool—two circumstances that will add to the comfort and the purchasing capacity of the agricultural classes. While the improvement in trade still leaves much to be desired, it has nevertheless been substantial, and the outlook altogether is considerably more cheerful than it was at this time last year.

The Iron Market.

There has been a quieter feeling in the Glasgow pig iron markets in the last few days, after the large amount of business and the further advance in prices that occurred towards the end of last week. It has been somewhat disappointing to speculators in warrants that more substantial results have not come out of the frequent rumours that have agitated the market with reference to prospective purchases of pig iron on American account. It is at last reported that a Scottish steamer has been chartered to convey a cargo of pig iron from Middlesbrough to Boston, Massachussets, but of what is likely to follow in the same line of business very little is known. The shipments of Scotch pig iron have hitherto been disappointing. Since last report business has been done in Cleveland warrants from 51s. 4½d. to 51s. 8½d., and back to 51s. 4½d. cash, 52s. 7½d. to 52s. 11d. one month, and 52s. 2d. to 52s. 6d. and back to 52s. 3d. three months. Transactions have also taken place at 52s. 4½d.[for delivery in seven days, 52s. 8d. nineteen and twenty-five days, 52s. 7½d. twenty-seven days, 53s. November 26th, and 53s. 2d. for 22nd December.

Scotch Makers' Iron.

The demand for the special brands of Scotch makers' iron is reported to be fairly active, and, with old contracts and fresh business, the makers are busy. Prices have in some cases been advanced 6d. since last report. The f.a.s. quotations at Glasgow are, for Monkland No. 1, 58s. 6d.; No. 3, 56s. 6d.; Carnbroe, No. 1, 61s.; No. 3, 58s.; Clyde, No. 1, 63s.; No. 3, 58s.; Gartsherrie and Calder, Nos. 1, 63s. 6d.; Nos. 3, 58s. 6d.; Langloan, No. 1, 65s.; No. 3, 60s.; Summerlee, No. 1, 65s. 6d.; No. 3, 60s.; Coltness, No. 1, 90s.; No. 3, 59s. 6d.; Eglinton, at Ardrossan or Troon, No. 1, 58s. 6d.; No. 3, 56s. 6d.; Glengarnock, at Ardrossan, No. 1, 65s.; No. 3, 59s. 6d.; Dalmellington, at Ayr, No. 1, 62s.; No. 3, 57s.; Shotts, at Leith, No. 1, 63s. 6d.; No. 3, 58s. 6d ; Carron, at Grangemouth, No. 1, 65s. 6d.; No. 3, 59s. 6d. per ton. There are 40 furnaces making hematite, 36 ordinary, and 5 basic iron, the total of 81 thus in operation in Scotland comparing with 75 at this time last year.

Hematite Pig Iron.

The market for hematite warrants has been dull. Cumberland warrants are quoted 62s. 1½d. per ton. The output of Scotch hematite is large, and substantial deliveries are being made under contract. The price is up 1s. 6d. since last week, merchants now quoting 63s. 6d. for delivery at the West of Scotland steel works.

Pig Iron Shipments.

The shipments of pig iron from Scottish ports have been disappointingly small, being only 3602 tons, against 8875 in the corresponding week of last year. The total shipments to date are 18,115 tons less than in the corresponding nine months of last year, and of this decline 12,384 tons is due to reduced coastwise and 5731 to foreign shipments. The arrivals at Grangemouth of pig iron from Cleveland and district were 8195 tons, being 563 less than in the corresponding week.

Finished Iron and Steel.

There is much lack of business in the malleable iron industry, and a great proportion of idle time at the works. Home orders are scarce, and competition for export business is severe, and prices said to be unremunerative. The state of matters in the steel trade is somewhat better, although not satisfactory. For thin sheets and plates the shipping demand is active for a variety of foreign destinations. Steelmakers report, on the other hand, that the specifications coming out for shipbuilding steel are very disappointing. Steel ship angles are quoted £5 15s.; ship plates, £6 2s. 6d.; and boiler plates, £7 2s. 6d., all less 5 per cent. discount for delivery in Clyde district. There is not sufficient work to keep the steel rolling mills in anything like full operation.

The Coal Trade

The coal trade has been dull, the shipping demand being only moderate, while home requirements have not increased as regards manufacturing qualities. House coal is passing away more freely. Prices are unchanged.

WALES AND ADJOINING COUNTIES.

(*From our own Correspondent.*)

Last Week's Coal Trade.

THERE was scarcely any difference in the condition of things to that which was shown in the previous week. Quotations for best remained rigidly in the same blocked state, neither going up nor down. There was the old pressure of buyers to get cheaper rates, and failing to obtain concessions of even a few pence per ton, and the old opposition of coalowners to maintain figures. The stormy weather and delayed tonnage had also its complications. Yet on the whole there was tolerable briskness shown. House coal showed a firmer condition, and more steadiness with smalls, No. 2 Rhondda maintaining its approved position for bunkering. The result of the week's trading was tolerably good, and with more settled weather would have been better. Patent fuel moderate, pitwood irregular.

Latest Quotations, Cardiff.

There was a more hopeful feeling on Change at the beginning of the week. Moderating weather and the coming in of vessels of large tonnage that would take some days to load, and the news that the men were resuming work at the collieries gave more animation and hopefulness, and the fact that coalowners were well stemmed to the end of the month gave increased firmness to the market, but there was no advance, some small parcel excepting. Smalls were a little stronger, and Monmouthshire coal, especially best kinds, were in moderately good demand. Latest prices:—Best steam coal, 17s. 6d. to 17s. 9d.; best seconds, 16s. to 17s.; ordinary seconds, 15s. 3d. to 15s. 6d.; best drys, 16s. 3d. to 17s.; ordinary drys, 14s to 14s. 3d.; best washed nuts, 14s. to 15s.; seconds, 13s. to 13s. 6d.; best washed peas, 12s. 6d. to 13s.; seconds, 11s. to 12s.; very best smalls, 8s. 9d. to 9s. 3d.; best ordinaries, 7s. to 7s. 9d.; inferior sorts, 6s. 3d. to 6s. 9d.; best Monmouthshire black vein, 15s. 3d. to 15s. 9d.; ordinary Western Valleys, 14s. 6d. to 15s.; best Eastern Valleys, 13s. to 13s. 6d.; seconds, 12s. 6d. to 13s. Bituminous coal: Very best households, 17s. to 18s.; best ordinaries, 15s. to 16s.; No. 3 Rhondda, 17s. 3d. to 17s. 6d.; brush, 13s. 6d. to 13s. 9d.; smalls, 10s. to 10s. 6d.; No. 2 Rhondda, 12s. 3d. to 12s. 9d.; through, 9s. 6d. to 10s. 3d.; smalls, 7s. 3d. to 7s. 6d. Patent fuel, 15s. to 15s. 6d. Pitwood, 18s. 6d. to 19s. Coke: special foundry, 24s. 6d. to 28s.; foundry, 19s. to 22s.; furnace, 17s. 3d. to 18s.

Newport Coal.

There was more vivacity in business during the week, and the month was regarded as showing better signs, both as regarded the market and labour questions, the opinion being strong that Federation troubles were coming to an end, the men paying up. The shipments for the past week were good—foreign 88,530 tons and coastwise 14,800 tons. Latest:—Best black vein, large, 15s. to 15s. 6d.; Western Valley, 14s. 3d. to 14s. 9d.; Eastern Valley, 12s. 9d. to 13s. 3d.; other kinds, 12s. 3d. to 12s. 6d.; best smalls, 6s. 9d. to 7s.; seconds, 6s. 3d. to 6s. 6d.; inferiors, 6s. to 6s. 3d. Bituminous:—Best house, 15s. to 15s. 6d.; seconds, 14s. to 14s. 6d. Patent fuel, 15s. to 15s. 6d. Coke: Foundry, 18s. 6d. to 19s.; furnace, 17s. to 17s. 6d. Pitwood, ex ship, 18s. 9d. to 19s.

Anthracite Coal, Swansea Market.

Large coal firm; ordinary coal easy. Red vein, large, still keeps its improved position, and nuts and cobbles in good state. Rubbly culm, it will be seen, is fairly strong, but duff does not improve. Steam coals are not strong, and little is being done. Latest:—Best anthracite hand-picked, 24s. to 24s. 6d. net; seconds, malting, 21s. 6d. to 22s. 6d. net; big vein, 18s. to 20s., less 2½; red vein, 12s. 6d. to 12s. 9d., less 2½; machine-made cobbles, 23s. 6d. to 24s. net; Paris nuts, 25s. to 26s. net; French nuts, 25s. to 26s. net; German nuts, 25s. to 26s. net; beans, 17s. 6d. to 18s. 6d. net; machine-made large peas, 11s. 6d. to 12s. 9d. net; fine peas, 10s. 6d. to 11s. 6d. net; rubbly culm, 5s. 6d. to 5s. 9d., less 2½; duff, 3s. to 3s. 3d. net. Steam coal: Best large, 17s. to 18s., less 2½; seconds, 14s. 6d. to 15s., less 2½; bunkers, 9s. 9d. to 10s. 6d., less 2½; smalls, 7s. 6d. to 9s. 6d, less 2½. Bituminous: No. 3 Rhondda, 18s. to 18s. 6d., less 2½; through, 14s. 9d. to 15s. 6d., less 2½; small, 10s. 6d. to 11s., less 2½. Patent fuel, 13s. 6d. to 14s., less 2½. Coal quotations all f.o.b., less cash 30 days.

Swansea Valley: Sunday Labour at the Spelter Works.

For some time there has been an effort principally confined to the Swansea district to do away with Sunday labour, but this is not favourably received by the management, principally for the interference and an adjustment of wages, thus entailing greater cost in carrying on the factories. The result has been that after some partial stoppages work of late has been carried on from "Monday morning until Monday morning" at each place. In the Swansea Valley the copper trade refineries, tube and tinplate works have been exceptionally busy, and it has been remarked that amongst the operatives work has been done with an evident satisfaction that there have not been the irregularities occurring in allied trades. The coal contention caused by imperial or local differences are, as an authority remarks, happily free from a good extent of the Swansea Valley.

Iron and Steel.

The sluggishness of the exports in rails was scarcely broken at the beginning of the week by the dispatch of 40 tons steel rails to Jersey. Two cargoes steel billets came to Newport—one of 428 tons from Antwerp, a second of 423 tons from Bruges, 670 tons pig iron from Grimsby, 1300 tons steel blooms from Antwerp. Mid-week there was an important cargo of steel rails sent to Tasmania from Cardiff—2173 tons, and 1730 tons of sleepers to Bombay. Local business dispatched coastwise is satisfactory. Seventy tons steel bars went to Lydney from Newport at one dispatch, and 135 tons another. To Bristol black plate and iron cargoes continue steadily; 310 tons spelter was received from Workington. There is little buoyancy in business, but a little doing at Dowlais. Reports of improvement continue to be received. It is currently reported that the reduction in the number of furnaces in South Wales since 1907 is 50 per cent., but the quantity of iron probably only 10 per cent. less. At the Swansea Exchange mid-week—metal—the following quotations ruled:—Pig iron, hematite, mixed numbers, 52s. 1½d. cash, 62s. 1½d. one month. Middlesbrough, 52s. 4d. cash, 52s. 7d. one month; Scotch, 58s. 4½d. cash; Welsh hematite, delivered, 67s. to 68s.; Siemens steel bars, £4 15s. per ton; Bessemer, £4 12s. 6d.; East Coast hematite, 66s. to 67s., c.i.f.; Rubio ore, 17s. 3d. to 17s. 6d.; second quality, 16s. 3d. to 16s. 6d. at Newport or Cardiff.

Tin-plate.

The receipts from works last week were limited in quantity, but a fair amount of activity was shown at the various mills; 106,626 boxes were turned out, and had the weather been less boisterous there is no doubt shipments would have been heavier. As it was they barely touched 50,000 boxes. The stocks now exceed 170,000 boxes. This the incoming tonnage, and less violent weather, will soon reduce. Steamers are loading for St. Petersburg, New York, Hamburg, South America, various Italian ports and other destinations. Little change in the situation. Business is good; the inquiry for tin-plates is vigorous, and prices though not moving rapidly show a tendency to advance. Ordinary tin-plates are at 12s. 9d. to 13s. per box; Siemens C. 20 × 10, 18s.; C. 20 × 14 charcoal, 12s. 9d. to 13s.

AMERICAN NOTES.

(*From our own Correspondent.*)

NEW YORK, September 29th.

LARGE quantities of iron ore are being imported from Sweden, Spain and Cuba. Reduced duties make this possible. Eastern blast furnaces are now largely relying on imported ores. Most of the arrivals are at Philadelphia, the nearest point to the furnaces. Large bodies of ore have been discovered in Cuba and are now being developed by two large steel companies, the Pennsylvania and the Bethlehem, whose future needs will be supplied from that source. Lower ore duties will work to the advantage of the Atlantic coast steel industry. The coke industry in Western Pennsylvania and in West Virginia is developing steadily under the stimulus derived from the expansion of the steel industry. This industry is prospering under a heavy demand for all mill products. One of the most prosperous of the iron industries is the pipe industry. Several large enterprises are projected in Oklahoma and Kansas. An order for 5000 tons of pipe has just been received from Seattle. Contracts will be placed before Saturday for 25,000 tons of pipe to be delivered at various southern cities. The railways of the country will soon begin placing their orders for most of the rails that they will need for next year's track laying. These requirements will be heavy, but may not tax the maximum capacity because of the immense Gary plant now in operation in Indiana. The rail makers look for a busy year and they will not be disappointed. Prices in all lines of iron and steel are pointing upward and slight advances have been made, but the advances will be made cautiously. The lighter iron and steel products such as sheet iron, bars, iron and steel nails and merchant steel are all in good demand. The requirements of agricultural implement makers will be considerably larger this season than last. High prices are stimulating agriculture, and the threatened shortage of wheat is leading to the development of new wheat growing sections through the avenue of railway construction. Crude irons of all kinds are moving up slowly. Furnace capacity will probably be taxed to its utmost. During the winter a number of enterprises now projected will be perfected, and their requirements, so far as iron and steel are concerned, will be covered in the early spring. Building operations are increasing in number and in magnitude. Railway managers are discussing the necessity of more extensive terminal facilities in the larger cities. Bridge-building requirements are second only in importance to car building. Large orders have just been received for material for lake boats of 6000 tons capacity. The copper market maintains its firm condition. Domestic consumers have begun to buy more freely. Quotations for electrolytic 13¼. Consumption is heavy. A large amount is afloat.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

THE Cambridge County Council have appointed Mr. J. E. Blackwall, of Bakewell, Derbyshire, as county road surveyor.

THE Holophane Glass Company has changed its address from 146A, Queen Victoria-street, London, E.C., to 12, Carteret-street, Westminster, London, S.W.

THE Consul for Russia at Leeds, Mr. R. Gaudin de Beaumont, asks us to request exporters desiring their names, &c., inserted gratis in his list of Yorkshire exporters to Russia to address themselves to him.

GEARY, ADAMS AND CO., Limited, of 25, Central Arcade, Wolverhampton, inform us that they have been appointed sole agents for Birmingham and district for Messrs. Davey, Paxman and Co., Limited, Colchester.

THE manufacture of calcium cyanamide is now carried on in thirteen works in Europe, viz, Notre Dame de Briançon, France; Martigny, Switzerland; Odda, Norway; Muhlthal, Trostberg, Westeregeln, Brühl, Knapsak, in Germany; Piano d'Orte, Terni, St. Marcel, in Italy; Sebenic in Dalmatia; and Fiume in Austria.

CONTRACTS.—Meldrum Bros., Limited, have secured the order to equip the boilers of the South-Western Hospital of the Metropolitan Asylums Board with their Koker stokers.—The Derwent Valley Water Board have placed an order with M. Armand Puech for the application to the roughing filters at Bamford, which are on the Puech-Chabal system, of an apparatus for cleaning the separate compartments of the filters by means of air and water combined. It is claimed for this system, which is automatic in its action, that by its means the filter beds are cleaned throughout their depth without handling of the materials in any way.

SHEFFIELD TRADE WITH THE UNITED STATES.—The consular returns of exports from Sheffield and Barnsley to the United States during the quarter ended 30th September last shows a total of £200,413 8s. 1d. As compared with the previous quarter, steel has advanced from £115,000 to £132,655. The corresponding quarter of 1908 showed a value of £62,806. In cutlery the return now shows various classes under their respective heads, and it is not, therefore, so easy to show the comparative value of exports for the two periods. But, taking the totals, the value of exports last quarter exhibits a decrease of close upon £1100 compared with the corresponding quarter of 1908. With regard to steel, it has to be borne in mind that the new tariff rates came into operation during last quarter, and the rush to get goods in before the higher duties were brought into operation no doubt considerably helped the total. Before the actual effects of the changes in the duties are known in steel, cutlery, &c., it will be necessary to wait the trading figures for the next quarter.

MANCHESTER ASSOCIATION OF ENGINEERS.—On Tuesday evening last the president of this association, Mr. Joseph H. Stubbs, entertained the members and lady friends, to the number of about 520 at a conversazione at the Whitworth Institute. After being received by Mr. and Mrs. Stubbs, the visitors had the choice between inspecting a magnificent collection of pictures and statuary, with the accompaniment of an excellent string band, and a vocal concert which was given in the lecture hall. Both forms of entertainment were greatly appreciated, and the members of the association agreed that the function was one of the most successful of its kind which has yet been held. The wonderful collection of water colour drawings at the Whitworth Institute has few equals. Their arrangement in chronological sequence is worthy of great praise, as it enables the student to grasp more easily the development of the art than is possible when pictures are grouped indiscriminately, as in most galleries. On Saturday the first meeting of the discussion session will be held, when the president will deliver his inaugural address.

INSTITUTE OF MARINE ENGINEERS.—A joint meeting of the Institute of Marine Engineers and the Cold Storage and Ice Association was held in the hall of the Society of Arts on Monday, October 4th, for the adjourned discussion on Mr. Robert Balfour's paper on "Refrigerating Installations, with special reference to the arrangements necessary when narrow limits of temperature are required." Mr. M. T. Brown presided. The discussion was opened by Mr. Hal Williams, who said he did not think enzymes had a very material effect upon the carriage of chilled meat, although they undoubtedly affected its quality; greater trouble, in his opinion, being caused by the fungi, of which *penicillium glaucum* was the most common. Mr. F. W. J. Moore referred to the great prevalence of a fungoid disease experienced this year in the carriage of fruit. Mr. J. A. Linley described the conditions under which the animal is killed and prepared for refrigeration in some of the foreign abattoirs, which, he stated, all tended to the generation of bacteria and the production of putrefaction in the meat. Mr. W. E. Farenden asked the author whether he thought it advisable to provide artificial circulation of air in the holds; also whether chilled meat was being carried to any extent by the cold air process. Mr. H. Brier, speaking on the mechanical aspect, said the greatest trouble hitherto had been to prevent condensation, and the carriage of chilled meat was particularly difficult, as it was necessary to keep just between the freezing point and the condensing point. Mr. J. T. Milton said that enzymes were ferments, not bacteria; to their action was due the deterioration in the meat from animals which were in a fevered or excited condition just before being killed, and treatment by sterilisation was of little value in such cases. Messrs. W. McLaren and J. Thom also spoke. Mr. Balfour, in replying, said in his opinion chilled beef could not be successfully treated by the cold air circulation process owing to the necessity of keeping within a very slight variation in temperature. With regard to fruit, he had found that very good results had been obtained by maintaining a temperature of 36 deg. without changing the air. If wooden fasteners were used there would be little trouble with the moisture. The danger in opening the hold was the creation of moisture, which was favourable to the growth of moulds.

NOTES FROM GERMANY, FRANCE, BELGIUM, &c.

(*From our own Correspondent.*)

Rheinland-Westphalia.

Generally, the opinion prevails that the worst has passed in the iron and steel industry; rates have moved up in several instances, both inland and foreign demand increasing steadily. The Union of Rhenish-Westphalian Bar Mills has raised the prices of sale M. 2.50 p.t. for orders up to 31st of March, 1910. Orders for structural iron for immediate delivery come in pretty freely.

Iron and Steel in Silesia.

An upward movement can be noticed in the iron and allied industries, though prices are complained of as being unremunerative. Breslau dealers have advanced quotations for Upper Silesian bars M. 5 p.t, plates and sheets M. 2 50 p.t., and scrap plates M. 5 p.t., above the prices quoted on January 6th of present year. Basis quotation, free Breslau, is at present M. 140 p.t., iron bars M. 155, heavy plates M. 142.50, sheets M. 150 p.t. In girders only a moderate business was done recently, but heavy plates have shown more life, and deliveries have been quite satisfactory. Basis quotations generally remain low. The condition of the sheet market is pretty favourable, exports being rather extensive. The Prussian State Railway Administration is reported to have entered into negotiation with various shops regarding the supply of 492 locomotives, to be delivered in the period from April to July next year.

List Quotations.

The following are the present list quotations per ton free at works:—Raw spathose ore, M. 10.90; roasted ditto, M. 15.50; Nassau red iron ore, M. 11.50; spiegeleisen, 10 to 12 per cent. grade, M. 60 to M. 63; white forge pig, Siegerland and Rhenish-Westphalian brands, M. 55; iron for steel making, M. 56 to M. 58; German bessemer, M. 58 to M. 60; basic, free place of consumption, M. 48 to M. 50; forge pig, Luxemburg quality, M. 44 to M. 46; Luxemburg foundry pig, M. 47 to M. 49; German foundry pig, No. 1, M. 56 to M. 58; No. 3, M. 55 to M. 57; German hematite, M. 57 to M 59; common bars in basic, M. 98 to M. 104; iron bars, M. 122.50; hoops in basic, M. 122 50 to M. 125; common plates in basic, M. 106 to M. 112; steel plates for boiler making purposes, M. 116 to M. 122; sheets, M. 120 to M. 125; drawn wire in steel, M. 127.50.

Coal in Germany.

The market in Rheinland-Westphalia shows symptoms of improvement, and in Silesia the amount of orders secured was satisfactory, though house fuel remains in weak demand. Coke has shown more life since the production of the blast furnaces has increased.

Austria-Hungary.

Consumption is moderately good in the iron and allied industries, having slightly improved quite recently. The Hungarian State Railways intend ordering 150 locomotives, and as the Hungarian Government machine shops are crowded with work, foreign shops are likely to obtain at least part of the contract. A fairly good business continues to be done in coal and coke.

Firmness in France.

Orders continue to come in regularly and freely, both for local and Government supplies, and the majority of the shops are in good employment, with the result that rates have grown firmer. Consumers and dealers, expecting a further stiffening in prices, are inclined to purchase rather largely now, and so the outlook is fair as regards activity. The business in coal is quiet, quotations being generally lower than those of this time last year, but then the latter were higher than ever before, average prices being 17.20f. to 17.43f. p.t., while they have not exceeded 16.34f. to 16.40f. p.t. in other years. Home consumption increased 750,000 t. in the first six months of present year, 425,000 t. being supplied from abroad. Coalowners, therefore, intend to raise the inland production in proportion to demand.

Favourable Accounts from Belgium.

More confidence is shown in the principal departments, and a sound trade has been done during the week. German competition was just a trifle less keen recently. Quotations are firm, with a slight upward tendency. In pig iron a favourable business was done, competition from South-West Germany and from Eastern France having decreased. A satisfactory development is reported in the finished iron department, and the business in scrap iron has accordingly improved. Bars are stronger, and plates have likewise shown more life than previously, £5 3s. 6d. being quoted for export, while local orders fetch 132.50f. p.t.; sheets are in lively call, and rails as well as girders have been well inquired for, consumers and dealers showing more confidence. Coal and coke are in regular demand, but the tone of the market is quiet. Nuts for manufacturing purposes have exhibited some weakness.

Borough Polytechnic Institute.—Under the auspices of the Coal Smoke Abatement Society a course of about twenty lectures on the training and work of stokers will be given at this Institute on Thursdays, at 8.30 p m, by Mr. W. H. Booth, M. Am. Soc. C.E., assisted by Mr. W. Hildred. The opening meeting was held yesterday, the 7th inst.

Institute of Marine Engineers.—The opening meeting of the winter session was held at the Institute of Marine Engineers, Stratford, E., on Monday, September 27th, the chair being occupied by Mr. A. Boyle, Vice-president. The chairman referred to the loss recently sustained by the Institute in the death of its president, Mr. James Dixon, late Chairman of Lloyd's Register of Shipping, and spoke of Mr. Dixon's warm interest in the work of the Institute. The council decided to appeal to the immediate past-president, Mr. James Denny, to occupy the chair till the end of the session. This wish had been acceded to by Mr. Denny. It was explained that it had been decided by the council to offer awards to the associate members, associates and graduates, which course had been rendered possible by making use of the Stephen legacy and the liberality of Mr. A. Ritchie, of Hong-Kong. The awards were then presented:—Associate member, Stephen award for paper on "The Steam Turbine," awarded to "Uranus," Mr. James S. Gander; associate, Stephen award for paper on "Feed Heating," awarded to "Enigne," Mr. W. W. Adamson; graduate, Ritchie award for paper on "The Functions of the Air and Circulating Pumps," awarded to "Vacuum," Mr. Walter Smith. The Lloyd's Register scholarship has been gained this year by Mr. Frank Duncanson, apprentice engineer, of Sunderland; and the Denny gold medal for the best paper in competition for the medal submitted during session 1908-09, had been awarded to Mr. Wm. P. Durtnall, Member, for his paper on "The Electrical Transmission of Power for Main Marine Propulsion." Papers on "Hydraulic Cargo Gear for Passenger Ships," by Mr. A. M. McAlister, Member; and "Water Hammer," by Mr. Bishop N. King, Member, were afterwards read, and after a short discussion it was decided that the further discussion on both papers be postponed. The adjourned discussion on Mr. Robt. Balfour's paper on "Refrigerating Installations" will take place in the Society of Arts Hall on Monday evening, October 4th. The annual dinner of the Institute will be held on November 3rd.

BRITISH PATENT SPECIFICATIONS.

When an invention is communicated from abroad the name and address of the Communicator is printed in italics.

When the abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent-office Sale Branch, 25, Southampton-buildings, Chancery-lane, London, W.C., at 8d. each.

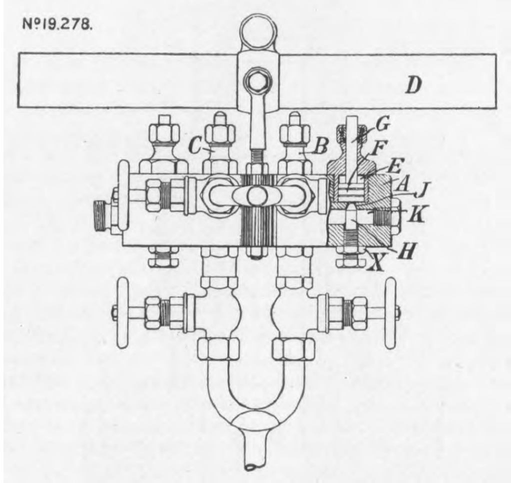
The first date given is the date of application; the second date at the end of the abridgment is the date of the advertisement of the acceptance of the complete specification.

Any person may on any of the grounds mentioned in the Acts, within two months of the date given at the end of the abridgment, give notice at the Patent-office of opposition to the grant of a Patent.

STEAM ENGINES.

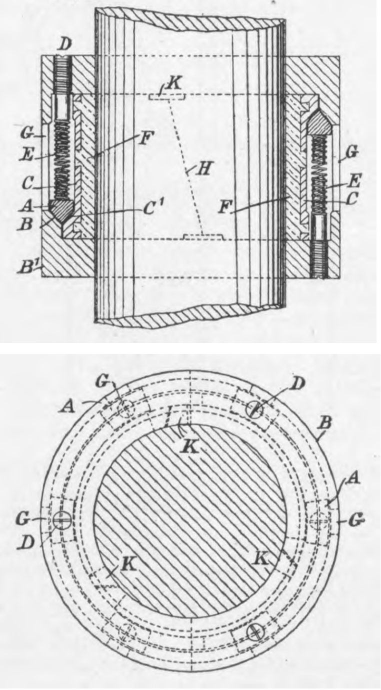
19,278. September 14th, 1908.—Improvements in Governors, John Gordon, of Northcote, Chelmsford-road, South Woodford, Essex, and Thomas Jackson, of the Lower-road, Deptford.

The illustration given shows the mercury tube capable of being tilted, and valve arrangements as referred to in prior letters patent No. 14,459 of 1907, with the invention applied thereto, the casing and needle valve being shown in full on the one side and in section on the other. The box A containing the control valves B C pivotally carries a mercury tube D in known manner. On each end of the box A a cylindrical chamber E is formed, in which slides a piston F, having a piston-rod G, the top end of which can engage with the under side of the mercury tube D. On the lower part of the box A is inserted a needle valve H, which passes across the channel K leading to the throttle valve operating power device. This needle valve H acts in conjunction with a seating J formed in the passage communicating between the channel K and the cylinder E, the rate of movement of fluid from the passage K into the cylinder being regulated by the amount of opening the needle valve H has relative to its seat J. When the needle valve is properly set, it can be locked into position by the lock nut. It may be observed that, whether the pressure or a vacuum exists in the channel K, the piston F will respond by moving outwards or inwards in its cylinder respectively. The function of the device described will be readily understood by the accompanying drawing, the apparatus being for governing marine engines in which a gravity control regulating element is adapted to control the application of fluid pressure to the throttle valve power operating device.—*September 15th*, 1909.


Nº19.278.

16,120. July 10th, 1909.—Improvements in Metallic Packings for Piston and other Rods Working in Glands, Robert Holmes, of 23, Arthur-street, Kingston-upon-Hull.

The method of adjustment consists in pressing the tongue or cod pieces A on to the conical parts B of the cage B¹, and the conical parts C¹ of the metallic packing C by means of screws D and spiral springs E being arranged at the top and bottom of the cage alternately. The internal parts are fitted with white metal liners F, which are arranged in three sections as shown, but any number of adjusting screws D and spiral springs E may be employed according to the diameters of the packings. As the white metal liners F wear, longer springs E would be inserted to obtain the necessary adjustment. The cage is provided with slots G in order to pass the springs E and tongue pieces A through the sides of the cage, which slots also lighten the cage. When the packing requires adjusting the gland is withdrawn from the gland box, and the packing is easily withdrawn, and can be adjusted without taking it off the rod by placing a clasp round the cage and tightening up the screws D. When the white metal liners are inserted in the cage and cut diagonally as shown at H, a flat tongue piece K is inserted at top and bottom to prevent any passage of steam. But as an alternative to cutting the packing diagonally these liners may be cut in halves circumferentially. There are three other illustrations.—*September 15th*, 1909.

Nº16,120


STEAM GENERATORS.

24,556. November 16th, 1908.—Improvements relating to Steam Boilers, William Harry Templeton, of 8, Springfield-terrace, Llanelly, Carmarthen, South Wales.

The invention relates to that class of steam boiler which has a pair of water headers, the inner plates of which are connected together by water tubes which are in communication at each end with the water headers, and consists of a novel construction and arrangement of parts whereby tight joints are made between the tubes and tube plates and tube plates and jackets; all rivets are dispensed with, and the entire boiler can be readily assembled and disassembled in a few hours, whilst the bolts used for connecting the bed-plate to its supports and the top plate and jackets to the tube plates, have their heads so formed as to avoid projecting into the furnace or combustion chamber.—*September 15th*, 1909.

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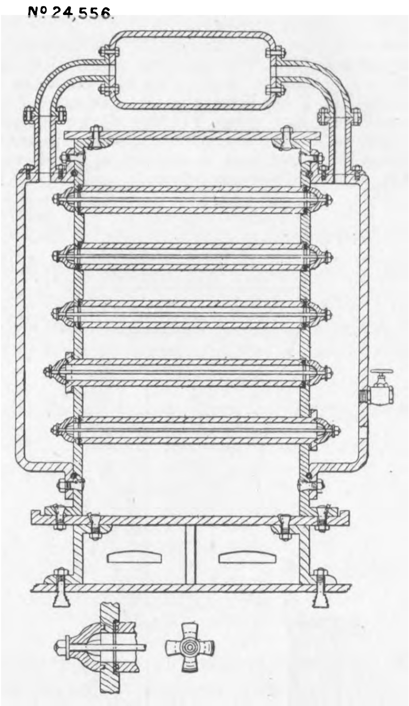
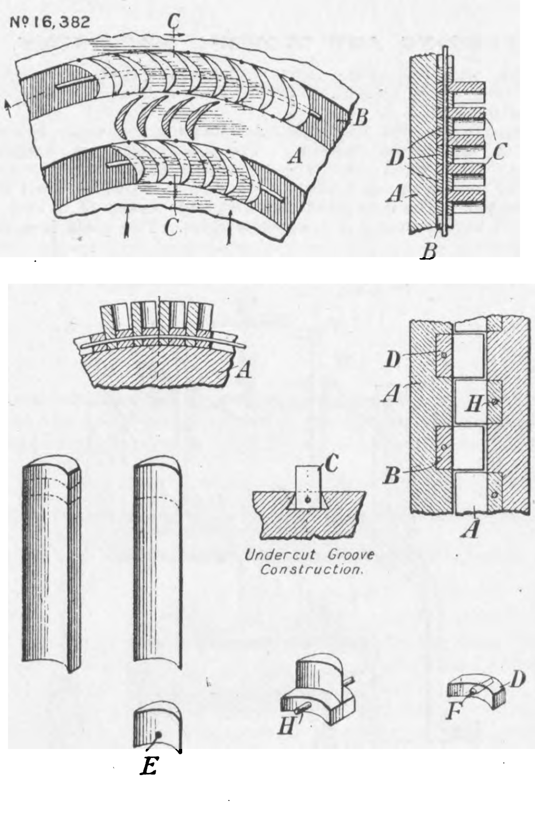


TURBINE MACHINERY.

16,382. August 4th, 1908.—Improvements in Turbines, *John Franklin Brady, of No. 45, Fulton-street, Chicago, U.S A.*

The type of turbine to which the improved form of vane is shown applied comprises two opposing and oppositely rotating vane members A, each carrying circular rows or groups of vanes, the rows of vanes of one member projecting between the rows of the opposing member. The path of travel of the motive fluid is in the direction of the arrow. There is provided in the working face of the vane member a plurality of concentric recesses B. These recesses are provided with parallel walls and with flat-bottom portions, and are designated to receive the vanes and blocks of the improved construction. The vanes C are of a concave-convex formation and, when secured in place, occupy a slightly inclined position, the lateral edges of the vanes engaging the side walls of the recesses. Between each vane is interposed a spacing block D. The front and rear walls of the spacing blocks engaging the vanes are complemental in form therewith and parallel, while the end walls of the blocks are parallel and engage the parallel walls of the recess B, serving effectively to prevent any turning or twisting of the vanes from their prescribed position. Forward or rearward movement of the vanes is prevented by completely filling each recess, so that the same substantially constitutes a solid mass of metal. Each of the vanes and the spacing blocks are provided with apertures E and F disposed intermediate of their outer edges and adapted to register when the blocks and vanes are connected, bringing the extreme lateral faces of the blocks D and the edges of the vanes C flush. A wire or rod H is provided, upon which the blades C and blocks D are strung. The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vanes and blocks may be loosely threaded upon the wire or rod, or, if desired, groups of six or eight blocks and blades may, after being threaded on the wire, be secured thereto in any suitable way, so that each group or section will be rigidly fixed to the wire. As shown in some cases, the grooves are undercut or dovetailed and the blocks are correspondingly formed; but the blades, as in the other constructions, are of uniform cross section throughout their length.—*September* 15*th*, 1909.

INTERNAL-COMBUSTION ENGINES.

26,100. December 3rd, 1908.—IMPROVEMENTS IN MEANS FOR FACILITATING THE REMOVAL OF THE VALVES FROM FLUID PRESSURE ENGINES, The Triumph Cycle Company, Limited, Manufacturers, and Albert George Franklin, both of Triumph Works, Priory-street, Coventry.

This device comprises a tubular portion A comprising the body, which is open at one side. The ends are closed as by caps B and C and these are slotted as shown. In operation the engine is turned until the cam D has lifted the required valve E off its seat and compressed the valve spring F. The device is then slipped into place as shown, the bottom cover C hooking under the valve washer G whilst the upper part B engages a recess or groove H formed in the valve guide or any other suitable part. It will be seen that, now, the spring is boxed in and that when the engine is further turned so as to move the cam D from beneath the valve tappet J, the tappet will fall, though the spring cannot do so. The valve can now be pushed down by hand, bringing the cotter K out of engagement with the washer G. The cotter can then be withdrawn, allowing the valve E to be drawn upwards out of the engine. When the valve is removed the spring remains in place, being held concentrically and ready in position for the return of the valve. This is an important feature. Obviously, the device, instead of being in tension when in use, may be in compression, being adapted to act between an abutment such as L and the under side of the washer G, instead of acting in tension, as shown. —*September* 15*th*, 1909.

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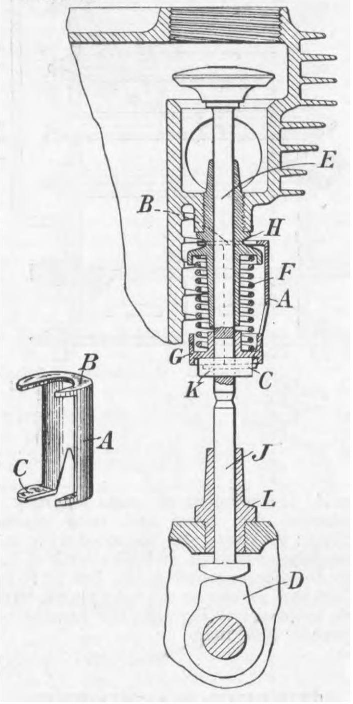

PUMPING AND BLOWING MACHINERY.

15,742. July 6th, 1909.—IMPROVEMENTS IN VALVES FOR PUMPS, *John Greer, of* 1020, *West Third-street, Dixon, in the State of Illinois, U.S.A.*

Referring to the engraving, A indicates the water cylinder and B the piston therein. The inlet valves are indicated at C. The water cap D encloses the outlet valves. Each of the outlet valves consists of a disc E to which a rod F is connected. The connection is formed by means of a shoe or plate G having flanges H at opposite sides. This plate is riveted to the disc and its flanges have holes K which receive a cross pin at the foot of the valve stem, so that a pivotal joint is formed which allows a certain amount of play to the valve disc. The valve stem works up and down through a tube L which projects through the water cap and which guides the movement of the stem. This tube is provided at the top with a stuffing-box M through which the stem works. The upper ends of the stems of the valves fit loosely in recesses N in the under sides of the opposite ends of a yoke O which extends across from one valve stem to the other, on the outside of the water cap. At the middle of the yoke is a spring which acts to close the valves, being connected at its lower end to an eye set in the water cap, and at its upper end to a screw eye which extends through the yoke and is provided with an adjusting thumb-nut, whereby the tension of the spring may be varied. The yoke acts as a lever, being, so to speak, fulcrumed on the opposite valve stems, alternately, and the action of the spring tends to close the valve. When one valve is lifted the lifting pressure is applied to close the other valve and to hold it closed until the return stroke, when the opposite action takes place. The quick action of the outlet valve assists the quick action or closing of the inlet valves, and consequently the action of the inlet valves is not interfered with by back pressure.—*September* 15*th*, 1909.

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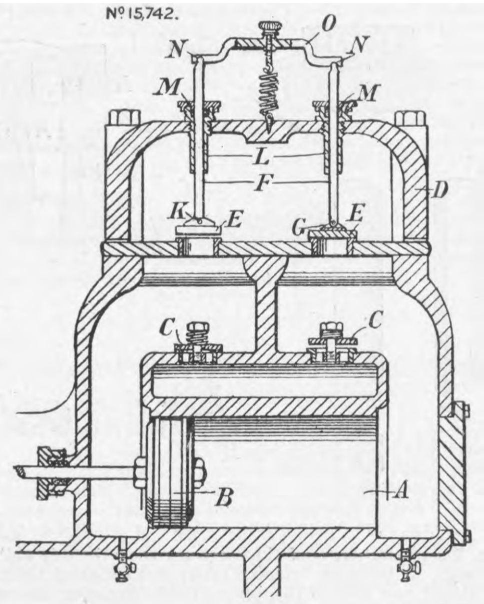
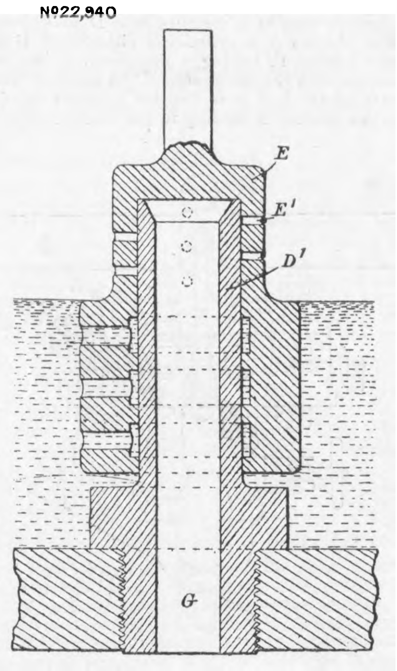


MISCELLANEOUS.

22,940. October 28th, 1908.—IMPROVEMENTS IN OR RELATING TO VALVES FOR ROTARY GAS BLOWERS AND FOR OTHER PURPOSES, Henry Andrews Neal and Arthur Pye-Smith, both of St. Pancras Iron Work Company, Limited, 171, St. Pancras-road, London, N.W.

The operation of this valve is as follows:—The fluid under pressure to be relieved enters the valve at G, passes up the interior of the tube D^1, and when the pressure overcomes the load upon E, raises it until the highest of the holes E^1 reaches the top of D^1, when the excess pressure can escape. An increase of pressure raises still further the cup E, exposing more of the holes E^1. Upon a decrease of pressure the cup E closes down again and successively shuts the holes E^1. The top of the tube may be ground to fit the underside of the cup E, or may be formed with a knife edge, as is well understood.—*September* 15*th*, 1909.

Nº 22,940



26,356. December 5th, 1908.—IMPROVEMENTS IN OR RELATING TO ELECTRIC FURNACES, Charles Bingham, of 11, Queen Victoria-street.

The furnace A has fixed above it girders or carriage-ways B, the ends of which communicate by turntables C or the like with other girders or carriage-ways D. On these carriage-ways carriages E are mounted to travel and these carriages are fitted with pulley tackle or the equivalent means whereby electrodes F for the furnace may be suspended from them and raised or lowered as required. Flexible connections G of suitable form and length to permit of the required movement are provided for connecting the bus bars H of the electric supply system with the electrodes F, and these are in duplicate, so that two electrodes may be simultaneously connected, one to each set, by any convenient form of connection. With such an arrangement, as one electrode becomes used up a second one may be brought alongside of it, and the one moved out of position while the other is moved into operative position. The used-up electrode and its holder and carriage may then be moved into the repair shop, with which the carriage-way communicates, and the old electrode removed and replaced by a fresh one, when the whole may be moved into a position ready for a further change. —*September* 15*th*, 1909.

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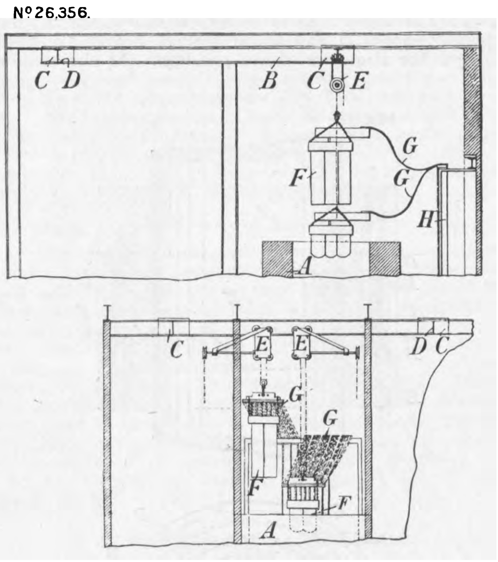

15,777. July 6th, 1909.—IMPROVEMENTS IN LOCK NUTS, *William Francis Kenney, of No.* 122, *Hope-street, Providence, in the State of Rhode Island, United States of America.*

The engraving shows a bolt provided with the right-hand screw thread A, and having an integral projection, having a left-hand thread F, preferably of less pitch than that of the thread A. The nut B is provided at one end of its bore with a screw thread fitting the thread A of the bolt, and at the other end with a finer left-hand thread D, which corresponds with the pitch of the thread F, and when the bolt is in use a hollow locking screw C is employed, having an outer thread which engages with the left-hand thread D of the nut, and an inner thread which engages with the left-hand thread F of the projection E of the bolt; and either one or the other of these engaging threads may be made of a fractionally different pitch, as, for instance, one-half more or less of a thread to an inch, in order to cause a cramping action of the threads as the screw C is being screwed forward into the bore of the nut B and also screwed upon the projection E of the bolt, the screw C being brought forward until the resistance encountered becomes so great that the screw C cannot work loose after the nut B has been screwed up and locked in its tightened position. There are three other illustrations.—*September* 15*th*, 1909.

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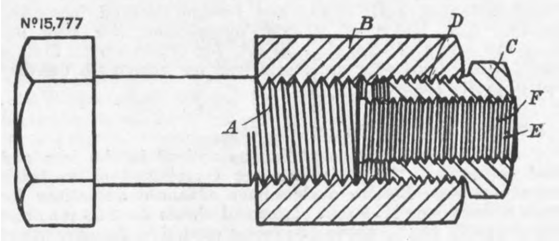

SELECTED AMERICAN PATENTS.

From the United States Patent-office Official Gazette.

930,525. LUBRICATOR FOR LOCOMOTIVES, *E. Blauhorn, Vienna, Austria-Hungary.—Filed June* 29*th*, 1908.

In a lubricator of the type described, the combination with the condenser and the oil drop forming devices of a trap having a discharge orifice, and into which the oil drops enter, means connected to the steam space of the condenser to supply steam to the trap, a chamber over the trap having a delivery orifice, and means to connect the chamber and steam space of the condenser. There is only one claim.

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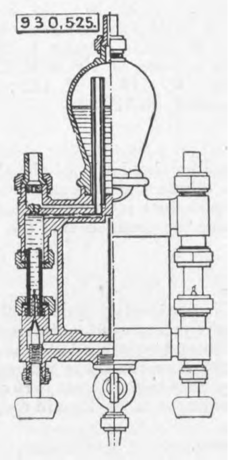

930,646. VALVE MECHANISM FOR HOT-WATER PUMPS, *C. Caille, Le Perreux, France.—Filed March* 9*th*, 1909.

This patent is for an air pump for high vacuum condensers. The thing claimed is a contrivance for promoting the complete filling of the pump chamber with liquid during the suction stroke, comprising a passage leading upward from the upper portion of the pump chamber, two valves in the passage, the outer valve opening outward and closing inward, the inner valve being a float-valve, which by the buoyancy of the liquid closes outwardly, with the exception of an orifice of fine bore, there being, between the two valves, a space sufficient temporarily to contain the small quantity of liquid which in the delivery stroke may be forced through the orifice of fine bore. There are two claims.

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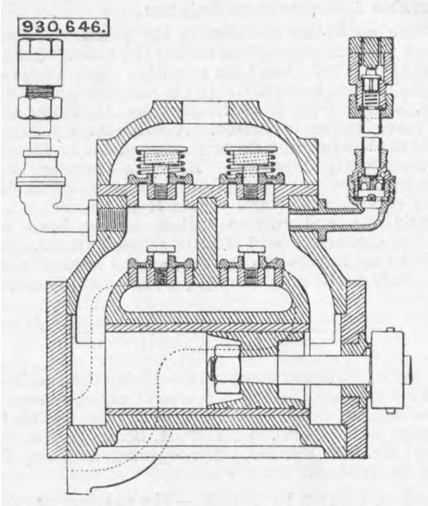

930,766. STEAM TURBINE, *J. Karrer, Zurich, Switzerland, assignor to the firm of Maschinenfabrik Oerlikon, Oerlikon, near Zurich, Switzerland.—Filed March* 1*st*, 1909.

This patent is for the combination with a turbine operating by live steam of a plurality of turbines operating by exhaust steam, the live steam turbine discharging into less than the whole number of exhaust steam turbines. There are eight claims.

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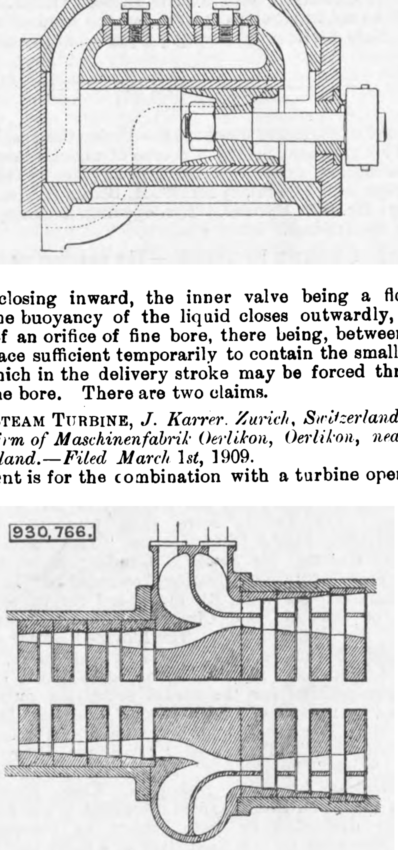


CYLINDER CONDENSATION AND THE TEMPERATURE OF CYLINDER WALLS.

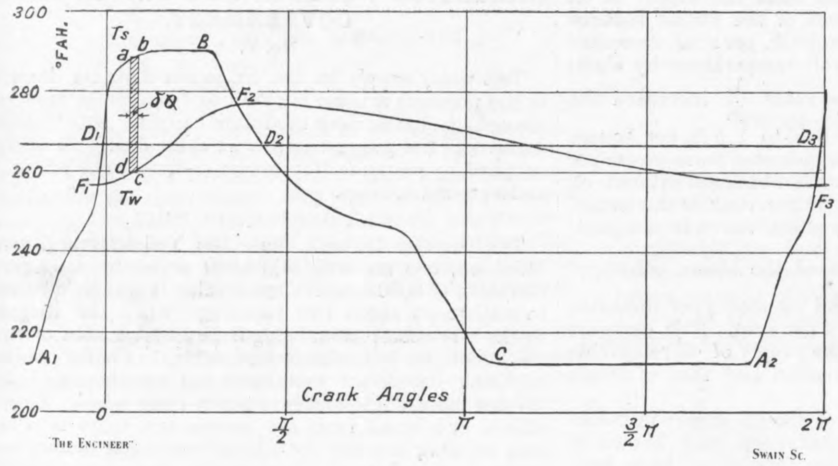
By R. ROYDS, M.Sc.

During recent years the "missing quantity" in reciprocating steam engines has been the subject of much controversy between those who uphold the initial condensation theory and the so-called valve leakage theorists, the real point at issue being the relative importance of these two theories in accounting for the missing quantity. It is generally conceded on all sides, however, that cylinder condensation plays a very important part, and that such condensation depends largely upon the temperature of the cylinder walls relatively to the initial steam temperature, that is, the lower the temperature of the cylinder walls relatively to that of the initial steam the greater will be the cylinder condensation and the missing quantity. Some advantage may therefore be derived from an inquiry into some of the conditions which affect the wall temperatures.

It is well known that the surface of a steam engine cylinder wall in contact with steam must necessarily fluctuate in temperature if it absorbs and rejects heat during each steam cycle, but both theory and experiment point to the conclusion that the magnitude of such cyclic fluctuations at ordinary speeds of rotation must be much less than that of the steam in the cylinder. Also the amplitude of the metal temperature fluctuation decreases very rapidly with the distance from the surface; in fact, with ordinary cylinder conditions the metal temperature will be practically constant at less than half an inch from the inner surface.* In any case the time mean temperature of the wall surface in contact with the steam will be practically the same as that of any point in the section of metal adjacent to the particular surface, especially if the cylinder is well covered externally, and no steam jackets are in use. Therefore, to measure the mean temperature of the inner surface of the wall at any particular place, it is generally sufficient to insert a small diameter mercury thermometer into a close fitting mercury-filled hole in the metal, with the thermometer bulb situated about half an inch from the inner surface.

Most writers on the theory of the steam engine, and more particularly many of those who write text-books on the subject, seem to have the idea that the wall action consists simply of the condensation of steam during the admission period, with subsequent re-evaporation during the exhaust period of the cycle, whereas this is only the effect of the wall action on the steam. Let us rather consider the wall action to be an alternate reception and rejection of heat through the wall surface, calling the rate of heat reception per unit area per unit of time, per degree difference of temperature between the steam and the wall the "receptivity" of the surface, and, similarly, the rate of heat rejection from the wall to the steam the "emissivity" of the surface.

Consider a unit area of the cylinder clearance surface. In Fig. 1 the curve A, B, C, A_2 represents the cylinder steam temperatures plotted on a crank angle base, and, for the sake of demonstration, assume that the curve F_1 F_2 F_3 represents the corresponding wall surface temperatures.



The Engineer Swain Sc.

Fig. 1

If T_s = steam temperature at any time t during heat reception by walls,

T_w = wall surface temperature at same time t,

r = surface receptivity at same time t,

ω = uniform angular velocity of the crank,

then, in the small period of time δt the heat received per unit area will be $r \times (T_s - T_w)\,\delta t = r \times (T_s - T_w)\,\frac{\delta\theta}{\omega}$.

Referring to Fig. 1, and considering the elementary shaded area $a\,b\,c\,d$ of width $\delta\theta$, it is seen that this area represents $(T_s - T_w)\,\delta\theta$ more and more nearly as $\delta\theta$ is made smaller and smaller, so that the heat received during this small angular period is represented by $\frac{r}{\omega} \times (\text{area } a\,b\,c\,d)$. The total heat received by the wall per unit area from point F_1 to F_2 is equal to the sum of all such terms—that is $= \Sigma_{F_1}^{F_2}\left\{\frac{r}{\omega} \times (\text{area } a\,b\,c\,d)\right\}$. (1)

If R represents a kind of average value of r between the points F_1 and F_2 the above summation reduces to

$$\frac{R}{\omega}\,\Sigma_{F_1}^{F_2}\,(\text{area } a\,b\,c\,d) = \frac{R}{\omega} \times (\text{area } F_1\,B\,F_2) \quad . \ (2)$$

Similarly, if E is a kind of average value of the emissivity between the points F_2 and F_3, the heat rejected to the steam by the clearance surface wall per unit area is represented by

$$\frac{E}{\omega} \times (\text{area } F_2\,C\,F_3) \qquad . \ . \ . \ (3)$$

If $D_1\,D_2\,D_3$ is the line of mean wall temperature, actual calculation shows that for any reasonable cyclic fluctuation of the surface temperature the area $D_1\,B\,D_2$ is nearly equal to area $F_1\,B\,F_2$, and similarly, area $D_2\,C\,D_3$ is nearly equal to area $F_2\,C\,F_3$, from which it follows that

To some scale the total heat received per unit area of clearance surface $= \frac{R}{\omega} \times (\text{area } D_1\,B\,D_2)$

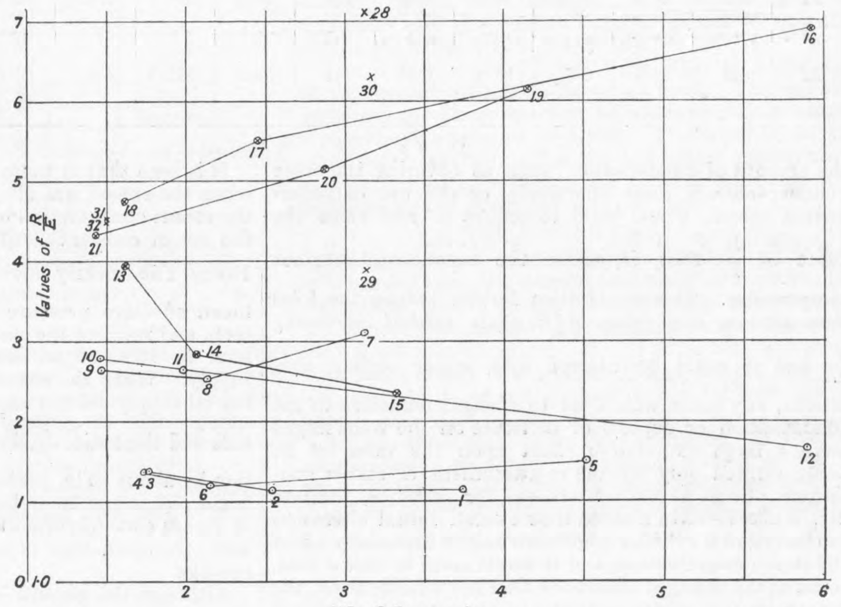
To the same scale the total heat rejected per unit area of clearance surface $= \frac{E}{\omega} \times (\text{area } D_2\,C\,D_3)$

When no steam jackets are used, and steady conditions are attained in the cylinder, the total heat received by the wall surface from the steam will be nearly equal to that rejected by the same surface to the steam, any difference being due to conduction and external heat losses, which are practically negligible in most ordinary cylinders compared to the amount of heat alternately stored and rejected. Therefore, in this case, $\frac{R}{\omega} \times (\text{area } D_1\,B\,D_2) = \frac{E}{\omega} \times (\text{area } D_2\,C\,D_3)$

$$\text{or } \frac{R}{E} = \frac{(\text{area } D_2\,C\,D_3)}{(\text{area } D_1\,B\,D_2)} \quad . \ . \ . \ . \ . \ (4)$$

If $R = E$, then area $D_2\,C\,D_3$ = area $D_1\,B\,D_2$, which would mean that the average or mean clearance surface temperature would be the same as the mean temperature of the steam in the cylinder. Again, if $R > E$, then area $D_2\,C\,D_3$ > area $D_1\,B\,D_2$, which means that the mean wall surface temperature would be greater than the mean steam temperature. Similarly, if $R < E$, the area $D_2\,C\,D_3$ < area $D_1\,B\,D_2$ and the mean wall temperature would be less than the mean temperature of the steam.

It is now desirable to demonstrate the possibility of R and E being equal, and the only cases of which the writer has knowledge where this equality has been attained have occurred on small engines with the cylinder not too well covered, but no serious error is involved by assuming that the total heat reception and the total heat emission of the clearance surface walls are equal in all cases where there is no steam jacket in operation. Messrs. Callendar and Nicolson* seem to have been the first experimenters to show that the mean clearance surface temperature could be the same as the mean temperature of the cylinder steam, and they considered that this would give the maximum or limiting amount of condensation. The late Mr. Bryan Donkin made a large number of experiments—"Proceedings," Institution of Civil Engineers, Vol. cxv.—on specially constructed cast iron, phosphor bronze, and other cylinders, about 3in. long, 2in. and 5½in. internal diameter, into which he admitted steam at about 60 lb. per square inch absolute and exhausted into a surface condenser at the rate of about 35 complete cycles per minute. He inserted mercury thermometers at various positions in the metal of the cylinder so as to measure the mean temperature of the wall. On the assumption that the surface temperature fluctuation would not materially affect the ratio $\frac{R}{E}$, the writer found that four of Mr. Donkin's tests gave values for this ratio in the neighbourhood of unity.



The Engineer Swain Sc.

Fig. 2

During the last winter session the writer made a number of experiments at the Glasgow and West of Scotland Technical College on a 6¼in. by 12in. stroke single-cylinder steam engine, having Meyer cut-off valves and running at about 100 revolutions per minute. The steam chest pressure was constant at about 45 lb. per square inch gauge, and the back pressure atmospheric. The values of $\frac{R}{E}$ obtained for the cover end of the cylinder are shown plotted on a number of expansions base in Fig. 2, the numbers in the figure referring to the test number. During the tests 1 to 12 the cylinder covers were bare, but the remainder were made with the cylinder ends covered with ½in. thick asbestos cement. Also, the tests were made in sets of three, each set on a different day. that is, Nos. 1, 2, 3, were made on one day, Nos. 4, 5, 6, on another day, and so on. It will be noticed that the tests 1 to 6 give values of $\frac{R}{E}$ slightly greater than unity, but the subsequent tests 6 to 12 show higher values, except that No. 12 value seems to agree better with tests 1 to 6. Nos. 13 to 21, with the cylinder ends covered, also show very discordant results, as each set of three tests appears to be quite different from any other set, though at late cut-offs the discrepancies are the least serious. These variations could hardly have been caused by thermometer errors in measuring the mean wall temperature, because the steam consumption was generally found to vary in a corresponding degree, that is, for any particular cut-off, the higher the mean wall temperature and the value $\frac{R}{E}$, the lower was the steam consumption. The probable reasons for these discrepancies will be discussed later.

In all the engine tests with which the writer is acquainted, where the cylinders were well covered, and in which the mean cylinder end temperatures have been measured, the values of $\frac{R}{E}$ were much greater than unity, that is, the mean clearance surface wall temperatures were much higher than the time mean steam temperature in the cylinder. Table I. gives representative values obtained from experiments made by Dr. Mellanby—"Proceedings" Inst. Mech. Eng., June, 1905—on a condensing cross compound engine with cylinder diameters 11½in. and 20in., stroke 36in., running at about 60 revolutions per minute. The high-pressure cylinder gives fairly high values of $\frac{R}{E}$, whilst moderate values are obtained from the low-pressure cylinder.

Table I.

No. of test.	No. of expansions.	Ratio $\frac{R}{E}$. Cover end.		Remarks.
		H.P. cylinder.	L.P. cylinder.	
100	8·1	7·6	3·75	No jackets in use
108	25·0	15·5	2·8	,, ,,

It has sometimes been assumed that the mean wall temperature of the clearance surface could not be lower than the mean temperature of the cylinder steam, unless there could happen to be an excessive external loss of heat. If this were true it would mean that the ratio $\frac{R}{E}$ could not be less than unity. The only experiments known to the writer, where $\frac{R}{E}$ was apparently less than unity, are some of Mr. Donkin's previously quoted. Three of these tests gave values less than unity, the lowest being 0.41.

The results of the tests so far quoted show how great the differences may be between one engine and another as regards the internal cylinder conditions, and even in the same engine at different times. All other conditions equal, the higher the mean wall temperature the higher is the value of $\frac{R}{E}$ and the lower the steam consumption, and a careful consideration of the preceding values of $\frac{R}{E}$ which have been given leads to several important conclusions. In the first place, when the value of $\frac{R}{E}$ is near unity, it may be inferred that the conditions at the surface of the clearance wall during the period of heat emission must be very similar to the condition during the period of heat reception, and as it is certain that the wall surface will be in a condition of wetness during practically the whole period of heat reception, under these circumstances it is reasonable to assume that the walls would be in a like condition during practically the whole period of emission, from which it would follow that the clearance wall surface would probably be more or less wet during the whole cycle. Moreover, if this is accepted as a reasonable assumption for the condition of the walls when R was about equal to E, it becomes easy to explain why the value of $\frac{R}{E}$ is generally greater than unity, for it is well known, and has been proved by various experimenters, that the emissivity of a dry wall in contact with steam is very small compared to that of a wet wall. Since the wall would be more or less wet during the period of condensation, the value of R is not likely to be much different, whether $\frac{R}{E}$ was large or had a value nearly unity; but if the moisture on the wall happened to be re-evaporated before the next steam admission point was reached, the emissivity after the walls become what could be called dry would be very small, and would thus reduce the value of E accordingly. Therefore, it is quite reasonable to expect that when $\frac{R}{E}$ is much greater than unity, the cause of this is the reduced value of E due to the walls becoming practically dry before the exhaust period is completed. Further, if it was found that the clearance surface of any particular cylinder had a value $\frac{R}{E}$ in the neighbourhood of unity, then it is probable that any small influence which slightly reduced the amount of condensation, such as covering the outer cylinder surface more effectively, or the use of superheated steam, would tend to reduce E and raise the value of $\frac{R}{E}$; that is, raise the mean wall surface temperature. This would then further reduce the total condensation and value of E, again further increasing $\frac{R}{E}$; and it could be inferred that, under certain conditions, any cause which led to a slight reduction in the condensation or deposit of moisture on the walls might have a large cumulative effect upon the value of E, being limited only by the re-attainment of stable conditions. Some experimenters—as, for instance, the late Mr. Willans—have noticed that a small initial alteration in the internal cylinder conditions might materially affect the steam consumption, and it would seem to follow that, so far as the changed conditions alter the condensation, the reason for this is the sensitive and cumulative nature of the average emissivity E.

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* Cotterill's "Steam Engine."

* "Proceedings," Institution of Civil Engineers, Vol. cxxxi., 1897-98, Part I.

Although the writer is not acquainted with any steam engine tests where the value of $\frac{R}{E}$ was less than unity, evidence of the possibility of this has been adduced from Mr. Donkin's tests on the small pistonless cylinders, and it would appear that the conditions most favourable to the production of such low values of $\frac{R}{E}$ are an excessive amount of moisture entering with the steam and depositing on the cylinder walls, and an excessive loss of heat from the cylinder by conduction and radiation. If the steam as it entered the cylinder had more than an ordinary proportion of wetness, it is quite likely that the excessive deposit of such moisture on the walls would not only prevent complete re-evaporation, but a portion of such moisture would probably be swept off the walls when the rush of steam occurred at the opening of the exhaust valve. This would tend to reduce the average thickness of the water deposit for the remainder of the exhaust period when compared to the average thickness during the steam admission period, and so cause the value of E to be greater than that of R, thus tending to produce a value for $\frac{R}{E}$ less than unity.

When speaking of a film of water as being deposited on a wall by condensation, it should be borne in mind that the common experience of experimenters on the phenomena of condensation is that such condensation does not generally occur as a film of uniform thickness, but as apparently isolated drops of water of various dimensions, which may or may not run together to form larger drops.

Other important factors which influence the receptivity and emissivity of metal walls are the condition of the receiving or emitting surface and the velocity of the steam relatively to that surface. To illustrate the influence of the surface conditions, the writer has recently made a series of special tests on the small single-cylinder engine previously referred to. The noticeable feature of the tests there quoted was the discrepancies which occurred on different days, as regards steam consumption, wall temperature, and the value of $\frac{R}{E}$. The writer was at first inclined to the opinion that the cause could be attributed to slight variations of the wetness in the steam, even though the throttling calorimeter in the steam pipe did not indicate any variations of much importance; but the special experiments mentioned above indicate that the principal cause for these discrepancies must have been the differences in the cylinder oiling conditions on different days. During the ordinary tests Nos. 1 to 21—Fig. 1—there were no special valve or piston oiling arrangements in operation, but the valve rods and piston-rod were oiled periodically just as might be thought necessary for the running of the engine. During the special tests a screw-down lubricator was put into communication with the steam chest when required to supply oil over the top of the valve, being driven from the valve rod, but no oil was used on the valve or piston-rods except when definitely arranged for. Also the steam chest drain was always kept partially open to the atmosphere to drain away any accumulation of water in the chest. The results of five of these tests are given in Table II. to illustrate their general nature.

TABLE II.

No. of test.	Duration of test.	Steam pressure. Lb. per sq. in. gauge.	Back pressure above atmos. Lb. per sq. in.	Average M.E.P. Lb. per sq. in.	I.H.P. at 100 revolutions per minute.	Total steam per hour at 100 revolutions per minute.	Steam per I.H.P. per hour.	Cover end clearance surface. Temp. Fah.	Ratio $\frac{R}{E}$	Cut-off per cent. of stroke.	REMARKS.
	min.					lb.	lb.				
28	30	44·7	−0·1	25·8	4·69	252	53·8	266·5	7·62	32·0	Engine oiled before starting in usual manner and kept running for about one hour before start of test. Half an hour after start of test wall temperature began to fall and steam consumption to rise.
29	30	44·6	0·3	23·75	4·31	277	64·2	255·6	3·84	32·0	Between end of test 28 and beginning of test 29, required about three-quarters of an hour to get steady conditions, and at the end of this trial the steam chest lubricator was put into action.
30	40	45·2	0·2	25·1	4·54	218·5	54·8	264·5	6·3	32·0	Steam chest lubricator in operation. Required about 15 minutes to get uniform readings after oil was thus put on.
31	100	44·9	0·75	36·7	6·66	403	60·5	271·5	4·52	66·0	Engine was started without any oiling whatever, and was kept running for over one hour before start of test. During the test there was no particular change in the wall temperature or the steam consumption.
32	40	44·4	0·7	36·2	6·58	384	58·5	271·3	4·5	66·0	At the end of the test 31 the lubricator was put into action, but there was practically no change in the wall temperature.

It is seen that in these special tests the supply of oil when the cut-off was 32 per cent. of the stroke reduced the steam consumption by about 28 lb. per hour, increased the mean clearance surface wall temperature by about 10 deg. Fah., nearly doubled the value $\frac{R}{E}$, increased the mean effective pressure by 1.0 lb. to 1.5 lb. per square inch, and reduced the steam per indicated horse-power per hour by 15 to 16 per cent. of that obtained without oil supply. When the cut-off was 66 per cent. of the stroke, the oil supply did not appear to affect the wall temperature and the ratio $\frac{R}{E}$, but reduced the steam consumption by about 19 lb. per hour, and the steam per indicated horse-power per hour by 3 or 4 per cent. The decrease of steam consumption due to the supply of oil represents both the reduction of condensation and that of steam leakage.

Although the general effect of the oil supply in reducing the steam consumption has been long known to several engineers, this influence seems to have been almost entirely ignored when discussions on the theory of the steam engine have arisen. The results just quoted show the possibility of considerable variations in the steam consumption, especially at early cut-offs. It is evident that, whatever the influence of a deposit of oil on the walls may have on the individual values of R and E, the results of these tests show that it probably makes a greater proportionate reduction in the value of E than of R at early cut-offs, but affects both values in equal proportion at late cut-offs. Fig. 1 also gives evidence that the oil supply may not materially influence the wall temperature and the value of $\frac{R}{E}$ at late cut-offs, when it is noticed how the tests 13, 18, 21, 31, 32, are grouped near together. It is quite certain that the discrepancies in the tests 1 to 12, and in the tests 13 to 21 were principally due to variations in the oiling conditions of the engine on different days.

The writer has not yet had an opportunity of testing the influence of the oil supply on larger engines, but if these results are generally true as regards other engines, it could be easily explained why most engineers have not recognised the influence of the oil supply. For example, marine engines on ocean-going steamers are generally operated with a minimum supply of cylinder oil, in some cases practically running without cylinder oil supply during a whole voyage, and as the engines usually work with a comparatively late cut-off in all the cylinders, the influence of oil on the steam consumption will have escaped particular notice if it does not exceed the 3 or 4 per cent. above mentioned. Again, land engines are seldom run without cylinder oil supply, and although a comparatively early cut-off is generally adopted in the high-pressure cylinder, no extensive comparison appears to have been made between cylinder oil supply and no oil conditions, so far as it affects the steam consumption, with the result that the important influence of oil may have escaped general notice. At any rate the above results show how important it might be, both in the commercial and in the scientific testing of steam engines, that the conditions as regards the cylinder oil supply should be clearly specified, and that the tests should be made in accordance with such specifications.

Both theory and experiment show that the value of the receptivity and the emissivity of a surface in contact with steam depend to some extent upon the velocity of the steam relatively to the surface, but no exact determination has yet been made which could be applied to the steam engine. It is known, however, that increased steam velocity tends to increase the value of the receptivity of the wall surface.

In conclusion, the writer would emphasise the necessity and the importance of the experimental determination of the actual values of R and E in steam engine cylinders, which could only be obtained by special apparatus that would imitate the conditions in an engine cylinder, both as regards the condition of the surfaces and the relative velocities of the steam over these surfaces. The results of experiments under uniform conditions such as occur in surface condensers cannot be successfully applied to the steam engine problem.

The influence of the cylinder barrel surface on the steam condensation is generally recognised as being comparatively small compared to that of the clearance surfaces, so that no useful purpose would at present be served by continuing the discussion in this direction.

IRRIGATION WORKS OF THE UNITED STATES GOVERNMENT.

No. IV.*

THE water supply for the irrigation districts described in the previous articles is obtained from great reservoirs formed by closing deep mountain canyons with masonry dams. In the present article we shall deal with districts supplied by pumping from rivers or from wells which tap underground sources.

THE HUNTLEY DISTRICT.

The Huntley District, along the Yellowstone River, in Montana, has an area of 33,000 acres, at an average elevation of 3000ft. above sea level. It was thrown open to settlement about two years ago, when the irrigation works were completed, being before that a tract of virgin soil which, for lack of sufficient water, had never produced anything but desert sage-bush and bunch grass. It is divided mainly into farms of about forty acres. Cereals, alfalfa, and small fruit are grown, and there is a large area growing beetroot for a large beet sugar factory some twelve miles distant. The district has special facilities for marketing its product, in that it is crossed by two lines of railway and has eight new towns.

The main canal heads directly from the river, without any diverting dam, and extends for a distance of about 30 miles. It has a capacity of 750 cubic feet per second, of which 500ft. is for irrigation and the balance for domestic use, pumping, &c. It is 13ft. wide on the bottom, 9ft. deep, with side slopes of ½ to 1, and has a concrete lining 10in. thick for a considerable part of the distance. Fig. 26 is a view of the newly completed canal in flat land, and shows one of the new farms. Fig. 28 is a section of the canal in side-hill ground.

There are three tunnels on the canal: 1200ft., 600ft., and 400ft. long. They are mainly in hard sandstone. They are 9½ft. wide and 9ft. high, with a roof of 5ft. radius. They were driven partly by hand drills, but mainly by Jeffrey hand-boring machines. Each heading had two of these machines, with three men to each machine. No timbering was required, except in a few places, but the tunnels are lined throughout with 8in. of concrete. The floor is flat, and the sides are vertical. Fig. 29 shows the tunnel section.

The forms or moulds for the concreting consisted of planks supported by transverse frames of old 12 lb. flange rails bent to shape. The feet of the rails were turned inward to rest on transverse floor timbers or sills. The planks for the side forms were first put in place, and a platform erected 4ft. above the floor. The concrete trucks, of 7 cubic feet capacity, were run on this, and the concrete discharged into the sides. In the upper part the concrete was discharged into pans, and thence thrown into place with shovels. The forms were left in place for three days. When they were removed, any voids were plastered with mortar to a level surface, and the entire surface then given a coat of cement wash with a brush.

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* No. III. appeared October 1st.

IRRIGATION WORKS IN THE UNITED STATES

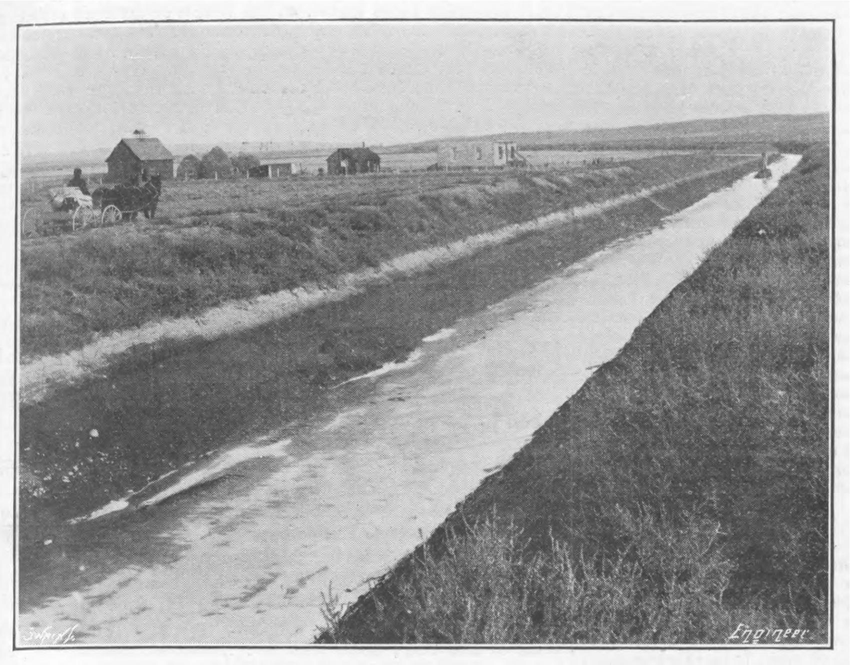

Fig. 26—MAIN CANAL, HUNTLEY IRRIGATION DISTRICT

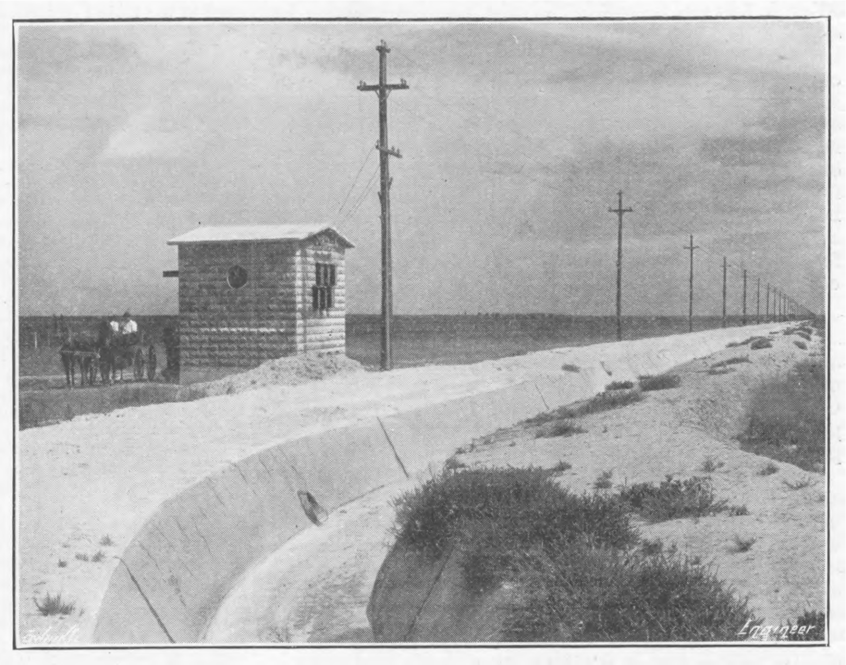

Fig. 26—ELECTRIC PUMPING STATION AND CONDUIT

The concrete was composed of 1 part Portland cement to 2½ parts sand and 5½ parts gravel crushed, and screened to a 1in. size. It was mixed by machine, and made as a very wet mixture.

A special feature of this district is an auxiliary pumping system. About 28,000 acres are supplied with water by gravity flow from the canal, but the remaining 5000 acres are at an elevation above the level of the main plateau. The main canal has a drop of 33½ft. at one point, in order to avoid excessive gradients with consequent high velocities. This drop is used as a means of developing power for pumping water to a high-level canal serving the 5000 acres. At this drop, the main canal ends in a concrete forebay, from which two 62in. pressure pipes, 220ft. long, lead to the pumping station. There is also a 42in. by-pass pipe directly connecting the upper and lower reaches of the main canal. The pipes are all of armoured concrete, 9in. thick. The pumping station is a concrete building, 30ft. by 14ft., with two pumping units. The energy developed is about 600 horse-power, and 240 cubic feet of water per second are delivered to the turbines and pumps.

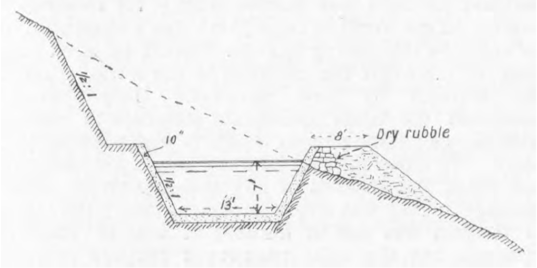

Fig. 28—SECTION OF MAIN CANAL

The arrangement of the pumping machinery is shown in Fig. 30. A 5ft. steel pipe extension of the concrete pressure pipe enters a large steel chamber, in the bottom of which is a vertical shaft turbine of the inward-downward flow type, the draught tube discharging into the lower reach of the canal. The vertical shaft extends up through the top of the chamber, and carries the runner of a horizontal centrifugal pump of the upward-outward flow type, the suction of which opens into the chamber. There is a head of 33½ft. for the turbine, of which 26½ft. is pressure head, and 7ft. is the draught tube head. The pump lift is 48½ft. above the source of supply, or 68½ft. above the pumps.

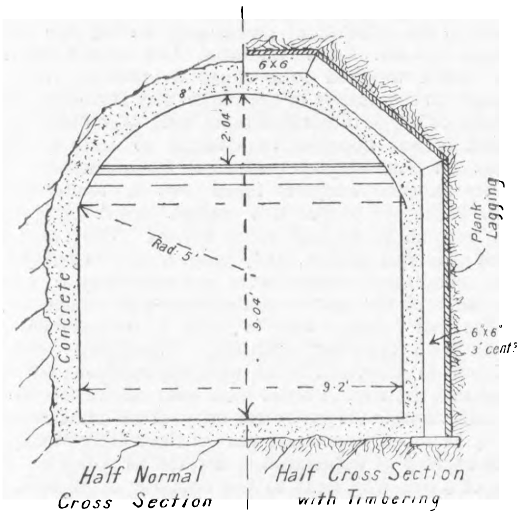

Fig. 29—SECTION OF TUNNEL

Each of the two pumps has a capacity of 28 cubic feet per second. Their discharge pipes deliver the water into an armoured concrete conduit, 9in. thick, and 1385ft. long, which extends to the high-level canal.

THE WILLISTON DISTRICT.

The Williston District is one of three districts in North Dakota in which water for irrigation is pumped from the Missouri River to canals serving table lands at a higher elevation. On the Government lands near Williston there are large deposits of lignite, and the Reclamation Service has established a mine whose entry is only 1500ft. from a steam-driven electric generating station. The current is distributed by transmission lines to eight pumping plants near the heads of the main high-level canals, and a future capacity of 5000 kilowatts is provided for.

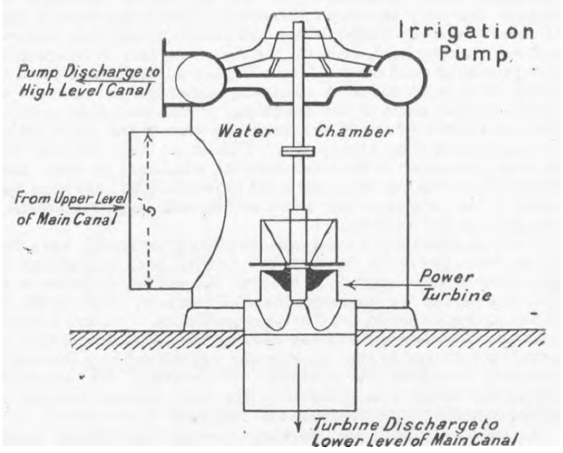
Irrigation Pump
Pump Discharge to High Level Canal
Water Chamber
From Upper Level of Main Canal
5'
Power Turbine
Turbine Discharge to Lower Level of Main Canal

Fig. 30—PUMP ARRANGEMENT

Owing to the character of the banks and the shifting channels of the river, it was deemed inadvisable to construct permanent intake pumping stations, and the pumping plants are therefore mounted on large barges which are moored in the river, and can be moved according to variations in the channel and the water level. The motor-driven pumps are enclosed in a large deck-house, and the transmission wires are led to the end of a horizontal pole or boom projecting from the top of the river bank. This boom can be thrust out or withdrawn by a ratchet mechanism, according as the barge is moored near the bank or farther out in the stream. This arrangement is shown in Fig. 31. The barges are hauled out of the water for the winter on account of ice jams.

The pumps have flexible connections from their discharge ends to the shore pipes, so as to allow for variations in water level. The shore pipes terminate at settling basins about 28ft. above the river. These are provided to remove the enormous quantities of silt carried by the river water. From the basins the water is pumped into the main canals, the velocity of flow in which is about 1½ft. to 2ft. per second.

A gravity canal, three miles long, serves about 500 acres directly, and supplies three pumping stations which force the water through pressure pipes to canals serving about 6500 acres of land at higher levels.

The Williston district has from 8000 to 12,000 acres at an elevation of 1900ft. above sea level. The soil of the bottom lands along the river is a heavy clay, containing a considerable amount of alkali. The upper lands, however, which are served by the irrigation canals, have a rich sandy loam, requiring for farming purposes about two acre-feet of water per acre per year.

THE BUFORD DISTRICT.

This is adjacent to the Williston district, and is served in the same way, the current being carried from the same generating station to the floating pumping station by a 22,000-volt transmission line 28 miles long. The pumps have a combined capacity of 150 cubic feet per second, with an average lift of 28ft. They deliver the water into large tanks or settling basins, not far from the river bank.

A main canal eight miles long leads from the basin and serves about 5000 acres. A pumping station 600ft. from the river takes water from the basin and forces it through 2700ft. of a 48in. reinforced concrete conduit to the head of another eight-mile canal, serving a tract of 8000 acres at a higher level. The total pumping lift from low-water level is 85ft., and the pumps have a capacity of 75 cubic feet per second. All the pump motors are driven by three-phase 2000-volt current, transformed from the

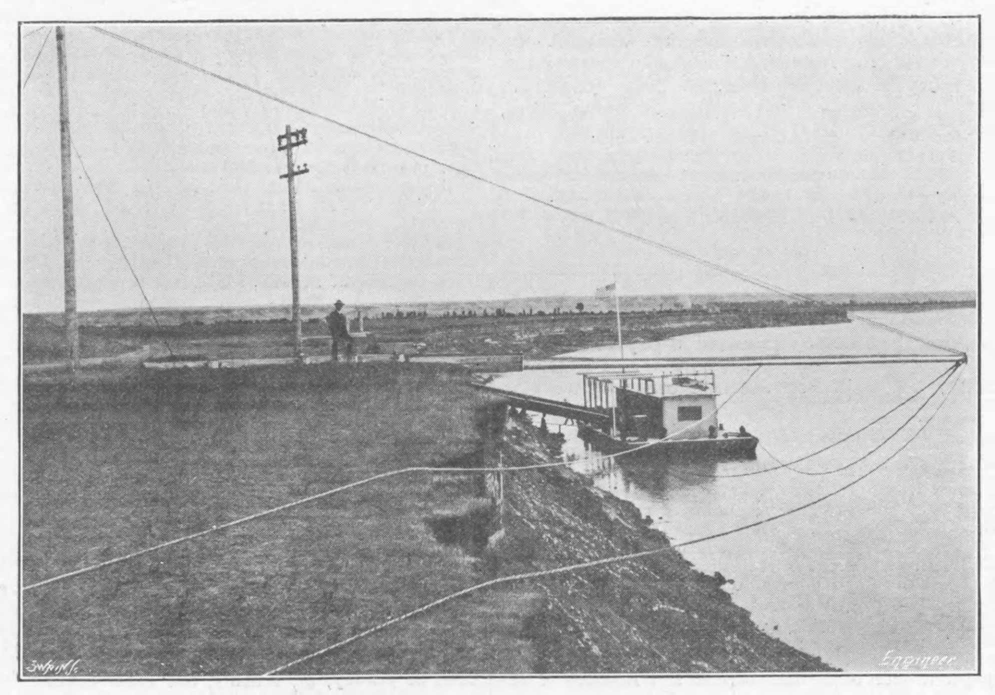

Fig. 31—FLOATING IRRIGATION PUMPING PLANT

22,000-volt transmission current by three 300-kilowatt transformers placed in the permanent pumping station.

The floating intake pumping station has four three-phase 60-cycle 2000-volt induction motors, each directly connected to a centrifugal pump having a capacity of 30 cubic feet per second. The land pumping station has a similar equipment, except that two of the motors are of the synchronous type, and the pumps are of 16 cubic feet capacity per second. The pumping head of the intake station varies with the stage of water in the river, but averages 28ft. To meet this varying condition, the frequency of the power transmission system is varied by changing the speed of the generating units. The normal frequency is 60 cycles for the average head of 28ft.; for heads above or below this the frequency is adjusted within a range of 10 per cent. above or below normal. The four units in the land station operate under a practically constant head of 50ft.

THE GARDEN CITY DISTRICT.

The Garden City irrigation district in Kansas has an area of only 10,000 acres, but is of special interest in that underground waters are utilised for irrigation. This Government work, indeed, is serving as an example for private irrigation schemes in other parts of the great plains where underground waters are to be found.

The district is in the valley of the Arkansas River, about 2925ft. above sea level, but the river flow is very unreliable, and could not be depended upon to supply water to the gravity canals. In time of drought the river is practically dry. The average rainfall is 20in., but it is all absorbed, and there is no run-off. When the water is high enough it is diverted into the headworks of the canals, but when the level falls the head gates are closed and recourse is had to pumping the underground water.

To tap the underground flow for this district the engineers have driven about 300 wells, 6in. to 16in. diameter, with an average depth of about 75ft. They are arranged in groups of ten to twelve wells, and each group has its own electric pumping plant, operated by current transmitted by wire from a central generating station. Suction pipes lead to the wells, and the pumps deliver the water into a concrete-lined open conduit leading to the main canal. Fig. 27 shows one of the twenty-three pumping stations, with the conduit and electric line. The building is constructed of concrete blocks.

These pumping stations are about 1000ft. apart along the conduit, which is 23,000ft. long. Ten of them are on the opposite side of the river, connection with the conduit being made by an inverted syphon built of concrete. The capacity of the pumping plants during the irrigation season is 11 billion gallons, or 30,000 acre-feet.

The generating station has two De Laval turbo generators of 225 kilowatts each, 6600 volts, 60 cycle, three-phase. There is an exciter directly connected to the shaft of each generator. The turbines are designed to operate with 150 lb. steam pressure at the regulator, 100 deg. of superheat and 28in. of vacuum. They are equipped with an automatic lubricating system for supplying, returning, and filtering the oil. Steam is supplied by two Stirling water-tube boilers of 200 horse-power each, working under 160 lb. pressure, and each equipped with a superheater which superheats the steam to 120 deg. Fah. There are two surface condensers with Edwards air pumps, and each condenser can take care of 5200 lb. per hour, maintaining a vacuum of 1½in. absolute, with cooling water at 65 deg. The switchboard has two panels for the generators, two for line service, and one for the exciters. The first four have the switches which control the oil switches, which are placed in the cellar.

There has been some trouble with the water supply first encountered, and some of the wells have shown a decreasing supply. Although used only in the dry part of the season, it is possible that the draught for irrigation purposes may exceed the supply. A test well is being sunk, therefore, to greater depths. This struck a flow of water of 225ft., rising to within 14ft. of the surface, but the quantity was insufficient, and the well is being carried to a greater depth.

The Government work has given an impetus to the installation of individual well-pumping systems by private enterprise in the neighbourhood, where water is found at depths of from 10ft. to 20ft. Many of these plants have petrol engines of 10 to 15 horse-power, and deliver from 500 to 1000 gallons per minute.

IRON AND STEEL INSTITUTE.

No. III.*

There was a good attendance when the President took the chair at the third day's meeting in the hall of the Institution of Civil Engineers, on Thursday, the 30th ult.

Mr. R. Price Williams submitted a paper on "The Serviceable Life and Cost of Renewals of Permanent Way of British Railways," an abstract of which we give below.

The Serviceable Life and Cost of Renewals of Permanent Way of British Railways.

According to the Board of Trade Railway Returns (1907) there are, roundly speaking, a little over 23,000 miles of railway open for traffic in the United Kingdom, of which about 13,500 miles consist of double and more lines, and about 10,250 miles of single lines, besides which there are 14,000 miles of sidings. The total annual cost of the maintenance and renewal of the permanent way and works amounted to roundly eleven millions sterling, nearly 15 per cent. of the entire working expenses, which have now and for some years past reached the exceptionally high figure of nearly two-thirds (63 per cent.) of the entire railway gross receipts.

In this paper the cost of the maintenance and renewals of the permanent way of fifteen of the principal British railways, having an aggregate of 15,184 miles of railway—equivalent to about 80 per cent. of the total mileage of the railways in Great Britain—will alone be dealt with, particulars of which expenditure have been furnished during the last ten years in some valuable tables in the C Appendix to the Board of Trade Returns. From these have been obtained the data from which the results in Table V. in the appendix have been compiled, giving in the case of each of these fifteen railways the expenditure in each year in wages and material in the renewals of the permanent way, and also the average annual cost of renewal in terms per mile of railway considered—as a railway must necessarily be, whether a double or single line—as a thoroughfare for the conveyance of railway traffic. From a reference to the table in question, it will be seen that the average cost of renewals per mile varies from an average maximum of £418.18 per mile during the ten years, in the case of the London, Brighton and South Coast Railway, to a minimum of £190.80 per mile in the case of the North British; while the tonnage of goods and minerals per mile in the latter case is just double that of the London, Brighton, and South Coast. In another case, that of the Lancashire and Yorkshire Railway, with a maximum tonnage of 41,678 tons per mile of goods and mineral traffic, the average annual cost of renewals is only £291.07 per mile, very little above the average. Again, in the case of the London and North-Western, with the large tonnage of goods and minerals of 26,493 tons per mile, the average cost of renewals is as much as £335.95 per mile, as compared with the North-Eastern Company's average of only £236.26 per mile, with its heavy tonnage of 36,004 tons per mile of goods and minerals. Next comes the London and South-Western, with its average cost of renewals much above the average—namely, £319.47 per mile, with the smallest average of 6735 tons per mile. It is clear, therefore, that we must look for something more than the mere weight of tonnage to account for the exceptionally large cost of renewals of the permanent way of some of the British railways, and there is everything to indicate that it is mainly due to the greatly increased weight and speed of the passenger traffic which has occurred since the introduction of the better and much more durable material of steel rails, and partly to the increased weight and speed of the goods and mineral traffic.

In this connection it will be as well to advert to the cost of the maintenance and renewal of the permanent way at the period almost immediately preceding the first introduction of Bessemer steel rails in the early sixties. The total cost of the renewal of these nine principal railways with iron rails during the eighteen and a-half years prior to 1865, with an average aggregate of 3401 miles of way, during that period only amounted to £5,796,135, and to an average of £170.40 per mile of way. It rapidly increased during the first ten years, after the first partial introduction of steel rails, to £285.53 per mile, partly owing, no doubt, to the high price then of steel rails. Notwithstanding the great subsequent reduction in the price of steel rails to a lower figure than even the best iron rails, the expenditure in the renewal of way on these nine principal railways has, however, now reached an amount of £28,101,881, and £314.66 per mile of railway, during the short space of the last ten years—a fivefold increase in amount and now double the cost per mile in renewals—the mileage of these nine railways having increased from 3401 to 8930.

While the mileage during the last forty-seven years has only a little more than doubled, the working expenses have increased nearly sixfold, the number of passengers carried has increased nearly sevenfold, the tonnage of goods and minerals carried has increased nearly fivefold, while the number of carriages and wagons has only increased threefold. This exceptionally rapid increase of railway traffic during the period in question, however, was never anticipated, even by the most sanguine believers in the new process of steel making, including the author himself, and the effect of it is, it must be admitted, somewhat to discredit the estimates then made of the capability of the steel rails enduring the destructive effects of the wear and tear of the traffic for the long periods of time anticipated. This in no way detracts from the high character of the steel material, which has at least maintained all its fine qualities, and great improvements have since been made in the process of the manufacture, and large reductions in the price of the material.

The manufacturers of steel rails, to their great credit, have done all in their power to improve the quality and to increase the durability of the material; it behoves the railway engineer to see that this part of the business is carefully seen to. The result will, in the author's opinion, lead to large economies. No one, however, with any experience of railway working but must admit that the principal railways in this country are maintained in a thoroughly standard condition of efficiency for working the constantly increasing traffic, as is testified by the large annual amount per mile expended on maintenance and renewals.

As already stated, the working expenses of railways in the United Kingdom have now reached the exceptionally high average of nearly two-thirds of the gross receipts, whereas in 1860, the date immediately preceding the introduction of the Bessemer steel rail, the working expenses only amounted to 47 per cent. of the gross receipts, and during the previous twenty years which the author can recall, they had scarcely ever exceeded what in nearly all other great and well administered commercial undertakings is regarded as the requisite normal expenditure of 50 per cent. It is not the purpose, however, of this paper to deal with this aspect of the question, but it is as well to bear in mind that nearly two-thirds of the total working expenses of these British railways have exclusive relation to the great iron and steel industries which supply most of the material required not only for the permanent way, but for the locomotive stock and large portions of the material of the carriage and wagon stock.

The permanent way does not comprise merely the steel rails, sleepers, cast iron chairs, points, crossings, and ballast, involving only an annual charge for their maintenance and renewal, but all that is essential to ensure safety and security in the conveyance of passenger and other traffic, the renewal of which, although indisputably constituting the main source of the permanent way working expenses, includes also the renewals or partial renewals rendered necessary by the natural decay of the "works of line," and other structures at much more distant periods, and the variations in periods for complete renewal, inclusive of the variations in the serviceable life of steel rails on different portions of the permanent way, render it impossible to determine the serviceable life of the permanent way except in its entirety and considered as a whole. Considered, however, in that sense, the average annual expenditure in maintenance and renewals of the permanent way, in terms per mile of railway, whether it consists of double or single lines, during a sufficiently long period of years, is in reality the real equivalent of the annual death-rate of all classes of the perishable materials which constitute the permanent way of any railway. By way of illustration a period of thirty years may be fixed as a sufficient interval of time to obtain average and reliable results of the destructive effects of the wear and tear of traffic, and of the natural decay and exceptional causes necessitating complete renewal of the materials of all kinds.

All that is required with the data now available of the actual annual expenditure per mile of railway of these fifteen railways during the past long period of years in question, taking thirty years as a definite and reasonable maximum limit of serviceable life of all classes of materials, subject to the destructive effects of wear and tear and of decay, is to multiply each year's annual cost of renewals per mile of railway by the past thirty years' fixed period, and to divide the total amount of renewals expenditure during the last ten years by it, and we get the equivalent number of miles of railway—whether double lines or more, or partly double or single, or exclusively single lines—of each of the fifteen railways. In the aggregate this amounts in the ten years to 5039 miles of railway, or, roundly, 504 miles annually, which have become worn out and have been replaced in most, if not all, cases with stronger and better materials, and as the traffic on these railways is still rapidly increasing, it may be satisfactory to the steel rail manufacturers in this country to know that at least that quantity of worn-out steel rails will have to be simultaneously renewed during a similar period in the future.

The late Sir John Hawkshaw, during the discussion on the author's paper in 1866 referred to, admitted that the improvements in the permanent way had not kept pace with the requirements of the rapid growth of railway traffic. It has since certainly been greatly improved and better maintained, and renewed with stronger and better materials; but on those portions of the main lines where there are junctions, and at all intermediate stations over which trains pass at high speeds without stopping, there are the knife-edged facing points and the main-line rail crossings, more especially those known as the obtuse or diamond crossings, at all of which there is a gap in the main-line rail, and they are all of the primitive types of crossing and switches as at the time Sir John Hawkshaw alluded to the permanent way in 1866. A method has been devised for dispensing with the gaps in the main lines and of rolling much stronger and larger and tapered facing points, which have been highly approved of by eminent engineers, amongst others notably by the late Sir Benjamin Baker and Sir Alexander Rendel, and especially by the late Sir Henry Bessemer, and the only objection made is the greater expense, and that the present types can be more cheaply constructed. With railway expenses at nearly two-thirds of the gross railway revenue, economy is most desirable; but where risk of accident and danger to life can be avoided, saving of expense, as Sir John Hawkshaw said on the occasion referred to, is false economy, to say the very least of it.

The paper was accompanied by various tables and engravings.

Mr. T. Hurry Riches said that the author had made little allusion to a point of considerable importance, the change in the class of steel used for tires which had taken place during recent years. Neither had the author commented on the sectional profile of tires in comparison with past years. The formation of the tire flange and the cross section of the tire had a great influence upon the life of the rail, and it was an excellent thing that in recent practice closer attention had been given, and more co-ordination had arisen between the road engineer and the rolling stock engineer, with the view to securing greater harmony in the sections of wheel and rail. Beyond this there was another factor influencing the wear of the rail; that was the material increase in the tare weight of vehicles. The author justly pointed out that the number of vehicles used in proportion to the tonnage carried had decreased, but while the vehicles had increased in capacity they had also increased more than proportionately in weight. It was not only the paying, but the unpaying load which had to be taken into account in regard to the wear and tear of permanent way, and the paper had given railway engineers a good deal to think about. The wear and tear of permanent way was a vital problem for railways to-day, and he hoped that the ventilation of the subject by Mr. Williams would lead to fresh efforts to improve the bearing surfaces of rails and tires.

Sir Hugh Bell said that to those who manufactured rails the wear and tear of the rails was obviously a subject of great interest. In this country there was little prospect of any increase in railway mileage, and the demand for rails was almost wholly for renewals, but looking to the world at large there was a stupendous field. It would be interesting to know what it required year by year to maintain the railways of the world, apart from the demand by new railways. Unfortunately we possessed the most inadequate statistics in connection with railway management which it was possible to conceive. To illustrate that he need only draw attention to one point, the absence of any information of passenger tonnage. That was a very important item; the real point of interest was not of number of tons of goods or of minerals, but the total quantity of tonnage running on axles, passengers as well as goods and minerals.

The deadweight per ton of passengers carried was probably far more than the deadweight per ton of parcels, and, although he was not certain on the point, the deadweight per ton of passengers was probably far greater per pound of revenue than that of a mineral train. From the author's figures it appeared that while the railways carried 13 tons of goods and minerals per million inhabitants in 1907, the figure was only 4½ tons per million in 1860, adopting the census figures of 1861. The quantity of goods and minerals increased, therefore, threefold during that period. The number of passengers carried per head of population increased from eight in 1860 to thirty-one in 1907, a fourfold increase. The passenger traffic had further to be considered in the light of the improved accommodation provided in recent years, which appeared likely to culminate at no distant date in the provision of third-class sleepers. A study of the figures showed that British railways had not only had a fourfold increase in the number of passengers during the period reviewed by Mr. Price Williams, but carried them in trains which weighed four times as much. With all deference to the author of the paper, any statistics which lost sight of these important facts were absolutely valueless, and it was hopeless to attempt to draw any conclusions on the subject presented for discussion. To turn to another subject, there was a tendency for railway engineers to put tire makers under obligations which became more and more severe. The same was true of the rail maker, and, indeed, it was sought to impose conditions which were contradictory in terms, particularly in the matter of hardness and resistance, so that the rail maker had to hold a delicate balance between two opposed qualities. There had been no endeavour to ascertain what were the relations between the rail and the tire, in order that wear might be reduced to a minimum. It was the duty of all concerned to make that most important part of the rolling stock, the tire, as capable of withstanding service as possible. The failure of a tire was, next to the breaking of an axle, the most untoward thing which could happen in railway operation. He had taken an interest in providing rails of special hardness, and would like to know if any inquiry had been instituted as to whether this hard rail was detrimental to the tire. If the railway business of the country was to be carried on satisfactorily, it was incumbent upon those who were charged with the duty to see that it was carried on as cheaply as possible. He was afraid that those who proposed to hand over our railways to officials to whom the earning of a dividend would be a secondary consideration would have a bitter undeception. It was scarcely possible to conceive a subject of more vital interest to the country than the economical administration of railways, and certainly the

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* No. II. appeared October 8th.

Iron and Steel Institute could discuss no subject with more profit than that raised in the paper.

Mr. Watson (North-Eastern Railway), who discussed many of the points raised by the previous speaker, drew attention to the important influence of the change in the character of passenger traffic. In 1860 the third-class coach weighed 12 tons, and carried 60 passengers; at the present day the third-class corridor coach weighed 30 tons and had seating accommodation for 42 passengers. Another instance of the growing weight of vehicles was the modern sleeping coach, which weighed 35 tons and only carried ten passengers. The dead weights per passenger were much higher, and the fares lower, than in 1860, the cheaper fares applying particularly to long-distance traffic.

In traffic other than passenger, although there had been an increase in the weight of rolling stock, most railway companies had been able to reduce the ratio of dead-weight to paying load by the use of trucks of 20, 30, and 40 tons capacity. Another point to be noted was the much greater weight of locomotives in modern practice.

Prof. H. Louis said that attention had been directed in the paper to the accidents at Salisbury and at Shrewsbury, and reference was made to the necessity of having curves of greater radius in the interests of safety. That was a subject which had long occupied his attention. When railways were first constructed in this country the curves were laid as arcs of circles of true radius. Investigation of the subject, particularly on the Continent, had shown that the best form of curve to adopt in railway construction was one of gradually increasing radius. When a train passed on to a curve of definite radius there must be a shock experienced, but that could be overcome by having a curve of gradually increasing radius. The subject was one of some geometrical complexity, but during recent years curves had been laid upon this principle.

Mr. Price Williams, replying on the discussion, said he had no means of ascertaining the deadweight of passenger traffic. All the things which had been referred to, the weight of locomotives, the greater length and weight of passenger trains, only served to emphasise what he stated in the paper. There could be little doubt that with regard to railway administration there was a great deal yet to learn. The iron and steel industry was greatly interested in the reduction of the cost of conveyance, and yet railway companies were quite unable to say what it actually cost to carry a single ton of goods or minerals or passengers. A railway manager of one of the principal lines had pledged his reputation at the time of the passing of the Railway Rates Bill that it was impossible to say what it cost to carry a parcel or a ton of goods. He considered such a condition of affairs discreditable to a profession in which 63 per cent. of the expenses were concerned with engineering. In view of foreign competition every effort should be made to determine the cost of conveyance of goods on our railways. With regard to what had been said about curves, the accidents at Salisbury and Shrewsbury had shown the need for exercising very great care in the laying out of curves. He had been told by Robert Stephenson himself that the really true curve for a railway was a parabola.

The President proposed, and the meeting carried, a hearty vote of thanks to Mr. Price Williams for his paper on this important subject.

Mr. E Adamson then briefly presented his paper "Tests of Cast Iron," of which an abstract is given below.

Tests of Cast Iron.

The very great variations in the tests which have been obtained from cast iron from time to time, and the differences of opinion which exists as to the best methods of testing, determined the author to make the comparative tests which form the subject-matter of this paper. These tests were all carried out in actual foundry practice, the metal used being taken chiefly from the ordinary cylinder mixtures, which remained over and above what was required for the tests used in the ordinary shop work. The object of the tests was in no way to secure the highest possible results, but, if possible, to arrive at the differences in results under varying working conditions.

The author wishes to state his appreciation of the work of T. Turner, W. R. Johnson, West, Keep, and Outerbridge, on cast iron. Their results are all of much value in the intricate problems involved in the study of that material.

Tensile tests.—Nine boxes were used for casting the twenty-four tensile test bars and six transverse test bars from the one ladle. The tensile bars numbered 1 to 3 were cast to a diameter of $\frac{7}{8}$in., Nos. 4 to 6 to a diameter of $\frac{3}{4}$in., Nos. 7 to 9 to a diameter of $\frac{5}{8}$in., and Nos. 10 to 12 to a diameter of $\frac{1}{2}$in. The tensile bars from 13 to 24 inclusive were cast 1in. diameter, and were machined down to the same diameter as Nos. 1 to 12, and the six transverse test bars were then cast on edge at an angle of 22½ deg. The results of the tests obtained appear to indicate that the bars which have been machined give better results than those which have been tested as cast with the skin on. Twelve tensile test bars and four transverse test bars were cast from the same ladle, duplicating tests Nos. 13 to 24, in order to confirm if there were any special diameter of the turned bars which gave the highest results, but it would appear that the bars turned down to $\frac{3}{4}$in. to $\frac{1}{2}$in. show very little variation in the test per square inch. Five sets of bars—three tensiles and two transverse bars, each with the same percentage of silicon (the latter cast on edge at an angle of 22½ deg.)—were cast from the same ladle of metal as those already alluded to, but varying percentages of 50 per cent. ferro-silicon were added to each small ladle—taken from the larger ladle—in order to increase the percentages of silicon in the test bars. This was duplicated.

A number of the tensile tests on these samples showed flaws. The sound bars were all tested, and the average results taken as the mean of each set of bars. It was noticeable that in spite of the silicon being increased from 1.53 to 2 per cent. in the one case, and in the other from 1.3 to 1.86, the combined carbon showed practically no alteration. Contradictory results were obtained in the tests which, according to the author, point to some condition of the iron, apart from the analyses, which has a greater effect on the results of the tests. Also from the fact that the percentage of combined carbon has not been reduced in spite of the addition of one-third more silicon, it would further show that silicon alone is not the only factor in the conversion of combined carbon to graphite. One point is very clear, namely, that with the increase of silicon the crystals of the iron have also increased in size; but these are also affected by the cooling conditions which are independent of the analysis.

Transverse bending tests.—In the transverse tests it was noticed that whilst the breaking weight of the transverse test-bars showed a slight variation, when the latter were worked out on the exact section of the bar to the moment of resistance, there was very little variation in the tests obtained from those bars with increased percentages of silicon, whilst it was also shown that increasing amounts of silicon decreased the strength, which confirms the tensile tests in this respect. In this case, also, whilst the percentages of combined carbon were not very materially altered, the fractures in the 2in. by 1in. test bars showed increasing openness as the silicon increased from 1.30 to 2.00, the bars with the higher percentage showing the most open fracture.

In the tests obtained from the transverse test bars as cast and as machined, a great improvement in the strength of the machined bar was indicated. It has generally been assumed that the skin of the test bar increases the strength, but this investigation has proved quite the contrary, and results in actual practice since these tests were made have confirmed the results.

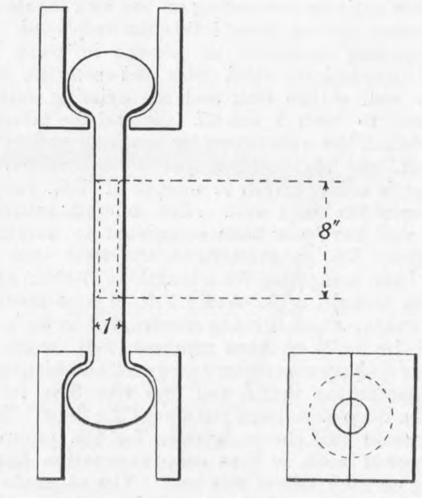
Whilst making these tests also it was thought desirable to see what position of the transverse test bar gave the best results. The bars in each moulding box were cast in a different position, namely, (*a*) cast flat with no inclination; (*b*) cast on edge with no inclination; and (*c*) cast on edge with an inclination of 3in. in 3ft. The results of tests do not show that there is any material difference in the bars cast on edge. It was shown by the author in May, 1906, in his paper read before the Institute, that the transverse test bar tested with the "fin" up—that is, the "fin" in compression and the lower part or sounder part in extension—invariably gave the best results.

Casting temperature.—There has been a good deal of discussion upon the temperature at which cast iron should be poured into the mould, a medium casting temperature being considered by some to give the best results. To prove this, 10 cwt. of iron was taken from the cupola and poured into five sets of moulds. The first mould was poured at 3.40 p.m., well within two minutes of being tapped from the cupola, the second at 3.45 p.m., the third at 3.50 p.m., the fourth at 3.55 p.m., and the fifth at 4 p.m., showing a five minutes' interval between each mould. The tests clearly indicated that the mould poured first gave the best results.

Conclusions.—1. The best tensile and transverse tests are obtained from bars which have been machined. 2. Transverse test bars cast on edge and tested with the "fin" in compression give the best results in testing. 3. The transverse test is not so reliable or helpful as that of the moment of resistance. 4. The use of high-grade ferro-silicon in the foundry is of no commercial value. 5. Cast iron gives the best results when poured as hot as possible.

The paper was accompanied by various tables.

Mr. Adamson also illustrated his clip for testing the bar, and the sketch he showed is reproduced below.



SHACKLE FOR TENSILE TESTS

Prof. Turner said that Mr. Adamson's conclusion that the best tensile and transverse tests were obtained from bars which had been machined was certainly correct, if the expression "best" were used in the sense of most trustworthy. The form of clip shown in the diagram was undoubtedly a good one in order to get a perfectly straight pull on a circular test bar. Rectangular test bars gave irregular results. It was a curious fact, to which other observers had called attention, that when tested with the "fin" downwards higher results were obtained than in any other position. The use of high grade ferro-silicon in the foundry was a very troublesome thing, and he would leave Prof. Outerbridge and Mr. Adamson to fight out that question. The former had shown the value of high grade ferro-silicon being added just before pouring. It would appear that very great care was needed; but if ferro-silicon were added in the right quantity and at the right time you might get an admirable result. Unless you succeeded in doing that, it was better to leave the ferro-silicon out. He noted that Mr. Adamson stated that cast iron gave the best results when poured as hot as possible, and it would be interesting to hear other views on that point.

A vote of thanks was accorded to the author, on the motion of the President.

The papers by Dr. Newton Friend on "The Action of Air and Steam on Pure Iron" and "The Constitution of Carbon Tungsten Steels," by Mr. T. Swinden, were formally received without discussion. Of both of these we give abstracts below.

The Action of Air and Steam on Pure Iron.

It is well known that when iron is heated in air it soon becomes tarnished, and the particular shade which the iron assumes gives a rough indication of the temperature. In order to compare the action of ordinary moisture-laden air on pure iron with that of perfectly dry air and of steam, each at varying temperatures, the following experiments were performed:—

A tube, sealed at one end and containing a bright strip of iron foil, was immersed in an oil bath and maintained at 100 deg. Cent. for five hours. At the end of this time no alteration in the appearance of the iron could be detected. The temperature was now raised to 150 deg. Cent. for a further period of five hours. Even after this treatment it was almost impossible to decide by mere observation whether or not the surface of the metal was tarnished, for the action was so slight. A fresh strip was now heated to 220 deg. Cent. in a similar manner, but in twenty minutes a slight straw tint developed, which became more pronounced as the heating was prolonged. At higher temperatures the oxidation of the iron was much more rapid, and an almost momentary immersion in a lead bath at 350 deg. Cent. sufficed to produce a clear blue tint.

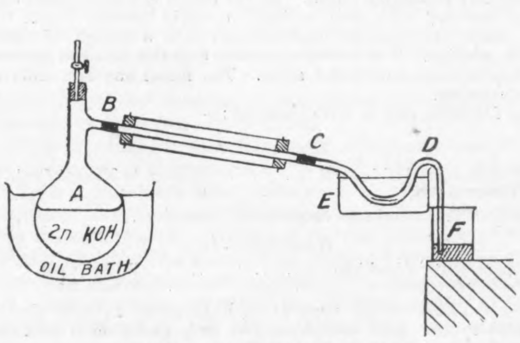
In view of the fact that H. Brereton Baker has frequently drawn attention to the influence exerted by minute traces of water-vapour on certain reactions, it was interesting to inquire whether or no pure iron would undergo oxidation on exposure to air at different temperatures dried over phosphorus pentoxide. The following results were obtained:—1. A tube, containing a strip of iron about 6 mm. long and 4 mm. wide, separated from some phosphorus pentoxide by a loose plug of glass wool, was sealed. After the lapse of four months the end containing the iron was immersed in an oil-bath at 190 deg. Cent. for thirty minutes. As the change produced was exceedingly slight, the temperature was raised to 220 deg. Cent. After the expiration of a second half-hour, the iron had assumed a light straw tint. 2. Two tubes similar to the above, one of which had been kept for three months, and the other six, were plunged into a bath of molten lead at a temperature of 350 deg. Cent. In a few moments the iron had assumed a bright blue colour. We thus see that the entire absence of moisture will not prevent the oxidation of pure iron at temperatures of about 200 deg. Cent. and upwards. These experiments are, therefore, being continued in order to include a wider range of observation.

Action of Steam on Iron.

For many years chemists have been familiar with the fact that, when steam is passed over heated iron, hydrogen gas is set free, and hammer-scale, or magnetic oxide of iron, remains behind. The equation usually assigned to this reaction is:—

$$3Fe + 4H_2O = Fe_3O_4 + 4H_2.$$

The author explained that he had previously drawn attention to the fact that a mixture of pure steam and air might be passed over pure iron at 100 deg. Cent. without producing any visible effect.



ACTION OF STEAM ON IRON

The following experiments were therefore undertaken with the object of determining if pure CO_2-free steam has any action upon pure iron at temperatures above 100 deg. Cent., and, if so, at what temperature that action begins:—

Temperature range, 100 deg. to 250 deg. Cent.—The apparatus used in these experiments is shown in the figure. The distilling flask A, of 500 c.c. capacity, contained a two-normal solution of potassium hydroxide, and was immersed in an oil-bath, the temperature of which was maintained at approximately 125 deg. Cent. In order to prevent bumping, the level of the potash solution was kept slightly lower than that of the oil in the bath, and small pieces of capillary tubing, sealed at one end, were dropped into A at the beginning of each experiment. It was found that, by adopting these precautions, a steady ebullition of the potash could be secured without the manifestation of any tendency to bump. The glass condenser B C was, in the later experiments, fused on to A at B, and connected with the glass tube C D by means of a short piece of rubber tubing. The free ends of the tubes at C were filed to fit one another, in the manner indicated by Bone and Coward,* so as to make a tight joint. At the beginning of the experiment a strip of iron foil, 3 cm. long, was put into C D, together with a few drops of potash solution to remove any adhering carbon dioxide. A was now raised to boiling point, and the steam condensing in B C washed the potash away from C D. When the water escaping from the open end F showed no alkalinity to phenol phthalein, F was closed with a mercury seal, the condenser B C allowed to run dry, and the oil bath E heated to various temperatures, not exceeding 250 deg. Cent. After half an hour's exposure to the action of the steam at any one temperature the experiment was stopped by cooling A and allowing a solution of potassium hydroxide to be sucked up through F into C D. In no case was the iron found to be appreciably tarnished. Temperature range, 300 deg. to 600 deg. Cent.

1. In Copper Tubes.—At first B C and C D were made of copper, whilst the oil in E was replaced by lead, the temperature of which was determined by means of a platinum resistance thermometer enclosed in a silica tube. The india-rubber joint at C was prevented from perishing with the heat by a loose wrapping of filter-paper kept moistened by a slow stream of water. The experiments were carried out in a manner precisely similar to that detailed above, save that before each fresh experiment C D was heated in a current of pure hydrogen gas to reduce any oxide. The following results were obtained:—

Experiment I.—Four strips of foil, from 2 cm. to 3 cm. long, were heated thirty minutes at 330 deg. Cent. The strips remained quite bright, but each was attacked locally at about four different places—presumably where they had lain in contact with each other.

Experiment II.—One strip of foil was heated for twenty minutes at 445 deg. Cent. The metal was decidedly tarnished.

Experiment III.—A strip of foil was heated for thirty minutes at 520 deg. Cent. The metal was thoroughly attacked.

It would appear from these experiments that pure iron is attacked by pure steam at some temperature intermediate between 330 deg. and 445 deg. Cent. To arrive at a more accurate determination of the temperature, however, it was necessary to eliminate several possible errors:—

(*i*) Caustic potash readily effects the oxidation of metallic copper in the presence of air, and the oxide thus produced is rapidly reduced by iron to cuprous oxide at temperatures near 350 deg. Cent., with the simultaneous formation of iron oxide.† It is clear, therefore, that during the initial stages of the experiment the inside of C D could scarcely fail to become oxidised, with the result that, on heating in the lead bath, the iron became slightly tarnished.

(ii.) Although the temperature of the bath could readily be determined, it was always possible that the temperature of the steam inside C D was slightly lower than this. As this is, unfortunately, an unknown factor, a correction could not be applied.

(iii.) It is well known that iron, in common with many other metals, possesses the property of absorbing quantities of different gases, such as the oxides of carbon, hydrogen, and nitrogen, and that the gases are evolved when the metal is heated.‡ It will be clear that these gases, even though present in very small quantity, might exert a disturbing effect upon the reaction under consideration.

(iv.) The most serious source of error, and one which it was found impossible to obviate entirely, lay in the difficulty experienced in removing every trace of air from A and B C. This was rendered practically impossible, because a number of capillary tubes, sealed at one end, had to be introduced into the potash solution immediately before each experiment, in order to prevent bumping. The error thus introduced is, of course, slight. It has already been shown, however, that air attacks iron fairly rapidly at temperatures above 200 deg. Cent. Consequently it cannot be expected that iron will remain absolutely untarnished, after exposure to steam containing traces of air, for any lengthened period. Bearing this in mind, however, it will be seen that the experiments described in the sequel, though but approximations to the truth, are not without value.

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* *Transactions of the Chemical Society*, 1908, Vol. xciii., p. 1984.

† A research into the nature of these reactions is already in progress.

‡ See Belloc, *Comptes Rendus*, Vol. cxlv., p. 1280; Boudouard, *ibid.*, p. 1283; Sieverts, *Zeitschrift für physikalische Chemie*, Vol. lx., p. 129.

2. In Silica Tubes.—In order to eliminate the first two possible sources of error mentioned above, tubes of transparent silica were employed, of internal diameter 0.4 cm. The length of that part of C D actually immersed in the bath E was 23 cm., and the strips of iron—usually two in number—were placed at the opposite end to that by which the steam entered. The latter had therefore to pass through a considerable length of the heated tube before reaching the iron, and had thus a better opportunity of attaining to the temperature of the bath. Only such iron was used as had been previously heated to redness for ten hours in vacuo, whereby the greater part of its occluded gases would be expelled. To remove the air as completely as possible from A and B C, the potash was kept vigorously boiling for from one to two hours before the experiment was commenced, and the condenser allowed to run dry. The silica tube C D could not be filled with potash solution, however, as in the corresponding experiments with copper tubes, for the iron was rapidly tarnished by the action of the silica when all the alkali had been washed away, and before the passage of steam was commenced. C D was therefore filled with semi-normal ammonium hydroxide solution, which served to expel all the air from the tube. On connecting at C the steam rapidly expelled the ammonia and most of the water, and immersion in the bath, already at the desired temperature, served to vaporise rapidly any remaining liquid. At the end of the experiment bath E was removed, and, after cooling to nearly 100 deg. Cent., C D was rapidly disconnected and plunged into a trough of dilute potash solution. This served at once to cool the tube and preserve the iron in contact with the silica. The metal was then removed and examined.

The following results were obtained :—

Experiment I.

Temperature of oil bath, E	292 deg. to 297 deg. Cent.
Passage of steam..	60 minutes

Result: The metal was very slightly tarnished.

Experiment II.

Temperature of lead bath, E	330 deg. Cent.
Passage of steam..	60 minutes

Result: Exactly the same as in Experiment I., save that in addition to the slight tarnishing, one strip had a small dark spot where the second strip had lain across it.

Experiment III.

Temperature of lead bath, E	360 deg. Cent.
Passage of steam..	60 minutes

Result: The metal was a dark straw colour.

Experiment IV.

Temperature of lead bath, E	380 deg. to 390 deg. Cent.
Passage of steam..	60 minutes

Result: The metal was very much darker, and thoroughly attacked.

Similar experiments were also performed for thirty minutes each at 430 deg., 450 deg., 470 deg., 510 deg., and 550 deg. Cent., and for sixty minutes each at 430 deg., 470 deg., and 500 deg. Cent. In every case the metal was found to be thoroughly attacked.

Since the iron was only very slightly tarnished, but to an equal extent, in Experiments I. and II., although the temperature difference was above 30 deg. Cent., it seems reasonable to conclude that the oxidation was caused by the traces of air in the apparatus, to which reference has already been made. Since these traces of air will remain practically constant in amount for any one apparatus, the increased oxidation observed in Experiment III. at 360 deg. Cent. may be attributed to the action of the steam. As the temperature is raised to 380 deg. Cent. and upwards, the corrosion becomes still more marked.

It appears, therefore, that steam begins to decompose in the presence of iron at some temperature intermediate between 330 deg. Cent. and 360 deg. Cent.—say, 350 deg. Cent. in round numbers. It is highly improbable that any definite temperature could ever be fixed exactly at which the decomposition of steam might be said to begin. For at a certain temperature the amount of decomposition which could take place might be too small for detection in one hour, and yet in the course of several hours, days, or weeks be most pronounced. Furthermore, the physical condition of the iron and of the walls of the tubes through which the steam passes will probably exert a marked influence, for it is well known that gases are very susceptible to changes in this respect.

The results detailed above are capable of explanation in two ways :—(i) We may assume, as is usually done, that the iron itself decomposes the steam at those temperatures at which corrosion takes place. (ii) The reaction may be regarded as taking place in two stages, comprising—first, the dissociation of the steam ; and, secondly, the union of the oxygen thus liberated with the metallic iron.

CONCLUSIONS.

The results obtained in this research may be briefly summarised as follows :—(1) Pure iron combines with ordinary air and with air dried over phosphorus pentoxide with increasing readiness as the temperature rises. Below 150 deg. Cent. the oxidation proceeds too slowly to be readily detected. (2) When pure iron is heated in pure steam at temperatures ranging from 350 deg. Cent. upwards, the metal becomes tarnished. (3) The author concludes that the action of steam on iron takes place in two stages, comprising, first, the dissociation of the steam ; and secondly, the combination of the dissociated oxygen with the iron, and the consequent liberation of free hydrogen gas. (4) If conclusion 3 is correct, the dissociation pressure of the oxide of iron produced at 350 deg. Cent. is of the order of 1.02×10^{-12} atmospheres.

THE CONSTITUTION OF CARBON STEELS.

This paper does not readily lend itself to abstraction, and must be considered as a whole in order to be properly appreciated. We do not, therefore, propose to do more than reproduce the summary of it which the author gives at the end. This is as follows :—

Hardness tests and exhaustive microscopic examination support in every respect the conclusions previously recorded upon the cooling-curve work.* First that the "lowering temperature" marks a definite reaction in which the tungsten is involved ; and secondly, that the rate of cooling from above the lowering temperature is without influence on the low point. Some facts are stated and observations made suggesting that the hypothesis of Edwards, that the lowering of the point is due to the formation of a carbide tungsten, is untenable.

The theory of a double carbide formation is also difficult to bring into accord with the cooling curve and microscopic facts. A tentative hypothesis is given, wherein the lowering of the recalescence point is attributed to the solution of a tungsten compound, probably Fe_3W, at the lowering temperature. The tungstide is re-precipitated at the low point, and the Fe_3C immediately separates also. Some figures in support of the latter view are included.

After the reception of these papers Professor A. McWilliam moved a vote of thanks to the Reception Committee, which was carried with acclamation, and Mr. E. P. Martin proposed a vote of thanks to the public bodies and private firms who had offered facilities for visits to their establishments. Both these resolutions were carried by acclamation.

The President moved the customary vote of thanks to the Institution of Civil Engineers for the use of the institution premises for the meetings, which was unanimously adopted.

A reception of the members by the Lord Mayor and Lady Mayoress in the afternoon, following a visit to Mercers Hall, was numerously attended.

VISIT TO PORTSMOUTH.

The concluding day of the meeting was devoted to a visit to Portsmouth Dockyard and Whale Island, and special arrangements had been made by the Admiralty for the convenience of members. Those participating in the visit travelled by special Pullman car train, to the number of between 200 and 300, being received on arrival by Rear-Admiral Alban G. Tate, the superintendent, and officials representing other departments of the dockyard. The programme arranged included a visit to the Dreadnought cruiser Invincible. This ship, which has already been described in The Engineer, is remarkable for the fact that, with the exception of the main engines and the steering gear, the whole of the machinery equipment is electrically operated.

The majority of the members afterwards made an inspection of the new factory, and only a very few paid a visit to the new Dreadnought lock works, the construction of which was put in hand some thirteen months ago. In the matter of lock accommodation Portsmouth has failed to keep pace with modern requirements, the capacity of the existing locks, built twenty-eight years ago, being too small for the recently constructed battleships and cruisers. The length of the two old locks is 464ft. 7in., with an entrance width of 81ft. 9in. The new lock, which is being constructed by Messrs. Morrison and Mason, will have a length of 850ft. with the caissons in their normal position, a width of 110ft., and a low-water depth at entrance, to which a channel will be dredged, of 33ft. The site of the lock is along the south side of the fitting-out basin, and the construction of the lock entrance will necessitate the demolition of the old coaling point. Work is now actively proceeding on the lock construction, the contractors having about 1000 men employed.

An interesting operation at present in hand is the driving of interlocking steel piles between the site of the south wall of the lock and the existing south wall of the basin to form a cut-off. Behind the piling, now nearly finished, the excavation for the lock wall is being carried out, and the concrete put in in sections. The steel piling is being driven to a depth of 35ft. below the foundations of the basin wall. Five concrete sections for the south wall have now been completed to within 38ft. of cope level. The excavations for the north wall of the lock have been completed for a length of 700ft., and the foundations brought up to within 50ft. of cope level. The floor of the lock, which is being constructed as an inverted arch, will be built of mass concrete, 19ft. thick. The work here is making satisfactory progress, and with the view to strengthening the south wall four ribs 30ft. in width and 8ft. 9in. deep have been put across the floor. Behind the south basin wall the excavation for the pump wells has been put in hand, so that deep excavation has been proceeding on each side of this wall. The entrance at the west end of the lock will be controlled by sliding caissons, for which a contract has been placed with Swan, Hunter and Wigham Richardson, Limited. The entrance from the lock to the adjoining basins will be controlled by a floating caisson, and a similar caisson will be fitted to the new entrance which is to be constructed to basins 3 and 4. These caissons are being supplied by Workman, Clark and Co. The contract for the penstock and penstock engines has been given to Cowans, Sheldon and Co. These engines, of which there are seven, will be of the horizontal double-cylinder type. The main pumping engines, designed to empty the lock when unoccupied in 4¼ hours, will be of the vertical spindle-balanced single-inlet centrifugal type, and are being built by Fullerton, Hodgart, and Barclay. It is intended, in view of the increasing size of battleships, to convert basins 4 and 5 into a single large wet dock, where it will be possible more easily to manœuvre ships of the Dreadnought class. The new lock is to be ready for service in August, 1912.

At the time of the visit by members of the Institute, the Neptune, launched the previous day, was lying in No. 5 basin, in close proximity to the St. Vincent, one of her immediate predecessors, and which is now approaching completion.

After luncheon members paid a visit to the gunnery school at Whale Island, returning to London by special train.

MANCHESTER ASSOCIATION OF ENGINEERS.

On Saturday evening last Mr. Joseph H. Stubbs, president of the above society, delivered his opening address, and took for his subject, "Engineering Efficiency," which he sub-divided into the following sections:—(1) Education and training; (2) Workshop efficiency ; and (3) Commercial efficiency. In connection with education, Mr. Stubbs asked whether it was not possible for the technical school authorities in conjunction with the engineers of any district to devise a scheme whereby the advanced engineering department of the school could be supplied with all the necessary detailed drawings and materials required for some actual work, which was to be carried out by the students under the supervision of a practical engineer. When completed, and if satisfactory, the work would have to be returned to the shop and charged for at the current shop rates, all spoiled materials being paid for by the technical school. Referring to the system adopted at the Manchester School of Technology for apprentices to attend the day instead of the evening classes, the author said that although good in theory, this has not been as successful as was anticipated, the reason being that it is practically impossible, in certain classes of engineering, to spare a number of apprentices at any one time. Again, referring to the Manchester School of Technology, Mr. Stubbs mentioned that workshop methods have not been entirely overlooked, and that a course of lectures for managers, &c., on workshop management, is now in the syllabus. He hoped that a more elementary course will be also arranged in the future in order to give younger students commercial education.

On the subject of workshop efficiency Mr. Stubbs gave some valuable information largely based on his own experiences. When designing works considerable trouble and anxiety may be avoided by adopting a uniform size and pitch of girder and diameter of driving shafts through the shops. Following this plan out may cause the girders and shafts in some parts of the works to be heavier than necessary, but the extra expense entailed is compensated for by the convenience when erecting, altering or extending; the multiplication of hanger patterns, various lengths and diameter of shafts, and bores of pulleys being rendered unnecessary. By this arrangement the hangers, shafting, couplings and pulleys are entirely interchangeable. The author then went into the lay-out and arrangement of the various sections of the works from the drawing-office to the smithy and stores.

"Organisation" Mr. Stubbs divided into the following items :—

(1) There must be a general manager, thoroughly efficient in every detail in the manufacturing and commercial departments of the business, endowed with common sense and tact. As the head dominates and influences the whole, it is therefore requisite that the one who has charge and control of large bodies of men should be a man educated for the position, with a strong character, able to lead and obtain the best possible service from his subordinates ; he should have courage and independence so as to hold his own in all arguments, yet open to conviction. Such influences result in better and more sympathetic relations between employer and employé, which are essential to success in any business. It has been proved many times that only when the master mind controls every detail can the best possible results be obtained.

(2) A works manager who has had practical and technical training in all departments of engineering, and experience in the control of workmen.

(3) Over each department a responsible and trustworthy head, specially trained for the position. His position, responsibility, and relation to the heads of the other departments being definitely understood and accepted, will obviate awkwardness, misunderstandings, and jealousy. These are fatal to the smooth and successful working of any establishment, as they often cause much unnecessary annoyance, loss of time, and interference with progress.

(4) Each department must fully recognise its importance and connection with the other departments. There must not be any independent working or overlapping.

(5) A complete system of supervision and inspection throughout the whole works.

(6) Practical encouragement should be given to workmen who suggest new ideas, improvements, or alterations in methods.

With regard to systems of payment Mr. Stubbs said he preferred the individual piece-work system. The premium system, he said, was faulty, owing to a time being definitely fixed and unalterable, and in actual practice it did not, in his opinion, work satisfactorily, but led to disputes. On the subject of commercial efficiency the author put in a strong plea for the commercial engineer. He said that the engineering department should be in charge of the commercial engineer, and sub-divided into three departments. First, the publicity and intelligence department; secondly, the estimating department ; thirdly, the drawing-office executive department.

After an enthusiastic vote of thanks to the president for his address had been passed, Mr. Stubbs announced that the Constantine medal for the best paper read during the previous session had been awarded to Mr. Leslie Denny, of Dumbarton, for his paper on "Modern Ship Design." A letter from Mr. Denny was read regretting the author's inability to be present to receive the medal.

THE ADMIRALTY HARBOUR AT DOVER.

H.R.H. the Prince of Wales performs to-day the ceremony of opening the new Admiralty Harbour at Dover, which, so far as the original scheme is concerned, has now been completed. We have referred briefly in our leading article on page 397 to the history of the undertaking, and the present article contains a short description which, with the plan and illustrations on pages 391 and 396, will enable our readers to form a fair idea of the magnitude of a work which has been under construction for nearly twelve years.

Towards the end of 1895 Messrs. Coode, Son and Matthews, of Westminster, were instructed by the Admiralty to make a survey of the harbour site, and to prepare plans for the construction of a national harbour of refuge. As a result, a definite project was adopted by the Admiralty, and a contract was let in November, 1897, to S. Pearson and Son, Limited, for the carrying out of the works, which were immediately begun. The site of the harbour was entirely exposed over half the compass, the only shelter being afforded by the land on the north and the old Admiralty Pier on the north-west.

The approved scheme consisted of an extension of the Admiralty Pier, and the formation of a reclamation, at the eastern end of the town of Dover upon the foreshore of the bay, and extending along the foot of the chalk cliffs in the direction of St. Margaret's for a length of 3900ft. From the eastern end of the reclamation a protection breakwater, known as the East Arm, was proposed, and between the Admiralty Pier extension and the seaward end of the East Arm, an isolated structure, known as the South Breakwater, was to be constructed.

The works have been carried out practically as designed, the actual length of breakwaters being as follows :—

East Arm	2942ft.
South or Island breakwater	4212ft.
Admiralty Pier extension	2000ft.
Total	9154ft.

The original Admiralty Pier is about 2000ft. in length, and the Prince of Wales Pier, which will shortly be handed over to the Admiralty by the Dover Harbour Board, is 2910ft. in length. This structure now forms a harbour jetty, which will be utilised for naval purposes.

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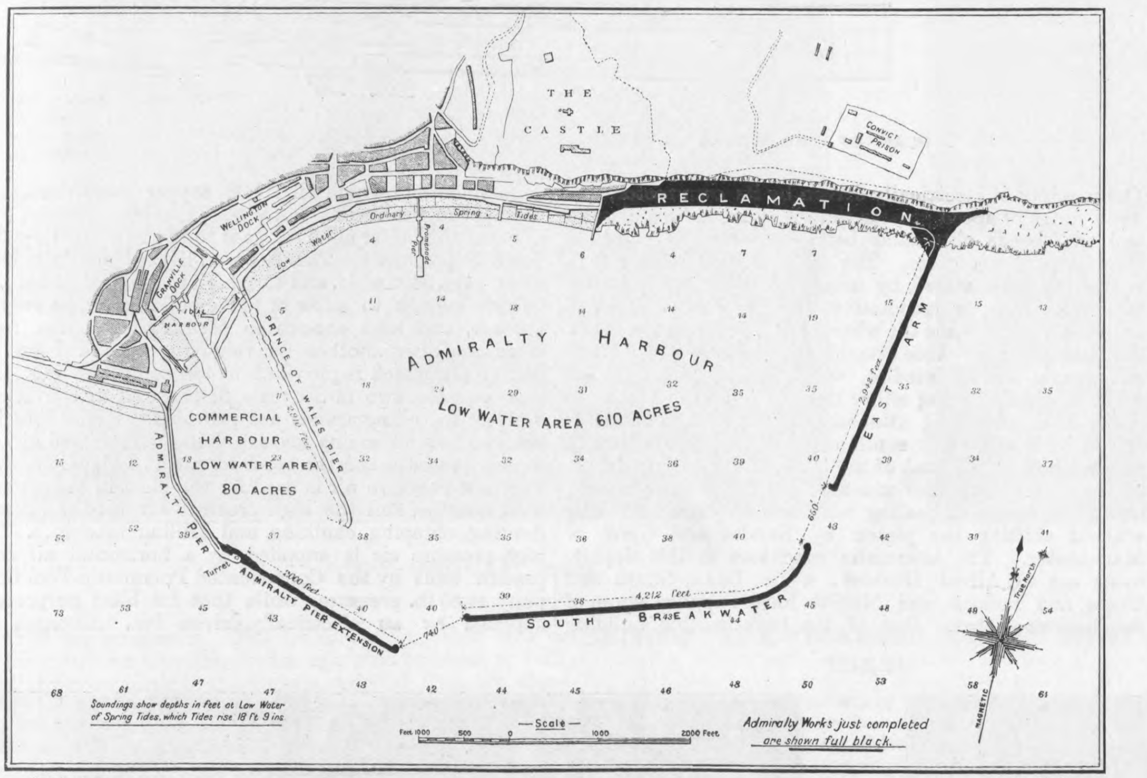
* *Vide* a paper by the same author, "Carbon Tungsten Steels," *Journal* of the Iron and Steel Institute, 1907, No. 1, pages 291-324.

The construction of the South Breakwater as an island, or detached work, was decided on in consequence of the necessity for the formation of an eastern as well as a western entrance, the latter 740ft. and the former 650ft. in width. The two entrances are necessary in order to promote tidal circulation, and to prevent shoaling within the enclosed area, and also to facilitate ingress to and egress from the harbour under varying conditions of tide and weather. The depths in the entrances are from 40ft. to 43ft. at low water of spring tides, and, as the tidal rise at springs is 18ft. 9in., the depths in the entrances and approaches to the harbour are about 60ft. at high water of spring tides. The Admiralty Pier extension, the whole of which is constructed on a site having a depth exceeding 40ft at low water, measures from foundation to top of parapet close on 100ft. in height.

The sea bed of Dover Bay consists of hard chalk near the shore, merging into chalk marl with flints further seaward, so that the breakwaters in all cases rest on good foundations. The area of the enclosure which constitutes the Admiralty Harbour is 610 acres at low water. The Commercial Harbour, lying between the Admiralty and Prince of Wales Piers, has an area of 80 acres at low water. This area will be somewhat reduced when the Admiralty Pier widening and reclamation for the new continental traffic station have been completed. At present the total enclosed area at low water is 690 acres, and the total volume of water entering and leaving the harbour at an ordinary spring tide is 17 million tons. A comparison of the soundings taken over the area of the harbour during the last twelve months shows that there has been practically no tendency to shoal over the enclosed space.



"The Engineer" Swain Sc.

THE ADMIRALTY HARBOUR AT DOVER

Dredging operations are now being carried out by the Admiralty with the view to further increasing the depth of water in certain parts of the harbour.

The breakwaters and piers are formed of concrete blocks of from 26 tons to over 40 tons each, and the average weight throughout may be taken as about 33 tons. The blocks of 6 to 1 concrete were built in the block yard, and those for face work have granite fronts, the stones being well bonded into the concrete matrix. All the blocks from foundation level upwards are bonded and dowelled in the vertical joints with 4 to 1 concrete "sausage" dowels of circular section; while above low water the courses are bedded and grouted in cement mortar. The shingle and sand aggregate for block making was obtained from Sandwich, Dungeness, and Rye; the volume of concrete built into the work reached the enormous total of approximately 1,300,000 cubic yards. In addition, 1,900,000 cubic feet of granite have been used. The blocks were set by means of goliath overhead travellers, running on temporary staging. The roads on the stagings were 27ft. 6in. above high water of spring tides, and 46ft. 3in. above low water. The piles in the staging, many of which exceeded 100ft. in length, were arranged in clusters of six to form spans of 50ft. 3in., and the goliaths, both on the stagings and in the work yards, were all of 100ft. gauge.

The system of operations, carried on simultaneously, was as follows:—At the outer end of the work was a stage erecting machine, followed by a goliath crane working a grab; then a second goliath, from which the diving bell was worked; next a third goliath setting blocks under water; and behind that a fourth setting the blocks above low water level. Most of the diving bells used on the works measured 17ft. 6in. by 10ft. internally, with 6ft. 6in. head room. They weighed about 35 tons out of water and 5 tons when submerged. They were all fitted with electric light and telephonic communication. Within the diving bells the workmen excavated the sea bed and prepared and levelled the foundations for the bottom course of blocks. The excavation for the foundations was carried out by grab-dredging down to within 12in. of the finished level before the bell divers commenced operations. The foundations generally are carried from 3ft. to 6ft. into the chalk and flint bed, and are further protected from the scouring action of currents on the outer face by an apron of concrete blocks 25ft. in width. The blocks in the apron vary in size from 9 to 14 tons, and are all 3ft. 6in. in depth. They were deposited by divers on a level bed excavated 2ft. deep in the chalk. Operations within the diving bells were, when weather permitted, carried on continuously, the men in the bells working in shifts of four hours each during the earlier stages of the work, but subsequently this period was reduced to three hours. Generally two shifts per day were worked by the men. Block setting under water was only possible at slack water for periods of about four hours each tide. The blocks were set by helmet divers.

The greatest depth of the foundations is 53ft. below L.W.O.S.T., the average depth being 47ft. There was thus an average working head of 66ft. at H.W.O.S.T., corresponding to a working air pressure of about 30lb. per square inch. This head was found to be a maximum for working under comfortable conditions; on several occasions, when the depth was exceeded for a short period, inconvenience was experienced from the extra pressure. The maximum working pressure was about 35lb. per square inch. The contractors provided the most perfect plant and appliances which could be provided for the efficient and economical carrying out of such an undertaking. It was on these works that electric concrete mixers were first adopted. In the work yards six portable mixers were used, each of which turned out on the average 100 cubic yards of concrete a day. The mixers were of the Messent type, revolved by a motor of 18 horse-power and driven from the point where the aggregate was received to the block moulds, where the finished concrete was deposited, by a 25 horse-power motor. The gauge of the mixers was 11ft. 7in. No less than 260,000 tons of Portland cement have been used in the construction of the works.

In connection with the works it was necessary to provide two extensive work yards where concrete blocks could be formed, shops erected and such other operations conducted as were necessary for the convenient carrying out of the undertaking. It was one of the conditions of the contract that the eastern reclamation, which includes an area of 22 acres to the east of Dover Castle along the foot of the cliffs and beyond the Convict Prison, should be used by the contractors for work yard purposes in connection with the construction of the East Arm and the South Breakwater, a corresponding depôt being provided in front of the South-Eastern Railway Town Station, immediately to the west of the Admiralty Pier, for the extension of the last-named work.

At the time of the commencement of the eastern section of the harbour works there was no available area where shops or appliances could be provided, and therefore the concrete blocks required for the first portion of the east reclamation were prepared at Sandwich, and shipped from there to Dover. Subsequently, as the reclamation extended, and a sufficient area was filled in at the back of the sea wall, with chalk obtained from the cliffs, a work yard was constructed, and a block-making yard established thereon. At this yard all the blocks for the east arm and south breakwater were made, the Sandwich depôt continuing to be used for the manufacture and storage of the blocks for the reclamation wall and the aprons.

The deck levels of all the breakwaters is at the same height above high-water of spring tides, viz., 10ft., and the walls batter 1 in 12 on both faces, with the exception of the inner face of the East Arm and a small portion of the inner face of the Admiralty Pier extension, which have been constructed with vertical faces for convenience of berthing ships. The deck widths are respectively:—Admiralty Pier extension, 45ft.; South Breakwater, 40ft.; and East Arm, 47ft. 6in.

The East Arm and the Admiralty Pier extension have been provided with sheltering parapets, as both of these works will be used for berthage The South Breakwater has not at present been provided with a parapet, but is flush decked. Provision has, however, been made for such protection to be added hereafter, if and when desired. About 1800ft. run of the East Arm has also been fendered on its harbour face. Gun emplacements and search-light installations for defensive purposes have been constructed, under the direction of the War Department, in several positions on the new works. Details of these works are not available. The lighthouse and fog signal arrangements, both temporary and permanent, were carried out under the advice of the Corporation of Trinity House and by them.

The Admiralty have recently decided to construct a small inner harbour or "camber," for the use of submarines and torpedo boats. This camber will be located at the north-east corner of the Refuge Harbour, and the scheme provides for the construction of a short pier at right angles to the reclamation, and another also at right angles to the East Arm. A contract has been placed for the construction of repair shops and an oil fuel storage depôt on the reclamation.

It is a matter for congratulation that no deaths or permanent injuries were attributable to working under compressed air, either in the bells or in diving dresses. The works have provided employment for a large number of men. At one time from 1500 to 1800 men were employed, including those engaged in operations in connection with the works, but away from Dover.

The Engineer-in-Chief for the Admiralty was Colonel Sir Henry Pilkington, K.C.B., R.E., of the Admiralty Works Loan. On his retirement in March, 1906, the duties of Engineer-in-Chief were transferred to Colonel Sir Edward Raban, K.C.B., R.E., the Director of Works of the Navy. The works were designed by Messrs. Coode, Son and Matthews, and carried out under their direction as chief engineers, Sir William Matthews, K.C.M.G., the senior partner of the firm, being intimately identified with them throughout. The superintending engineer for a period of seven years was Mr. M. F. G. Wilson, who on joining the firm of Coode, Son and Matthews, was succeeded by Mr. A. G. Vaughan-Lee, who had previously acted as chief assistant engineer. Mr. Vaughan-Lee retired in 1908 in consequence of serious illness, since when the appointment of Admiralty Superintending Engineer has been held by Mr. C. H. Colson. Mr. F. P. Lane has for a considerable period acted as chief assistant engineer. For the contractors, Messrs. S. Pearson and Son, Limited, whose chairman is Sir Weetman Pearson, Bart., Mr. E. W. Moir has acted throughout as Director-in-Charge. Messrs. Pearson's principal local officials have been Messrs. A. H. Owles, W. C. Hawke, and F. W. Duckham.

The total cost of the Admiralty Harbour Works has, up to the present, amounted to under £4,000,000.

Brief reference should be made to the extension works which the Dover Harbour Board are now carrying out. These works are independent of the naval harbour, and are being erected by the Harbour Board in conjunction with the South-Eastern and Chatham Railway Company, by whom the interest on the outlay is guaranteed under an Act of Parliament of 1906. In February last a contract was placed with S. Pearson and Son, Limited, for the reclamation of a site adjoining the east side of the Old Admiralty Pier, upon which a new marine station for continental traffic will subsequently be constructed. A new deep-water landing stage and covered railway platforms are to be completed within nine months from the date of signing the contract, while a period of three years is allowed for the execution of the reclaimed area portion of the work. The provision of adequate landing and station accommodation at Dover for cross-Channel and ocean passenger traffic has been long delayed, largely owing to the varied plans previously under consideration for the construction of the new naval harbour, and the consequent uncertainty as to the accommodation available. An arrangement has been made with the Admiralty by which the Prince of Wales Pier will be handed over by the Harbour Board for the exclusive use of the Navy, and the whole of the Admiralty Pier and its extension, with the exception of a small portion of the latter at the seaward end, which is reserved for the War Department, and for signalling purposes, devoted to commercial traffic, including the accommodation of ocean liners, hitherto berthed on the eastern side of the Prince of Wales Pier. The new passenger station will be constructed by the railway company on the site now being reclaimed from the harbour on the east side of the Admiralty Pier, having an area of 11¾ acres. The first work to be completed at the end of the present year includes a new landing stage, with covered platforms, on the Admiralty Pier extension, which must be finished before the larger work at the inshore end can be fully entered upon. The engineer for the work is Mr. A. T. Walmisley, engineer to the Dover Harbour Board, with Mr. A. C. Hurtzig, of Westminster, as consulting engineer. The contract already placed involves the expenditure of about £400,000.

The Institution of Mechanical Engineers: Graduates' Association.—The first general meeting of the session was held on Monday, October 11th, at 8 p.m. Mr. Mark Robinson, member of Council, was in the chair. The annual report of the previous session was presented and adopted by the meeting. A paper entitled "Invention and Industrial Progress, with a Treatise on the British Patent System," by Mr. J. E. S. Lockwood, Graduate, was read, and the following graduates took part in the discussion:—Mr. A. B. Symons, Mr. R. D. McGroarty, Mr. S. A. Smith, and Mr. J. S. Warner, Assoc. Member. The chairman also contributed to the discussion.

Lectures on Aeronautics.—The governors of the East London College (University of London), Mile End-road, E., have arranged for a special course of lectures on aeronautics to be given by Mr. A. P. Thurston. The course of lectures will commence on Monday, October 18th, at 7 p.m., and will be followed by drawing-office practice in the design and construction of aeroplanes. The following is the syllabus of the lectures:—(1) The normal and inclined plane; (2) streamline surfaces, the centre of pressure, resistances of bodies; (3) the propeller and helicopter; (4) calculations applied to a flying machine; (5) the biplane; (6) the monoplane; (7) aeronautical engines; (8) automatic stability and control; (9) dirigible balloons.

THE WORKS OF KERR, STUART AND CO., LIMITED, AT STOKE-ON-TRENT.

The works of Kerr, Stuart and Co., Limited, are situated half-a-mile south of Stoke-on-Trent station, stand on a plot of land fifteen acres in extent, and are served on one side by the North Stafford Railway Company's main line and on the other by the Trent and Mersey Canal. The works are, moreover, conveniently situated as regards obtaining supplies of coal, water, and the raw materials, and in times of brisk trade find employment for about 850 hands. The products of the works are chiefly locomotives of all classes and gauges, but wagons, railway points and crossings, and materials for light railways are also manufactured in considerable quantities. With the object of increasing the efficiency of the works as a whole, and separating the various branches of manufacture, considerable extension and reorganisation have recently taken place. As will be seen from the general plan given in Fig. 1, the foundry is situated midway among the buildings for convenience of distribution. Intercommunication is afforded between the various shops by lines of railway, both narrow and standard gauges, while a siding is provided and gives access to the adjacent main railway line. All the water for the works' requirements is obtained from the canal.

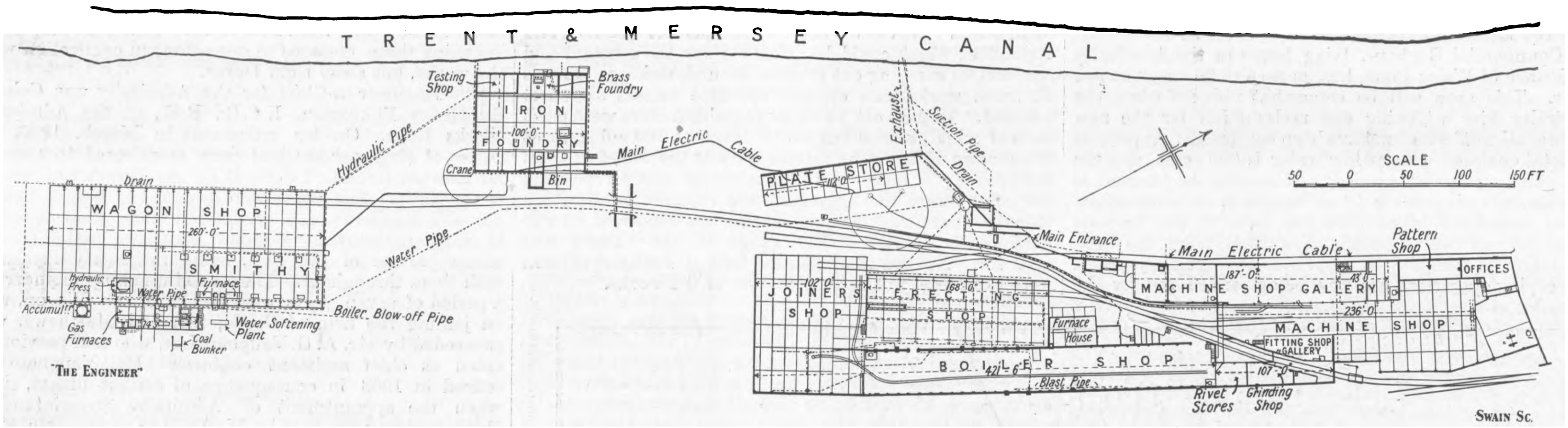


Fig. 1—PLAN OF THE WORKS

The works are driven throughout by electric motors, continuous current at 480 volts pressure being obtained from the Stoke Corporation's power station. The only steam power used is in the smiths' shop. Here part of the steam is derived from the waste heat of the furnaces and the remainder from hand-fired boilers. Compressed air and hydraulic pressure are also distributed throughout the works by mains, the air compressor being driven by an electric motor and the water pressure by steam-driven pumps situated in the wagon shop. In the yard shunting and hauling operations are performed by an electrically-operated capstan. A glance at the plan will suffice to explain the difficulties which have had to be overcome in extending the works to cope successfully with their increasing requirements. The older portion of the works, in which are situated the offices, is a long and somewhat narrow building impossible of lateral extension for several reasons. This has been adapted to the requirements of machine shops, fitting, boiler and pattern-making shops, while new buildings have been erected for the erecting shop, joiners' shop, ironfoundry, and wagon and smiths' shops.

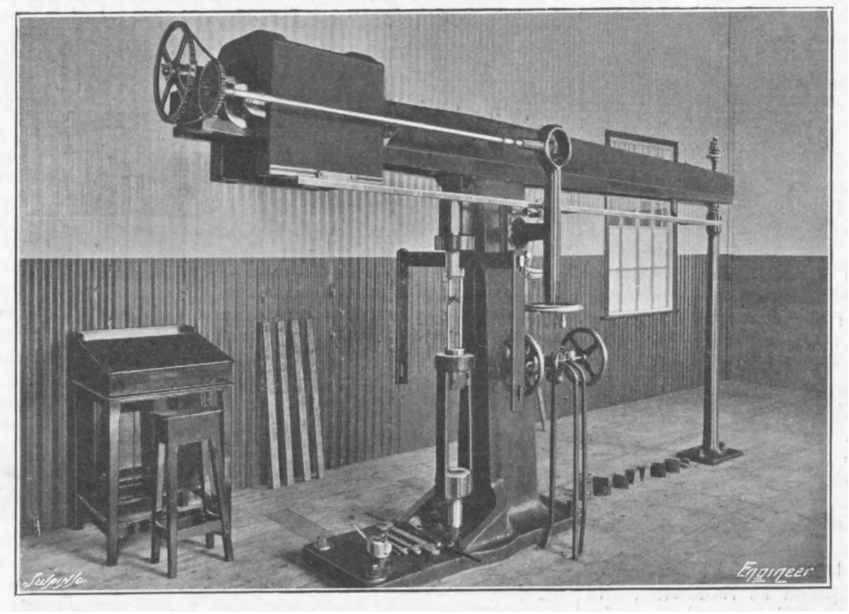


Fig. 2—30-TONS TESTING MACHINE

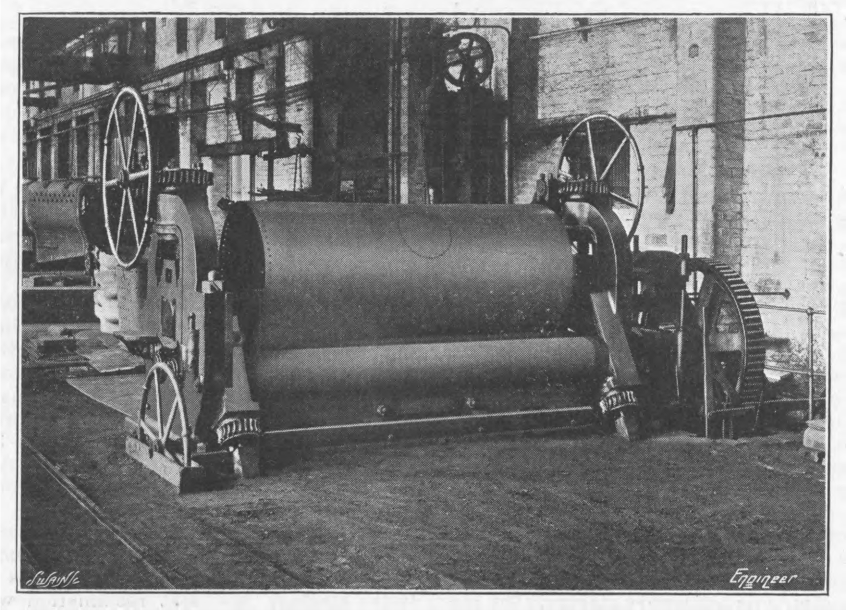


Fig. 3—COMBINED BENDING AND STRAIGHTENING MACHINE

On leaving the offices for a tour of inspection of the works the visitor enters the machine and fitting shops—see Supplement. The power for driving the tools in these shops is supplied by two 30 horse-power electric motors, supplied by J. and P. Hall, of Oldham. The motors are mounted on a channel steel framework at one end of the building, and drive the line shafting at 200 revolutions per minute by Balata belting. Rope and hand-driven overhead travelling cranes are carried on rails secured to longitudinal steel channels supported on stanchions. Amongst the extensive collection of modern machine tools are to be observed milling machines by Brown and Sharpe, Kendal and Gent, and Becker-Brainard; planers by Redmans; radial drills by Craven Brothers and Asquiths; slotting machines by Muirs; capstan lathes by Wards (of Birmingham), Jones and Lamson, and Warner and Swasey; and a double-headed drilling machine by Campbells and Hunter. Amongst the special tools is a slot drilling machine by Wards, in which the cutter spindles run at a very high velocity with a fine feed. In operation on a slot the two tools are caused to approach one another from opposite sides, and by means of an ingenious arrangement, when they are just about to meet one spindle and tool are withdrawn and allow the other to finish the slot. This machine is kept very busily employed on locomotive work, and effects show an immense economy in the time taken on this kind of operation. Another special machine made for this firm is a 7ft. wheel lathe built by Beyer, Peacock and Co., Limited. This was illustrated in The Engineer, vol. cvi., page 600. The machine is electrically driven by its own motor, and has a range of speed greater than is usual in this class of tool, the speeds obtainable being between 0.37 and 30 revolutions per minute. The lathe is also fitted with a quartering attachment, by means of which the holes for the crank pins in locomotive driving wheels may be accurately bored while the wheels and axle remain between the lathe centres. This attachment comprises two interchangeable boring spindles, which enable holes to be made in wheels having either right or left-hand cranks to lead. The quartering attachment, it should be added, is driven by a belt which communicates the motion from a countershaft at the back of the lathe, and is in turn driven by the motor. Another machine is a frame plate milling machine, capable of dealing with frame plates 32ft. long without shifting the plates, by Kendal and Gent, of Manchester. The automatic machines in this department are by Alfred Herbert; while Dean, Smith and Grace, and Pollock and McNab have supplied some of the heavier lathes. One of the bays in this building is devoted to wheel and axle fitting and hydraulic testing of steam cylinders.

Grinding machinery forms a considerable section in modern machine shop practice, and Kerr, Stuart and Co. have a shop specially set apart for this class of tool. Every part of the motion work of a locomotive comes through this department for treatment. There are two link grinding machines, one large and one small, by Mayer and Schmidt, one universal grinding machine for pins by Brown and Sharpe, and a machine for grinding slide bars made by Craven Brothers, of Manchester. A view of the shop is given in Fig. 7. After glancing through the well-equipped tool room, fitting shop, and general stores, the boiler shop—see Supplement—is reached. This has recently undergone considerable extension and re-arranging, and now measures over 425ft. in length by 38ft. wide. It contains all the appliances necessary for the building of locomotive boilers. It is served by one 15-ton overhead crane and several hand cranes. The plates are unloaded from railway wagons by a crane at one end of the boiler shop, from which they pass to the drawing-off tables. Near these tables is placed a battery of high-speed drilling machines by Stirk. Alongside the drilling machines is placed a plate edge planing machine by Bucktons. Passing further along the shop we come to a set of combined bending and straightening rolls by Craig and Donald, these rolls being driven by a 30 horse-power electric motor—see Fig. 3. The machine tools are all driven by 30 horse-power motors. For drilling the holes in boiler barrels there is a special machine. The complete barrel is set vertically on a turntable and the plates are drilled by an arrangement of pneumatic drills. A portion of this shop is set apart for boiler mounting and testing, the completed boilers being passed through by an overhead crane directly into the erecting shop. Still further along the shop we come to the angle smiths, who in addition to dealing with general angle work, also make the foundation and firehole rings required for the boilers. Mention should not be omitted of the well-ordered stores for this department, in which all rivets, copper stays, tubes, &c. are kept in readiness.

From the boiler shop we pass to the new erecting shop—see Supplement. This is a well-lighted and lofty shop 168ft. long, 56ft. wide, and 42ft. high to the roof tie bars. It is wide enough to allow of the erection of three engines abreast, and high enough to permit the engines to be lifted one over another for removing to and from the testing pit, which is provided in the same building. For this purpose two of Royce's 35-tons electric overhead 3-motor travelling cranes are provided. Under the floor are two sets of mains for supplying compressed air, one for low pressure and the other for air at a higher pressure. The low-pressure air is used for the blast in the portable rivet hearths, and the high-pressure air for the portable riveting, chipping, caulking, and drilling machines. The high-pressure air is supplied by a horizontal air compressor built by the Consolidated Pneumatic Tool Company at 85 lb. pressure, while that for blast purposes is supplied by an electrically-driven fan. Amongst the work in progress in this shop at the time of our visit we saw several six-wheels-coupled metre gauge engines for the Argentine Government Railways, and several other locomotives forming part of an order for 32 engines for the South Indian Railway Company.

Adjoining the boiler and erecting shop is the joiners' shop, another new and well-lighted building, over 100ft. long and divided into two bays. This shop is well equipped with modern wood-working machinery and was busy on an order for wooden wagons for Columbia. After the coppersmiths' shop, the next shop of importance is the foundry, of which a view is given in the Supplement. This measures 100ft. by 86ft. The greater portion is devoted to iron casting, but part of one of the bays is divided off for brass work, while a further portion is reserved for testing operations. This is shown in Fig. 2. It contains a 30-ton tensile machine of Bucktons, fitted with an arrangement for cross-breaking cast iron specimens, and measuring the deflec-

THE WORKS OF KERR, STUART AND CO., LIMITED, STOKE-ON-TRENT

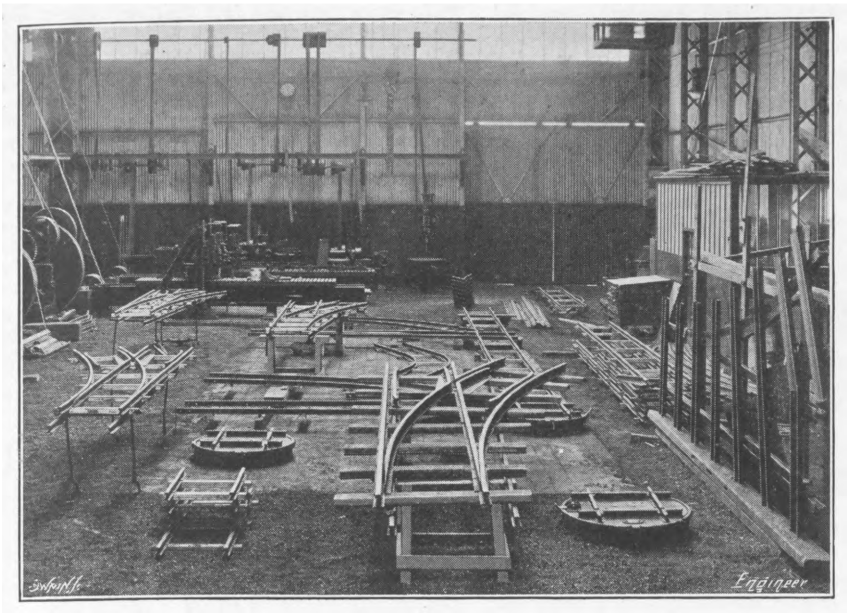


Fig. 4—THE RAIL SHOP

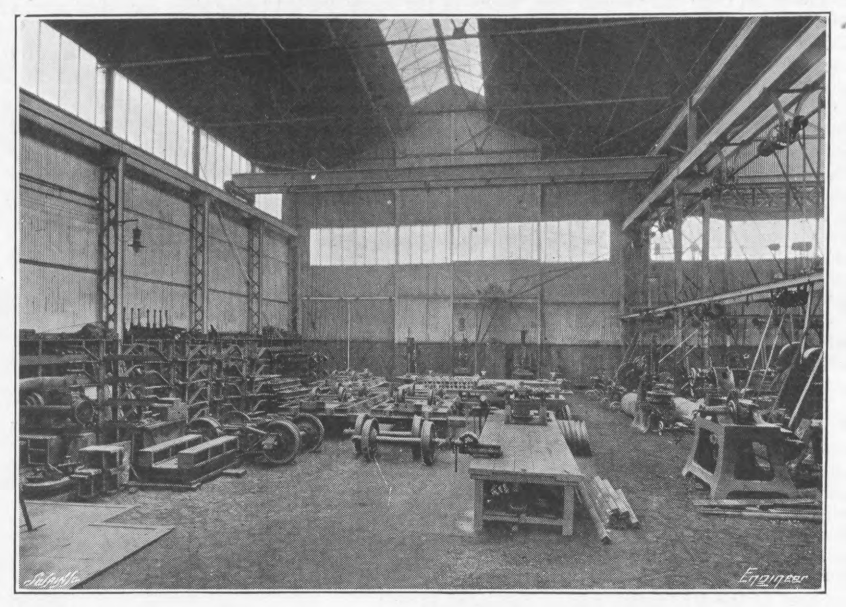


Fig. 5—THE WAGON FITTING SHOP

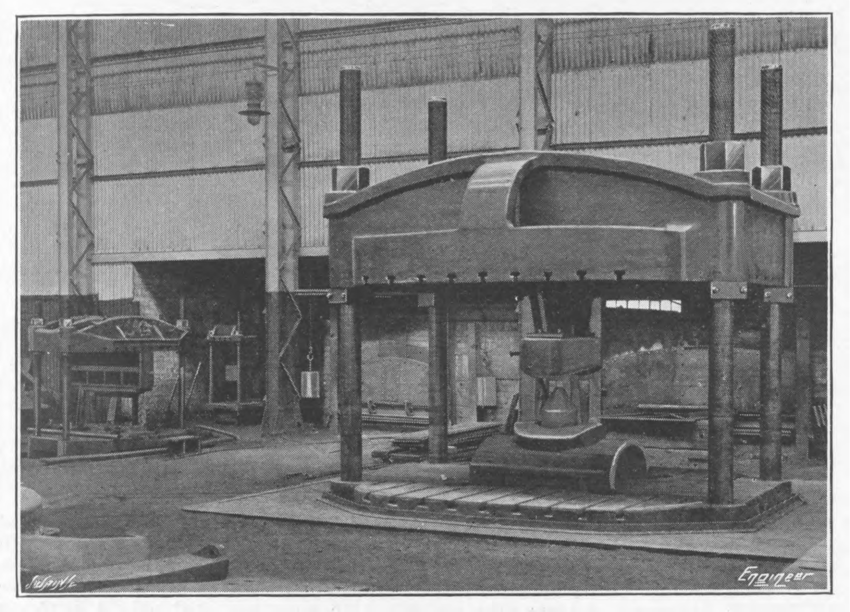


Fig. 6—380-TONS HYDRAULIC PRESS

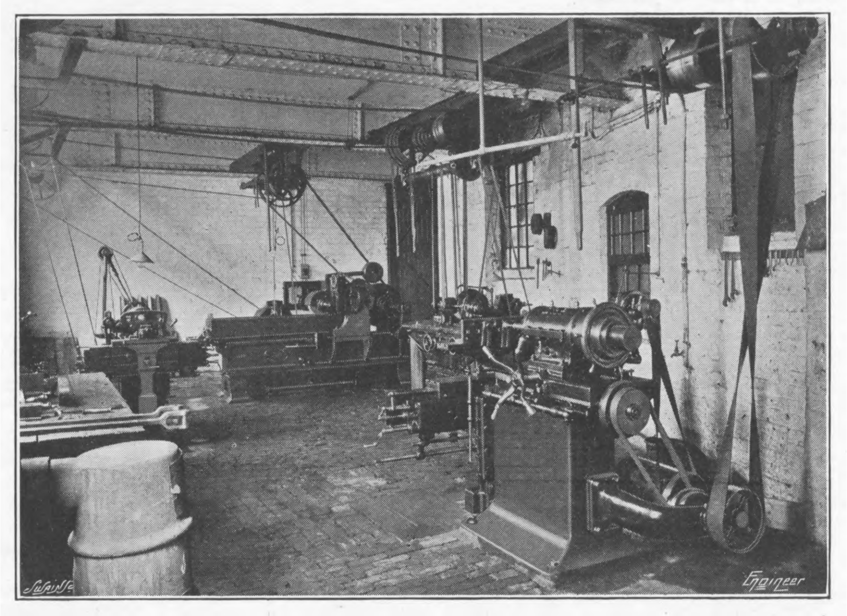


Fig. 7—THE GRINDING SHOP

tion of the specimens. The foundry is provided with a 5-ton overhead travelling crane operated by hand, and all the power required in the shop is supplied from an electric motor. The foundry equipment includes two of Hislop's gas-heated core ovens, and a cupola for the cast iron and crucible furnaces for the brass foundry, sand mill, &c. The shops are illuminated at night by arc lamps. The natural formation of the land allows the raw materials to be tipped on to the charging platform of the cupola direct from the line of rails which runs through the works yard.

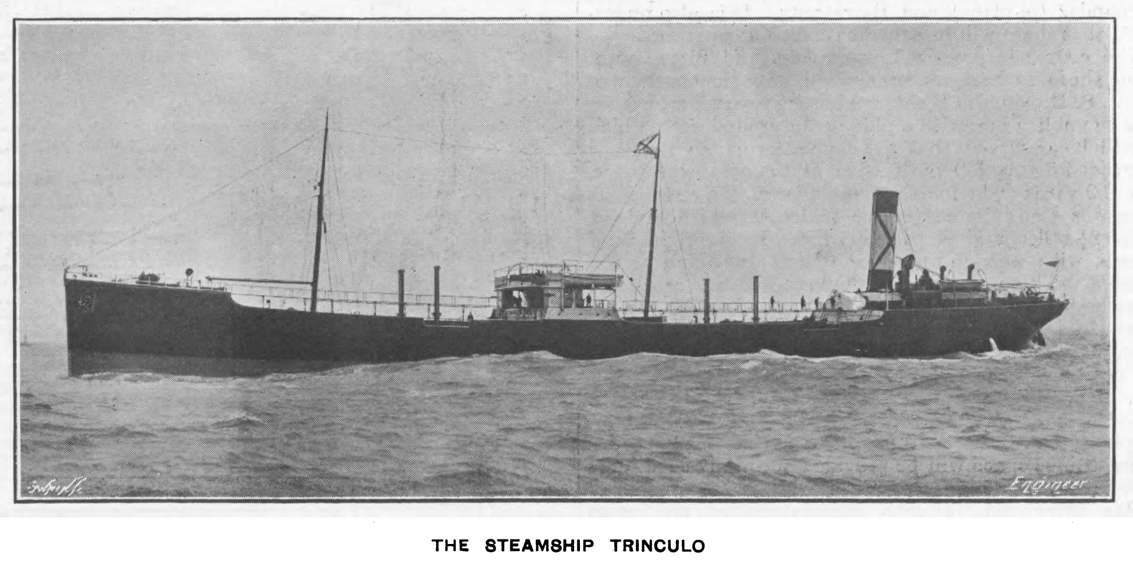
From the foundry we pass to the large new building, 260ft. long, which is chiefly devoted to the construction of railway wagons—Fig. 5. This building is composed of two spans, each 50ft. wide, and there is a third bay for the boilers, furnaces, hydraulic pumps, &c. It is constructed of steel and corrugated iron, with a roof of Eternit slates, and is well lighted both by day and night. A large portion of one bay—see Supplement—is occupied by the smiths, and contains the usual smiths' hearths, steam hammers, hydraulic flanging press by Fielding and Platt —Fig. 6—and other necessary appliances. The reheating furnaces for the flanging presses are gas fired on Hislop's system. A line of rails runs into the building on the wagon side, and there are two overhead travelling cranes —one 5 ton electric crane by Royces, and one hand crane in the smithy bay. The shop also contains a number of heavy machine tools, such as wheel lathes, drilling machines, punching, shearing, and bending machines, the power for all of which is supplied by a 60 horse-power electric motor. For the hydraulic press power is obtained from a battery of boilers, two being fired by the waste heat from the reheating furnaces, and there are also a Babcock boiler with water softening plant, and two coal-fired auxiliary boilers. The hydraulic compressor engine is by Fielding and Platt, and there is also a steam-driven air compressor by the Consolidated Pneumatic Engineering Company, which supplies air under pressure for the riveters.

It may be stated that there are new pattern and paint shops being built, and that most of the improvements have been carried out within the last two years, and the firm anticipate that it will take a further two years to complete the whole extension scheme.

Kerr, Stuart and Co. is strictly a private limited liability company. The combined offices of chairman and managing director are in the hands of Mr. George Glass Hooper, with whom are associated on the Board Captain the Hon. F. C. Stanley (vice-chairman), and Sir Thomas Parkyns, Bart. The position of works' manager is ably filled by Mr. J. W. Kidd. It is only some eighteen years ago that the first locomotive was built at these works, so that it will be seen the progress made has been rapid.

BRITISH TANK STEAMERS FOR THE PACIFIC TRADE.

ONE of the most important of this year's transactions in the tank steamer business has been the equipment of the Pectan, of the Shell Line, and of the Oberon and Trinculo, owned by Messrs. C. T. Bowring and Co., with the Meyer's system of oil fuel burning, and the chartering of these steamers to run in the California oil trade. The Trinculo underwent her trials off the Tyne on Tuesday, September 28th. Owing to the strong easterly wind and occasional wind squalls, she did not leave the river in the early morning, but at ten o'clock the company invited to be present went on board off Smith's Docks, North Shields, and before eleven o'clock the large steamer (she carries 7500 tons of oil) was steaming out to sea.



THE STEAMSHIP TRINCULO

It was found when the vessel got outside the piers that the weather was too hazy for the officers to make out the landmarks on the measured mile, and it was decided to take the runs by the log. Naturally, interest in the trip centred in the stokehold equipment and the work of the engines running under oil fuel. The system was most carefully studied, and the results, which were secured with a fuel oil supplied by the Anglo-American Oil Company, were satisfactory from the two most important points of view—low consumption and increased speed. The vessel ran slightly more than 11 knots, and, working under trial trip pressure, had a fuel consumption that worked out at 24 tons a day. Before the fire-boxes were warmed up—the steamer having come straight out of the river to run her trial—the furnaces gave off some smoke, but before the run was finished there was perfect combustion, and the engineers expressed themselves thoroughly satisfied that on the run out to the Pacific the vessel would make some interesting records in this particular trade.

The feature of the system is the distribution of the oil as a spray in the furnace in a heated condition and under pressure from an oil pumping plant. On the occasion of the Trinculo trial, the company was shown a simple hand pump and spraying contrivance working with water. This gave a fine spray reaching away 4ft. or 5ft. from the nozzle. The arrangement elucidated points not easily grasped during a visit to the stokehold.

The pumps are in duplicate, one being for use while the other is in reserve. A suction heater has two filters, one of which can be used while the other can be cleaned. There are also two delivery heaters, of which one is always in reserve. In general construction these heaters consist of a chamber within which heating pipes are arranged, the suction heater having its duplicate filters arranged one on each side. Steam is supplied and passed through three stop valves and pipes to the coils of the delivery and suction heaters, and leaves them by pipes connected to the main exhaust pipe, which also takes the exhaust pipe of the pumps.

The pipes from the various fuel tanks in the vessel are led to a distributing box having a stop valve for each tank, and this box is connected to the pipe communicating with the suction heater. The pump sucks the oil through the pipe from the filter out of the suction heater, and delivers it to one of the delivery heaters in use, and thence through a pipe to the furnaces. Each furnace is provided with a distributing box having four valves and four jets—one valve for each jet. Each jet consists of a nozzle having a needle pressed into place by a spring and end cap, and is also provided at its end with a screwed portion by which the oil under pressure is sprayed into the furnace. The fuel delivered is regulated by the stop valve of each jet, and any excess delivered by the pump is discharged through the spring-loaded by-pass valve back to the suction heater, so that the stokehold regulation can be carried out without reference to the speed of the pump, although, naturally, this latter is regulated under conditions just above the maximum demand for the sake of economy.

The furnace front is fitted into the flue so as to leave an annular space, and its periphery has radially disposed ribs by which the air is heated in its passage through the annular space. Upon the furnace front and covering the annular space is a ring damper having a screw arrangement on its inner surface which co-acts with studs on the furnace front having the function of a male screw. On the ring being rotated by the handle, the face of the ring can be brought up to and be receded from the furnace front, so that the area of the air passage can be regulated at will.

It is worthy of special mention that the converting of the vessel back again to coal was accomplished in the short time of 48 hours, without interfering in the slightest with the taking in of the bunker coals.

We give in the following table certain particulars regarding the trial above referred to :—

S.S. Trinculo.

Details of Oil Fuel Trial with Meyer's Liquid Fuel Installation.

Engines—	
Stroke	25in., 43in., and 72in. by 48in.
Working pressure	180 lb.
Total heating surface	7281 sq. ft.
Mean speed	11.1 knots by log
Revolutions	68 to 69 per minute
Steam pressure	178 lb.
Pressure in m.p. chest	68 lb.
Pressure in l.p. chest	13 lb.
Vacuum	25in.
Indicated horse-power on trial	2417
Consumption of fuel per I.H.P.	.94 lb. of oil
Specific gravity of oil fuel at 65.5 deg. Fah. .895, equal to about 40.15 cubic feet per ton.	
Pressure of oil at heaters	25 lb.
Mean temperature of oil at burners	200 deg. Fah.
Mean temperature of furnaces at front of striking column, *i.e.*, 5ft. 9in. from furnace fronts taken with a Siemens pyrometer	2290 deg. Fah.
Temperature 3ft. 6in. in from furnace front by pyrometer	1870 deg. Fah.
Temperature in air conveyor passages 9in. in from front	370 deg. Fah.
Temperature at base of funnel	520 deg. Fah.
,, on deck	58 deg. Fah.
,, in stokehold	85 deg. Fah.
Air passing through each front per minute	3322 cubic feet
Air passing down one ventilator per minute	12,964 cubic feet
Pressure in stokehold	2.3 lb. per sq. ft.

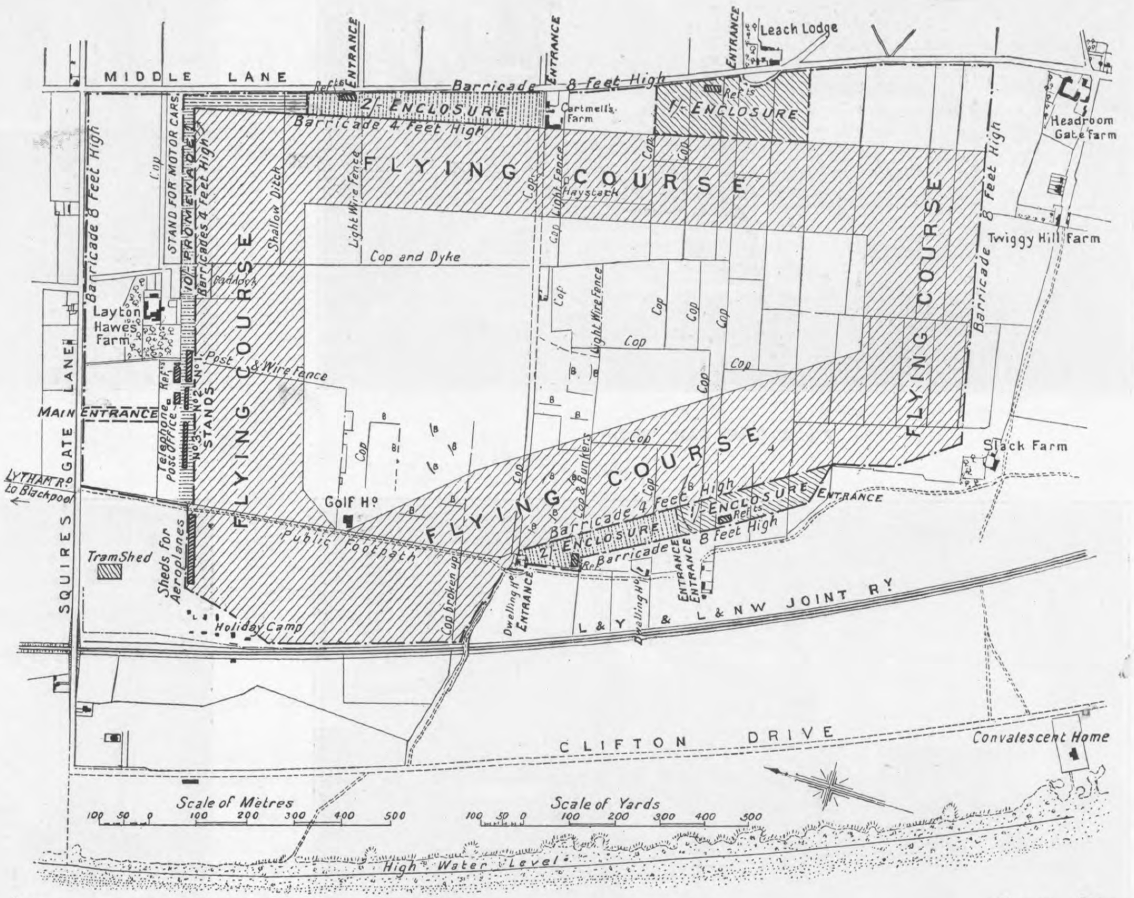
The following auxiliaries were also working :—
Steam steering gear.
Dynamo
Weir's feed pumps.
Gwynne's circulating pumps.

BLACKPOOL AVIATION WEEK.

Although the full list of entries for the various flying competitions which are to be held at Blackpool next week cannot yet be published, it is now certain that, with the exception of M. Bleriot, the most successful continental aviators are under contract to compete. The following are the names of those with whom definite arrangements are said to have been made :—Farman, Paulhan, and Dufour (Farmer bi-planes), Le Blanc (Bleriot monoplane), Rougier, Fournier, and Gobron (Voisin bi-planes), Latham (Antoinette monoplane), Fernandez (bi-plane), and Barratreux. It is also understood that there will be several English competitors.

The course is practically complete, and fifteen aeroplane sheds or hangars are erected. By the courtesy of Mr. J. S. Brodie, the Blackpool borough surveyor, we are able to publish herewith a plan of the ground, from which it will be observed that the course forms an irregular four-sided figure, 250 yards wide at the commencement, and 100 yards wide for the remainder of the circuit. It measures along the centre line 4 kiloms. = 4376 yards = about 2½ miles, and is perfectly flat. It is a right-hand course, with wooden towers or pylons 40ft. high at the corners. These towers are hollow wooden erections, surmounted by a flag-pole 20ft. high, and in each will be placed a telephone instrument to enable the attendants to communicate with the judges' box. The outside of the course will be marked out by a canvas barricade 3ft. 6in. high, and grand stand accommodation will be provided for about 5000 persons, together with a large telegraph-office, refreshment pavilions, &c. Along the sides of the course space will be provided for many thousands of the general public.

The prize list is very comprehensive, the most important being the Grand Prize of Blackpool for Long Distance. In this competition the first prize will be £2000, the second prize £720, and the third £280 for the competitors who complete the greatest number of circuits during the meeting. For the competitors flying the greatest altitude there will be three prizes, namely, £600, £240, and £160; no prizes will be awarded unless the minimum height of 200ft. be attained. Two prizes will be awarded for carrying passengers, namely, £400 and £100. These prizes will be awarded to the competitors carrying the greatest weight over one complete circuit of the course. For speed there will be two prizes, one of £400 and one of £100. For the three British aviators who shall cover the longest distances without touching the ground there will be three prizes, namely, £250, £150, and £100. In this case the minimum distance to earn a prize will be 250 yards. The "All British" prize awarded by the Blackpool Tower Company consists of two sums, £150 and £100, for British aviators piloting an all British machine, *i.e.*, designed and built in the United Kingdom and fitted with a British engine. The minimum distance in this competition is 100 yards. For the competitor who completes a circuit in the slowest time there is a cup value £100 and £100 in money; this is a novel but very desirable competition. There will also be prizes to the value of £500 for general merit throughout the meeting, and a sum of £50 will be awarded among the assistants of the competitor who completes the greatest number of circuits.

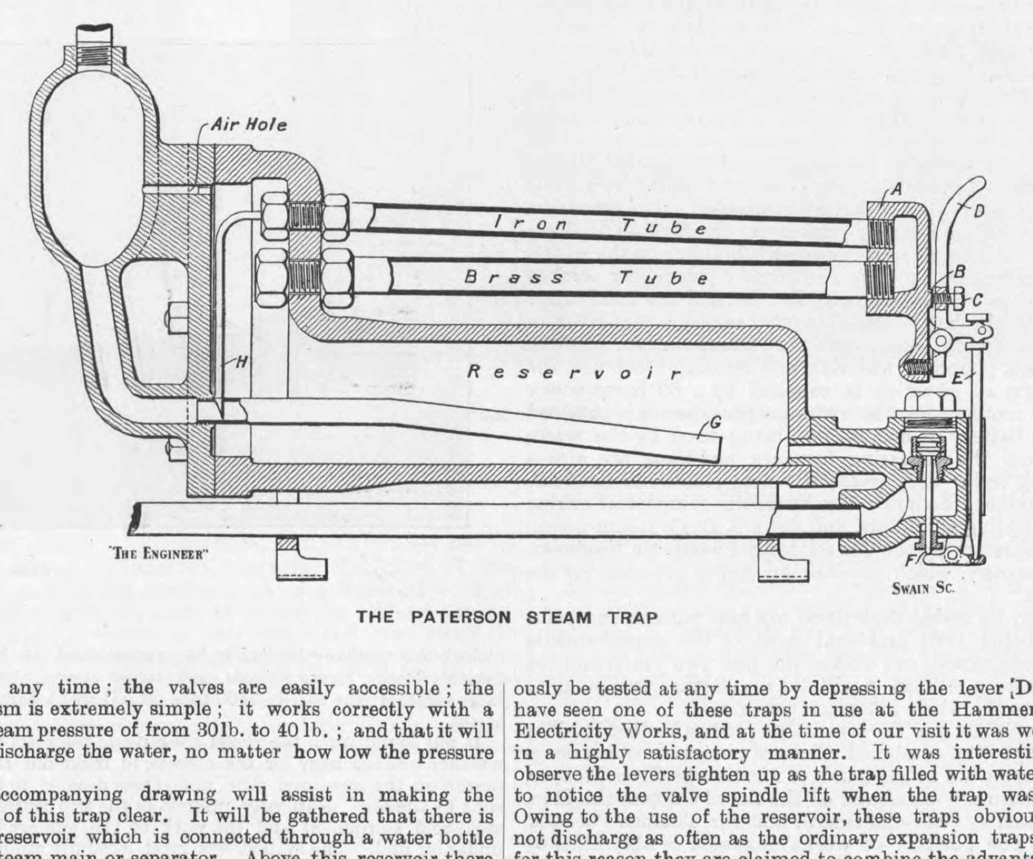


"The Engineer" Swain Sc.

PLAN OF THE BLACKPOOL FLYING COURSE

A NEW STEAM TRAP.

A new type of steam trap, for which several important advantages are claimed, has recently been brought to our notice. It is the invention of Mr. Paterson, of the Hammersmith Electricity Works, and it is being manufactured by the firm of Charles Wicksteed, of Stamford-road, Kettering. Although it has only recently been put upon the market, we are informed that it has been tested for a period of three years, and that it has proved highly satisfactory. Briefly, the special advantages claimed for it are as follows :—It does not dribble; it only discharges periodically; the water is comparatively cool; the discharge valve is always in water; the expanding and contracting parts cannot cause it to leak; it can be set to any pressure in a minute; it can be tested by hand at any time; the valves are easily accessible; the mechanism is extremely simple; it works correctly with a fall in steam pressure of from 30 lb. to 40 lb.; and that it will always discharge the water, no matter how low the pressure may fall.



"The Engineer" Swain Sc.

THE PATERSON STEAM TRAP

The accompanying drawing will assist in making the principle of this trap clear. It will be gathered that there is a closed reservoir which is connected through a water bottle to the steam main or separator. Above this reservoir there are two tubes, the top tube being of iron and the bottom of brass. The expansion and contraction of these tubes operate the valve through the medium of the levers shown on the right. When the trap is idle, that is to say, when it is cold, owing to the contraction of the tubes, the levers on the right are rigid. This arises from the fact that, on cooling, the head-piece A descends, and since there is a wedge-shaped projection at B, the screw C is subjected to compression, which forces the lever D outwards, the rod E downwards, and the valve spindle F upwards, thus opening the valve. Now, when a steam main is being put into use, so long as there is water, this passes through the large pipe G and out at the valve, which remains open until the inlet pipe is emptied of water as far as the small tube H. The steam passes through this small pipe H and into the iron and brass expansion pipes, thus raising their temperature. By reason of the lower or brass tube expanding the most, the head-piece A is thrust upwards, relieving the screw C and the rods E and F of compression. The valve thus falls on its seat, where it is held by the pressure of steam. This is accomplished before the water is drained out of the bottom of the reservoir, thus the valve is not subjected to alterations of temperature which tend to make it leaky. The valve remains closed until the reservoir and all the pipes are filled with water, when the head A comes down again and forces the valve up in the manner described when the water is discharged. A feature to which Mr. Paterson particularly calls attention is that the water is not stored in the expansion tubes in the usual manner. The great advantage as regards wear and tear and efficiency in using the expansion tubes merely to open and shut the valve when the reservoir fills, instead of using them as reservoirs themselves, will, Mr. Paterson believes, be apparent to all who have studied the matter. The trap can obviously be tested at any time by depressing the lever D. We have seen one of these traps in use at the Hammersmith Electricity Works, and at the time of our visit it was working in a highly satisfactory manner. It was interesting to observe the levers tighten up as the trap filled with water, and to notice the valve spindle lift when the trap was full. Owing to the use of the reservoir, these traps obviously do not discharge as often as the ordinary expansion traps, and for this reason they are claimed to combine the advantages of the expansion and float types. For superheated steam they are said to be eminently satisfactory.

RAILWAY MATTERS.

The *Bulletin Commercial* (Brussels) of 2nd October states that, according to the *Java Bode*, the Colonial Administration in Java have applied to the Dutch Minister of the Colonies for permission to extend the tramway of Atjeh from Sangsar to Koeala Simpang. For this work, which is expected to be executed during the year 1910, the sum of 1,200,000 florins (£100,000) has been set aside in the budget.

The August number of the *Revue Commerciale du Levant* states that there is an opening for a tramway system at Ada Bazar. It is pointed out that the town is very scattered, and situated on level ground; there is a large amount of traffic, and the railway station is at the extremity of the town. It is to be noted that Ada Bazar is situated on the Anatolian Railway at a comparatively short distance from Scutari and Constantinople.

The first section of the Shanghai-Hangchow Ningpo Railway, which extends from Shanghai to Fengch'ing, a distance of 38 miles, was opened to traffic on May 30th last. This line was built under Chinese engineers. The preliminary survey of the line was made in the winter of 1907. There are 10 stations and 48 steel bridges on this section. The longest bridges have spans of 140ft., 400ft. and 200ft. respectively. The average cost of construction was £7000 per mile.

According to *Electrical Engineering*, the platforms of the Central London Railway are being converted from wood to concrete, on the recommendation of the Board of Trade, in the interests of the greater safety of the travelling public. The recommendation in question was made as the result of the fire at the Moorgate-street station of the City and South London Railway, and the platforms at twelve stations of that company are being reconstructed in the same way.

It is reported that the Italian State Railway authorities have decided upon the adoption of electric traction through the Mont Cenis tunnel and on other portions of line where the gradients are considerable, with a view to improving the service from Modane to Turin. For this purpose the Municipality of Turin is being approached regarding placing a 3500 k.v.a. set in the Chiomonte generating station on the Dora Riparia at the disposal of the railway for a guaranteed payment of £8000 per annum.

The scheme to connect Singapore with Bangkok by rail through British territory, or territory within the British sphere of influence, states the *Indian and Eastern Engineer*, is expected to be effected within the next few years. The line from Singapore for a distance of 196 miles in this direction will be completed by the end of 1910, which will leave but 150 miles to make connection with the Siamese terminus. It is proposed to spend the £4,000,000 loan provided for in the Anglo-Siamese Treaty to continue the line from Bangkok to the border at Kelantan. There is a project ultimately to connect the Burma railways with this system.

As a result of the active agitation which has been carried on for some time in favour of the compulsory conversion of all steam railways entering the city of Chicago to electric traction, states *Electrical Engineering*, the City Council have drawn up an ordinance requiring all railways within eight miles of the City Hall to adopt electrical power after January 1st, 1912, in accordance with plans approved by the Commissioner of Public Works. There is considerable opposition on the part of the railway interests, but the city officials consider the legality of the ordinance unquestionable. The ordinance has yet to be reported on by the committee on local transportation, but in the opinion of our contemporary there is every likelihood of its being finally carried.

The report of the Chief Commissioner for New South Wales Government Railways and Tramways, for the year to June 30th, 1909, shows that the railways open in the State now amount to 3623¼ miles, over 150 of which were opened in that period. The gross earnings amounted to £5,028,450, an increase of £84,316 on the previous year's figure. Expenditure, however, mounted up from £2,714,839 to £2,952 824, an increase of £237,985; the net surplus after providing for interest on capital being £388,892, against £579,931 last year. In the case of tramways, there was an improvement in both the gross and the net revenue, the total earnings rising from £1,011,994 to £1,097,565, while the net surplus amounted to £79,174, as compared with £68,425 last year.

According to a contemporary, plans are at present under consideration for the building of a bridge over the Ganges for the Eastern Bengal Railway at Sara, where hitherto the traffic has been carried on by means of a ferry. The new bridge will be over a mile in length, and is estimated to cost about £1,300,000. The plans for the work provide for a girder bridge built in spans of 360ft. Each span will weigh about 800 tons. The main difficulty of the work from the engineering standpoint lies in the great depth—150ft. into the river bed—to which the foundations for the piers will have to be sunk, in order to guard against the deep scour of the river. The piers are designed for a double-track bridge, but at the outset there will be only a single line on the bridge. The general policy of rebuilding and strengthening the bridges of the State railways in India is being vigorously prosecuted at the present time, partly by reason of the age of certain of the bridges, but more in consequence of the increased loads due to the greater weight and speed of trains.

A change in signalling, consisting of a new position of the signal arm for "proceed" has been adopted as standard by the Baltimore and Ohio Railway, and will be used in all future installations. The new position, instead of being below the horizontal, as heretofore, is above. No change, however, has been made in the stop indication, the arm being horizontal, or at right angles to the mast. The "proceed, caution" indication is given by the arm in the 45 deg. position above the horizontal, as compared with a similar position below the horizontal under the old method. The "proceed clear" indication is given by the arm in the vertical position outside the line of the mast above the horizontal, whereas under the old method this sign was indicated by a similar position below the horizontal. The operating officials believe that the upper quadrant system provides a more distinct aspect than under the old method. The first test of the new method was begun about three years ago, and though a large number of installations of this type of signal has been made during the past two years, it was not finally adopted as standard until recently.

In his report on the trade of the district of Lyons, Mr. Consul Edward Vicars points out that it has been proposed to construct a lateral canal, 167 miles long, from Lyons to Arles, where it would join the Arles-Marseilles Canal, now under construction, at an estimated cost of £20,234,000, say, £120,720 per mile. No insignificant part of the ambitious and far-reaching scheme is that which provides for the creation of river ports all along the canal, and for linking up of the new waterway with the railway. Hitherto the existing ports have been ill-organised and ill-equipped, without either proper basins or quays, while, owing to the uncompromising hostility towards any connection with waterways which has been part of the declared policy of the Paris-Lyons-Mediterranean Railway Company, the Rhone has remained practically cut off from the railway, and communication between the river ports that exist and towns on the line but a few miles distant has had to be made by means of carts. The railway company has, indeed, made no secret of the enmity with which it regards canals and navigable rivers, and the late chairman frankly affirmed that, though linking up railroads with waterways might help the latter and be of general value commercially, it would be detrimental to the interests of the railways themselves.

NOTES AND MEMORANDA.

Earthwork on the Southern Pacific incline in Jalisco, Mexico, cost the sub-contractors from 12 to 16 centavos per cubic metre. The work was done by Indians carrying the material in baskets from the right of way, making an embankment of upward 15ft. in height.

The first great electric smelting plant for the treatment of ores to be established in Canada is to be erected at Sault Sainte Marie, Lake Superior. Similar furnaces are now in successful operation in Sweden. A second plant, involving an investment of some £1,400,000, is contemplated at a point on the Ottawa River, and it is confidently expected that this will be followed by many more plants of a similar nature.

The production of forged iron and steel car and locomotive axles, shafting, anchors, armour plate, &c., by the rolling mills and steel works of the United States in 1908 amounted to 131,143 gross tons, of which about 13,646 tons were iron, and about 117,497 tons were steel. In 1907 the production of forged products by rolling mills and steel works amounted to 380,805 tons, of which about 23,772 tons were iron and about 357,033 tons were steel, while in 1906 the production of forged products was 352,636 tons.

Arrangements have been completed whereby a standard clock at the Hamburg Observatory, Bergedorf, is connected to the trunk telephone system. A sounder automatically emits a siren-like note from the fifty-fifth to the sixtieth second of each minute—mid-European time—and this goes automatically to all the receivers connected, at that time, with the special exchange number which has been allotted to the time signal. Thus Hamburg and neighbourhood and other towns of east Germany are supplied with a ready means of ascertaining the standard time.

In a recent issue of the *Electrical World* a patent issued to Mr. B. Frankenfield is described. The claim relates to an arrangement whereby the load on several shunt-wound direct-current motors connected in both mechanical and electrical parallel can be divided equally among the machines. Each motor is provided with as many separate field-coil sections as there are individual motors, the sections on one machine being joined in series with those on the other machines. The arrangement is such that any change in the field circuit resistance of one machine varies the strength of the fields of all the machines equally. This action prevents any motor from taking more than its share of the load, as would be the case if the motors were independently connected to the supply system and the field winding of one became hotter, and therefore admitted less current than the field winding of another motor.

Mexico, states an American contemporary, holds the fifth position in the production of quicksilver in the world, but falls short by a considerable amount of producing enough to supply the home market. Prior to the introduction of the cyanide process for the treatment of the silver ores the importations of quicksilver, known in the Spanish as "azogue," was very heavy, and the necessity of having this metal for the patio process was so great that the Government removed all taxes from quicksilver mining, both federal and state, and provided for the free admission of quicksilver into the country. This same law is enforced to-day, and is one of the causes stimulating the new developments in the Mexico quicksilver districts. The falling off of production in other parts of the world has turned attention to the Mexican districts, and the prospects of greater activity in quicksilver mining in Mexico are very good.

A report on "The Chrome Iron Ore Deposits of the Eastern Townships, Province of Quebec," has been published recently by the Mines Branch of the Department of Mines of Canada. It is prepared by Fritz Cirkel, long connected as consulting engineer with the chromite and asbestos industries. The deposits of these two substances in the Province of Quebec occur in the same region, and the origin of both is closely connected with the serpentine rocks of the eastern townships. The present pamphlet, which contains 141 pages, not only gives data concerning Canadian chromite deposits, but also chapters on the uses, the technology, and the metallurgy of chromium, and its descriptions of the various deposits in all parts of the world. The statistics given indicate that the total value of the Canadian exports of chromite since 1886 has been £136,743. The production in 1908 amounted to 7225 net tons, valued at £16,401.

A detailed study of the lengths of the waves emitted by many of the ordinary forms of generators of short electric waves has been carried out by Messrs. H. W. Webb and L. E. Woodman, at Columbia University, and the results are given in the August number of the *Physical Review*. The object of the authors was to establish such definite relations between the dimensions and electrical properties of the generators and receivers of the waves as to enable future workers to calculate the wave length with certainty from the dimensions of the apparatus used. The method employed was Boltzmann's, the beam sent out by the generator being reflected at two mirrors, and the two half beams brought together to produce interference. Rod, cylinder, Righi, and other generators were tested, and the wave length measured in each case, a non-selective receiver being used. For apparatus of the same type, but of different size, the wave length is proportional to the linear dimensions of the apparatus.

Soldering ordinary platinum vessels is commonly done with platinum itself as the soldering material, or with pure gold, using the oxyhydrogen blow-pipe or its equivalent melting flame. Gold has the disadvantage that it melts at a lower temperature than the platinum, and under temperatures to which crucibles or other vessels may be subjected, it melts and leaves the crack open. In *Central-Zeitung für Optik und Mechanik* it is recommended to close the crack with a mixture of platinum powder and turpentine oil, then to heat the joint to a white glow, and in this condition to hammer the parts together. Another method, applicable where the crack is on the edge, consists in hanging a narrow strip of platinum sheet over the crack, then placing the article in the fire, heating it white hot, and hammering if necessary. According to *Metall-Arbeiter* a small hole may be closed by a rivet made of platinum wire, welded after hammering both heads closely. For larger holes a patch is made of platinum sheet, riveted on, and then welded.

The *Electrical Review and Western Electrician* gives an account of an electrically-driven rail bender in which the framework of the machine is a heavy steel casting made in one piece, the solidity of which ensures regularity of curvature and rapidity of work, which, with the small amount of manual labour required, renders the tool extremely useful on construction work. The power-driven bending roll is mounted in a frame which is driven forward to give the desired curvature by a hydraulic cylinder, the power for which is a small hand pump mounted on the frame of the tool above the cylinder. The roll can be driven out under a pressure of 50 tons. The two fixed roll centres are 34in. apart. The driving roll is geared to make one turn to eight turns of the pulleys, which are 24in. in diameter and have a 7in. face. The bending rolls must be made to suit each shape of rail to be bent. The outer bending rolls are changed by loosening set screws and pulling out the pins. The arm holding the middle bending roll can be worked in and out by a lever without the aid of the pump, if the release valve is open, so that the pump is necessary only when bending a rail to get the desired curvature. The capacity of the machine is about one medium length rail per minute when once adjusted,

MISCELLANEA.

The trials of the new German improved Dreadnought Westfalen in the North Sea are stated to have been highly satisfactory. She developed 24,000 horse-power and attained a speed of 20 knots, compared with the 20,000 horse-power and 19 knots stipulated for in the contract with the Weser Yard.

The high steam shovel record for August on the Panama Canal excavation was made by a shovel working in the Culebra District, which excavated 45,694 cubic yards of earth in twenty-six working days. A shovel working eight days in the Culebra District and eighteen days in the Empire District excavated 16,755 and 26,518 cubic yards respectively, a total of 43,273 cubic yards, the second best record for the month. A third shovel in the Culebra District made the high record for one day by excavating 2549 cubic yards of rock and earth.

The specification for ammeters and voltmeters [No. 49], just issued by the Engineering Standards Committee, classifies the instruments as sub-standard, first grade, and second grade, according to their accuracy, and defines the limits of error permissible in the three classes. The user can thus see at a glance the degree of accuracy he may expect for the class of instrument he requires; and by the adoption of the specification manufacturers will be saved a large amount of needless trouble in tendering, and also should be enabled to cheapen production through standardisation of the detail work.

There appears to be every prospect of the Persian import of galvanised iron increasing, for according to the British Consul at Shiraz, every house now built for a well-to-do Persian is roofed with this material. At present, however, it is not stocked by any merchant, but ordered as occasion arises from Liverpool through Bombay. It is used in the three following qualities and dimensions:—(*a*) Plain sheets of 1.6 by 0.8 m., weight about 20 lb., this being the quality most usually employed; (*b*) corrugated, same dimensions and weight; (*c*) elongated, sheets of 2.3 by 9.65 m. This last size is for the protection of small gables over windows and doors.

At one of the London power stations, states the *Electrical Engineer*, it has been found that the energy required to work the air pump, circulating pump, and fans for the cooling tower costs more than the saving made by condensing. In other words, in this station it would pay to exhaust to atmosphere. The engines are of a very high-class make, with Corliss valves and guaranteed to use under 20 lb. of steam per kilowatt hour, and yet the whole station is taking nearly 40 lb. It is clear, therefore, that the condensing arrangements and auxiliaries require overhauling, and no doubt there are many stations which would do with a thorough inspection by an expert mechanical engineer.

The United States Government have issued returns as regards telegraph and telephone systems in the country, and, from particulars published by the *Telegraph Age*, it would appear that there are 65 miles of wire in the Republic of Panama, 484 miles in Puerto Rico, 1403 miles in Alaska, and 6438 miles in the Philippines. These systems handled over 1,000,000 messages. The Weather Bureau controlled 537 miles of wire and 96 miles of submarine cables, and 2280 places were supplied with forecasts, 734 with special warnings, and 5998 with emergency warnings, all this being done at the expense of the Government. Daily forecasts were sent to 2,141,151 addresses. Puerto Rico boasts of 128 offices and 1774 miles of wire, and the traffic amounted to 216,489 messages.

It is stated that the Thames Conservancy have purchased the Ray Mills Estate, adjoining Boulter's Lock, with a view to making a new lock and greatly improving this popular part of the river. The matter, it is reported, has been settled, and will be formally ratified by the Conservancy Board at their meeting next Monday, October 18th. It is proposed to use the existing lock for barge traffic only, and to construct a new up-to-date lock for the pleasure traffic. The island purchased is extensive. The flour mills and other buildings included in the transaction will be pulled down, and the total cost of the scheme will amount to many thousands of pounds. The terms of the purchase include immediate possession, and the new work will be undertaken at the earliest possible date.

Among the electrical exhibits at the Brescia Exhibition, states the *Electrician*, is a complete installation of the Bellini-Tosi system of directive wireless telegraphy. Owing to the confined space—for the Exhibition is held in part of the Castle of Brescia—the transmitting and receiving stations are only 40 m. apart; but, with the exception that the antennæ employed are reduced to only 3 m. in height, all the other apparatus is of full size—in fact, the radio-goniometer at the receiving station is the actual apparatus which is to be erected in the new station of the French Government (Post-office) which will shortly be opened at Boulogne. All the special features of the system, such as directive emission and reception of the waves and location of the direction of the transmitter, can be readily demonstrated, in spite of the small distance between the stations.

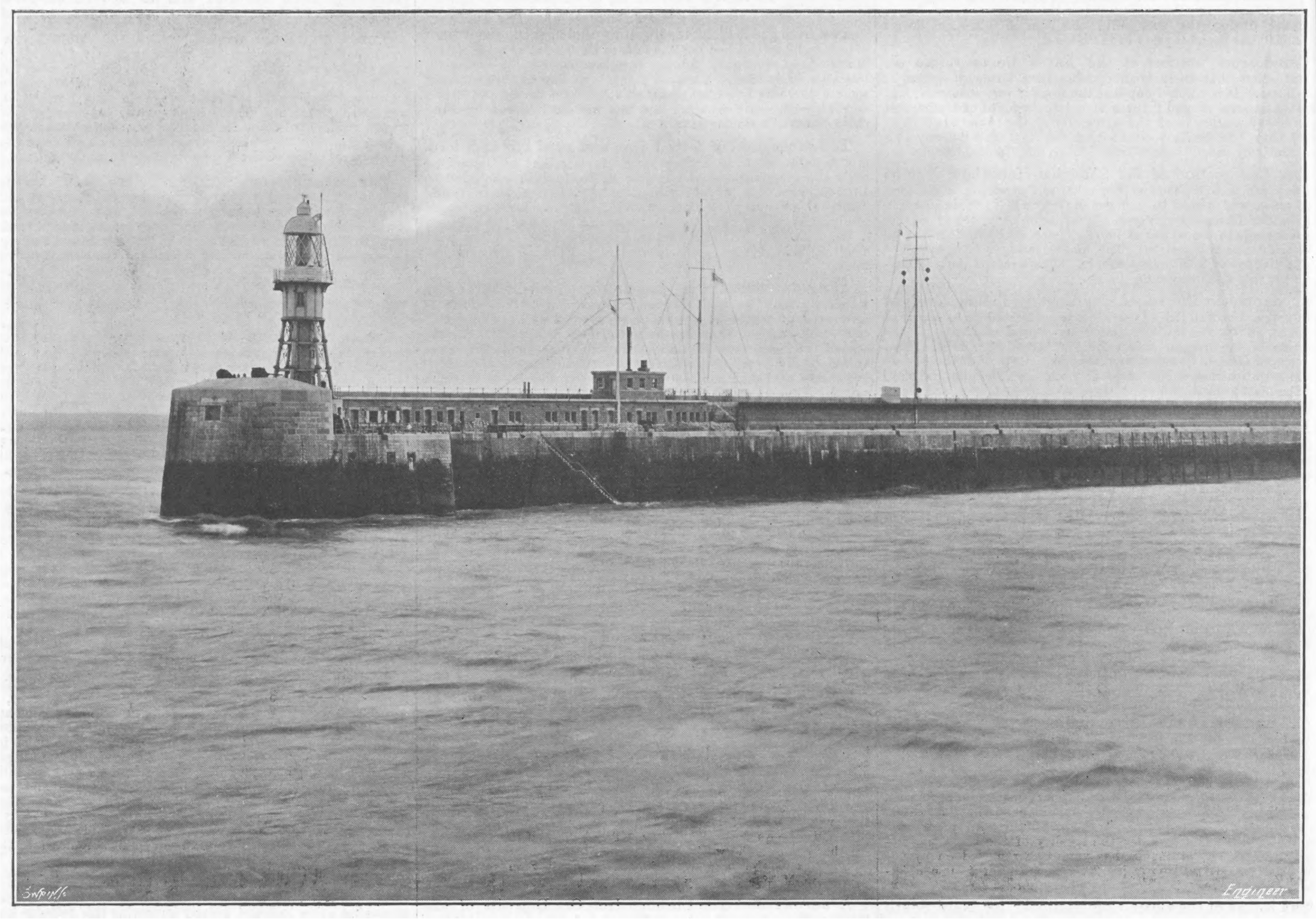
It is proposed to erect an electric generating plant on the Colorado River at what is known as The Needles, situated about 25 miles south of Powell, Ariz. Colonel C. E. Apponi has secured the water rights to a strip of the river territory five miles in length at the first rapids, and it is at that place the plant will be situated. A complete survey of the site has been made, and a syndicate of Milwaukee has been interested. The initial plant will have a capacity of 30,000 horse-power, and a number of transmission lines to supply towns and industrial plants within a radius of 170 miles of the generating plant will be erected. There are also many mines within the proposed radius. A large dam will be constructed, a storage reservoir will be built, and a system of canals will be utilised for irrigation purposes over a large area of land. The estimated expenditure is about £400,000.

The *Electrical World* states that several important hydro-electric schemes are on foot in the mining districts of Mexico. A Canadian syndicate is preparing to erect a large installation on the Conchos River; the Mines of Mexico Company is about to commence the construction of works on the Mayo River, near Alamos, to supply a rich mining territory within a radius of 175 miles; the Guanajuato Power and Electric Company and the Michoacan Power Company are extending their plant, which will have a total capacity of 21,000 horse-power when completed, and the manager reports that, besides the mining companies, farming interests and factories are taking power freely, and thousands of irrigation wells are being pumped by electric power. Other new installations will be situated on the Altar River, on the Santiago River, near Guadalajara, on the Quetzalpa River, and on the Matamoros River.

With reference to the proposals to establish an iron industry in Brazil, H.M. Legation there reports that a Presidential message to Congress urges that this should be done by the collaboration of the Government with private enterprise. The authorisation of Congress is requested to enable the President to take measures to encourage the working of the deposits and the establishment of ironworks. With regard to the exportation of iron and manganese from Minas, the remark is made that competition with the outside world is impossible without special privileges and subventions; the State levies an export tax of 300 reis per ton on these ores, and the freight on the Central Railway to Rio de Janeiro amounts to 600 reis per ton. So far no facilities have been planned at the new quays for the handling of manganese, and in the tariff now under contemplation for the port works, the despatching charges are heavy.

THE ADMIRALTY HARBOUR AT DOVER

(For description see page 390)


Swain Sc
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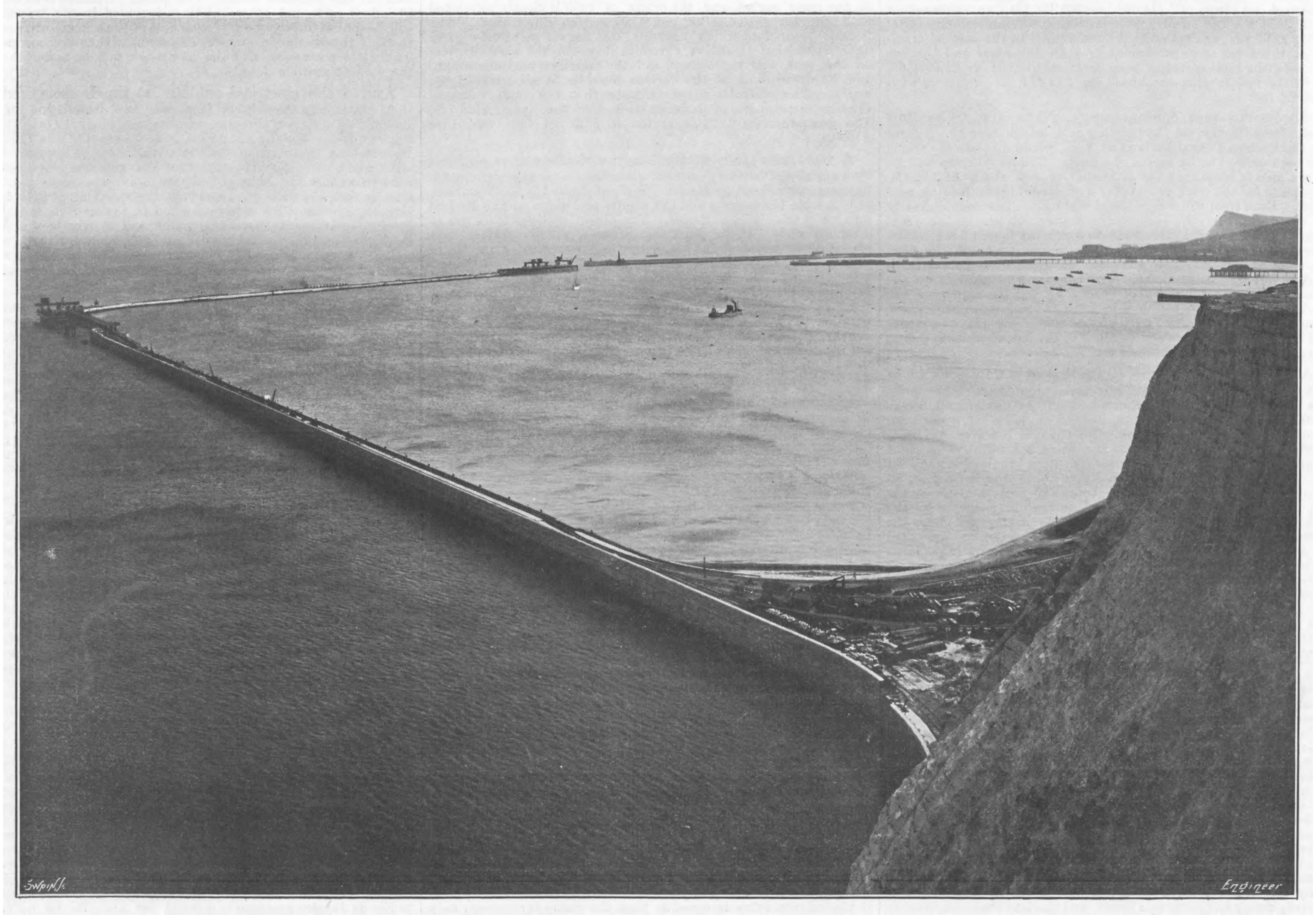
EXTENSION OF THE ADMIRALTY PIER—MAY, 1909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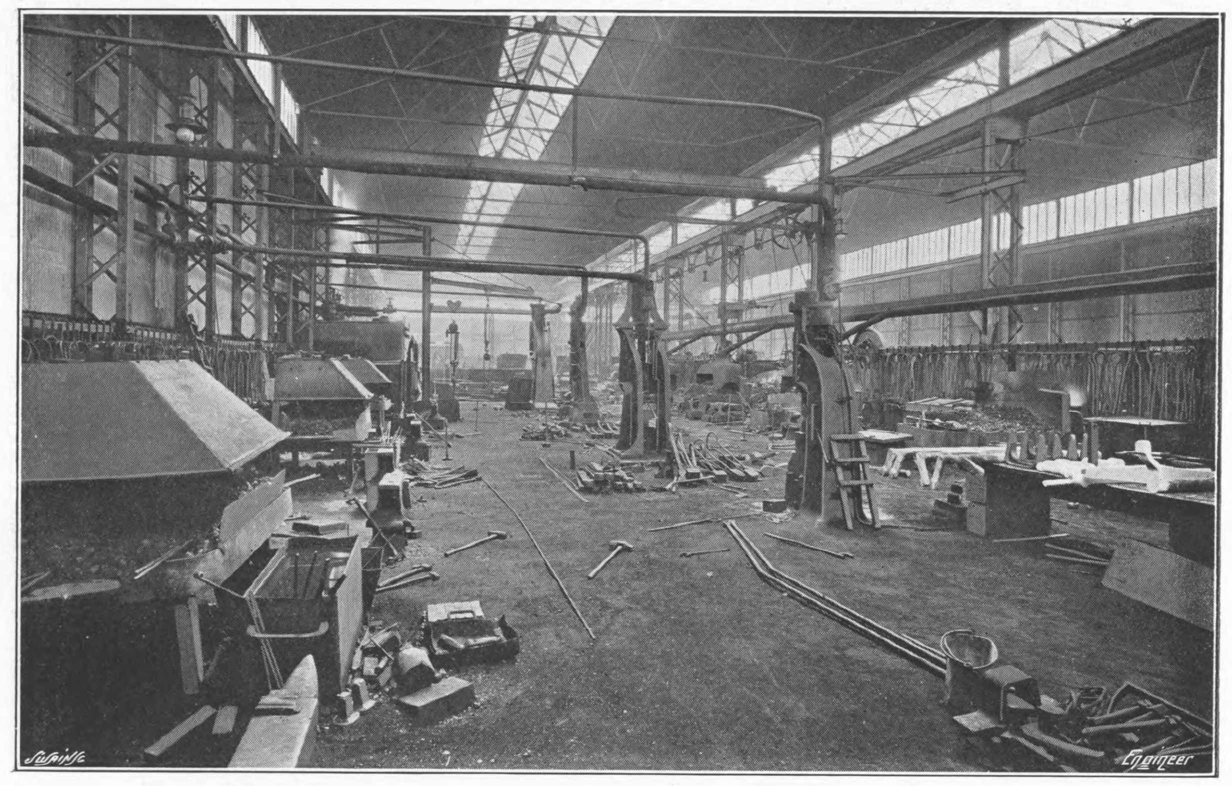
GENERAL VIEW OF THE HARBOUR—JULY, 1907

THE WORKS OF KERR, STUART AND CO., LIMITED, AT STOKE-ON-TRENT



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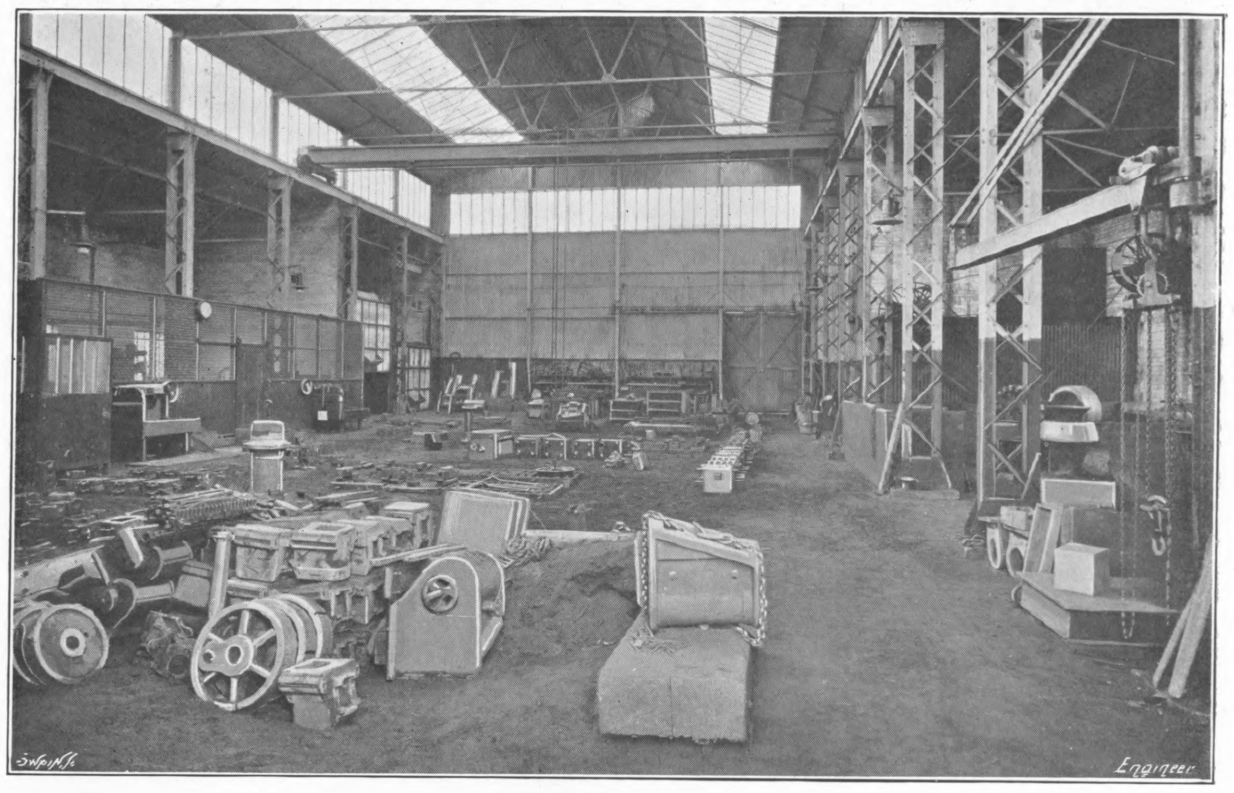

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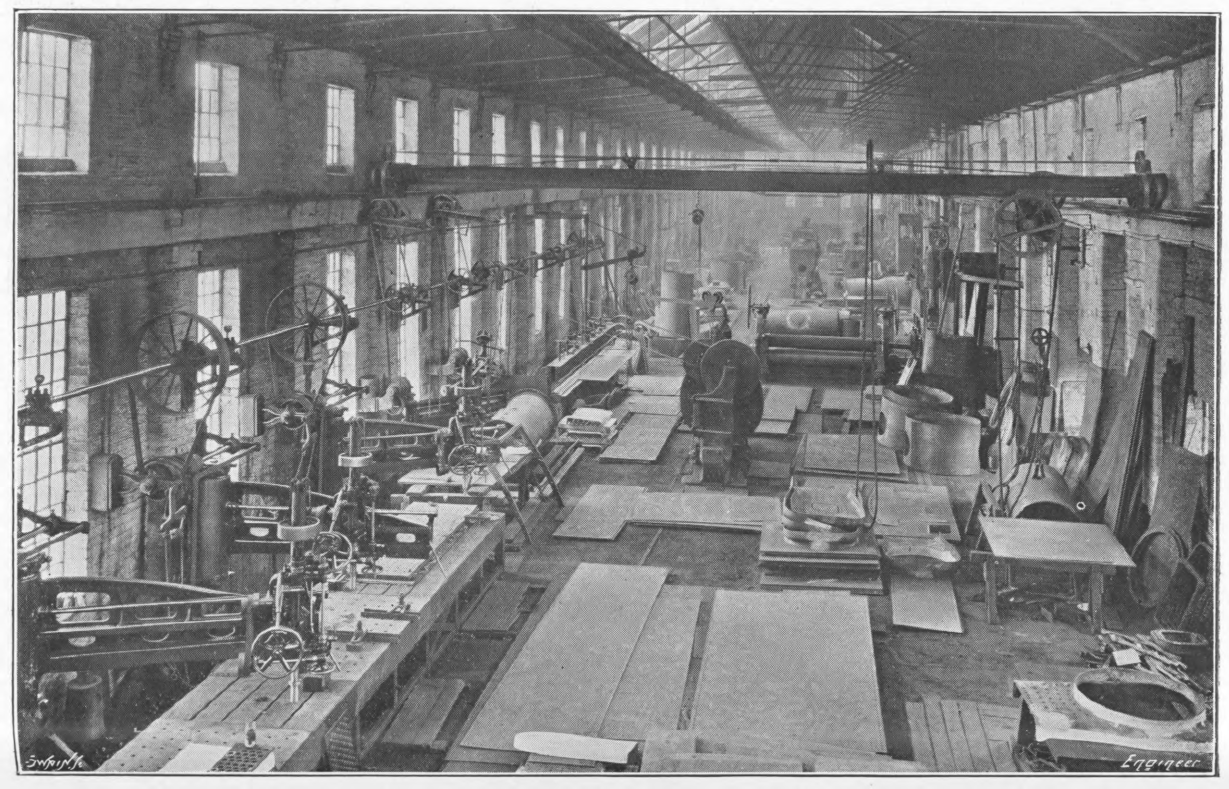
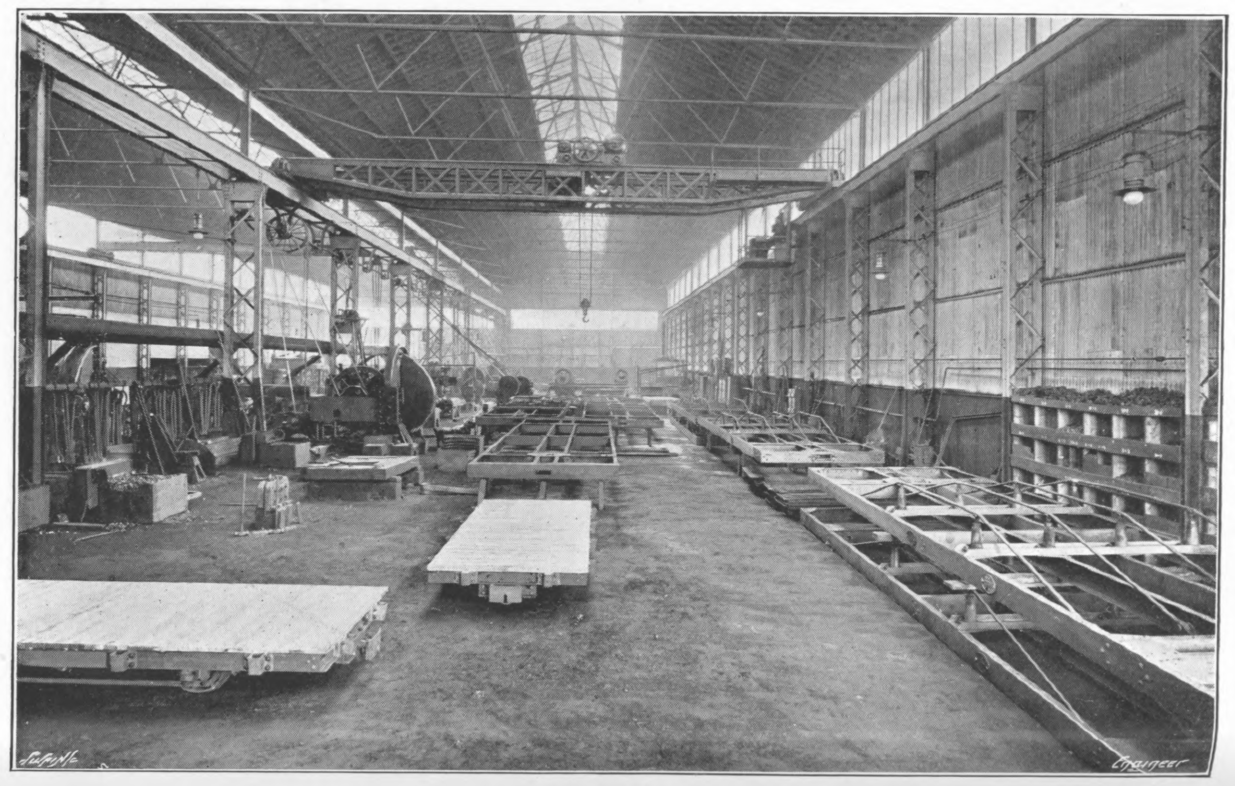
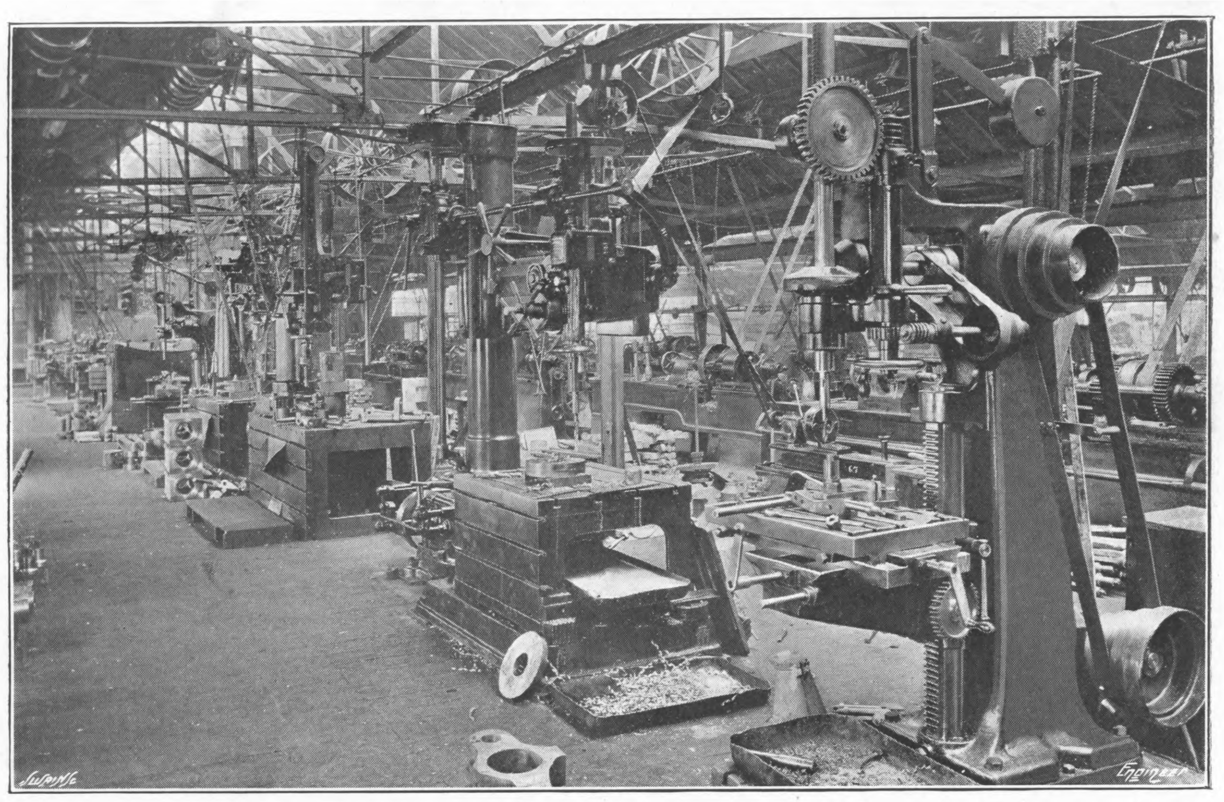


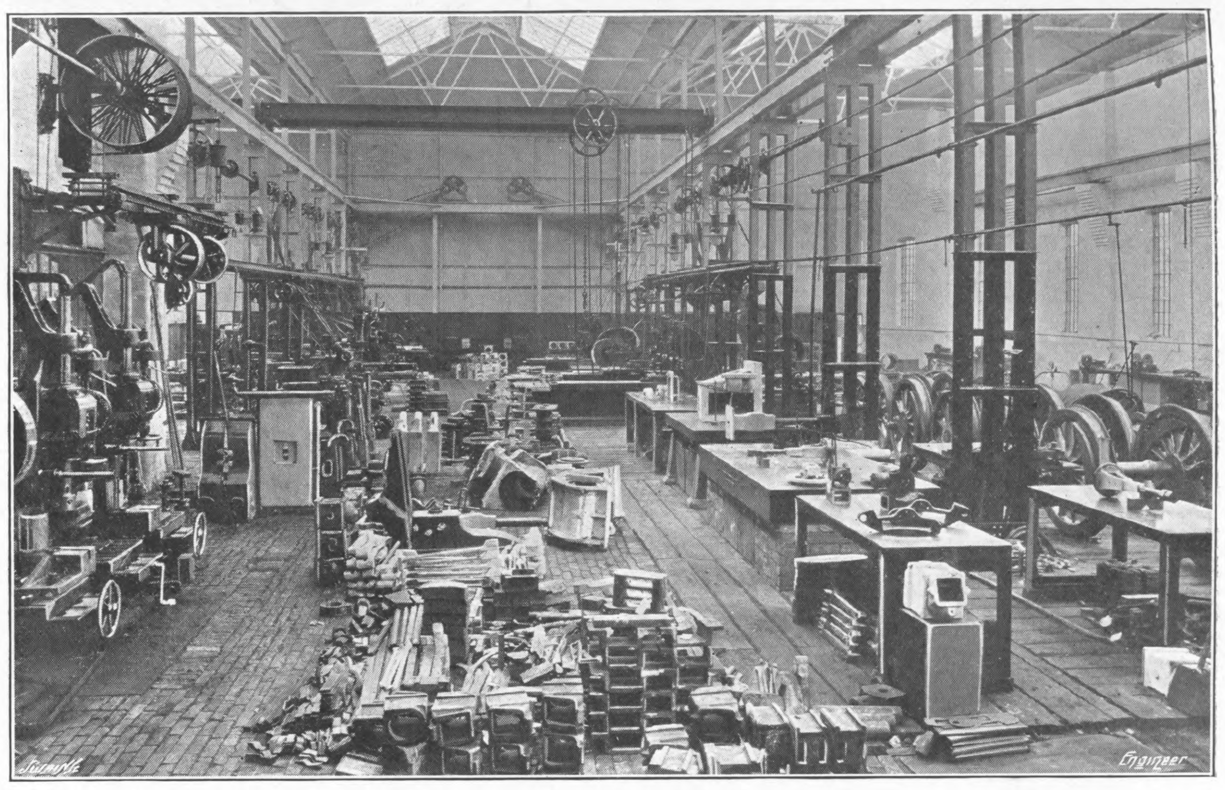
BOILER SHOP



WAGON SHOP



OLD MACHINE SHOP



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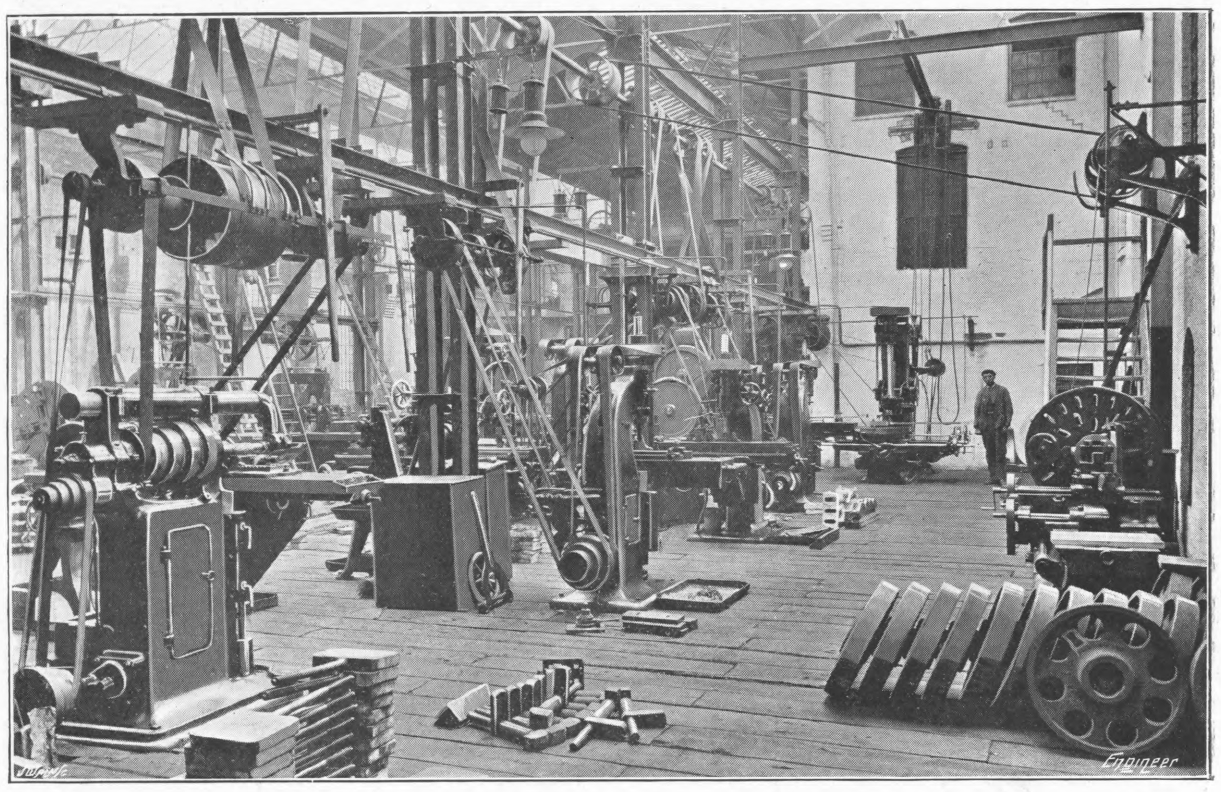

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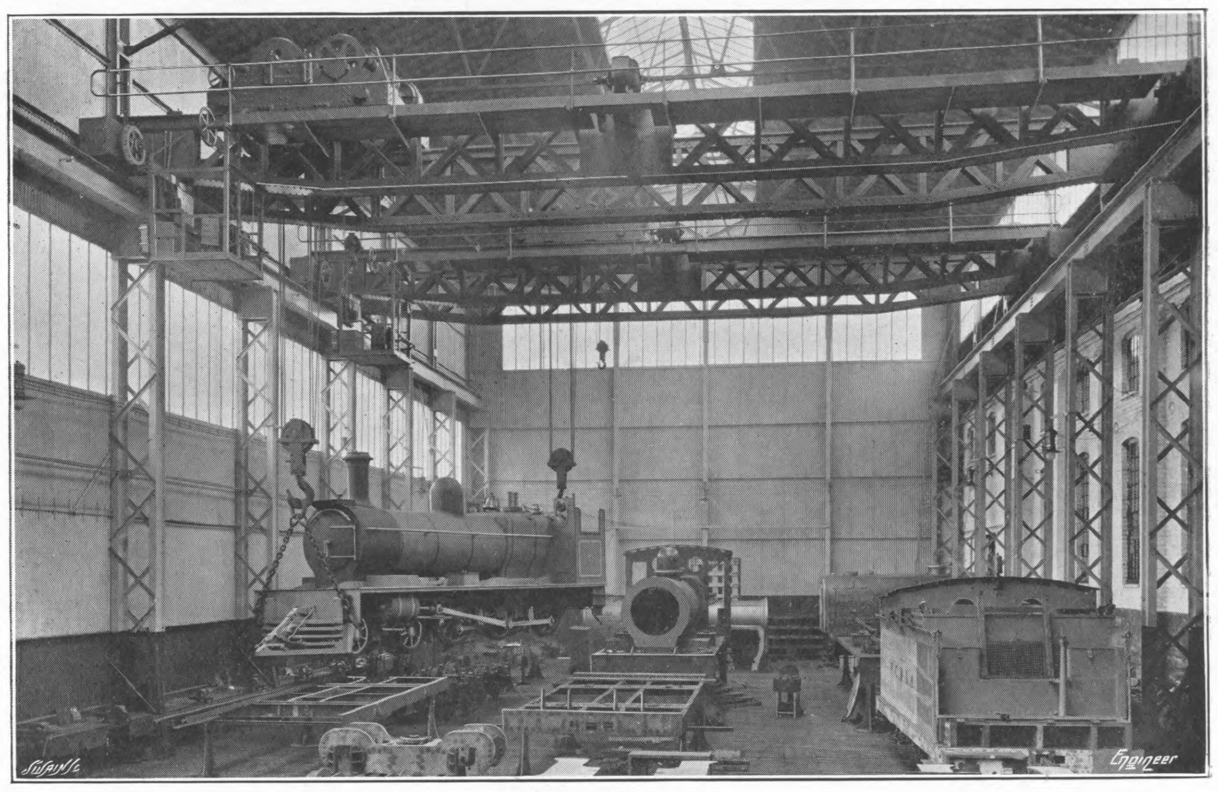

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⁂ *With this week's number is issued, as a Supplement, a Two-page Engraving of the Works of Kerr, Stuart and Co., Limited, at Stoke-on-Trent. Every copy as issued by the Publisher includes a copy of this Supplement, and subscribers are requested to notify the fact should they not receive it.*

H.M.S. VANGUARD.

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☛ ***We cannot undertake to return drawings or manuscripts; we must, therefore, request correspondents to keep copies.***

REPLIES.

N. A. (London).—The makers are averse to publishing drawings of the condenser at the present moment, but you may take it that apart from the modifications mentioned in our article, it does not differ materially from the ordinary Contraflo type.

G. C. (Leith).—We should advise you to see articles in our issues of June 1st, 8th, 22nd, and 29th, 1906, entitled "Commercial Organisation of Engineering Factories." The articles form only part of a long series, but deal with the classification of workshop time, wages, &c.

S. J.—The injector was invented by Giffard in 1858, and was first fitted to locomotives in this country by Sharp, Stewart and Co. about 1860. From that time onwards there was much disputation about it. You cannot do better than consult the volumes of The Engineer, in which the progress was closely followed. See our issues for 1859, in which the injector was first illustrated and described. In succeeding volumes it is discussed editorially and by numerous correspondents. In 1865—The Engineer, September 22nd—a good paper on it was read before the British Association.

MEETINGS NEXT WEEK.

Institute of Marine Engineers.—Monday, October 18th, at 8 p.m., at 58, Romford-road, Stratford, E. Discussion on Mr. McLaren's paper on "The Extended Uses of Electricity on Board Ship."

The Institution of Mining and Metallurgy.—Thursday, October 21st, at 8 p.m., at the Rooms of the Geological Society, Burlington House, Piccadilly, W. Ordinary general meeting. Papers to be discussed: "The Influence of the Railroads of the United States and Canada on the Mineral Industry," by James Douglas, LL.D. "The Development of Heavy Gravitation Stamps," by W. A. Caldecott.

Junior Institution of Engineers.—Monday, October 18th, at 7 p.m. at the Royal United Service Institution, Whitehall. Annual general meeting, followed by annual general meeting of the Benevolent Fund. Paper, "The Reinforced Concrete Construction of the New General Post-office Buildings, London," by Mr. T. A. Watson. Saturday, October 23rd, at 7 p.m., at Caxton Hall, Westminster. Conversazione.

Physical Society of London.—Friday, October 22nd, at 5 p.m., at the Imperial College of Science, Imperial Institute-road, South Kensington. Papers: "On Cadmium Amalgams and the Normal Weston Cell," by F. E. Smith, A.R.C.Sc. "The Production of Helium from Uranium and Thorium," by Frederick Soddy, M.A. "The Production of Radium from Uranium," by Frederick Soddy, M.A. "Note on a Gravitational Problem," by C. V. Burton, D.Sc.

THE ENGINEER.

OCTOBER 15, 1909.

Dover Harbour.

The formal opening of the Admiralty Harbour Works at Dover by H.R.H. the Prince of Wales to-day marked the practical completion of the most extensive harbour construction in any part of the world. The Admiralty Harbour is a harbour pure and simple, and includes no dock accommodation whatever; for the comparatively insignificant docks at the rear of the old commercial harbour have nothing to do with the great undertaking which has been in course of execution for nearly twelve years. No other open harbour of entirely artificial construction in any part of the world, with the single exception of Colombo, possesses an enclosed water area approaching that of the National Harbour, which at low water extends to 610 acres, excluding the area of the Commercial Harbour, which is about 80 acres in extent at low water. Nearly seventy years ago —to be exact in 1840—a Royal Commission recommended the construction of a refuge harbour at Dover at a cost of two millions. Another Commission reported in 1844 to similar effect, and in the following year still another Commission sat to consider plans submitted by several engineers for the proposed works. As the outcome of all these deliberations the construction of the Admiralty Pier, on the west side of the old harbour, was commenced in 1847, but the work was not completed until over twenty years later. Nothing, however, was done towards the realisation of schemes for the construction of a large harbour of refuge, or naval harbour, and Sir John Coode prepared plans for the Dover Harbour Board for the construction of a small commercial harbour, which was sanctioned in 1891. Owing, however, to the revival, between 1891 and 1895, of the proposal for the construction of a National Harbour, the Harbour Board's scheme underwent considerable modification, and the only important item of the work which was actually constructed is the Prince of Wales Pier, which now forms the eastern limit of the Commercial Harbour. It was not until the present year that the scheme for the much needed improvement of cross-Channel passenger facilities reached definite shape, and the new works, which, by-the-bye, have no connection with the Admiralty Harbour, are now under construction.

Towards the end of 1895 instructions were given to Messrs. Coode, Son, and Matthews for the preparation of a complete engineering survey of Dover Bay, with a view to the framing of designs and estimates for the formation by the Admiralty Board of a National Harbour. The problem presented to the engineers was the construction of an artificial harbour in a situation where the configuration of the coast line offered no advantages or natural protection. Generally speaking, the site available for the harbour was exposed to all seas from the west around to east. To the northward of west shelter was afforded by the Admiralty Pier and the adjacent foreshore and cliffs. It will therefore be seen that the bay was entirely exposed over half the compass. The engineers' investigations resulted in the approval by the Admiralty of a scheme, the contract for the execution of which was let to S. Pearson and Son, Limited, in November, 1897. The completion of the main structures of the breakwaters was effected towards the end of 1907—ten years from the date of signing of the contract—but the temporary gantry spanning the eastern entrance between the East Arm and the South or Island Breakwater remained in position for nearly two years longer, until the erection of the lighthouses on the South Breakwater and the completion of various subsidiary works, including the War Department batteries, had been completed. The damage done to the western head of the Island Breakwater in October, 1907, by the liner Finland not only delayed the opening of the eastern entrance, but the completion of the work. This accident entailed the removal and replacement of some 10,000 tons of concrete and masonry.

The engineers, in designing the harbour breakwaters, selected the system of block construction for the entire work, from the foundations to above high-water level. In view of the nature of the foundations, which for the most part are chalk, and the notable failures of rubble mound structures in exposed situations, such as Alderney, Tynemouth, and Port Erin, the selection of this design was justified by considerations of security and the reduction of maintenance charges. Compared with the probable cost of upkeep of a structure consisting of rubble and block mound with solid superstructure in a similar situation, the cost of maintenance of the Dover breakwaters per lineal foot of the work may be estimated at an insignificant figure. From the point of view of first cost the method of rubble mound construction in many cases offers advantages, but in the case of Dover there seems to be little doubt that the method adopted possesses the advantage of economy over the other system. The great depth of water at the sites of the Island Breakwater and Admiralty Pier Extension—over 60ft. at high water—would have entailed the construction of rubble mounds of considerable cubical dimensions, and the absence locally of suitable material for the purpose must have still further enhanced the cost. Moreover, the Admiralty Pier Extension and the East Arm are both intended for berthing purposes, for which rubble mound construction would have been less suitable. The magnitude of the works carried out may be gauged when we remember that the Admiralty Pier Extension has a total height of nearly 100ft. from the foundation to the top of the parapet over the greater part of its length, and a base width, exclusive of the apron, which in places exceeds 60ft. Those who view the completed structures from the sea or from the land commonly fail to appreciate the enormous bulk of the works. The visitor is apt to overlook the fact that at half tide little more than one-fourth of the total bulk of the breakwater is visible above the water level.

Perhaps the most difficult problem which faced the designers of the harbour was that connected with the tidal ebb and flow and the coastal currents. The total quantity of water required, during an ordinary spring tide, to fill the harbour, and which must pass through the two entrances, is 17 million tons. Conversely this volume has to be discharged during the ebb. Considerably more than one half of the total volume flows into the harbour during less than two of the five hours intervening between low and high water. The conditions are complicated by the existence of strong coastal currents which at certain states of the tide sweep across the southern entrance at the rate of five knots at springs. These and other considerations connected with the silting of the harbour led the engineers to design the works with two entrances, one on the western side, partially protected from the west by the overlap of the Admiralty Pier Extension, and the other on the eastern side, between the East Arm and the Island Breakwater. The latter affords an alternative means of ingress and exit at times when the conditions of sea, wind, and tide make the use of the southern entrance difficult and even dangerous. It is satisfactory to note that up to the present no appreciable amount of silting of the harbour area has taken place. The current in and out of the western entrance attains at times a rate of three knots when unaffected by wind. Two or three years ago the tidal flow and eddy currents through and in the neighbourhood of the entrance occasioned some difficulty in connection with large liners using it, and accidents in making the harbour occurred. These difficulties were undoubtedly due, to a great extent, to inexperience on the part of the pilots of the altered tidal conditions caused by the construction of the harbour works. Wider experience and the opening of the alternative eastern entrance have entirely removed any difficulties which may formerly have existed, and the western entrance has been regularly used for some time past both by battleships and mail steamers without any difficulty.

Perhaps the feature of the harbour works which most forcibly strikes engineers who have the opportunity of inspecting them is the splendid and almost extravagant finish of the masonry in the visible structures. Some may be inclined to cavil at the unnecessary degree of finish in the fine tooled granite work of the copings, parapets and such details, and while no one can gainsay the statement that less finished workmanship and some economy of dressed granite would have resulted in a structure of equal durability, it is only fair to admit that this criticism applies to but a small portion of the whole work, and that the material and workmanship in the underwater structures could not have been economised without risk of a corresponding reduction in efficiency. When the additional cost of what one might call the architectural finish of the superstructures is spread over the entire work, it amounts to a comparatively insignificant fraction of the total of nearly four millions sterling. This costliness of finish and material in positions where neither fine workmanship nor the most expensive material are necessary has been for years a characteristic of Admiralty work, and, in the case of some undertakings, such as the Keyham Dockyard Extension, undoubtedly involved a large expenditure which might well have been avoided. The designs for the Rosyth Base are, we understand, comparatively free from the criticism we have indicated, and approach more nearly than any other similar Admiralty work to the practice usual in the highest class of commercial construction.

The Life of Permanent Way.

It will, we think, be remembered that in writing last week about Mr. Price-Williams' paper on "The Serviceable Life of Permanent Way on British Railways" we directed attention to the rolling stock, its nature, its speed, and its resistance as powerful factors requiring very careful attention. Mr. Price-Williams holds that points and crossings must be considered, and we propose now to say a little concerning a cognate factor to which he has not even alluded. Before going further, however, it is advisable to point out that nothing has been said in dealing with train mileage and wear and tear in the way of defining precisely what is meant by the words "permanent way." We have already been told that it includes all that is necessary to the conduct of traffic in the shape of signals, &c., but we require something closer in the way of definition. Mr. Price-Williams tells us that there are not less than 14,000 miles of sidings. Assuming that this is not a misprint for 1400 miles, we have 13,500 miles "double or more," and of single lines 10,250, giving us 23,750; adding the sidings we have 37,750 miles. If, again, "miles open" refers to the rail roads and not to rails only, then we have at least to double, and certainly to add a large percentage, when there are three or four parallel lines of rail laid on the same road. Now, Mr. Price-Williams bases his comparative cost on the goods ton-mileage, but he does not tell us what the words imply. To illustrate our meaning, let us suppose 50 miles of line laid with four tracks and 50 laid with two tracks. Each of these roads carries, say, 50,000 tons of minerals. On one assumption, to wit, that the length of road only is concerned, we have for the first a rail mileage of 250 tons, and for the second a rail mileage of 500 tons; but the road mileage is the same in both cases, namely, 50 miles. It might very well appear, therefore, that the cost of maintenance in one case, although double that in the other, on paper, was really the same. This is a very important matter. Obviously, the greater total rail surface available for the carriage of a given quantity of traffic the less ought the wear and tear and cost of repairs to be. Of course in one sense the comparison which Mr. Price-Williams has drawn is interesting; none the less it is incomplete, and unless used with care may do an injustice to individual companies. Furthermore, it must be kept in mind that on most of the great main roads one or more lines of rails are reserved almost exclusively for slow traffic, and the wear and tear will be less than it is on the tracks set apart for express and fast passenger trains. If Mr. Price-Williams can carry his analysis a little further he will enormously enhance the value of his statistical investigations.

We now come to consider the entirely different factor referred to above, about which next to nothing whatever has been said so far. We refer to the characteristics of the permanent way. Mr. Hurry Riches, in the course of the very unsatisfactory discussion which followed the reading of Mr. Price-Williams's paper, pointed out that the author had not commented on the improvements made of late years in the character of the steel used, and of the changes in the profile of tires, which, he said, tended greatly to prolong the life of rails. It is true that the Board of Trade Returns only come down to 1907, but it does not appear that any very serious modification in track has since taken place; and we doubt that the figures for the last and the present year will show any marked alteration. Putting this in another way, we say that what the permanent way of the North British and the London, Brighton, and South Coast railways was in 1907 it is almost certainly to-day. The methods of laying, the quality of the sleepers, and the nature of the ballast will remain substantially unaltered. This being conceded, we may next proceed to ask how this affects the cost of maintenance.

We have to do here with a complicated financial question. Let us suppose that there are two methods of dealing with permanent way, one which we shall call A, representing a maximum capital outlay, and the other B, representing a minimum capital outlay. Which of the two should be adopted? Both are supposed, of course, to be equally safe. Thus, for example, on system A sleepers are specially selected, and cost 6s. each. On system B they cost only 4s. each. A is laid with 100 lb. rails, B with 84 lb. rails, and so on. The cost of the various materials renewed will be smaller than they would be on line A. Yet in the long run the sums spent might be larger because the renewals would be more frequent. In the long run which will be the more economical? Much, of course, will depend on the character of the traffic. If that is very heavy, then perforce the road for mechanical reasons must be strong; but this is quite another issue. The true problem is so to balance the capital outlay and repairs against each other that the most economical result shall be secured; and it seems that it is not certain that, all charges considered, that road which costs least for maintenance must be the most economical.

This brings us to another question. How far out of condition may a road be permitted to become? The question is very difficult to answer. In the cases we have cited, B would never be in good condition, taking A as the standard. It is certain that permanent way is on the whole, on the Continent and in the United States, inferior—in some cases very much inferior—to that of this country. This is one reason why French locomotive springs have about double the range of ours, and why American engines are almost always fitted with balance levers. It is quite possible that the engineers of the North British may hold that an outlay of £191 per mile suffices to keep their roads in sufficiently good condition, although double that sum might be spent. Everything depends on the standard of excellence set up. Wages, too, in the North are comparatively small, and the cost of carriage of materials is much less than it can be for a line in the South of England far removed from coal and iron centres. Again, while comparisons drawn between lines with the like traffic are convincing, they have little appositeness to cases like those of, say, the London and North-Western, and the London, Brighton, and South Coast, which has an enormous suburban traffic conducted over switchback lines, such as that from Victoria to the Crystal Palace, and only a few coal trains to represent mineral traffic.

When, however, we clear the ground the fact still remains that a general disparity between the cost of maintenance and the traffic exists, and it is the cause of this disparity that presents the really interesting problem. If, for example, it can be shown that by the judicious outlay of capital on ballast and sleepers and rails, the cost of repairs and renewals might be reduced from the 15 per cent. of which Mr. Price-Williams speaks to 10 per cent., or, say, to £7,300,000, by the outlay of any sum short of £3,700,000, then the companies ought to obtain the money and spend it on the improvements. It seems clear, however, that the bulk of the expenditure would be confined to a comparatively small number of lines. A doubtful and very perplexing fact must be mentioned in this connection. It is that it is impossible to see how any material improvement can be made in the permanent way of some of our best managed lines. The permanent way of the London and North-Western seems, for instance, to be beyond improvement; it cannot be made better. It may, of course, be admitted that the branches are not as good as the main line. But branch lines cannot count for much. Further inquiry should be departmental. Thus the precise cost of repairs and renewals should be ascertained for main roads "out in the country." First, carrying fast passenger traffic; secondly, goods and minerals. Then come great shunting yards and sorting sidings, and, lastly, minor yards. Having this kind of information we should know where we are in a way that is not at all known now. As we have already spoken of the part played by rolling stock it is not necessary to say anything about it here. There remains for mention one detail which apparently does not receive the attention it deserves, to wit, ballast. The circumstances in this country are almost inconceivable under which it will not pay to use good ballast. When ballast is bad it is impossible to maintain a line in order without an extravagant outlay on labour; there are thousands of miles open in this country with ballast so bad and worn out—for ballast does wear out and sometimes very quickly—that a considerable expenditure would certainly be found an excellent investment. Indeed, we are disposed to endorse the opinion once expressed by a skilled engineer, who said, speaking of a road which had fallen into bad order, "The ballast is the key of the whole position." As for Mr. Price-Williams's statistical paper, we have nothing but praise for it, so far as it goes; but, unfortunately, it does not go far enough to enable any useful lesson to be drawn save one. It teaches the railway world that further inquiry is necessary, and would probably repay the inquirers very fully indeed.

The Labour Problem in France.

THE number of labour disputes is increasing to a remarkable extent in France, and the total of eighty during September is probably a record. The agitation is particularly marked amongst unskilled labour, which is in a perpetual state of unrest. In the engineering and other trades the unions, although affiliated to the Confédération Générale du Travail, preserve a certain independence, and only rally round the Confédération when they have decided to organise a strike. Outside the ranks of skilled labour the Confédération is autocratic, because it reflects the ideas and sentiments of a class which is notorious for its revolutionary tendencies. The Confédération Générale du Travail and the great mass of unskilled labour are uncompromisingly antagonistic to employers as well as to all classes above their level. Class hatred is fostered in every possible way, and the Confédération stops at nothing to attain its ends. Rarely does a strike take place without intimidation and personal violence. For some weeks past there has been a strike of unskilled labour in the building trades and on the Paris Metropolitan works, and as a good many men have refused to go out, the others seize every opportunity of invading the works and driving out those who will not yield to persuasion. Fights between workers and strikers are by no means an uncommon occurrence. Dredgers on the Seine have been sunk, and men imported to take the place of strikers have been stoned and attacked with dangerous weapons. Last week, near Juvisy, a railway contractor sustained considerable loss through men setting fire to barrels of oil because they were discharged for a few days owing to a temporary suspension of work. All building and other enterprises in Paris are under police protection, and those strikers who have been caught interfering with the workers have been severely punished. Even this fails to stem the agitation, which becomes more and more violent as the chances of a successful issue appear more doubtful.

So far as the Confédération Générale du Travail is concerned, the agitation is of an unmistakably political character. Whether the men regard it in the same light may be open to question, but they are perfectly willing to obey orders from a central body when they see the prospect of getting wages out of all proportion to the work they are expected to do. So far, the Socialist theory of a uniform rate of wages irrespective of the capabilities of the men has failed to make any headway amongst skilled labour, but the Confédération is strenuously endeavouring to enforce this policy upon employers of unskilled hands, and one of the causes of the present strikes is the refusal of contractors to pay the same wages to navvies and ordinary labourers. One proof that the agitation is not promoted for the benefit of the men is observable in the fact that every effort on the part of employers to conciliate the men is checkmated by the syndicates. Only a week or two ago a quarry owner in the neighbourhood of Paris, who saw his men go out on strike for the first time in thirty years, decided to apply the principle of a participation of profits so often advocated by the Socialist. He prepared contracts guaranteeing the men 50 per cent. of the net profits, and each man received his agreement for signature. Apart from the clause relating to the distribution of profits, there was only one other giving the employer the right to discharge any man for disorderly conduct, disobedience, or incapacity. The men accepted these conditions, when a delegate from the union interfered and asked for forty-eight hours' grace. This was accorded, and two days afterwards the delegate returned with the announcement that he rejected the proposition, because, he said, he could "read between the lines" of the contract. Had the proposal been accepted it would have meant that each man would have received a present equal to 5 or 10 per cent. of the annual amount of his wages. The men were then called out by the union because the employer would not pay a uniform wage to the different classes of workers. Since then he has received threatening letters, and shots have been fired through his windows. This is one example of many showing the lamentable feeling being created between unskilled labour and employers by the unions. There appears to be no sense in it, unless we come to the logical conclusion that the revolutionary bodies which have got the majority of unskilled labourers under their control are working for political ends. Happily the Government is doing everything it can to protect those who are willing to work, and so long as the agitation is confined to unskilled labour it will not do much harm to industry generally, although it is causing serious inconvenience to the execution of public works.

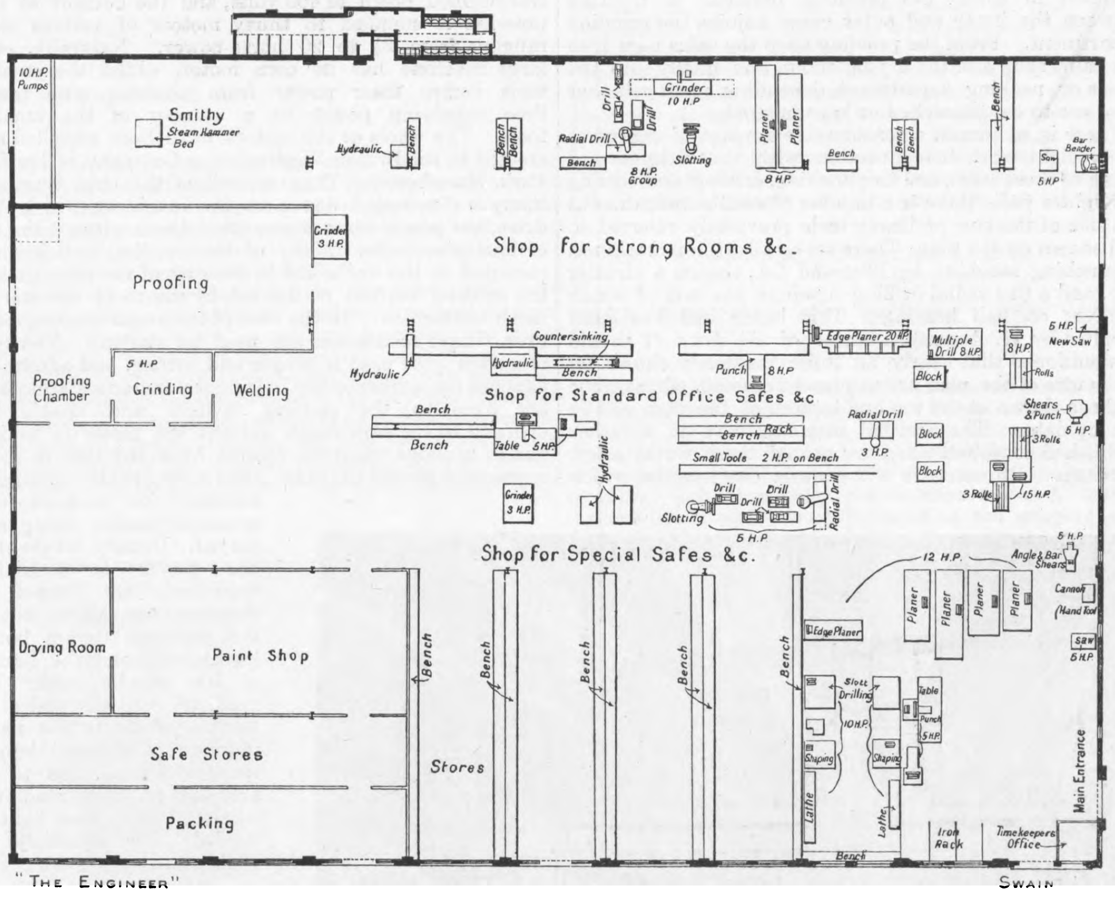
NEW WORKS AT WOLVERHAMPTON.

London has now lost practically all the large engineering works it once had. One by one they have been transferred to the Midlands, the North of England, to Scotland, and to other parts of the United Kingdom, where better facilities for the metal working industry are to be found. Although this process of removal has been going on for years, firms are still taking their departure; but it seems that the time cannot be far distant when none but very small works will remain. In common with many other manufacturing firms, Chubb and Son's Lock and Safe Company has been compelled to consider the best means for providing for a larger output. The company's present chief works for safe making are in Camberwell, S.E., but seven years ago, as an experiment, the firm opened a small branch works alongside its lock works in Wolverhampton, the object being to test the facilities and the relative cost of manufacture in London and in Wolverhampton. In addition to initiating this practical test, they carefully considered the relative advantages of ultimately establishing larger works at other manufacturing centres or in some country district.

The outcome of all the firm's inquiries and of the practical experiment with the temporary overflow works at Wolverhampton is that the directors came to the conclusion that Wolverhampton was undoubtedly the most suitable place for carrying out the firm's manufactures. They also believed it to be one of the most convenient places for workmen to obtain excellent and cheap houses. In consequence the company has purchased a freehold plot of land, 10 acres in extent, situated on the Wednesfield-road, just inside the borders of the borough of Wolverhampton, and within a few minutes of the goods stations of the London and North-Western, Great Western, and Midland railways. On this site fine new works have been erected, and they were formally opened by the Lord Mayor of London yesterday. Not only are these works close to many houses and cottages suitable for the workmen, but within a short distance a large garden suburb is being planned, and upon this it will be possible for the men to obtain or lease modern cottages of an exceptionally good type, and at reasonable cost.

Before entering upon a description of these new works a few remarks relating to the history of the firm may prove of interest. The business now carried on under the name of Chubb and Son's Lock and Safe Company was commenced in the year 1818, when Mr. Charles Chubb, aided by his brother, Mr. Jeremiah Chubb, invented the Chubb detector lock. From that date to the present time, although alterations have been made in the form and arrangement of the lock, the principle remains the same, and the firm claims that no key lock has since been invented which can successfully compete with it for security. After the death of Mr. Charles Chubb in 1846, the business was carried on by his son and partner, Mr. John Chubb, till the year 1872, when, upon his death his sons succeeded him as sole partners until the concern was converted into a private limited company in the year 1882, since which time it has been chiefly owned and entirely managed by members of the family in conjunction with a board of directors. When the business was started it was confined to the making of locks, later on the manufacture of safes, strong rooms, and safe deposits was taken up, and at the present time this latter branch of the business has grown to very large dimensions.

The foundation stone of the new factory opened last Thursday was laid by Sir George Hayter Chubb, on the 8th July, 1908. The works, which are shown on page 400, cover an area of 63,500 square feet, and as will be gathered from the plan, a good portion of this area is set aside for erecting purposes. The plan, although not quite correct as regards the arrangement of some of the machinery, will serve to show the general lay out and the methods the firm has adopted for turning out its manufactures. The large erecting shop at the back of the centre line of machine tools, and illustrated separately on page 400, is set aside for the construction of steel strong-rooms, treasuries, and safe deposits; it is 350ft. long and 40ft. wide, with a height of 33ft. clear of all girders and roof principals. The height of the remainder of the factory is from 16ft. to 14ft. at the lowest point. One inaccuracy in the plan to which attention should be called is that this large shop just referred to has been extended 75ft. to the right of the other part of the works, as can be seen from the illustration of the exterior of the works. Nearly the whole area is undivided by parting walls, and the general design of the buildings gives the maximum amount of light, avoiding as much as possible direct sun rays. Careful consideration has also been given to the question of sanitation and ventilation. The centre part of the works where the greater number of the machine tools are situated is where the ordinary office safes will be constructed. There are twenty-five standard sizes of these safes, and there are also many intermediate patterns which are fitted up to meet various requirements. The firm's object in designing these works has been so to arrange the machines that as the work passes from one tool to another the material which entered the door at one end gradually assumes the form of finished articles and ultimately leaves at the opposite end of the building without during the course of manufacture having travelled very far out of a straight line. The part of the building shown on the lower part of the plan has been set aside for special safe work, and it is here where the plan is again a little incorrect, the final arrangement being to erect some of the machine tools shown in the right-hand bottom corner of the plan in the spaces between the second and last row of benches counting from the left. The benches also run in the opposite direction to that shown in the drawing. The group of machine tools marked 5 H.P. will also be erected in the space between the second and last row of benches. Now, turning to the centre row of machine tools, which are already erected, and upon which, as previously stated, the twenty-five standard sizes of office safes will be manufactured, the first machine met with on the right is a plate roll by Craig and Donald, of Johnston. Two sets of rolls are shown in the drawing, but up to the present only one of these has been put down. Here the plates are first rolled, and they are afterwards passed on to the blocks, where the flattening process is completed by hammering. These levelling blocks, only one of which has so far been erected, are made of armour plate from the original and now obsolete Dreadnought. The flattening of these plates is an art to which safemakers attach some importance and pride. Having been flattened, the plates are then passed on to a large edge planer by J. Buckton and Co., of Leeds. The work is held down on this and other machines hydraulically, thus saving an enormous amount of time. Next to this edge-planing machine there is a heavy punching machine by W. Smith and Co., of Glasgow, on which the necessary holes in the thick plates are punched. Then in the same line of machine tools we come to a very handy machine for counter sinking holes, which has been supplied by John Hetherington and Sons, Limited, of Manchester. The drill carriage can be run along in a straight line, and the holes in the various parts used in the construction of these safes can consequently be countersunk with great rapidity.

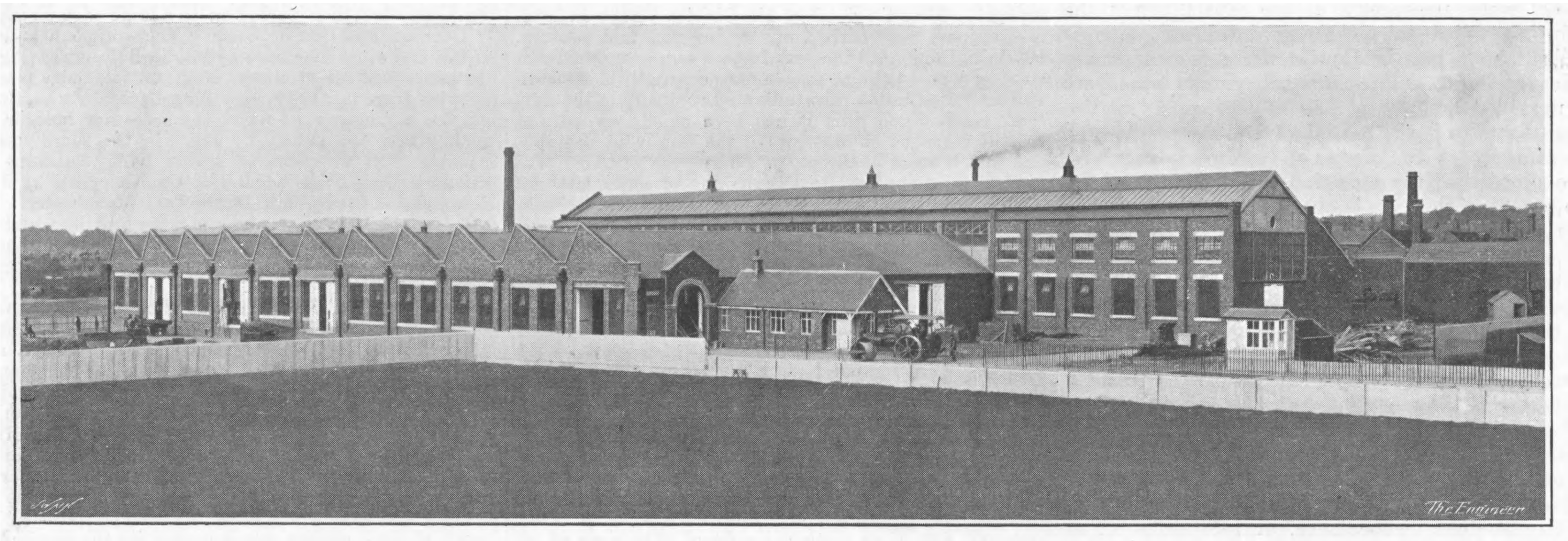


PLAN OF THE WORKS

A point to which attention should be directed is that a centre punch or a foot rule are never used in the manufacture of the company's standard safes. When a man commences a drilling job, for example, he has handed out to him from the stores the necessary jigs and an instruction sheet, and in this way marking-off work is entirely dispensed with. The last operation performed on the heavy plates, by means of the machines in the centre of the building, is that of bending, this being carried out by means of two hydraulic presses shown at the left of the row of tools which have just been considered. The larger of these presses, which is used for the longitudinal bending, is by Hugh Smith and Co., Limited, of Possil Park, Glasgow, whilst the smaller is by Hollings and Guest, Limited, of Birmingham. It should be mentioned that above all these machines, in the centre of the building, there is a mono-rail, and in addition, as can be seen from the plan, there are special roller benches at the sides of these machines, so that the operation of conveying heavy plates from one tool to another and placing the work in position is considerably simplified, and this, together with the close proximity of one tool to another, should be the means of saving much time. The roller benches are arranged to support the work whilst the punching or drilling or whatever other operation is being performed is in progress.

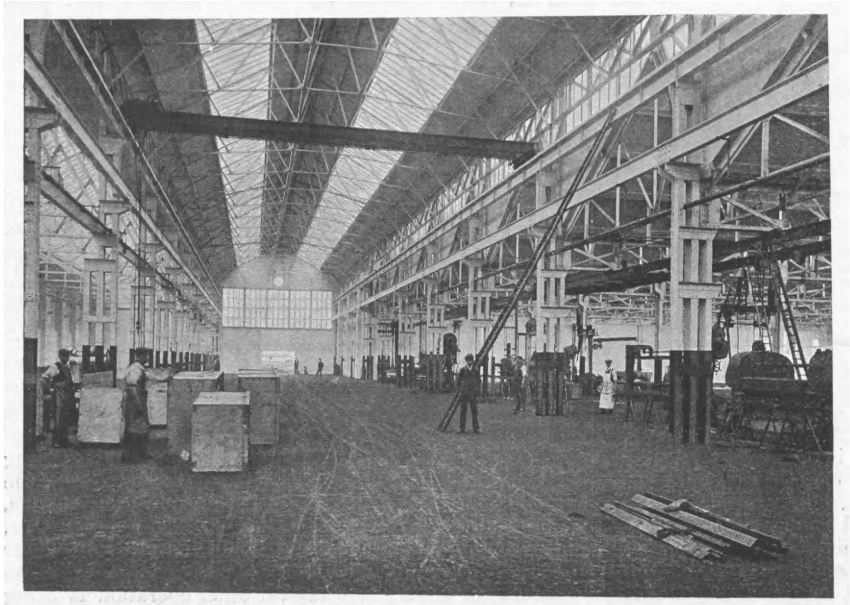
It will be seen from the plan that the welding department is directly opposite the line of machines just dealt with, and that the safes can be lifted by a travelling crane into this department. The welding at these new works is to be carried out by the oxy-acetylene method, an acetylene gas generator, together with the other necessary equipment, having been supplied by the British Oxygen Company, of Westminster. The gas generator is in a well-ventilated house adjoining the main building. The ordinary system of welding is used at Camberwell, but at this new factory an endeavour has been made to take full advantage of everything modern, and the oxy-acetylene system has consequently been adopted, and it is possible, we understand, that this process will ultimately be employed for cutting. When the welding process has been completed the next operation consists of grinding off the rough parts so as to give the safes a perfectly smooth surface. This operation, as will be gathered from the plan, is performed in the apartment next to that in which the welding process is carried out. Here a special grinding machine has been erected, with which all the rough parts set up in welding are removed. This grinding machine has been constructed by John Holroyd and Co., of Milnrow, near Rochdale. It consists of a long vertical column and an overhanging arm similar to that of a radial drilling machine. This arm carries a revolving emery wheel mounted at an angle, by means of which the rough places on the safes are removed. The

CHUBB AND SON'S LOCK AND SAFE COMPANY'S WORKS AT WOLVERHAMPTON



arm carrying the emery wheel can be raised or lowered over a wide range in order that work of various dimensions may be dealt with. The machine is driven by means of a vertical motor fixed at the top. The proofing chamber in which the proofing material is inserted between the inner and outer cases adjoins the grinding department. From the proofing shop the safes pass into the paint shop and the drying room, and finally into the stores or packing department, depending upon whether they are to be dispatched or kept in stock.

There is, of course, a considerable amount of comparatively light work in connection with the fittings and lining of these safes, and for punching, drilling, and cutting the lighter parts there is a number of smaller machines at the side of the line of heavy tools previously referred to and shown on the plan. There are small drilling machines, a punching machine by Bliss and Co., shears, a circular saw, and a fine radial drilling machine, the arm of which revolves on ball bearings. This latter tool has been supplied by W. Asquith, Limited, of Halifax. It should be mentioned that nearly all those machines shown on the centre of the plan are at present erected, whilst some of those shown at the top and bottom of the plan will be put up later. The smiths' shop was also in a rather unfinished condition when we visited these works a few days ago. Ultimately it will contain five hearths, which are all being put in by James Keith and Blackman and Co., Limited, who are also supplying the blower.



STRONG ROOM SHOP

We may remark here that an entirely new departure in the construction of safes is being undertaken which embodies all the best known principles, such as heavy 12 bend bodies with welded corners, asbestos inner doors, and inner and outer doors of new design built on the external lock case principle.

A vertical boiler has been erected in the smiths' shop for supplying steam for heating the drying room. The hydraulic pumps and accumulator are also erected in this shop. The pumps have been supplied by Hugh Smith and Co., of Glasgow. There is also an electro-pneumatic hammer by B. and S. Massey, of Manchester. It is in this shop that the hardening is to be carried out. A double furnace for hardening two large plates at once for strong-rooms will be provided, and electric instruments for measuring the temperature so as to ensure the plates not being overheated. The plates are heated to a cherry red and then plunged into a tank of water through which a continuous supply of cold water flows.

Although it may appear from the illustration showing the exterior of the works that a power plant has been put down for driving the machinery owing to the presence of the tall shaft in the background, this is nevertheless not the case, the shaft in question belonging to the works of J. Evans and Son, which are in close proximity. The whole of the machinery in Chubb's new works is driven by three-phase induction motors, all of which are of the squirrel-cage type. Three-phase current is taken from the Corporation mains at a pressure of 5000 volts. It is transformed down to 400 volts, and the current at this pressure is supplied to thirty motors of various sizes ranging from 2½ to 20 horse-power. Naturally, each large machine has its own motor, whilst the smaller tools derive their power from shafting, one motor thus supplying power to a number of the smaller tools. The whole of the motors have been supplied and erected by the British Westinghouse Company, of Trafford Park, Manchester. They are all of the open type, and many are mounted direct on the machines which they drive, the power being transmitted direct without the use of chains or belts. Many of the starting switches are mounted on the walls, and in the case of the large motors the starting current is limited by means of the star to mesh connection. In the case of the small motors, however, simple resistances are used for starting. The type of switch gear used is simple and strong, and admirably adapted for workshop use. In many instances ammeters are fixed to the starting switch, and enable the operator to see how much current the motor is taking, and so to judge when the change from the star to mesh connection should be made. The wiring is also admirably suitable for workshop use, armoured cables being employed. Usually, where electric power is available, workshops are lighted by means of arc lamps, but in this instance Osram lamps have taken their place. Lamps of 100 candle-power are used, and are suspended by flexible wires in the usual manner. Additional lamps, we understand, are to be provided on those machines where a good local light is needed. The periodicity at Wolverhampton is 50.

For lifting the plates in the large shop where the strong-rooms are to be manufactured, a travelling magnetic crane is to be erected. Alternating current for a magnetic crane is, of course, quite unsuitable, and to overcome this difficulty a continuous current dynamo is to be driven from the shafting. This will charge a storage battery so that continuous current for use on the crane will always be available.

A small block of temporary offices has been provided, adjoining the main factory, and a foreman's cottage is in course of construction. The protecting fences and walls enclose an area of about 20,300 square yards. The approach from the Wednesfield-road is by a wide private cart road. A large piece of land is retained at the back of the factory for future extensions, to which additional access has been provided from the Woden-road. In the meantime it has been placed at the disposal of workmen and others for sports. A bowling green has also been laid down.

The whole of the factory buildings have been designed on lines carefully thought out by the present directors and successfully carried out by their architect, Mr. G. Gordon Stranham, of Bush-lane, Cannon-street, London, E.C. Mr. C. H. M. Mileham, of Lincoln's Inn-fields, has acted with him as consulting architect, and Mr. F. T. Beck, of Wolverhampton, as local superintending architect. Mr. F. Simpson was the general clerk of the works. The contract for the buildings was placed in the hands of Henry Lovatt, Limited, of Wolverhampton. The steel construction is by Drew, Bear, Perks and Co., of London. The consulting electrical engineers were the British Engine, Boiler and Electrical Insurance Company, Limited, of Manchester.

HULL COAL TRAFFIC.

THE official return of the Hull Chamber of Commerce and Shipping for September shows it to have been the busiest month of the year in the coal trade with the great Yorkshire port. The weight from all sources dealt with at Hull amounted to 615,120 tons of fuel, thus exceeding the tonnage sent in September last year by 117,296 tons. The previous best on record was September of 1907, when the weight forwarded to Hull was 576,960 tons, which was exceeded last month by 38,160 tons. The weight for the completed nine months of the year was 4,448,144 tons, or 52,432 tons short of the aggregate for the corresponding period of 1908. The total for the nine months of 1907 was 4,830,672 tons.

These figures of increased trade last month are exceptionally interesting in view of the lessened export traffic from Hull. The increase is thus due to the extra tonnage required for bunker purposes at the port. The total weight sent to distant markets last month was 287,452 tons, against 300,625 tons in 1908, and 355,510 tons in 1907. The totals up to the end of the third quarter are :—1909, 2,395,520 tons; 1908, 2,198,207 tons; 1907, 2,470,818 tons. The principal foreign market for the month was North Russia, which took 96,271 tons, against 108,735 tons for September of last year; for the nine months 571,587 tons, against 543,418 tons. Germany comes next with 53,053 tons, against 54,947 tons; for the nine months 377,132 tons, against 351,404 tons. Holland is third with 32,459 tons against 25,255 tons; for the nine months 384,619 tons against 285,647 tons. Then comes Sweden, with 26,148 tons against 36,832 tons; for the nine months 271,421 tons against 307,163 tons. France follows with 17,381 tons, against 16,580 tons; for the nine months 109,731 tons, against 166,339 tons.

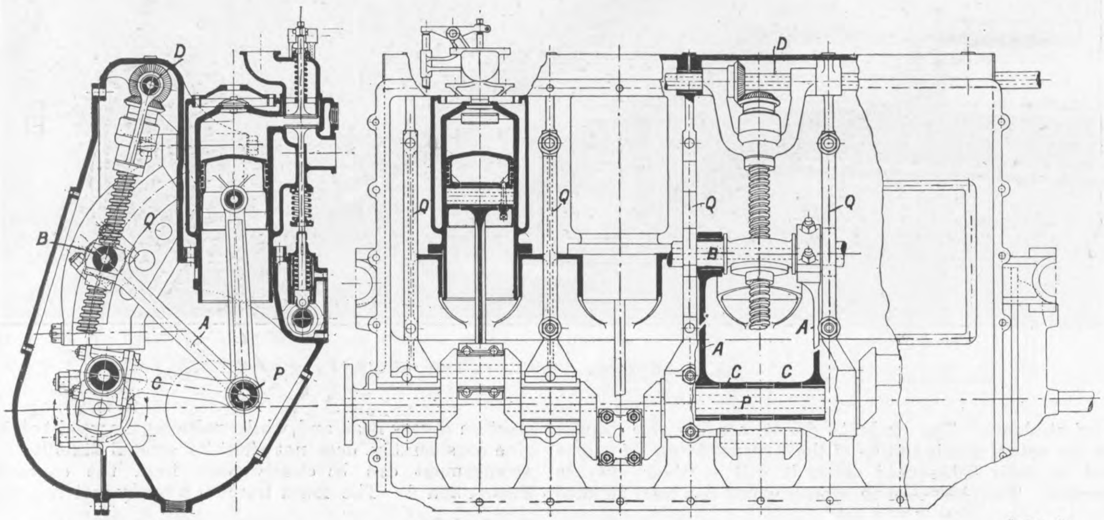
The Baltic ports took about one-third of the total export, but there was a decrease of about 12,000 tons on the month, the quantity required evidently having been forwarded earlier this year than in former seasons. The diminished trade with Sweden is no doubt due to the labour troubles, which interfered with business. The increase with Austria for the nine months is somewhat remarkable—to 73,069 tons from 10,330 tons for the nine months of 1908. South America is another largely increasing market, receiving from Hull last month 13,655 tons, against 6169 tons in September of 1908; for the nine months 146,466 tons, against 118,307 tons. Decreases on the month were shown by Belgium, Egypt, Norway, and Turkey; increases by Austria, Denmark, France, Holland, Italy, South Russia, and Portugal.

Coastwise exports from Hull amounted to 66,065 tons, as compared with 69,755 tons in September of last year, and 108,663 tons in September of 1907. Of the total last month, London took 46,580 tons, Southampton coming next with 8090 tons. The total coastwise exports from Hull for the nine months were 618,959 tons, of which London received 421,544 tons and Southampton 64,579 tons. Taking in Plymouth, which took 32,153 tons, these three markets received 518,276 tons out of the total of 618,959 tons delivered during the nine completed months of this year.

Scottish National Exhibition at Glasgow.—The project of organising and bringing into being in 1911 a "Scottish Exhibition of National History, Art, and Industry," the site for which will be virtually the same as that of the highly successful International Exhibition held in Glasgow in 1901, viz , the Kelvingrove Park, is rapidly taking shape. The guarantee fund now exceeds £60,000, although the minimum aimed at as ample for all requirements of the project as originally conceived was only £40,000. The object chiefly aimed at is to aid, and finally complete, the fund being raised for the endowment of a chair of Scottish History and Literature in Glasgow University. The outcome, however, may be of more far-reaching consequence so far as modern Scotland is concerned. The Executive Council are considering at present a scheme of exhibits which takes account of the following:—That there should be a collection of exhibits showing the varied nature of Scotland's industries and of those carried on by Scotsmen in the Colonies and abroad, and that in many industries a contrast should be made between the old and the new. That there should be an electricity exhibit, dedicated to the memory of Lord Kelvin. That there should be a shipbuilding and marine engineering exhibit of a historical nature, showing the development of steam navigation in its home on the Clyde. That the river Kelvin should be taken advantage of to represent historic episodes in Scottish life and industry. That the Colonies, so largely peopled from Scotland, be invited to tell of the progress of the Scot abroad. The Exhibition project has a large number of titled patrons, the Marquis of Tulibardine being hon. president. Lord Provost McInnes Shaw is hon. chairman of executive, Mr. Andrew H. Pettigrew is chairman of executive, and Mr. D. D. Binnie is secretary.

A VARIABLE STROKE PETROL ENGINE.

If a vehicle were to be direct driven by a petrol engine geared so as to have the same piston velocity as in the case of the steam vehicle, where a direct drive is possible, the engine would not only be abnormally large and heavy, but when less than full load was required the economy would rapidly fall, because the compression pressure varies with the amount of gas admitted to the cylinder. Also, if the load were reduced much below a third, the charge would fail to ignite, and the motor would stop. An engine designed by Messrs. J. F. Gill and T. C. Aveling, who have been assisted by Mr. Remington, is believed to be capable of overcoming these difficulties associated with the problem of direct drive for petrol motor vehicles. With this new variable stroke engine and direct drive the variations of leverage between the piston and road wheels are produced in a gradual manner, without the use of toothed wheels, thus, it is claimed, ensuring total absence of shock, and a continuous drive throughout.



"The Engineer"

Swain Sc

Fig. 1—VARIABLE STROKE PETROL ENGINE

The drawing—Fig. 1—shows sections of an engine of this type. It is capable of developing 50 horse-power, and has four 5in. cylinders. The crank radius is 2½in., but the piston stroke can be varied from 2in. to 7½in. without shutting off the power. The combustion chamber is automatically reduced in volume as the stroke is shortened, so that the compression pressure is constant at all strokes, and in this way, it is claimed, maximum economy is obtained under all conditions. This constant compression is naturally of great importance in the case of engines designed to operate with paraffin.

The cylinders, it will be observed, are vertical, and they are placed out of line with the crank shaft. Each cylinder has an ordinary piston and connecting-rod, the lower end of the latter working on a pin P to which is attached the forked end of a marine type connecting-rod C, the big end of which works on the crank-pin. The two anchor rods A are mounted on the ends of the pin P outside the forked end of the connecting-rod C. These anchor rods A, which swing on the shaft B, serve to constrain the motion of the pin P, so that it must always swing in the arc of a circle. It is by moving the centre of this circle in the shaft B along the definite circular path provided by the fixed quadrant Q that the variations in leverage between the piston and crank shaft are effected. The lengths of links and radius and position of the quadrants can be so designed that the clearance volume always bears the same ratio to the working volume irrespective of the length of the stroke, though in the present design the compression pressure has been made slightly lower on the short than on the long stroke. The shaft B is continuous throughout for the four cylinders, and there are five quadrants provided with cod pieces for B to work in. The position of this shaft B relative to the quadrants is varied by means of four acme-threaded screws, each mounted in a swivel head, with a ball-thrust washer, and driven by bevel wheels from the shaft D, which is operated by hand from the driver's seat.

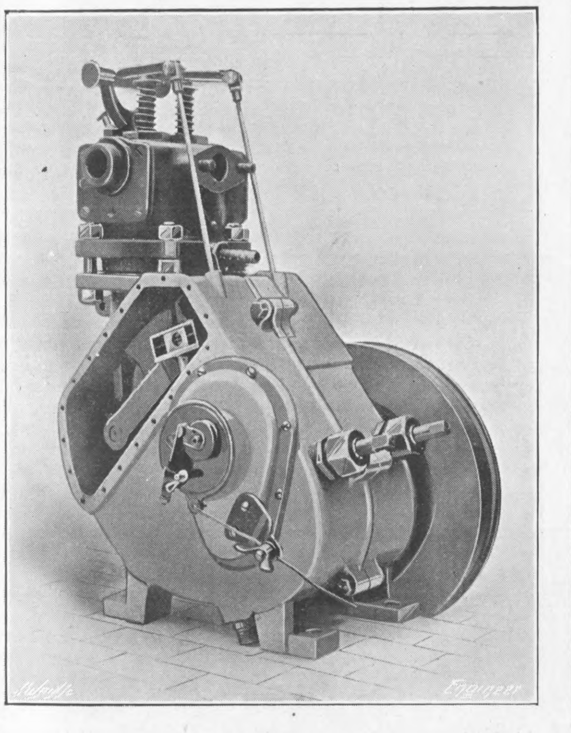


Fig. 2—2-H.P. ENGINE

When the shaft B is at the top of the quadrants the piston stroke is 2in., whilst when B is moved to the bottom of the quadrants the piston stroke is to 7½in. The crank case is of aluminium, and it is split vertically through the main bearings.

Inspection doors are provided, both in the main crank case and in the cover. The valves are in one pocket, and they are operated from the one cam shaft in much the ordinary way. These details, together with the cylinder water jacket, &c., are in accordance with standard practice, and call for no comment. Whilst this engine has a greater first cost than the ordinary type, the running expenses, both for fuel and repairs, are said to be much less. In addition to the economy being high on all strokes, owing to the compression being constant, it is also claimed that the mechanical efficiency will be constant also. The greater portion of the work lost in an engine, the inventors point out, is due to piston friction, which is practically the same for all loads. But attention is drawn to the fact that in this engine the reaction of the cylinder walls is zero when the piston has its maximum velocity and the stroke is proportional to the load on the engine, so that the mechanical efficiency of the engine should be high even at the smallest outputs.

Among other advantages claimed for this engine is its ability to increase its rotational speed much beyond that permissible in ordinary practice without increasing the piston velocity, and hence without excessive inertia forces. One feature of the motion is that the piston attains its maximum velocity earlier in the stroke than is usually the case, thus the expansion of the charge whilst at its highest temperatures is more rapid, thereby reducing the heat loss to the jackets. Another feature is that the dead centres are not diametrically opposite. On the down stroke of the piston the crank moves through 225 degrees, whilst on the up stroke it moves through the remaining 135 degrees.

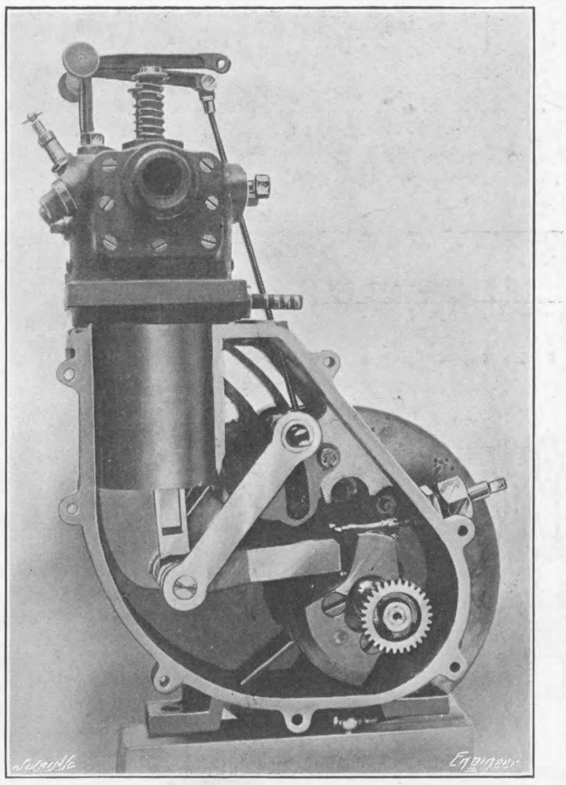


Fig. 3—OPEN TO SHOW MECHANISM

This has the effect of reducing the stresses on the crank pin during the explosion stroke, because the force on the connecting-rod is sustained through a greater angle. A four-cylinder engine will consequently have the turning efforts overlapping by a substantial amount, so that the equality of torque will be comparable with that of a six-cylinder engine, thus permitting the use of a lighter fly-wheel. The starting of this engine is said to be easily accomplished on the short stroke, and the starting handle may be fixed on the dashboard.

After the engine has been started the stroke is then increased to its maximum, the throttle being closed to control the speed until the clutch is put in, when the throttle is again opened full and all further regulation is done by varying the speed, unless even the 2in. stroke gave excess of power, in which case the throttle would again be brought into use. The engine thus provides a direct drive over a 3 to 1 speed ratio. The only change of gear necessary is the reverse, and when going ahead once the clutch is in it remains in. Some tests have been carried out at the Birmingham University by Mr. Gill, on a small single-cylinder engine of this type, which is shown in the illustrations, Figs. 2 and 3. The bore of this engine is 3in. and the stroke is variable from 1in. to 3½in. The valves were placed in the cylinder head and were operated from the cam shaft by tension rods. Brake horse-power tests were made at various speeds on each different stroke, and the results are given in the table below :—

Test of 2 H.P. Variable Stroke Petrol Engine.

Stroke.	Revs. per min.	Piston velocity. Feet per min.	B.H.P.
1in.	1700	284	.44
1in.	1800	300	.57
1in.	2250	375	.58
1½in.	1100	275	.7
1½in.	1400	350	1.08
1½in.	2000	500	1.5
2in.	1500	500	1.7
2in.	1600	533	1.84
2in.	2000	667	2.07
2in.	2200	734	2.09
2½in.	1050	438	1.6
2½in.	1500	625	2.09
3in.	900	450	1.66
3in.	1000	500	1.76
3in.	1150	575	1.85
3in.	1500	750	2.07
3½in.	750	437	1.59
3½in.	850	496	1.74
3½in.	900	525	1.77

The compression pressure was about 85 lb. per square inch on all strokes. The maximum speed obtained was 2800 revolutions per minute on a 1½in. stroke running light, whilst the maximum piston velocity was obtained on a 3in. stroke at 2400 revolutions per minute. The slowest speeds at which this engine would run when throttled were 320 revolutions per minute on a 3½in. stroke and 240 revolutions per minute on the 1in. stroke. During the normal running of this engine the throttle is seldom used, so that, as the pressure in the cylinder never falls appreciably below atmosphere, no oil can be sucked past the rings, and, the compression always being correct, perfect combustion of the product is said to be always obtained. That this was so was, we are told, apparent from the very clear and odourless exhaust. It will be seen from the drawings that most of the parts can be examined through the inspection covers. The whole of the shaft can also be removed without unseating the engine by simply removing the front half of the case.

THE TESTING OF RUBBER AND OTHER MATERIALS.

The fourth number of the *Mitteilungen aus dem Königlichen Materialprüfungsamt zu Gross-Lichterfelde West* (Berlin) for 1909 contains a lengthy communication with regard to rubber by Messrs. K. Memmler and A. Schob. The *Prüfungsamt* has turned its attention to the testing of rubber, both chemically and mechanically. A difficulty which has hitherto been experienced in the gripping of the plain samples has been obviated by making these in the forms of rings. This entailed a reconstruction of the testing machines, which Messrs. L. Schopper, of Leipsic, accordingly undertook.

The main object of the treatise under consideration is to demonstrate that the method really yields trustworthy results. It was necessary, first, to determine whether objections existed to the use of such rings, and to this end a series of tests were undertaken. Sheets of rubber about ¼in. in thickness, differing from one another as much as possible in their various properties, were obtained and cut up, extreme care being taken to cut from them correctly shaped samples, with clean edges. A Schopper machine, such as is used for the testing of paper and textile materials, was adapted for the experiments, a roller arrangement being fitted in place of the gripping jaws.

For time tests bar-shaped samples were hung up in gripping jaws, with trays of weights attached to their lower ends. Similar samples were also tested by the old method in the Schopper machine, and the results were then compared.

The time tests with rings were carried out in a special Schopper machine made to the designs of Professor Martens.

The results are given in a series of tables covering twenty-four pages of the report, and a diagram shows the effect of the successive addition of weights in a number of cases in which the final stresses only are tabulated. A peculiarity of the curves given in the diagrams is that the elongation of the material is greatest in the earlier stages of the application of stress, instead of in the later stages, as in the case of steel.

The elongation values for the ring samples are distinctly greater than those for the bar samples, and must be considered the more satisfactory.

As regards the ultimate strength, it appeared that the plain bar form of sample without a head of increased breadth was quite unsuited for testing purposes, its tendency to draw from the jaws and to break there being too great. Of the samples with broad heads, it appeared that those in which the heads were five times as broad as the bars themselves still often broke in the jaws. In general, it would appear that, for kinds of rubber capable of considerable alterations of form, the bar sample, even with a large head, was not very suitable for the purpose.

The length of the sample does not appear to affect the elongation, as in the case of steel.

Attention has been given to the influence exercised by the proportion borne by the "measured length" and the actual length of the prismatic part of the sample. As in the case of steel, this influence was found to be considerable. It is important that the length of the measurement taken should not exceed that of the prismatic part.

On a general review of the ultimate strengths and elongations, it appears that those obtained by means of the ring samples give the better results, and are more generally trustworthy.

In answer to the objection made to the ring test, that it cannot show the strength of the rubber in two directions of the sheet at right angles to one another, it is urged that, while this is a costly and doubtful proceeding in the case of the bar-sample tests, the least resistance in all directions which is yielded by a few tests made with rings is of more value to the manufacturer, and can be much more easily and certainly obtained. The influence of a previous straining of the samples on the test results is shown by the bar samples as well as by the rings, but in a more marked degree by the latter.

The advantages of the ring sample tests are summed up as follows :—

(1) The rings are easy to make.

(2) The holding of the ring samples in the machine is easier than in the case of other samples.

(3) The ring sample tests require little attention.

(4) Suitable ring tests can be more readily agreed upon than is the case with any of the various shapes that can be given to the bar.

(5) The ring test exhausts the extensibility of the material better than the bar test.

(6) The ring test can be applied to materials of all kinds, while with the bar test this is not the case.

(7) The ring and bar tests show results bearing the same relation to each other for the different qualities of rubber tested, except for those in which the bar tests have broken in the beads.

(8) Differences of strength in the length and breadth directions of sheets of rubber are of less importance than the least resistance in any direction, which the ring test gives.

(9) The ring test shows the effect of previous straining more clearly than the bar test.

The report further contains a summary of a paper on "Campeachy or Log Wood and its Secondary Effects," read by Dr. P. Heermann before the International Congress for Applied Chemistry in 1909 in London, from which it appears that, in addition to colouring effects, the application of log wood exercises a very marked effect on the weight of stuffs treated with it, and especially on that of silk, to the strength and durability of which it also adds.

Another report by the same author deals with the subject of raw silk, in the treatment of which reform is advocated. Raw silk, consisting of fibroin and tussore, being usually sold by weight, the percentage in it of the valuable fibroin may vary considerably. Dr. Heermann would like to see the tussore eliminated, or the silk valued in accordance with the proportion of fibroin contained by it. Statistics are given which show the great variation in the percentage of tussore in different kinds and different consignments of silk.

THE official report of building operations for August from 45 cities in the United States, as indicated by the filing of plans for new structures, shows an aggregate gain of 38 per cent. in value as compared with August, 1908. In New York City between January 1st and September 4th, 2479 buildings were projected, estimated to cost £25,989,000, as against 1542 in 1908, to cost £13,130,000. As is well known, the activity in filing plans in New York City in the past year has been due in part to anticipation of changes in the building code. Building operations throughout the country are considered more than fair, and the prospects for the future are encouraging.

A NEW EXPERIMENTAL ENGINE.

WE have from time to time drawn attention to and illustrated various types of experimental engines which have been erected in one or other of our technical colleges for the use of students. The students derive considerable benefit from the actual manipulation of the different forms of engine which in their subsequent career it will be their duty to supervise. This has been th policy which has been pursued at the South-Western Polytechnic, and which has led the governors to place in their laboratories, as far as funds have permitted, more than one type of apparatus, whether for dealing with the theory of applied mechanics, the testing of the strength of materials, hydraulics, or heat engines. Frequently in the case of the larger pieces of apparatus, these are ordinary standard commercial machines for which the necessary measuring appliances have been made by the students themselves under the direction of the workshop instructor. This policy has simultaneously limited the initial cost and imparted information which the students may later adapt to commercial exigencies.

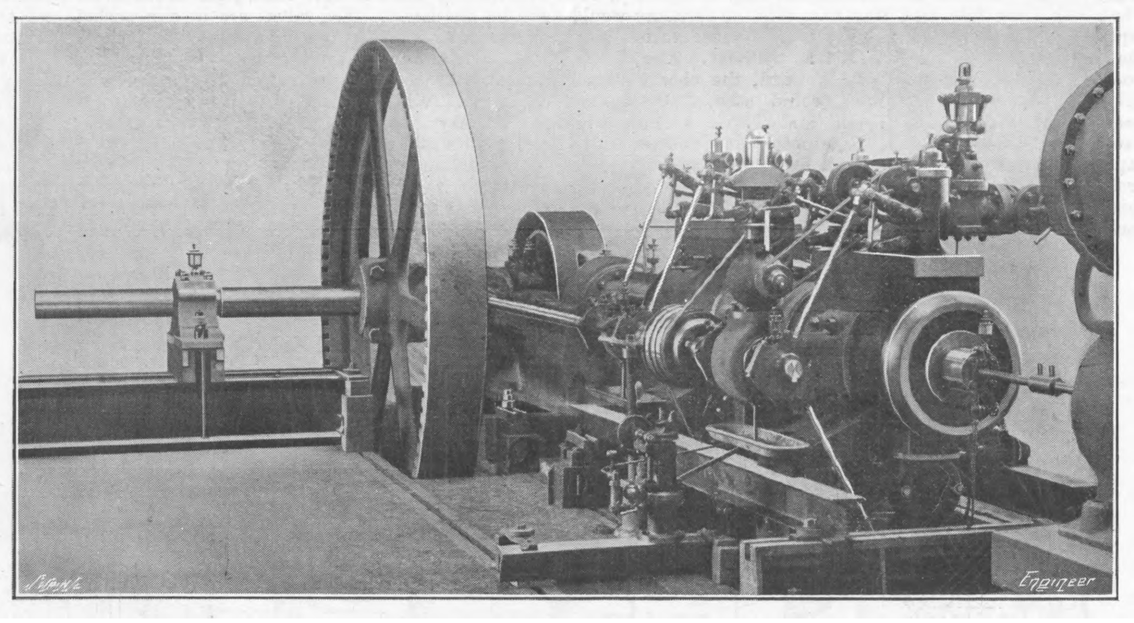


Fig. 1—GENERAL VIEW OF THE ENGINE

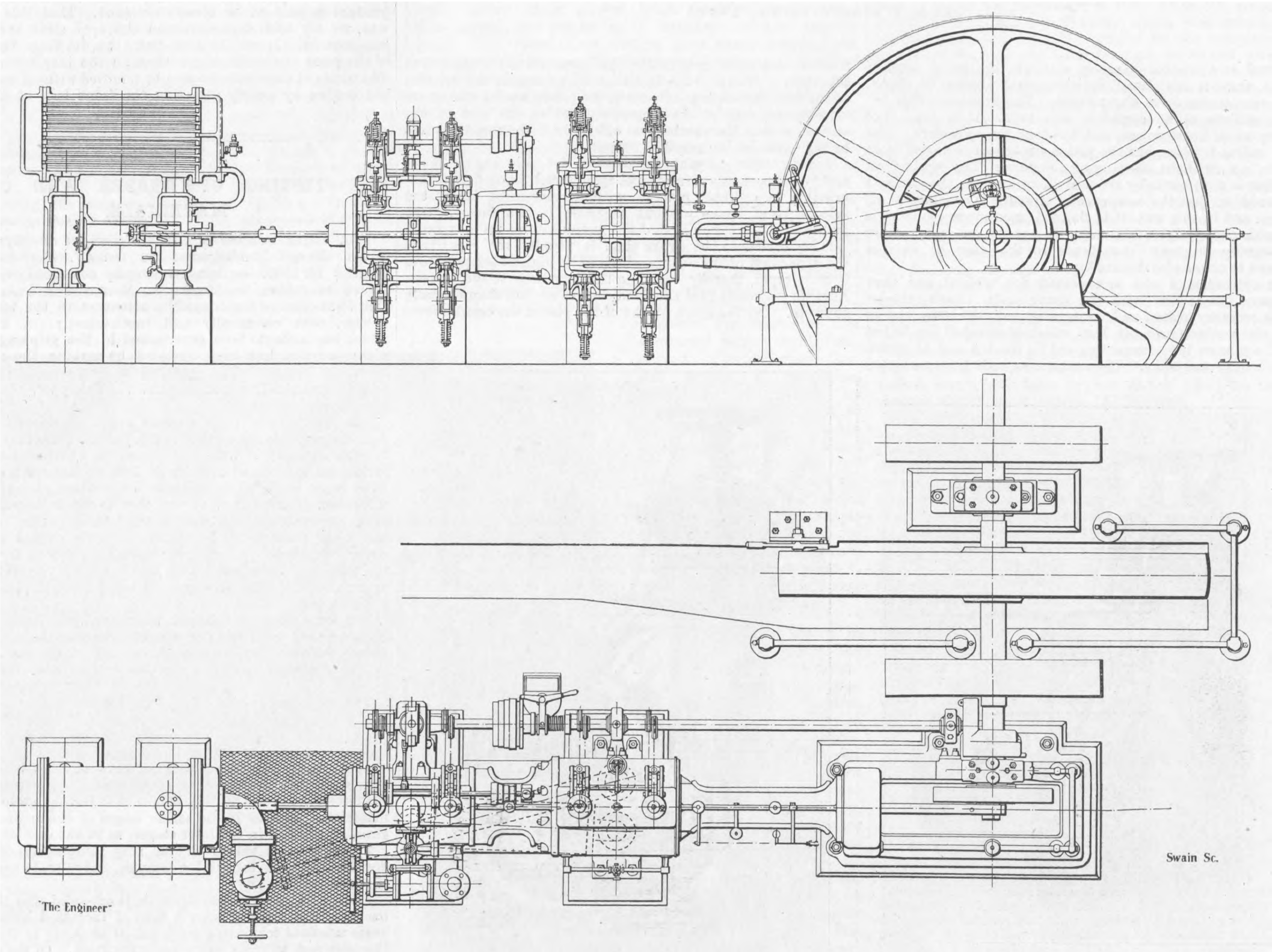


Fig. 2—GENERAL ARRANGEMENT OF THE EXPERIMENTAL DROP VALVE ENGINE

The latest addition to the engineering laboratory is an engine of the drop valve type, and at first it might appear strange that this type should have been selected. There are, however, already several of the more common types of engines at this Polytechnic.

The new engine, an illustration of which we give in Fig. 1, has been constructed by Easton and Bessemer, Limited, of Taunton. It is of the compound horizontal surface condensing type, the cylinders being arranged in tandem fashion and connected by a central trunk casting. This arrangement of erection is very neat, and, whilst reducing the weight of the engine considerably, does not affect its general stability. The arrangement can be clearly seen from the engraving—Figs. 1 and 2. The main frame is a heavy cast iron Corliss girder, to which the bored girders for the piston-rod crossheads are bolted. The cylinders are 9in. and 15in. diameter, and have a 24in. stroke, and the normal speed of the engine is 120 revolutions per minute. The cylinders are steam jacketed, and are fitted with liners of a specially hard mixture, and radiation is diminished by the provision of polished shield covers. They are fitted with automatic relief valves, and indicator cocks with copper connecting pipes, Fig. 4. The details of the valves are clearly shown in the engraving—Fig. 3. They are double beat, and are actuated by an automatic trip gear by means of which the cut-off can be varied from zero to five-eighths of the stroke. The trip levers are actuated by excentrics keyed to a lay shaft—as also shown in Fig. 3—which is driven by gearing from the main shaft.

The amount of valve opening is altered by means of a nut which shortens or lengthens the action of the valve spindle. The lead is altered by means of other nuts which permit of the length of the excentric rods being altered. The cut-off is also adjustable. The valves are prevented from hammering on their seats by means of the provision of a small air valve placed on the dashpot.

Whilst the normal speed of the engine is 120 revolutions per minute, it can be varied by eight steps from 50 to 125 revolutions per minute by a special change-speed gear connecting the governors to the lay shaft. There are two governors—one which normally controls the trip gear of the high-pressure cylinder, and a second which controls the throttle valve. The latter is a Whitehead isochronous governor, and keeps the speed of the engine within a very narrow range. Both governors are driven off the same countershaft, and are always run simultaneously, though only one controls the speed of the engine at one time.

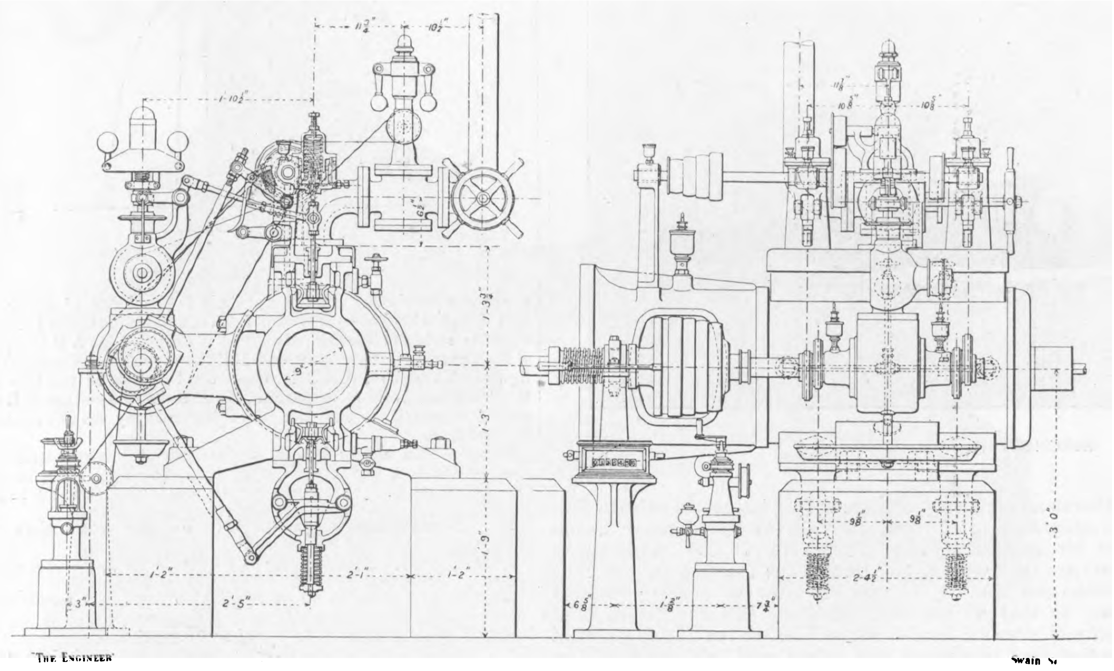


Fig. 3—END VIEW AND CROSS SECTION

When the expansion governor controls the engine the speed-adjusting spring of the throttling governor is given its maximum tension, and the speed at which it comes into action is 3 or 4 per cent. above that of the expansion governor. It is therefore dormant, but immediately comes into action if the expansion governor fails. In this way it is a safety appliance.

When it is desired to control the engine by the throttling governor, the adjusting spring is slacked out until the normal speed of that governor, which is about 2 per cent. below the normal speed of the expansion governor, is reached. The latter then drops out of action, and the speed is controlled by the Whitehead governor. Should the throttling governor fail, the speed of the engine will increase up to the normal speed of the expansion governor, which will then take charge of the engine. There is thus a safety check whichever governor is being used.

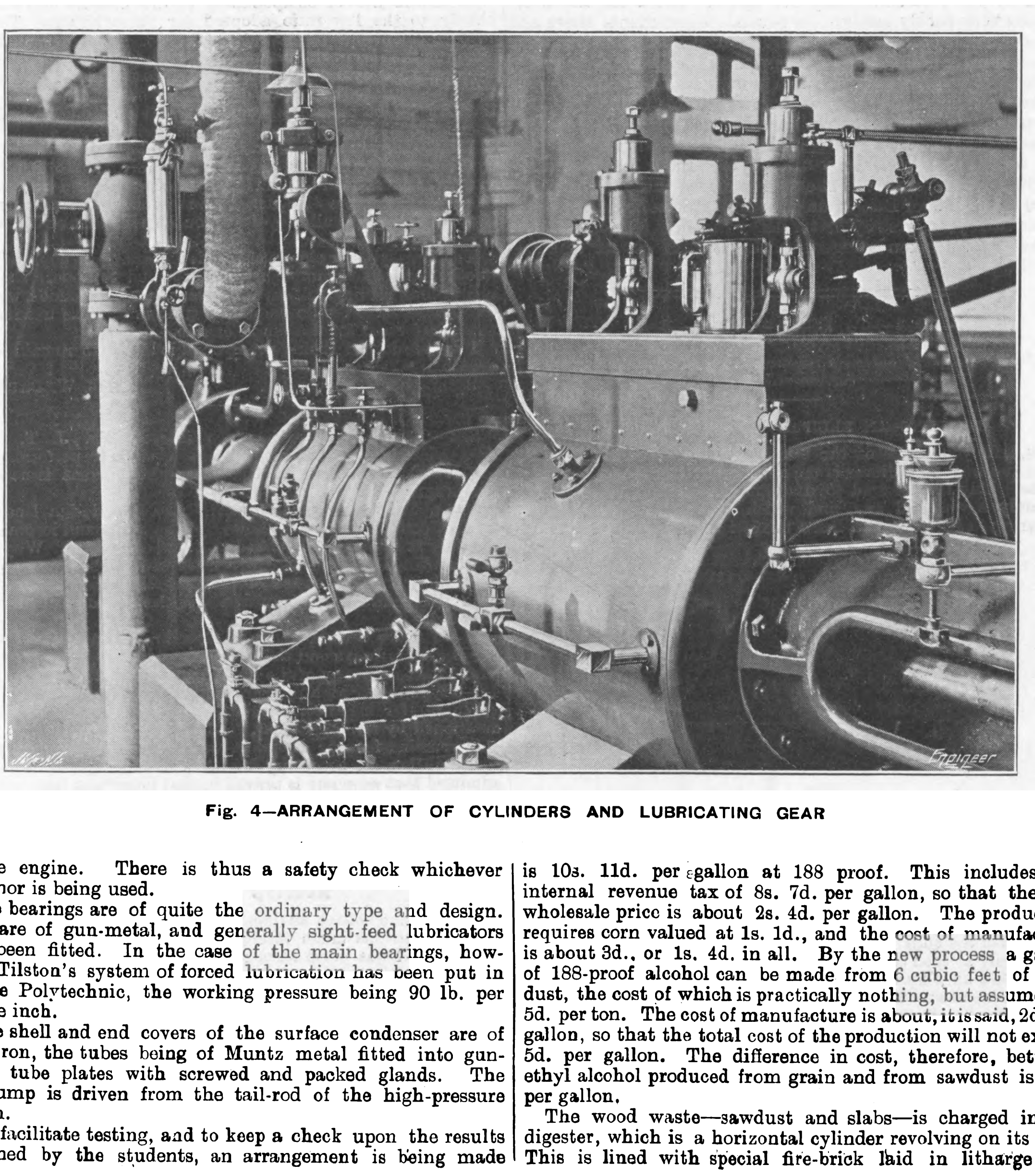


Fig. 4—ARRANGEMENT OF CYLINDERS AND LUBRICATING GEAR

The bearings are of quite the ordinary type and design. They are of gun-metal, and generally sight-feed lubricators have been fitted. In the case of the main bearings, however, Tilston's system of forced lubrication has been put in at the Polytechnic, the working pressure being 90 lb. per square inch.

The shell and end covers of the surface condenser are of cast iron, the tubes being of Muntz metal fitted into gun-metal tube plates with screwed and packed glands. The air pump is driven from the tail-rod of the high-pressure piston.

To facilitate testing, and to keep a check upon the results obtained by the students, an arrangement is being made to record automatically the consumption of steam and cooling water, and the number of revolutions of the engine.

THE PRODUCTION OF ETHYL ALCOHOL FROM WOOD REFUSE.

IN the manufacture of commercial timber there is a great amount of waste or *débris* in the form of sawdust, slabs, &c., and many attempts have been made to utilise this material for the extraction of by-products. Wood alcohol is the principal product to be recovered, but while this has been recovered successfully in laboratory work, most of the processes have not been economically applicable on a commercial basis. A new process has recently been introduced in the United States, by which is produced ethyl alcohol of the same quality as is produced from grain, that is to say, the best grade of alcohol that is used for drinking purposes. Under this process ethyl alcohol 190 deg. proof is produced from wood waste at an extraordinarily low cost.

Methyl alcohol, or methylated spirits, is made by destructive distillation, and being assumed to be non-drinkable, is free from the Government restrictions and regulations. Fuel alcohol may be made under the new process, and a certain amount of wood alcohol or other poison being added in order to avoid liability for the Government liquor tax.

The wholesale price of grain alcohol in the United States is 10s. 11d. per gallon at 188 proof. This includes the internal revenue tax of 8s. 7d. per gallon, so that the net wholesale price is about 2s. 4d. per gallon. The production requires corn valued at 1s. 1d., and the cost of manufacture is about 3d., or 1s. 4d. in all. By the new process a gallon of 188-proof alcohol can be made from 6 cubic feet of sawdust, the cost of which is practically nothing, but assumed at 5d. per ton. The cost of manufacture is about, it is said, 2d. per gallon, so that the total cost of the production will not exceed 5d. per gallon. The difference in cost, therefore, between ethyl alcohol produced from grain and from sawdust is 11d. per gallon.

The wood waste—sawdust and slabs—is charged into a digester, which is a horizontal cylinder revolving on its axis. This is lined with special fire-brick laid in litharge and glycerin. The digester being charged and the door closed, a mixture of sulphuric acid gas and steam at 120 lb. pressure is blown in through a pipe—which passes through the centre of the cylinder and is perforated—so as thoroughly to treat the wood. Under the action of the acid and the heat the starchy tissue is converted into sugar, while at the same time the heat volatilises the turpentine, resin, and oils. The average time for cooking a charge of 600 cubic feet is 75 minutes, but varies with the character of the wood.

The delivery pipe being closed, the contained steam and gas are exhausted through water, which absorbs the sulphurous acid and liquefies or condenses the turpentine.

The heated mass is then removed from the digester and carried by conveyors to the diffusion battery, which consists of a series of tanks or vats connected by pipes, and each containing a screen. Hot water is run through the series of tanks, and flows from the last one as a strong solution of sugar. The vats are filled in turn—one at a time—and the clean water is delivered first into the vat which has been washed for the longest time, and whose contents are consequently weak in sugar. The solution finally flows through the freshly charged vat, and goes to a neutralising tank. Here it is partially neutralised by treatment with slaked lime, as it cannot be fermented while in an acid condition. When the acidity has been sufficiently neutralised, the liquor is pumped to a settling tank, before going finally to the distillery, where it is delivered to a battery of fermenting vats. The fermentation is caused by a special kind of brewers' yeast cultivated for the purpose. Under the Government regulations the fermentation process must be completed in 72 hours, but in practice it is completed in from 18 to 24 hours. The remainder of the process is similar to that of an ordinary distillery, and, as required by law, every stage of the process is carried on under the supervision of Government Inspectors.

8.The Standard Alcohol Company has its plant at Chicago Heights, and has marketed a considerable quantity of its product as the best grade of ethyl alcohol, this being handled by wholesale dealers in chemicals. An important part of the company's business will be in licensing the construction of plants operating under this patented system, as it is expected that the system will be taken up actively by timber and saw mill firms for the purpose of recovering a valuable by product from the sawdust, slabs, &c., which are at present simply waste material. The first licensed plant, however, was that of the Du Pont de Nemours Powder Company, which uses the alcohol in the manufacture of its explosives.

THE SHEDS in which the Zeppelin airships are put together comprise attached machine shops, besides the erecting sheds proper. The special requirements are that (1) the temperature shall remain approximately constant; (2) any escaping gases shall be quickly carried off. Further, lighting, accessibility, good clearance, are also necessary. There is docking accommodation for two airships. The length of the shed is 200 m.

THE BOARD OF TRADE have received copies of Acts passed by the Legislature of Western Australia authorising the construction of a railway 26 miles long, from a point on the Geraldton-Northampton railway about eight miles from Geraldton to the Upper Chapman Valley, and of a railway from Nannine to Meckatharra, about 24 miles long. An Act has also been passed authorising the borrowing of £1,445,000 for public works, &c., including:—Railways, £451,400; harbour works, £95,600; water supply and sewage works, £113,200.

A QUICK PIECE OF WORK.—Our attention has recently been directed to a smart piece of work which has been carried out by the firm of David Rolls and Sons, of Liverpool. It was recently decided to fit a new high-pressure cylinder of improved design to the engines of the steamer Star, of New Zealand, and, as this vessel is engaged in the meat trade, it was important that the change should be effected in the shortest possible time, during, if possible, the discharge of her Liverpool consignment. Although this was considered as verging on the impossible, the firm set to work as soon as the vessel arrived, and the necessary change, which entailed machining and fitting all auxiliary parts, was completed in the remarkably short period of 5½ working days. The Star, of New Zealand, is a vessel of 4400 tons, her engines indicating 2500 horse-power.

POWER STATION AT CHRISTIANIA.—We have received from Escher, Wyss and Co., of Zurich, particulars of the turbines they are supplying in connection with the large contract received by Brown, Boveri and Co., and referred to in our issue of September 24th. The turbines are of the impulse wheel type, each being capable of developing 14,500 horse-power at 250 revolutions per minute. The quantity of water which each individual turbine is calculated for is 160 cubic feet per second, and 930ft. head—corresponding to a pressure of 405 lb. per square inch—with four separate nozzles; these act on the buckets of two impulse wheels mounted on one single shaft. The diameter of the impulse wheels is about 9ft. The water is conducted to the power-house through ten separate pipe lines, each about 2400ft. long; the diameter of the pipes varies from 5ft. to 4ft., a separate pipe line being provided for each turbine. There will be ten turbines, each developing 14,500 horse-power, so that the whole complete plant aggregates 145,000 horse-power, this being the greatest output of any hydro-electric power station in the world. The plant will be put in operation in about a year.

SHEFFIELD SOCIETY OF ENGINEERS AND METALLURGISTS.—The opening meeting of session 1909-10 of the Sheffield Society of Engineers and Metallurgists was held on Monday night at the University Department of Applied Science. Mr. J. Rossiter Hoyle, the president, was in the chair. Mr. H. O. Wraith, M.I.E.E., read a paper on the 1909 Home-office regulations for the generation, distribution, and use of electrical energy in factories—which use has been certified, in pursuance of Sec. 79 of the Factory and Workshop Act, 1901, to be "dangerous." Mr. Wraith gave tables as to the number of electrical accidents in factories, engineering works, and generating stations during 1908. The number of accidents from the use of electricity apparatus was, he said, small as compared with those from the engine and boiler plant. This spoke very well indeed for the safety of electrical power transmission, as well as for the soundness of the apparatus used. It seemed, if one might judge from these statistics, that the use of electricity in factories was not so dangerous as the use of many kinds of machinery, though if badly designed and carelessly looked after there was no doubt that an electrical installation was a source of great danger, and, in view of this, an attempt had been made in the new regulations not to hamper the users of electrical energy, at the same time giving the Home-office a handle for insisting that his electrical installation should be a safe and properly conducted one. The lecturer then went on to examine the regulations in detail. In summing up, he said that at this early stage, before their effect had had time to show itself, and before the weak or contentious points had actually arisen in practice, it was very hard to know exactly how to deal with a number of them, or what their exact meaning might be. He did not think they would find any properly designed and conducted installation in the country which did not conform, if not in the letter, wholly in purpose, to the regulations.

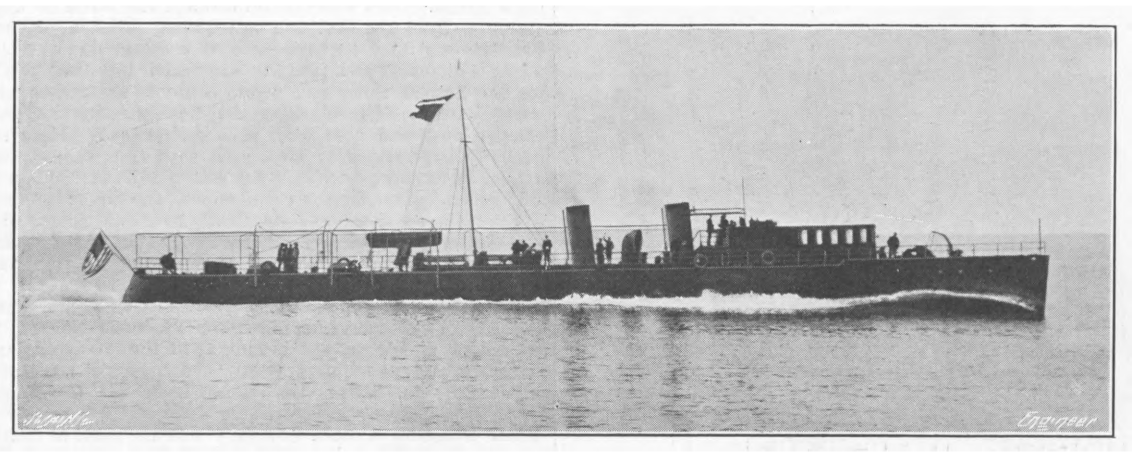
THE STEAM YACHT WINCHESTER.

THE fast steam yacht Winchester, constructed for an American owner by Yarrow and Co., Limited, of Glasgow, recently passed through her trials in the Firth of Clyde. Her estimated speed was 26 knots, and the mean speed obtained on a two hours' trial was 26.7 knots.

The dimensions of the vessel are :—Length, 165ft. ; beam, 15ft. 6in. She is built on torpedo boat lines.

The propelling machinery consists of three turbines of Parsons type—constructed by Messrs. Yarrow—with three shafts, one propeller on each shaft. The port shaft is actuated by a high-pressure turbine, the centre shaft by a low-pressure turbine in which is incorporated an astern turbine, and the starboard shaft by a middle-pressure turbine. Steam to the turbines is supplied by two Yarrow water-tube boilers, constructed for burning oil fuel exclusively.

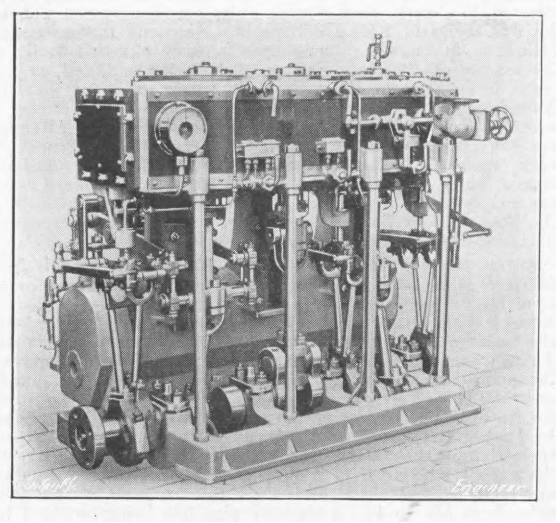
The accommodation for the owner, which is below deck abaft the machinery space, and is very commodious and handsomely decorated, consists of a double state-room, two single state-rooms, drawing-room, bath-room, and toilet rooms. There is a teak deck-house forward, 25ft. long, containing dining-room, captain's cabin, and pantry. The quarters for the officers and crew, and the galley, are below the main deck forward. The vessel has a complete electric light installation, and is heated by steam. A view of the vessel under way is given in the accompanying engraving.



THE STEAM YACHT WINCHESTER

ENGINES FOR TRAINING TRAWLER ENGINEERS.

THE Grimsby Education Authority have taken a wise step in purchasing a small set of marine engines for educational purposes. These engines are to be used for the examination and training of trawler engineers who are, as a rule, untrained men in the Board of Trade sense. The engines, of which we give a small illustration above, are representative of an ordinary outfit, but the crank shaft, to meet the specification, is built up. The cylinders are $4\frac{3}{4}$in., $7\frac{1}{2}$in. and 12in. by 7in. stroke, and the working pressure is 200 lb. The air, circulating feed and bilge pumps are driven off the low-pressure cylinder. These neat little engines have been constructed by Mr. F. T. Harker, of Stockton-on-Tees.



MARINE ENGINE FOR TRAINING TRAWLER ENGINEERS

TRADE RETURNS.

FROM the Board of Trade returns for September and the first nine months of the year it would appear that the trade of the country is improving. The September exports have reached the value of £32,801,024, which is better than in the corresponding month of last year by £1,179,818 ; whilst the exports for the nine months have amounted to £277,337,314, which is only behind the corresponding period of a year ago by £8,325,688, or under 3 per cent. It is evident that the lee-way caused by two years' dull trade is gradually being made up. The imports have also increased, and this extends to both periods. The month's importation was £49,473,546, or better than last year by £1,458,891 ; and the nine months' total was £449,777,616, or an advance upon last year of £13,999,185. The business of the country continues therefore to recover, and if the convalescence is slow it may turn out to be all the more sure. With regard to the part which the iron and steel and engineering trades are taking in the recovery, it is encouraging to find that, although the single month's total is rather down on the year, yet that the total quantity of "iron and steel and manufactures thereof" exported during the nine months has risen from 791,649 tons last year to 877,651 tons this year, the corresponding value having risen from £5,550,393 to £5,860,808. Railway material, galvanised sheets, and tin-plates are three important departments, in each of which the shipments of last year, both for the single month of September and for the nine months' period, have been far surpassed. This is a state of affairs well worth noting, favourable as it is to some of the leading industries of the North of England, the Midlands, and South Wales.

Cleveland pig iron producers will be interested to learn that the shipments of British pig iron to the United States rose for September from 7305 tons to 9987 tons. Two years ago they were 13,538 tons. The increase for the nine months was from 39,118 tons last year to 82,989 tons this year, so that we are evidently doing better; but there is plenty of room for further advance before the 410,371 tons of the first nine months of 1907 is regained. That, it will be seen, was four or five times as good as this year. The relative positions of the three years comes out more plainly when the nine months' values of these shipments are stated. These were—1907, £2,023,396; 1908, £284,306; 1909, £515,079. No wonder the North of England pig iron producers and merchants are wishing for a return of the 1907 United States market.

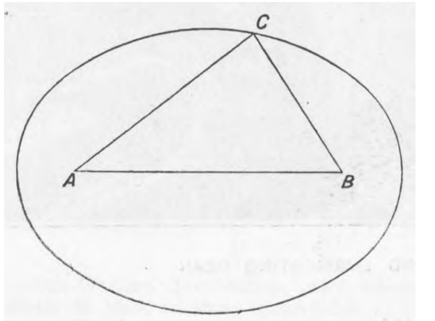
The engineering trades can hardly be said to be sharing in the trade improvement as yet to the extent that could be desired. The value of the September shipments of machinery and engines to all countries was £2,324,643, or still behind a year ago by £88,536—which, however, is not relatively a large amount. For the nine months it amounted to the considerable aggregate of £21,089,186, but this again was below a year ago, the difference being £2,115,600. There can be no doubt that the Continent is keeping us back. No one can study the returns without seeing this. But, with better reports now coming in almost daily from the continental centres, it may reasonably be hoped that the European demand will before long improve again. India also has been buying very poorly lately. In several departments there are stocks to be cleared off there. Then neither railroad extension nor irrigation works appear to be proceeding apace there lately, whilst the political unrest in that country may probably be included as another unfavourable influence. But when we look at the Colonies, especially South Africa and Australia, and also at South America, it is positively refreshing to see how well they are buying under heading after heading of the returns. The demand from these markets for nearly all kinds of British engineering productions has been, so far this year, greatly better than the first nine months of a year ago. Taken altogether, the British export trade is mending.

LETTERS TO THE EDITOR.

(*We do not hold ourselves responsible for the opinions of our correspondents.*)

DRAWING AN ELLIPSE AND A PARABOLA.

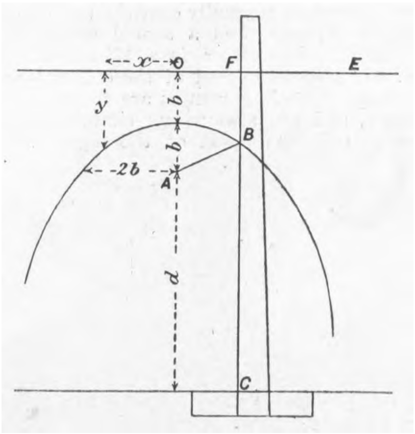
SIR,—In your issue of the 8th instant, I notice that "D. B." sends you what he believes is the only method of drawing a true ellipse. May I be allowed to describe another method, which is certainly a very old one, and which also gives a true ellipse. Referring to Fig. 1, A and B are the foci of the ellipse, and A B C a piece of silk, or some material which is not liable to stretch very much, with the ends joined to form a continuous loop. A pin is fixed firmly at each of the foci, and by opening out the loop to its full extent, an ellipse can be drawn as easily as a circle with a pair of compasses. That this gives a true ellipse is obvious when it is remembered that an ellipse is the locus of every point in a plane such that the sum of its distances from two given points in that plane is equal to a given length, the two points being the foci.



The distance $AB = \sqrt{M^2 - m^2}$, where M is the major axis and m the minor axis.

The length of the silk $ABC = M + \sqrt{M^2 - m^2}$

While on this subject I should like to give a method of drawing a parabola, which may be of interest to those who have many such curves to draw, and which, as far as I know, is original. Referring to Fig. 2, A B C is a piece of silk fixed at A, the focus of the parabola, and at C, the cross head of a T-square and on the ruling edge. By moving the T-square along the edge of the drawing board and keeping the silk taut along the edge of the T-square by means of a pencil at the angle of the silk, the resulting curve is a parabola. Since a parabola is the locus of every point in a plane which is equidistant from a given point, the focus, and a given straight line, the directrix, it follows that A B is equal to B F, where A is the locus and D E the directrix, as shown in the figure. Therefore, A B C is equal to C F. But as the line which the T-square follows is parallel to D E, it follows that A B C is a constant length, so that the curve described by the above method is a parabola.



Suppose the centre line of a parabolic arch is required with a span of $2l$ and a rise of r. Taking the origin at O, the equation to the curve is $y = b + ax^2$. But we know that when $y = b + r$, $x = l$. Substituting we get $a = \frac{r}{l^2}$. We also know that when $y = 2b$, $x = 2b$. Substituting in equation for x, y and a we have $b = \frac{l^2}{4r}$. This gives us all we require to draw the parabola, the length d being merely determined by convenience.

TALBOT C. BROOM, Assoc. M. Inst. C.E.

Liverpool, October 12th.

BRITISH LOCOMOTIVE PRACTICE OF TO-DAY.

SIR,—Shortly after I started this discussion, Mr. Riekie said that in order for a compound to compete favourably with a simple locomotive, not only should the high-pressure cylinders be as large as those of the simple engine, but the low-pressure cylinders should be at least two and a-half times their capacity. Now, with 19in. high-pressure cylinders, this means that the low-pressure cylinders must be no less than 30in. diameter. Your readers will remember that I pointed out that such immense cylinders were impossible on a British locomotive. The result was that Mr. Riekie proposed to subdivide the two 30in. cylinders into four of $21\frac{1}{4}$in. diameter each. This method of construction entailed the use of six large cylinders, an arrangement that, needless to say, did not find favour.

Mr. Riekie now proposes to use two 19in. and two 24in. cylinders. This gives a cylinder ratio of 1 to 1.6—a much lower ratio than Mr. Riekie's original suggestion.

Messrs. King, Brewer, Dearberg and myself have pointed out that the failure of compounding in this country has been due chiefly to the low ratio adopted for the cylinders. The most modern compounds have a ratio of 1 to 3. If, therefore, 24in. be taken as the size of the low-pressure cylinders, it follows that the high-pressure cylinders must not be more than 14in. diameter; 24in. is certainly the largest cylinder diameter that could be got on a British locomotive. From this it will be seen that Mr. Riekie's compound is not possible on an English railway.

I have recently made inquiries in official quarters with a view to finding out what is likely to be done with regard to British locomotive practice. Mr. R. M. Deeley having resigned his position as chief of the locomotive department at Derby, it is more than probable that the building of compounds will cease on the Midland Railway.

The four-cylinder simple engine is increasing in popularity, and another very fine example may be expected to appear shortly on one of our leading railways. Never since compounds were first introduced have our locomotive engineers been so unanimous in their preference for the simple engine.

I am afraid Mr. Riekie's compound is likely to remain a paper engine.

Birmingham, October 9th. CHAS. W. DAUNCEY.

SIR,—I have read with much interest Mr. J. T. Burton-Alexander's article on some recent locomotive performances on the Northern Railway of France in the current issue of THE ENGINEER.

I do not understand why practical men who design locomotives in this country fail to acknowledge the compound locomotive as the only type which will embody needful economies. Why should they continue further to experiment with high-pressure systems when they must be aware of the progress which is being made with the continental compound engines as described by Mr. Alexander?

If we make a comparison as regards loads and roads between our British railways and the Northern of France Railway, we must admit the superiority of the French compound locomotives of the 4-6-0 type to our high-pressure engines.

Where, for instance, could we find such results as the run, mentioned by Mr. Alexander, to Calais?

It remains for our designers to give this matter most serious consideration, as, accepting Mr. Alexander's figures, it must be admitted that economy is proved in that important item coal, and in the original cost without loss of efficiency.

A. G. ROBINSON.

Manchester, October 9th.

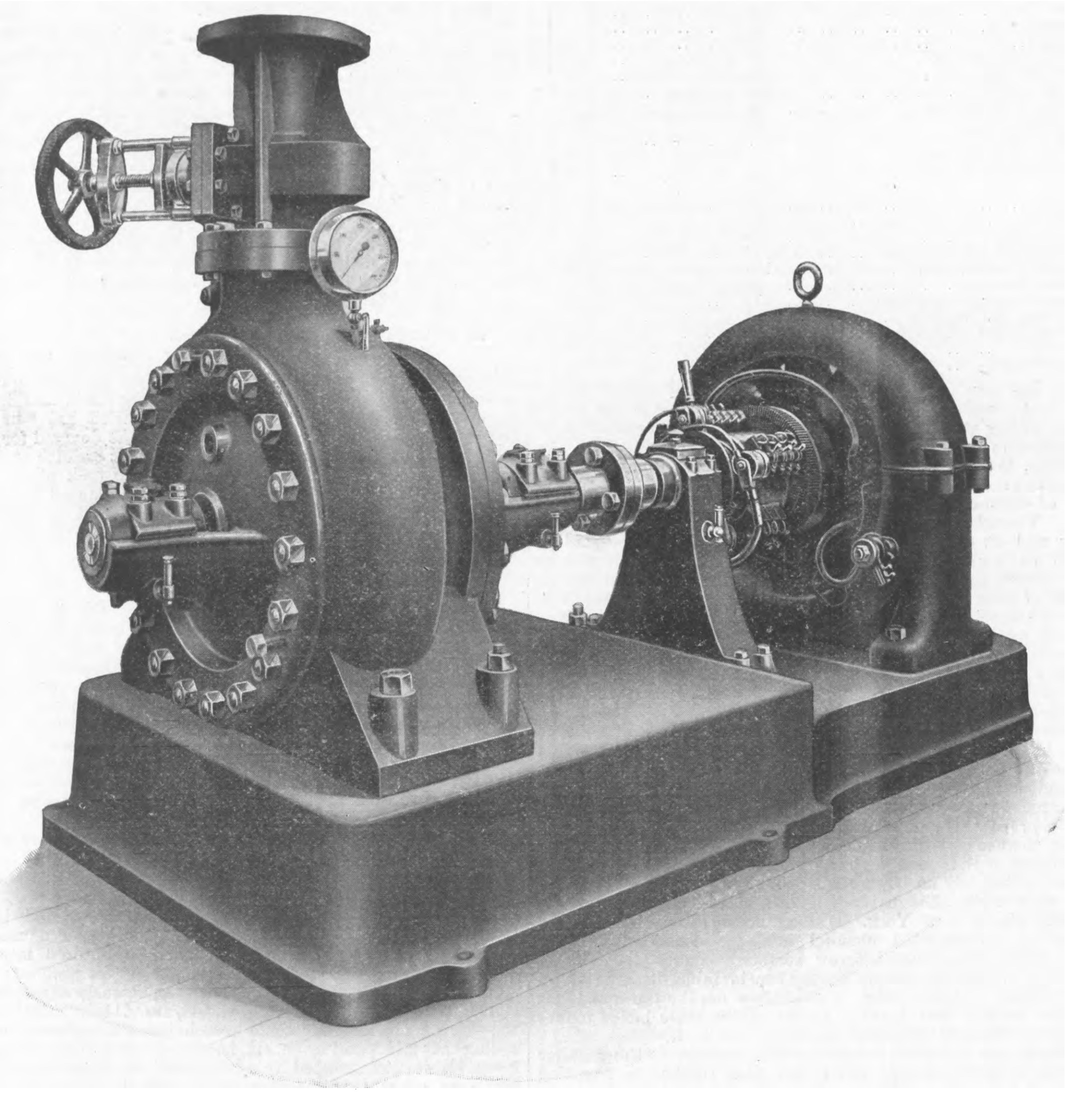
HEATING BY FRICTION.

SIR,—I am a retired engine-driver of one of the leading English railways, and was much interested in your leader, "Heating by Friction." I was often struck by the same experience with hot bearings, as they occurred from time to time without giving the least warning, although working cool and bright and getting plenty of lubrication. I have ridden at great risk scores of miles on the engine framework trying to keep the hot bearings under, as failure or bent rods were always visited by fines or suspension. Short of oil and neglect was the charge against you. If locomotive foremen would only read and digest the article named, and not be too ready to inflict punishment, a great load would be taken off the minds of the men, who have responsibility enough in other ways. I would also commend the article to the notice of locomotiv engineers in general. JOHN LOMAX.

Manchester, October 11th.

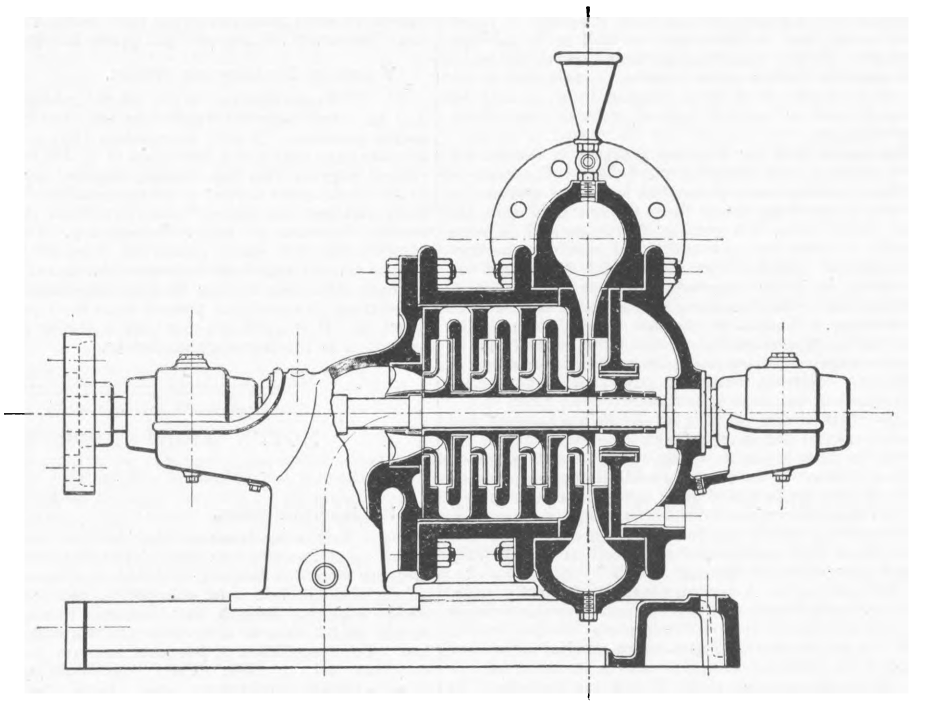
ELECTRICALLY DRIVEN TURBINE PUMP

WILLANS AND ROBINSON, LIMITED, RUGBY, ENGINEERS



A NEW TURBINE PUMP.

THE great simplicity, low prime and maintenance costs, coupled with the other well-known advantages attending the use of turbine pumps, have caused them to gain considerable prominence in many varieties of service, and, in consequence, quite a large number of the leading engineering firms have been led to take up their manufacture. The improvements in the design of details and the excellent efficiencies now obtainable have converted what was once regarded as a somewhat unsatisfactory article into one which may be said to have reached a high stage of perfection—a fact which is amply evident from the large number of turbine pumps which have been put into service. To the list of firms manufacturing these pumps Willans and Robinson, Limited, may now be added, the "Victoria" turbo-pump being the latest production at Rugby. High efficiency, great simplicity, small floor space and cheapness are among the firm's principal claims, and there are certain advantageous features about the construction to which the makers particularly direct attention.



THE VICTORIA TURBINE PUMP

It will be seen from the section above, that from the entrance to the discharge the passage of the water through the pump is as direct and as short as possible. The water flows from the suction bend into the first impeller, from which it is discharged at its maximum velocity into the guide channels. These are shaped as diffusers, and thus transform the kinetic energy into potential energy, or static pressure, this, it is claimed, taking place with a minimum loss due to friction and eddies. The water then passes round smooth curves into the diaphragm chamber behind the guide wheel, through which it flows at a low velocity towards the centre of the next propeller, and so on. The same amount of static pressure is generated by each stage, and the number of stages is, therefore, directly proportional to the total lift required. The impellers and guide wheels are made of a special bronze, the composition of which, we are informed, has been determined by protracted tests. An illustration of one of these pumps coupled to an electric motor is shown above. For pumps dealing with acid water a special acid-resisting bronze is used.

The makers point out that a particularly noteworthy feature of this pump is that it has no pressure stuffing-box, and that water at only a low pressure exists in the end chamber behind the last diaphragm. They maintain that one of the most fruitful sources of trouble in high-lift pumps is the pressure gland at the delivery end. It is urged that to avoid undue leakage these glands have to be screwed up tightly, and the pressure of the packing material on the shaft causes considerable wear and also loss of efficiency amounting to as much as 7 per cent. The stuffing-box at the suction end is water-sealed, and as it has only to hold tight against one-tenth of an atmosphere, there is no necessity to press the packing hard against the shaft.

Another feature to which attention may be directed is that there is no end thrust bearing in the "Victoria" pump. The end thrust is balanced by a simple patented arrangement which, it is claimed, cannot wear or get out of order, and automatically adjusts itself for changes of head and output while the pump is running and for any wear that may take place on the impellers. The firm directs attention to the fact that although the end thrust may be balanced when a pump is new, as soon as wear takes place this balance is destroyed. This, it is stated, is not the case in the "Victoria" pumps, the end thrust being balanced under all conditions. That this claim can stand the test in practice appears evident from the fact that no thrust bearings are fitted to these pumps. The main bearings are separated by a gap of an inch or two from the packing, the object being to render it impossible for any grit, mud, or water to enter. The bearings are cast in one piece with the covers, and these latter fit cylindrically into the centre casing. It is obvious that this construction renders it impossible for any part to get out of alignment if the pump is dismantled. Pumps of the type illustrated are fitted with ring lubrication, but in the case of sinking pumps the oil is supplied to the bearings under pressure. In some pumps there is a separate section for each stage, but in this design the impellers are in one casing, the central casing being of cylindrical bore, and the guide wheels and diaphrams fit cylindrically into the casing. The dismantling and reassembling of the sundry parts is, therefore, an easy matter, as they have only to be pushed in one after the other from the open end. It is, therefore, impossible for even an unskilled erector to get the various parts out of true alignment. The inner surfaces of the impeller and guide-wheel channels are carefully finished, either by machine or by hand, so that the water during its whole passage through the pump from the first impeller to the delivery casing never comes into contact with rough surfaces. That the finish of these parts is important is well known, and experience has shown that the wheels treated in this manner have a much longer life when dealing with gritty or muddy water than those having unfinished channels. The central casing of these pumps is in all cases lined with special bronze so that no acid or gritty water comes into contact with the casing itself at any point. The high-lift pumps are being built for heads of some 2000ft., whilst the low-lift pumps are constructed for pumping against 50ft. to 60ft. or less. When circumstances demand it these pumps are designed with vertical shafts. Here, again, the automatic balancing device takes the weight of the pump spindle, shaft, and motor armature, and thus provides against any end thrust, and, as stated above, the bearings have forced lubrication, as such pumps are mostly used for sinking purposes, although in some instances it is found advisable to adopt the vertical arrangement for stationary pumps. Turbine pumps of this type are also designed for working under abnormal conditions. It is well known that in the case of a turbine pump of ordinary design running at constant speed, if the head changes the discharge of water is also changed; that is to say, that when the head is reduced the discharge increases, and the power called for from the motor increases disproportionally. This feature is recognised, and various methods of dealing with it have been brought out. For overcoming it the Victoria pump can be fitted with movable guide vanes, whereby the efficiency is, it is claimed, maintained almost constant down to quarter of full load, and it is possible to reduce both the lift and the water discharged without influencing the satisfactory working of the pump. The "Victoria" turbine pumps are being manufactured to the designs of Mr. Jens Orten Böving, of 72-74, Victoria-street, S.W. Lastly, we should not omit to mention that every part is interchangeable, the pumps being made to limit gauges throughout.

KIRKCALDY HARBOUR EXTENSIONS.

ALTHOUGH the question of providing better shipping facilities at Kirkcaldy has received attention and been discussed at frequent intervals for many years, it was only about seven years ago—the matter once more pressing for solution—that a scheme emanating from the town council, for a deep water harbour, was heartily taken up by the ratepayers. In due course a design for the undertaking was submitted by the engineer, Sir A. M. Rendell, by which the old harbour would be extensively enlarged and deepened. This was approved of and a provisional order obtained for powers to proceed with the work. Messrs. Charles Brand and Son, Glasgow, secured the contract for the undertaking, which involved, in the first place, the extension of the east pier by 500ft., but during the progress of the work, which was begun in 1903, another 100ft. was added, thus carrying the extension out 600ft. in all, in a south-easterly direction, beyond the point of the former pier. Considerable difficulty was experienced in connecting the old pier with the new work, but this was successfully overcome. The pier extension is constructed of large concrete blocks, and these, in order that each should take the required amount of duty, were laid in diagonal courses on to the rock, which was levelled off in places by concrete bag-work, and the whole then grouped together with mortar. This part of the work had to be carried on by divers, and the grouping of these blocks under such conditions was a task of no small difficulty. The roadway of the pier is about 28ft. wide, giving room for two rails, which are protected by the parapet. The east pier finished, the second section of the work was entered upon in 1907 by the erection of the south pier, which was immediately followed by the extension of the existing dock. The new dock embraces the whole area of the old tidal basin and dock, the new area being 4 acres, with 22ft. depth of water at ordinary spring tides, the depth over the sill being 20ft. The entrance is 50ft. wide (as against 32ft. in the old dock), and the dock has a total quayage of 1840 lineal feet. All this work led to almost continuous blasting operations, which were carried on both day and night. The walls, which were carried down to the rock, were built tidally, and, instead of having freestone to contend with, blaes was encountered in the early operations in far greater proportion than had been anticipated, and with the view of securing a solid foundation the walls were carried down to the freestone bed. The heavy excavations were turned to good account in the reclamation of the old foreshore, thus increasing the accommodation in the vicinity of the harbour. The whole of the new tidal basin, 5½ acres in extent, was dredged out to an average depth of 4ft. Like the rest of the concrete and masonry, the work in connection with the dock gates is of the most substantial description. The contractors for the gates were the Brandon Bridge Company, Limited, Motherwell, and the gates may be worked either by hand power or electricity. The weight of each leaf, about 40 tons, is distributed partly by a roller on to the roller path fixed to the dock bottom, and also by means of a top collar firmly held back on to the concrete by large blocks. A fine swing bridge, swung upon a steel pedestal, has been thrown across the entrance, thus providing ample means for railway and vehicular traffic round the dock. A special feature is the enormous increase in the quayage space, the dock quayage being increased threefold. Vessels 300ft. in length, with 46ft. beam, and 18ft. draught, may now be berthed in the new dock. The north wall of the basin is to be equipped with the most modern machinery, including electric travelling cranes for handling the regular trade, while the western side is to be reserved for lines for a coal siding should it be resolved to load coal at the harbour. The total cost of the improvement will amount to £140,000. The new harbour and dock were formally opened on Saturday, September 19th, in the presence of a gathering of between 10,000 and 12,000 people, by Admiral Sir George Warrender, Bart. By his moving a lever the swing bridge was opened, and simultaneously the dock gates were opened through the working of the capstans by patrols of the Boy Scouts. The first vessel to enter the port was the London and Kirkcaldy steamer Kirkcaldy, which broke a ribbon stretched across the entrance.

INLAND NAVIGATION IN THE UNITED STATES.*

The domestic water-borne traffic carried by vessels of the United States is far larger than the foreign trade so carried, and of much greater importance. Coastwise traffic is by law restricted to American vessels, but most of the foreign trade is carried in foreign vessels. The coastwise trade routes radiate mainly from a few central ports, such as Boston, New York, Philadelphia, and Baltimore, on the Atlantic Coast, and San Francisco, Portland, and Seattle, on the Pacific On the Lakes, notwithstanding the large number of routes, the great movement of traffic follows a few well-defined main lines. Most important is the route from Lake Superior ports through Lake Huron to Lake Erie ports. Another main route, formerly the most important, is that from Lake Michigan ports to Lake Erie ports. The Atlantic coast line of the United States is more than 2000 miles in length, and it is extended for 1820 miles more by the Gulf of Mexico. The Pacific coast line is more than 1800 miles long. The coast line of continental United States aggregates 5700 miles. This is increased to a developed length of 64,604 miles by including the numerous indentations, many of which provide important bay, sound, and inlet routes. Next in significance are the Great Lakes, the most important group of inland waterways in the world. Their shore line in United States territory is 2760 geographical miles. The meandered length of shore line is 4329 miles. They are connected by a series of natural and artificial channels. Canals also connect the Lakes with the Atlantic Ocean and the Mississippi and Ohio rivers, but these are not of dimensions to permit of through navigation by large vessels. A series of canals constructed by the Canadian Government along the St. Lawrence River gives 14ft. draught to Montreal, and these canals are used to some extent by American vessels. The number of navigable streams used to a considerable extent for commercial purposes in the United States is about 295, with an approximate mileage of 26,400.

Most of these streams are navigable only for light-draught boats. Forty streams have a total of about 2600 miles of 10ft. navigation, and seventy streams give about 3200 additional miles of navigation of from 6ft. to 10ft. during the greater part of the year, making a total of about 5800 miles of river navigation 6ft. and over. These totals, however, do not of course mean that there are any such continuous stretches of inland waterways of these respective depths. The longest connected river system is the Mississippi and its principal tributaries, with about 2500 miles of a depth of 6ft. and more.

It is evident that rivers of a navigable depth of only 6ft. cannot be used by vessels suited to ocean or Great Lake navigation, and that vessels which give the most economical service on rivers having that depth cannot be used on still shallower rivers. These facts, together with the shortness of the navigable length of most rivers having a 6ft. depth and their unconnected character, are of great importance in estimating the present value of the inland waterways. It is evident that these waterways constitute by no means a unified system.

About 4500 miles of canals have been constructed in the United States. Of these, 2444 miles, costing in all about £16,000,000, have been abandoned.

The height of interest in canal building came about 1827 to 1837, after the success of the Erie Canal. The crisis of 1837 stopped canal building for the time. The introduction of the railroad about this time was also an important factor in this decline. Since then the use of canals has been as a whole steadily decreasing, both in absolute amount and still more markedly in proportion to the total traffic of the country.

This is due in part to improvident original location of the canals, in part to mismanagement and to adverse control of strategic connections and terminals, but above all else to the fundamental inability of the ordinary type of towpath canal to meet modern conditions of transportation. They are thus unable to compete with railroads to any considerable extent.

Notwithstanding these facts, private and State canals still exist. State canals are maintained in New York, Ohio, Illinois, and Louisiana, with a total mileage of nearly 1360—including branches and feeders—constructed at a cost estimated at £31,400,000.

The canals in Ohio and Illinois are antiquated waterways, with little traffic. The Erie Canal, in spite of its important past, is inadequate in its present condition to meet modern traffic demands, although the new barge canal in course of construction by the State of New York is intended to give a revival of this route.

There are sixteen private canals in operation in the United States of more than local importance, with an aggregate mileage of 632.

The capital stock reported by the companies owning these canals is £8,660,000. Their indebtedness is £7,660,000. The more important private canals are those comprising the Atlantic coast system, which connect neutral waterways so as to furnish continuous inland communication for light draught vessels from the sounds of North Carolina to Long Island Sound, though their use for such long distance traffic is wholly insignificant. Most of these canals have a declining traffic, and several have come into the possession or control of railroads, which appear to discourage their use. The control of canals by private interests does not appear to be successful.

Canals owned by the National Government form links in through water routes rather than distinct routes in themselves. The improvement of rivers by the Government has consisted in the removal of obstructions to navigation, the deepening of channels, the construction of bank revetments, and the development of slack-water navigation by the building of locks and dams for the purpose of maintaining a proper depth. Such improvements have been carried out to some extent on most of the navigable streams of the country, the most comprehensive and connected system of river improvement being that of the Mississippi and some of its important tributaries.

Canals in the United States.

	Length. miles.	Depth. feet.
Canals owned by States:		
Erie	355	7
Champlain	81	5
Oswego	38	7
Cayuga and Seneca	25	7
Ohio and Erie	326	4
Miami and Erie	269	4 to 6
Illinois and Michigan	102	6
Chicago	33	22
New Orleans	7	8
Canals owned by companies:		
Delaware and Raritan	66	8 to 9
Morris	107	5
Lehigh	48	6
Delaware	60	6
Schuylkill	90	6½
Chesapeake and Delaware	13	10
Chesapeake and Ohio	185	6 to 7
Dismal Swamp	22	9
Albemarle and Chesapeake	11	9
Newbern and Beaufort	4	6
Batataria and Lafourche	7	6
Harvey	5½	6
Lake Borgne	7	7

There has been a notable increase in the size of vessels on the coasts and the Great Lakes, similar to the increase in the size of railroad rolling stock, and with similar results in the reduction of transportation costs. As a general rule, and with vessels of the same type, the larger the vessel the lower the cost of carriage.

The size of vessels is, however, limited in nearly all cases by the depth of channels and harbours and by the terminal accommodations. Though the limits vary widely on different classes of waters and at different ports and channels, it may be said in general that a great many vessels have already been built with as great draught as the waterways they use will permit, and that in the case of most of our rivers and canals the maximum draught of vessels is scarcely sufficient to permit very economical operation.

Vessels used on quiet inland waterways, such as smaller inlets and lakes, and on rivers and canals, are neither sufficiently strong nor have they sufficient freeboard to permit them to be used on the Great Lakes or the ocean. Experts even assert that were there enough channel depth to take vessels like the great ore freighters from the Great Lakes to tide water, nevertheless it would be preferable, and almost necessary, to transship at tide water as now. These ore freighters on the Great Lakes are not in model or in structural strength adapted for ocean conditions.

The narrowness and tortuousness of river channels almost entirely prevent the use of sailing vessels, and practically also prevent the use of large steam vessels, such as are adapted to the Great Lakes or the ocean. Thus, even on a channel as deep as the Hudson, practically no large ocean boats are seen at any distance above New York, though there is 25ft. of water up to Hudson, 100 miles above New York. Owners do not care to risk the dangers of a restricted channel in large ocean-going craft. Again, even light-draught screw steamers cannot be used to advantage on the Mississippi at any considerable distance above New Orleans. Aside from the shallow depth, the need for constant backing and turning at the innumerable bends makes the paddle the only generally successful method.

Specialisation in vessels is not only with respect to the peculiar condition of the waterways, but it has gone further in adapting them to the peculiar conditions of the different kinds of traffic. This adaptation is especially conspicuous in what are known as bulk cargo vessels; that is, vessels which do not carry package or diversified freight, but which carry one or at most a few kinds of articles in bulk. Thus on the Great Lakes bulk steam vessels for ore or coal, and others for grain, are used to an enormous extent. On the Atlantic and Gulf coasts there are bulk vessels for coal, for oil, for fruit, &c. On the Pacific coast a type of steam schooner has been developed, especially intended for carrying lumber in bulk, and special lumber vessels are also used on the Great Lakes and the Atlantic Ocean. On the Ohio and Mississippi rivers bulk coal barges are extensively used, and other bulk boats to some extent. The use of rafts of logs on the Great Lakes, on the rivers, and on the Pacific coast is a special development of bulk transportation.

It is obvious, as already stated, that our inland waterways are far from constituting a unified system, and that, save on the Great Lakes, and in the coal traffic on the Ohio, they are very inferior in efficiency to railroads. The traffic on rivers and canals of the United States is insignificant in comparison with the rail traffic, or with traffic on the Great Lakes and the coasts. Diversity in channel and navigation conditions, diversity in vessel types, in motive power, and in terminals, as well as in carriers' liability, insurance, freight classification, and traffic contracts generally, have resulted in extreme absence of organisation of our water system as a whole. It is thus helpless in competing for long-distance traffic with a modern, unified, standardised system like that of the railroads.

There is little doubt that for a given distance a continuous water haul in a boat of even moderate size is, and will continue to be, cheaper in operating costs alone than a similar continuous rail haul. If the channels are made deep enough to permit the use of relatively large boats, this greater cheapness will, in some cases, be sufficient to cover also the additional cost of transshipment. The question is, however, whether besides doing so it will afford enough saving to cover reasonable interest on the investment in waterways and water terminals necessary to secure such measure of efficiency. This is a question which can only be answered after exhaustive engineering estimates of the cost of constructing waterways of different depths and investigations of operating expenses of different kinds and sizes of vessels, in comparison with expenses of rail transportation.

In most of the States water craft of all kinds are assessed and taxed like other personal property, either at the residence of the owners, or—what is often the same thing—at the port of enrolment, registry, or licence. A few States provide for taxes measured by the gross or net tonnage in lieu of other taxes on such property, on the assumption that the value of vessels is roughly in proportion to size. Vessels engaged in the foreign trade are in several States favoured either with exemption from taxation or with very light taxes based upon their net earnings.

There is no Federal tax on American vessels in domestic trade. The National Government imposes a tonnage tax on vessels entered at Ports of the United States from foreign ports, at the rate of 1½d. per ton in the case of vessels from near-by foreign ports, and 3d. per ton from more distant places, but not to exceed 7½d. per ton per annum in the former case, or 1s. 3d. per ton per annum in the latter case.

Marine insurance charges are an important factor as an addition to the cost of transportation by water, and they must be taken into consideration in comparing the relative economy of rail and water routes.

Since the floating equipment and cargoes protected by insurance are of various kinds, there is a similar diversity in the types and stipulations of insurance policies. As regards vessels, there are river hull policies, ferryboat hull policies, inland hull, tug, yacht, schooner, and steamboat policies. As regards cargoes, there are cotton policies, coal, lake cargo, and river cargo policies. There are also blanket policies on hull and cargo and on all the vessels and cargo of particular lines.

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[*] From a report of the United States Commissioner of Corporations.

Shipbuilding Works.—We understand that Harland and Wolff, Limited, propose to expend a sum of about £1,500,000 on a dry dock and shipbuilding works in Canada.

THE IRON, COAL, AND GENERAL TRADES OF BIRMINGHAM, WOLVERHAMPTON, AND OTHER DISTRICTS.

(*From our own Correspondent.*)

Iron Trade Quarterly Meeting.

The October quarterly meeting has been held this week, and though demand was not so good as up till a few weeks ago had been expected there was a strength about the raw material market to-day (Thursday) in Birmingham which was encouraging. In pig iron purchases were confined pretty much to special parcels, consumers having for the most part anticipated their requirements. Many of them are covered to the end of the year; but there is little material addition to the business negotiated for the other side of Christmas. South Staffordshire common forge iron was quoted this afternoon 47s. to 84s.; part-mine, 50s. 6d. to 51s. 6d.; best all-mine, 85s.; and cold blast 110s. Northamptonshire producers quoted 49s. to 50s., but there was hardly enough business circulating to seriously test the sincerity of these figures. Derbyshire brands were offered at 50s. to 51s., and North Staffordshire at 51s. 6d. to 52s. 6d.

No Change in Marked Bar Prices.

Up to a few weeks ago it had been expected that Staffordshire marked bars would be advanced 10s. per ton at the quarterly gathering owing to the late advance of 5s. per ton in best Staffordshire all-mine pig iron. But this anticipation has had to be abandoned by the bulk of the trade, since the demand for manufactured iron is not by any means of sufficient breadth at date to support the proposal. No advance therefore took place to-day, and the existing figure of £8 per ton was reannounced for the new quarter. Ironmasters declare that prices cannot go lower than they are for any descriptions of rolled iron, whether best or second or third-class bars.

Iron Prices and Continental Competition.

Unmarked bars remain at £6 2s. 6d. to £6 5s. for merchant sorts, and common bars are £6. There is somewhat less irregularity in prices of merchant qualities of iron than recently, and the advance which has lately occurred in Belgian and German finished iron prices helps to steady Staffordshire unmarked bar makers. Good class merchant bars can now be produced in the district to compete on fairly equal terms with the continental importations. In the commonest grades of bars there is, however, still a good deal of price disparity. Belgian supplies, it is asserted, can still be obtained at about 7s. 6d. per ton below local rates. The pressure of Scotch competition is also still being severely felt. North Staffordshire bars are selling on the £6 10s. basis delivered at outports for export. Hoops are £6 15s., and gas tube strip iron £6 5s. to £6 7s. 6d. Rivet iron is £6 15s. to £7.

Galvanised Sheets.

The galvanised iron makers keep busy, and brought excellent reports to the quarterly meeting. Producers are excellently employed on shipping contracts entered into when prices were lower than those now ruling. Latest accounts of the state of new orders arriving are, however, scarcely so satisfactory. Galvanised doubles, *i.e.*, 24 w.g. sheets, are £11 5s. to £11 10s. per ton—makers' price—but some merchants are understood to be selling at £11, and even, it is stated, £10 15s. Steps are, however, it was asserted this afternoon in Birmingham, being taken to prevent this underselling. Black sheets are £7 to £7 2s. 6d. for 20 w.g. material, £7 2s. 6d. to £7 5s. for 24 w.g., and £7 15s. to £7 17s. 6d. for 27 and 28 w.g.

Steel Joists Advanced.

An advance of 5s. per ton is announced in steel joists for the home trade. This makes the basis price £6 per ton for lots of 100 tons and under. The price of joists was not changed when other classes of structural steel were advanced a month ago, but it was stated then that an early rise was not improbable. The advance now announced is believed to be due in some measure to the increased cost of hematite iron. Export prices are unchanged.

Copper Tubes.

It was rumoured on the Birmingham Exchange that the Seamless Copper Tube Association had been dissolved, but this was subsequently denied. It appears, however, that the Association has relinquished price control in the matter of radiator tubes, the list basis price of which was 8½d. per lb. This action has been rendered necessary by the fact that outside makers were underselling Association houses, and although underselling exists in a smaller degree in other branches of the tube trade, it is not expected that the Association will declare open prices in regard to these.

Wages in Engineering Trades.

The engineering employers of Birmingham and the district will be called together within the next few days to consider the wages question. It may be recalled that early in the year the masters gave notice of a reduction of 1s. per week in the minimum rate of wages. This was strongly opposed by the men, and eventually the masters agreed to postpone action for six months in the hope that trade would sufficiently improve in the interval as to render a revision of wages unnecessary. Unfortunately, such a revision has not taken place, and it is not improbable that the employers will renew their demand for a reduction. Wages disputes in other engineering districts have been settled by the men consenting to accept the present rates for a period of three or five years, and it is quite possible that a similar arrangement may be arrived at in the Birmingham district.

NOTES FROM LANCASHIRE.

(*From our own Correspondent.*)

Manchester, Thursday.

Pig Iron Still Quiet.

The attendance on the Iron Exchange on Tuesday was about up to the usual average, but the undercurrent was weak. Holders were not inclined to grant concessions, and buyers held off in consequence. In connection with the few transactions which were put through, and then only to cover pressing requirements, prices were in their favour to the extent of 3d. to 6d. per ton. The speculation in warrants appears to be "tapering off," and this has, to some extent, unfavourably affected Middlesbrough brands. Still there was a better feeling at the close in this department, while Scotch (Eglinton) was slightly lower. Lincolnshire remained fairly steady, but sales of Derbyshire were spoken of at under what may be termed "official" rates. Hematite was very dull, and occasionally 1s. lower for West Coast and 6d. for Scotch. There was not much life in forge iron, and this was also in buyers' favour to the extent of 6d. per ton.

Finished Iron and Steel.

In finished iron it was reported that bars would probably be advanced shortly, owing to the increased price of fuel, which is in accord with makers' views expressed on 'Change. On the other hand, buyers are equally insistent that the state of trade does not warrant any advance. In steel there was little change to record. Foreign billets remain scarce.

Copper, Lead, and Tin.

Extremely quiet for manufactured, and prices have a downward tendency. Lead: Sheets about 5s. per ton higher. Tin: English ingots lower.

Quotations.

Lincolnshire, No. 3 foundry, 56s.; Staffordshire, 54s.; Derbyshire, 55s.; Middlesbrough, open brands, 60s. 6d. Scotch: Gartsherrie, 63s.; Glengarnock, 62s. 6d.; Eglinton, 60s. 3d., delivered Manchester. Delivered Heysham: Gartsherrie, 61s.; Glengarnock, 60s. 6d.; Eglinton, 58s. 3d. Delivered Preston: Gartsherrie, 62s.; Glengarnock, 61s. 6d.; Eglinton, 59s. 3d. West Coast hematite, 63s.; East Coast ditto, 60s., both f.o.t. Finished iron: Bars, £6 10s.; hoops, £7 12s. 6d.; sheets, £7 15s. to £8. Steel: Bars, £6 2s. 6d. to £6 5s.; Lancashire hoops, £7 5s.; Staffordshire ditto, £6 17s. 6d. to £7; sheets, £7 17s. 6d. to £8; boiler plates, £7 5s. to £7 7s. 6d.; plates for tank, girder, and bridge work, £6 5s. to £6 7s. 6d.; English billets, £4 12s. 6d. to £4 15s.; foreign ditto, £4 10s. to £4 12s. 6d.; cold-drawn steel, £9 10s. to £9 15s. Copper: Sheets, £71; tough ingot, £62; best selected, £62 per ton. Copper tubes, 8½d.; brass tubes, 6⅞d.; condenser, 7⅞d.; rolled brass, 6¼d.; brass wire, 6½d.; brass turning rod, 6½d.; yellow metal, 6d. per lb. Sheet lead, £17 to £17 5s. English tin ingots, £135 to £135 10s. per ton.

The Lancashire Coal Trade.

The attendance on the Manchester Coal Exchange on Tuesday was fairly good, but it was in best house coal only that there was practically any movement. Secondary stuff was quite neglected. In this connection a meeting of Lancashire coalowners was held during the day, but no decision regarding prices was come to, and an adjournment for a fortnight took place. It is quite possible that no advance may result after all. The advance in steam and manufacturing coal made recently has checked business to some extent, and this is accentuated by the condition of the cotton trade. Latest quotations are:—Best Lancashire for domestic purposes, 14s. 2d. to 15s. 8d.; seconds, 12s. 2d. to 13s. 2d.; common, 10s. to 11s. 2d.; best burgy, 10s. 6d.; round furnace coal, 11s. 6d.; best slack, 9s. 6d.; medium, 9s.; common, 7s 6d., at the pit. Coal for bunkering purposes: Screened, 11s. to 11s. 6d.; unscreened, 10s. 6d., delivered Manchester Ship Canal.

Barrow-in-Furness, Thursday.

Hematites.

The record of business done during the week is not one which affords satisfaction, as it proves that the demand has fallen off, at any rate, for prompt deliveries. Makers are, however, for the most part well sold forward, and the probabilities are that before they are anywhere near the end of their commitments they will secure a further run of good orders, as they have assurances of orders from a variety of sources which justifies the belief that the present depression will soon pass away. In the meantime there is a large consumption of crude iron by local and other steelmakers, and this is likely to continue. Prices are easier, but makers continue to quote 62s. 6d. for mixed Bessemer numbers net f.o.b., while the market prices of business actually done in warrant iron during the week shows a falling off of 1s. on the week. Sales are reported at 61s. 6d., 61s., and 60s. 4½d. net cash. It is expected that business will be done at lower prices yet, as in the meantime the orders coming from the Continent and the Colonies are only small, and there is practically nothing doing with America. Stocks of iron are somewhat lower on the week, and now stand at 15,187 tons. There are only twenty-three furnaces in blast in the district, but it is expected that the three furnaces which stopped a few weeks ago at Distington owing to an accident will be at work again next month. Makers throughout the district are now quoting for deliveries in the beginning of the year. Special hematites are in good demand, and a fair trade is doing in ferro-manganese, spiegeleisen, and charcoal iron. Some good sales of scrap iron are reported. Iron ore is quiet at 12s., 14s. 6d., and 18s. for ordinary, medium, and best sorts net at mines.

Steel.

A steady trade is being done in railway material, and the mills are being kept regularly employed, although the bulk of orders held is not large. Merchant steel is only in moderate request. The sale of shipbuilding material is at a low ebb, as the demand for plates is not sufficient to keep the mills going even on short time, and prices are so low that it is questionable whether any profit could be made at current values.

Shipbuilding and Engineering.

There are much better prospects in the shipbuilding and engineering trades than for some time past. Vickers, Sons and Maxim have been entrusted by the Admiralty with the turbine machinery and auxiliaries for the new battleship cruiser to be built at Devonport. This is a very big order, as it is reported that the vessel has to steam at the rate of 28 knots per hour, and even up to 30 knots when pressed. These turbines have to develop no less than 70,000 horse-power. Tenders for other Admiralty work are also being prepared. H.M. cruiser Liverpool, being built at Barrow, is to be launched at the end of this month.

Shipping and Coal.

The exports of iron and steel from West Coast ports last week amounted to 12,572 tons—iron, 6570 tons; and steel, 6182 tons—as against 9152 tons in the corresponding week of last year, an increase of 3600 tons. For the year to date the shipments aggregate at 478,033 tons, against 377,753 tons for the corresponding period of last year, an increase of 100,280 tons. Coal and coke represent only comparatively small business.

THE SHEFFIELD DISTRICT.

(From our own Correspondent.)

The Business Situation.

The new quarter has opened very tamely, and without much hope of any considerable activity in the immediate future. Ordinary requirements, however, are fairly well maintained, and, while there is no great improvement in demand, it cannot be said there is any falling off. In several lines of general iron and steel requirements perhaps a little more is being done. The coal trade is steady, with a perceptible shrinkage in the volume forwarded for shipment. Pits are fully employed for the most part, and there are no stocks in hand in steam coal, but there are not any heavy accumulations of orders to be dealt with.

Steam Coal—Inquiries for Next Year.

Although the shipping season is coming to an end, the opening of October saw a heavy tonnage forwarded from Hull, the total for the week ending the 5th inst. having been 86,274 tons, as compared with 57,247 tons for the corresponding week of last year. The principal market is again Cronstadt, which took no less than 21,162 tons, Rotterdam coming next with 12,572 tons. Some inquiries are being received for next year's requirements in the Baltic trade. Quotations are ranging from 9s. to 9s. 6d. per ton, but sellers are not anxious to push the trade in view of contingencies that may arise in the production of coal. For industrial purposes prices are easier, as is usual when shipment is nearing its close, and supplies of steam coal for industrial undertakings are at the rate quoted last week—about 9s. per ton. The railway companies, in some instances, are receiving extra supplies for stocking purposes.

House and Gas Coal.

House and gas coal continue in fair demand, but not such as to warrant an official advance for domestic fuel. As the present contracts, however, are being worked off, the collieries are demanding and getting the usual season's advance of 1s. per ton for house coal. The best qualities are in most request, and can be had at from 11s. 6d. to 13s. per ton, secondary sorts ruling at from 10s. to 11s. per ton. Gas companies and corporation gas departments are taking deliveries more freely, as is usual towards the approach of winter.

Small Coal and Coke in Good Request.

The best qualities of slacks are firmly called for, and there is a ready market for all that is raised. The principal trade is in the qualities required for the textile districts, to which supplies are being forwarded at from 4s. 6d. to 5s. 6d. per ton. In the cheaper slacks there is less activity, with some stocks in hand. For coking smalls there is a brisk inquiry. Coke continues firm, best washed making from 12s. to 12s. 6d. per ton; unwashed, from 11s. to 11s. 6d. per ton.

Iron—Market Unchanged.

The dull condition of the iron market, reported last week, has not altered, there being very little business all round. This remark applies to hematites and other irons alike. The absence of specifications causes the deliveries of raw materials to be weaker than what is desired. It is pretty evident that buyers who bought largely some time ago are not disposed to accept deliveries so quickly as what was at one time expected. Current quotations:—Hematites, West Coast, 68s. to 70s. per ton; East Coast, 65s. to 67s. per ton, both net, delivered in Sheffield and Rotherham. Lincolnshire, No. 3 foundry, 52s. 6d. per ton; No. 4 foundry, 51s. 6d. per ton; No. 4 forge, 51s. 6d. per ton; No. 5 forge, mottled and white, 51s. 6d. per ton; basic, 52s. 6d. per ton, all net, delivered in Sheffield and Rotherham. Derbyshire, No. 3 foundry, 52s per ton; No. 4 forge, 50s. 6d. per ton, both net, delivered in Sheffield and Rotherham.

Bars, Hoops, and Sheets.

Bar iron continues very quiet. Business is so languid that any upward movement in prices is not considered possible, although pig iron has advanced out of proportion to the present quotations for bar iron, billets, and other kinds of semi-finished material used in this district. Bars remain at £6 10s. per ton; hoops at £7 10s. per ton; and sheets at £8 10s. per ton. Most of the rolling mills, forges, and tilts are but indifferently employed. Makers of steel materials who had laid in large stocks in confident expectation that trade by this time would be brisk have been disappointed, as results have fallen far short of what were looked for.

Work at the East End.

The heavy industries at the East End, in one department or another, are fairly busy. Various requirements for armour plates, gun forgings, and other manufactures are producing a little more activity in the early stages of these processes, such as the Siemens steel and press departments. The railway companies still continue to give out their orders for replacements rather than new work. These are not of any bulk, but a fair number of small orders for stores and other purposes come steadily forward. We have no change to report for the better generally in marine specialities, which is the department in which activity would be most welcome, affecting as it does so many branches of local industry. The trade revival in the United States is benefiting the Sheffield district to a considerable extent, chiefly in respect of tool steel. The demand is mainly for the new high-speed, ordinary high-speed, and the higher grades of carbon crucible steel. Otherwise the crucible steel trade is not active, and several other local industries are also dull.

Cutlery Exports—An Improvement.

The official return of cutlery forwarded to foreign markets shows a further increase, carrying the total for the completed nine months of the year above that for the first nine months of 1908. The figures, however, are still about £100,000 below 1907. The value of exports last month was £62,606, as compared with £54,537 for September of 1908, and £66,547 for September of 1907.

NORTH OF ENGLAND.

(From our own Correspondent.)

Cleveland Pig Iron.

Since last report the pig iron market has been affected by a "slump" similar to that which has been reported in the stock markets and the other material markets, and which has been brought about mainly by dearer money, the rises in the British and the German bank rates. So far as Cleveland iron was concerned, it made speculators in warrants rather nervous, and on Monday there was a keen desire manifested by holders to sell out. This helped on the fall, and buyers were not very ready to take the iron off the hands of these speculators, and the price dropped to 51s. 3½d. cash buyers, which was 1s. 4½d. less than the figure that was attained before the weakening in prices of the last few days began. The market was also adversely affected by the slackening of inquiries from the United States, and the few orders that had been secured from that quarter. The continued heavy increase in the stock of Cleveland pig iron in Connal's public store is not favourable to business. Only once in the history of the trade has the stock increased so rapidly as now reported—over 1400 tons per working day has this month been added to the stock, and that in a period which is usually one of the briskest shipping months of the year. That being so, traders naturally fear what is to be the state of affairs in the winter season, and that tends to check advances in prices. But the situation with regard to stocks is not so bad as Connal's figures would indicate, and it cannot be said that the production of the district is exceeding the requirements by the quantity that is going into Connal's stores. It must not be forgotten that there are the makers' own stocks to be taken into consideration. It is true that no official particulars of these are to be obtained, the Ironmasters' Association having ceased to take the public into their confidence in this respect just thirteen years ago. But it has become known that they are reducing their stocks, and that the aggregate quantity held by them does not exceed a week's production. It would pay the ironmasters to let this be known officially, as it would tend to counteract the bad influence of the state of Connal's stock, for naturally it is inferred that all stocks are moving in the same way. Since Tuesday the market for Cleveland pig iron has recovered somewhat from the easing of prices, and holders of warrants have been less ready to throw them in the market. Whereas on Monday 51s. 3½d. was all that would be given for Cleveland warrants at the close of the day, 51s. 9d. was offered on Tuesday, and more on Wednesday. No. 3 Cleveland pig iron was as low as 51s. 3d. per ton on Monday, but producers asked 51s. 9d. on Wednesday for prompt f.o.b. delivery, with 9d. more for delivery over the first quarter of next year. No. 1 is at 54s., No. 4 foundry at 50s. 3d., and No. 4 forge at 49s. 9d.

American Demands for Cleveland Iron.

The market for Cleveland pig iron continues to be regulated in great part by the state of affairs in the United States and Canada, and it was adverse reports from America at the beginning of the week that were the main cause of the drop in prices. But the intelligence has since become more encouraging, and prices have stiffened. Inquiries from across the Atlantic are not so numerous as they were last week, and producers in Cleveland are somewhat disappointed that, so far, so little business has resulted, but the margin of difference in prices is yet too small to tempt American consumers to buy much on this side. However, most traders expect that Cleveland will be called upon to send large quantities of pig iron to the States, and they are not so much disquieted by the rapid increase in Connal's stock as might be expected. If America comes forward to anything like the extent that had to be reported in 1905 and 1906 the stock will be rapidly drained away. This week the Glenesk has loaded, at Messrs. Wilson's, Pease and Co.'s wharf, Middlesbrough, 2000 tons of G.W.L. Cleveland pig iron for Boston, the rate of freight being 6s. 3d. Palmer's Shipbuilding and Iron Company, Jarrow-on-Tyne, has sold 6000 tons of hematite pig iron to Canada. The orders that have been secured from the United States have not been so much for pig iron; what was wanted was chiefly scrap steel, and of this some good lots have been sold, while a good deal more is expected to be bought.

Hematite Pig Iron.

The improvement in East Coast hematite pig iron proceeds steadily; this branch is not affected by speculative operations of a character that influence the market for ordinary Cleveland pig iron. It is almost solely legitimate trade that regulates the prices of hematite in this district. There are no East Coast hematite warrants. The prospects are encouraging, and the tendency of quotations upwards. Mixed numbers are at 59s. 6d. per ton for October delivery, 60s. for delivery to the end of the year, and 62s. 6d. for delivery in the first quarter of 1910. Advances in ore prices are looked for, as the Spanish mineowners, who have been selling Rubio at 12s. 6d. f.o.b. Bilbao, now quote 14s. for delivery next year. Consumers are not prepared to buy much yet for 1910 delivery. Coke is very firm at 17s. per ton delivered at Middlesbrough furnaces this quarter.

Stocks and Shipments of Pig Iron.

The stock of Cleveland pig iron in Connal's public store on Wednesday was 327,344 tons, an increase for the month of 13,369 tons. The stock consisted of 302,973 tons of No. 3; 21,461 tons of No. 4 foundry; and 2910 tons of iron undeliverable as standard. The shipments of pig iron from the Cleveland district are improving a little, but that is to be expected in October. The quantity exported up to 13th was 50,607 tons, as compared with 40,377 tons last month, 44,018 tons in October last year, and 64,567 tons in October, 1907, all to 13th.

Cleveland Miners' Wages.

The blast furnacemen's wages in the North-East of England having been settled last week for the last quarter of the year, there has been a conference this week between the Cleveland ironstone mine owners and the representatives of the men to adjust the rates in that industry. The employers stated that they did not consider that an advance of more than 0.3 per cent. was due, having regard to the amounts which had been dropped by the owners from their claims in recent quarterly settlements, but eventually they decided to offer 1 per cent. advance, to which it is expected the men will agree.

Manufactured Iron and Steel.

Business in most branches continues to increase, and this may be regarded as a legitimate improvement. Traders hold that the revival is commencing at the right end when it begins in the finished branches. The makers of steel joists have raised their quotations 5s. per ton, and now ask £5 12s. 6d. to £6 per ton, less 2½ per cent. f.o.t. The prospects for plate and angle manufacturers are good, and the quotations are maintained at £6 for steel and iron ship plates, £7 for steel boiler plates, £5 7s. 6d. for steel ship angles, £7 for iron ship angles, all less 2½ per cent. f.o.t.

Shipbuilding.

The prospects for shipbuilders are improving, so far as regards the amount of work secured, but there is not much improvement in price, for the builders have still to tempt the shipowners to give out orders, as there is not much change for the better in the rates of freight, and more steamers will be on the laid up list as soon as the Baltic season is over. The number of idle vessels is not just now being reduced. There are 49 on the Tyne, 9 on the Wear, and 3 on the Tees. The cost of running steamers does not decrease, but rather the opposite, with coals dear, and insurance rates increased, now that Lloyd's have put up theirs 10 per cent. The returns issued by Lloyd's show that there are more vessels in course of construction in British shipyards than at the end of June, 1909, or at September 30th, 1908, there being—exclusive of war vessels—290 vessels of 778,036 tons gross being built.

Trade of Middlesbrough.

The statistical report of the Middlesbrough Chamber of Commerce shows that while the figures for pig iron were very poor in the third quarter of the year, the total value of the trade of the port showed an increase in value—it was £2,194,968, or nearly half a million more than in the corresponding quarter of last year, and that was the best return this year. For the nine months the value was £6,065,029, or £11,292 more than in the first three quarters of last year. The exports of pig iron during the nine months were 775,910 tons, or 18½ per cent. less than in the corresponding period of 1908, and the worst since 1905; but there was an increase in the exports of manufactured iron and steel, which reached 478,690 tons, 2 per cent. more than in 1908, and 10 per cent. more than in 1907.

Coal and Coke.

The steam coal trade is somewhat disappointing, for export demand, which should be very brisk at this season, seeing that the Northern shipping season is nearly over, is not good, and the price is weak. Germany is becoming a keener competitor than ever where continental orders are concerned, and English coalowners will be placed at a disadvantage, owing to the increased cost of working under the new Eight Hours Act. German firms have just secured an order for 100,000 tons of small coal for delivery over next year at Swinemunde. This has hitherto been considered a special preserve of British collieries, and large quantities have been sent every year. Best steam coals are quoted at 10s. 9d. per ton f.o.b. Best gas coals are at 11s., and seconds at 10s. 3d. The coke trade is very firm and satisfactory, though less seems to be required for export.

NOTES FROM SCOTLAND.

(From our own Correspondent.)

The General Business Position.

There is a quieter feeling in business generally which is attributed to the set back in the Stock Exchange, iron, and other markets. Speculative dealing has received a shock from these and several other causes. Purchases of raw material had been made on a considerable scale in anticipation of a growing expansion in manufactures, and the rapid upward movement in prices appears to have deterred rather than stimulated such an expansion. Poor railway traffics and disappointing iron shipments, together with increase in stocks, have had a discouraging effect. Political uncertainty and apprehensions of dearer money have, perhaps more than anything else, contributed in the last few days to the inaction that has prevailed in trade circles. It is so far satisfactory that the markets are ready to respond to any favourable influences from without.

The Pig Iron Market.

The tone of the pig iron market was rather dull in the early part of the week, and there was a reaction in prices of warrants to the extent of about 1s. per ton below the highest figures touched in the recent upward movement. Holders of warrants, it was stated, were inclined to realise profits in view of the belief that the increased output of pig iron in America was adverse to considerable shipments from this side, and there was an impression that the prospects of the States taking English and Scotch pig iron had probably been exaggerated. Yet, as soon as a more cheerful report had been received as to American business, the prices of warrants rapidly recovered. Since last report business has been done in Cleveland warrants from 52s. 3d to 51s. 3d., and up again to 51s. 9d. cash, 52s. 4d. to 51s. 6d., and up to 52s. 2d. one month, and 52s. 10½d. to 52s. 2d., recovering to 52s. 7d. three months. A considerable amount of business has been done for future delivery. Transactions have occurred at 51s. 11d., and 52s. 4d. for delivery in fourteen days, 51s. 5d. sixteen days, 52s. 2d. seventeen days, 52s. 4d. November 24th, and 52s. 9d. for 4th January. Business has been done in Cumberland hematite warrants at 61s. 2d. and 61s. 4½d. cash, and 61s. 6d. one month.

Scotch Makers' Iron.

The demand for Scotch pig iron has been fair, although neither so large nor so pressing as in some recent weeks. Output has been increased by the addition of one furnace, and there are now 82 furnaces in blast, compared with 76 at this time last year. Prices of the various brands are steady. Free at ship in Glasgow Monkland No. 1 is quoted 58s. 6d.; No 3, 56s. 6d.; Carnbroe, No. 1, 61s.; No. 3, 58s.; Clyde, No. 1, 63s.; No. 3, 58s.; Gartsherrie and Calder, Nos. 1, 63s. 6d.; Nos. 3, 58s 6d.; Summerlee, No. 1, 65s.; No. 3, 59s; Langloan, No. 1, 65s.; No. 3, 60s.; Coltness, No. 1, 90s.; No. 3, 59s. 6d.; Eglinton, at Ardrossan or Troon, No. 1, 58s. 6d.; No. 3, 56s. 6d.; Glengarnock, at Ardrossan, No. 1, 62s.; No. 3, 57s.; Shotts, at Leith, No. 1, 63s. 6d; No. 3, 58s. 6d; Carron, at Grangemouth, No. 1, 65s. 6d.; No. 3, 59s. 6d. per ton.

Shipments of Pig Iron.

The shipments of pig iron from Scottish ports in the past week were 7651 tons, compared with 6920 in the corresponding week of last year. To Canada 1855 tons were despatched, bringing up the total for the present year to date to 10,537 tons, against 8621 tons taken by the Dominion in the same period of 1908. Holland took 924 tons, Australia 515, Italy 344, Germany 245, South America 210, India 155, Belgium 55, France 30, other countries 300, the coastwise shipments being 3018, compared with 3114 in the same week of last year. The arrivals at Grangemouth of pig iron from Cleveland and district amounted to 8221 tons, showing a decrease of 7703 tons compared with the quantity received in the corresponding week of 1908.

Finished Iron and Steel.

These branches, or at least those that are engaged in heavy work, are greatly in want of orders, and much machinery is standing idle. The steel trade is dull, as far as regards what may be termed the staple manufacture, that of shipbuilding steel, specifications for which are difficult to obtain. There are questions as between merchants, manufacturers, and consumers which seem to affect the business adversely, and with regard to which the different parties hold separate views. It is certain, however, that makers expected to be much better supplied with work than they are at present. There is a fair amount of business passing in material for export. In the malleable iron trade the depression is severe and competition very keen for all inquiries coming into the market.

The Coal Trade.

Business has assumed a somewhat more encouraging aspect in the coal trade. Exports are increasing, and inquiries for future supplies are more plentiful. Heavy supplies have had a depressing effect on prices, and coalmasters and merchants, while anxious for business, hesitate to enter into contracts based upon even a moderate advance on current prices.

WALES AND ADJOINING COUNTIES.

(*From our own Correspondent.*)

Last Week's Coal Trade.

THE severe weather of late has told seriously on business, tonnage coming in most irregularly; but the expectations of buyers that prices would droop, or that concessions might be obtained, were not realised. As a rule it was a difficult matter for buyers to get even small reductions in best steam coals. They did better with inferior coals, or when demurrage was feared, or wagons were badly needed. Generally speaking prices were firm, the outlook being regarded as favourable. Floating rumours, traced to trustworthy quarters, also supported the confidence of sellers by stating that good business had been done in steam at long dates at 17s. per ton. This strengthened the impression that prices would remain as at present for some time. Some cases of easier figures for smalls were to be noted, and pitwood was by no means strong.

Latest Cardiff Quotations.

When business began this week the report on 'Change was—"inquiry slow and prices unsteady." Sellers' quotations of the previous week were maintained. Monmouthshire steam coal very quiet. Latest:—Best steam coal, 17s. 3d. to 17s. 9d.; best seconds, 16s. 6d. to 17s.; seconds, 15s. 9d. to 16s. 3d.; ordinaries, 15s. to 15s. 6d.; best drys, 16s. 3d. to 16s. 9d.; ordinary drys, 14s. to 14s. 3d.; best washed nuts, 14s. to 15s.; seconds, 13s. to 13s. 6d.; best washed peas, 12s. 6d. to 13s.; seconds, 11s. to 12s.; very best smalls, 8s. 6d. to 9s.; best ordinaries, 6s. 9d. to 7s. 6d.; inferior sorts, 6s. to 6s. 6d.; very best Monmouthshire black vein, 15s. 3d. to 15s. 9d.; ordinary Western Valleys, 14s. 6d. to 15s.; best Eastern Valleys, 13s. to 13s. 6d.; seconds, 12s. 6d. to 13s. Bituminous coal: Very best house, 17s. to 18s.; best ordinaries, 15s. to 16s.; No. 3 Rhondda, 17s. 3d. to 17s. 6d.; brush, 13s. 6d. to 13s. 9d.; smalls, 10s. to 10s. 6d.; No. 2 Rhondda, large, 12s. 3d. to 12s. 9d.; through, 9s. 6d. to 10s. 3d.; smalls, 7s. 3d. to 7s. 6d. Patent fuel, 15s. to 16s. Pitwood, 18s. 3d. to 18s. 6d. Coke: special foundry, 24s. 6d. to 28s.; foundry, 19s. to 22s.; furnace, 17s. 3d. to 18s.

Newport Coal.

Tonnage much delayed, and little doing in consequence. Prompt business open to concession, but market firm for future business. Latest quotations:—Best Newport black vein, large, 15s. to 15s. 6d.; Western Valleys, 14s. 3d. to 14s. 9d.; Eastern Valley, 12s. 9d. to 13s. 3d.; other kinds, 12s. 3d. to 12s. 6d.; best small steam, 6s. 9d. to 7s. 3d.; seconds, 6s. 3d. to 6s. 6d.; inferiors, 6s. to 6s. 3d. Bituminous coal:—Best house, 15s. to 15s. 6d.; seconds, 14s. to 14s. 6d. Patent fuel, 15s. to 15s. 6d. Coke: Foundry, 18s. 6d. to 19s.; furnace, 17s. to 17s. 6d. Pitwood, 18s. 3d. to 18s. 9d.

Swansea Coal.

Swansea has fared better than other ports in having a more regular supply of tonnage, and this gave animation to business this week. Prices were reported to be stiffening. Best brands strong, but still a little weakness in other coals not of such approved value. Red vein again remains about the same, but machine coals in strong demand. Latest:—Best malting, 24s. to 24s. 6d. net; second malting, 21s. 6d. to 22s. 6d. net; big vein, 18s. to 20s., less 2½; red vein, 12s. 6d. to 12s. 9d., less 2½; machine-made cobbles, 23s. 6d. to 24s. 6d. net; Paris nuts, 26s. to 27s. 6d. net; French nuts, 26s. to 27s. 6d. net; German nuts, 26s to 27s. 6d. net; beans, 17s. 6d. to 18s. 6d. net; machine-made large peas, 11s. 6d. to 12s. 9d. net; machine-made fine peas, 10s. 6d. to 11s. 6d. net; rubbly culm, 5s. 3d. to 5s. 6d., less 2½; duff, 2s. 6d. to 3s. net. Other coals: Steam, 17s. to 18s.; seconds, 14s. 6d. to 15s.; bunkers, 9s. 9d. to 10s. 6d.; small, 7s. 6d. to 9s. 6d; No. 3 Rhondda, 18s. to 18s. 6d.; through, 14s. 9d. to 15s. 6d.; small, 10s. 6d. to 11s.; patent fuel, 13s. 6d. to 14s., all less 2½ per cent.

Iron and Steel.

The only work being done at Cyfarthfa of late has been just sufficient to show that a little life is remaining. No mills working, no furnaces in blast, and only a few hands employed at the smiths and fitters, who keep the colliers' tools in order. At Dowlais, after a period of almost stagnation, there was a little briskness, though principally confined to light manufactured goods, colliery and tram rails, fish-plates and such being the chief. The absence of rails on the bank was marked, but it is hoped that Indian States rails and requirements for New Zealand and Ceylon will change the character. One fact to be borne in mind is that the mills at Dowlais turn out very large quantities when needed, often followed by a quiet interval. At Llanelly the steel works are doing well. Swansea imported 1640 tons pig iron and 1889 iron plates. Steel accumulations in this district will necessitate, it is thought, some stoppages unless the demand improves. Ebbw Vale continues busy with importations of iron ore, principally from Bilbao, and Onton Guest from Hovallo and Bilbao; 2715 tons came to Newport mid-week from Port Vendras for Ebbw Vale. At the Swansea Metal Exchange the following were the latest quotations:—Pig iron: Hematite, mixed numbers, 60s. 4½d. cash and one month; Middlesbrough, 51s. 7d. cash, 51s. 10d. one month; Scotch, 57s. 7½d. cash and month; Welsh hematite, d.d., 67s. to 68s.; Siemens steel bars, £4 15s. per ton; Bessemer, £4 12s. 6d. to £4 15s.; East Coast hematite, 66s. c.i.f. 650 tons pig iron from Grimsby came to Newport this week, and substantial cargoes of ore to Guest, Keen and Nettlefolds. Rubio ore at Cardiff and Newport remains at 16s. 6d. to 17s.

Tin-plate.

At one time in the annals of this industry it was the one which was constantly prominent for labour or other friction, until a systematic course was entered upon between employers and workmen. Now it is the one freest from trouble, and the prosperous condition continues unchecked. Last week it was feared that American competition might interfere, but this has not done so, and works are well placed for business. Good orders are held in the Swansea district, and there are substantial lines for such oil plates as C. 18¾ × 14, C. 20 and 10. Employment, stated a manager last week, has not been so regular for a long time. Last week shipments mounted up to 144,078 boxes, and receipts from works totalled 98,400 boxes. Stocks now are only 129,799 boxes compared with 175,477 boxes. Spelter factories are fully occupied, and the copper works all doing well; fair average work daily at the three establishments. Mannesmann tube works are also well placed. Each department is busy. Latest: Tin market very firm. Makers are well placed with orders and specifications. Prices of tin-plates are expected to be well maintained. Reported that the American Tin-plate Company is not likely to be a serious competitor for export business for the next twelve months. Latest prices, Swansea:—Ordinary plates: I. C. 20 × 14 × 112 sheets, 12s. 4½d. to 12s. 6d. Bessemer and Siemens: Ternes, 28 × 20 × 112, 22s. C. A. roofing sheets, £8 to £8 15s. per ton. Big sheets for galvanising, £8 10s. per ton; finished black plates, £9 10s. per ton; galvanised sheets, 24 g. £11 to £11 5s. per ton. Block tin, £137 15s. cash, and £139 2s. 6d. three months. Copper, £57 8s. 9d. cash, and £58 8s. 9d. three months. Lead: £13 15s., English; Spanish, £13 5s. Spelter, £23 5s. Silver, $23\frac{1}{16}$d. per oz.

The Egyptian Railways Contract.

The settlement of this, which has been regarded with interest as indicating the opinion of the leading coalowners, is considered by the coal world as satisfactory. The principal coals were second-class steam and Monmouthshires. The latter continue in favour, and were only at slightly easier figures than present quotations. The steam coal was selected at 14s. 6d. net per metrical ton—fairly equivalent to 15s. This, as the delivery will extend from December to August, may be taken to be hopeful of the continuance of fair prices for a time, and the cessation of those labour frictions which do so much harm to the great coal industry. Very ordinary daily despatches from Cardiff are rarely under 50,000 tons, and last week Swansea despatched 67,727 tons, and Newport 88 tons foreign and 14,098 tons coastwise. The Belgian State Railways contract was also placed this week. This was for small coal and patent fuel, and is said not to exceed 25,000 tons, for delivery over next year. The bulk of the requirements have been arranged with two local firms, and the balance with Belgian and German firms.

Pembroke Dockyard.

It is stated—and the news has been received with much satisfaction—that new work is now obtained, and that the torpedo gunboat Antelope has been brought around to Pembroke to be refitted. She is now moored off Hobbs Point. The work will need an outlay of about £12,000. Of this £7000 will be for labour, and this will be a welcome addition to the dockyard. There is also the launching of the Blanche, which is to take place at an early date, and the yard will be fully occupied for some time.

AMERICAN NOTES.

(*From our own Correspondent.*)

NEW YORK, October 7th.

A NEW combination of iron and steel manufacturing interests is said to be under process of formation at Pittsburg which proposes to absorb all of the mills which are susceptible of purchase. The new combination will probably be under the management of John A. Leishman, a former president of the Carnegie Steel Company. The independent interests include a number of powerful corporations which heretofore had been acting alone. Whether this can be accomplished is a matter of money on the part of the organisers and willingness to sell upon the part of the independents. The reasons for their coming together are not so strong as was the case with those units which now compose the United States Steel Corporation. That corporation was practically another name for the Carnegie interests. The construction of pipe lines continues to occupy attention in the south-west, especially in Kansas, Oklahoma, and Texas. These lines are for the carrying of oil and gas. The latest enterprise is a sixty-mile line to be built by the Kansas Natural Gas Company which will build a 16in. line from Joplin, Missouri, into Oklahoma. The demand for locomotives continues, and the latest large order was for sixty locomotives for the Baltimore and Ohio Railroad. The two great locomotive building concerns, the American Company, and the Baldwins, are now working full time. All of the railway companies are adding to their motive power equipment, and many are enlarging their machine-shop capacity. In addition to this some large railway systems have decided upon building their own rolling stock, and contracts have been let for the construction of large plants at western points. The eastern car-building shops have been working to the limit of their capacity for some time, but it seems to be the policy of some of the larger systems to become independent of outside sources. The general tone of the steel market is strong, and prices have been advanced within a week on a number of mill products. These advances have been made necessary by higher prices for crude material, such as Bessemer and basic pig and steel billets. Large blocks of foundry and basic pig have been purchased—one lot of 20,000 tons and another of 10,000 tons. The National Tube Company has just advanced prices under an enormous demand for tubes all over the United States. Notwithstanding the upward tendency of prices generally, the disposition to contract for remote deliveries is limited to estimated requirements.

There is nothing new to note in the copper market. The prices are steady and the domestic demand is restricted to small purchases owing to the temporary withdrawal of the large consumers. The price is 13⅛. Unless the demand improves there will be an accumulation, but this is not disturbing. The present supply of tin is 3300 tons larger than a year ago.

CATALOGUES.

J. W. AND C. J. PHILLIPS, 23, College-hill, Cannon-street, London, E.C.—Bulletin No. 103, relating to all the "Bristol" instruments used in connection with blast furnaces has reached us. Also Bulletin No. 108, which deals with the "Bristol" electric indicating pyrometers specially suitable for hardening furnaces. Both publications are well illustrated, and the descriptive matter is clear and concise.

STORK BROTHERS AND CO., Hengelo, Holland.—Centrifugal and turbine pumps are dealt with in a well got up little publication to hand from this company. Among other things it gives some useful information concerning the erection and working of centrifugal pumps, data required for estimates upon proposed centrifugal pumping plants. Then some eighteen pages are devoted to the company's low-lift centrifugal and turbine pumps, wherein prices and weights, dimensions, and much other useful information is given. At the end of the pamphlet high-lift centrifugal and turbine pumps are dealt with. The pamphlet contains many excellent illustrations.

SIEMENS BROTHERS' DYNAMO WORKS, Limited, Caxton House Westminster, S.W.—A pamphlet received from this firm has reference to commutation pole traction motors. From this pamphlet we notice that the firm has standardised a line of commutating pole traction motors ranging from 22½ horse-power to 150 horse-power, and even larger machines have been designed, with outputs up to 275 horse-power. It is stated that for the smaller motors a special design has been patented, by means of which the introduction of commutating poles causes very little extra expense and small increase in the overall dimensions of the motors. The pamphlet contains some instructive information concerning these machines, and will no doubt be read with interest by engineers associated with electric traction work.

THE LINOLITE COMPANY, 25, Victoria-street, Westminster, S.W.—Those who have to deal with electric lighting problems will no doubt find something to interest them in the literature just issued by this firm. A tasteful little pamphlet deals with the subject of electric lighting from the point of view of efficiency and economy, and gives particulars of the "Tubolite" system of lighting, in which the coiled filament of the ordinary bulb is replaced by a straight filament forming the nucleus of a "tube of light," and backed by a polished reflector which increases the percentage of useful light from a lamp of a given candle-power. We notice that metallic filaments are now used with this system of lighting. In addition to the pamphlet referred to above we have also received three leaflets relating to this system of lighting; also a leaflet descriptive of the "Challenge" door alarm, this being a simple apparatus which automatically switches on and off an electric bell connected with a door directly the latter is moved.

CONTRACTS.—Bennis and Co., Limited, have recently received orders for forty mechanical stokers and furnaces of various kinds, the majority of these being for the firm's gritless and smokeless stokers, and many being repeat orders.

THE NEW AUSTRALIAN PATENT ACT.—The Manufacturers' Association of Great Britain informs us that it has, through the Commonwealth representative in London, made representations to the Australian Government regarding some features of the new Patent Act Amendment now passing its final stages in the Commonwealth Parliament. British manufacturers realise that the new amendment is a logical sequence to Australia's new protective tariff. At the same time, owing to the very limited capacity of the Australian market, the new provisions for compulsory working are regarded as being somewhat in advance of the country's industrial development. The Act will have to be very carefully administrated, or the effect of the compulsory working feature will undoubtedly be to compel the establishment of industries which, owing to market limitations, will be unprofitable, and so do the country more harm than good. Mr. G. Byng, the chairman of the Manufacturers' Association, has urged the Commonwealth Government to reserve powers in the Amending Act that will enable the Government, at any future time, without further legislation, to grant to Great Britain concessions in return for similar concessions which may be made by any British Government for the time being. In view of the growth of public opinion in favour of establishing closer trade relations with the Overseas States British manufacturers are anxious that no opportunity shall be lost of rendering less difficult the work of co-ordinating these local measures which affect Empire trade and industry.

NEW QUAYAGE AND HARBOUR FACILITIES AT GLASGOW.—Glasgow harbour facilities for the handling of grain and fruit imports have long been so inefficient as to be a standing reproach to Glasgow, and a source of inconvenience, annoyance, and loss to all concerned, as was frankly admitted by Mr. W. H. Raeburn, deputy-chairman of the Clyde Trust, at the last meeting of that body. Apart from the handling of grain by the regular liners, which had their own facilities, the tramp steamers brought a large quantity of grain and fruit to the Clyde, and these had been given berths anywhere in the harbour. The means of unloading were antiquated and the cost was heavy. The excuse hitherto made to the grain trade has been that the harbour was so congested that no place could be provided for their trade. With the completion of the new quayage at Meadowside, a short distance below the mouth of the Kelvin, this state of affairs will, however, soon be altered. This important extension to the available quayage of Glasgow harbour and the ground adjoining has been reported on by a special committee of the Clyde Trust as affording a site admirably adapted for the needs of the grain and fruit trade, and it has been decided to complete the quay and the ground to which it is a frontage in a way suited to and commensurate with the needs of this growing branch of Glasgow's shipping trade. It has been decided that a goods shed 1650ft. long by 100ft. wide, estimated to cost £26,000, shall be erected 40ft. from the face of the quay; that a double line of tramway, when required, shall be laid in front of and behind the shed with relative crossovers, turntables, and capstans, to suit, but without cranes for the present. A large granary is to be provided by the Trustees, erected at the back of the goods shed at the west end of the ground, where there are 3½ acres unappropriated. In connection with this there will be two travelling grain elevators on the front of the quay, and all necessary modern appliances, the whole operated by electricity. It has been decided also that the whole operations of discharging, handling, storing, and delivering grain at Meadowside shall be under the control and management of the Trustees. At present the charge to shipowners for the discharge of their vessels by elevators, which they have to hire, or by steam winch, is a little less in some cases than the charge which it is proposed the Trust should make at Meadowside, but the extra cost in all cases will be more than compensated for by the extra dispatch. Not only will the grain be handled more expeditiously, but it can be stored in up-to-date warehouses at a less cost than at present prevails.

NOTES FROM GERMANY, FRANCE, BELGIUM, &c.

(*From our own Correspondent.*)

Rheinland-Westphalia.

Though accounts of an improvement in the iron trade have, at first, been received with some distrust, a feeling of confidence has now gained ground, and the last few weeks have brought more life into the iron and steel industry. At the Düsseldorf 'Change on October 1st all sorts of iron were advanced in price—crude iron, on an average, M. 1 to M. 2 p.t.; basic bars are quoted M. 100 to M. 106, or M. 2 p.t. more than previously; hoops stand at M. 125, as compared with M. 122 50 p.t.; heavy plates, M. 108 to M. 115 p.t., as compared with M. 105 to M. 112 p.t.; boiler plates, M. 118 to M. 125, as against M. 115 to M. 122 p.t.; sheets cost M. 123 to M. 130 now, which is about M. 3 p.t. more than previously. Inquiry for next year's delivery continues lively. Producers show much reserve as regards the booking of forward orders; this, and the fact that foreign competition has been less keen recently, have caused the tone of the market to become firmer, and the prices of sale are likely to meet with further advances later on. The majority of the mills and factories report themselves in good occupation, and they have their order books pretty well filled. On the 1st of October the Bar Convention was finally formed in Berlin. All the mills belonging to the Steel Convention have bound themselves to sell bars, during the period from October 1st to December 15th, only for delivery up to the first quarter next year; they are also bound, with the exception of the Hoesell works, to sell bars for next year's delivery not below M. 102 p.t. free Oberhausen. The rolling mills still complain of being in a neglected and unsatisfactory condition. The German export in iron is stated to have improved, and of the increase of 550,000 t., as compared with last year, in orders booked by the Steel Convention, a great part falls to export. Prices for foreign orders, unfortunately, remain low; but there have also been symptoms of an improvement here.

From the Siegerland.

In the iron ore trade the business for 1910 begins to be transacted at the former rates. Nassau iron ore has been in better request lately at improved rates. Minette remains rather lifeless. The physiognomy of the Siegerland pig iron market has brightened; more contracts come in, and makers no longer feel compelled to accept famine prices. Present rates are:—M. 56 to M. 58 p.t. for German foundry pig No. 1; M. 55 to M. 57 p.t. for No 3; M. 57 to M. 59 p.t. for German hematite; and M. 56 to M. 58 p.t. for iron for steel making.

Upper Silesian Pig Iron Syndicate.

At a general meeting, which was held in Benthen on the 2nd of October, the Upper Silesian Pig Iron Syndicate has been prolonged for another year, *i.e.*, till the end of 1910.

Production of Pig Iron in Germany.

According to statistics given by the Union of German Iron and Steel Makers, the production of pig iron in Germany, including Luxemburg, was for September, 1909, 1,068,345 t., as compared with 1,100,671 t. in August, 1909, and as against 928,729 t. in September, 1908. Output in the different sorts of pig iron was as follows:—Foundry pig, 211,781 t., as against 181 964 t. in 1908; Bessemer, 33,962 t.; 27,637 t. in 1908; basic, 684,305 t., 603,575 t. in 1908; steel and spiegeleisen, 93,983 t., as against 71,951 t.; forge pig, 44,314 t., as compared with 43,602 t. in September, 1908. Production during the period from January to September, 1909, amounted to 9,509,037 t., as compared to 8,924,665 t. in the corresponding period the year before.

Coal in Germany.

The business in coal and coke remains steady, but deliveries in house fuel are rather smaller than usual. Silesian coalowners especially complain of an abatement in demand, and a reduction in output has even been taken into consideration. In coke, on the other hand, a rising tendency could be felt.

Austria-Hungary.

Very little life is stirring in the iron and steel industry; inland as well as foreign competition is keen, influencing the condition of trade unfavourably. The prices now ruling are likely to prevail up to end of 1909. The Hungarian ironworks have secured fewer orders than during last year; instead of an order for 2000 wagons that was expected to be given out by the Government only 500 wagons have been ordered. A fair business is being done in all descriptions of fuel. The production of coal in the Ostrau-Karwin district this year was, up to end of August, 50,406,430 q., as compared with 49,980,186 q. in the year before, which is equal to a rise of 426,244 q.

Belgian Iron Trade.

From week to week more firmness is shown, and business transactions have been rather extensive. The returns of the larger ironworks show trade in iron and steel to have been, on the whole, less unfavourable than was at first anticipated. Orders come in pretty freely, and rates incline to firmness in many cases. Increasing life is felt in merchant iron; sheets, too, are more animated than before; plates of 5 mm. sell at £5 4s. f.o.b. Antwerp. On the Belgian coal market prices continue the same as before; even at the late tenderings for the State Railways very slight alterations in price could be noticed. There is a good deal of confidence shown generally.

LAUNCHES AND TRIAL TRIPS.

Gladstone, steel screw trunk steamer; built by Ropner and Sons, Limited; dimensions, 378ft. 6in. long; to carry 7900 tons; engines, triple-expansion, constructed by Blair and Co., Limited; trial trip, September 24th.

Rosendal, steel screw steamer; built by the Laxevaags Engineering and Shipbuilding Company, Bergen; to the order of Hardanger-Sondhordlandske Steamship Company; dimensions, 150ft. by 23ft. 6in. by 11ft. 3ft.; engines, triple-expansion, 13½in., 22in., 35in. by 25in. stroke, pressure 180 lb.; constructed by the builders; trial trip, September 25th.

Bellucia, steel screw steamer; built by David and William Henderson and Co.; to the order of Bell Brothers and Co., of Glasgow; dimensions, 400ft. by 51ft. by 26ft.; to carry 4400 tons; engines, triple-expansion, 25in., 41in., 61in. by 48in. stroke; constructed by the builders; launch, September 28th.

Natalia, steel screw steamer; built by Swan, Hunter and Wigham Richardson, Limited; to the order of the Linea de Vapores Serra of Bilbao; dimensions, 290ft. by 42ft. beam; to carry 3250 tons; engines, triple-expansion, constructed by the builders; launch, September 28th.

Westgarth, steel screw steamer; built by Sir Raylton Dixon and Co.; to the order of R. and G. H. Rea; dimensions, 252ft. by 36ft. 3in.; to carry 2320 tons; engines, triple-expansion, 18in., 30in., 50in., by 36in. stroke, pressure 180 lb., constructed by the builders; launch, September 30th.

Dumb hopper barge; built by the Blyth Shipbuilding and Dry Docks Company; to the order of the North-Eastern Railway Company; the machinery was built by Tangyes Limited, of Birmingham.

Parkmill, steel screw steamer; built by the Clyde Shipbuilding and Engineering Company; to the order of T. P. R. Richards, Turpin and Co.; dimensions, 235ft. by 36ft. by 17ft. 3in.; engines constructed by the builders; launch, recently

BRITISH PATENT SPECIFICATIONS.

When an invention is communicated from abroad the name and address of the Communicator is printed in italics.

When the abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent-office Sale Branch, 25, Southampton-buildings, Chancery-lane, London, W.C., at 8d. each.

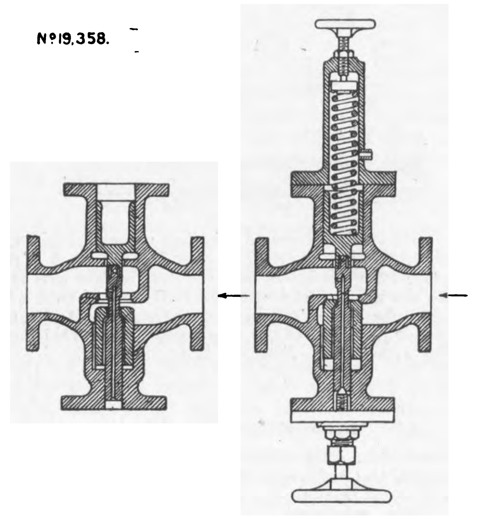
The first date given is the date of application; the second date at the end of the abridgment is the date of the advertisement of the acceptance of the complete specification.

Any person may on any of the grounds mentioned in the Acts, within two months of the date given at the end of the abridgment, give notice at the Patent-office of opposition to the grant of a Patent.

STEAM ENGINES.

19,358. September 15th, 1908.—An Improved Pressure-regulating Valve, *Otto Brutsch, of 5, rue de l'Avenir, Asnières, Paris, France.*

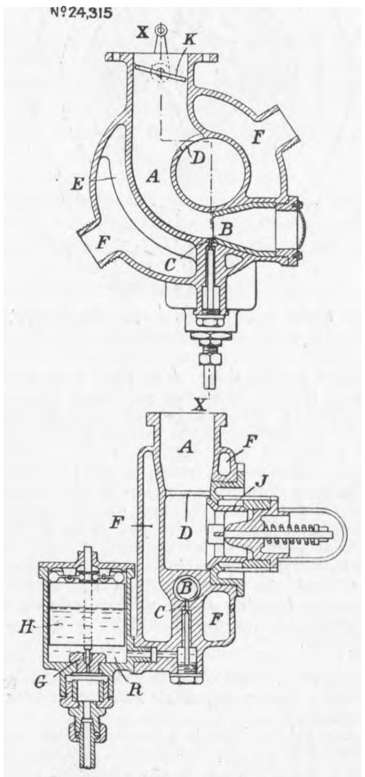
This improved valve is of simple construction, and designed to provide a reliable means for controlling the passage of steam under high pressure, and reducing it to any non-varying pressure, the valve being constructed to work automatically to suit the varying load of steam whether wet or superheated. In the known constructions the auxiliary valve is loaded on one side by high-pressure or middle-pressure steam, so that the main spring of the auxiliary valve has to overcome this pressure before it can open the auxiliary valve. This high-pressure or middle-pressure steam acting on the auxiliary valve is situated in a balancing chamber formed beneath the main valve, so that on the opening of the auxiliary valve this pressure is suddenly released and reacts on the main spring, thereby occasioning the known hammering. According to the present invention, the auxiliary valve is formed as a piston, the lower portion of which works in a chamber formed concentrically within or beneath the balancing chamber of the main valve, and communicating freely with the low-pressure side through a central boring of the auxiliary valve. Owing to this construction, the auxiliary valve is acted on by low-pressure steam on both sides, and thus the main spring has not to overcome any high or middle steam pressure when opening the auxiliary valve, thereby avoiding hammering of the valve, and occasioning an immediate opening of the main valve.—*September 22nd*, 1909.



INTERNAL COMBUSTION ENGINES.

24,315. November 12th, 1908.—An Improved Carburetter for Internal Combustion Engines Working with Paraffin or other Heavy Petroleum, Sydney Dawson Begbie, of the White House, Harlesden, Middlesex.

Referring to the engravings, A is a conchoidal fluid conduit to which air is admitted through a passage B, and C is a spraying or atomising device delivering petroleum in the form of a cold spray or mist into the current of air entering the conduit A through the passage B. A port D opens into the conduit A to admit an additional quantity of air. The conchoidal fluid conduit A has ribs E formed thereon to act as heat collecting surfaces, and is arranged within a chamber F through which pass the hot exhaust gases from the internal combustion engine fed by the carburetter or other heating media are employed to raise the wall of the said conduit to a suitable temperature. A valve G controlled by a float H provided in a chamber R operates in the well-known manner to control the supply of petroleum to the spraying device C, and a spring controlled valve J is provided to regulate the rate of admission of air through the port D. The current of air entering the carburetter through the passage B carries the cold petroleum spray into contact with the hot wall of the conduit A, whereby the vaporisation of the petroleum is completed and the temperature of the air raised. The mixture of heated air and vapour next passes the port D, through which a further supply of air is drawn in under the control of the valve J, which is adjusted to regulate the amount of air entering through this port, in accordance with the rate at which the said heated mixture of air and vapour is drawn through the conduit A, whereby the carburetted air leaving the carburetter is diluted to the required degree. A valve K may be arranged at the exit end of the conchoidal conduit A.—*September 22nd*, 1909.

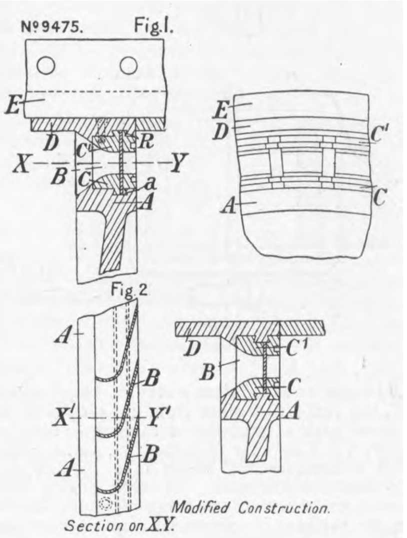


Section Through X X.

TURBINES.

9475. April 21st, 1909.—Improvements in Turbine Nozzles, James Howden and John Holloway, both of 195, Scotland-street, Glasgow.

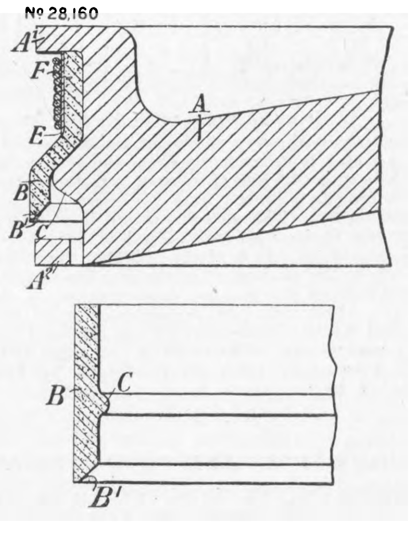
The engraving, Fig. 1, is a horizontal section of the outer part of the stator where it bears against the side of the casing. The figure shows the inner or disc part A of the stator as being of usual construction, made in halves, planed and then temporarily bolted face to face, the disc part being thereafter turned all round its circumference, with the usual extended entrance for the steam, the usual recessed check on the same side, and a dovetailed groove *a* to receive the inner ends of the fixed blades B and the inner distance pieces C; or the blades B may be held in position by the distance pieces, without engaging the dovetailed groove. The outer ring D bears against the side of the turbine casing E, the part shown being on the level of the jointing face, where the upper or removable half of the casing is bolted against the lower or fixed half by means of horizontal flanges. The outer ring D is checked and dovetailed at R to receive the outer distance pieces C^1 which are shaped similarly to the inner distance pieces C, and hold the outer ends of the blades B between them. The outer ring D is preferably, like the disc part A, made of cast iron, this metal being sufficiently strong and expanding equally with the casing at the same temperature. The distance pieces and the blades forming the nozzles are shown clearly in Fig. 2, while Fig. 1 shows the contour of the nozzles on a radial plane parallel with the axis and as passing through the line $x^1—y^1$ of Fig. 2.—*September 22nd*, 1909.



PUMPING AND BLOWING MACHINERY.

28,160. December 24th, 1908.—Improvements in Packing the Pistons of Vacuum Brake Apparatus and the like, the Consolidated Brake and Engineering Company, Limited, and Edward Sydney Luard, both of Spencer House, South-place.

The upper engraving represents a section of a portion of a vacuum brake piston provided with improvements in accordance with this invention. The lower engraving is a section illustrating a modified packing ring. A is the body of the piston, and B is the annular india-rubber band packing, carried by and secured to the outer peripheral surface thereof beneath the flange A^1. As will be seen, the unbound or free end of the band is chamfered as indicated at B^1. C is the rib or projection extending around the piston and bearing against the inside of the packing B below the point at which the latter is secured to the piston. By the described construction and arrangement the ring B is maintained in such a position that the chamfered end thereof always provides a good joint between the piston and the vacuum brake cylinder, not shown. The rib C, instead of being on the piston, may be formed on the inner surface of the band B, as shown in the lower engraving, the periphery of the piston being left plain. E is the copper band, which is preferably employed around the ring for securing the latter to the piston. F represents the wire for binding the band E in place, either or both ends of the wire being conveniently passed through a hole in the flange A^1, and soldered in

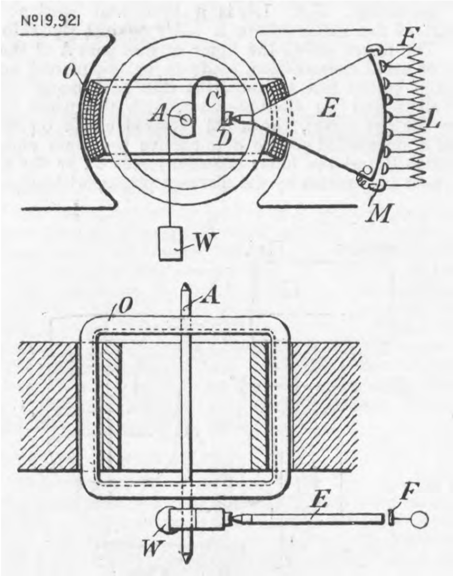


place. Among other things the invention renders possible the use with rubber band packing of a piston having a flange at the lower end, as shown at A², as well as the upper end, which hitherto has not been possible.—*September* 22*nd*, 1909.

DYNAMOS AND MOTORS.

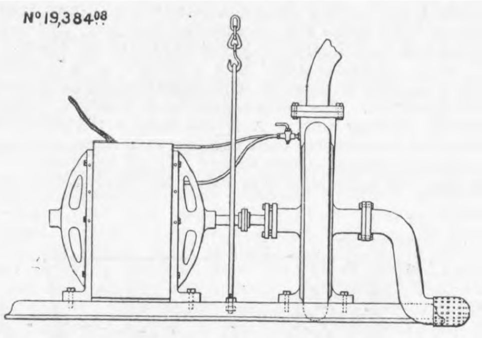
19,921. September 22nd, 1908.—Improvements in and relating to the Regulation of Dynamo Electric Machinery and the Like, *Aktiengesellschaft Brown, Boveri et Cie., of Baden, Switzerland.*

In carrying the invention into effect in the form illustrated, which is suitable for use with direct currents, a moving coil O is mounted on a spindle A, together with a spring C, which carries the point bearing D. A rolling sector E is pressed by the spring C against the contacts F, which are stationarily mounted around the centre of the spindle A. In addition, a lever is mounted on the shaft A, which in this form of the invention is shown as a roll H, which carries at the same time the spring C. In operation if, for instance, a direct-current flow in the turning coil O, and a uniformly saturated magnetic field cut it after the manner of Weston's instrument, which current has such an intensity that the developed torque counterbalances the torque produced by the weight W, the coil will adjust itself to a definite position. A slight increase in the intensity of current or terminal pressure will then result in a turning movement in, say, a clockwise direction, whilst a decrease will result in a turning movement in a counter-clockwise direction. If the moving coil be connected across the leads of a shunt dynamo, and so operate according to voltage or pressure, and if the resistance L be placed in the field circuit, then, as the rolling sector E is electrically connected with the one end M of the resistance, a rotation in one direction will result in an increase in the terminal pressure, whilst a decrease of pressure will take place by rotation in the other direction, introducing resistance in the field circuit for such a period until the torques acting in opposite directions on the moving coil O are equal to each other. There are two other illustrations.—*September* 22*nd*, 1909.


Nº19,921

19,384. March 11th, 1909.—Improvements in and relating to Electric Motors for Driving Submerged Pumps.

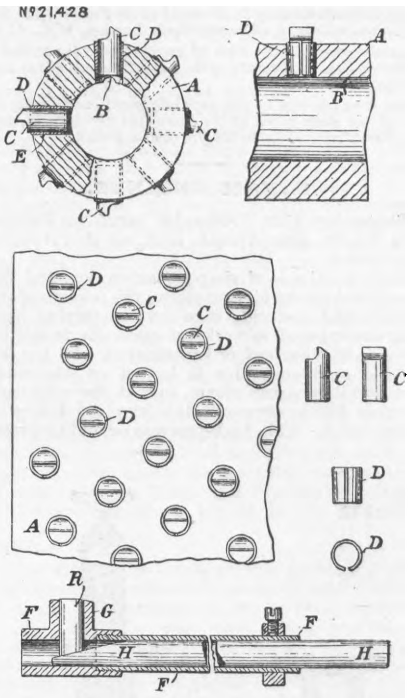
The present invention relates to electric motors intended to be submerged and operated in water without the use of any enclosing casing, and has for its object particularly a motor which can be economically designed to operate efficiently under such conditions without any risk of damage if the motor has to run for some time unsubmerged. Economic design is attained by taking advantage of the presence of the water as a cooling means, and allowing a correspondingly high current density in the conductors, and to avoid risk of heating the motor is provided with a pump, by which it continually throws a stream of water over its windings. Where the motor is permanently connected to a pump—and this is one of the commonest uses of submerged motors—it is, of course, sufficient to provide a branch from the pump outlet to conduct water to the motor. The motor is shown in the accompanying engraving, but in its main mechanical outlines it is similar to motors already in use. It is of the induction type, current being supplied only to the winding of the stator. The rotor has conductors passing through it, which are short-circuited at the ends by metal rings These rings are preferably enclosed in insulating material, and the rotor conductors are also insulated from the core preferably with rubber. The shaft of the motor is mounted in lignum vitæ bearings, which are unaffected by the water.—*September* 22*nd*, 1909.


Nº19,384⁰⁸

MACHINE TOOLS AND SHOP APPLIANCES.

21,428. October 10th, 1908.—Improvements in Milling Cutters, Kendall and Gent, Limited, and John Robert Ingham, of Victoria Works, Belle Vue, Manchester.

Referring to the engravings, A is the cylindrical body of the cutter bored to suit a mandril, and provided with a keyway B for fixing same thereto in the usual manner. C are the cutting tools of circular section and made of steel suitable for the purpose, the body A being also made of material suitable for the purpose, which in most cases would be mild steel, and which may be case-hardened if desired. D are the locking bushes. These are bored to suit the cylindrical portion of the cutting tools, and are made taper on the outside. The holes E in the body A for receiving these bushes are also made to a similar taper, and the bushes being split longitudinally as shown, on being driven into the said taper holes, forcibly compress or grip the shanks of the cutting tools C, which are previously inserted into position and rest on a stop piece inserted into the bore of the cutter body so as to prevent them being driven in with the bushes. For the purpose of extracting one of the cutting tools in case it may be desired to replace same with a fresh one, a drifting appliance may be used such as is shown in the bottom engraving. In this illustration F is a tube having at one end a short branch G at right angles to the main bore. A drift H arranged to slide in the aforesaid tube has one end made with an inclined face. A short cylindrical plunger R is arranged to slide in the branch G, having its lower face inclined to the axis so as to rest fairly on the inclined end of the drift H, and of such a length that when the tube F rests on one side of the bore of the cutter, the plunger R is just clear of the other side of the said bore, the drift H being withdrawn.—*September* 22*nd*, 1909.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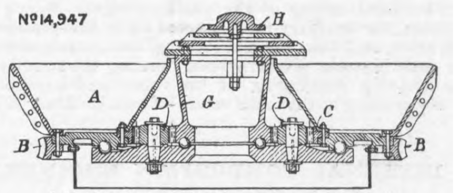
MISCELLANEOUS.

14,947. June 26th, 1909.—Improved Rotary Grate for Gas Producers, *Gutehoffnungshütte, Aktienverein für Bergbau und Hüttenbetrieb, of Oberhausen,* 2, *Rhein Provinces, Germany.*

This invention relates to a rotary grate for gas producers, consisting of two concentrically arranged parts, an inner cylindrical or conical part carrying the grate and an outer annular dish. These parts are rotated in opposite directions, and the inner part performs a greater number of revolutions per unit time than the outer part, with the object of rubbing together and grinding masses of clinker and of loosening the charge in the whole gasifying zone so as to produce uniform distribution of the blast and vigorous gasification. The dish A is driven through a toothed ring B fixed to the outer periphery of its bottom; to the inner periphery is fixed a second toothed ring C which drives through four pinions D the conical grate support G, the base of which is formed as a toothed wheel F to engage the pinions; thus the direction of rotation of G is the opposite of that of A. The step grate H is circular in plan, and is mounted excentrically to the axis of rotation on the support G. The number of revolutions performed by the grate H in unit time is a multiple of that performed by the dish A, and this multiple can be varied by varying the ratio between the diameter of the toothed ring C and the toothed wheel F. When a strongly caking coal or a coal forming much clinker is being gasified, the number of rotations per minute should be as high as possible.—*September* 22*nd*, 1909.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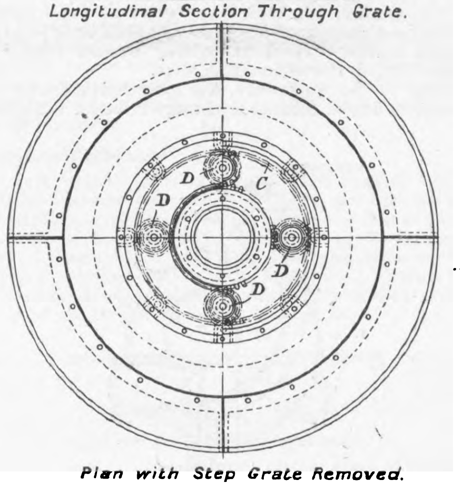
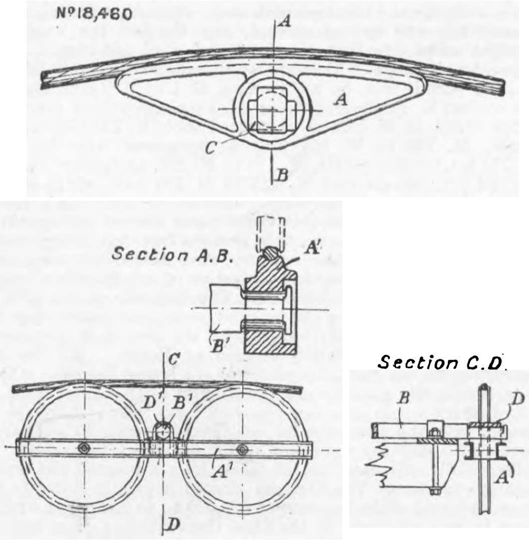
Longitudinal Section Through Grate.



Plan with Step Grate Removed.

18,460. August 10th, 1909.—Improvements in Bearer-shoes for Wire-rope Railways, *Adolf Bleichert and Co., of Leipzig-Gohlis, Germany.*

The present invention relates to a bearer device or shoe for the supporting ropes of single and double rope railways, and consists in a considerable simplification of the fixing of the shoe to the supporting beam, by which the manufacture and mounting of the shoes is considerably cheapened and the cost of the rope railway installation reduced. In the form illustrated in the upper engraving the bearer-shoe A^1 on which the rope rests is supported by the transverse beam B^1 which is fixed to the support; the beam is a flat iron bar, placed on edge and near the end has a rounded constriction, on which the bearer-shoe rests, the extreme end of the beam retaining its original rectangular shape. The shoe has a rectangular aperture C somewhat larger than the head of the beam, with a rounded cavity at the top. The bearer shoe is placed in position by pushing it over the end of the beam, while held in a position 90 deg. from its normal position, and then rotating it to horizontal position. Rounded surfaces of the shoe and beam then coincide. The projecting head of the beam prevents the shoe from sliding off in this position. In the form for single rope railways shown in the two lower engravings a flat iron bar D is fixed to the iron pulley supports, said bar being adapted to be placed over the head of the beam B when the whole is in a reversed position. The same device can be used, if, instead of two, there are four or more pulleys, which can be carried by a system of automatically adjustable levers.—*September* 22*nd*, 1909.

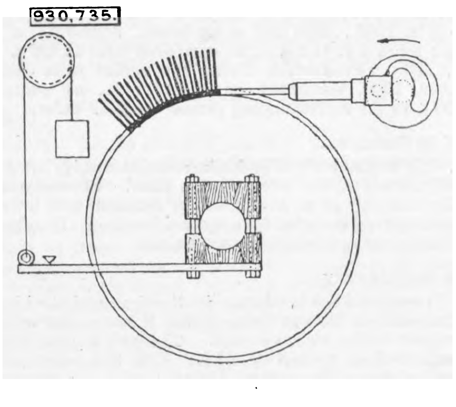

Nº18,460

SELECTED AMERICAN PATENTS.

(*From the United States Patent-office Official Gazette*)

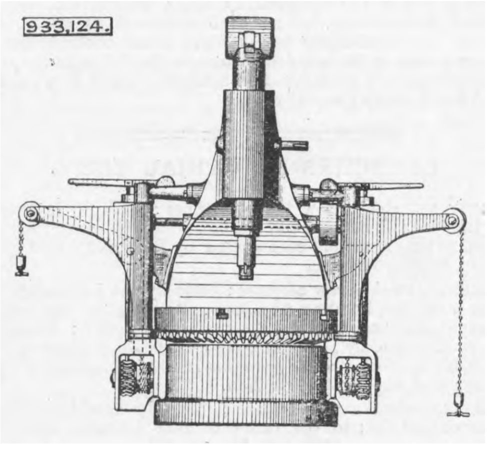
930,735. Device for Fixing Turbine Blades, *J. Dahl, Gross-Flottbek, near Hamburg, Germany, assignor to Blohm and Voss, Commanditgesellschaft auf Actien, Hamburg, Germany, a Firm.—Filed January* 12*th*, 1909.

There are six claims. The fifth runs as follows:—A device of the kind described for fixing turbine blades and distance pieces in a blade-carrying member of a turbine, said member having grooves, comprising a rotatable shaft mounted parallel to the axis of said blade-carrying member, a disc carried by said shaft, a pin excentrically fixed on said disc, a pneumatic hammer mounted on said pin, a stem on said hammer movable in the grooves on the blade-carrying member, and a brake for said blade-carrying member.


930,735.

933,124. Boring Machine, *W. T. Sears, Philadelphia, Pa., assignor to Niles-Bement-Pond Company, Jersey City, N.J.—Filed January* 25*th*, 1908.

This patent is for the combination with large boring machines of two jib cranes, as shown in the engraving. The cranes can be worked independently, so that one may lower while the other lifts. There are two claims.


933,124.

Royal Agricultural Society of England, Liverpool Show, 1910.—It has been definitely decided to hold the Show of the Royal Agricultural Society of England at Liverpool (Wavertree Playground) in the week following the Ascot Meeting, from Tuesday, the 21st, to Saturday, the 25th June, 1910. The Society has also decided to institute competitions for the best-managed farms in Lancashire and Cheshire, and classes will be provided for large and small arable farms, and large and small stock or dairy farms, with prizes of £100 and £50 for the large farms, and £50 and £25 for small farms, the total amount of the prizes being £450. Detailed particulars of the farm prize competitions will be forwarded on application to the Secretary, 16, Bedford-square, London, W.C.

NOTES ON THE DESIGN OF SHAFTS, WITH SPECIAL REFERENCE TO HIGH-SPEED ELECTRIC GENERATORS.

By H. H. JEFFCOTT.

No. I.

Abstract of contents.—The following articles contain some results of an investigation of the lateral stability of rotation of loaded shafts and the factor of safety.

The lateral stability depends chiefly on two mechanical reasons, (1) the perfectness of balance, (2) the speed not being a whirling speed. Loaded shafts are balanced statically and dynamically—statically, by arranging that it is in neutral equilibrium in all positions when on horizontal knife edge supports, in order to secure that the total loads on opposite sides of the axis are of equal moment to one another; dynamically, by running the shaft and noticing at convenient sections if there is any excentricity of motion, in order to secure that the loads which are diametrically opposite each other are of equal moment with regard to the axis.

Dynamic balancing presents an interesting phenomenon. If there is excentricity at a section under examination, the addition of a balance weight opposite the point of maximum displacement sometimes has the effect of simply reducing that displacement; and sometimes, in addition to reducing the displacement, it causes the displaced point to travel round the section, the addition of a further balance weight causing a further rotation. This is explained in sections 2, 3, 4, and the results given throw light on the nature of the out-of-balance loads when the phenomena of dynamic balancing are observed at a number of sections.

The determination of the whirling speeds is a matter of great importance. The first whirling speed is usually required with some accuracy, and for some purposes the second and even the third may be desired. The principal steps of a method for their determination in the general case of a shaft loaded symmetrically with regard to its axis are given.

At a whirling speed the centrifugal and elastic forces on a shaft are in dynamic equilibrium for an imagined displacement of proper type. The method followed consists in equating these forces for any system of load, and obtaining therefrom an equation which the displacement at any point of the neutral axis must satisfy. This equation can be solved in certain cases for all the whirling speeds, but in general a displacement curve is assumed with coefficients which are determined by imposing concidence at certain points between it and the actual displacement curve. The solution of the equations in all cases gives the speeds at which the centrifugal and elastic forces are equal, or the whirling speeds. The unbalanced magnetic pull which arises in dynamos, consequent on a displacement of the armature, aids the centrifugal forces, and must be added to them. Its value in any case is indicated. The effect of end thrust on a shaft on its whirling speeds is also considered.

General expressions are given for the strains in a rotating shaft under torsion and supported by two bearings. The flexural, torsional and rotational strains are examined separately, and the factor of safety approximated to. The effect of flaws on these strains is considered, as well as the nature of application of the loads. General remarks relative to the factor of safety required in any particular case are added. An example of the determination of whirling speeds and factor of safety of a turbo-dynamo shaft is appended.

1. It will be understood that in the following articles a loaded shaft primarily means a shaft supported at both ends by bearings, which in general are not free, so that they exert bending couples on the journals. The shaft is conceived to be loaded with masses distributed in any manner along its length, but symmetrical with regard to its axis. The case of a high-speed electric generator or turbo-dynamo will, in the main, be dealt with, and unbalanced magnetic forces arising from the departure of the armature from the centre of the field will be taken into account.

In particular cases the shaft will be considered to be free from end bending couples, and to have its load not quite symmetrical with regard to its axis. In general, too, the speed of rotation will be considered as quite uniform. It will be noted that if the angular velocity ω is not constant, the bending stresses on the shaft due to out-of-balance loads correspond to a constant angular velocity Ω, where $\Omega^4 = \omega^4 + \left(\frac{d\,\omega}{d\,t}\right)^2$.

2. The lateral stability of motion of a loaded shaft (as distinct from torsional stability) depends chiefly on two things:—(1) The perfectness of the balance of the load, or its symmetry about the shaft axis; (2) the speed not being a whirling speed.

If a body be rotating about a fixed axis, which is not a principal axis through its centre of inertia, it will in general exert stresses on the axis, and the bearings which keep the axis fixed will experience stresses. If the axis of rotation is a principal axis through the centre of inertia of the body, and if it be under no external forces, there will be no stress on the axis, and the body will rotate freely.

With regard, then, to imperfection of balance, for each small out-of-balance load m distant r from the axis of rotation the shaft experiences a force $m\,\omega^2\,r$ in a direction at right angles to its length passing through the mass. Or, expressed in a more convenient form, the force in lbs. weight $= 2{\cdot}84\ r\ N^2\,10^{-5}$ per lb. of material, where r is expressed in inches and N is speed in revolutions per minute.

For a number of such out-of-balance loads there will be a corresponding number of forces. The bearings will in general be subject to reactions due to these forces, which rotate in direction along with the shaft, so that a bearing is at one instant urged in one direction, and half a revolution later in the opposite direction. This may cause vibration in the bearing, especially if the bushing is worn away; a result which is accelerated by this action.

It should be noticed that although the various out-of-balance loads may be statically balanced, yet they will give rise in general to actions on the bearings. The simple case of two out-of-balance loads of equal magnitudes, and equidistant from the axis on opposite sides, but at different points along the length of the shaft, will make this clear. These two loads are statically balanced; *i e.*, if the shaft be placed on horizontal knife edges at its ends it will be in neutral equilibrium in all positions. If rotated, however, there will be reactions on the bearings. In fact, the two centrifugal loads then give rise to a couple whose axis is perpendicular to the shaft (and to the centrifugal forces), and this is balanced by an equal couple consisting of the pair of equal and opposite forces on the bearings. In this case the bearings are each subject to forces rotating in direction, equal in magnitude, but in opposite directions at any instant. Hence the importance of dynamic balancing in addition to static balancing. To secure dynamic balance the various parts of the load are often separately balanced statically, and finally to test the dynamic balance the completed armature and shaft are mounted in bearings and run at a convenient speed. A pencil is held near the rotating mass at a suitable point, and if the balance is not quite true the pencil will mark the circumference at one position only, showing excentricity of rotation; while a continuous mark all round the circumference indicates dynamic balance at that section.

If the shaft be out of balance it is customary to place a balance weight opposite the point of maximum throw out at the section examined (indicated by the position of the pencil marking), and when the shaft is run again the marking will be found to have altered in one of two ways. First, the marking may have the same central position but extend more round the armature in both directions, and if further balance weights be added, ultimately extend equally all round the periphery. Secondly, the central position of the marked portion may shift round the armature through a certain angle, the extent of the marking becoming gradually greater than at first. If, then, an additional balance weight be added opposite this new central position, the central position of the marking on a further trial will be found to have travelled still further round the armature. At the same time the marking gradually increases in extent till balance is obtained.

3. To understand this let us imagine an out-of-balance load m_1 at a point P_1, along the shaft. This load on rotation will bend the neutral axis between the bearings into a curve, and the displacement of any point on the neutral axis from its original position will be greatest near P_1, the position of the load. If a second load m_2 is added at a point P_2, so that m_2 is on the opposite side of the axis from m_1, this load would on its own account produce a displacement curve of the neutral axis on the opposite side to that due to m_1, and this displacement would be greatest near P_2. If both loads are on simultaneously, the curve of the neutral axis will be the resultant of the two curves, which is got by taking the algebraic sum of their ordinates. Now for given masses m_1 and m_2 the effect of m_2 (at P_2) on the displacement at P_1 is greater the nearer P_2 is to P_1, for the displacement there is got by subtracting the displacement at P_1 due to m_2 (at P_2) from the displacement at P_1 due to m_1; and we have seen that the displacement due to m_2 is greatest near P_2.

For the particular case of equal and opposite loads we can see this otherwise. From the theory of beams on two supports, the displacement at P_2 due to a load m at P_1 is equal to the displacement at P_1 produced by m at P_2. Hence remembering that the displacement is greatest near the load, the effect of the second load on the first is greatest when their points of application on the shaft coincide.

Now the magnitude of the force exerted by the mass m_1 depends on the distance of m_1 from the axis of rotation, which distance is equal to the displacement r_1 of the axis at P_1 plus the distance a_1 by which the load is initially distant from the axis—when stationary. Thus the force exerted is $m_1\,\omega^2\,(r_1 + a_1)$.

Accordingly, when m_2 is placed near P_1, since it then exerts the greatest effect it can in reducing the displacement r_1 at P_1, it consequently exerts its greatest effect in reducing the force $m_1\,\omega^2\,(r_1 + a_1)$, and thus still further reduces r_1.

It is to be noticed that, conversely, m_1 will then exert its greatest effect on m_2, so that the force due to m_2 is least when P_1 and P_2 coincide. But as the force depends only in part on the displacement (and, further, we may for present purposes take a_2 considerably greater than a_1), we can in general take it that the second load exerts the greatest effect on the first when its position is near that of the first load.

Imagine now three out-of-balance loads, two (m_1, m_2) on one side of the shaft, and the third (m_3) on the opposite side. Then, from what we have said, if the points P_1, P_2, P_3 of application of the loads occur in that order along the shaft, m_3 exerts a greater effect on m_2 than on m_1, since P_3 is nearer P_2 than P_1. In other words, if we had a shaft with two out-of-balance loads, m_1, m_2, on one side, and we add a third, m_3, on the opposite side, the load m_2 is rendered less effective comparatively than m_1.

If, further, m_1 and m_2 be not on the same side of the axis, but m_2 be in a plane through the axis making an angle θ with m_1, the displacement at any point P_3 is the resultant of the displacements due to m_1 and m_2 separately, and it makes an angle ϕ with m_1, where ϕ is less than θ. If, now, a balance weight m_3 be placed at P_3 on the side opposite to ϕ, it will in general diminish the force of m_2 more than that of m_1, so that the resultant of m_1 and m_2 changes its direction somewhat, and ϕ becomes smaller.

In other words, if we have a shaft with two out-of-balance loads, and the point of maximum displacement at a given section be determined, and a balance weight be added on the opposite side of the shaft in that section, the position of maximum displacement in that section will be found to have shifted round the shaft by an amount dependent on the magnitudes of m_1, m_2, m_3, a_1, a_2, a_3, ω, and the distances $P_1\,P_3$ and $P_2\,P_3$.

Thus if a_1 is large compared with a_2, and $P_1\,P_3$ is large compared with $P_2\,P_3$, there may be considerable angular shift of maximum displacement. On the other hand, if a_1 and a_2 are nearly equal, and likewise $P_1\,P_3$ and $P_2\,P_3$ also nearly equal, the amount of shift may be very small.

In practice the positions and magnitudes of the out-of-balance loads are, of course, unknown, except in so far as they are statically balanced. Dynamic balancing consists in examining the circumference for displacement at two or more sections, and it will be readily seen that the principles introduced in the above examples are applicable. When a balance weight is added at a section it in general reduces the out-of-balance forces near that section more than those remote from it, so that the resultant displacement then comes nearer to the direction of the resultant of the remote loads. The amount of the angular shift of the displacement at a section depends on the positions and magnitudes of the various loads, and whether they are composed of small masses at large distances from the axis, or large masses at small distances. Sometimes the angular shift will be large, sometimes very small. If the out-of-balance loads are all in the same plane (containing the axis), there will plainly be no angular shift, since all the displacements lie in that plane.

4. A proper consideration of this phenomenon throws light on the best method of balancing in any given case. Ideal balancing is to place an equal balance weight opposite each out-of-balance load, but this cannot be realised, as the loads are not known, and even if they were it would not be possible for constructional reasons to place balance weights at any point along the shaft. Usually it is convenient to consider two or three sections along the length at which provision is made for the addition of balance weights By a close examination of these sections in the light of what precedes, the best arrangement of balance weights may be devised. Thus the effect of the addition of a trial balance weight opposite the points of maximum throw out in each of the sections may be observed before any permanent addition is made, as well as the points of greatest displacement in these sections before the trial weight is added. This will generally give some information as to the disposition of the out-of-balance loads, and the arrangement of balance weights is to be chosen to meet this disposition as proportionately as possible, and at the same time the preservation of static balance must be kept in view.

In the final result the bearings should be free from rotational stress; the couple occasioned by the dynamic out-of-balance loads about an axis perpendicular to the axis of rotation of the shaft should be neutralised by an equal and opposite couple about the same axis due to the added balance weights. Further, the local (displacement) strains at any point in the shaft should be kept as small as possible.

It is not intended in the present paper to express the general case of unbalanced load mathematically; suffice it to say that expressions for the angular shift have been worked out for certain typical cases.

5. Beyond the unevenness and vibration in running, and the consequent wear of bearings, out-of-balance loads can hardly be regarded as dangerous. The second cause of lateral instability of motion that is noted above —Sec. 2—is, however, different in this respect, for if a machine be run at a whirling speed, very serious consequences may follow. Accordingly it is very important in design that the normal working speed of a machine should not nearly coincide with a whirling speed. To define whirling: If a shaft loaded symmetrically with regard to its axis be rotating about that axis, and be slightly displaced by bending from its straight position, two sets of forces will in general be called into play. These are (1) centrifugal forces tending to increase the displacement; (2) elastic forces of restitution tending to restore the shaft to its straight position. In addition, in dynamos there is an unbalanced magnetic pull which aids the centrifugal forces. When the speed is low the elastic forces predominate, and the shaft comes quickly back to its original straight position. If we increase the speed, however, the centrifugal forces increase until they become equal to the elastic forces. The corresponding speed is called a whirling or critical speed. At this speed there is no tendency for the shaft, when once displaced, to return to its original straight position—it remains bent. The bearings then are subject to forces rotating in direction, and of a period corresponding to the speed of the shaft; forces which may be regarded as composed of horizontal and vertical components, each varying with the same period. Above this speed the centrifugal forces for that type of displacement preponderate, and the shaft tends to become further displaced from the straight position.

Looking at the matter from a somewhat different point of view, we may take the case of a shaft supported between two bearings. The shaft will remain displaced provided the distance between the bearings has a definite value corresponding to a given speed of rotation. If the bearings be closer together than this distance the elastic forces of restitution are greater than the centrifugal forces, and the vibration will quickly vanish on account of molecular friction (unless reinforced by some other force of proper period). The displacement is a permanent one only when there is a definite relation between the length and speed.

The motion then corresponds to that of the shaft executing free lateral vibrations between the bearings, and the bearings may be regarded as nodes. If the speed be raised the nodes become closer together than the bearings, and permanent vibration of a fixed period cannot take place (until the bearings coincide with the nodes again). The imagined displacement gives rise to a vibration which is quickly damped out by friction.

For the simple case of a single load m on a massless shaft we have $T = 2\,\pi\,\sqrt{\frac{m}{f}}$, if f is proportional to the elastic force of restitution minus the centrifugal force, and T is the periodic time of vibration. When $f = o$, T is infinite, and the load remains permanently displaced. For smaller values of the centrifugal force, T is finite; and when the centrifugal force vanishes (*i.e.*, $\omega = o$), T is the period of lateral vibration of the load. (See Dr. Chree's paper, *Phil. Mag.*, May, 1904.)

GERMAN SHIPYARDS.

No. II.*

THE AKTIEN-GESELLSCHAFT "WESER."

The present Aktien-Gesellschaft "Weser" had its origin in the shipyard of C. Wätjen and Co., which was established in 1843. The transformation into the Aktien-Gesellschaft "Weser" took place on March 26th, 1872, the object in view being principally that of undertaking the construction of large iron steamers and other vessels for the navy which was to be created for the new German Empire. The company, the capital of which was about £225,000, took over the whole works of the firm of C. Wätjen and Co., Herr C. Wätjen remaining as manager. By the purchase of adjacent tracts of ground the site was gradually increased in extent to 8¾ acres. Since, however, the chances of farther extension were then at an end, and as the yard only possessed building slips for broadside launching, which were unsuited for the construction of large war and merchant vessels, the company decided to relinquish the whole of its Bremen estate and to lease a new site in the suburb of Gröpelingen from the State of Bremen for a period of sixty years from January 1st, 1901. The work was gradually transferred to the new yard, and the old site with all its plant was sold on June 30th, 1905, for £75,000 to the Norddeutscher-Lloyd, which company thereupon called into being the Norddeutsche Maschinen und Armaturfabrik.

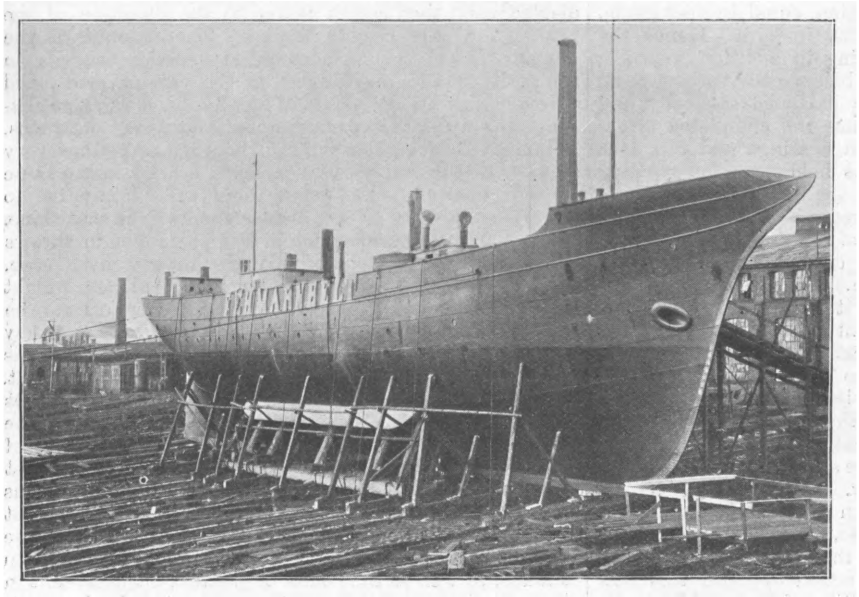


Fig. 2—THE LIGHTSHIP FEHMARNBELT ON THE STOCKS

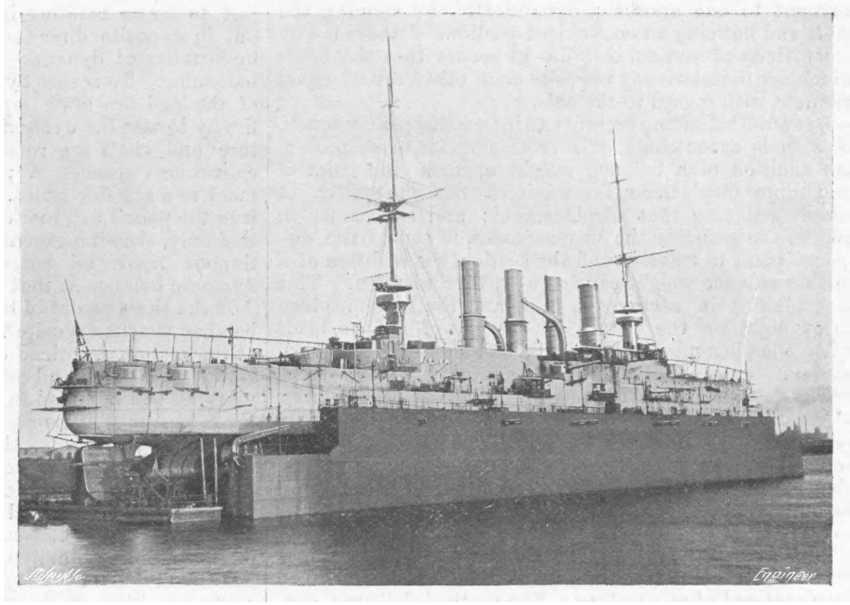
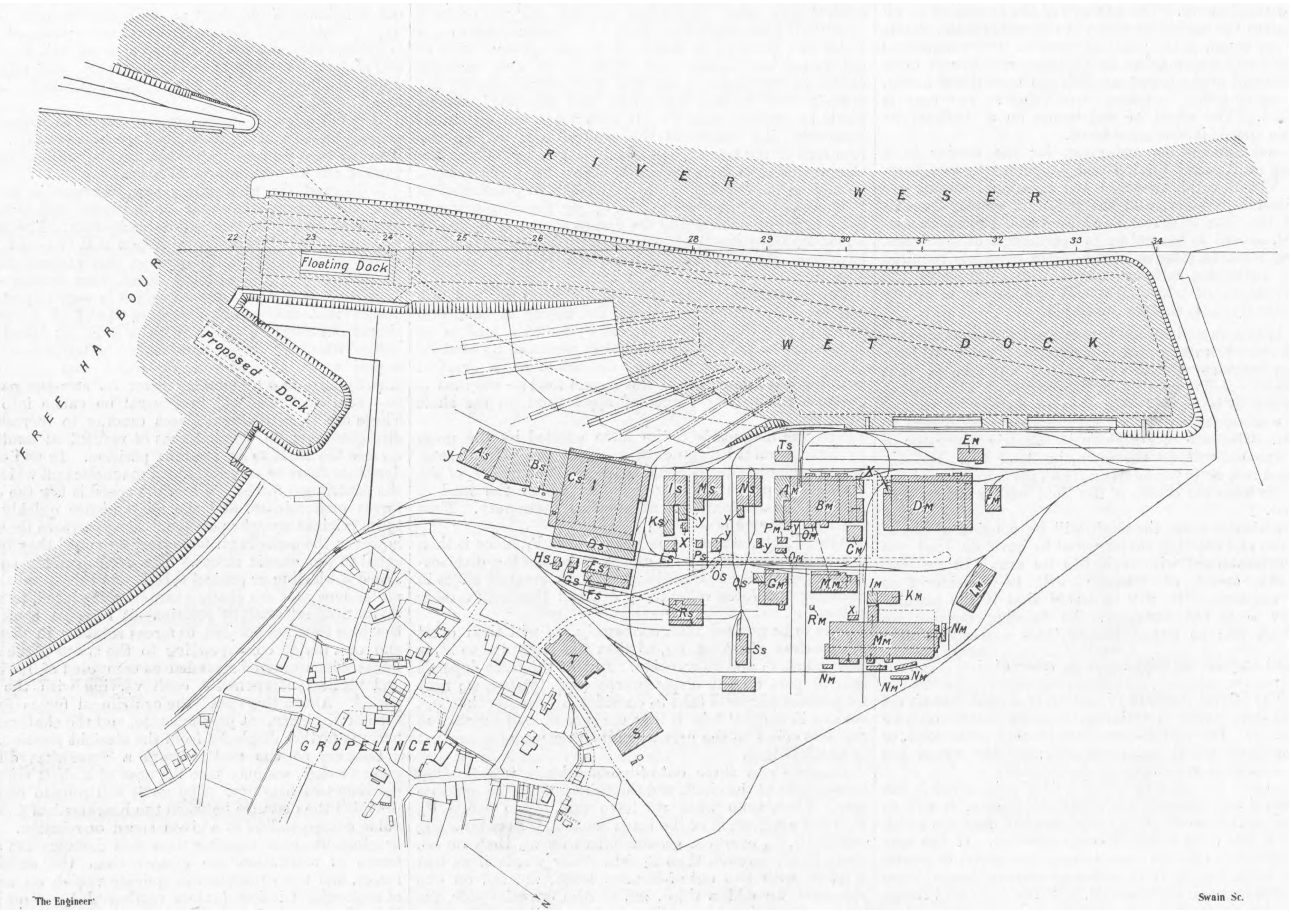


Fig. 3—THE CRUISER GNEISENAU ON THE FLOATING DOCK



Mark.	
As.	Shipyard Smithy.
Bs.	Sheds for Frame Blocks, Setting Blocks, Angle Furnaces, and Boilers.
Cs.	Machine Sheds and Sheds for Plate Furnaces.
Ds.	Plate Store, with Moulding Loft above.
Es.	Central Power-house for Shipyard.
Fs.	Central Boiler-house for Shipyard.
Gs.	Building for Water Purification.
Hs.	Cooling Tower.
Js.	Engineers' Shop.
Ks.	Tinsmiths' and Coppersmiths' Shop.
Ls.	Breakfast Hall.
Ms.	Store.
Ns.	Joiners' and Carpenters' Shop.
Os.	Painters' Shop.
Ps.	Painters' Store for Oil, Tar, &c.
Qs.	Galvanising Shop.
Rs.	Saw Mill.
Ss.	Timber Store.
Ts.	Shipyard Office.
Am.	Coppersmiths' Shop.
Bm.	Boiler Shop.
Cm.	Store Sheds for the Boiler Shop.
Dm.	Engine Shop.
Em.	Engine Works Fitting Shop.
Fm.	Store Sheds for Finished Machinery.
Gm.	Engine Works Smithy.
Hm.	Engine and Boiler-house of the Engine Works Power Station.
Im.	Office Building for the Foundry.
Km.	Pattern Shop.
Lm.	Pattern and Timber Store.
Mm.	Foundry.
Nm.	Shed and Store for Foundry Materials
Om.	Shed for Charcoal.
Pm.	Resin-melting Shop.
Qm.	Iron Store.
Rm.	Sheds for the Testing of the Boilers.
S.	Canteen.
T.	General Offices.
Y.	Lavatories.
Z.	Enclosures.

Fig. 4—PLAN OF THE "WESER" SHIPYARD AT GROPELINGEN

The work done in the old yard of the C. Wätjen Company comprised the building of 18 steamers and 120 other vessels. Under the Aktien-Gesellschaft "Weser" the numbers rose to more than 500, and included 50 vessels for the German navy, 90 sea-going vessels of considerable size for the Norddeutscher-Lloyd, the German steamship companies Hassia and Neptune and other Bremen firms, and, in addition, 51 steam dredgers. Amongst the latter was the sea dredger Franzius, which was able to handle 35,000 cubic feet of material per hour from a depth of 56ft. The first war vessels built by the A. G. Weser were three 30-ton mine-laying boats, each of 30 horse-power and 7½ knots speed. These were followed, amongst other craft, by 13 boats of the Wespe class. These boats were the first German armour-clad gunboats, and each were of 1100 tons displacement, 700 indicated horse-power, and 9 knots speed. In 1882 the Weser yard built the first German torpedo flotilla, consisting of seven boats of the Schütze class, each of 54 tons displacement, 700 indicated horse-power, and 16 knots speed. Then followed several small cruisers, the two armoured coast defence vessels Beowulf and Frithiof, each of 4100 tons displacement, 5100 indicated horse-power, and 15½ knots speed. The largest war vessel built in the old Weser yard was the protected cruiser Victoria Louise, of 5660 tons displacement, 10,000 indicated horse-power, and 19 knots speed, which was completed in 1897. This vessel was followed by eight small cruisers of 2700 to 3250 displacement, 8000 to 12,500 indicated horse-power, and 21½ to 23½ knots speed.

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* No. I. appeared October 8th.

Of these the small cruiser München, of 3250 tons displacement, 12,500 indicated horse-power, and 23½ knots speed, which was the fiftieth war vessel built for the German navy and the last one built in the old yard, was launched on April 30th, 1904. As above mentioned, the old Aktien-Gesellschaft "Weser" had only slips for broadside launching. Large vessels are now rarely built on slips of this kind except on the Great Lakes of America.

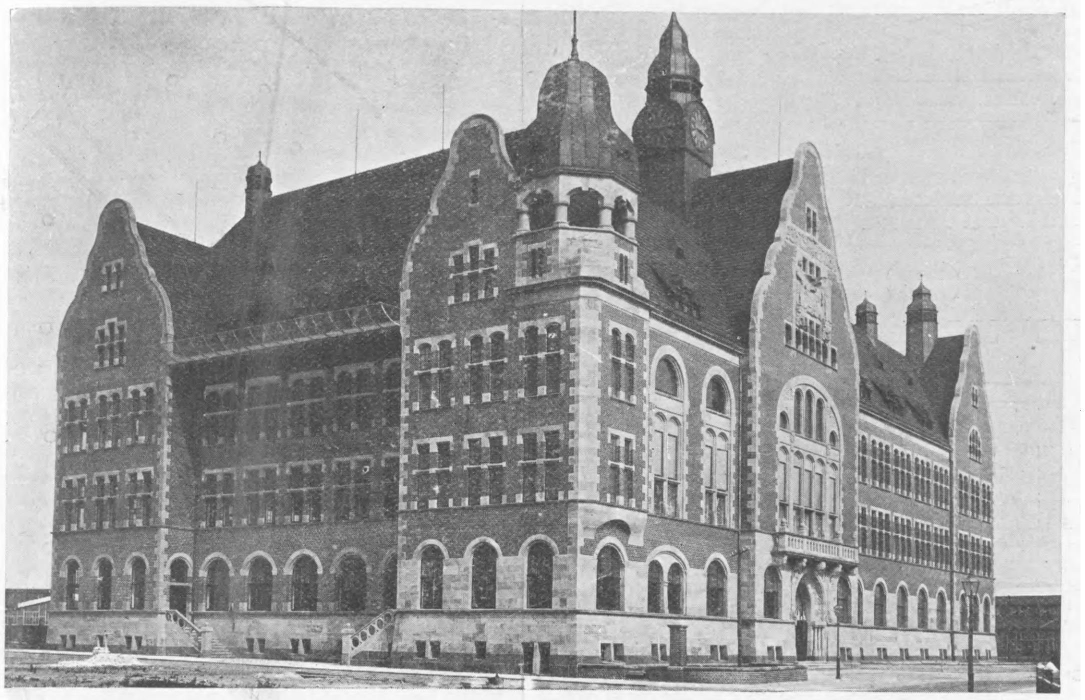


Fig. 5—THE OFFICES

With the lightship Fehmarnbelt, which was the last vessel built by this firm on the old broadside slip, the work of the company in the old yard in Bremen came to an end. Fig. 2 shows the vessel just ready for launching.

From this time forward all the vessels have been built in the new yard at Gröpelingen, the slips of which are set for fore-and-aft launching, the arrangements being such as to enable the company to build rapidly and in an up-to-date manner vessels of the very largest class. In addition to several smaller craft, the merchant vessels hitherto built in the new yard comprise four steamers for the Neptun Company, the steamer Rheinfels for the Hassia Company, and the two liners Lothringen and Thuringen, the Imperial mail steamer Lutzow, and the cargo and passenger steamer Berlin for the Norddeutscher Lloyd. In addition, three lightships, a pilot steamer, and several dredgers have been delivered to their various owners. For the Imperial Navy the output has been two mine-laying steamers named the Nautilus and the Albatross respectively, the surveying vessel Planet, the small cruiser Leipzig, and the armoured cruiser Gneisenau—a view of which vessel after completion and in floating dock is given in Fig. 3. The battleship Westfalen, the first vessel of the Dreadnought type ordered by the German naval authorities, is now being fitted out, and a second vessel of the same size, the Ersatz Beowulf, is still on the stocks.

As mentioned above, the new Weser Yard is in Gröpelingen, and is situated close to the entrance to second basin of the Bremen Free Harbour. The total area of the site is 150 acres, and the length of the water frontage 1312 yards. The arrangements include a wet dock, completely separated from the river Weser by a tongue of land 1640 yards in length running from south-east to north-west—see Fig. 4—so that the shipping traffic and the shipyard work do not interfere with each other. The wet dock is about 1312 yards long by 219 yards broad, and is dredged to a depth of 33ft., which is sufficient for the accommodation of the largest vessels, while the longest building slips are opposite the largest and deepest part of the stretch of water. The entrance to the wet dock is from the outer basin of the second dock of the Free Harbour. This outer basin is so roomy that vessels of the largest size can turn in it without difficulty.

In the broad mouth of the wet dock lies a large new floating dock, which was itself built in the yard. Its length is 590ft., its width over all 90ft., and its displacement 10,500 tons. It is arranged in five sections, and, should the necessity for it arise at a later time, it may be lengthened to 656ft., so that it could accommodate the very largest war vessel in existence. In Dock No. I. of the Free Harbour the company also owns an older floating dock, with repairing shops, which, however, is only able to raise vessels ranging up to 2800 tons.

Beside the main entrance, on the landward side, are situated the three-storeyed office buildings, a large structure 223ft. in length by 128ft. in depth, in which the commercial and technical offices are arranged—see Fig. 5. From a large pillared entrance hall broad staircases lead to the upper storeys. The entrance halls and offices are commodious, well lighted, and airy, and are arranged in accordance with the latest ideas. All the rooms are lighted electrically, the floors are sound-proof, and are laid with cork covered with linoleum. In the basement is a central telephone exchange, which is connected with about 100 call stations distributed over the yard and buildings. Close to the offices lies a one-storeyed shed, which was temporarily used for office purposes, and on the removal of these to their proper quarters it was fitted up as a canteen. Here about 1000 workmen dine daily at an exceedingly cheap rate, while numerous officials and others are served in a separate restaurant.

The site of the works is so extensive that ample room is left for additions which may in future become necessary. Similarly all the shops are laid out in such a manner that they can be enlarged lengthwise without difficulty, and so as to permit of their present crane arrangements being utilised. The various shops are so placed that the ship and engine building departments are entirely separated. At the southern side of the yard behind the slips lie the shipbuilding shops in the following order:—Smithy, shed, bending-block sheds, bar furnaces, and boiler-house. Then come the machine sheds with the plate stores, moulding loft, shipyard, power station, &c., behind them, followed by the shipyard engineer's shop, the tinsmiths' and coppersmiths' shops, the shipyard store, the joiners' and carpenters' shops. Close at hand there is the breakfast hall, whereby the workmen are saved the long journey to the canteen in the breakfast hour—see plan, Fig. 4. Then come the painters' shop and the stores for oil, tar, &c., and finally, standing entirely apart from the rest, the saw mill and timber stores.

In the space of ground behind the wet dock are all the engine shops, comprising the coppersmiths' shop, boiler shop, store sheds, the erecting shop, and stores for finished parts; behind these again lie the engine smithy, the engine works power station, the foundry office buildings, and the pattern shop, while standing entirely by themselves are the foundry with its store, the material sheds, and the timber store.

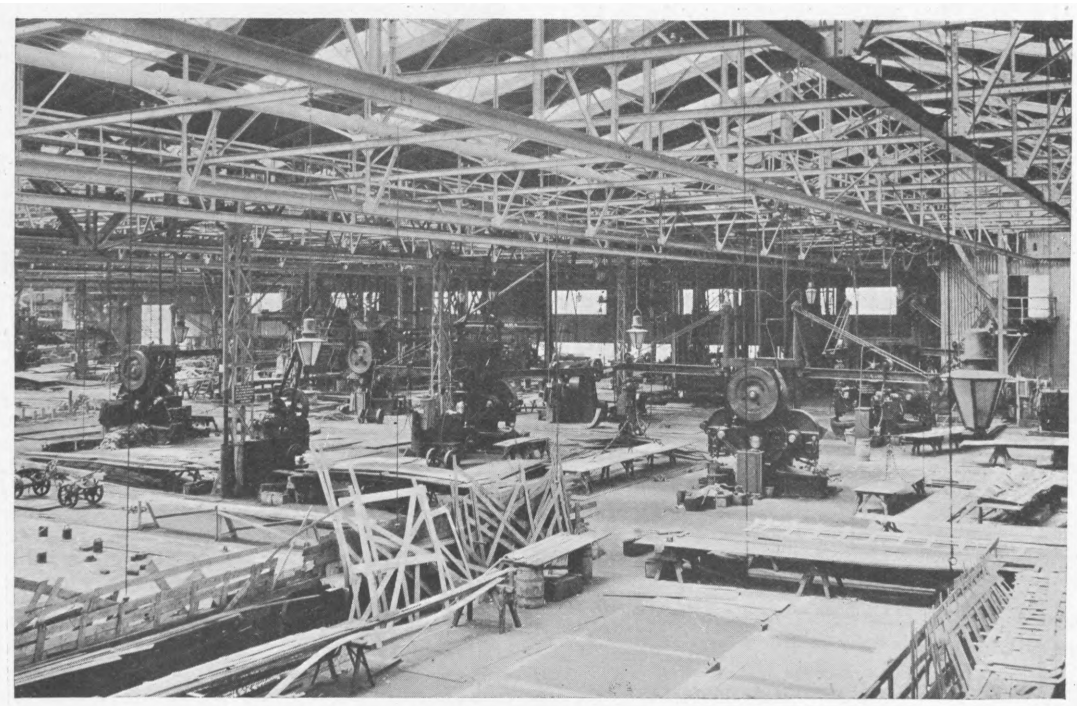


Fig. 6—INTERIOR OF THE SHIPYARD MACHINE SHEDS

The material is brought in partly by water and partly by rail, the yard being connected by a branch line with the State Railway. The branch line comes in from the south, and divides into four main branches, one of which leads to the plate and bar store behind the shipyard workshops; a second passes along behind these shops to the engine works department; the third leads to the timber store, and the fourth to the foundry. The three latter branches join together again on the far side of the machine sheds into one line, which with its branches serves the needs of the wet dock, the water frontage, the machine sheds, and the building slips. All the main lines have small branches into the various shops, and are inter-connected by means of cross lines and points; turntables, on account of the expense of their installation and of the trouble and loss of time in working which they occasion, being resorted to only in places where they are unavoidable. The lines are all laid to the standard gauge and have an extra inner line for narrow-gauge vehicles as well. Material is transported by walking cranes and also by steam storage locomotives, which obtain steam at 118 lb. pressure from the power station.

Immediately in front of the building slips are the machine sheds—see Fig. 7—consisting of four longitudinal bays, each measuring 82ft. by 328ft., and a transverse bay measuring 82ft. by 345ft.—see plan, Fig. 7. The latter serves as a plate laying-off floor, and above it is arranged the moulding loft.

In the four longitudinal bays are to be found the various machine tools enumerated in the accompanying list, and arranged as shown. The tools are driven in groups by means of belting, with the exception of the larger machines, which are driven separately. The plate-laying-off floor in the transverse bay is supplemented by two smaller floors of 246ft. by 23ft. and 82ft. by 18ft. respectively in the longitudinal bays, which will be removed elsewhere when the sheds have to be extended to make room for additional tools. In the plate laying-off shed there is a 5-ton overhead travelling crane of 82ft. span. The path of the crab extends 23ft. beyond each end of the shed, so that the material can be passed conveniently through the outer doors and transferred to the cranes in the longitudinal bays.

In each of the four longitudinal bays there are two electrical travelling cranes of 15ft. 6in. span, on each of which there are two crabs of three tons capacity, which can be worked by the men themselves. In addition, all the machine tools are provided with cranes, the arrangement, capacities, number, &c., of which may be seen in the table accompanying Fig. 7. To facilitate the handling of material the line running past the building slips passes in a transverse direction through the longitudinal bays, so that the material, when worked into shape, can, by the help of the overhead travelling cranes, be loaded directly on to the railway trucks, and carried along to the vessels under construction.

At the south side the machine sheds are adjoined by three sheds, each of 150ft. by 65ft. 6in., containing the plate and frame-bending blocks and the plate furnaces —79ft. by 10ft. Each of these latter sheds has two electrical overhead travelling cranes of two tons carrying capacity. The individual machines are likewise provided with ten large cranes. Worthy of special notice are the hydraulic frame-bending apparatus and bevelling machines by Davis and Primrose, of Leith, which are here made use of. The method of using the former may be gathered from Fig. 8.

The central power-house for the shipyard department has four steam engines totalling 1000 indicated horse-power, which drive eight dynamos and two air-compressors. Occupying the same building is a further steam-driven air-compressor. The steam boilers have 8600 square feet of heating surface, and three additional boilers are still to be erected. The boiler feed-water is supplied by a special line of pipes, while the condensed water is cooled and purified by means of a special chimney cooler.

While, as above pointed out, the building slips in the old yard were all of the broadside launching type, because there was not room for the fore-and-aft method, those in the new yard are arranged in the ordinary way, and lead into the wet dock. So far five building slips have been constructed. On these vessels up to 650ft. in length can be built. When required, three additional slips for vessels of still larger dimensions can be added. Two of the five existing slips are worked entirely by travelling tower cranes, four in number, which were constructed by the Benrather Maschinenfabrik Aktien-Gesellschaft—one of them is shown in Fig. 9. The greatest outreach of the cranes is 65ft. 7in., and their carrying capacity at that radius is 2.75 tons, while with an outreach of 32ft. 9¼in. the capacity is six tons. The highest position of the lifting hook is 96ft. 6in. above the top of the crane path rails. The speeds with the maximum load and the necessary motor powers are the following :—

Moving the crane ...	197ft. per minute with	60 horse-power (motor)
Turning the crane ...	246ft. ,, ,,	9 ,, ,,
Moving the crab ...	98ft. ,, ,,	10 ,, ,,
Hoisting	66ft. ,, ,,	36 ,, ,,

With a load of 2.75 tons the speed in the last-mentioned case becomes 164ft. per minute. The width of opening in the base in the case of two of the cranes is 16ft. 5in., while in that of the other two it is 19ft. 8in., and the distance from centre to centre of the trolleys is 27ft. 10½in. The crane consists of an outer supporting framework 115ft. in height, the lower part of which is of portal form, so that the trucks for bringing up the building material have ample room to pass by two lines of rails through the portal. At about half height above the portal a footstep is built into the framework on which rests the revolving pillar that bears the jib. Since by this design all the forces act vertically on the wheels any lateral movement of the portal crane is impossible, as is also the development of considerable frictional resistances on the points of contact between the wheel flanges and the rails. The jib takes the form of a lattice-work parallel girder, and is suspended from the revolving column by tension rods; the chain runs in the middle of the long arm, while at the end of the shorter arm a box filled with concrete acts as balance weight. Above this, on a strong cast iron bed-plate, is mounted the hoisting gear, which also at the same time acts as balance weight.

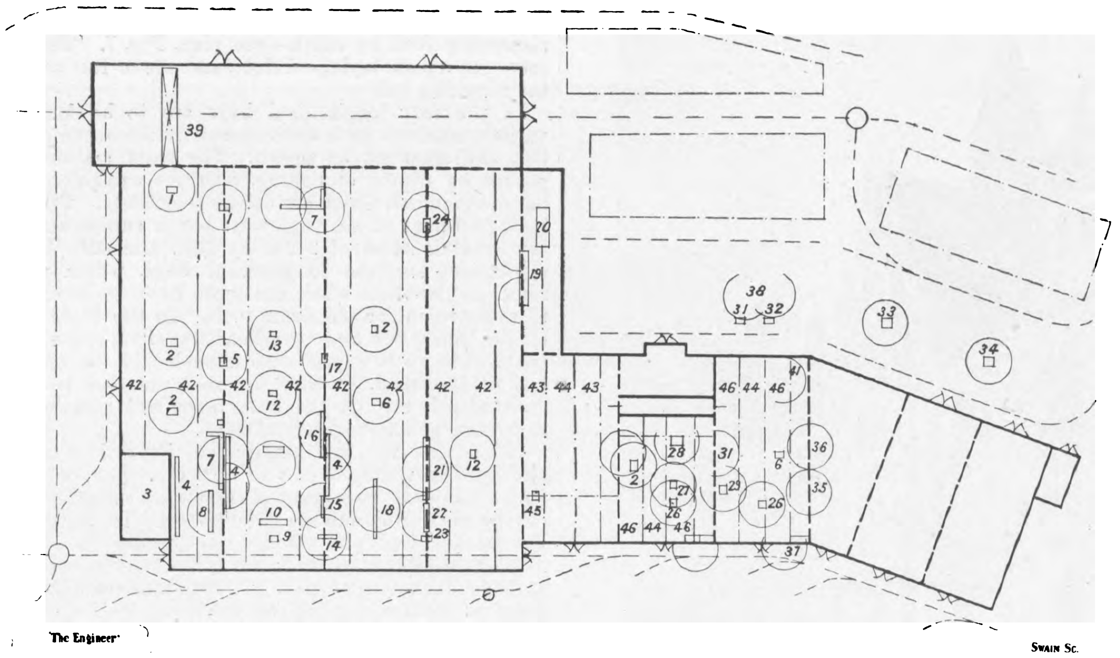


Fig. 7—PLAN OF THE SHIPYARD MACHINE SHEDS—(See Table Below)

List of the Machine Tools, Travelling Cranes, &c., in the Shipyard Workshops of the Aktien-Gesellschaft "Weser."

No. in plan.	Machine, &c.	Corresponding crane.	Name of makers of machines, &c.
1	Shears for 1in. plates	1 crane of 2 tons carrying capacity and 19ft. 8in. outreach ..	Breuer and Schuhmacher
2	Combined shears and punch	1 crane of 3 tons ,, ,, ,, ,, ..	Ernst Schiess
3	Hoisting appliance shop	—	—
4	Countersinking machine	3 small cranes	Breuer and Schuhmacher
5	Double punch for 1½in. holes	2 cranes of 3 tons carrying capacity and 16ft. 5in. outreach ..	Ernst Schiess
6	Punching machine	1 crane of 1 ton ,, ,, ,, ,, ..	,, ,,
7	Plate-edge planing machine for plates 33ft. × 13ft.	2 cranes of 3 tons ,, ,, 19ft. 8in. ,, ..	,, ,,
8	Bending machine and rolls	—	Smith, Glasgow
9	Emery wheel	—	—
10	Planing machine for 19ft. 8in. cut	—	Breuer and Schuhmacher
11	,, ,, ,, ...	—	,, ,, ,,
12	Shears and punch	2 cranes of 3 tons carrying capacity and 16ft. 5in. outreach ..	Wagner, Dortmund
13	,, ,, ...	2 cranes of 3 tons ,, ,, ,, ,, ..	Ernst Schiess
14	Joggling machine for plates up to 1in.	1 crane of 1 ton ,, ,, ,, ,, ..	Breuer and Schuhmacher
15	Countersinking machine	1 crane of 2 tons ,, ,, ,, ,, ..	,, ,, ,,
16	Plate-edge planing machine for 40ft. cut	1 crane of 3 tons ,, ,, 19ft. 8in. ,, ..	Smith, Glasgow
17	Forming machine	—	Breuer and Schuhmacher
18	Bending machine for plates 33ft. long	1 crane of 3 tons carrying capacity and 16ft. 5in. outreach ..	,, ,, ,,
19	Joggling and bevelling machine	2 cranes of 3 tons ,, ,, 19ft. 8in. ,, ..	,, ,, ,,
20	Furnace for plates of 33ft. × 11ft. 6in.	—	—
21	Plate-edge planing machine for 50ft. cut	1 crane of 3 tons carrying capacity and 16ft. 5in. outreach ..	Ernst Schiess
22	Bending machine	—	Breuer and Schuhmacher
23	Countersink drill for angles	—	Ernst Schiess
24	Rolls—4 above, 3 below, 82ft. long	1 crane of 3 tons carrying capacity and 19ft. 8in. outreach ..	Smith, Glasgow
25	Punch for plates up to 1in. and 1⅛in. dia. holes ..	1 crane of 1 ton ,, ,, 23ft. outreach	A. G. Weser (themselves)
26	Shears	1 crane of 1 ton ,, ,, 23ft. ,, ...	,, ,, ,,
28	Forming machine	1 crane of 1 ton ,, ,, 18ft. ,, ...	Breuer and Schuhmacher
29	Angle shears	1 crane of 1 ton ,, ,, 16ft. 5in. outreach ..	,, ,, ,,
30	Countersinking machine	—	,, ,, ,,
31	Hydraulic joggling machine	—	—
32	Hydraulic bevelling machine	—	—
33	Shears and punch for heavy beams	2 cranes of 1 ton carrying capacity and 26ft. 3in. outreach ..	—
34	Hydraulic angle-cutting machine	—	—

Cranes.

35	2 cranes of 15 cwt. carrying capacity, with 16ft. 5in. outreach and 180 deg. angle of rev.	Benrath Maschinenfabrik A.-G.
36	1 crane of 1 ton ,, ,, 21ft. 3½in. ,, ,, 360 ,, ,,	
37	1 crane of 1 ton ,, ,, 23ft. ,, ,, 180 ,, ,,	
38	2 cranes of 3 tons ,, ,, 29ft. 6in. ,, ,, 180 ,, ,,	
39	1 electric travelling crane of 82ft. span, 5 tons carrying capacity and 16ft. 5in. outreach to both sides (Fig. 10).	
40	2 movable blocks and tackle on beam of 65ft. 7in. in length	
41	1 crane of 3 tons carrying capacity, with 16ft. 5in. outreach and 180 deg. angle of rev.	
42	8 longitudinal tracks through the bays, each for 2 electric cranes 14ft. 9in. in breadth, with crabs of 3 tons carrying capacity	
43	2 ,, ,, ,, 2 ,, ,, ,, 2 ,, ,,	
44	3 tracks running on beams for electric cranes of 2 tons carrying capacity	
45	2 ,, ,, ,, blocks	
46	4 longitudinal tracks through the bays, for electric cranes with crabs of 5 tons carrying capacity	
47	1 electric crane with crab of 5 tons carrying capacity	

The hoisting motor acts by means of a bevel wheel meshing with teeth on the hoisting drum, and an electro-magnetic strap brake can be worked from the driving platform by means of a hand lever, so that the load and also the empty hook can be lowered by a simple easing of the brake. The motor for moving the crab is built into the latter, and likewise acts through bevel gearing on the four motion wheels, while the turning gear of the crane is mounted at the foot of the revolving column. Between the worm wheel and the bevel wheel gear, which in this case transmit the motion, is inserted a maximum friction coupling, which is so adjusted that it can just set the crane in motion in presence of a wind pressure of 10.2lb. per square foot; when the wind pressure exceeds this amount the coupling begins to slip, and the jib turns automatically in a direction parallel with that of the wind. The whole crane rests on eight cast steel running wheels 31½in. in diameter; there are two of these to each of the sub-frames, which are mounted under the foot of the framework and are geared together, so that they are always subjected to the same pressure. The motor mounted above the portal transmits its motion by means of toothed-wheel connecting gear to four of the eight running wheels.

Since the cranes run on an inclined plane at an angle of 1:20 and offer a large surface to the wind, carefully devised appliances are fitted to prevent them from running away or upsetting. An electro-magnetic strap brake, which at once acts when the motor loses current, is attached to the horizontal shaft of the driving gear. On the same shaft there is also a second strap brake, which can be applied either by an electro-magnet or by hand from the driving platform, as well as from a platform situated beside the crane-driving motor and from below. In addition to these brakes there are four brake shoes arranged in front of the wheels. These are, under ordinary circumstances, held up by means of a catch arrangement, but in case the other brakes fail to act they can be released either from the driving platform or from below. At the lower end of the crane-track rails, also, projections are arranged which release the catches when the crane is set in motion. When not at work the cranes can also be firmly held by four powerful rail grips, which are pressed against the rails from both sides by means of screws. The stability of the cranes is brought about by balance weights, which are mounted in the channel bars that connect the feet of the base. They are said to be perfectly stable in spite of their great height, even when the load is slung at the greatest outreach and with the heaviest wind pressure likely to be met with.

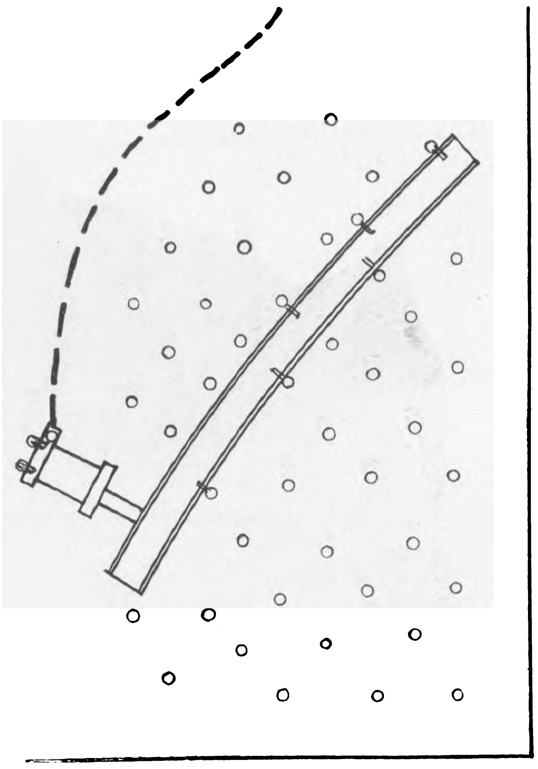


Fig. 8—FRAME BENDING

The driving cabin is arranged immediately below the jib, so that the attendant can keep an eye on all the movements of the crane; in addition, there is a second cabin beside the crane-driving motor, from which the crane can be controlled during foggy weather.

The current is transmitted to the crane by means of copper rails, which are led along one of the track-rails in a completely enclosed channel, and from which the current is taken by means of roller collectors and conducted in armoured cables, which pass through a hole in the pivot of the revolving column, to a sliding contact arrangement; current is collected from this by means of carbon brushes and transmitted to the switchboard in the driver's cabin. Continuous current at 220 volts is used. The first cost of the four tower cranes, including the track rails, was about £15,000.

In addition to these four travelling tower cranes, which were set to work in 1906, and which serve the two southern slips, the A.-G. Weser in 1908 put up another set of cranes for the two northern slips. These cranes are of

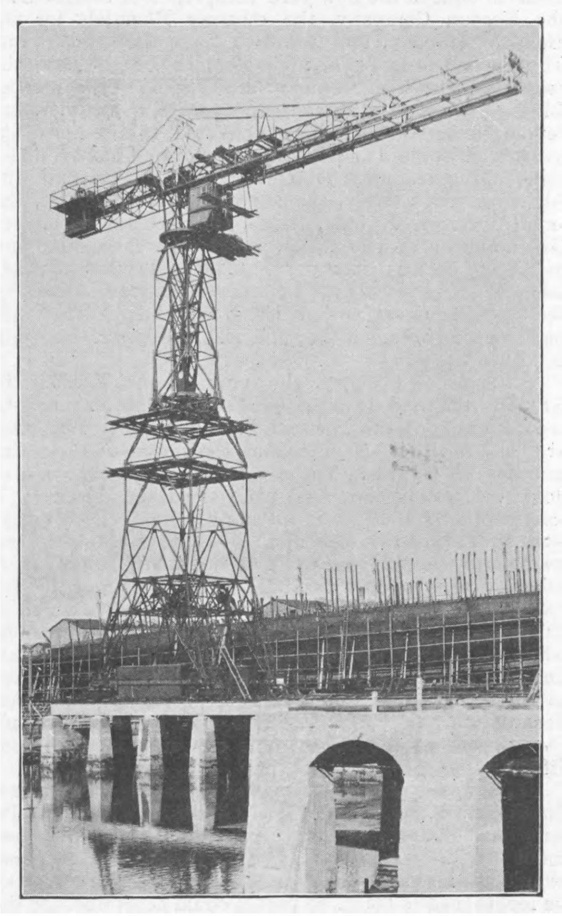


Fig. 9—REVOLVING TOWER CRANE

the fixed-tower pattern, which have not the disadvantage possessed by the travelling tower cranes of requiring a large space between the slips.

The fifth slip, which lies between the two groups just described, can be worked on the one side by the travelling tower cranes, and on the other by the new plant. This latter has also been supplied by the Benrather Maschinenfabrik, and consists, as may be seen in Fig. 10, of six fixed tower cranes, which are connected together at half their height by an endless overhead railway. By this means the room taken up by the cranes is much reduced, and the moving parts become considerably lighter. It is true, however, that the great advantage of the movable tower cranes is lost, and while the latter can work on either slip, as required, the fixed cranes stand unused when the slip is empty.

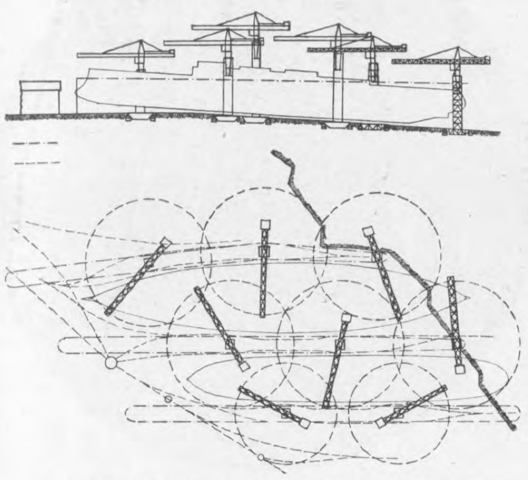


Fig. 10—ARRANGEMENT OF SHIPBUILDING CRANES

The lifting of the parts is effected by two crabs on each side of the slip, which do not interfere with each other owing to the circumstance that the overhead railway is arranged on each side in the form of a complete ring. The jibs of the tower cranes are 82ft. long, and can move vertically, so that they can work one above another, and are so arranged that every point of the slip is commanded by the crane hook. Eventually two additional cranes may be erected at the other side of the northern slips. The cost of the plant ready for work, *i.e.*, of the six cranes, overhead railway with connections, &c. &c., was about £21,500.

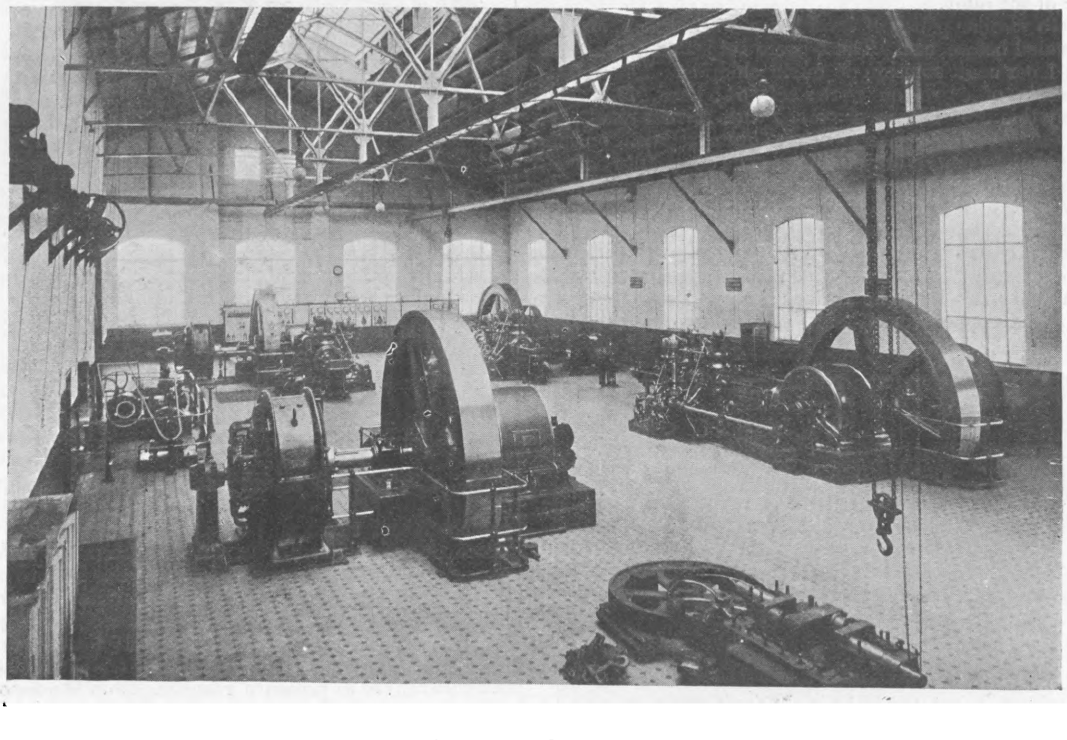


Fig. 11—CENTRAL POWER STATION

The slips themselves, which are open towards the water, are laid with cement of about 3ft. 3in. in thickness, reinforced with iron bands. They are wide enough to take the launching ways of the broadest vessels with ease.

The riveting is for the most part performed by the help of hydraulic and pneumatic appliances. For the pneumatic riveting an extensive network of air pipes is laid above and between the slips. The air is compressed to 110 lb. per square inch.

The engine works begin with the coppersmiths' shop and the boiler shop, the latter having an area of 6000 square yards. In the upper storey of the main building two cranes, each of 50 tons carrying capacity and capable of working together, run on framework girders. The boiler shop—see Fig. 15, page 424—is provided with all modern tools, such as shell plate bending machines, hydraulic riveting, flanging and planing machines, as well as numerous drilling machines, both of the radial and of the horizontal types. Since the "Weser" Company was founded, 200 boilers and numerous iron structures have been turned out by the boiler shop, such as floating cranes, railway bridges, iron lighthouses, buoys, &c. The engine shop is a building covering a ground area of 10,000 square yards, divided into several sections. It is provided with three travelling cranes of 15 tons, 20 tons, and 40 tons carrying capacity, and numerous smaller cranes. Since the foundation of the "Weser" Company about 900 engines have been built. The fitting and turning shops are shown in Figs. 12 and 13.

The foundry—Fig. 14—has an area of about 6700 square yards, and is arranged for casting in steel, iron, and bronze. Parts of the largest size can be produced by it. One of its specialities is the casting of large propellers in manganese bronze.

The power required for the whole engine department is supplied by a second central station—see Fig. 11—in which four suction gas motors of, together, 100 E.H.P., are installed, and are coupled directly to four dynamos.

Opposite the engine shops the wet dock is provided with a substantial quay, at which, after launching, the vessels are equipped and finished. Here there are two large cranes of special construction which were built by the yard itself, and which, with an outreach of 65ft. 7in., have carrying capacities of 6 tons. For the shipping of the boilers and heavy parts of the machinery there is a floating crane, made by the Duisburger Maschinenfabrik vorm. Bechem und Keetmann, of 100 tons carrying capacity, which is driven by an internal combustion motor; the pontoon was built by the yard itself. The welfare of the yard officials is amply provided for. There are social and hygienic institutions such as sick funds, pension fund, &c. A special room is arranged as a first-help station, and is fitted up with all necessary surgical instruments and material; a duly qualified surgeon is constantly in attendance. The canteen for the convenience of workmen and officials who live at a considerable distance from the yard has been referred to above. Attention has been paid to the prevention of fire in the shipyard buildings, in the first place in the general arrangement of these. In addition, water pipes provided with hydrants are led through the whole of the works, and a brigade is organised for the extinction of fires.

THE INSTITUTE OF METALS.

The autumn meeting of the Institute of Metals was held in Manchester on Thursday and Friday, October 14th and 15th, under the presidency of Sir William White. The programme included a general meeting of the members in the hall of the Municipal School of Technology, Sackville-street, each morning, when papers were read and discussed. Thursday afternoon was devoted to visits to the University of Manchester and an inspection of the Municipal School of Technology. In the evening the members were entertained at a reception at the Town Hall by the Lord Mayor. On Friday afternoon the members had the opportunity of visiting the following works:—Baxendale and Co.'s lead mills, Trafford Park; the British Westinghouse Company, Limited; Richard Johnson and Nephew, Limited, Salford; Smith Brothers, goldbeaters, Bridge-street; and Isaac Storey and Co.'s works, Cornbrook.

In the unavoidable absence of the Lord Mayor, the proceedings were opened on Thursday by a few remarks by Dr. H. C. H. Carpenter, chairman of the local Reception Committee, who welcomed the members and spoke of the success which had already been achieved by the society. Councillor T. C. Abbott also gave the members of the Institute a hearty welcome to Manchester, and made special reference to the fact that the inception of the society was largely due to Manchester, and especially to Mr. Johnson. Mr. Reynolds, the principal of the Manchester School of Technology, informed the members that the hall in which the meeting was being held was formerly the site of the foundry of Sir Joseph Whitworth. Sir William White gave a short but pithy address, in which he laid special stress upon the harmful results produced abroad by a certain section of the British Press in disparaging the work and enterprise of this country, as if the spirit of our forefathers was dead. He referred to the need of a society to deal with the non-ferrous metals, and said that this country was the first to organise such an institution. It was further mentioned that the membership roll of the society included the names of some of the most eminent metallurgists of this and other countries. In order to show the necessity for the Institute he gave some figures relating to the number of members, from which it appeared that when the first meeting was held in Birmingham last year the number was 240. As a result of the meeting there was an immediate accession of some 160 new members, while on July 1st last the members numbered 487, which had been further added to since that date. He maintained that these figures constituted a proof that there existed a real want for the society. As regards the assertion which was made by some persons that the society would have a weakening effect on other kindred organisations, Sir Wm. White said that this was disproved by the attitude of these societies to the Institute of Metals, and mentioned that the Institutions of Mining and Metallurgy and Mechanical Engineers showed the warmest sympathy with the movement.

Speaking of the society's "Proceedings," the President said that the first volume of the *Journal* was one which would bear favourable comparison as an example of excellence and practical value with any "Proceedings" of similar societies. The papers therein showed the threefold aspect of the Institution's work relating to scientific research, manufacture, and use. After mentioning the satisfactory financial position of the society, and an appreciative reference to the secretary, Mr. Scott, the President remarked upon the loss which they had experienced during their first year by the deaths of Mr. Norman Cookson, of Newcastle-on-Tyne, and Dr. Elgar, both of whom were keenly alive to the interests of the Institute. It was announced that Sir Gerard Muntz would succeed Sir William White as president of the Institute.

Sir William White then called upon Mr. C. A. Edwards to read the first paper, which dealt with "The Constitution and Properties of the Aluminium-Copper-Tin Alloys," the joint work of the reader and Mr. J. H. Andrew, both of the Victoria University, Manchester.

The following is an abstract of the paper:—The constitution of a ternary system may be graphically represented by means of an equilateral triangle. Each corner of the triangle represents one of the three metals. The three sides correspond to the binary mixtures. Any point inside the diagram indicates a certain mixture of the three. The length of lines drawn at right angles from each side, to a common point inside the triangle, is proportional to the percentage composition of the metal represented at the opposite corner. With the triangular diagram it is possible only to indicate variations of composition. To represent temperatures, a new axis is taken perpendicular to the plane of the triangle: Thus, when temperature and concentration are considered, they are represented by a solid right-triangular prism. The upper surface of this figure is always irregular, and indicates the temperatures at which the various alloys begin to deposit solid. It is much more difficult to represent in the model, the solidus and structural changes occurring below the solidus, for it would then be necessary to cut the model into sections, each of which represent alloys which deposit the same solid phase on freezing and undergo the same changes on further cooling. An easier, and perhaps more comprehensive method is to use, for different temperatures, triangles which are divided up into areas showing the boundaries of the phases that are present at those temperatures. By this means the process of solidification, &c., can be followed down to the ordinary temperature.

The following are the conclusions arrived at by the authors:—(1) No ternary compound is deposited from the liquid alloys; (2) no ternary eutectic is formed; (3) judging from the constitution and general appearance of the alloys it is quite obvious that those possessing reasonable mechanical qualities are confined to two very limited areas, namely, those containing upwards of 86 per cent. copper and those which contain more than 85 per cent. of aluminium; (4) theoretically, no advantage is gained by adding tin to those alloys of aluminium-copper containing about 10 per cent. Al and 90 per cent. Cu; (5) it is considered probable that an alloy containing 6.5 per cent. aluminium, 5.5 per cent. tin, and 80 per cent. copper will have the same properties as an alloy containing 10 per cent. tin and 90 per cent. copper, while it would be less expensive than the copper-tin, and would have a lower specific gravity; (6) alloys containing the compound $CuAl_2$ with tin may be found of use as bearing metals, for when made under the proper conditions they consist of a very hard constituent embedded in a soft matrix of tin. It is, however, impossible to make homogeneous castings of these from these alloys, but at temperatures between 540 deg. Cent. and 232 deg. Cent. they are plastic and capable of being moulded.

Dr. H. C. H. Carpenter, in opening the discussion, said that the work involved in connection with the equilibrium diagrams of the ternary alloys was very great, but it had to be done. He would point out that one diagram—No. 2—in the paper involved the making of more than 450 alloys. A scientific fact of considerable interest which came out was that tin was completely insoluble in very many alloys, and separated out. That appeared to him to have a useful commercial application, because with aluminium at the price at which it stood at the present time it might be possible to employ it to extract tin from tin residues which were not at present worth working on commercial lines. It was almost tragic that the authors limited the number of alloys having any commercial possibilities to a microscopically small part of the diagram No. 5. At the same time, although that might be a tragic conclusion, it was a very useful one, and in future work it would only be necessary to concentrate attention on those alloys marked out for industrial application.

Mr. Sinclair referred to one or two investigations he had made with aluminium alloys. Among the other facts which he demonstrated, after prolonged investigation, was that in sea water alloys of aluminium and copper lose less in weight than other alloys, and when treated as a galvanic couple with other metals, he reached the astonishing result that the alloy of 10 per cent. of aluminium and 90 per cent. copper experimented with lost nothing at all.

Mr. J. Brentnall referred to work he had carried out on alloys of 50 per cent. tin and 50 per cent. aluminium. In making manganese bronze castings great difficulty was experienced in preventing leakage under pressure, and he accordingly turned his attention to aluminium and tin alloys which had peculiar properties as regarded corrosion. When copper was added to the alloys referred to up to about 10 per cent., this seemed to stop the corrosive action, but with a greater addition of copper the action was not checked to the same degree. Taking the alloy of tin and aluminium and adding zinc, the corrosion was enormously increased, until with 95 per cent. of zinc and 5 per cent. of tin and aluminium the action was so great that it was found possible to collect 250 c.cm. of hydrogen gas in half-an-hour.

Dr. Desch said that the authors had shown great courage in investigating alloys of such extreme complexity as the copper-tin and copper-aluminium series, and they would be the first to admit that the investigation was not complete. It was worth noting that the method adopted by the authors of systematic quenching from selected temperatures in order to fix the structures stable at those temperatures was introduced by two English metallurgists, Messrs. Heycock and Neville, some years ago. The authors' conclusions seemed for the most part to be very firmly established, and, indeed, the only statement from which he would be inclined to dissent was that the definite compound Cu_3Al could separate from the liquid. One would be reluctant to assume the existence of a compound dissociating in that way with falling temperatures. He was of opinion that the compound named, if capable of existence, had a range of stability at lower temperatures only. The conclusion stated that the alloy Cu_3Al was homogeneous at 900 deg. Cent. and 500 deg. Cent., but broke up into two phases at intermediate temperatures was of the highest scientific importance. It differed from anything previously known, and was a fundamental point in the theory of metallic solid solutions. The practical conclusions drawn by the authors were extremely interesting, and he hoped that the investigation would be continued with the some remarkable degree of success which had characterised it up to the present time.

Mr. Hudson pointed out that it was the appearance of the gamma phase which destroyed the usefulness of the alloys, and it was of the utmost importance that the authors should have determined at what point the brittle phase appeared.

Mr. W. H. Johnson said that the production of this paper was a clear proof of the usefulness of the Institute. Metallurgists and scientists had at once responded to the appeal of practical men, and the research was admirably illustrative of the good results which should follow from the co-operation of science and practice.

Sir William White referred to the work being done first by Dr. Carpenter and now by Dr. Rosenhain for the Alloys Research Committee of the Institution of Mechanical Engineers. There were a great many interesting points raised in the paper, and the absence of Dr. Rosenhain, who was conducting an investigation of ternary alloys, was to be regretted. As Chairman of the Alloys Research Committee he was familiar with the work which had been done. The results were to be placed before the Institution of Mechanical Engineers in the near future, and they would be found extremely interesting taken in connection with the work recorded in the paper which had been discussed at that meeting. The determination of the alloys of industrial value had involved an enormous amount of work, and had given practical men the advantage of being able to concentrate their attention on that particular group.

Dr. Rosenhain, in a written contribution, stated he was disappointed that the paper consisted largely of a bald statement of results. The publication of the data would have been of greater permanent value than the summary of conclusions. The results put forward might very probably require modification, and if that were the case, owing to the absence of data, subsequent investigators would find it difficult to derive much help from the present paper.

On the motion of the President a cordial vote of thanks was accorded to the authors of the paper.

The next paper read was on "The Surface Appearance of Solders," by Mr. C. Bannister and Mr. H. J. Tabor. It contains the results of experiments carried out with a view to obtain exact information on the effect of small quantities of impurities on the surface appearance. It seems that the sale of solder is influenced largely by appearance rather than by analysis, and it is important that when cast in the form of strips the solder should have a white, bright surface with a furrow, and be free from rough patches, spots, pits, &c. The effect of antimony is dealt with in the paper, and the results confirm the statement that tinman's solder containing 2 per cent. antimony, 46 per cent. tin, and 53 per cent. lead is superior in appearance to that of the alloy consisting wholly of lead and tin in equal proportions, and that with 3 per cent. antimony spots appear on the surface. The microscopic examination of these alloys throws some light on the effect of antimony, for with the addition of 3 per cent. antimony bright cubical crystals are seen on the prepared sections after polishing and etching with hydrochloric acid. These crystals probably consist of the compound Sn Sb, and are not found in alloys containing 1 and 2 per cent. of antimony. The segregation of the crystals to the top of the alloy seems to cause the spots. Solders containing small quantities of copper have good surfaces, but have a tendency to spot, while larger quantities, 0.5 per cent. and upwards, give dull, flat, and crystalline surfaces. In the case of silver in small quantities a peculiar white crystalline appearance is produced. Zinc is a most detrimental metal to have present in solders, as minute traces give very inferior surface appearances. Bismuth in small quantities has no effect at all on this surface appearance.

An interesting historical fact was brought out in the discussion by Professor Gowland, who said he recently had in his possession a piece of Roman solder dug up at Silchester. When analysed it was found to be of the same composition as that of the sealed solder of the Plumbers' Company, namely, 2 parts lead and 1 of tin. The specimen dated from about 300 A.D.

In reply to a question the author stated that an addition of 2 per cent. of antimony, while giving a superior appearance, did not produce a solder of the same working qualities as an alloy containing no antimony.

The third paper taken on Thursday was by Mr. E. L. Rhead, and was entitled "Some Causes of the Corrosion of Copper and Brass." Copper and copper zinc alloys in contact with saline solutions, such as sea water, corrode in a peculiar manner. Brass condenser tubes exhibit deep pits on the side next the water. These often occur in lines. In other situations, and under other conditions, copper enrichment takes place. The pits, in the case of condenser tubes, are most common on the side of the tube lying undermost when in position. This corrosion is most erratic, and is generally attributed to selective chemical action, and to electrolytic effects due to the duplex structure of the alloy.

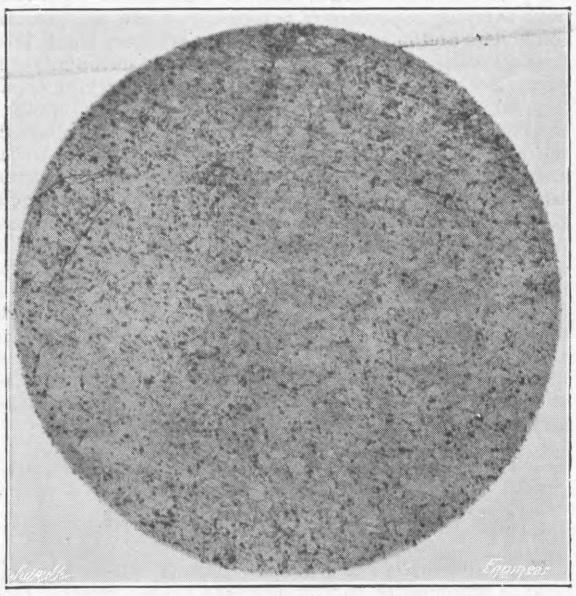


Fig. 1—HARD BRASS, MAGNIFIED 50 DIAMETERS

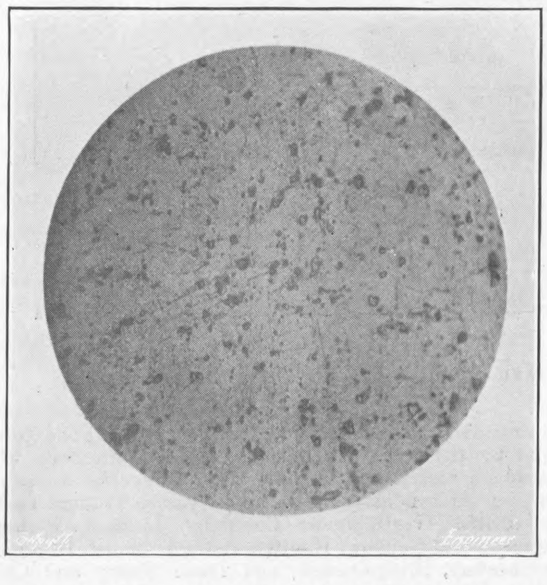


Fig. 2—HARD BRASS, MAGNIFIED 120 DIAMETERS

Two similar plates of hard brass were taken, and one annealed before use. These were subjected to corrosion in a 1 per cent. solution of ferric chloride. The relative amounts of corrosion were: soft, 51; hard, 49. Apparently this was not in sequence with former results, but the sample of hard brass became quite reddish on both sides, due to copper enrichment. The copper did not form a film, but when placed under water the colour showed very distinctly. The softened plate showed no trace of such an appearance, and was uniformly acted on except where the edge of the sheet projected above the level of the corroding liquid and came into contact with the air. Just below this level the surface showed greater corrosion and some copper enrichment. Along two narrow lines, the continuations of which were visible owing to their somewhat greater brightness on the part not immersed, this deposit could be traced for about half an inch below the line of liquid. These had the appearance of marks produced by rolling, the effects of which had not been quite obliterated by the annealing. Both plates were treated in the same jar, but were insulated from each other by glass rods. The structure of the metal before annealing is shown in Figs. 1 and 2, under a magnification of 50 and 120 diameters respectively, and after annealing, in Figs. 3 and 4, the same magnification, 50 and 120 diameters, being used. The effect of cold rolling on the crystalline structure will be noted. In Muntz metal and other similar alloys used as sheathing, tube plates, &c., the corrosion may extend inwards from the surface, though not equally from every part, till the whole mass is completely changed. The residue is brittle, breaks with a dull fracture, but yields a bright surface when filed. In other cases where rapid circulation effectually removes the products, general wastage, accompanied by pitting, may occur.

A strip of hard brass measuring 0.02in. thick was softened over a portion of its length, and bent in the form of a ∩. The two limbs were placed in a corroding liquid containing approximately 10 per cent. hydrochloric acid and 5 per cent. copper chloride. They were left for twelve and twenty-four hours respectively. On removal from the liquid the difference in the rate of attack was very obvious. The hard limb had been seriously corroded, especially on the side facing the soft limb, as will be seen in Fig. 5. It appears that an electric couple is formed between the hard and the soft metal. The surface of the hard metal was made very rough and irregular, while the soft portion remained smooth. These roughnesses may form points from which the disengagement of gases dissolved in water flowing through the condenser tubes may take place, thus helping on the process of corrosion of the tube. From this the author considers that the final cold drawing of a tube to produce stiffness is liable to cause irregularities that may increase the rapidity of the attack. The author also suggested that the corrosion of propeller blades is probably not unconnected with the liberation of gas from the water by the differences in pressure resulting from the revolution.

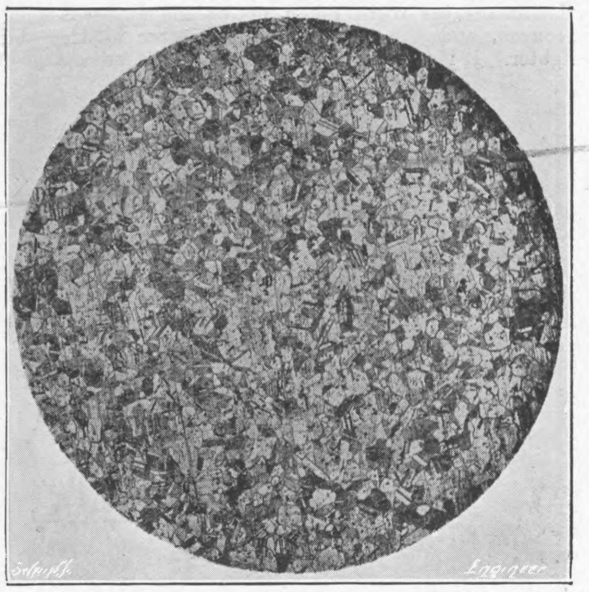


Fig. 3—ANNEALED BRASS, MAGNIFIED 50 DIAMETERS

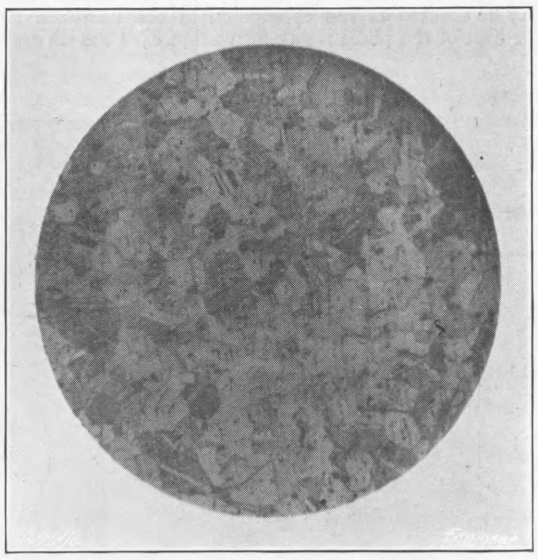


Fig. 4—ANNEALED BRASS. MAGNIFIED 120 DIAMETERS

Sir Gerard Muntz, in the course of a long speech, said that the corrosion of metals was a subject of particular interest to manufacturers. With regard to the pitting of condenser tubes, that was very seldom on the steam side, and when that did happen it was almost invariably the result of using improper oil, containing acids and carbonaceous matter. The tubes were chiefly pitted on the lower side, and the reason was that all deposit naturally gravitated to that side. It was the deposit that was the

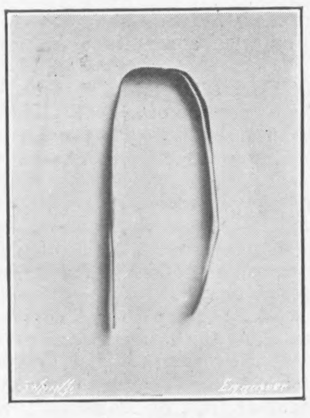


Fig. 5

cause of the trouble, and particles of carbon or iron adhering to the upper side of the tube would probably fall off owing to vibration. The cause of pitting in lines arose from several causes, the chief of which were continuous deposits lying along the bottom, and spills on the inside surface of the tubes, which were generally the result of the adherence of particles from the cores in casting, which subsequently became elongated in the process of drawing. It was suggested by the author that plugs of copper were sometimes found in tubes, but these were really only points where the copper remained in situ, the zinc having been abstracted. In 99 cases out of 100 the deposits were something which had been brought in by the circulating water. The deleterious action in all these cases arose from the setting up of galvanic couples between the zinc and the carbon or iron. Another cause of corrosion was the decomposition of air and gases which might result from too slow a flow of the circulating water which consequently became overheated. Misplacement or malformation of the water intake was another point which should be referred to, as it led to the introduction of an excessive quantity of free air, and in that case where an alteration in the intake had been made the trouble had altogether ceased. On ships the ash discharge was often placed forward of the condenser intake, the natural result being that cinders were drawn in with the water. It would perhaps interest the meeting to know that his firm had had condenser tubes returned as defective, and investigation had shown them to be wadded almost solid with shrimps and seaweed. Reference had been made to the corrosion of Muntz metal sheathing, bolts, and the under-water fittings of ships. That trouble began with the employment of electrolytic copper in 1898, and save for the introduction of copper manufactured by the electrolytic process the practice of manufacture had remained unaltered for three-quarters of a century. When the trouble arose his firm made a most exhaustive inquiry, and called in the assistance of consulting engineers. The results of a long research went to show that the corrosion was due first to the employment of electrolytic copper in the manufacture; and secondly, to the use of cheap black varnishes in the fastening of the sheathing in place of the smelted copper and genuine Stockholm tar which ought to be employed. The result was the formation of galvanic couples between the carbon in the varnish and the zinc in the metal sheathing.

Mr. Bengough said that the modern view was to accept the electrolytic theory of corrosion, and the whole subject was of great importance from both the practical and the scientific point of view. The theory to which he referred had been arrived at after much laborious investigation, and it indicated the direction in which prevention might be looked for. The speaker explained the electrolytic theory at some length, and pointed out that worked material was usually electro-positive to soft material, and hence the results obtained by Mr. Rhead in his ferric chloride tests, which showed the greatest total corrosion. This also accounted for the copper enrichment round the cut edges of plates. These were not deposits of copper, but areas from which the zinc had been dissolved, as pointed out by Sir Gerard Muntz. The practical consequences of the electrolytic theory were that anything which increased the number of ions in solution, which were less electro-positive than zinc, would increase corrosion.

Mr. Sinclair referred to the effect of vagrant electric currents escaping from electrical equipment. There was a tendency for the current to go through the water pipes which formed the easiest path, and then through the condenser, and in that way electrolysis had been set up. In one case pipes came into the condenser carrying the waste steam, and it was just where the drops of water were formed that the trouble took place. As a possible cure he suggested that the whole condenser should be made electrically continuous, so that there would be no joints where the current would have to pass through the salt water.

On the motion of the President a vote of thanks was accorded to the author for bringing the subject before the meeting.

On Friday, 15th inst., a valuable paper on "The Copper Zinc Alloys," by Professor T. Turner and Mr. M. Thornton Murray, of which the following is a brief *résumé*, was read by the former:—For some years past investigations have been in progress at the University of Birmingham on the changes in volume which occur when metals pass from the fluid state to the temperature of the air. Cast iron, for instance, has been proved to have three different expansions while the solid metal is cooling, these kinks in the cooling curve corresponding to particular temperatures and the separation of certain ingredients. The experiments have been extended to alloys of copper and zinc, which, as the brasses, constitute the most important of the industrial alloys. In the paper the hitherto unrecorded fact is published that with certain percentages of zinc and copper the metal when poured into the mould does not immediately begin to contract owing to cooling, as might be expected, but for a short time actually expands. This expansion, no doubt, accounts for the excellent impression of the mould and the sharp lines which are met with in certain brass castings. One alloy with about 15 per cent. copper expands in a remarkable manner—so much so that after the metal has finally cooled and shrunk in the mould the bar is finally as long as the pattern from which it is cast. It is curious to note that some of the alloys in the series do not expand at all when solidifying, these being the brass with 60 per cent. of copper, known as Muntz metal, and that with 40 per cent. copper, which is a hard, white, brittle alloy, and probably a definite chemical compound. The authors have determined the hardness of these alloys, and find that the 40 per cent. alloy is the hardest of the series, and is actually much harder than mild steel. The instrument used for determining the volume changes in the brasses was an improvement on the extensometer described by Professor Turner in the Iron and Steel Institute *Journal*, 1906, No. 1, pp. 48-74.

Mr. Bengough found the paper of great practical as well as scientific interest. From the practical point of view the curve of total shrinkage would undoubtedly prove of great interest, as it varied very greatly in the different alloys and with different sizes of castings. Perhaps if the results had been presented in tabular form they would have been more readily available for workshop purposes. He would draw attention to the agreement between Brinnel and the scleroscope tests, but it should be borne in mind that the agreement only held for cast alloys, and was not applicable to rolled material, in which case the hardness numbers, as shown by the scleroscope, increased more rapidly than with the Brinnel test. Attention should also be directed to the resemblance between the Brinnel test and the tensile results given in the fourth report of the Alloys Research Committee.

Dr. Desch failed to find any proof in the paper that a true expansion of volume occurred on the passage of these alloys from the liquid to the solid state, and, indeed, there were not wanting evidences that contraction took place. The apparent expansion was, he suggested, due to the thrust exercised during the growth of crystals. The point was one rather of scientific interest, as it did not matter from the practical brassfounder's point of view whether it was a true expansion or mechanical action.

Mr. Vaughan Hughes characterised the paper as one of the best of the kind presented to any technical institution for some years past, and Mr. Hudson pointed out that the points raised in the paper opened up a very wide field of research.

Mr. Rhead was of opinion that microscopical examination might throw some light on the suggested thrust due to expansion, while another speaker said that in the shops it would be far easier to deal with the troubles met with in casting if the casting properties at high temperatures were known. What was wanted was the determination of the elastic limit and other physical properties at high temperatures, and if the research were followed up on those lines brassfounders would be very grateful.

Sir William White said that a point of the highest importance was that there should be multiplicity of observation at the points where the conditions were discontinuous, and he gathered that this condition had been complied with. Whatever the explanation which might be given to the facts recorded, it was generally admitted that the paper was one of the most notable which had been put forward for some time past.

Dr. Walter Rosenhain, in a written communication which will appear in the "Transactions," said he felt some difficulty in accepting the indications of Professor Turner's "extensometer" without reservation where volume changes during solidification were concerned. The most interesting portion of the paper dealt with actually observed expansions, so that the correlation of the expansion with the equilibrium curves of the brasses remained as a most valuable forward step in our knowledge of alloys. Metallurgists were under a considerable obligation to Professor Turner for breaking new ground.

The paper, entitled the "Elastic Breakdown of Nonferrous Metals," submitted by Mr. C. Alfred M. Smith, of the East London College, fills 62 demy octavo pages. It was much too long. The most interesting portion is that descriptive of the sphingometer, an instrument devised by Mr. Smith for measuring the strain of specimens either in tension or compression. This instrument has now been in use for two years, and has undergone some very rough handling, but continues to give good results. It works on the general principle that a helix of elastic material if compressed or extended tends to wind or unwind. A piece of phosphor-bronze, about 7in. long, $\frac{1}{8}$in. wide, and 0.004in. thick is used. The material is divided into two lengths. At the centre an attachment is made, so that a mirror (preferably of about one metre focus) may be fastened. One half of the strip is then wound as a right-handed spiral, and the other half is wound as a left-handed spiral. At the two ends the strip is soldered to a thin piece of metal, which has drilled through it a hole for a set screw. By means of this set screw at each end the strip is attached to a tube in which it is carried.

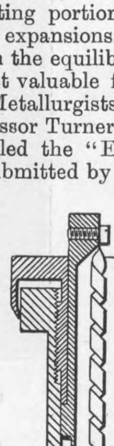


Fig. 6—SINGLE SPHINGOMETER STRIP AND CASE

A ray of light is thrown on the mirror and reflected on to a scale in a well understood way. It was noticed that when a single instrument of this kind was employed different strains were recorded if the points of attachment were moved round the test piece. It was therefore decided to use three coils at once at 120 deg. to each other. A single sphingometer strip and case is shown in Fig. 6, and one of the carriers in Fig. 7. The tubes are held between two carriers placed dead parallel to each other, in the specimen one tube being held in each of the clamps marked V.

One of the most important facts noticed by the use of the instrument, says Mr. Smith, is the variation in strain which accompanies a tensile or compressive stress. Bending, probably due to excentric loading, occurs always. It is to be expected that when a specimen is in compression there will be bending. In order, therefore, to emphasise the importance of this fact of variation of strain, the author will confine his remarks to the tension tests. At the same time the importance of recording this variation in stress upon a specimen in compression is mentioned. The theory of elasticity and all engineering applications of it are based upon Hooke's Law, viz., that the strain on a material is proportional to the stress. There is no evidence to show that the law is not a compound interest one, although it is always assumed that it is a law of simple interest. This fact should be kept in mind when deducing the limiting conditions for the shear stress theory of the elastic failure of materials. It is the stress at elastic failure which it is desirable to record. There is probably some general law for the elastic failure of all materials For low-carbon mild steel elastic failure takes place when a definite shear stress has been reached, no matter how the material be loaded. This may be a particular case of a much more general law, but it will not be possible to find what is this general law until we can measure with great accuracy the maximum strain upon the material. The maximum strain cannot be calculated unless the extension upon three planes be measured. If these three measurements are recorded, then it is possible to calculate the maximum strain. When a load is applied to a specimen in tension or compression, three readings in planes at 120 deg. are taken. It is found that the three strains recorded are unequal.

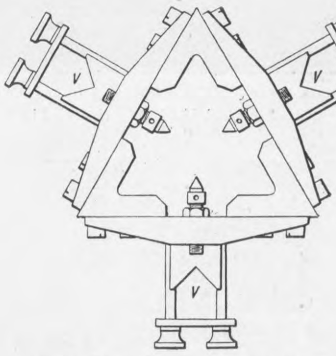


Fig. 7—SPHINGOMETER CARRIER

Sir Gerard Muntz, in opening the discussion, referred to Professor Smith's statement on the subject of the want of uniformity of the specimens. That, of course, was one of their great troubles in connection with non-ferrous metals, and it was a trouble which the Institute had been formed to assist in overcoming. There had always been great difficultiy in obtaining similar results from what was apparently an identical process, and considerable trouble was experienced in complying with the requirements of engineers in respect of tensile strength, elongation, and elastic limit. In the case of iron and steel materials about which more was known, it was not difficult to comply with the conditions stipulated, but a very different state of affairs existed in regard to copper. Many questions arose in connection with heat treatment, and the other processes of manufacture, and very slight variations affected the ultimate result. These matters were always being investigated in their works, and he had been supplying materials to some of their scientific members in the hope of finding out more about the effect of the various processes upon copper. He hoped that the researches now being undertaken would lead to a greater knowledge of the subject.

Mr. Parker, in the course of a long speech, said that in his opinion the sphingometer was not necessary or suitable for commercial work, owing to the trouble arising from vibration. The only extensometer on the market which could be said to be a commercial instrument was the Unwin extensometer. He would like to point out that many of the tests carried out in this country were conducted in what he considered to be a very slovenly manner; in particular, he would refer to the method of gripping the specimen. Wedge grips for holding specimens should be discarded, and screw nuts and screw grips with spherical seats should be made compulsory for testing round specimens. Shear fracture was not so uncommon as Professor Smith seemed to infer. The phenomena of overstrain had an important effect upon the modulus of elasticity; it usually increased its value—that was to say, it altered the angle of inclination of the stress-strain curve. Hence for a correct determination of elastic modulus the specimens should not be stressed in any way prior to the actual test. It was confusing to say that overstrain made metals more elastic. What it did was to increase the range of stress over which they were elastic. In his opinion both stress-set and stress-strain curves should be given with research reports. Stress-set curves were highly important to the designers of petrol motors, high-speed turbo-generators, and other modern high-speed machinery. A definition of elastic limit was badly needed in this country, and he hoped that the authorities interested would take steps to obtain it. For engineering work the best definition would be the stress per square inch which produced a permanent set of exactly .001in. on a gauge length of 2in.

Sir William White, in closing the discussion, said that Professor Smith wanted assistance in order to carry on his research at the East London College, which had been termed the poor man's college, and he appealed to manufacturers and others interested to supply him with the necessary materials to carry on the investigation in order that further knowledge might be obtained of the physical properties of the alloys of non-ferrous metals. Professor

THE ASHENDON-AYNHO RAILWAY

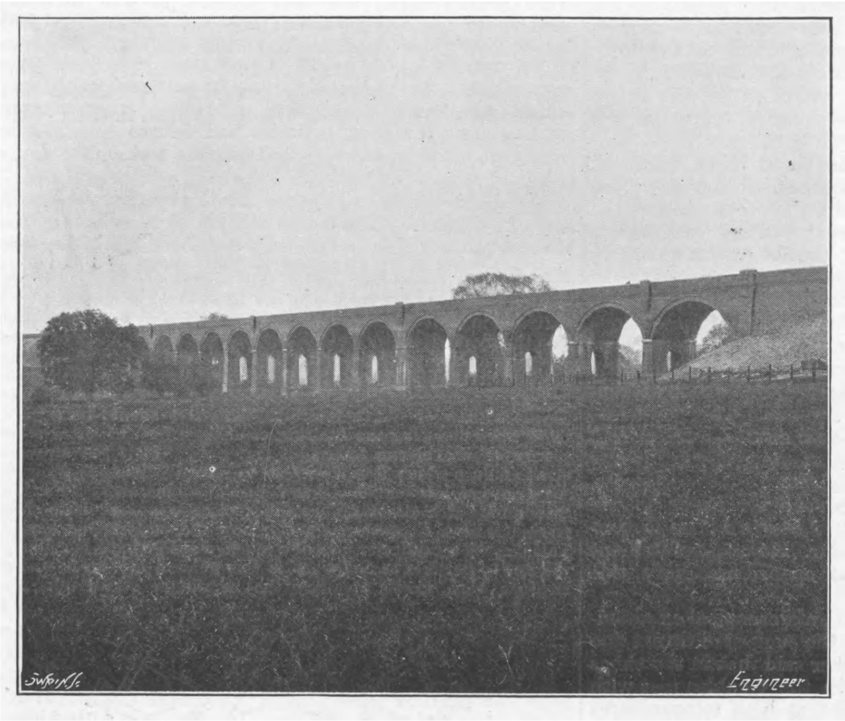


Fig. 1—VIADUCT No. 1—EIGHTEEN 40ft. ARCHES

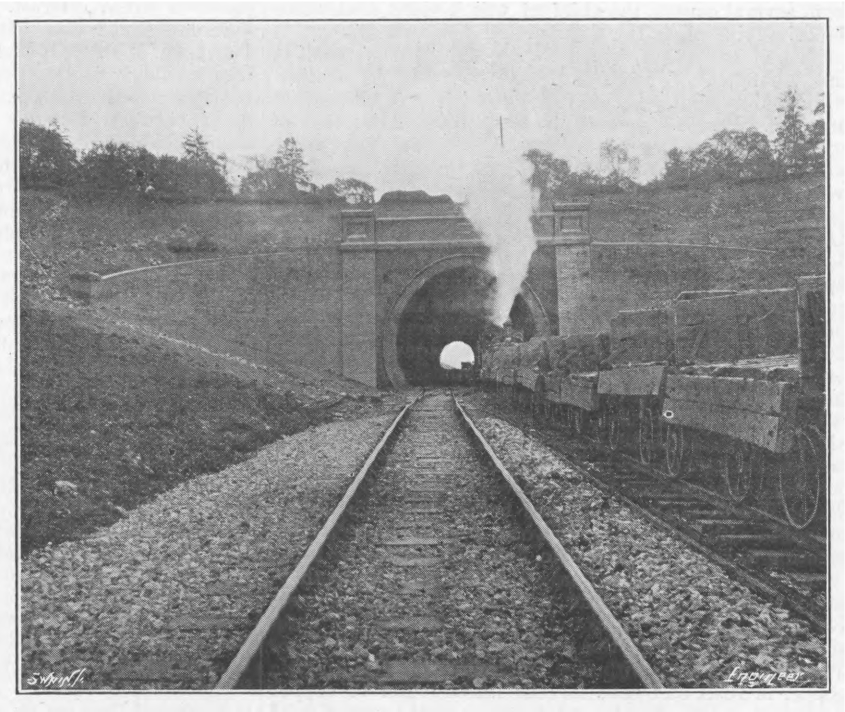


Fig. 2—THE NORTH FACE OF TUNNEL No. 1

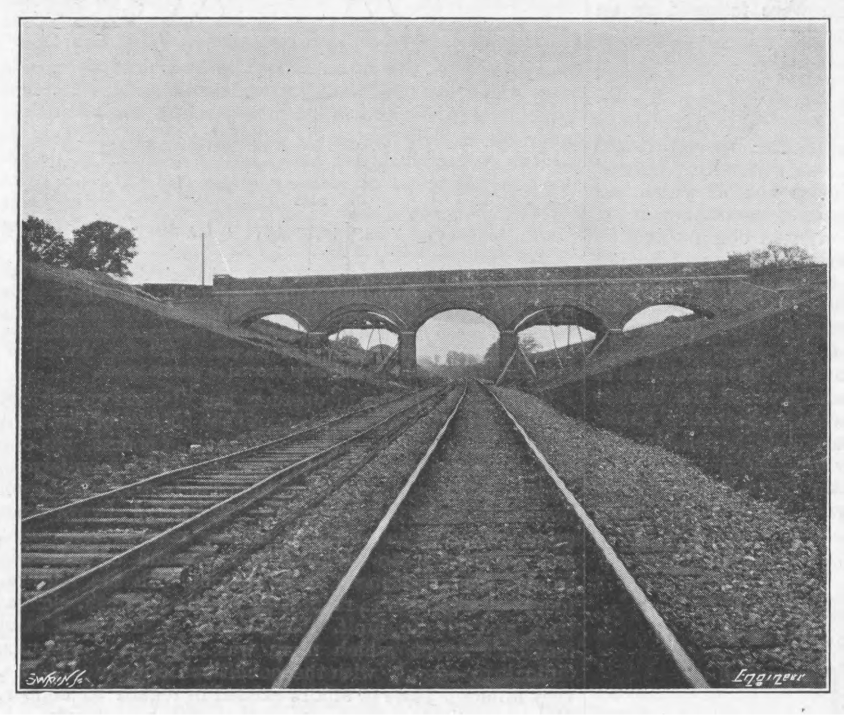


Fig. 3—FIVE-ARCH OVER-BRIDGE AT 2 MILES 35 CHAINS

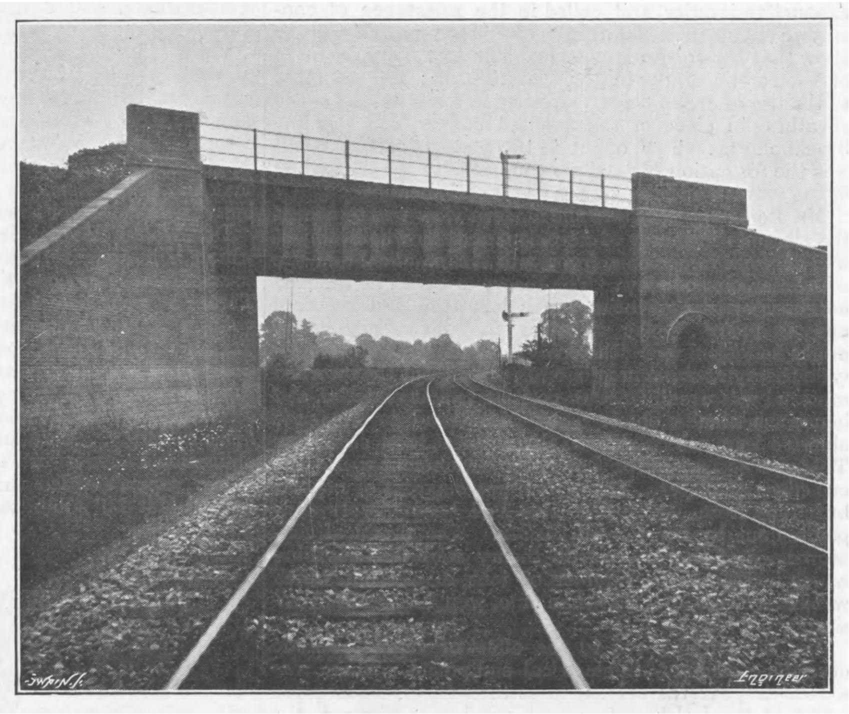


Fig. 34—STEEL GIRDER BRIDGE OVER L. AND N.W.R. NEAR BICESTER

Smith was working on scientific lines, as even such a critic as Mr. Parker would be the first to admit.

Professor Smith, in replying on the discussion, said that the trouble owing to want of uniformity in copper specimens had greatly hampered the work. It seemed to him that there was some method by which uniformity might be secured. He was, as Sir William White had pointed out, most anxious to obtain specimens. With regard to what had been said as to the trouble of vibration in connection with the use of the sphingometer, it was perfectly true that if you wished to measure and get accuracy you must not have any vibration, but at the same time it was easy in practical work to make a correction for that.

A paper on the "Production of Pure Spelter" was next contributed by Mr. John S. G. Primrose. After a brief review of the commercial position of zinc and the existing methods of refining the metal, Mr. Primrose dealt with the theory of the new process of purification by fume filtration during distillation. Lead is sensibly volatile below its boiling point in the presence of zinc vapour, and passes out of the retorts in a state of gaseous solution in the zinc. Its repeated impingement on the surface of the filter material dissociates the alloy, allowing the zinc to pass on to the condenser almost pure, but retaining the lead chiefly in the metallic condition and recoverable in this state. He described the plant at Irvine Spelter Works, and gave details of the working of dross refining, which is said to yield 99.8 per cent. spelter from impure material in one step.

The process was somewhat severely criticised by Prof. Gowland, who said the published tests were too short, and the process extremely imperfect, its success depending on the price which can be obtained for the residues. Prof. Gowland afterwards made an interesting statement concerning the early history of brass. He said brass was made as long ago as the year 20 B.C. A coin of that date had been discovered, containing 75 per cent. to 80 per cent. copper and the rest zinc., no tin being used. Ornamental brass work and brass armour could be traced back to the second and third centuries, and the metal contained 80 per cent. copper and the rest zinc.

Mr. Bannister, in the course of a long speech, claimed advantages for carbonaceous filters over those made of refractory material.

A paper on "The Technical Assay of Zinc," by Messrs. H. W. Greenwood and F. J. Brislee, was the last to be read, and a very successful meeting was concluded by the visits to works which have been previously mentioned.

THE ASHENDON-AYNHO RAILWAY.

In The Engineer of 14th July, 1905, was published a description of the Princes Risborough and Grendon Underwood Railway. This line, it will be remembered, forms part of the Great Central Railway Company's route from London, alternative to that of the Metropolitan Railway as between Harrow and Quainton Road, whereby access to the metropolis was first obtained. It is linked to the wholly new or re-modelled sections of old railway, which now form a homogeneous system, extending from Neasden to Northolt Junction, and thence *viâ* Ruislip, Denham, Gerrard's Cross, Beaconsfield, and High Wycombe, to Princes Risborough. Northolt is the junction of a Great Central line from Neasden *viâ* Wembley, and a Great Western line from West Acton *viâ* Perivale and Greenford. From Northolt Junction to Ashendon Junction, which lies 9 miles 35 chains north of Princes Risborough, the system is jointly owned by the Great Western and Great Central Railways, and managed by a joint committee. The distance from Northolt to Ashendon is 35 miles 67 chains. The line between Ashendon and Grendon Underwood, 5 miles 69 chains in length, belongs to the Great Central Railway alone. The latter company commenced to make use of this new route with passenger traffic on July 1st, 1906.

However, the scheme of these new railways in Middlesex and Bucks was originally promoted by the Great Western Railway for the purpose of obtaining a shorter route to Birmingham, the Midlands, and the North. The partnership with the Great Central Railway was an after thought—the outcome of difficulties arising between the latter company and the Metropolitan. To complete the Great Western scheme a railway from Ashendon to Aynho on the existing route to Birmingham, &c., was necessary. The construction of this line was begun in the late autumn of 1906, and it is hoped to open it, together with the entire new route for passenger traffic, at Easter, 1910—certainly not later than the summer of that year.

Generally speaking, the Great Western's new route will effect a saving in distance of 19 miles as compared to its existing one *viâ* Reading, Didcot, and Oxford, which saving will extend not only to Banbury, Leamington, Birmingham, and Wolverhampton, but also to every part of the company's northern system, which embraces the prolongation of that main line through Shrewsbury to Chester and Birkenhead, together with numerous branches.

The table below furnishes a comparison between the present and future distances, and the existing journey times by the competitive Great Western and London and North-Western routes, while the situation is further elucidated by the two maps, Figs. 7 and 8, one showing the line itself and the other of both systems as affected by the Great Western's cut-off:—

—	Great Western Rly.			London & North Western Railway.	
	Present distance from Paddington.	Present quickest journey time to or from Paddington.	Distance from Paddington by new route.	Distance from Euston.	Present quickest journey time to or from Euston.
	Miles.	h. min.	Miles.	Miles.	h. min.
Bicester	No route	—	$53\frac{1}{4}$	$66\frac{1}{4}$	1 42
Banbury	$86\frac{1}{4}$	1 31	$67\frac{5}{8}$	77	2 15
Leamington	106	1 50	$87\frac{1}{2}$	$91\frac{1}{2}$*	1 50
Birmingham	$129\frac{1}{4}$	2 20	$110\frac{3}{4}$	113	2 0
Wolverhampton ...	$141\frac{3}{4}$	2 44	$123\frac{1}{4}$	$124\frac{3}{4}$	2 29
Wellington	$161\frac{3}{8}$	3 15	$142\frac{3}{4}$	$152\frac{1}{4}$	2 56
†Shrewsbury	$171\frac{5}{8}$	3 28	153	$162\frac{3}{4}$	3 12
Chester	214	4 50	$195\frac{3}{8}$	179	3 34
Birkenhead	$228\frac{1}{2}$	5 25	210	$194\frac{1}{2}$	4 15

* *Viâ* Weedon; $97\frac{1}{2}$ miles *viâ* Rugby.

† Junction for G.W. and L. and N.W.R. joint line to Welshpool for Welsh coast.

It will be seen that in nearly every instance the advantage of the shorter route at present possessed by the London and North-Western Railway crumbles away before the new Great Western one.

The North-Western Company has built up a very strong hold upon the London, Birmingham and Wolverhampton traffic. For some years past the Euston-Birmingham train service has been undergoing constant acceleration and augmentation. It now consists of nine trains performing the journey in two hours without intermediate stop, one train in 2 h. 5 min., one in 2 h. 10 min., two in 2 h. 20 min., thirteen others averaging 2 h. 38 min., and eleven more, which travel *viâ* Northampton (115 miles), and average 2 h. 54 min. There is a tendency to imagine that when a railway company projects a new route like this it is solely actuated by the desire to get on even terms with its rival. The Great Western Company, in the present instance, was influenced, we believe, just as much by the necessity of providing relief for the increasing traffic on its existing lines, especially on those between Reading, Didcot, and Oxford.

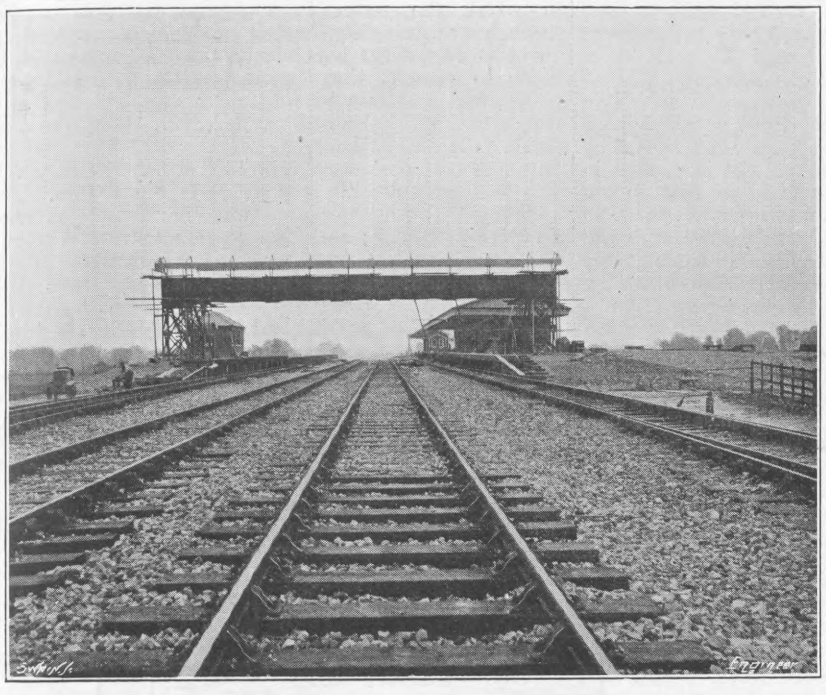


Fig. 5—BICESTER STATION, LOOKING SOUTH

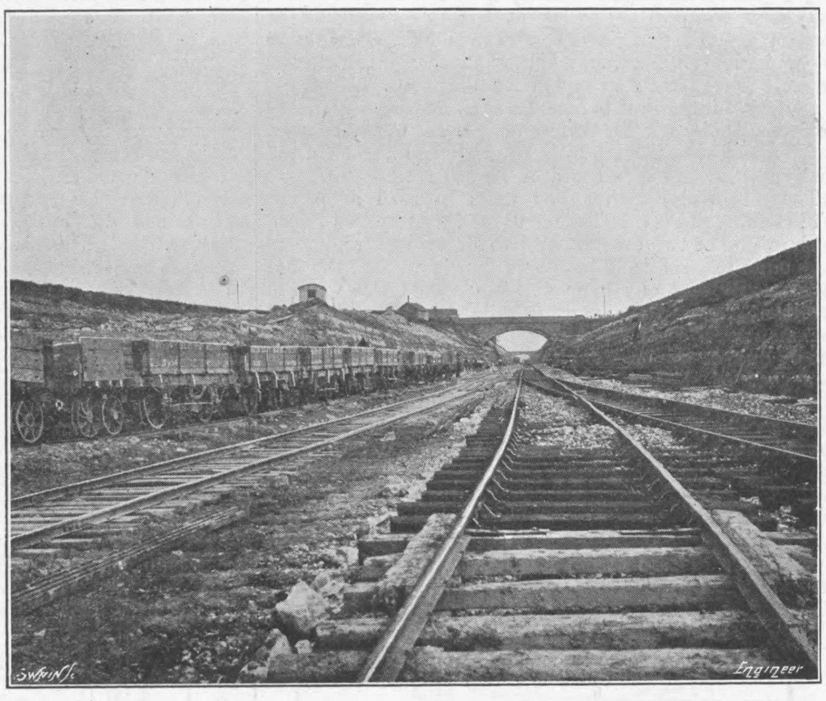


Fig. 6—CUTTING No. 6 AT ARDLEY

The Ashendon-Aynho Railway is 18 miles 12 chains in length, and for most of the distance traverses Oxfordshire. Ashendon Junction is distant 44 miles 10 chains from Paddington, and the Oxford and Wolverhampton Railway is joined at a point half a mile north of Aynho Station. The junctions at each end are of the "fly-over" kind. At Ashendon the "up" line of the new railway is carried over the Great Central tracks from Grendon Underwood, and joins the latter at a point a quarter of a mile nearer Princes Risborough than the bifurcation of the "down" line. This arrangement will necessitate two signal cabins at Ashendon. At Aynho the "down" track of the new railway crosses over the old line from Oxford, but both of the new tracks converge equi-distantly with the latter. Except at certain stations and other places specified below the new railway comprises two lines of way, and no provision has been made in the way of acquisition of land for augmenting the track capacity. The following are the intermediate stations at present decided upon, together with the distance of each from Ashendon:—

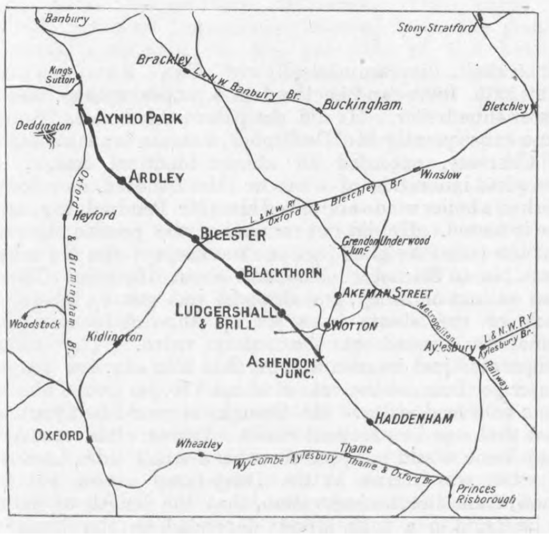


Fig. 7—THE ASHENDON-AYNHO RAILWAY

Brill and Ludgershall, 3 miles 15 chains; Blackthorn, 6 miles 15 chains; Bicester, 9 miles 12 chains; Ardley, 12 miles 76 chains; Aynho Park, 17 miles 23 chains. With the exception of Bicester, which is a town of 3000 inhabitants, these stations merely serve small villages.

On the Greenford-Princes Risborough section the new method of laying out the more important intermediate stations, as commenced with the Badminton line to South Wales, was followed, viz., the two lines expand to four, and the platforms are reached by loops from the pair of "fast" lines. This same system has been adopted at Brill and Ludgershall, Bicester, and Ardley, and in the case of the two first-named amplified by prolonging each "slow" loop for a sufficient distance beyond the platform to accommodate an 80-truck goods train, and furnishing an additional throw-over to the through line at its termination. Therefore, these two stations will take a train drawn up at a platform, and a long goods train shunted in advance, and permit of both being passed by an express travelling in the same direction. Similar loops for the use of goods trains only are provided both at Dalton, distant one mile from Ashendon, and Aynho Junction. As Bicester is an important hunting centre, the station offices will include special accommodation for hunting folk in the way of dressing, tea-rooms, &c.—Fig. 5.

The construction of the Ashendon-Aynho Railway comprises many heavy works. The tunnels are two in number. The first under a hill known as Rushbeds Wood—Fig. 2—begins at 2 miles 13 chains, and is 192 yards in length, It pierces clay and is quite straight. Tunnel 2 will probably be known as the Fritwell. Beginning at 14 miles 78 chains, it is 1150 yards long, upon a curve of 2 miles radius and mostly through clay. It was constructed by break-ups from four shafts, one of which is permanent. The rails are 100ft. below the surface at the lowest point. Notwithstanding great trouble being experienced from water, this work was carried out in eighteen months. To facilitate the last stages of its construction and the subsequent passage of the spoil trains through it, a temporary electric lighting plant has been installed at the north face.

There are only two viaducts, and they are situated close together. Viaduct 1—Fig. 1—extends from 16 miles 16 chains to 16 miles 31 chains. It consists of 18 arches, each of 40ft. span, and has a maximum height of 55ft. from ground to rail level. Viaduct 2 begins at 16 miles 70 chains, and is 396 yards in length. It comprises 24 arches, each of 40ft. span, and has a maximum height of 53ft. from ground to rail level. Both of these viaducts have brick piers and arches, faced with brindled bricks, while the copings of the parapets are finished with Derbyshire stone.

Excluding viaducts and culverts, there are forty-five bridges under or over the line. The new railway, however, encounters no stream worthy of being designated a river, the most important watercourse negotiated being the Ray, a mere brook in the summer, which is crossed a little south of Bicester. Two "foreign" railways are met with. Near the Ashendon side of Tunnel 1 a steel girder over-bridge has been provided for the steam tramway from Quainton Road to Brill. A quarter of a mile south of Bicester Station the London and North-Western line from Bletchley to Oxford is crossed by a steel girder bridge —Fig. 4—the span of which, measuring 54ft. on the square and 65ft. on the skew, is wide enough for four tracks to pass underneath. The single line flying loop bridge at Aynho Junction is of the braced girder type, and its span measures 128ft. on the skew, while the similar structure at Ashendon Junction is 100ft. on the skew. At 2 miles 35 chains occurs the only five-arch over-bridge—Fig. 3—each span of which is 28ft. 6in. on the square and 28ft. 9¾in. on the skew. The other over-bridges are mostly three-arch brick bridges, the span varying between 25ft. 6in. and 28ft. 6in.; but there are a few fly-arch bridges in the deeper cuttings, and a few plain girder bridges. The under-bridges, as a rule, are of the ordinary plate girder type, with cross girders.

The principal cuttings and banks alternate as follows:—Cutting 2, from 50 chains to 2 miles 13 chains, containing 415,000 cubic yards; maximum depth, 40ft. Cutting 2 A, from 2 miles 22 chains to 3 miles 20 chains, containing 453,000 cubic yards; maximum depth, 46ft. Cutting 3, from 3 miles 39 chains to 3 miles 70 chains, containing 100,000 cubic yards; maximum depth, 25ft. Bank 1, from 3 miles 70 chains to 6 miles 53 chains, containing 350,000 cubic yards; maximum height, 18ft. Cutting 4, from 6 miles 53 chains to 6 miles 76 chains, containing 83,000 cubic yards; maximum depth, 35ft. Bank 2, from 6 miles 76 chains to 11 miles 8 chains, containing 1,500,000 cubic yards; maximum height, 29ft. Cutting 5, from 11 miles 8 chains to 11 miles 56 chains, containing 51,000 cubic yards; maximum depth, 15ft. Cutting 6, from 11 miles 62 chains to 14 miles 78 chains—south face of Fritwell Tunnel—containing 1,300,000 cubic yards; maximum depth, 52ft. Cutting 6 A, from 15 miles 50 chains to 15 miles 58 chains, containing 74,000 cubic yards; maximum depth, 57ft. Bank 3, from 15 miles 58 chains to 16 miles 16 chains, containing 300,000 cubic yards; maximum height, 43ft. Bank 4, from 16 miles 31 chains to 16 miles 70 chains, containing 178,000 cubic yards; maximum height, 33ft. Bank 5, from 17 miles 8 chains to 17 miles 70 chains, containing 240,000 cubic yards; maximum height, 36ft. Cutting 7, from 17 miles 70 chains to 18 miles 12 chains, containing 10,000 cubic yards; maximum depth, 14ft. Cuttings 2, 3, and 7 are through clay. The remainder are through rock, which is very hard in No. 6—Fig. 6—the heaviest cutting, the whole length of which had to be steam-drilled and blasted.

The new railway is very easily graded, there being nothing steeper than 1 in 200. The line ascends from Ashendon for a distance of 2 miles 10 chains. From thence it falls to 4 miles 70 chains, which is its lowest point, viz., 209ft. above sea level. It then rises almost continuously to 14 miles 10 chains, which is its summit level, viz., 377ft. above datum, beyond which it falls all the way to Aynho Junction. Except at junctions the line has been constructed with no curves sharper than 2 miles radius, while those at the former are kept as flat as half a mile radius. There are three straight stretches exceeding 2 miles in length, and another of 1 mile 57 chains.

There are no level crossings for road vehicles, but a number of hunt crossings for horsemen and hounds are provided. These latter consist of gently graded ramps at the side of the cuttings or banks. They are protected by two gates on each side, one of which is situated at the beginning of the ramp, and the other adjacent to the lines of way. These gates are kept locked, but accredited hunt servants are supplied with keys. The permanent way will be of the standard Great Western main line pattern, viz., bull-headed steel rails weighing 97½ lb. per yard, and 50 lb. chairs. No track troughs are required between Ashendon and Aynho, as such equipment already exists near Ruislip, on the joint line, and at two other places on the existing route between Banbury and Birmingham.

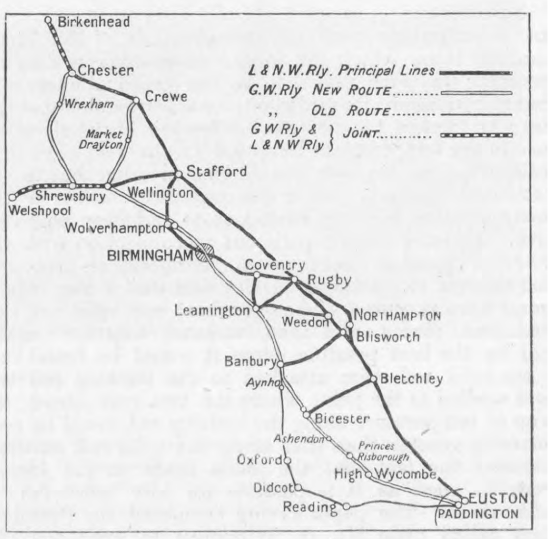


Fig. 8—SYSTEMS AFFECTED BY THE NEW LINE

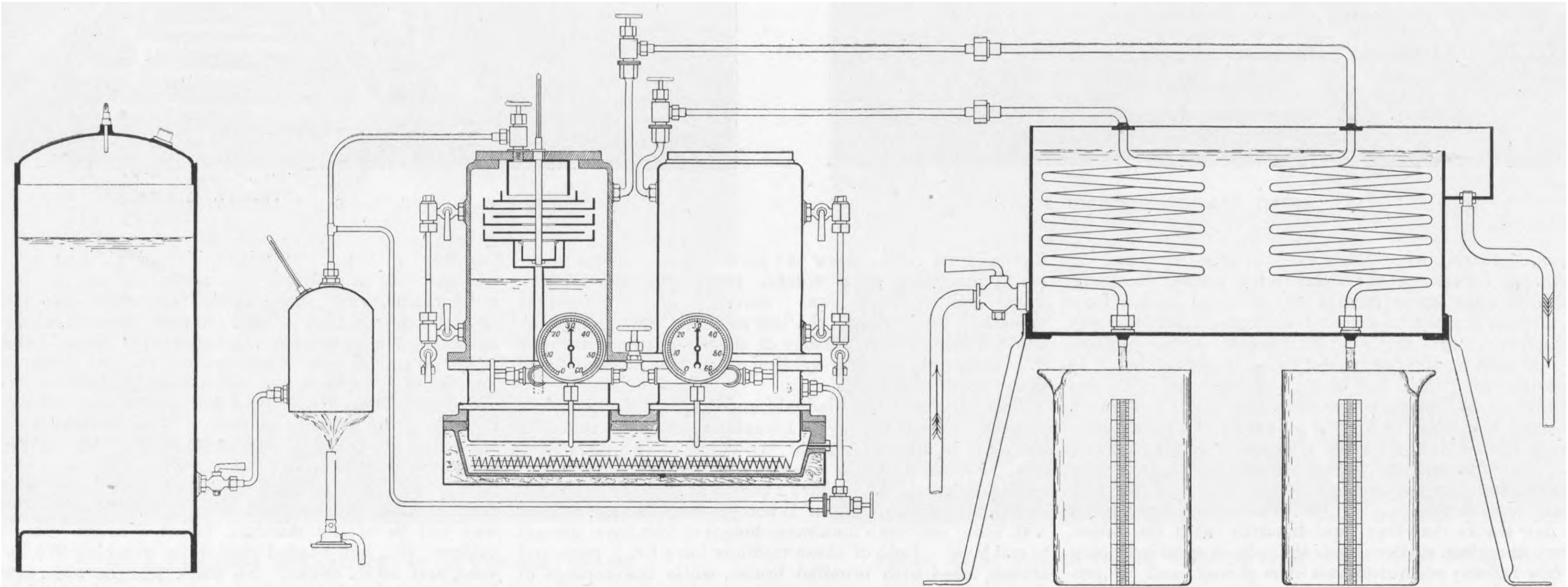
Messrs. Walter Scott and Middleton are the contractors for the entire works, and they have had 1200 men and seven steam navvies constantly employed thereon. The contractors' headquarters are situated at Ardley.

Institution of Electrical Engineers: Manchester Section.—The opening meeting of the present session will be held in the banqueting hall of the Midland Hotel, Manchester, this evening at 7.30 p.m., when the chairman, Mr. S. J. Watson, will deliver his address. The next meeting will be held on Tuesday, November 2nd, and the syllabus giving the dates and papers arranged will be issued prior to this date.

INSTITUTION OF MECHANICAL ENGINEERS.

The first meeting of the session of the Institution of Mechanical Engineers was held on Friday last at Storey's-gate. The President, Mr. J. A. F. Aspinall, occupied the chair. After the minutes of the summer meeting had been read and confirmed, it was announced that, owing to the resignation of Mr. George Whale, Engineer-Vice-Admiral Sir Albert John Durston had been elected to fill his place on the Council, subject to his consent. The paper presented was by Professor Dalby, and it was entitled "Heat Transmission," an abstract of which is begun on page 432. Before calling on the author to read his contribution, the President drew attention to the fact that the object of the research which Professor Dalby had undertaken was to place before the members of the Institution a general view of the work which had been done relative to the transmission of heat from boiler heating surfaces. In order to do this it had been necessary to search for papers bearing upon the subject which had been contributed to the technical Press and to various societies in Europe and America. Over 500 papers had been read, and lists of those relevant to the subjects were given in an appendix to the paper. Abstracts of the most important papers, he said, had been made by Professor Dalby and his colleague, Mr. H. C. A. Thieme, and those abstracts were to be found in the library of the Institution, where they could be readily referred to.

The author was then called upon to read his paper. Whilst doing so Prof. Dalby mentioned that he had hoped to show one or two experiments to demonstrate some of the points referred to in his paper, but in view of the fact that he only had one hour at his disposal, this was not possible. One of the experiments he had hoped to show was mentioned in the paper, and could easily be carried out by any of the members who felt so inclined. This was that of sticking a piece of paper on the bottom of a metal pot, and boiling water in the pot, without even charring the paper. This experiment demonstrated that the temperature of the paper could not be anywhere near the temperature of the flame. Another thing which the author mentioned worthy of recording was with reference to the electrical analogy of heat transmission. He said that those who used this analogy, and who likened the potential difference in the electrical case to the temperature difference in the two sides of a boiler plate, for example, should bear in mind that in the latter case radiation had to be considered, whilst in the electrical case nothing analogous to radiation was met with. An interesting experiment in connection with the effect of joints in metal, on the temperature drop, was also referred to. Professor Dalby said that if two rods of metal were procured, and one of these rods were cut, say, into four pieces, and then screwed together again, making the best possible joints, it would be found that if the solid rod were attached to the built-up rod and heat applied to the point where the two rods joined, the drop of temperature along the built-up rod would be considerably greater than that along the solid rod, notwithstanding the fact that the joints made in the former were as good as it is possible for any workman to make them. The paper having been read, the President then called upon Mr. G. Wilkinson to open the discussion.



THE WILKINSON EXPERIMENTAL APPARATUS

First of all Mr. Wilkinson referred to the early part of the paper where the author laid stress upon the importance of high temperature in the fire-box. Some time ago he carried out an experiment with the object of testing whether the presence of fire-bricks in the flue tube of a Lancashire boiler would increase its performance. He lined the flue tube of a Lancashire boiler with fire bricks, which were raised to a white heat. The boiler was worked for a period of three weeks, but no more steam could be got out of it than before the bricks were put in. Their effect in giving rise to a high temperature was neutralised by their inferior heat-conducting properties. That experiment, he thought, went to show that brick arches in a locomotive, or other type of boiler, were not desirable from the point of view of increasing the output. As regarded the water film, he thought it possible that vigorous boiling would break it up. The author had made no reference to soaking pegs. The effect they had was to break up the gas and water film. He had carried out an experiment with these pegs. By sweating pieces of metal on the inside and on the bottom of a metal pot, he had succeeded in evaporating 4 per cent. more in a given time than was possible with ordinary plain surfaces.

Mr. Wilkinson then described an apparatus which he had designed for the purpose of ascertaining the amount of heat which can be added to the feed-water from live steam within the boiler in order to produce maximum efficiency of evaporation. He said that it was a well-known fact that heating the feed-water by means of live steam could be carried out up to a certain point with good effect, but it was possible with a low initial temperature of the feed-water to extract so much heat from the steam as to cause the efficiency curve to reach a maximum and then turn down again; the final result being worse than if no live steam heating had been used at all. He then went on to describe his experimental apparatus, which is illustrated herewith. He said that it consisted of two vertical boilers, each 6in. in diameter and 12in. high. These boilers were mounted on a tray containing linseed oil, each boiler being immersed in the oil by the same amount. The oil was used as the heat-conveying element, and served to transfer the heat from resistance wires, equally spaced at the bottom of the tray. These wires were heated by an electric current. A thermometer was immersed in the oil, and the current was regulated so that the oil maintained a temperature of about 400 deg. Fah. to 450 deg. Fah. By this method all possible errors due to combustion were eliminated, and the boilers were subjected to exactly the same conditions with regard to the application of heat. The boilers were designed for a maximum working pressure of 50 lb., and the pressure used in the experiments was 30 lb. Pressure gauges were fitted to each boiler, and they were also connected together by means of a valve, and when this valve was opened one gauge could be checked against the other. Water gauges were also fitted on the boilers, and were provided with indicators for showing the water level. The feed to the boilers was obtained from a galvanised iron tank which was closed. Into the upper part of the tank compressed air was pumped, the pressure of which was in excess of the steam pressure in the boiler. The compressed air thus served to force the water into the boilers when the feed valves were opened. Between the feed tank and the boilers there was an auxiliary tank, which was provided with a thermometer and was heated by a Bunsen gas burner. This tank thus provided a means for varying the initial temperature of the feed-water to the boilers. One boiler was fitted with a live steam heater, and the water was supplied to the top as shown in the diagram. It was passed through the heater, and finally delivered at the outlet, terminating near the bottom of the boiler. A thermometer indicated the temperature of the water on leaving the heater. The feed to the other boiler was taken in direct to the bottom, as shown in the diagram. The steam from each boiler was led to a separate surface condenser, fixed in a common tank, through which cold water was continually circulating, and finally the water due to condensation dropped into separate standardised glass receivers. The steam pressure in each boiler was maintained uniform by regulating the stop valve leading to the condensers, and the latter were so proportioned that the delivery therefrom to the glass receivers, when the boilers were evaporating at the rate of 10 lb. per square foot of heating surface, was cold, thus nothing was lost in the way of steam evaporating to atmosphere. When the apparatus was set to work very erratic results were obtained. Finally, the boilers were filled up, and the feed entirely cut off, when it was discovered that the boilers could not be depended upon to give uniform evaporative results, and notwithstanding the regular supply of heat to each boiler the output from each varied considerably. Many experiments were made in this manner, but the results could not be reduced to a definite law. Sometimes the output from the left-hand boiler would exceed that of the right-hand, and *vice versâ*. The results, the speaker thought, seemed to indicate that there was some obscure principle governing the output of boilers other than the variation of furnace conditions. In conclusion, Mr. Wilkinson said that in view of Professor Dalby's recommendation that further experimental work should be carried out by the Institution, he would be pleased to place the experimental apparatus at the Institution's disposal.

Mr. Vaughan Pendred said that the subject of Professor Dalby's paper was far too large to permit of any attempt at complete treatment in the short time at his disposal. He would say nothing about theory, confining himself as far as possible to practice. First, he would point out that while a great deal was said about the temperature of the outside surface of a boiler plate, no one referred to the inside surface temperature. The result of his own investigations was that so long as the plate was wetted—that is to say, so long as there was true molecular contact between the water and the plate—the temperature of the inside surface and that of the water would be nearly identical; the presence of the plate might be ignored, and we might regard the water as being directly heated, just as it was in Fletcher's apparatus, in which the water in a fine spray was passed through the intensely heated products of combustion. In order to get the best results the hot gas should be made to present the largest possible surface to the plates, and that was best done by sub-dividing it. It was a fact which he had verified, that flues 6in. long would take all the heat out of gas raised by a Bunsen burner to a temperature of from 1500 deg. to 2000 deg. Fah. The flues were of thin copper plate, 6in. square. The distance between the plates was ¼in.; the plates were arranged vertically; each flue represented half a square foot of surface. A small conservatory heater made in this way delivered the products of combustion little hotter than the water, say, 160 deg. to 180 deg. Flue length was settled by diameter and draught. The larger the diameter the greater must be the length. As an example of what could be done by short flues, he said that he had invented a boiler which was very simple in construction. Briefly, it might be described as consisting of two "saddles" united by short fire tubes—this boiler was illustrated diagrammatically in The Engineer for May 12th, 1899—and enclosed in a proper uptake, like a water-tube boiler. He did not patent this boiler. Some time subsequently Mr. De Vignes, a steam launch builder of Chertsey, patented an almost identical design, in complete ignorance of what he (Mr. Pendred) had done. He had a boiler made and asked him (Mr. Pendred) to go and see it tested. He did not remember the precise figures, but the boiler weighed just one ton empty; the fire tubes were 1in. in diameter inside and about 1ft. long. There was an iron chimney, and draught was got by turning a part of the steam in a jet up this chimney. The remainder wasted at the safety valve. The boiler evaporated just its own weight, that is to say, one ton of water per hour, at the rate of about 7 lb. per pound of coal from cold feed water. He thought it would be admitted that that was an excellent result. It was often asserted that flame would not pass through a small tube, because of what was known as the Davy lamp action, but he knew, from direct observation, that the length of flame to be found in a tube largely depended on the draught. Thus he had seen the flame in a portable engine boiler burning straw pass right through tubes 6ft. long and 2½in. in diameter, and that with quite a moderate smoke-box vacuum—not more, indeed, than 2in. He concluded by complimenting Professor Dalby on the production of a paper so full of interest.

Mr. H. P Jordan, of the Municipal School of Technology, Manchester, spoke at great length. He first referred to the large amount of work the author and Mr. Thieme had done in making the abstracts and the index given at the end of the paper. Although it was, perhaps, a little unreasonable, he would draw attention to the fact that Professor Dalby's paper only dealt with a portion of the subject, no mention, for example, being made to the rate of heat transmission under conditions similar to those met with in a condenser. In discussing the paper he wished specially to emphasise the effect of the speed of circulation in diminishing the resistance to the transmission of heat by conduction and convection, or velocity of flow effect of speed of circulation on the rate of heat transmission. Professor Dalby had quoted formulæ showing that the heat transmission increased with the square root of the velocity. That might possibly be true for the condensation of steam, but it was not true for heat transfer from a gas to metal where the gas only parted with sensible heat. That was shown to be the case by Dr. Nicholson in his paper read before the Institution of Junior Engineers last year, and he thought also that this was a fact that had been acknowledged by many engineers for some years back. During the past two years he had been engaged on a research relating to that point, the main results of which were embodied in a paper which had been accepted by the Institution of Mechanical Engineers. The general scheme of his experiments was to pass hot air through a calorimeter, where it was cooled down by water circulation, the heat transmitted being measured by the product of the quantity of water and its rise of temperature. A large number of experiments were carried out with different rates of flow both of air and water, and in order to study the effect of the dimensions, or section of the channel on the rate of heat transfer, a number of tests were carried out, using different sizes of pipes in the calorimeter. The point to which he particularly wished to draw attention, however, was that by means of four thermo-electric couples placed at different points along the calorimeter, he was able to measure the temperature of the metal and thus to obtain the temperature gradient from the air to the water. It was not, of course, possible directly to measure the surface temperature of the metal, but by this means the temperature could be measured at a known depth in the metal and the surface temperature could be calculated. The figures he obtained confirmed the general opinion as to the greater drop of temperature on the gas side as compared with that on the water side of a smoke tube.

Here Mr. Jordan drew attention to a curve on the wall showing the temperature gradient from air to water. In this it was seen that the difference between the mean air and metal temperatures was 246 deg. Fah., as compared with a drop from metal to water of 7 deg. Fah. The relative value of the temperature drops; or to use Professor Dalby's term, the drop of temperature head depended upon the relative speeds of flow of air and water.

The main results of his investigation might be summed up as follows:—(A) For a constant rate of mass flow the rate of heat transfer is proportional to the temperature difference; (B) for a given temperature difference the rate of heat transfer increases with increasing speed according to a linear law; (C) for a given rate of flow and temperature difference the rate of heat transfer increases with the absolute value of the temperature; (D) the rate of heat transfer depends on the condition of the heating surface; (E) the rate of heat transfer depends on the size of the channel through which the gas is flowing. The effect of speed of flow was very clear from some of the figures obtained. In one experiment the air and water flowing at speeds represented by pressures of 2.4 and 20.5 lb. per square foot of sectional area of channel, per second, *i.e.*, mean approximate velocities of 48 and .328ft. per second respectively; the heat transmitted was 2500 British thermal units per square foot per hour, the mean temperature difference being 254 deg. Fah. In a second experiment with rates of flow of 17.45 and 98 lb. per square foot sectional area per second, *i e.*, velocities of 347 and 1.57ft. per second, the heat transmitted was 11,450 British thermal units per square foot per hour, with a temperature difference of 262 deg. Fah. Thus by increasing the velocity of the gas from 48 to 347ft. per second, the heat transmitted per square foot was increased from 2500 to 11,500 British thermal units per hour with nearly the same temperature difference. One point of direct practical importance followed from the greater thermal resistance on the gas side of the heating surface. At quite low speeds of circulation, the water appeared to have no difficulty in absorbing all the heat transmitted, the loss of temperature head on the water side being in all cases small compared with that on the air side. Clearly, then, any further increase in the speed of circulation of the water would produce no very material effect on the ratio of heat transfer, since nearly all the resistance was on the air side. It was a matter of the greatest difficulty to form even an approximate estimate of the rate of water circulation in a boiler, but it appeared possible that in the case of the water-tube boiler the water circulation might be sufficiently great to bring the temperature of the tubes nearly down to that of the water; thus a further increase in the speed of circulation of the water would produce no appreciable increase in the heat transmitted. If, however, the circulation of the gases were improved, then, owing to the decrease of the thermal resistance on the gas side, the tube temperature would rise, the heat transmitted would be increased, and the rate of circulation of the water might then be profitably increased also. It was perfectly obvious that the greatest increase in the efficiency of the heating surface would result from diminishing the greater resistance—that was to say, the resistance on the gas side. The experiments showed that the rate of heat transmission increased with a decreased size of pipe, which agreed exactly with Professor Dalby's conclusion.

As regarded the heat transmission from water to metal, the results showed a decrease in the thermal resistance of the surface film while increasing the velocity of flow. One interesting result was noted in the heat transmitted from the metal to the water. In one experiment a fine thread was cut on the water surface of the tube, the intention being to break up the flow of the water and to secure that it impinged well on the pipe. The rate of heat transfer, however, was not appreciably increased. The bottom of the thread was full of water, which was quite at rest. Mr. Lawford Fry, in his paper on "Combustion and Heat Balance in Locomotive Boilers," gave a great deal of information concerning the rate of heat transmission from the gases to the water. The rate of heat flow could be gauged from the quantity of coal burnt and the air used per pound of coal, as found from the gas analysis. The heat transmitted by conduction and convection could be approximately estimated as the produce of the weight of the gases passing through the tubes, the fall of temperature and the specific heat. Results deduced in this way, however, could only be regarded as approximate, on account not only of errors involved in the calculation, but also on account of the great difficulty in accurately measuring the temperature in the fire-box; but they were sufficiently accurate to show clearly the effect of speed of flow, the speed of flow increasing according to a linear law in these experiments with high temperatures, as well as in his own experiments with considerably lower temperatures. Returning again to the point previously raised, namely, that Professor Dalby's paper dealt almost exclusively with the problem of heat transmission in boilers, and that it made practically no reference to the problem as it presents itself in connection with a condenser, the speaker said under such conditions the law of heat transfer might be somewhat different to what it would be in cases in which the gas merely gave up its sensible heat. Since the completion of his experiments on heat transfer between air and metal he had carried out a number of experiments on the rate of condensation of steam. The problem of the transfer of latent heat from a gas or vapour into a metal surface was more complicated than it was when no change of state of the heat-carrying fluid took place, since the adherent film would not be a film of merely steam, but a mixture of steam and water probably changing from water next to the cold surface to more or less wet steam on the outer surface.

The last speaker was Mr. R. S. Prinsep, who first dealt with the remarks of Mr. Wilkinson with reference to lining the flue tube of a Lancashire boiler with fire-bricks. He said the reason that the boiler did not develop a greater output with the use of the bricks was that coal dust was being burnt at a very high rate. Combustion was not obtained, but dissociation. Unless the radiant heat was absorbed, and the temperature of combustion lowered, the gas was simply passed on unburnt. It was burnt later, but the same difference of temperature was not obtained. It was necessary to absorb the radiant heat in the furnace and lower the temperature. The speaker also briefly referred to some experiments carried out on Belleville boilers, with the object of determining the rate of the transmission of heat. Lastly, Mr. Prinsep said that a reference was made in the paper to separating the heat transmitted by conduction and convection, but he defied any one to make such a separation.

The discussion was then adjourned until October 29th.

THE BREWERS' EXHIBITION.

THE thirty-first Annual Exhibition of machinery, appliances, &c., used by brewers, distillers, and others was opened at the Royal Agricultural Hall, Islington, on Saturday, October 16th, and it closes to day. Many decidedly ingenious machines were shown, and some were quite new.

An extensive display of brewer's machinery was to be seen on the stand of G. R. Seton and Co., Limited, of Friar-street, Carter-lane, Ludgate-hill. Among other things there was one of the firm's "Eureka" rotary bottle fillers, capable of dealing with 72 pint bottles per minute; also a smaller machine for filling 36 pint bottles per minute. There was a bottle washer of the firm's latest type which is claimed thoroughly to cleanse and rinse 1500 bottles per hour with one operator. Other exhibits took the form of gravity conveyors and elevators for all purposes, an air compressor, a quadruple-acting top pressure regulator for cask-filling or bottling of conditioned beer without loss of CO_2 or the liquid itself. Lastly, there was a complete bottling installation, including a bottle soaker, a bottle brusher and rinser, automatic rotary filling machine and revolving drainer, &c.

Leylands Motors, Limited, of Leyland, Lancs., were exhibiting a 3-ton 35 horse-power brewers' lorry and also a 5-ton lorry with a large flat platform. The latter is shown in Fig. 1. Both machines are of the firm's standard design, the four-cylinder petrol engine being fitted with dual ignition. Each lorry also has a four-speed gear box and a gate change control. The wheels are of the firm's composite type. Two sets of improved expanding compensating brakes are fitted to each of the road wheels. The blocks acting on the larger drum are worked by pedal, whilst those on the other drum by means of a hand lever. The gear shafts run on ball bearings. There is a double jaw coupling between the engine and gear box. The back axle provides a further reduction between the differential shaft and road wheels, and is of the live type combined with the firm's patented spherical thrust block drive which relieves the springs of all torsional driving strains, making them more flexible. The driving axles and propeller shaft are entirely encased, and so arranged that no strain other than the drive comes upon them, the outer casing carrying all the weight. The power is transmitted from the propeller shaft to the differential by a bevel drive, and from the latter to each of the axle ends by a single reduction spur gear. The whole of this gearing is of special oil-tempered steel, and runs on ball bearings in an oil bath, so that the wear and tear may be reduced to a minimum.

Alley and MacLellan, Limited, of "Sentinel" Works, Polmadie, Glasgow, were exhibiting a well-finished 6-ton steam wagon. The Berna Commercial Motor Company, Limited, was showing a 35 horse-power brewer's van to carry 5 tons dead-load. This van is fitted with a four-cylinder slow-speed engine, a four-speed gear-box, and forced lubrication. It has an exceptionally strong and simple transmission gear. Mann's Patent Steam Cart and Wagon Company, Limited, exhibited a steam wagon with a locomotive boiler and compound engine. The firm of William Allchin, Limited, of Globe Works, Nottingham, was exhibiting a 5-ton over-type steam motor wagon. Although this firm's previous type of wagon, with its oil bath, engine and chain case, met with great success, the firm has been compelled to meet the demand for a simpler wagon with a more accessible engine. The locomotive type of boiler has been adhered to in this new wagon, and the engine is designed on similar lines to that of the makers' original compound traction engine. The inclined slide valves are operated through the medium of the standard link motion by excentrics on the crank-shaft. A five-ton steam wagon fitted with a compound engine and horizontal multitubular boiler was shown on the stand of Forden's Limited, of Sandbach, Cheshire. On the stand of W. Tasker and Sons, Limited, of Waterloo Ironworks, Andover, Hants, there was shown a five-ton steam wagon with a locomotive boiler designed for working with a steam pressure of 200 lb. per square inch. The engine is of the compound type, having cylinders of 4½in. and 6½in. diameter. The stroke is 7in.

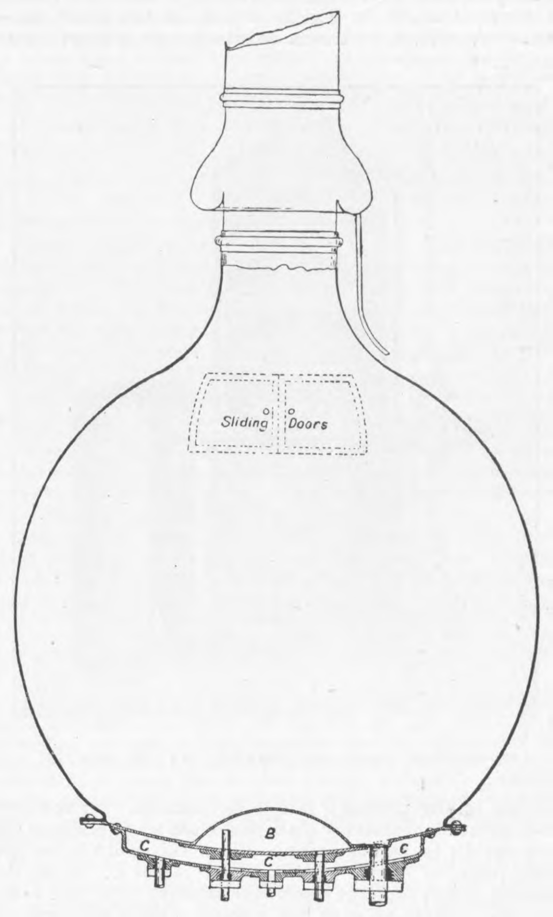


Fig. 2—BRIGGS' STEAM COPPER

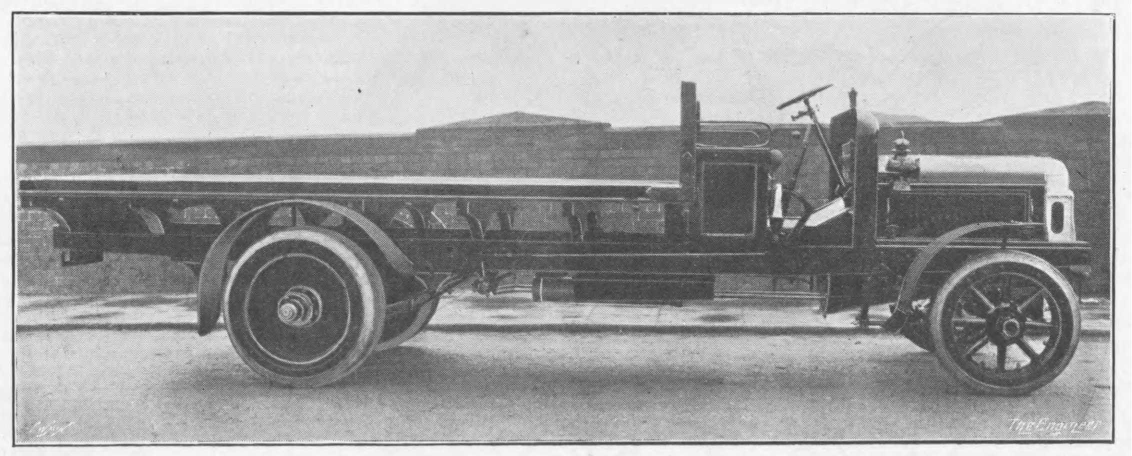


Fig. 1—LEYLAND BREWERS' LORRY

The Albany Engineering Company, of Old Kent-road, S.E., exhibited some brewers' pumps. These pumps, which are fitted with ball-bearings, are also claimed to be suitable for boiler feed purposes, deep wells, hot liquids, boiling soap, oil, tar, crude oil, petroleum, fats and other liquids of high specific gravity. The suction lift of this firm's new type of pump has now been increased to 28ft., and they will force the water to a height of 200ft.

Various kinds of refrigerating machinery were shown on the stand of Montague, Sharp and Co., Limited, of 124 to 127, Minories, E.C.: also a combined rapid cooling and carbonating plant, rapid beer filters, an automatic pulp washer, bottle filling machines, "Mammoth" filtering appliances, glass enamelled steel tanks, &c. J. W. Fowler and Co., of Eclipse Works, Wimborne, Dorset, were exhibiting bottling and corking machines, also bottle washing machines having a capacity of 120 dozen bottles per hour. There was a labelling machine capable of dealing with 180 dozen bottles per hour. Other exhibits were an improved syphon-filling machine, a new cone hand corking machine, and a dry hopping machine.

A varied display of brewers' machinery was to be seen on the stand of S. Briggs and Co., of Burton-on-Trent. Among other things there was a new steam copper, a vertical refrigerator, a reversible sparger, a patented air-wort rouser for fermenting tuns, a patented draw-off float for coolers, and some noiseless rope-tired truck wheels. The copper referred to above is shown in Fig. 2. There are two steam spaces worked separately, by means of which very efficient control over the boiling process is said to be obtained. At the commencement of operations both spaces are used, bringing the wort rapidly to boiling point. When this point is reached steam may be turned off the outer jacket C, whilst the chamber B still contains steam, the amount thus used being adequate to keep an even boil without it being too vigorous, thus eliminating the risk of fobbing over, the wort being boiled at a high temperature, ensuring the thorough cooking which brewers desire. Another advantage claimed for the outer jacket is that it forms an efficient lagging for the inner jacket when the latter is working. If necessary, a small jet of steam can be kept going in the outer jacket. The inner and outer steam chambers, we are informed, are carefully proportioned to their work, so as to give a perfect boil. Gauges are fitted to the steam mains as they enter the two jackets and also to the pipes through which it leaves them.

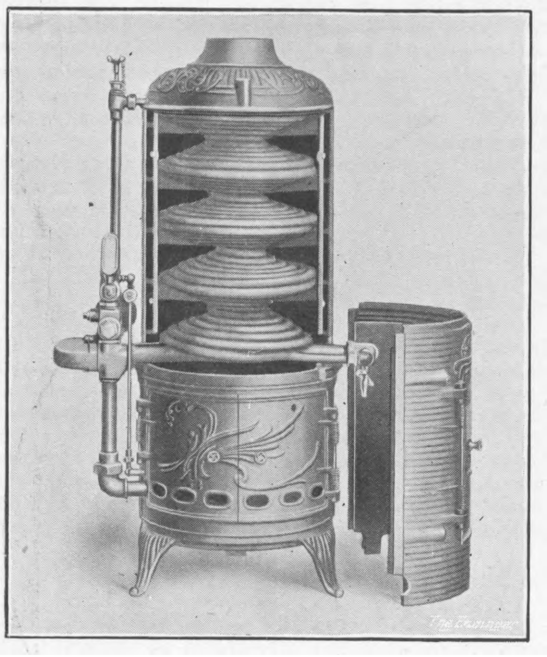


Fig. 3—THE RUUD AUTOMATIC WATER HEATER

A 35 horse-power gas engine was shown by the firm of Richard Hornsby and Sons, Limited, of Grantham, which was driving various machines on neighbouring stands. Lawrence and Co., Limited, of 78, Queen Victoria-street, E.C., were showing their patented capillary refrigerators, mashers, spargers, condensers, &c. A decidedly ingenious cask-washing machine was shown by the firm of R. Ramsden and Son, of 177, Kingsland-road, London, N.E. Among other things this firm also exhibited a steam-pressure copper and a patented corrugated heater, steel carbonating cylinders, &c. Large supply filters for mineral waterworks, breweries, &c., yielding from 100 to 10,000 gallons per day, were shown in operation by the Berkefeld Filter Company, Limited, of 121, Oxford-street, W. There were many other firms exhibiting machines and appliances used in connection with brewing and kindred industries. Great ingenuity has been exercised in some of the designs, and many of the machines and appliances to which we have referred are worthy of more detailed description than space has permitted us giving.

The firm of T. and E. Wannbacher, of 28A, Basinghall-street, E.C., was showing several ingenious devices. The Ruud instantaneous automatic water heater, shown in Fig. 3, was an exhibit of this firm's which is worthy of mention. The apparatus consists of an insulated cast iron jacket which contains a long copper heating coil. Under this coil is an improved Bunsen burner. The automatic mechanism consists of a water valve of simple construction and an "internal" thermostat. The latter, which regulates the temperature of the water by controlling the flow of gas to the burners, is constructed in accordance with Ruud's patent, and is identical to that used on the White steam car. The opening of any hot water tap which may be connected to the heater causes the water valve on the latter to open a gas valve. The gas is lighted from a pilot flame. The water heats as rapidly as it is drawn, and flows at a good temperature as long as the tap is open. When the water tap is closed the gas is shut off instantly. The apparatus can be attached to any existing water supply. We had an opportunity of seeing this heater at work at the Exhibition, when it operated in a satisfactory manner.

The Gasquet pasteuriser for bottled liquids was exhibited by La Société du Filter Gasquet, of Bordeaux, the sole agents for Great Britain and Germany being L. Anker Ges. m.b.H., of Hamburg. The machine is used to pasteurise such liquids as are bottled; that is, to submit them to a process which will enable them to keep in perfect condition for a long period. So far, the machine has been mainly used for treating beer. In order to obtain satisfactory results, the bottles have to be immersed in a water bath at a temperature of 158 deg. Fah. for a given time, and, so as to avoid any mistake, which may lead to serious consequences, a clock strikes every five minutes, and thus guides the operator in the manipulation of the machine. Periodical changes are imperative, for if the temperature is too high or the bottles remain in the bath too long, there is a great risk of the beer losing its clearness, and depositing a sediment. There are other troubles which may also arise which are well known to brewers and need not be dealt with here. In this machine a constant circulation of water gradually heats the bottles, pasteurises the liquid which they contain, and cools them down again in a simple and effective manner. It will be gathered from the drawings, Figs. 4 and 5, that the bottles are placed in compartments arranged in a circle. These compartments are connected together by means of pipes in such a manner that when one section is full of water it overflows into the bottom of the next compartment. The hottest water will naturally rise to the surface, and will thus make its way through the overflow pipe into the next compartment. A heating tank is placed in the centre of the circle of compartments, and water may be drawn out of any compartment by means of an ejector into this tank. Steam is supplied to the tank which heats the water and also works the ejector. Cold water is drawn out of a compartment and hot water injected into the next simultaneously. The suction and delivery pipes can be turned to any part of the circle. A thermometer is fixed upon the delivery pipe for indicating the temperature of the water which this pipe discharges. Lifting gear is also provided for lifting the bottles out of the various compartments. The connection between the segments is interrupted by using a stopper which, however, allows a little water to escape. This stopper is put into the overflow of that segment which has been exposed to the greatest heat for twenty minutes. The clock, which strikes every five minutes, serves to regulate five operations. At this signal the operator knows that a segment containing pasteurised and cooled-down bottles has first to be emptied and then refilled. Also that the suction and delivery pipe have to be moved on to the next segment, and lastly that the stopper has to be put into the last of those four segments which are at the maximum temperature. Space forbids us dealing with the process in detail, but the plan shown in Fig. 4 will give an idea of how the heating and the cooling of the bottles is carried out, the rise and fall of temperature round the circle being represented by the shaded parts.

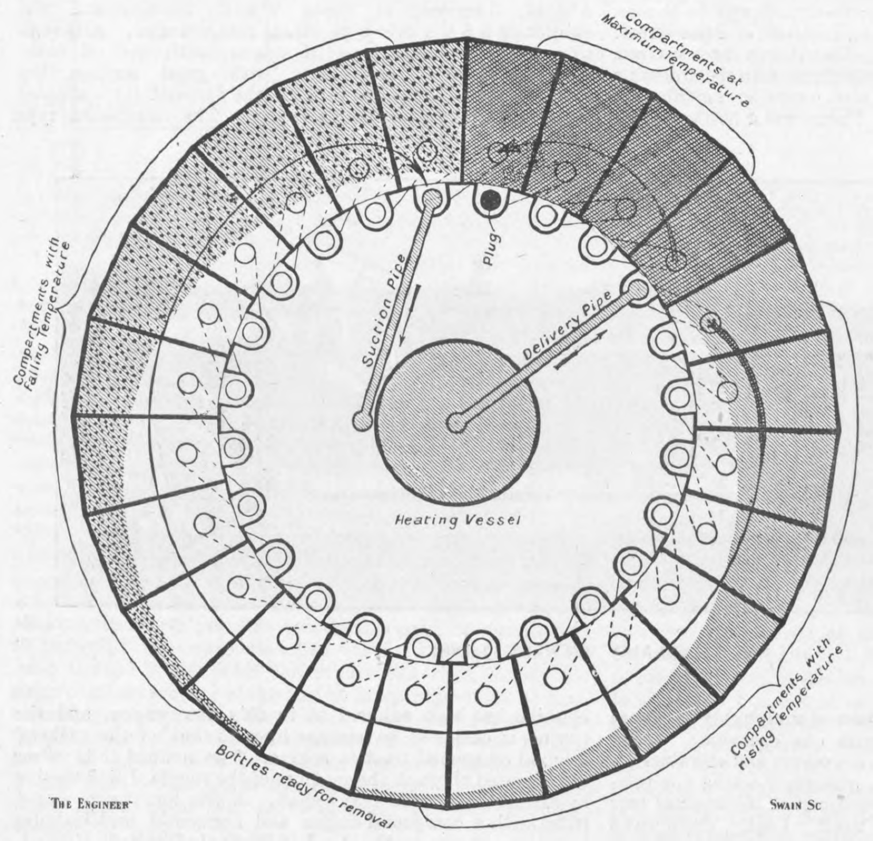

Compartments at Maximum Temperature
Compartments with Falling Temperature
Suction Pipe
Plug
Delivery Pipe
Heating Vessel
Compartments with rising Temperature
Bottles ready for removal
The Engineer
Swain Sc

Fig. 4—PLAN OF GASQUET PASTEURISER

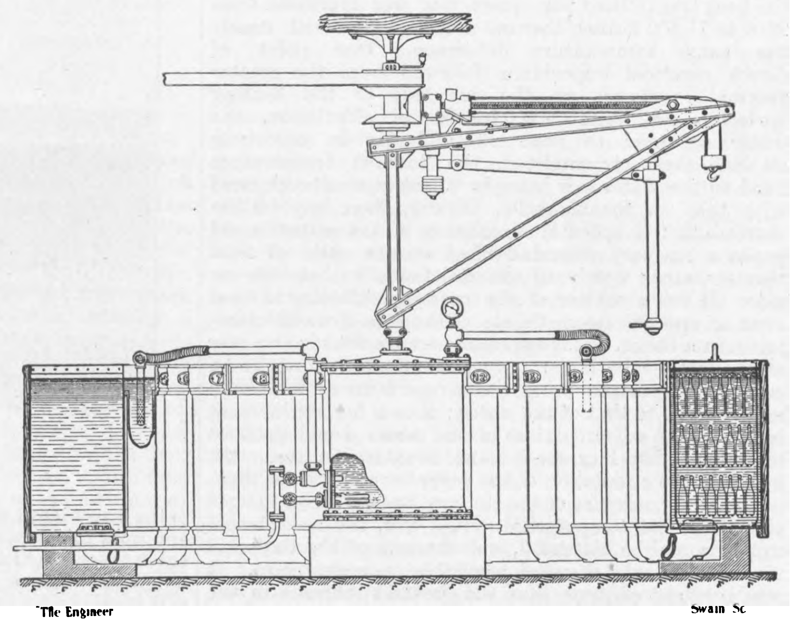


Fig. 5—SECTION OF GASQUET PASTEURISER

SHIPBUILDING NOTES.

THE official copies of the "Proceedings" of the Institution of Naval Architects, containing the papers read at their last meeting, have now been issued, and with one exception appear to be much the same as when they were reported and commented on in the columns of this paper in April last. The exception is Sir Philip Watts' paper on the trial results of the Cossack on the Maplin Sands and at Skelmorlie, which has been amplified, and which now acquires an added interest in view of the results obtained from some high-speed vessels recently. The depth of water on the Maplin Sands is under 10 fathoms, while that at Skelmorlie is 40 fathoms, and readers will remember that the object of the experiments was to determine the effect of this difference of depth on speed and trim. As the paper is now presented this is shown very clearly. On Skelmorlie the power curve is characterised by a continuous and fairly constant increase for increase of speed, whilst the Maplin results show a very much greater increase in power for increase in speed up to 21 knots. From 22 to 24 knots the curve is practically parallel to the base line, and for speeds over 24 knots a continuous increase in power is again visible; less, however, than in the trials in the deep water. Similar phenomena are evident in the other curves shown, and altogether the paper is quite the most practical and useful contribution of the session.

MANY shipbuilders who have been brought into contact with Mr. James Bain, the general superintendent of the Cunard Company, will regret his retirement. Mr. Bain has enjoyed a long and intensely interesting career, and he has finished his active professional life where he began it, in the service of the Cunard Company. In the early part of his career he was one of the officers of Lloyd's Register, and in his latest and most responsible task—the construction of the express steamers Lusitania and Mauretania—he was again brought into close touch with the officials of that society. Mr. Bain's retirement almost synchronises in point of time with the beginning of the construction of the new Cunard liner at Wallsend.

THE quarterly returns compiled and issued by Lloyd's Register of Shipping for the quarter ending with September make, as usual, interesting reading. Compared with the corresponding period of the preceding year, we find a decrease of 28 in the number of steam vessels being built, but a welcome increase in the total steam tonnage of 43,000 tons. There is also an increase over the tonnage in course of construction at the end of last quarter of about 32,000 tons. As regards the distribution of the work, we find that Glasgow and Greenock have between them 93 vessels aggregating 285,000 tons, whilst Newcastle and Sunderland come next with 81 vessels of 203,000 tons. It is significant that Belfast has 4600 tons more than Glasgow, but represented by 19 hulls only, as against 61 in the latter port.

ALTOGETHER, from these returns, it would appear that business is again a little brisker, and events which have occurred during the present month strengthen that view. Several contracts have been placed, the most important of which are, perhaps, the two 10,000 tons iron ore vessels referred to recently in this column. These are, it is understood, to be built by Armstrong, Whitworth and Co., and on the longitudinal system.

ONE of the most interesting of the vessels completed during the present month is the Star of Canada, 470ft. by 58ft. by 38ft. 6in., built by Messrs. Workman, Clark and Co. for Messrs. J. P. Corry and Co. She is interesting, not only in respect of her being one of a series built by the same builders for the Star Line, but because of the arrangements made necessary by the conditions of her trade, that of carrying frozen meat, &c., from the Antipodes to this country. In these vessels there are two considerations of primary importance, first, the obtaining of maximum capacity in the holds, in view of the nature of the cargo to be carried, and secondly, the simplification of the structure, in order to avoid complexity in the insulation. The most interesting product of these conditions is the type of framing which is often fitted. This consists of a shallow sectional frame with a reversed bar attached to the face of it. By this means maximum capacity in the hold is obtained with substantially the same strength as in the deeper frame usually fitted. The beams also are kept as shallow as possible, and, in order to avoid large projections on the under side of the deck, the girders supporting the deck are fitted double, and of small depth.

RAILWAY MATTERS.

We learn, says the *Railway News*, that the report of the Viceregal Commission on the Railways of Ireland will probably be published next month, certainly before the end of the year.

An electrified industrial track in a recently constructed plant is laid in a concrete floor, and, in order to have the rail bonds accessible, 3in. by 18in. recesses are moulded in the floor on one side of the joints, and are normally covered with removable cast iron plates.

Representatives of the steam railroads in the United States and a number of Government officials have joined in a co-operative plan to conduct an inquiry into the physical properties and methods of manufacture of steel rails, so as to ascertain what can be done to improve the rails now purchased.

The Ganz steam motor car built by the Railway Auto Car Company and tested by the Chicago, Rock Island and Pacific Railroad about a year ago, has been returned to the railroad fitted with a new Ganz engine of low steam pressure and a new Baldwin boiler and superheater. The car will shortly be placed in service on one of the company's branch lines.

We understand, says the *Electrician*, that objections have been raised by the Post-office Telegraph Department in connection with the electrified section of the London, Brighton, and South Coast Railway between Victoria and London Bridge and its effect on telegraph and telephone lines. It is stated that the question is at present under consideration by the two parties.

The branch line of the Great Western Railway at Brixham was closed during three days recently in order to remove the old longitudinal permanent way and to lay down the transverse sleeper system, with bull head rails. The line is about two miles long, and extends from Churston to Brixham. It was opened for traffic in February, 1868, and for goods traffic in May, 1869.

Returns recently published by the Indian Railway Board show the progress which is being made in the fitting of vacuum brakes to railway rolling stock in India Nearly all the passenger vehicles on the broad gauge and about half on the metre gauge are now fitted. Of goods trucks, however, only about a quarter on the broad gauge and one in eight on the metre gauge have been so fitted.

The report of the surveyors of the Trans-Australian Railway from Port Augusta. in South Australia, to railhead in Western Australia, has, the Perth correspondent of the *Standard* says, been made public. Their opinion is favourable in all respects, and the country through which the line would pass is said to be mainly suitable for settlement. The railway would cost about £4,000,000 to construct.

Steam and electric traction on the same tracks has been in operation on the Colorado and Southern Railway for about 26 miles out of Denver, Colo., since May, 1908. No difficulty has been experienced in the operation of trains, and it has not been found that smoke or steam has in any way damaged the overhead construction. The electric cars operate a suburban and inter-urban service auxiliary to the steam train service.

A railway bridge across the Sioule gorge in France, at a height of 450ft. above the ground, was opened a few days ago. The bridge, it is said, consists of a continuous girder, 40ft. deep, divided into three spans by two intermediate masonry piers 370ft. high. Work was commenced in 1901, but trouble arose through the subsidence of one of the abutments, causing much delay. The main span is 470ft. long, each of the outer spans having the length of 380ft.

The construction in the departments of the Rhone and Loire of an important series of narrow-gauge light railways of a total length of some 80 miles, linking up various industrial centres in the mountainous and isolated country between Lyons, Roanne, and Saint Etienne, is, the British Consul at Lyons reports, about to be begun, the Government having approved the scheme. The estimated cost to the department of the Rhone is £328,100, to be raised by means of a 3¾ per cent. loan.

Rain gutters at the eaves and headers have been dispensed with in the buildings of the new Scranton locomotive shops of the Delaware, Lackawanna, and Western Railroad, thus doing away with the numerous troubles experienced with them. The roofs project about 12in. beyond the walls, and the drippings are caught in a monolithic concrete gutter at ground level, which is sloped to perforated drain covers placed at convenient intervals. The gutter is a dished slab moulded in place against the building.

From official statistics recently published in Russia, it would seem that to a very large extent the electric tramway lines in that country are owned by Belgian companies and firms. Out of a total length of 1312 versts of electric tramways, 1086 versts, or upwards of 80 per cent., are in the hands of Belgians. The remaining 226 versts belong to various municipal authorities. Of the 42 undertakings now in operation, or in course of construction, 34 are Belgian, and three are French Belgian capital is represented by 85 companies, and five private undertakings, supplying the different municipal tramway services.

The Government of New Zealand are at present building the Midland Railway, which will unite the parts of the South Island which are separated by a high mountain range, containing numerous peaks 12,000ft. high. The work was undertaken by a private company, but after finishing about 35 miles of line the difficulties were found to be so great that the company was obliged to abandon the project, and it passed into the hands of the Government. The character of the difficult part of the line is shown by the existence in a length of nine miles of four high steel viaducts, with a maximum height of 236ft., many small bridges, and seventeen tunnels, the longest about 2000ft., while there are but a few short lengths of level line. The chief engineering feature of the line is the Otira tunnel, about 5½ miles long, which traverses hard slate, and passes under the Otira Gorge. The tunnel from end to end is a straight line, and has a gradient of 1 in 30, which it is thought will not be a serious inconvenience, since it is almost certain that electric locomotives will be used.

With the opening of the railway between Thamshavn, on the Orkedals Fjord, and the mining town of Lokken, the single-phase electrification of Norwegian railways has commenced. Current is obtained from a motor generator plant at Thamshavn, transforming from a 50-period 15,000-volt three-phase supply to 6000 volts 25 frequency single-phase current, distributed through the overhead trolley wire, which is on the single catenary system. Each of the two motor generators erected is of 250 kilovolt ampère capacity, and capable of dealing with 500 k.v.a. for short periods. The trolley construction has a hard-drawn grooved copper wire 65 sq. mm. section hung from a steel cable, carried on insulators mounted on steel brackets attached to wooden poles, and supported by tie rods. At no place is the trolley wire more than 9in. from the centre line of the track, and, normally, it is 5.5 metres above rail level. Each locomotive weighs 20 tons, and carries four motors. The current passes from a pantograph bow collector to a transformer suspended inside the cab. Control is obtained by connecting tappings to a preventive coil, from the centre of which is taken the main lead to the motors. Two motors are arranged in series with each other, in each case these motors being of the single-phase series compensated type, giving 40 horse-power for one hour,

NOTES AND MEMORANDA.

In the remote districts of Mexico, refractory and high grade gold and silver ores are being treated by cyanide at a large cost to avoid the greater cost of transport to the railway of the crude ores.

A unique discovery of vanadium in appreciable quantity is said to have been made recently in one of the coal deposits near Rockwood, Penn. Details of the new discovery are being closely guarded.

In order to eliminate all danger of infection from dirty milk bottles, and to place the distribution of whole milk on a strictly sanitary basis, the New York Milk Committee, in its seven infants' milk depôts, is using for the first time in New York City a single service paper milk bottle, which it instructs its patrons to throw away as soon as it is emptied of milk.

An air steam engine has been invented by a professor of engineering in one of the Western colleges of America In this invention, a cylinder is filled with compressed atmospheric air into which saturated steam is introduced. The chief merit claimed for this system is that cylinder condensation is almost totally avoided by the high temperature of air compression and the high superheat of the mixture.

A recipe for a non-shrinking alloy, to be used in duplicating patterns, is given as follows by *The Metal Industry* :—Tin, 50 lb.; zinc, 50 lb. This gives a tough, hard metal that runs well if a good grade of zinc is used. The addition of 2 lb. of bismuth will render it even more fluid and enable it to be poured at a lower temperature. By using heavy sprues and pouring cold, the shrinkage, which is slight, may be largely overcome.

If the report prove accurate, says an American writer, that China, Chili and Argentina are about to place orders in Europe for eight ships of the Dreadnought type, there will this year be either built, or under construction or authorised, no fewer than seventy ships which may be regarded as belonging to the Dreadnought era, each representing on an average an expenditure of two millions sterling, and, therefore, aggregating a total outlay of about £140,000,000.

In the laboratories of an American chemical company the determination of minute quantities of arsenic in brimstone is performed in the following manner:—The brimstone is oxidised by a mixture of three volumes of carbon tetrachloride to two volumes of pure bromine, followed by nitric acid. A little water is added and the nitric acid and carbon tetrachloride removed by evaporation. The arsenic is then determined in the residue by the Marsh or Gutzeit methods.

The compressive strength of concrete when reinforced with separate transverse ties or iron wire arranged in lattice form, and when mixed with scraps of iron wire, has been investigated by Mr. W. P. Nekrassow, of St. Petersburg. He reported to the Copenhagen Congress of the International Association for Testing Materials that when the wires of the lattice are from 4 mm. to 3 mm. or less in diameter, the increased resistance to crushing is in every case as great as that of hoops. The same is true with scraps of iron wire when they are 0.5 mm. to 0.25 mm. in diameter.

From a study of the concentric annual layers of growth of conifers growing in various latitudes, between the 60th and 67th parallels, Lemstroem finds that the thickness of the annual layer, varies according to a definite law showing maxima and minima which indicate a period of ten or eleven years, coinciding with the period of sun spots and auroras. The differences, furthermore, are greater in the great firs within the Arctic circle, at 67 deg. north latitude, than in trees growing further south. This is quoted as tending to indicate that the atmospheric electricity of the polar regions exerts a beneficial effect upon vegetation.

The mining industry in Corea gives employment, directly and indirectly, to some 8000 Coreans. As regards copper deposits the Kapsan mine, in the north-east of Corea, which is now held by an American company, has for centuries been worked by Coreans, and preliminary surveys of the property revealed the possibilities of rich deposits of the metal. Coal and iron are widely diffused, but difficulties of transport render the working of these deposits, even where rich, impossible at present except in the case of the anthracite coal mines near Pyeng-Yang, which are under the control of the Corean Government. Graphite deposits occur in many places, especially in the east of the peninsula, and this mineral appeared for the first time in the 1908 returns as an export, though it had long been worked by the Coreans. Deposits of mica and asbestos are also known to exist, but have not as yet been worked.

The greatest possible interest attaches, says the *Scientific American*, to the announcement that Mr. George Westinghouse, Rear Admiral Melville, and Mr. John MacAlpine have devised and built a reduction gear for interpolation between the steam turbine shaft and the propeller shaft for turbine-driven marine engines. The helical spur gear has been in use for many years on the De Laval turbines, but in the present device, by an ingenious construction of an automatically adjustable bearing, it has, it is said, become possible to apply the gear so as to transmit 6000 horse-power, at 1500 revolutions of the pinion per minute, at a reduction ratio of 5 to 1. It is claimed by Mr. Westinghouse that by using this reduction gear, and with an inconsiderable loss from friction, it would be possible to apply the 70,000 horse-power of the Mauretania to three propellers with a reduction of 50 per cent. both in the weight of the turbine and in the length of the engine-room.

In a report on the mineral resources of Brazil, compiled by the British Legation in that country, it is pointed out that the native iron ores are practically undeveloped, although Brazilian ore contains 60 per cent. of metallic iron. The beds are said to be the largest in the world; but the cost of carriage is too high for an export trade to be done, and there is not sufficient fuel for smelting the iron in the country. This situation, it is pointed out, would be completely changed by the perfection of the processes of electric smelting, as Minas Geraes, like almost every State in Brazil, has abundant water-power. All steel for use in the country could be manufactured there. Even under existing circumstances an important steel plant is to be laid down in Rio de Janeiro, which will utilise native iron. The State of Matto Grosso possesses enormous deposits of manganese, near Cuyaba; but the cost of transport down the river Paraguay is prohibitive.

The commutator of a dynamo or motor gives better results and wears less rapidly if it can be made to glaze over. As it is necessary in electro-plating dynamos to use copper brushes, it is more difficult to glaze the commutator than when carbon brushes are employed. Owing to the low conductivity of carbon, they would have to be made much larger than those of copper to carry the same current. The following composition has, according to the *Brass World*, been found excellent for glazing the commutators of electro-plating dynamos:—Dissolve 4 oz. of caustic potash in 1 pint of water and then boil and add 1 oz. of flowers of sulphur. Boil until the sulphur is wholly or partially dissolved, making a yellow-coloured solution. Then add lard oil and boil until a soap is made. Cool and add a mixture of equal parts of flowers of sulphur and graphite—very fine or that known as electrotypers' graphite—until a thick paste is produced. This is applied to the commutator, but very little is needed to produce the desired results,

MISCELLANEA.

Work is in hand on the sinking of a new shaft at Monceau-sur-Sambre, Belgium, for the Société des Charbonnages de Monceau-Fontaine, which company has also just acquired 45 acres of coal-bearing land near the place.

The imports of foreign-made motor cars into this country are still showing a downward tendency. During the nine months of this year the total value of the motor cars, chassis, and parts imported was £3,246,762, as compared with £3,356 154 during the first nine months of the previous year, and £3,610,826 during the corresponding period of 1907.

A decision has recently been given by the Australian Customs authorities to the effect that "relay instruments, time elements, used in connection with electrical circuit-breakers, but are separate and distinct from them," are dutiable at the rate of 17½ per cent. in the case of foreign productions, those of British manufacture being admitted at 10 per cent. *ad valorem*.

It is officially announced that a Russian squadron, consisting of the Bogatyr, Aurora, and Diana, will arrive at Plymouth about the 25th inst., under the command of Rear-Admiral Magnekovsky. The vessels will be in the port on the 28th inst., when Lady Loreburn will name and launch the new cruiser Indefatigable at Devonport.

Old tin cans which find their way to the domestic rubbish heap have been turned to good account by the Liverpool Corporation. Last year, from this source, the Health Committee realised £300. In future the revenue is likely to be increased, because the authorities are engaged in putting down new plant. It is estimated that at least £1200 a year might be derived from this form of municipal trading.

The City Corporation have prepared a scheme, which they propose to proceed with, for the widening of the west end of Fleet-street, at a total estimated cost of £400,000. They have asked the London County Council to redeem their promise to contribute half the expenditure, and the Improvements Committee have reported in favour of the proposal. It is suggested that the contribution should be spread over the next four years.

The figures of Canadian immigration for the first three months of the present financial year have been issued by Mr. J. Bruce Walker, Commissioner of Immigration at Winnipeg. They show that there has been a decrease over last year of some 7000 in immigration from the ocean ports, but this has been offset by a more than corresponding increase of American settlers. The total immigration for the three months was 74,242, compared with 68,973 in 1908.

It is expected that aluminium coins of low value will be in circulation in France by the end of this year. It is interesting to note, in this connection, that the adoption of M. Naquet's proposition for an aluminium coinage in 1871 would have resulted in a heavy loss to the French Treasury. Although experts declared it to be impossible that the value of the metal should decrease, it has now fallen to nearly half the price ruling thirty-eight years ago.

The third report of the Royal Commission on Canals and Waterways was issued last week. In addition to the meetings and witnesses referred to in previous reports, the Commission has held thirty-six meetings and examined sixty-four witnesses. So far as the Commissioners are able to judge, they will not need to take further oral evidence, and they hope in a few months to present the final report on British canals. The final report on Irish canals will be presented somewhat later.

An announcement that a new trade arrangement had at length been arrived at which would practically abolish all friction between the Steel Trust and the independent firms, and result in amicable working between them, has, according to the *Central News*, been made in New York. It is understood that the leading steel manufacturers of the United States and Canada are all embraced in the new arrangement. They are said to produce among them 58 per cent. of the output of the world.

A largely-attended meeting was held at Norwich on Saturday, the 16th inst., for the purpose of considering the question of inviting the Royal Agricultural Society to hold their show there in 1911. A letter was read from Mr. Russell J. Colman, in which that gentleman offered the site upon which the Royal Show was held in 1886, namely, the meadows adjoining Crown Point. The result of the meeting was that it was definitely decided to request the society to hold its show there in the year after next. It is understood that the society regard the proposition favourably.

Reports lately in circulation as to the conclusion of negotiations between the Egyptian Government and the Suez Canal Company for the prolongation of the concession under which the canal is worked have been confirmed by the *Bourse Egyptienne*. The original lease dated from the opening of the canal in 1869, and was for a term of 99 years. This period is now increased by 45 years, so that the waterway will not revert to the Egyptian Government until 2013. The terms of the new contract are, it is stated. £3,000,000 cash down, to be paid to Egypt, and a fifth share in the annual profits of the canal.

The recent fatal accident to the airship La République was due to the breakage of the screw propeller. This was first attributed to a flaw in the metal, but the report drawn up by the official committee of inquiry does not bear out the hypothesis. The steel tube of the propeller, closely examined, presented two distinct breakages. The first, or interior breakage, the cause of the fatal accident, is attributed to "over-heating, in consequence of a powerful rotation, attaining 1600 revolutions per minute. The best tempered metal cannot support such a speed, and finishes by dilating, and in consequence by snapping."

A deputation from the Chartered Institute of Patent Agents waited on Captain R. Muirhead Collins, the representative in London of the Australian Commonwealth, at his office in Victoria-street this week, with regard to the new Australian Patents Bill now before the Legislature, and especially with reference to the clause making it compulsory for patentees to work their patents in Australia at the risk of revocation in case of failure so to do. The deputation placed the views of the Institute before Captain Collins, suggesting that this clause should be omitted, or, if that was impossible, that an agreement should be entered into to the effect that working in one country should be equivalent to working in both, thus following the example of many other countries. Captain Collins undertook to bring the views of the deputation under the immediate notice of the Commonwealth Government.

The construction of the Berlin-Stettin Ship Canal is progressing rapidly. The depth of water in the middle of the canal will be 3 m. (10ft.), and the breadth at the surface 33 m. (110ft.), while in soft, peaty ground it will be from 37 m. to 38 m. (123ft. to 127ft.). For a distance of 16 miles the bed and banks of the canal will have to be packed with clay, the surface of the canal there being above the water-level of the surrounding country. At one point the canal crosses the valley of the river by an embankment provided with a culvert 160 m. in length, the construction of which is already completed. The construction of the eleven locks for the descent into the Oder Valley is to be commenced in the course of this year, one of them having a fall of 9 m. (29ft. 6in.). The question of building a lift beside the series of locks has not yet been decided. The thirty-seven canal bridges are all to be built of iron to various designs,

THE SHIPBUILDING WORKS OF THE AKTIEN-GESELLSCHAFT "WESER" AT GROPELINGEN

(For description see page 412)

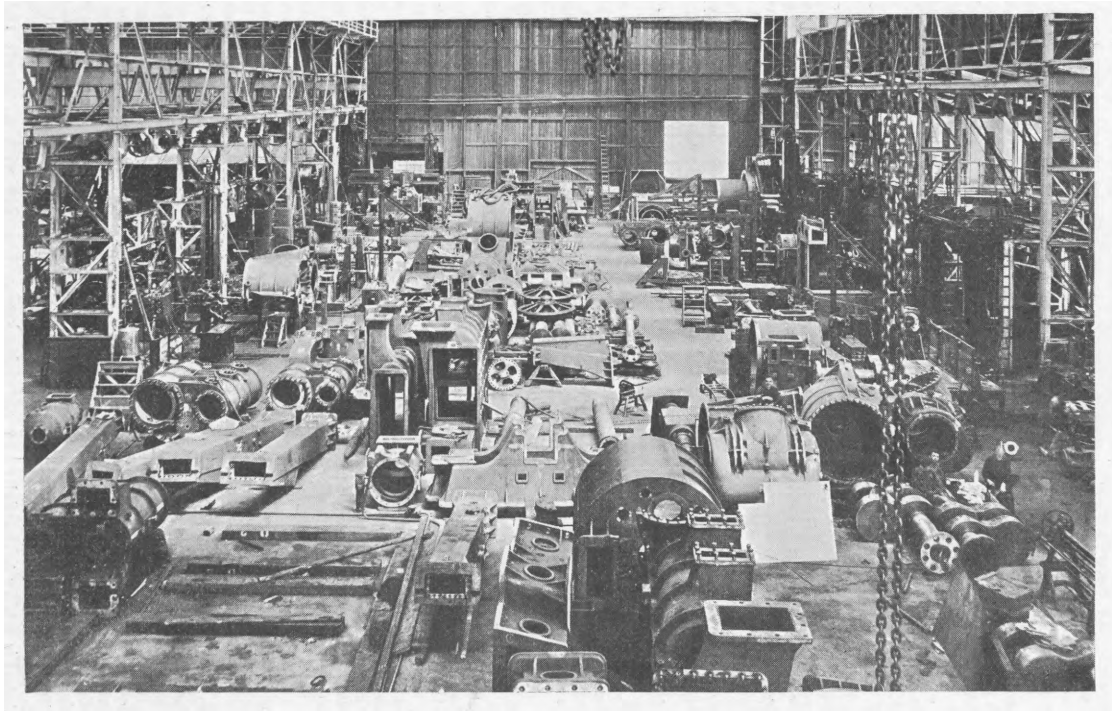


Fig. 12—THE FITTING SHOP

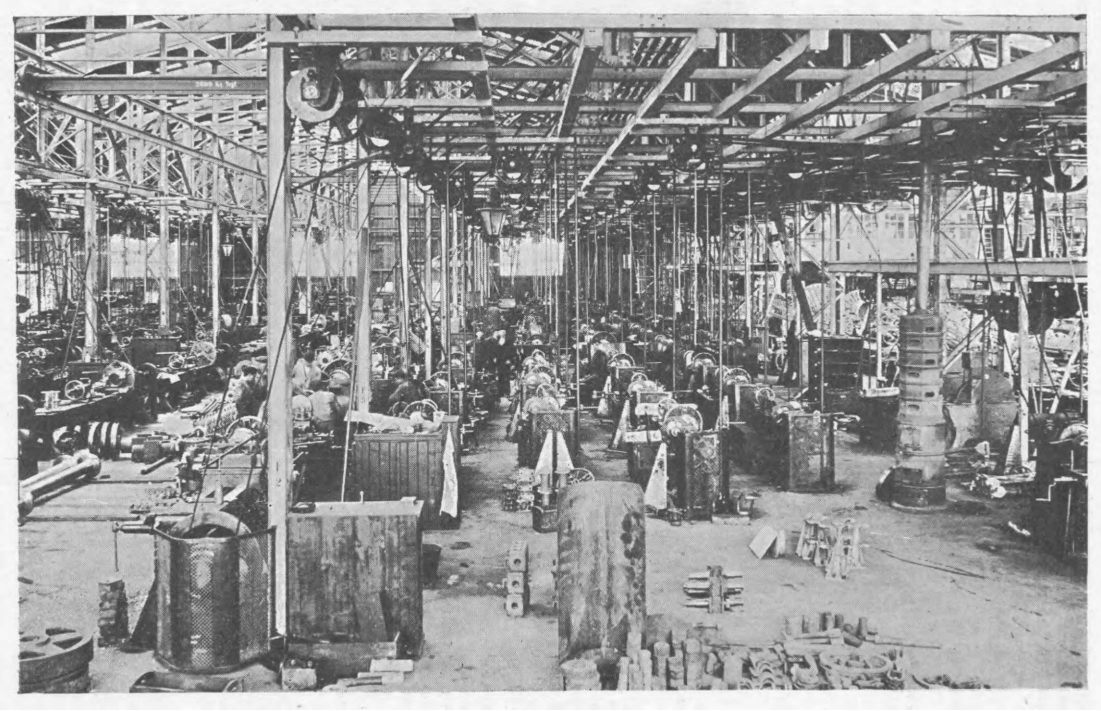


Fig. 13—THE TURNING SHOP

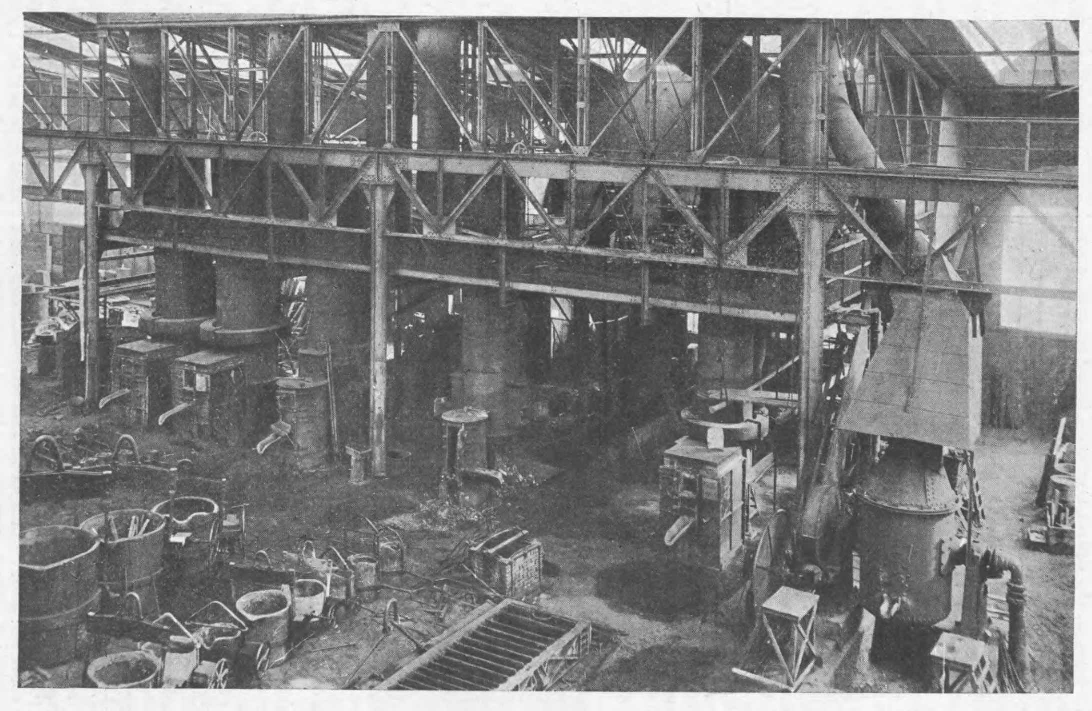


Fig. 14—THE FOUNDRY

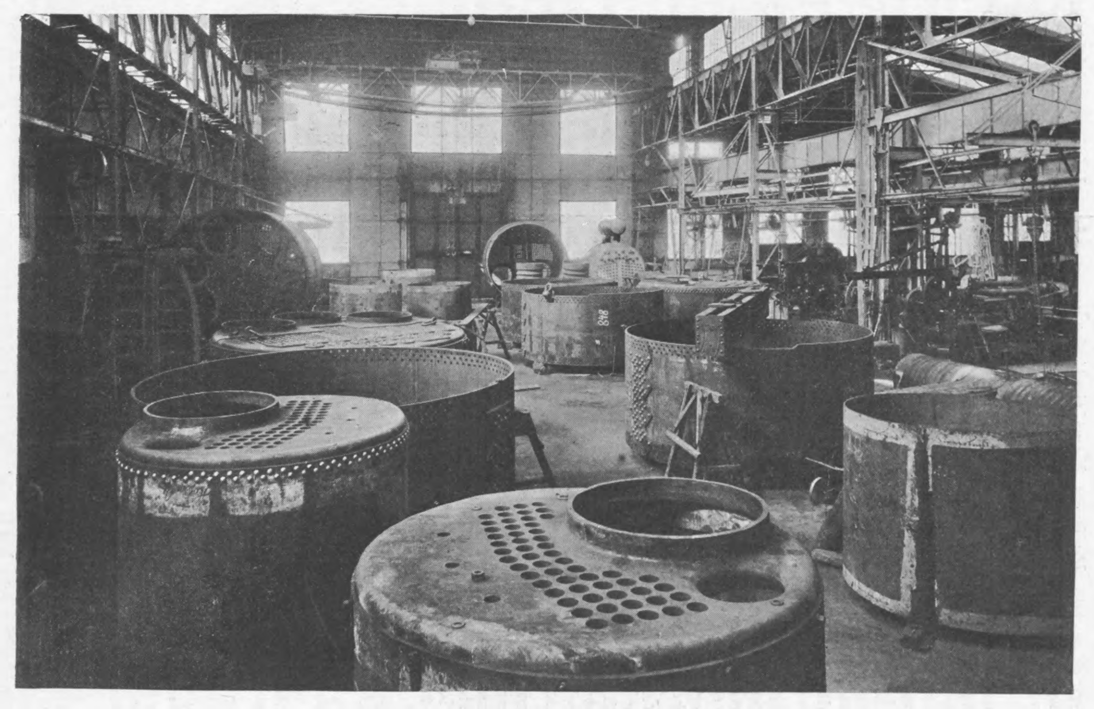


Fig. 15—THE BOILER SHOP

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TO CORRESPONDENTS.

☛ *In order to avoid trouble and confusion we find it necessary to inform correspondents that letters of inquiry addressed to the public, and intended for insertion in this column, must in all cases be accompanied by a large envelope legibly directed by the writer to himself, and stamped, in order that answers received by us may be forwarded to their destination. No notice can be taken of communications which do not comply with these instructions.*

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REPLIES.

P. A. H.—Both the methods of drawing an ellipse which you are good enough to send are quite familiar.

C. B. (Stamford)—We believe you can obtain the welding apparatus you require from the British Oxygen Company, Limited, Elverton-street, Westminster, S.W.

A. P. A. (Bedford).—(1) You can get all particulars concerning the scholarships from the Board of Education, South Kensington. (2) We regret that we are unable to recommend any one teacher or institution.

INQUIRIES.

BOSSHARDT STEEL.

Sir,—Can any of your readers give me any information regarding Bosshardt steel, and tell me where I can obtain it? C. M.
October 19th.

WEBSTER'S MULTIPLEX FEED-WATER FILTERS.

Sir,—I am endeavouring to find out the name and address of the makers of Webster's multiplex feed-water filters. Can any of your readers help me in the matter? L. L. D.
October 19th.

MEETINGS NEXT WEEK.

Institute of Marine Engineers.—Monday, October 25th, at 8 p.m., at 58, Romford-road, Stratford, E. Discussion on Mr. McLaren's paper on "The Extended Uses of Electricity on Board Ship."

The Institution of Mechanical Engineers.—Friday, October 29th, at 8 p.m., in the Institution House, Storey's Gate, St. James's Park, Westminster, S.W. Extra meeting. Discussion on Professor W. E. Dalby's report on "Heat Transmission."

The Institution of Electrical Engineers: Leeds Local Section.—Wednesday, October 27th, at 7.15 p.m., at the University, Leeds. General meeting. Presidential Address, by W. M. Rogerson, M.I.E.E. Paper, "Notes on Superheated Steam," by A. B. Mountain, M.I.E.E.

THE ENGINEER.

OCTOBER 22, 1909.

The Development of the Gas Engine.

It has been said that difficulties only occur to the engineer to be overcome, a remark which, though savouring somewhat of hyperbole, may be generally accepted, with the reservation that the process is often slow and tedious. This is especially so when principles are not completely understood, and progress has become to a great extent a matter of trial and error, or, if you will, rule of thumb. It is always interesting, and sometimes profitable, to trace the development and endeavour to forecast the future of some particular branch of engineering by a process analogous to plotting and extending a curve. In the case of the gas engine the development has been remarkable, though probably not so rapid as seemed at one time probable. What have been and what are the obstacles to progress? Before answering this question it is necessary to remark that for small powers, the upper limit of which it is not easy to define, but which may be taken as between 300 and 500 horse-power, the gas engine as a simple, reliable, and economical prime mover holds the field. This is a general statement, and, like all such, must be qualified, the exceptions being those special cases, such as marine propulsion, where the successful application depends much more on perfection of detail than on any questions of principle. In these cases sufficient pioneer work has not yet been done, though there can be little doubt of the ultimate result.

Leaving the small gas engine, and considering the larger powers, we find that, as in all other engineering problems, it has two aspects, the technical and the financial or commercial, and these cannot be entirely separated, for it is obvious that a first condition to be realised before an industry can develop is that the article manufactured can be sold at a profit, while, on the other hand, it is also necessary that after being sold it shall, as the result of knowledge and forethought in design and manufacture, continue to give satisfaction in the hands of the user. It is necessary to touch briefly on the financial aspect of the question, because some of the hindrance has been due to causes of this nature. It is known that some makers have held back from making the larger size gas engines, not because they feared the engineering difficulties, but because they were not convinced that there was any money in it. It would seem at first strange that there should be one law for the small gas engine and another for the large. Every species of manufactured article has its own particular law of cost which follows directly from the engineering conditions or requirements. In a steam installation, for example, the engineering conditions say that for a given power the cylinders, shafts, &c., must be of a certain size, the boiler must have a certain amount of heating surface, and so on, all of which determine the amount of material to be employed and the amount of labour to be spent upon it, and hence are determining factors in the ultimate cost. As we proceed from one size to another, we find, as we should expect, that the total cost varies in no simple manner, being made up as it is of a large number of separate items, each varying in its own particular way. The cost of different sizes can, however, as a rule, be plotted on a curve, and such curves are very useful and instructive when applied to the manufacture of a number of articles of the same species, but of different size, and they show graphically what we have called the law of cost. If plotted with horse-power as abscissæ and cost per horse-power as ordinates, the law for most prime movers shows the general characteristic that the cost per horse-power diminishes as the horse-power rises. This characteristic will be most marked where the engines, motors, or whatever the prime mover may be, are all of identical type, consisting of the same number of parts, differing only in dimensions, where, in short, the small may be considered as a model of the large. In the case of steam machinery, for example, whether reciprocating or turbine, we can pass from a small size to a large without any change in the general features of the design; but this is not the case with the gas engine, where beyond a certain diameter of cylinder the engineering requirements which follow from the high temperatures and thickness of metal demand special consideration and a radical change in design. Up to a certain power the single-acting cylinder with unjacketed piston and ordinary mushroom valves quite meets the case, but above this size the exhaust valve and piston must be water-jacketed. At this point we should find a discontinuity in the curve of cost which will rise suddenly due to these additions. The increase, moreover, will be greater than would at first sight appear, for the addition of the water jacket to the piston involves heavier reciprocating weight, a slower speed of revolution, and therefore a larger engine. Proceeding upwards in power, we arrive at a point where, owing to increase of diameter of the cylinder, it becomes desirable either to make the engine double-acting or sub-divide the power in two cylinders. Either alternative means additional cost for the double-acting cylinder means a water-cooled piston-rod, external guides and other working parts again adding to the reciprocating weights with a further reduction of speed of revolution. The latter alternative involves duplication of parts with increased cost of machining, fitting, and erecting. In the larger sizes also it is generally deemed advisable to fit more elaborate and costly mechanism for working the valves. Other factors have contributed to make the large gas engine a rather costly thing to produce, and this disadvantage has weighed against it except in cases where the fuel is to be had for nothing, as in the waste gases for blast furnaces, though even here some engineers favour the burning of the gases under a boiler and using the steam in a turbine. The advance made in steam turbine construction and economy of recent years has undoubtedly to some extent hindered the growth of the large gas engine. Turning to the purely engineering side of the question, the problem of extending the gas engine to larger units resolves itself largely into the consideration of the stresses set up by the high temperature in the cylinder and in the avoidance of pre-ignition. The large gas engines which have been run successfully in this country and on the Continent using blast furnace and similar waste gases are a class to themselves, and, so far, have not been greatly employed with gases of higher calorific value. It is the engines using mainly producer gas to which we now refer. No difficulty is to be feared in the mechanical problems to be solved, it is only the thermal conditions which cause anxiety, and though experience is daily accumulating, it is mostly a record of effects the causes of which are as yet imperfectly understood.

In a recent paper Professor Hopkinson showed what the temperatures were in an uncooled piston, and calculated the magnitude of the stresses set up. It is common knowledge that the troubles due to unequal expansion are more often met in the water-jacketed ends, and these are frequently of such complex construction that even if the difference of temperature on the two sides of the metal were accurately known, it would be quite impossible to calculate the stress. It is known, however, that the stresses increase rapidly as the size of cylinder and thickness of metal is increased, and the general direction in which this difficulty is being met is in the avoidance of extraneous causes which would tend to facilitate fracture, and in the use of stronger material, such as cast steel in lieu of cast iron. The most common of the extraneous causes is "casting stress," and it is now the almost universal practice to simplify the cylinder-end casting as much as possible, and avoid tying the parts to one another by rigid connections. Probably sufficient attention has not yet been directed to the use of cast steel. The stronger material enables the thickness of the walls to be reduced for a given diameter of cylinder; the temperature difference is reduced, and the stresses due to unequal expansion reduced also. It will be noted that in the inner surface of the wall of a cylinder end the stresses due to the pressure in the cylinder, and the expansion due to temperature, are both compressive, and the real stress is their sum. Making the wall thinner will increase the stress due to the pressure, but diminish the stress due to temperature, because the temperature difference has been reduced. This point is sometimes lost sight of, and accounts for the fact that an increase of thickness has often failed to cure fractures of cylinder ends. There appears to be a tendency at the present time towards the engine with several cylinders, so as to keep the unit below the line where expansion troubles commence, the multiplication of parts being accepted as the lesser evil. Moreover, the engine with several cylinders has advantages in some cases where even turning moment and higher speeds of revolution are desired. How far this movement will spread remains to be seen, but it appears a good interim policy pending further experience with the larger sized cylinders.

Locomotive Engine Cylinders.

The interesting discussions about locomotives which have gone on in our correspondence pages for some time have recently circulated round cylinder capacity. Various arguments have been adduced for and against every conceivable accepted type of locomotive. But in the end we gather that the principal advantage to be obtained from compounding is due to the greater space swept out by the pistons during each revolution. Several of our correspondents are obviously in a condition of pardonable puzzledom. They can make nothing of locomotive practice. They do not know where to have it. Anything can be proved by what seem, on paper at all events, to be facts. No peculiarity of design is fatal. No excellence represents finality. The locomotive is all things to all men. What can the miserable advocate of any particular type do under such adverse circumstances?

The facts, present and historical, are indeed remarkable and interesting. When the designer of marine engines is at work he always takes into consideration the power he proposes to get, and proportions the capacity of his cylinders accordingly. If a man wants a mill engine to give him twice the power he has already, he will, other things being equal, make his new engine twice as big as the old one. Nothing of the kind is done in railway practice. It has not been done for many years. The designer of locomotives may make changes in anything else; scarcely ever in the capacity of his cylinders. Loads are being daily made heavier and speeds increased, and yet the tendency is to make the engines smaller. The augmentation of dimensions is all in the boiler, or in the frames or details; the cylinders remain the same. Stirling used 18in. cylinders, 28in. stroke, on the Great Northern Railway thirty years ago, with about 1000 square feet of heating surface. Engines with twice that boiler surface have cylinders 18½in. by 26in. Gooch's engines, of the Lord of the Isles class, had 18in. by 24in. cylinders, and 2500 square feet of heating surface. Stroudley's engines, built in 1885, had 18¼in. cylinders by 26in. stroke, with about 1500 square feet of surface. Mr. Aspinall, on the Lancashire and Yorkshire, uses cylinders 18in. by 26in., with 1217 square feet, and 19in. by 26in., with 1928 square feet. Every reader who is versed in locomotive practice, or, indeed, if only he reads this journal, will see that it is unnecessary to give further proof that it would appear that no relation whatever exists between heating surface and cylinder capacity. But this is very far from being all. Neither the load to be drawn nor the amount of adhesion available seems to be taken into account. We find the cylinders the same, whether the engine has a single pair of driving wheels, or two pairs, or three pairs. Even when four simple cylinders are used their united capacity is only about that of two normal cylinders. If the load is, say, 150 tons behind the tender, the cylinders are 18in. by 26in., and the driving wheels 6ft. 8in. diameter. If the load is 300 tons the cylinders are 18½in. by 26in., the driving wheels 6ft. 6in., but in the latter case the boiler will probably have 50 per cent. more heating surface. It would seem reasonable to say that if the cylinders were big enough for 300 tons they must be a great deal too large for 150 tons. But nobody ever argues that way about locomotive engine proportions. It may be said that in the last cases stated the boiler pressure is much higher than it is in the first case. To a certain extent this may be conceded. But we cannot call to mind any instances in which the increase would compensate for the apparent inadequacy of the cylinder capacity, save to quite a moderate extent. If it did, it would represent a higher average and terminal pressure in the cylinders; the steam would be used to less advantage, and the engine would be very uneconomical. But, so far as is known, the engines with small cylinders use less rather than more coal per mile; and history tells us that attempts to use large cylinders have almost always ended in disappointment.

The reasons for all this are, no doubt, quite complex in character. In the first place, when a train is running at a high velocity, the tractive effort of the locomotive in any case becomes quite small. Large cylinders and a great tractive effort are required only for acceleration purposes, to start a train quickly out of a station. Again, when the train is running fast, if the rails are clean, there is always as much adhesion supplied by even a single pair of wheels as the engine can utilise, and large cylinders suitable for, say, four or six-coupled drivers are unnecessary. In point of fact, the work to be done by the engine and boiler is never constant, as in the case of a marine engine. Much of it is really not of that kind that demands much pulling, and a small cylinder does better than a large one. When we come to climbing banks the case alters; and at all times and seasons we have to keep the influence of the weather in view. An engine with small cylinders may slip continuously boiler and still keep fairly good time, if only the is big enough to supply the extra steam wanted. There are a hundred-and-one other considerations which affect the design and the performance of a locomotive. There are mechanical difficulties in the way of using very large cylinders, and it is not perhaps too much to say that in the present day the designer generally schemes for the biggest cylinders he can get in, being quite certain that they will be none too large for the boiler which is to supply them. The locomotive engine is a compromise. Its life conditions vary almost from hour to hour. Hard-and-fast rules of proportion could not improve it; and it is, generally speaking, rash to assert that any change in the relative dimensions of a given engine must certainly be for the better. First of all, can this be said with truth about cylinder capacity? There is no fixed relation between that and boiler power, simply because neither the work to be done, nor the power of either the engine or boiler to do it is ever fixed. The locomotive problem is far too full of varieties and unknowns to admit of that general solution, which some of our readers desire.

The Missing Quantity.

Mr. Royds' paper, published in our last impression, is one of the very few contributions to the literature of cylinder condensation in which an attempt is made to differentiate between cylinder surface and clearance surface. The attempt is desirable, because inquiry pushed along that line may help to a much wanted understanding of the reason why small clearance conduces to economy. No line of argument has yet settled that question conclusively. The usual contention is that large clearance operates by reducing the amount of expansion. It is obvious, however, that the real ratio is determined by other factors than clearance space alone, and nothing is easier than to adjust the point of cut-off to the clearance in such a way that we shall have as many expansions as we like, be the clearance what it may. The second and third cylinder of compound and triple-expansion engines have virtually an enormous clearance in the shape of the intermediate receiver, but this in no way affects their economy. Indeed, it is well known that the Woolf engine in which there is no intermediate receiver, the steam passing direct from the high into the low-pressure cylinder, is less economical than engines of the normal type. If it could be shown that the metal ranges of temperature were different in the clearance spaces from those in the cylinder, then something would be gained. It is in the clearance space and the first few inches of the stroke that initial condensation takes place. It is there that the interchange of heat is most energetic, and the consequences most marked.

Our contributor is not as definite as he might have been, and it is quite easy to imagine that he thinks it possible that a cylinder may give out more heat than it receives, or receive more than it gives out; of course he thinks nothing of the kind. A cylinder as a whole must give back just as much as it receives in some shape. For if it did not, its temperature would gradually rise until it was slightly higher than that of the steam, when the transfer of heat would cease. Nor can it part with more than it receives, because, becoming colder, it would take up more and more heat until equilibrium was reached. But it is not at all impossible that a clearance surface may take up more heat from the steam than it returns directly to the steam, transference occurring through the sides of the cylinder in pursuit, so to speak, of the piston. Mr. Royds draws a somewhat subtle distinction when he says: "Most writers on the theory of the steam engine, and more particularly many of those who write text-books on the subject, seem to have the idea that the wall action consists simply of the condensation of steam during the admission period with subsequent re-evaporation during the exhaust period of the cycle, whereas this is only the effect of the wall action on the steam. Let us rather consider the wall action to be an alternate reception and rejection of heat through the wall surface, calling the rate of heat reception per unit area per unit of time per degree of difference of temperature between the steam and the wall the 'receptivity' of the surface, and, similarly, the rate of heat rejection from the wall to the steam the 'emmissivity' of the surface." This means that we should concentrate our attention on what goes on in the metal, leaving the consideration of the behaviour of the steam on one side for the moment. It is worth while to point out here, however, that text-books do not deal quite so simply as Mr. Royds implies with the theory of the steam engine. They usually explain that re-evaporation is not confined to the exhaust period; it probably commences the moment the cut-off closes and expansion begins, and it is this assumed or real re-evaporation that is used to explain the fattening up of the toe of a diagram. That is to say, the rise of the expansion curve above that given by calculation.

While the attainment of a knowledge of the mean temperature of cylinder walls is, as explained by Mr. Royds, a fairly easy matter, the case is quite different as regards the change of surface temperature, about which it is not too much to say that no accurate information whatever exists. The depth of metal affected is to be measured in extremely small fractions of an inch. The changes are so rapid that no mercurial or spirit thermometer can keep pace with them. Many years ago Bryan Donkin did what he could with thermopiles fixed in the metal of the cylinder cover. But in the first place it is impossible to make a thermo-pile which shall be, so to speak, only a thin surface. Of necessity it must represent an appreciable section of the thickness of the cylinder cover. In the second place it was found impossible to construct any instrument which would record the temperatures when the engine ran fairly fast. The galvanometer needle simply flickered on the dial, and so the attempt had to be given up. Until some means of determining the temperatures during each revolution have been obtained, the secret of the steam engine will remain a secret. All that inquiry seems to have settled up to the present was known by Watt. It is simply stated that the hotter the cylinder the more economical will be the engine.

We are glad to see that our contributor lays due weight on the effect of oil in the cylinder on the reduction of the missing quantity. We believe that the late Bryan Donkin was the first to call attention to this. He arrived at the conclusion that oil in a cylinder did as much good as jacketing or moderate superheating. We commend Mr. Royds' table on page 386 to our readers. Oil is not used at sea because it gets into the boilers and does much harm. It apparently acts for economy simply by preventing that internal molecular contact of the steam with the metal which is essential, under all circumstances, to a maximum rate of heat transfer. At first sight this would seem to be much the same as saying that it rendered the cylinder a non-conductor. Theory tells us that with a non-conducting cylinder there should be no missing quantity. The only conversion of heat would be into work. Unfortunately the steam engine in practice continually contradicts theory. As the clearance space, the cylinder cover and the piston face play the most important part in initial condensation, it would seem that much ought to be gained by making them of non-conducting material. The experiment has been tried, patents have been taken out, indeed, for facing pistons and cylinder covers with slate; coating them with enamel; or with lead, which has a very low specific heat and conducting power; but, curious to say, these things never made the slightest difference in the consumpton of steam; thus flatly—at least in appearance—contradicting theory. May we suggest, however, that further experiments in this direction might be made with advantage, say by Mr. Royds or Dr. Mellanby.

BLACKPOOL AVIATION WEEK.

It was somewhat unfortunate for the enterprise of the Blackpool Corporation that this popular seaside resort could not lay claim to being the first in these islands to promote flying competitions. Although the Lancashire town was generally understood to be the first in the field, its Yorkshire rival, Doncaster, having a course ready at hand, actually made a start two days earlier. The counter attraction of Doncaster, however, has not in any way militated against the success of the officially recognised meeting at Blackpool, where several of the best known continental aviators were engaged to fly. These included Farman, Latham, Paulhan, Fournier, Rougier, and Le Blanc. Although these men no doubt furnished the principal attraction from a spectacular point of view, there were many who attended in the hope of witnessing some degree of success on the part of British competitors.

In spite of the comparatively short space of time which the promoters had at their disposal to make all necessary arrangements, practically everything in connection with the flying ground was in readiness when the proceedings were opened on Monday morning. The same, however, cannot be written of the competitors and their machines. The weather, too, was on its best behaviour, and better climatic conditions could scarcely have been chosen. Early in the morning the sun shone out through a slight haze, and with only a light breeze, said to be between five and ten miles an hour, the officials were enabled at once to hoist a white flag on the signal-board indicating "Flying will probably take place." At eleven o'clock this signal gave place to the more definite announcement, "Flying will take place." It was not until a little after mid-day that the waiting crowds were enabled to obtain their first glimpse of a flying machine which was brought out of its shed. The machine proved to be one of English build called the "Avroplane," the owner being Mr. A. V. Roe. Its initial performance only served to confirm the doubtful impressions which its general appearance foreshadowed. It is a triplane, and in this respect possesses a certain amount of originality. It weighs about 300 lb., of which the engine accounts for one-third, and with a rider weighing about ten stones there is provided 1 horse-power per 50 lb. of weight. The plane area amounts to 320 square feet. The engine is a J.A.P. petrol engine as used in motor cycles, capable of giving 9 horse-power. It has two cylinders arranged obliquely, and this drives a propeller at about 500 revolutions per minute. The tractor propeller is of a somewhat primitive character, having four thin wooden blades secured to tubular arms, which fit into a boss. The body and planes of the machine are built up of thin strips of wood covered with varnished paper, with a thin coarse canvas backing. After some considerable effort the engine was induced to start, and when the owner had vaulted into his seat in the V-shaped paper body the machine ran along the ground for about 200 yards against a head wind of some 9 or 10 miles an hour. Then it came to a stop with a broken stay, and had to be hauled back to the shed.

This was not a very successful commencement of the flying week, but the spectators soon had an opportunity of witnessing a real flight when M. Henry Farman, at 12.20, brought out his biplane, and, after an easy ascent, flew some few hundred yards before descending. Ten minutes later he rose again, and completed the first circuit of the course. About half an hour later M. Paulhan took the place of M. Farman in the same machine, and flew much higher than the former. He completed one circuit of the course in about three minutes, or at the rate of 40 miles per hour. The Farman machine is of the biplane type, and in point of design and workmanship compares most favourably with any other aeroplane on the ground. It is propelled by a Gnome rotary engine having seven cylinders of 110 mm. and 130 mm., which revolve round a fixed crank shaft, and carry with them the built-up two-bladed wooden propeller. The engine cylinders are air-cooled by means of gills, an arrangement which subsequent flights proved to be satisfactory. The plane area of the machine is 48 square metres, the diameter of the propeller 2.60 m., and the pitch 1.75 m. Every possible step has been taken by the designer of this aeroplane to diminish resistance to the air, and with this end in view the vertical struts are of oval transverse section, being secured to the horizontal members by aluminium connections, pins, and nuts. The wooden frame is of the girder type, stayed by wires which are ingeniously tightened. The flight of the machine is controlled by means of two ailerons placed at the back edge of the upper main plane, and by means of an elevating plane pivoted horizontally on a steel tube. These are all operated by one lever, a movement in one direction inclining the elevating plane, while motion applied to this lever in the opposite direction causes a movement of the ailerons. The foot of the aviator is used to move a vertical rudder at the rear through the medium of a lever.

No further flight was attempted until 3.20 p.m., when the slight breeze of the morning had almost died away; in fact, the conditions were ideal. At this time Henry Farman again mounted his machine, with the object of competing for the speed prize. This necessitated the completion of a distance of at least three circuits of the course—about 7½ miles. Although M. Farman did not rise to a great altitude, the aeroplane created a very good impression by its easy sinuous motion, and was not brought to earth until seven circuits had been completed. During the last circuit the flight was a low one, but the speed was the highest of all the circuits. The official speeds for the rounds were given as follows:—

Round.	Miles per hour.
1	45·2
2	45·4
3	45·7
4	45·4
5	45·1
6	44·4
7	46·6

Average speed 45·4, distance 17 miles 712 yards

While M. Farman was in the air M. Rougier made a trial flight of one circuit with his Voisin aeroplane. This is also of the biplane pattern, the main planes being built up on the lines of a box kite. The machine is propelled by means of an E.N.V. 8-cylinder water-cooled engine giving about 60 brake horse-power, and this drives direct a large two-bladed aluminium propeller situated behind the aviator. After completing one circuit of the course, during which the machine showed remarkable soaring capacity, Monsieur Rougier descended rather suddenly to earth to enable some wet canvas on the rudder to be removed. Twenty minutes later he started on what proved to be the longest flight of the day. He rose to a height of some 250ft. and did not come down again until he had covered 22½ miles or 9 laps. The times of the circuits are appended:—

Round.	Miles per hour.
1	40·9
2	41·2
3	39·3
4	38·6
5	39·9
6	38·7
7	37·2
8	37·7
9	37·2

The average speed was 38.9 miles per hour, and the descent was made with ease and grace.

While Rougier was reeling off circuits with mechanical precision, Henry Farman's machine was again brought out under the guidance of M. Paulhan, and the spectacular effect produced by the two machines flying simultaneously was greatly appreciated by over 60,000 spectators. M. Paulhan drove the aeroplane at a greater elevation than its inventor, probably on account of the calmness of the atmosphere. He completed six circuits of the course at the following official speeds:—1st round, 41.6 miles per hour; 2nd, 42.3 m.p.h.; 3rd, 39.3 m.p.h.; 4th, 39.3 m.p.h.; 5th, 39.7 m.p.h.; 6th, 38.8 m.p.h.; the average speed being 40 miles per hour.

Advocates of the monoplane form of construction had next an opportunity of witnessing a flight with the speedy Blériot machine. M. Le Blanc gave an exhibition of the capabilities of this aeroplane by flying once round the course, during which flight he never rose more than about 15ft. from the ground. No official time was taken, but the speed was high. The machine has a bird-like outline, with two huge planes and a tail. The propelling power is supplied by a three-cylinder Anzani motor driving a tractor propeller placed in front of the machine. The cylinders are placed 45 deg. apart in the same plane.

The second day's proceedings were commenced in favourable weather, though there was a little more breeze than on Monday. It was officially announced as between 5 and 10 miles per hour, and it blew across the ground from the same direction as on Monday. At eleven o'clock it had freshened up to between 10 and 15 miles per hour, and had the disadvantage of being gusty and uncertain. There were still several machines in an incomplete state, but great expectations were built up on the presence of Mr. Latham, who had arranged to make a flight on the elegantly designed Antoinette monoplane, which we had an opportunity of inspecting while the "tuning-up" operations were being carried out. The Antoinette machine has a long skiff-shaped body measuring about 10 metres long. In the front end of this body is placed a 50 horse-power engine with eight cylinders arranged V fashion. The engine is water cooled, the radiators being arranged along the side of the body. They are composed of long rows of small zinc pipes which fit closely to the frame. The total area of the wing-like planes is 30 square metres, and the total width across from tip to tip is about 13½ metres. The rear end of the body tapers off to a fine horizontal canvas plane, and the steering is effected by two vertically pivoted <-shaped rudders. The main planes are raised or lowered simultaneously by means of a hand wheel, chain and wires. The centre of gravity of the machine is situated near to the front of the machine, so that when flying or running along the ground, the tail is raised to a horizontal position. On this account the aeroplane does not require wheels at the rear end. It has an ingenious form of combined carriage and runner at the front. The main support of this is a central cylindrical pillar in which fits a pneumatic plunger, so that shocks due to a too sudden descent are softened.

At 12.15 Mr. Latham commenced a flight on this machine for the Speed Prize in a 15-mile wind. He had, however, not covered more than about half a mile when, owing to the mechanism which operates the planes becoming deranged, the machine came to earth. Fortunately, the aeroplane had not reached a high altitude, and the only damage which resulted was a broken wheel and bent aluminium propeller blade. This necessitated the machine being towed back to the shed.

A little later Mr. E. V. Roe decided to make another attempt at flight on his 9 horse-power tri-plane, which he tested unsuccessfully yesterday. The result was somewhat better, as the machine rose from the ground twice in a distance of a few hundred yards, but on the whole the attempt could not be considered satisfactory.

In the afternoon both M. Rougier and M. Paulhan brought out their machines, but the wind, which was still blowing at about 15 miles per hour, was sufficient to deter the former from making a flight. M. Paulhan, however, flew eight circuits of the course, and no doubt, owing to the increased speed of the wind, compared with that of Monday, the speed of the Farman machine showed a considerable falling off, the first round being covered at the speed of 30.3 miles per hour; the second at 29.8; the third at 29.11; the fourth at 29.09; the fifth at 29.52; the sixth at 28.9; the seventh at 29.57, and the eighth at 28.79, or an average of 29.4 miles per hour.

While M. Paulhan was flying the Fernandez bi-plane and the 9 horse-power Avroplane were brought out on to the course, but neither met with any success. The Fernandez seemed quite unable to leave the ground.

On the whole, the flying demonstrations on Tuesday were extremely disappointing, and the proceedings must have been monotonous to the 30,000 spectators who waited for several hours in the hope of witnessing considerable progress in the various competitions. Had it not been for M. Paulhan's plucky exhibition in the face of a high wind in which no other aviator dared to ascend, the disappointment would have been complete. It was exciting to watch the movements of Paulhan's Farman machine under the trying conditions. The machine at no time rose to the height reached on the previous day, and the manner in which it lurched, dipped, and staggered as the pressure of the wind affected its flight was thrilling to behold. The speed with the breeze astern was perceptibly faster than when the wind was ahead or athwart, and the machine seemed to float along like a thing lighter than air. The day's work was finished off rather summarily by the floating of a black flag, indicating to the spectators that there would be no more flying that day.

On Tuesday night and in the early hours of Wednesday morning there was very heavy rain, which made the course very unpleasant for the spectators. The morning, however, broke fine, and the breeze at the time set for commencing exactly the same as on the two previous mornings. Still the aviators were indifferent as regards flying. The first machine to turn out was the new Voisin aeroplane belonging to Mr. Singer, who took the helm for his first attempt. For some reason he could not get the aeroplane to leave the earth, and eventually abandoned any further attempts for the day. A similar flight befel the aviator in charge of the Fernandez, which, so far, has proved singularly ineffective. This is a biplane, with a front elevator plane and a vertical rudder secured at the end of a stern frame. It has a 40 h.p. E.N.V. engine, water cooled, with a tubular radiator arranged horizontally above the motor. The engine is arranged on a level with the lower plane, and drives a two-bladed propeller—which is fixed at a higher level—at a lower speed than the engine. It is a low-built machine, and, although provided with ample power, the arrangement seems unsuitable for flying. It is noteworthy that up to Wednesday evening no machine in which the speed of the propeller is less than that of the engine has succeeded in flying.

The Farman machine was brought out at one o'clock, and under the guidance of its builder proceeded to make what proved to be a record flight for this country. In a light wind, it flew at a low elevation, never rising above 25ft., and remained in the air for over an hour and thirty-two minutes, covering a distance of 47 miles 1184 yards. It maintained a singularly even speed of between 30 and 31 miles per hour throughout.

The wind had now freshened somewhat, but M. Rougier attempted a flight at an altitude of about 100ft. He had, however, only covered about five miles in 12 minutes when he deemed it advisable to return to earth. M. Paulhan essayed a flight in his Farman machine, which M. Farman had just flown so successfully, but found a wind of over 15 miles per hour unsafe. The machine was therefore returned to its shed. This concluded a fairly interesting day's sport.

It was announced on Tuesday that the International Aeronautical Federation has made a new rule as regards the measurement of courses which will have the effect of reducing somewhat the distances recorded on Monday and Tuesday. Hitherto the length of a course has been reckoned by a line drawn down the centre. It has now to be measured along the inner boundary. The official length of the course is now therefore 3496 yards—or 24 yards less than two miles.

In addition to completing our report of the meeting in our next week's issue, we shall give some particulars of several machines, chiefly of British design and manufacture, which have not yet competed.

MOTORS FOR THE TRANSPORT OF TROOPS.

At the Royal United Service Institution, on Wednesday last, Mr. T. Clarkson delivered a lecture on "The Use of Motors for the Transport of Troops." In his opening remarks the lecturer said that the type of car which gave the largest carrying capacity in relation to the road space occupied was unquestionably the double-deck omnibus. It was also capable of a fairly high average speed, and lent itself to standardisation. Four of these cars could convey a company of 120 men fully equipped at an average speed of 12 miles per hour for long distances. In the case of emergency the speed could be increased to an average of 14 miles per hour.

In dealing with private cars for the transport of troops the lecturer said that the experiment of conveying a battalion of Guards by private cars to Hastings showed very conclusively the unsuitability of this car for such a duty. He did not hesitate to say, in fact, that the chief value of that experiment was in showing how the transport of troops by motor should not be done. In the first place, the 400 cars occupied an excessive amount of road space, and the seating capacity only averaged between three and four men per car. By reason of the great amount of road space occupied, many of the troops had to march considerable distances to reach their motors, and there was much delay. A soldier in full war rig found it extremely difficult to fit himself into a basket seat intended for an ordinary person. Many other troubles in connection with this experiment were referred to, and stress was laid on the fact that with a scratch lot of cars, and with undisciplined drivers, trouble is sure to arise.

Then the lecturer turned his attention to various experiments of this kind which have been carried out with double-deck cars. A trial was described which was carried out with a double-deck steam car on the 22nd of June, 1909. The trial was made for the purpose of determining how far men could be conveyed in one day. A car having a gross weight of six tons left Chelmsford at 4 30 a.m. and proceeded *viâ* Woolwich Ferry to Folkestone, returning the same day to the starting point. The total distance was 186 miles. It arrived at the stopping place at Folkestone at 1.7 p.m., eight minutes before the anticipated time. Exactly the same programme reversed was executed on the return journey. The car left Folkestone at 3.4 p.m. and arrived at Chelmsford at 12.3 a.m. From that trial Mr. Clarkson said he was satisfied that distances up to 200 miles could be covered without difficulty in twenty-four hours. There would be a certain retardation of speed with consequent reduction of distance by a large number of cars running together. In another trial 160 men were conveyed on five cars from Chelmsford to Colchester, a distance of 22 miles, in two hours five minutes. Such transport could be profitably carried out at ½d. per passenger mile.

A short discussion followed the lecture, in which Colonel Gerard R. C. Paul, and Dr. Miller McGuire took part. Both speakers dealt with points of military importance. The former said that Mr. Clarkson had given the average speed as 12 miles per hour, but he thought that 8 or 10 miles would be nearer the figure. Mr. Clarkson had gone so far as to say this method of transport was superior to the railway, and yet, according to his own statement, it would only be possible to cover 200 miles in 24 hours. The second speaker principally dealt with the question of using alcohol in internal combustion engines, which he thought was a great advantage, as this spirit could be obtained almost anywhere. In his reply to Colonel Paul's remarks, Mr. Clarkson said with regard to only covering 200 miles in 24 hours, it should be remembered that in the case of the railway the soldiers had to get to the station, and, further, they might be put down at a place a considerable distance from their desired destination. As to the use of alcohol in internal combustion engines, many experiments had been carried out, but the results were not very satisfactory.

OBITUARY.

HARRY WILLIAM YOUNG.

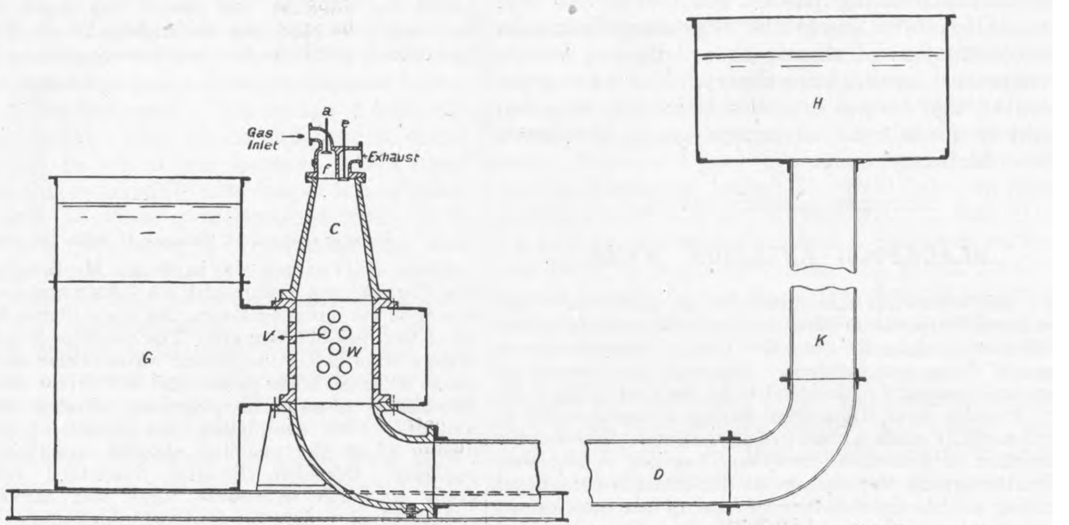
WE regret to have to record the death of Mr. Harry William Young, which took place on the 1st inst. at his home, Tittenhurst, Moseley, Birmingham. Mr. Young was one of the partners of Messrs. Youngs, manufacturers of lifting appliances, of Ryland-street Works, Birmingham. He was the son of Mr. Thomas Young, and was born at Wednesbury in 1865. He was, therefore, forty-four years of age at the time of his death. He received his early education at Queen Mary's Grammar School and Walsall, and began his engineering career in the works of Elliott's Metal Company, of Selly Oak. He was with this firm for seven years, and in 1887 joined with his brother in forming the above-mentioned firm. To do this necessitated the purchase of the businesses of John Williams, of Ryland-street, Birmingham, and of W. Eades and Co., of St. Peter's place. For the last seven years Mr. H. W. Young has been far from well, and unable continuously to attend to the business.

THE QUEBEC BRIDGE COMMITTEE met in Montreal last month, and it was decided to call for tenders for both the cantilever and suspension types of bridge. The final choice will then be determined by the relative cost and the time required for building. Several important changes were decided upon. The new bridge will be 150ft. above high tide for 600ft. in the centre of the river; it will also be 24ft. wider than the old bridge, which was only 61ft. wide. The centre span will be reduced from 1800ft. to 1715ft. by building a new pier 100ft. farther from the north shore than the present pier. On the south side the present pier will be widened and strengthed, so as to bear the greater weight. Nickel steel will be used in the eye bars and for compression members. It is expected that a start will now be made very shortly, as this meeting has removed many of the causes of delay.

THE CRYSTAL PALACE OLD STUDENTS' SOCIETY.—The fifteenth annual dinner of this Society was held in the Criterion Restaurant, London, on Thursday last, October 14th. The president, Mr. H. C. H. Shenton, was in the chair, and the company included amongst others Mr. Charles Hawksley, Past-president Institution of Civil Engineers; Mr. A. T. Walmisley, engineer to the Dover Harbour Board; Mr. J. W. Wilson, the Principal of the Crystal Palace School of Practical Engineering; Mr. A. S. E. Ackermann, secretary, Society of Engineers; Dr. S. Rideal, and Professor Merritt, of the Royal School of Mines. Mr. Hawksley, in proposing the toast of "The Crystal Palace School of Practical Engineering," paid a tribute to the able manner in which the school was conducted, and compared the advantages enjoyed now-a-days by engineers for securing a thorough training in their art with those which were placed at the disposal of the men who had gone before. In his response to Mr. Hawksley's toast, Mr. Wilson, the Principal of the School, said they had been conducting classes at the Crystal Palace for the last thirty-five years, and in that time they had turned out about 1800 students, some of whom are to be met with in almost every quarter of the world. Although the Crystal Palace was at present in evidence before the public, he assured his audience that whatever happened the School of Engineering would continue, and asked his hearers to support him in bringing this before others. Other toasts followed, and the evening was concluded with a programme of music rendered by the Rossignol Quartette.

AN INTERNAL COMBUSTION PUMP.

A FORM of pumping engine, widely different in principle from those usually met with, has recently been subjected to a thorough series of tests by Professor W. C. Unwin, F.R.S., the results of which we give below. This pump has been designed by Mr. H. A. Humphrey, M. Inst. C.E., and is the product, we understand, of much careful experimenting and a long experience with internal combustion engines.



"The Engineer"

Swain Sc

Fig. 1—DIAGRAM SHOWING THE ARRANGEMENT OF THE PUMP

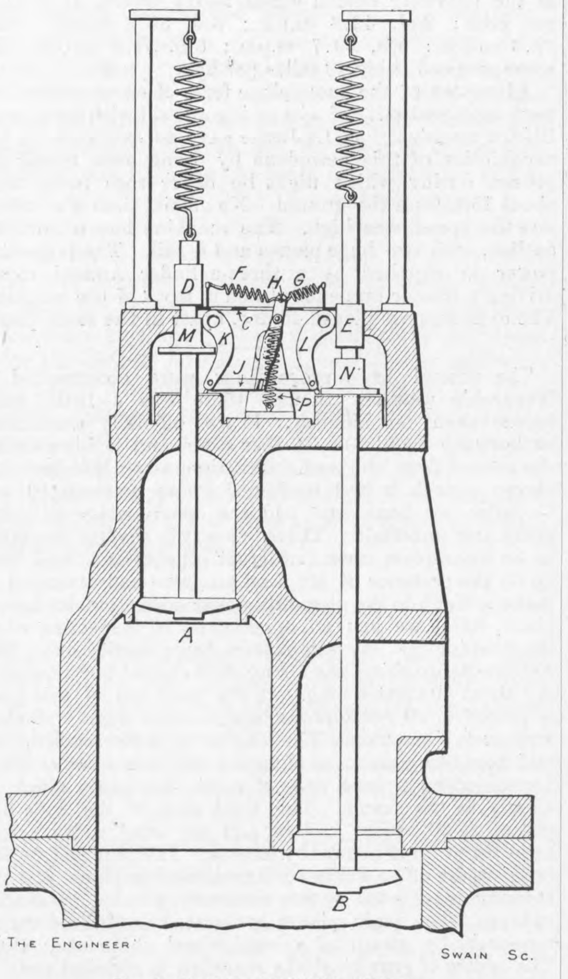


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Fig. 2—VALVE LOCKING GEAR

In diagrammatic form the general arrangement of the parts of this machine is shown in Fig. 1. Considered in brief, the pump consists of a combustion chamber C, a valve chamber W, and a discharge pipe D. Round the surface of the valve chamber W several non-return valves V opening towards the centre of W are situated, the supply tank G, from which the water is to be pumped, being in communication with these valves by means of an annular passage surrounding the chamber. At the top of the conical combustion chamber C are two valves *a* and *e*, the former, controlling the gas supply, opening into a small pocket *f*, the latter, leading to the exhaust pipe, formed in the crown of the chamber at a level below that of the admission valve. A sparking plug projects into the chamber *f*. With the exception of an automatic interlocking gear attached to the valves *a* and *e*, of which a description will be found below, we have now indicated the essential features of this novel type of pump. To follow its method of working we will assume that the water is initially at rest, and at the same level in the tank G, the chamber C, and the upward bend of the discharge pipe K. Under these circumstances we will suppose a charge of compressed gas and air introduced into the chamber *f* over the surface of the water. On this being exploded the pressure on its surface drives the water along the pipe D and up the vertical limb K, which leads to the point of discharge represented in our illustration by the tank H. During this outward flow of the water the pressure within the chambers C and W falls when the exhaust valve *e* opens the combustion chamber to atmospheric pressure. The same reduction of pressure also brings about a flow of water from the tank G through the valves V to the chamber W. This additional water joins the water initially present in the pump, and partakes of its further movements. When the kinetic energy of the outward flowing mass of water has become changed to potential energy, the water will, of course, flow back along the pipe D, carrying with it the added portion of water. As it rises within the chamber C the volume of water expels the products of combustion through the exhaust valve *e* until this valve is closed by the impact of the water on its lower face. There is now only a small portion of the burnt gases remaining in the combustion chamber, and this the rising water compresses within the pocket *f*. A cushion of gas is therefore formed which will cause the water again to flow in the outward direction. For the second time, therefore, in the same cycle the pressure in C and W falls, but the water valves V do not open again, as this second outflow of water does not go sufficiently far to cause a reduction of pressure on the back of the valves great enough to allow the springs thereon to act. This second reduction of pressure, however, causes the gas valve to open and admit a supply of fresh mixture to the combustion chamber. The velocity of discharge in this case is less than in the first, and the water soon returns, compressing the charge into the upper end of the chamber, thus completing the cycle.

It is obvious that the valves *a* and *e* require some form of locking device to secure their alternate opening when the reduction of pressure within the combustion chamber takes place. The gear for this purpose is shown in Fig. 2, when A is the admission valve and B the exhaust. On each valve rod is a collar D, E, and beneath these the edges of the sliding plate C catch alternately. The movement of the plate C is controlled through the springs F, G by the lever H, which receives its motion from the bar J and pawls K, L. These pawls are in turn actuated respectively by the collars M, N on the valve rods.

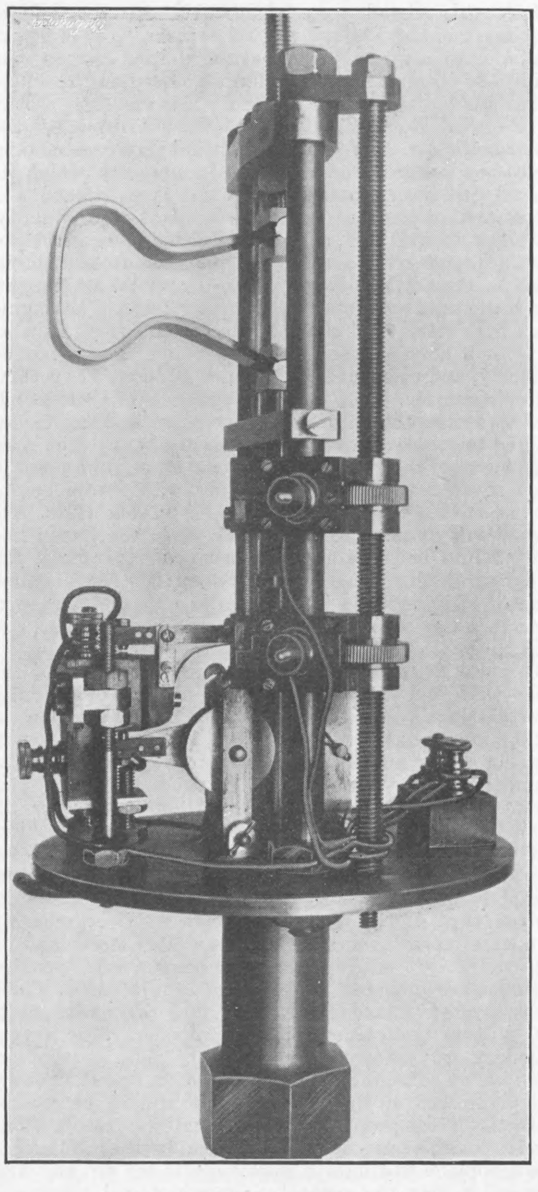

Fig. 3—IGNITION APPARATUS

In the position shown in the engraving the gear is set for the exhaust stroke. On the impact of the water on the exhaust valve the valve rod moves up, allowing the edge of the plate C to slip beneath the collar E, the motion being brought about by the tension in the spring F. The suction stroke then taking place, the admission valve is free to descend, and in doing so causes the collar M to bear against the pawl K, thus throwing the lever H over to the other side, where it is held by the spring P. No motion of the plate C, however, takes place during this period, as its edge is bearing against the collar D. The exhaust valve, therefore, remains locked until the admission valve rod rising allows the plate to move over to the left, when the exhaust valve is set free and the admission valve locked.

For the ignition of the charge the apparatus shown in Fig. 3 is employed. This consists of a piston moving in a cylinder which is in communication with the combustion chamber. The piston-rod points upwards, and is loaded at its upper end with the indicator spring shown in the engraving. Two small pulleys bear against the piston-rod, being held up to it by springs. On one of these pulleys is a small arm, the attachment between the two being, however, only due to friction. The motion of this arm is limited in amount by an upper and a lower stop. It will thus be seen that during the upward motion of the piston-rod, that is, when the pressure within the combustion chamber of the pump is rising, the arm is pressed against the lower stop, but as soon as the pressure commences to fall the arm rises, making contact with the upper stop, thus giving a spark at the plug.

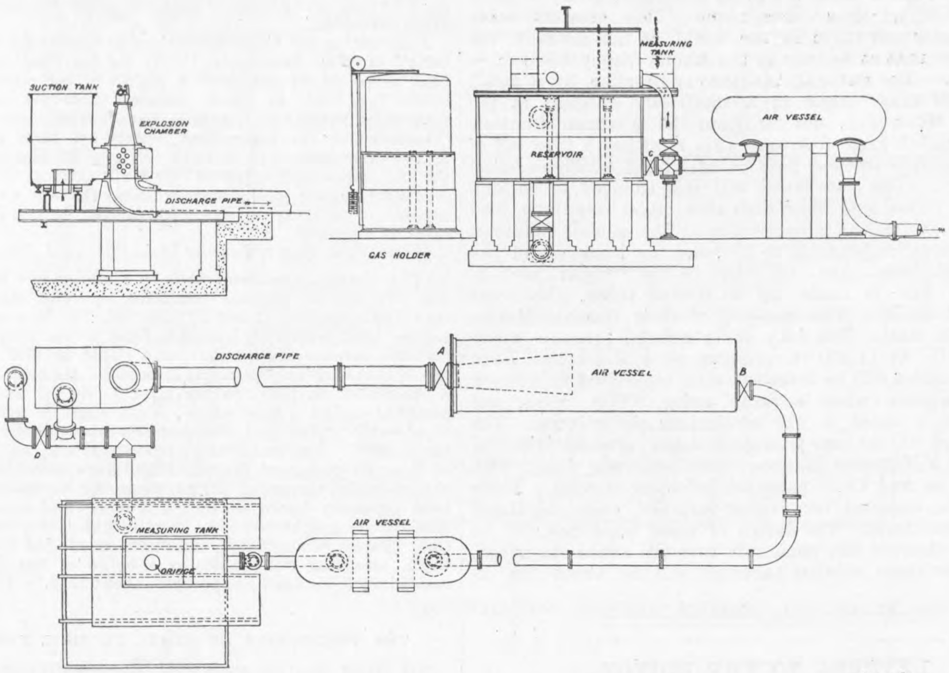

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Fig. 4—TESTING APPARATUS USED BY PROF. UNWIN

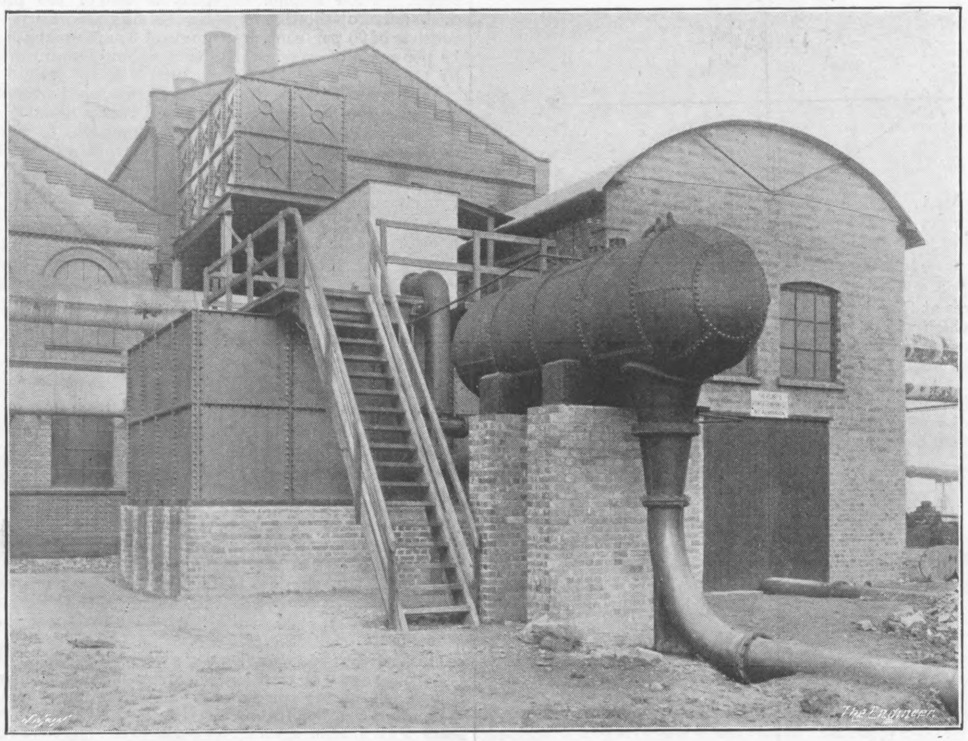


Fig. 5—VIEW OF TEST HOUSE AT DUDLEY PORT

With this apparatus the charge is, therefore, fired as soon as the compression pressure reaches its maximum value, but the engraving shows other details which can be used alternatively to give a spark at any desired constant pressure.

Table I.

Trial number.	Mean lift in feet.	Head over orifice in feet.	Volume pumped.		P.H.P. actual H.P. in water lifted.	Cycles per minute.	Gallons pumped per cycle.	Duration.	Fall of gasholder.	Gas pressure by water gauge.	Absolute pressure in inches of mercury.	Temperature of gas in deg. C.	Actual volume of moist gas used in trial.	Gas used per minute corrected to dry gas at 760 mm. and 0 deg. C.	Gas used per hour per P.H.P.
			Cubic feet per second.	Gallons per minute.											
								min	ft.	in.			cub. ft.	cub. ft.	
I.	32.91	3.90	4.339	1624	16.20	13.9	117	10	4.36	2.5	29.63	20.0	247.2	22.30	82.62
II.	32.84	3.77	4.267	1597	15.92	13.9	115	10	4.41	2.6	29.64	20.1	249.5	22.50	84.78
III.	32.84	3.82	4.293	1607	15.99	13.9	115	10	4.37	2.7	29.65	20.1	247.7	22.33	83.76
IV.	32.86	4.01	4.398	1647	16.39	13.7	120	10	4.40	2.9	29.66	20.1	249.5	22.51	82.38
V.	32.91	3.92	4.350	1629	16.24	13.7	119	10	4.32	2.7	29.65	20.1	244.9	22.08	81.60
VI.	32.81	3.90	4.339	1624	16.15	13.7	118	10	4.40	2.8	29.66	20.2	249.5	22.49	83.58
Means	32.87	3.89	4.331	1621	16.15	13.8	117	—	—	—	—	—	—	22.368	83.12
VII.	26.23	3.74	4.249	1591	12.64	12.1	132	12	4.32	2.8	29.66	20.7	244.9	18.35	87.08
VIII.	25.71	3.54	4.132	1547	12.05	11.8	131	12	4.41	2.8	29.66	20.7	250.0	18.73	93.24
IX.	25.92	3.61	4.174	1563	12.27	11.5	136	12	4.45	2.8	29.66	20.6	252.3	18.91	92.46
Means	25.95	3.63	4.185	1567	12.32	11.8	133	—	—	—	—	—	—	18.663	90.93
X.	20.54	4.43	4.625	1731	10.78	11.6	150	12	3.97	2.8	29.66	20.5	225.1	16.83	93.96
XI.	20.80	4.69	4.759	1782	11.23	11.2	159	12	4.09	2.8	29.66	20.4	231.9	17.40	92.96
XII.	20.84	4.45	4.636	1735	10.96	11.5	151	12	4.03	2.8	29.66	20.3	228.5	17.15	93.90
Means	20.73	4.52	4.666	1749	10.99	11.4	153	—	—	—	—	—	—	17.145	93.61

Professor Unwin's tests of the pump were carried out at Dudley Port on September 21st and 22nd, and from his report we have taken the tables published herewith. In Fig. 4 we reproduce the illustration accompanying the account of the experiments, and showing the arrangement of the apparatus employed. Fig. 5 shows a general view of the test-house at Dudley Port, while Fig. 6 represents the pump as erected.

The arrangements for the trial will be gathered from the following account, and by reference to Fig. 4. A supply of Mond gas was available at the works, and this was delivered to the pump from a gasholder. During any trial the gasholder was shut off from the main and the amount of gas consumed determined by noting the fall of the holder over ten or twelve minutes. This necessitated an observation of the temperature and pressure of the gas within the holder, and it was assumed that the gas was saturated with moisture. The pressure in the gasholder was measured by a water gauge, while the temperature of the gas was noted on a thermometer placed in the pipe leading to the combustion chamber of the pump. To calibrate the holder the circumference was measured by a thin wire, and, allowing for thicknesses, the internal diameter was found to be 8.5ft. A pointer moving over a graduated scale served to determine the fall of the holder during a test. To arrive at the calorific values of the gas employed analyses were undertaken for each separate test, and the value calculated from a knowledge of the calorific value of carbon monoxide, hydrogen, and marsh gas. The following values in British thermal units per cubic foot at 0 deg. Cent. and 760 mm. pressure were taken as correct:—CO; 342.4, H_2; 292.3, CH_4; 963.0. It was thus possible to calculate the total heat expended in the engine. It was, however, deemed advisable for purposes of comparison with other types of pumping engines to reduce the values thus found into terms of the equivalent expenditure of standard anthracite coal. For this reduction it was assumed that the calorific value of anthracite coal was 14,400 B.T.U.'s per pound. Such coal when used in a producer having an efficiency of 80 per cent. would, it was assumed, give a gas having a calorific value of 11,520 B.T.U.'s per pound of coal expended, and therefore the equivalent expenditure of anthracite coal in a producer would be $q \times C \div 11{,}520$ lb., where q represents the actual consumption of Mond gas in a test, and C its calorific value in B.T.U.'s per cubic feet.

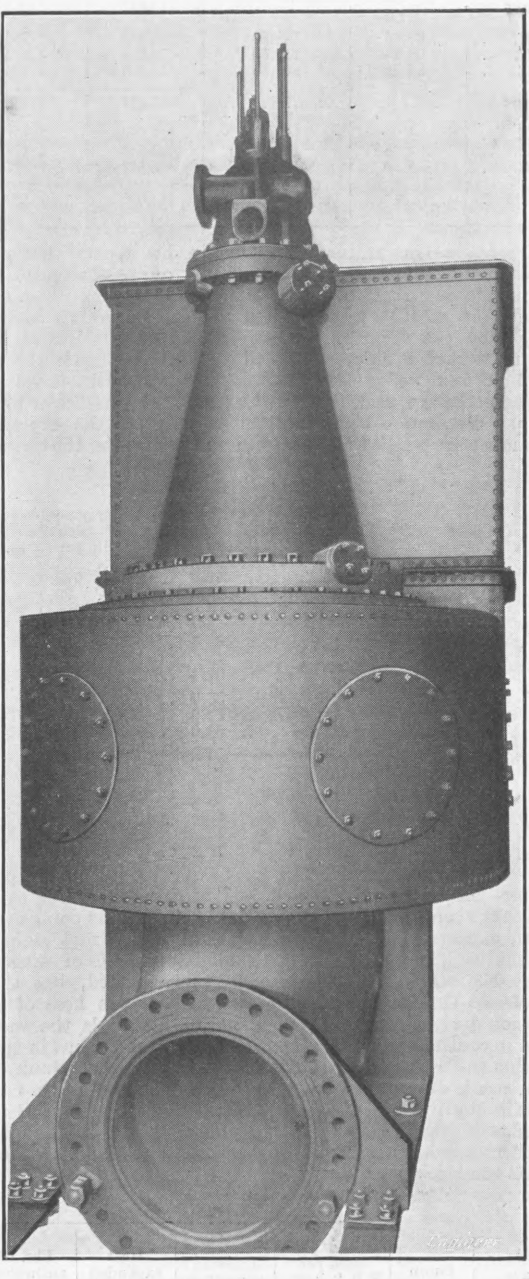


Fig. 6—GENERAL VIEW OF PUMP

Coming now to the arrangements made for measuring the work done by the pump, the report states that the discharge pipe was 135ft. in length and 2ft. in diameter, and discharged into a large air vessel as shown in the plan in Fig. 4. To secure constancy of pressure within this vessel a regulating sluice valve controlled by manual power was provided at the outlet B. From the large air vessel the water flowed through a smaller one to a measuring tank provided with baffles. A sharp-edged circular orifice 9in. in diameter was formed in the bottom of this tank, and through this the water returned to the storage reservoir supplying the suction tank. During each trial the head over this orifice was observed at intervals of about 1½ minutes, and the volume of discharge calculated from the formula

$$Q = c\omega\sqrt{2gh}$$

c being taken at 0.62 and ω at 0.4418, the formula becomes $Q = 2.197\sqrt{h}$, the discharge being given in cubic feet per second.

To measure the lift of the pump a mercury syphon gauge was attached by one leg to the suction tank of the pump and by the other to the large air vessel. Taking the density of mercury at 13.59, a difference in level of *h* feet in the gauge would correspond to a lift in feet of water of 12.59 *h*. A scale graduated to read directly the lift in feet of water was placed alongside the syphon gauge.

For a discharge of Q cubic feet per second and a lift of H feet, the pump horse-power was calculated from the formula

$$\text{P.H.P.} = G\,Q\,H \div 550.$$

Taking G at 62.4, this becomes equal to .11344 Q H.

In Table I. the various quantities observed, with some of their reductions, will be found, while Table II. gives the figures relating to the gas and heat consumption.

During the trials indicator diagrams were taken, and from the data thus acquired Table III. was compiled. Table IV. summarises the performance, and from this, it is remarked, the striking fuel economy will be apparent.

Table II.

Trial number.	Gas used per P.H.P. hour.	Calorific value of gas B.Th.U. per cub. ft. Mean values from Twiss & Pinnock's analyses.	Heat expended per P.H.P. hour.	Lb. of anthracite in producer per P.H.P. hour.
	cu. ft.		B.Th.U.	
I. ..	82.62	146.48	12,105	1.051
II. ..	84.78	148.43	12,583	1.092
III. ..	83.76	146.03	12,232	1.062
IV. ..	82.38	145.49	11,985	1.040
V. ..	81.60	151.23	12,340	1.071
VI. ..	83.58	146.10	12,210	1.060
Means ..	.. .. ..	.. ..	12,243	1.063
VII. ..	87.08	146.20	12,730	1.105
VIII. ..	93.24	139.82	13,036	1.132
IX. ..	92.46	144.33	13,344	1.158
Means ..	.. .. ..	.. ..	13,037	1.132
X. ..	93.96	146.01	13,718	1.191
XI. ..	92.96	145.80	13,556	1.177
XII. ..	93.90	145.96	13,517	1.173
Means ..	.. .. ..	.. ..	13,596	1.180

Professor Unwin further states in his report that once started and adjusted the pump works quite automatically, requiring no attention. The actual starting is easily accomplished by means of compressed air, and beginning cold an explosion can occur in five seconds. During the trials the pump worked at different lifts without any change in the gas and air mixture or any alterations in the cushion volume being necessary, and, it is further stated, no missfire or hitch of any description occurred. As all parts of the explosion chamber are washed by water twice in each cycle, the chances of pre-ignition are eliminated, and further, the same cause keeps the temperature of the walls, &c., low, thus doing away with expansion and contraction troubles. At first sight it might be urged as an objection to the method of working that the water would become sensibly heated, but this, Professor Unwin says, is not so, as most of the heat of explosion disappears in the exhaust. In his trials the water was in continuous circulation through the pump, but in spite of this the temperature of the water in the storage tank did not rise 1 deg. Cent. during an hour. He states that the maximum lift apparently depends solely on the length of the discharge pipe, and that the pump works at lower lifts without any alteration and without any considerable change in its efficiency.

Table III.

Trial number.	Average compression pressure. lb. per sq. in.	Average explosion pressure. lb. per sq. in.
I. ..	44.3	101.0
II. ..	45.5	102.0
III. ..	44.5	89.0
IV. ..	46.0	105.0
V. ..	45.7	100.7
VI. ..	42.3	102.7
Means	44.7	100.1
VII. ..	33.7	85.0
VIII. ..	32.0	71.0
IX. ..	34.0	82.7
Means	33.2	79.6
X. ..	18.0	87.5
XI. ..	20.3	86.3
XII. ..	21.0	85.3
Means	19.8	86.4

Table IV.

Lift feet.	Pump horse-power.	Mond gas used per P.H.P. hour, at 760 mm. and 0 deg. C. cu. ft.	Calorific value of gas per cu. ft. in B.Th.U.	Heat expended per P.H.P. hour. B.Th.U.	Lbs. of anthracite in producer per P.H.P. hour.
32.87	16.15	83.12	147.3	12,243	1.063
25.95	12.32	90.93	143.5	13,037	1.132
20.73	10.99	93.61	145.3	13,595	1.180

In criticising the Humphrey gas pump on the results of these tests, Professor Unwin compares its performance with that of a gas engine driving a centrifugal pump of the same capacity. He states that under similar circumstances the gas engine and centrifugal pump installation would require from 120 to 127 cubic feet of gas per pump horse-power hour, while the Humphrey gas pump requires 83.1 cubic feet. He also compares the new type of pump with some large steam pumping engines of the highest class, and remarks that, although the steam sets had the advantage of a much greater lift, their economy did not approach that of the Humphrey pump. The pump horse-power of the three examples of steam sets mentioned ranged from 217 to 450, and the lift from 54ft. to 129ft., while the coal consumed per pump horse-power per hour was 1.996, 1.622, 1.695 respectively. In the case of the Humphrey pump tested, the lift was 32.9ft. and the pump horse-power 16.15, but the equivalent consumption of coal per pump horse-power hour was only 1.06 lb., a figure which Professor Unwin states is, as far as he is aware, unexcelled by any other pumping arrangement.

THE ADAMELLO POWER PLANT—NORTHERN ITALY.

At the present time Escher Wyss and Co., of Zürich, are engaged in installing the turbines and pipe lines for an interesting power plant at Adamello in Northern Italy, where about 28,000 horse-power are to be generated under a gross head of 3060ft. This, though one of the greatest heads worked under anywhere in the world, is not actually the greatest, for that at Vouvey in the Rhone Valley is 980 m.—say 3215ft. The water at Adamello is supplied by a small river which takes origin in a small lake situated in the Adamello Mountains, not far from the Austrian frontier, which is called Lage d'Arno. This river has a total fall of 4600ft., and it is the top part of this head which is being utilised first. The installation will, it is thought, be working next year. Two pipe lines, each about 1650 yards long, lead the water down to the power station. The outside diameter of the pipes varies from 3ft. to 2ft., and the thickness of the pipe metal from $\frac{5}{16}$in. to $1\frac{5}{16}$in. The upper part of each pipe line is made up of riveted tubes, the lower of welded tubes. The material used is Siemens-Martin open-hearth steel. The duty under normal pressure varies from 8500 lb. to 11,400 lb. pressure per square inch. Four turbo-generators will be installed, each calculated to develop 6600 horse-power when working under 3000ft. head, and running at a speed of 420 revolutions per minute. The turbines are of the one-jet high-pressure impulse type, the jet having a diameter of about 3in., and are fitted with Escher Wyss and Co.'s patented deflecting nozzles. There will also be installed two exciter turbines, each calculated for 500 horse-power. The design of these machines will be similar to that of the generator turbines above described. The jet for these smaller turbines will be about 1in. in diameter.

LETTERS TO THE EDITOR.

(*We do not hold ourselves responsible for the opinions of our correspondents.*)

DRAWING AN ELLIPSE—AND A FLAT CURVE.

Sir,—Referring to Mr. Talbot C. Broom's diagram in your last issue, I venture to try and go one better. To draw a true ellipse :—Fig. 1 given A B and C D, the major and minor axes.

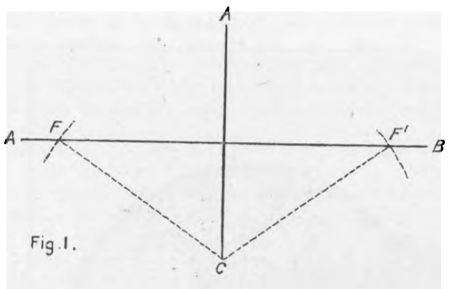


Fig. 1.

With centres at C and with rad = half the major axis cut A B at F and F¹, which will be the two foci. Take a string equal in length to the major axis, fasten the ends at F and F¹. Thus, with a pencil in the loop, a true ellipse can be drawn as described by Mr. Broom.

The following has been found of considerable use :—To draw a small arc of a flat curve, the radius and chord being given and the centre being unattainable.

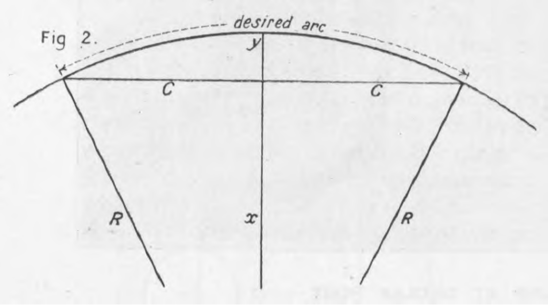


Fig 2.

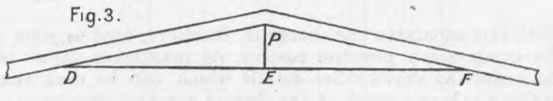


Fig. 3.

Fig. 2, given $2\,C$ = the chord

R = radius

$= x + y.$

Then $R^2 - C^2 = x^2$

$R - x = y.$

Fig. 3, Let $D\,E\,F = 2\,C$

$P\,E = y,$

On D E as a base set up P E as a perpendicular, produce D E to F; place pins or pegs at D and F.

Then, if the template shown be rocked on the pins, a pencil at P will describe the desired arc.

Ernest Benedict, M. Inst. C.E.

Westminster, S.W., October 19th.

THE INVENTION OF THE STEAMBOAT.

Sir,—Referring to your leading article in your issue of the 1st inst., in connection with the Hudson-Fulton celebration in New York, you mention Papin as having actually constructed a steamboat. Is there any authentic proof in existence to support such a statement? If so, of what does it consist, and where is it to be seen? Commencing with Blasco de Garay—1543—I have carefully examined into the many claims down to 1807. Yet the earliest claim supported with undoubted proof is that of Jonathan Hulls, 1706.

You state: "Then Jonathan Hulls obtained a patent for a stern wheel steamboat," but omit to mention that he also provided in his specification for the side paddle steamer. This is a point that is generally overlooked, but careful examination of his specification will prove its correctness.

Your remarks would lead your readers to imagine that beyond patenting his method Hulls took no further steps with his invention, but his Treatise (1737) clearly shows that not only did he invent, but that he actually FORMED his steam boat—a fact also generally overlooked—and that it was a "practical success." I quote from the account given in "The History of Progress in Great Britain," published 1859, viz.:—

"Thus we arrive at the time when in 1736 Jonathan Hulls' steam boat took a sailing ship in tow, and, amid the wonder, doubts, and jeers of the spectators, made a great splash, a loud noise, and a black smoke, yet managed to haul the cumbrous hulk along, and gave promise that the child which had distinguished itself by such an unheard of feat would one day become a giant of great strength."

I am setting out these particulars as against the claim made on behalf of Wm. Symington (1801) for his Charlotte Dundas, a boat propelled by means of a paddle wheel placed in a cavity inside the boat, to whose memory there are erected various memorials, notably at Leadhills, Lanarkshire, claiming him as the "inventor of the steam boat"—sixty-five years after Jonathan Hulls. The method employed by Symington died with him. Yet the two principles "invented" by Hulls exist at this present day. And with regard to the stern-wheeler, there is no other method capable of carrying out its purpose even at this date, 173 years after its inception.

Manor Park, Essex, October 14th. J. Hooper Hulls.

[The statement is given thus by Thurston in "Robert Fulton: His Life and its Results," published by Dodd, Mead and Co., of New York, between 15 and 20 years ago:—"As soon as the steam engine took practically available form it was proposed to use it for this purpose (navigation); and Papin in 1690 suggested the use of his piston engine in this direction. He actually constructed a steamboat, in 1707, on the river Fulda, at Cassell, using his pumping engine to raise water; which water in turn was applied to a water wheel, and drove thus a set of paddle wheels on the same shaft. The contrivance, crude as it was, was found capable of doing its work, and the boat might have been the pioneer in a commercially successful use of steam for navigation had it not been promptly destroyed by the ignorant and superstitious boatmen of the neighbourhood, who thought it the work of the Evil One. Papin, disappointed and discouraged, fled to England, and there, becoming well known as a fellow of the Royal Society, resided until his death, in poverty, about 1712."—Ed. The E.]

THE PRODUCTION OF ETHYL ALCOHOL FROM WOOD REFUSE.

Sir,—In your issue of the 15th inst. there is a note upon a process worked in America with the above object. It is interesting, but, unfortunately, methods and terms are so mixed up that the first part of the article is misleading.

The writer has applied the name in almost universal general use for indicating methyl alcohol, viz., "wood alcohol"—which is synonymous with wood spirit, pyroligneous alcohol, pyroxylic spirit, alcool de bois, espirit de bois, and holzgeist—to the ethyl alcohol derived from wood cellulose.

The statement that methyl alcohol or methylated spirit is made by the destructive distillation of wood is a confusion of inexactitudes. Wood alcohol or spirit is one of the products of the destructive distillation of wood. Methylated spirit in this country consists of 90 per cent. by volume of commercial ethyl alcohol and 10 per cent. of wood spirit, with other denaturants as required by the Excise.

With reference to the proof terms used—there is no such strength here as 190 deg. proof. This evidently refers to the United States revenue standard, equivalent to spirit containing 92·93 per cent. by weight of absolute ethyl alcohol, or of the strength of 67 over proof United Kingdom standard. The highest proof strength on the United Kingdom scale is 75.25 over proof, equal to 100 per cent. absolute alcohol.

Many attempts have been made to convert wood cellulose into ethylic alcohol, but so far without any appreciable commercial success. Difficulties arise in actual work on a manufacturing scale which are not in evidence in the laboratory, consequently the success of the American working referred to by you is notable.

J. C. Stead.

London, W.C., October 18th.

CENTRIFUGAL FORCE.

Sir,—Students are prone to ask inconvenient questions. I have been asked to give a graphic demonstration of centrifugal force. My answer was, of course, the well-known diagram. But this was not what my student wanted. He quite understood the principles. His difficulty, and mine, is this:

A stone is tied to a string, and whirled round. As the pull is direct on the string, the popular idea is that the stone, if the string broke, would fly away in the line of a radius of the circle described. But it does nothing of the kind; it goes away on a tangent—that is to say, at right angles to the string.

The difficulty, then, is this: We have two forces, balancing each other, but at right angles.

How am I to show this on a "graph?"

Perhaps some of your clever correspondents who write about the drawing of ellipses can help me.

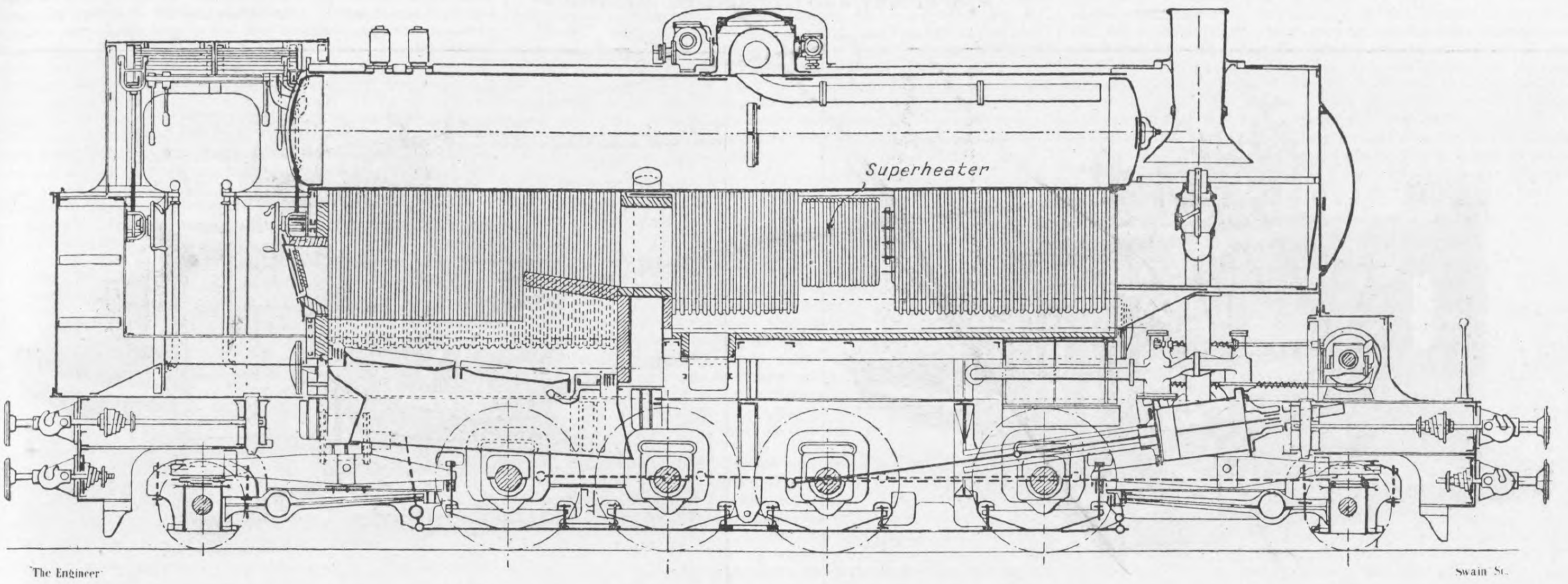
London, October 19th. Pater.

Colliery Development in South Yorkshire.—On the 13th inst. operations were commenced for the new colliery at Thorne Common, near Doncaster, where, without any public ceremony, the first sods were cut. This new development in South Yorkshire is due to the enterprise of Pease and Partners, Limited, and is one of the most important colliery undertakings in the country. The Barnsley bed of coal under this site lies at a depth of 920 yards. In reaching this depth great difficulties will have to be encountered. There are quicksands, as were experienced in the sinking of the colliery at Bentley, ten miles distant, where the Barnsley seam was reached at a depth of 626 yards. The same contractors, Messrs. Eaton, Son, and Hind, have also this work in hand. The colliery will not only be one of the deepest—it is stated that it will be the second deepest—in the country, but, with shafts 22ft. in diameter, and other arrangements, it is calculated to bring forth an output of over 4000 tons a day. The seam of coal is estimated at 9ft. thickness, of the usual rich quality the Barnsley bed provides. It is expected that the colliery will ultimately find employment for over 3000 people. The North-Eastern Railway line is close to the place.

Whitworth Scholarships and Exhibitions.—The list of successful candidates for the above has just been issued. For this year four scholarships have been awarded, the following being the names of the recipients:—A. W. Judge, 21, Plymouth; J. Airey, 24, Shipley; H. S. Rowell, 23, Newcastle-on-Tyne; H. Mawson, 25, Leeds. Exhibitions have been awarded to the following:—F. Duncanson, Sunderland; A. Ryan, Oldham; A. H. Campbell, Portsmouth; J. J. Clark, Liverpool; W. H. Shinkfield, Portsmouth; A. W. Stevenson, Melrose; G. W. E. Hayward, Southsea; J. Morgan, Sheerness; A. F. Grieveson, Chatham; A. E. Gladwyn, Plumstead; W. H. T. Harvey, Swindon; T. H. Webster, Newcastle-on-Tyne; W. J. Davis, Plymouth; O. R. Randall, Birmingham; G. F. Haddock, Sunderland; F. H. Reid, Plymouth; G. B. Kellagher, Gillingham (Kent); T. Norcross, Hollinwood, Oldham; L. P. Parker, Leytonstone; A. Morris, Portsmouth; J. Smith, Crewe; W. Shaw, Woolwich; H. E. Pinch, Sheerness; D. H. Emby, Plumstead; W. Fox, Plumstead; R. H. May, Leytonstone; E. D. Brodie, Swindon; H. J. Goudie, Leith; H. Collins, Gillingham (Kent); C. Williams, Plumstead. The scholars each received £125 a year for three years; the exhibitioners, £50 for one.

LOCOMOTIVE WITH A WATER-TUBE BOILER

MESSIEURS SCHNEIDER ET CIE., CREUSOT, ENGINEERS

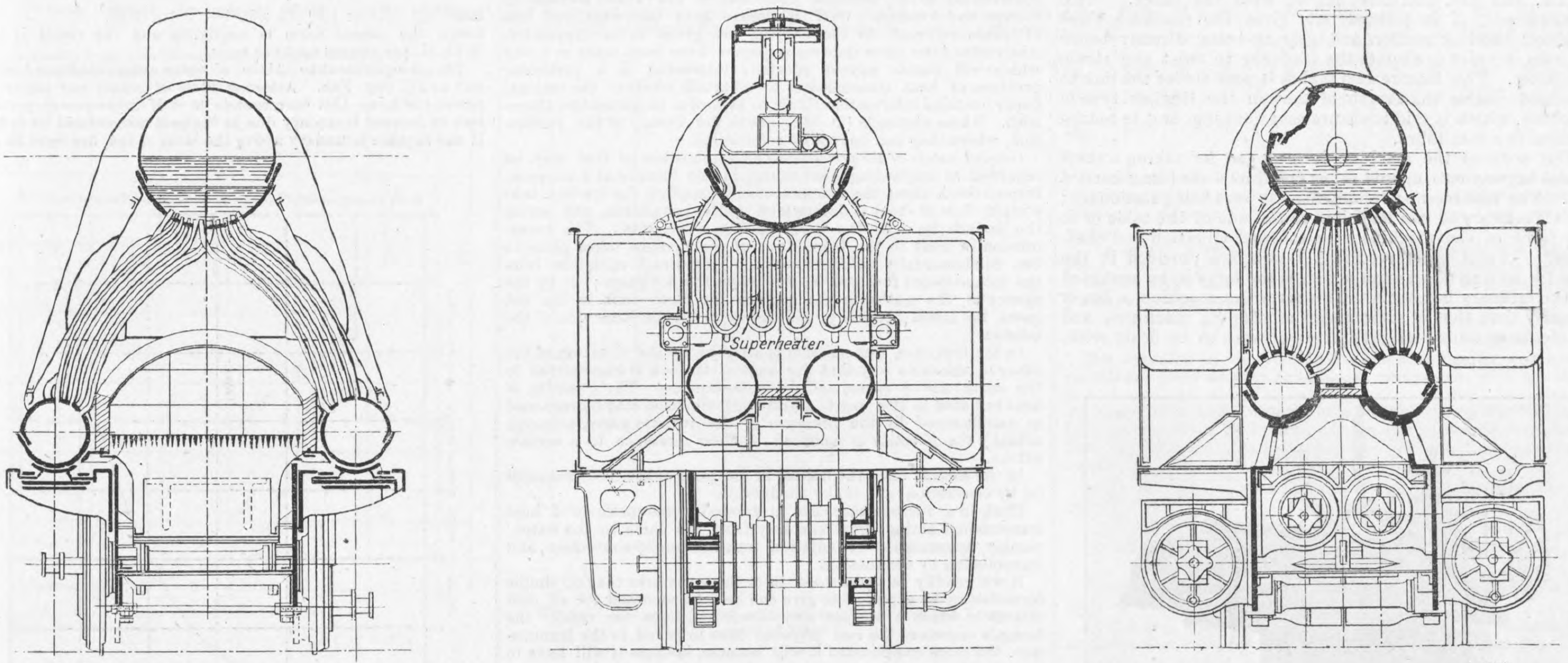


LONGITUDINAL SECTION SHOWING THE BOILER AND SUPERHEATER

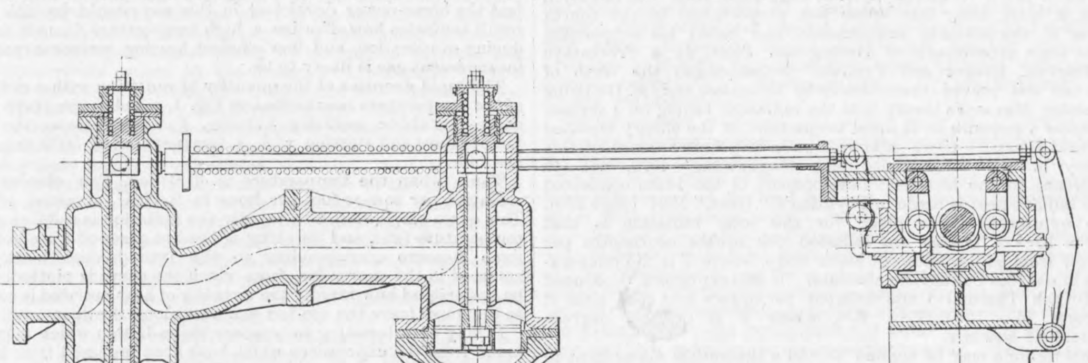
LOCOMOTIVE WITH WATER-TUBE BOILER.

THE suggestion that locomotives should be provided with water-tube steam generators in place of the boilers that are indissolubly connected with their name has often been made, but rarely acted upon. A few such boilers have from time to time been tried on existing engines, but apparently, since the type is almost non-existent, with but little success. Now, however, Schneider and Co. have gone a step further and have built an entirely new type of engine with a water-tube boiler, a superheater, and rotary distribution valves. Our French contemporary, *Le Genie Civil*, describes this novel engine, and we take the liberty of reproducing some of the drawings, with a translation of the description. The engine has been built specially for hauling coal and minerals for Creusot. It is of normal gauge, and was shown at the Nancy Exhibition. The boiler, as will be seen from the longitudinal and cross sections, consists of an upper drum and four lower drums. Two of the latter are placed one on each side of the grate, and the 450 tubes, 1in. internal diameter, connecting them with the upper drum, are bent so as to form the arch of the furnace. The other two lower drums are placed in front of the first pair and are much closer together. They are connected with the upper drum by 1in. tubes that are for the greater part of their length vertical. There are 968 of these small tubes, but they are omitted from the part of the boiler where the superheater is situated. The two front drums are coupled to the two after drums by pipes, from which downcomers, 8in. diameter, extend up to the steam drum above. The two outer rows of water tubes touch each other so as to make a water wall of a familiar kind. The whole generator is covered with non-conductive material, and enclosed in a casing which observes the conventions by resembling an ordinary boiler. The steam pressure is 20 kilos. per square centimetre, or about 285 lb. per square inch.

The general form of the superheater will be gathered from the cross-section. It has a total area of 13.44 square metres, and is composed of twenty tubes, 1in. internal diameter. These tubes connect two receivers, to one of which steam from the regulator enters; the other is connected to the cylinder. Dampers permit more or less of the superheater to be in use.



CROSS SECTIONS THROUGH THE BOILER



VALVE GEAR—HIGH-PRESSURE CYLINDER

The valve gear of this engine is of the kind known as Schneider and Altmann. Each cylinder has an admission and an exhaust valve at each end. These valves are all the same, and consist of circular seats with sixteen radial openings covered by circular plates with corresponding openings. Full admission or exhaust is given by $\frac{1}{32}$ of a revolution, and during movement the valve is slightly lifted from its seat. A cross-section through part of one high-pressure cylinder is given, showing two admission valves. Distribution is effected by a pair of bevel wheels at one end of the third coupled axles. From this point a long rod passes to the front and drives a cross shaft, on which cams are cut. These cams move the valve rods endways, as shown in the section. Short levers on the valve spindles hinged to the valve rods give the necessary rotary movement. The whole cam shaft can be moved endways to alter the point of cut-off and to reverse the engine.

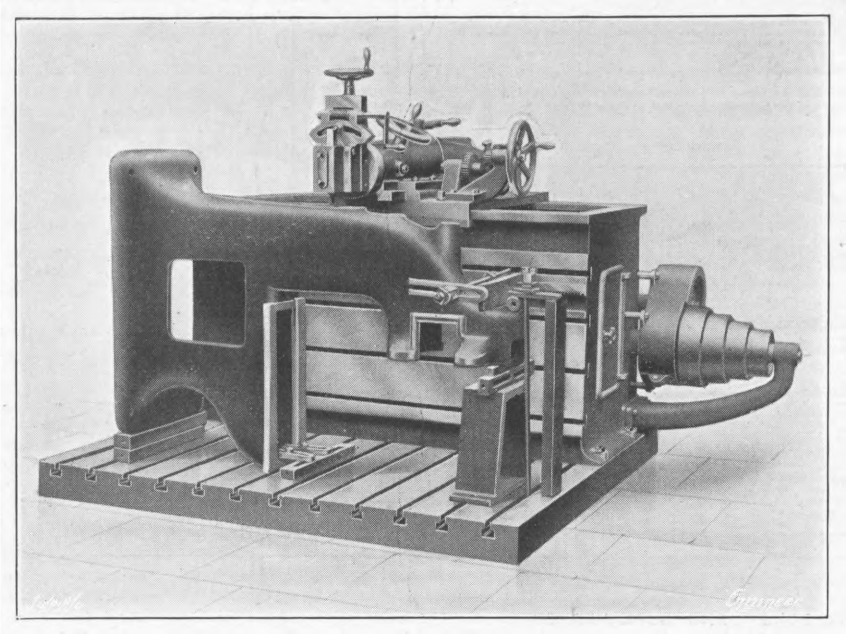
The engine has eight coupled wheels and two Bissel trucks. The two middle axles are driven, the leading one by the internal high-pressure cylinders, the trailing one by the two low-pressure outside cylinders. The cylinders are approximately 13½in. and 21½in. diameter, and the stroke 21½in. The total heating surface is about 1600 square feet.

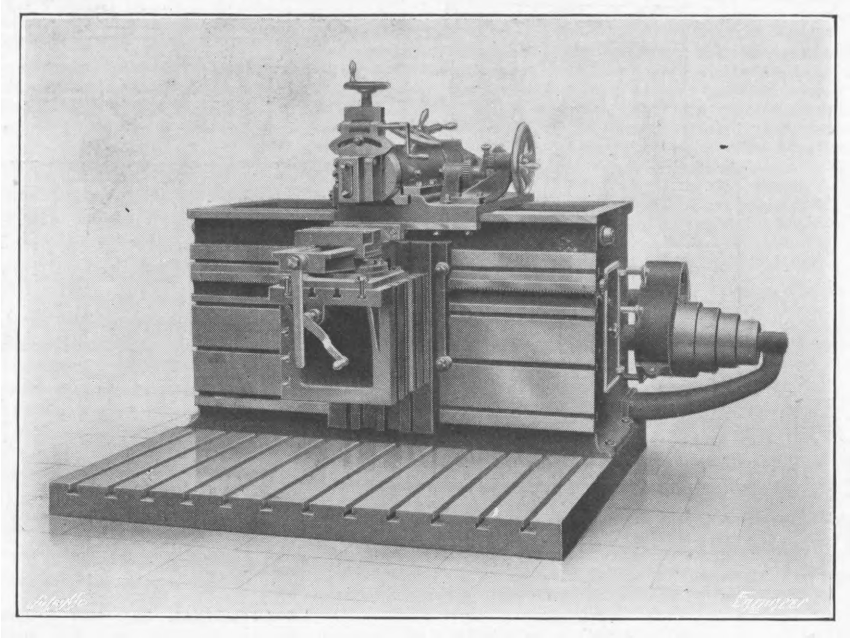
INSTITUTION OF ELECTRICAL ENGINEERS: GLASGOW LOCAL SECTION.—The Committee have arranged that the eighth annual dinner of the section shall be held in the Banqueting Hall of The Grosvenor, Gordon-street, Glasgow, on Wednesday, 1st December, 1909.

CITY AND GUILDS OF LONDON INSTITUTE.—For the 1909-1910 session of the Finsbury Technical College, which began on the 4th inst., the following evening courses of instruction have been arranged:—In Practical Mechanics, Elementary and Advanced, on Fridays and Tuesdays respectively, from 8 to 9 p.m.; in Mathematics, on Tuesdays and Fridays, from 6 to 8 p.m., the Fridays being devoted to a course of lectures on "The Calculus for Engineers;" in Mechanical Drawing, on Thursdays, from 7 to 8 p.m.; in Machine Drawing, on Mondays and Thursdays, from 6 to 9 p.m.; in Structural Engineering, on Mondays, from 6 to 9 p.m.; and in the engineering workshops, on Mondays and Wednesdays, from 6 to 9 p.m.

SHAPING MACHINE

J. H. STOREY AND CO., LONDON, ENGINEERS

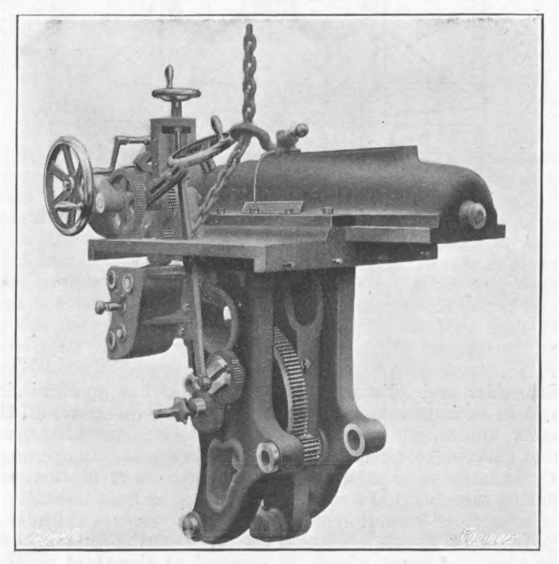




A NEW SHAPING MACHINE.

A shaping machine which is claimed to have special advantages has been put upon the market by the firm of J. H. Storey and Co., of Hatcham, London, S.E. As will be gathered from the illustrations given herewith, the driving gear, link motion, and quick return gear, are enclosed in the body of the machine, and carried directly under the saddle, and are, therefore, moved with the latter. This arrangement, it is pointed out, gives the machine great rigidity; the link motion and gearing being directly below the ram in order to obviate the tendency to twist and strain the latter. This feature also makes it possible for the link to be about double the length of that in the English type of machine, which is said to ensure easy running, and to reduce friction to a minimum.

The body of the machine is arranged for taking a shaft whilst keyway cutting and other operations are being carried out. The base has no adjustment, the work being stationary; or if necessary it can be bolted to the side of the table or to the front of the machine so as to avoid vibration and chattering. It will be observed that T-slots are provided in the base for bolting down work which is too large to be mounted on the ordinary box table. This gives the machine a larger capacity than that of some makes of shaping machines, and enables irregular or weighty pieces of work to be dealt with.



THE SADDLE REMOVED FROM THE BODY

The ram is of arched form, which design gives strength where it is most needed. It is adjusted by means of a hand wheel placed in a convenient position, so that adjustment can be made without the operator having to leave the head of the machine. The stroke is adjusted by means of a screw, and is positive in its action, and the makers point out there is no danger of slipping. The index for the stroke is fitted in a position level with the ram. It is said to be simple, accurate, and easily seen, and has no complicated parts to get out of order. The cutting stroke may be altered whilst the machine is in motion. The feed may also be stopped, started, or reversed whilst the machine is in operation, and it is arranged to slip in the event of the strain being excessive, thus avoiding the danger of breakage of the feed mechanism. The back gear is thrown in and out by means of an excentric lever, and it is quite clear of the belt drive at any angle. The rocking arm has a length connection for the varying movement, and is extremely long, giving a smooth and steady cut. Attention is drawn by the makers to the fact that these machines are well proportioned, and that they are equal to stand the strain of the latest high-speed steel, and will take the heaviest cuts with the greatest ease. These machines are made in various sizes having bottom tables 4ft., 5ft., 6ft. 6in., 8ft., 11ft. 9in., and 14ft. long, and the large sizes are fitted with one or two saddles and box tables, according to requirements.

HEAT TRANSMISSION.*

By Professor W. E. DALBY, Member, of London.

Introduction.

Object of the research.—The object of the research is to place before the members of the Institution a general view of the work which has been done relating to the transmission of heat across boiler heating surfaces. In order to do this, it has been necessary to search for papers bearing upon the subject which have been contributed to the technical Press and to the various societies in Europe and America. Over 500 papers have been read, and lists of those relevant to the subject are given in an Appendix. Abstracts of the more important papers have been made in a way which will enable anyone specially interested in a particular problem of heat transmission to ascertain whether the original paper contains information likely to be useful in connection therewith. These abstracts (in MS.) are in the library of the Institution, where they can be readily referred to.

General nature of the problem.—The combustion of fuel may be regarded as originating heat energy in the furnace at a temperature so much above the temperature surrounding the fire-box, that a rapid flow of heat is determined to its boundaries, and across the boundaries into the water on the other side. The transmission of heat to the boundaries of the furnace takes place in two fundamentally different ways: (1) by direct radiation from the incandescent fuel and the flame and the hot gases; (2) by the agency of the matter in the path of the flow—that is, the hot gases, the metal boundary, and the water on the other side of the boundary.

In the first case, transmission is effected by the vibration of the ether in the same way that the heat of the sun is transmitted to the earth across space, and is instantaneous. The quantity of heat radiated in this way to a first approximation may be regarded as uninfluenced by the presence of the furnace gases, although actually the quantity is modified by their presence to a certain extent.

In the second case, the matter in the path of the flow transmits (*a*) by convection, and (*b*) by conduction.

Thus, in a furnace there are in general three methods of heat transmission acting simultaneously from the flame to the water; namely, transmission by radiation, transmission by convection, and transmission by conduction.

It will readily be understood from these remarks that no simple formula can be expected to give the heat transmitted for all conditions in which a furnace may be worked, since the nearer the formula expresses the real physical laws involved in the tranmission, the more complicated it will become, because it will have to include the numerous constants and variables involved in a complicated operation. Formulæ of simple form have been devised to express the results of definite sets of experiments; but before these formulæ can be safely used to predict new results, the conditions of the experiments furnishing the data on which they are based should be ascertained, and the application of the formula should be strictly limited to cases in which similar conditions prevail, and which fall within the range of the original experiments.

Transmission of Heat by Radiation.

General law of radiation.—Stefan suggested that the radiation from a black body into space was proportional to the fourth power of the absolute temperature, and based his supposition upon some experiments of Dulong and Petit, de la Provostaye et Desains, Draper and Tyndall. Subsequently the truth of this law was proved theoretically by Bolzmann and B. Galitzine assuming Maxwell's theory that the radiation falling on a surface produces a pressure on it equal to one-third of the energy radiated per unit volume. Clerk Maxwell gave the first account of this theory in his "Electricity and Magnetism," 1873, vol. 2. Reference to the historical development of the ideas connected with radiant heat is made in Poynting's "Heat," 1904 (page 250). The expression there given for the total radiation is that $5\ 32 \times 10^{-5} \times T^4$ ergs are radiated per square centimetre per second from an incandescent black body, where T is the temperature in degrees Centigrade absolute. If this expression is reduced to British Thermal Units radiated per square foot per hour it becomes $16 \times 10^{-10} (T_1^4 - T_2^4)$, where T is now in degrees Fahrenheit absolute.

This formula may be applied to find a theoretical upper limit to the quantity of heat radiated to the fire-box boundaries, by making the assumption that the flame is actually composed of solid masses of incandescent carbon, which radiate to the same extent as the black body assumed in Stefan's law, and that the fire-box is filled with flame, so that the area of flame and incandescent fuel radiating heat is equal to the area of the sides and roof of the fire-box reckoned above the level of the fire. This assumption implies that the total heat radiated in any furnace is proportional to the area of the furnace boundaries above the level of the fire, and therefore the radiation received per square foot of boundary may be calculated from the above expression. The expression ceases to apply when the gases are not incandescent because a hot gas even at flame temperature is not equivalent to a black radiating body and therefore does not radiate so much.

An example may be taken to illustrate how the formula may be applied to find an upper limit to the quantity of heat transmitted by radiation from the flame in a furnace to the boundaries, it being understood, that in practice the actual quantity would be considerably less, though it could not be greater. Suppose the flame temperature in a furnace to be 3000 deg. Fah. absolute, and the temperature of the boundary to be 800 deg. Fah. absolute; then, assuming the flame to fill the fire-box so that the area of the radiating surface is the same as the absorbing surface, the quantity of heat in B.Th.U. absorbed by each square foot of the boundary per hour is:—

$$16 \times 10^{10} \left\{ (3 \times 10^3)^4 - (8 \times 10^2)^4 \right\}$$

that is $16 \times 10^{10} (81 \times 10^{12} - 0.4 \times 10^{12})$

hence the second term is negligible and the result is 129,600 B.Th.U. per square foot per hour.

This is equivalent to 134 lb. of water evaporated per hour from and at 212 deg. Fah. Allowing 30 lb. of steam per boiler horse-power per hour, this corresponds to 4.47 horse-power per square foot of furnace boundary due to the heat transmitted by radiation. If the furnace boundary above the level of the fire were 50 square feet the horse-power developed in this way would be 223. This result indicates how effective a high temperature flame is in producing evaporation, and how efficient heating surface exposed to incandescent gas is likely to be.

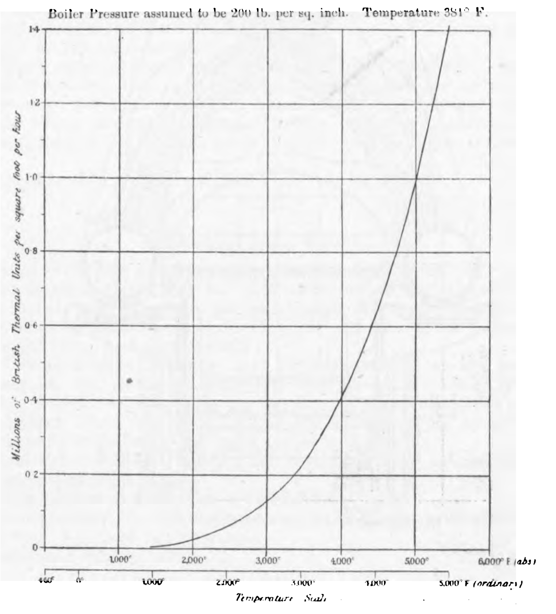


Fig. 1.—Heat Radiated at various Temperatures of the Fire.

Boiler pressure assumed to be 200 lb. per square inch. Temperature 381 deg. Fah.

The rapid decrease of the quantity of radiation with a reduction of the temperature is exhibited in Fig. 1, which is the graph of the expression above, assuming 842 deg. Fah. absolute as the lower temperature and starting with a temperature of 5000 deg. Fah. absolute.

Thus, when the temperature is 4000 deg. Fah. absolute, the radiation per square foot per hour in B.Th.U. is about 410,000. This curve emphasises how rapidly the radiation is reduced as the temperature falls, and thinking of the hot gases of a fire-box as in some measure corresponding to the incandescent black body assumed in the expression, from which the curve is plotted, it will be understood how rapidly the quantity of heat radiated is reduced as the gases leave the fire-box and pass along the flues.

It may be interesting to compare the radiation which would be found from the expressions which have been proposed from time to time with the one given above. This comparison has been made by Professor Callendar in a paper published in *Nature*—Vol. lix., 1898-9, page 494—and Fig. 2 is a reproduction of the curves therein given, the scales having been changed to British units.

Professor Mollier has specially studied the expressions for radiation given by Peclet, and concludes that for temperatures below 240 deg. Cent. any of the three formulæ: (1) Dulong and Petit, (2) Rosetti, and (3) Stefan, answers very well. The rate of increase of radiation with temperature is too quick at high temperatures with Dulong and Petit, and comparing Stefan's formula with Rosetti's, he considers that Rosetti's is, on the whole, sufficiently accurate for technical problems, and is easier to manipulate.

Experiments bearing upon the greater efficiency of the fire-box heating surface.—There are many experiments proving the simple fact that the heating surface exposed to the direct action of the incandescent gases is more efficient than that merely exposed to hot gases; but with few exceptions investigators make no attempt to separate the heat transmitted by radiation from the total quantity transmitted; in fact, the total transmission is tacitly regarded as being due to convection and conduction. The following experiments may be cited :—

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* The Institution of Mechanical Engineers.

Messrs. Dewrance and Woods in 1842 divided the water space between the tube plates in a locomotive boiler into six equal compartments by means of vertical partitions. It was found that the evaporation per square foot in the first compartment was equal to the evaporation per square foot of the fire-box. In the second compartment the evaporation was one-third of that in the first compartment, and the evaporation in the remaining compartments was practically nothing.

Graham in 1860 divided a cylindrical boiler set in brickwork into four compartments by vertical transverse plates, each compartment being open to the atmosphere, and found that 67.6 per cent. of the total water was evaporated in the first division, 18.2 per cent. in the second division, 8.1 per cent. in the third division, 5.4 per cent. in the fourth division.

Wye Williams in 1862 arranged six separate evaporating compartments round a common flue tube, the first compartment being quite separated from the remaining five and its heating surface being exposed to the flame. More water was evaporated from the first compartment, which was only 1in. long, than from the last 2ft. of the tube.

Couche in 1876 divided a locomotive boiler into five compartments by means of tube plates. Experiments were made with all the tubes open, and also when half of them were closed. Five distinct draughts were used, ranging from ¾in. to 3⅛in. vacuum in the smoke-box. The results show that the evaporation per square foot of surface was from two to three times greater from the fire-box section than from the first tube section. As much as 50 lb. of water per square foot of surface was evaporated from the fire-box part of the boiler. The effect of closing up half the tubes caused an increase in the heat transmitted per square foot exposed.

Further information on experiments of this kind may be found in the papers of Sir J. Durston, Strahl, Sir E. Reed ; see also The Engineer, 1901 (Vol. xci. p. 479).

TRANSMISSION OF HEAT BY CONDUCTION AND CONVECTION.

General considerations —Transmission by conduction and convection is generally held to be conditioned by the fact that at the boundary of the hot gases in the fire-box and flues there is clinging to the plates a thin film of gas, in which convection currents do not apparently take place and which offers a high resistance to the passage of the heat other than radiant heat, since the heat can pass across the film by conduction only. There is a similar film of water on the water side of the plate, though the resistance to the passage of heat through it is considerably smaller.

Starting from a point in the interior of the mass of gas in the fire-box, the path of the heat flow to a point in the interior of the mass of water may be considered as made up of the following parts :—(1) The gaseous part of the path from the starting-point to the gas film clinging to the plates. (2) The gas film itself. (3) The surface of contact between the plate and the gas. (4) The part of the path through the metallic plate. (5) The surface of contact between the plate and the water. (6) The water film. (7) The water from the film to the point in the mass of water. If the plate be dirty, there must be added a layer of sooty deposit on the gas side and a layer of scale on the water side, on which there may be in some cases a deposit of oily matter. The method of transmission along this path differs in the different elements. Thus, starting from the assumed point in the mass of the hot gas, the heat is carried to the boundary by a movement of the hot particles of the gas, caused partly by convection currents and partly by currents caused by the draught. Conduction plays a negligible part in transferring the heat along this element of the path. Transference across the bounding gas film, through the metal of the heating surface and across the water film, takes place by conduction, after which the heat is carried to the interior of the water mass mainly by convection.

The notations T¹, etc., show the curves deduced from the formula found by each experimenter, *e.g.* Petavel found that radiation varied as the 5th power of the absolute temperature T

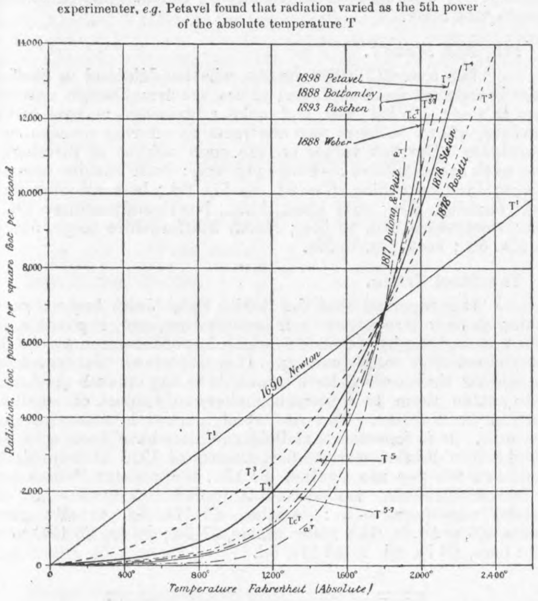


Fig. 2—Energy Represented by Heat Radiation.

Curves reproduced from the paper by Professor Callendar.
The notations T¹, &c., show the curves deduced from the formula found by each experimenter, *e.g.*, Petavel found that the variation varied as the fifth power of the absolute temperature T.

So far as transmission is concerned, the part of the path which requires special consideration is the metallic plate with its film coatings. Transmission of heat along this path may be likened to a flow of electricity through a circuit made up of the elements of different resistances. The potential difference, which causes the current to flow along against the resistance of the elements of an electric circuit, may be compared to the differences of temperature along the elements of a heat circuit. Just as it requires a large potential difference to force a current of electricity through a small element of a circuit of high resistance, so it requires a large temperature difference to force heat to flow along a small element of the path offering a great resistance. Difference of temperature may be regarded also as a " temperature head," by analogy with the flow of water ; with known data the temperature head could be plotted in a diagram. Such a diagram is sketched in Fig. 3, not however, from any data, but merely to show the main characteristics of the flow.

Starting from a point *a* in the interior of the hot gas, A *a* represents the temperature, and this is shown as gradually falling to the value B *b* at the surface of the gas film. The resistance of the film is extremely great, consequently the temperature falls to C *c* in passing through it, the transfer of heat having been effected by the temperature head B *b*—C *c*. There is probably a further drop of temperature head represented by *c d* which is required to force the flow across the surface where the gas film is in contact with the metal ; corresponding with the potential difference at a joint in an electric circuit. The temperature head required to cause the flow through the metal itself is C *d*—E *e* with a further fall of head *e f* at the surface of contact between the metal and the water film. The fall of temperature head through the water film is E *f* − G *g*, until finally the temperature has fallen to that of the water, and the heat transmission through the mass of the water is continued by movement of the water particles.

To give some idea of the order of magnitude of these temperature differences, some figures from a paper by Mr. Hudson (The Engineer, Vol. lxx., page 523, and Vol. lxxvi., page 107) may be cited. In this paper it is deduced from experimental evidence that 98 per cent. of the total available temperature head is required to force the heat from the gas into the plate, the remaining 2 per cent. being all that is required to transfer the heat from the plate to the water in the boiler. Or, referring to the diagram, the total available temperature head is A *a*—G *g*. The above figures indicate that :—

$$(\mathrm{A}\,a - \mathrm{C}\,d) = 0{\cdot}98\,(\mathrm{A}\,a - \mathrm{G}\,g)$$
$$\text{and that } (\mathrm{C}\,d - \mathrm{G}\,g) = 0{\cdot}02\,(\mathrm{A}\,a - \mathrm{G}\,g)$$

Mr. Hudson also arrives at the conclusion that the hot side of the plate of the heating surface is never more than 36 deg. hotter than the water side. The experiments of Sir John Durston (The Engineer, March 31st, 1893) substantially confirm these conclusions. They show that, when the temperature of the water was 212 deg. and the plate clean, the temperature on the hot side of the plate was 68 deg. higher than that of the water. Although the actual figures, namely, 36 deg. and 68 deg., appear to be discrepant, yet, when the temperature difference is expressed as a percentage of the whole temperature head, there is sufficient agreement to show what a small temperature head is concerned in causing the flow of heat through the plate, compared with the total temperature head used in the transfer from the interior of the hot gas.

Sir John Durston in the paper quoted above gave experiments to show the effect of a coating of grease on the water side of the heating surface. Briefly, when 5 per cent. of the mineral oil was added to the water, the temperature difference increased from 68 deg. to 98 deg.; with 2½ per cent. of paraffin, the difference increased to 118 deg.; and with a greasy deposit $\frac{1}{10}$in. thick, the temperature rose to 550 deg. above the temperature of the water.

On the existence of a gas film coating the plate.—The idea of a film coating the plate is a useful mental conception, though actually it is probable that there is a thin layer of gas in contact with the plate which is nearly at the temperature of the plate forming the first of a succession of thin layers, gradually increasing in temperature to the temperature of the flame. The total thickness of temperature stratification is probably of the order $\frac{1}{40}$in. Justification for this statement is found in an experiment of Mr. Fletcher. If a piece of paper be stuck to the bottom of a metal pot, water can be boiled in the pot by means of a strong gas flame underneath without even charring the paper. This shows that the temperature of the paper cannot be anywhere near the temperature of the flame ; in fact, the paper must be immersed in a comparatively cool film of gas at a temperature not much higher than the temperature of the boiling water. In this experiment, whatever the flame temperature may be, it is clear that a large proportion of the head corresponding to it is used up in forcing the heat across the thin film of cool gas in which the paper is immersed, and that the remaining head is used up in forcing the heat through the paper, the metallic bottom of the pot, and through the water film.

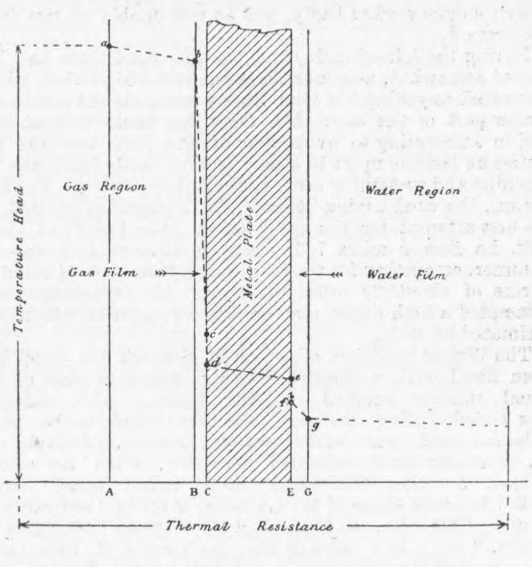


Fig. 3—Diagram indicating Loss of Temperature Head due to films of Gas and Water offering Resistance to the Transmission of Heat.

If the eye is brought to the level of the paper, the existence of this film can be seen. Mr. Fletcher, who found it to be about $\frac{1}{40}$in. thick, measured it by placing strips of copper on the paper next the gas flame. When the copper exceeded $\frac{1}{40}$in. thick the paper charred.

Heumann in 1876 showed the existence of a film by heating a plate, when it was noticed that the flame did not touch the plate until the plate had attained a certain critical temperature, when the film disappeared and contact between the flame and the plate took place. Reference to, or experiments bearing upon, the existence of this gas film have been made by many writers—see Lord Kelvin, Halliday, Professor Lewes, Dr. Smoluchowski, Dr. Stoney, Harold Dixon.

On the existence of a water film coating the plate.—There is considerable evidence to show that a water film clings to the plate on the water side separating the bulk of the water from the plate. This film is the cause of anomalous results in such a simple case as the measurement of the heat required to raise the temperature of water in an open vessel with a gas flame underneath. If in one case the water is maintained absolutely at rest, so that nothing is done to break up the film, then the heat transmitted to the water will be considerably less for a given temperature head than it would be if means were taken to break up the film. This is because heat must pass by conduction without convection currents, consequently it is the conductivity of water which is called into play, and this is known to be exceedingly small. The water film is further considered below. In a boiler the question is much more complicated, because of the formation of steam bubbles.

CONDUCTIVITY OF THE ELEMENTS IN THE PATH OF FLOW.

Experiments giving the conductivity of gases.—The transmission of heat from one point to another through a gas is, in general, as already stated, accomplished partly by radiation, partly by convection, and partly by conduction. Transmission by radiation and convection takes place so readily that it is difficult to devise experiments in which the heat transferred by conduction can be separated from that transmitted by the other methods. Most of the great physicists have devoted attention to this problem, and much work has been done, especially of a qualitative nature. Some references are given in the appendix to important papers on the subject.

The most brilliant and original contribution to the subject was made by Clerk Maxwell, who predicted from the kinetic theory of gases that the conductivity K is proportional to the product of the coefficient of viscosity and the specific heat at constant volume. This prediction has been amply verified by experiment. It follows that if η is the cofficient of viscosity, and κ_v the specific heat of a gas at constant volume

$$\mathrm{K} = \eta\,\kappa_v \times \text{a constant} \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

The value of this constant is stated by Meyer to fall between the values of 0.5 and 2.5. An account of the kinetic theory of gases and the application of the theory to various heat phenomena will be found in "The Kinetic Theory of Gases," by O. E. Meyer, translated by R. E. Baynes, and published by Longmans, Green and Co. Clerk Maxwell's papers on the subject will be found in the *Phil. Mag.*, 1860 and 1868, and in his collected "Scientific Papers," Vol. i., page 403, and Vol. ii., page 74.

The coefficient of viscosity of a gas may be defined as follows :—

If two planes in a gas be at a distance d apart, and if one plane moves with a velocity v relative to and parallel to the other plane, it exerts a tangential force F on it given by

$$\mathrm{F} = \eta\,\frac{v}{d}$$

where η is called the coefficient of viscosity of the gas.

Maxwell has shown that the coefficient of viscosity is given by

$$\eta = \rho\,\mathrm{L\,U} \times 0.31$$

where ρ = the density, L the length of the "mean free" path of the molecules, U the mean velocity of the molecules.

The product L ρ is constant for a given gas, and it has been experimentally proved that η is independent of the pressure through a wide range of pressure. The value of η depends on the temperature, and it varies approximately as a power of the absolute temperature, the value of the power being slightly different for different gases. The following table has been constructed from data given in the "Physickalisch-Chemische Tabellen of Landolt-Börnstein," published by J. Springer, Berlin. It shows : In the first column, the values of the power n of the absolute temperature according to which η varies ; in the second column, the values of η_0 at 0 deg. Cent. ; in the third column, the values γ of the ratio of the specific heat at constant pressure to the specific heat at constant volume ; in the fourth column, the values κ_p of the specific heat at constant pressure ; the values in the fifth column of the specific heat at constant volume are deduced from the figures in Columns 3 and 4. The sixth column gives the value of the product $\eta\,\kappa_v$, and the seventh column the experimental values of K at 0 deg. Cent. Comparing Columns 6 and 7, it will be seen that the several products $\eta\,\kappa_v$ require to be multiplied by a constant about equal to 2, in order that they may agree with the corresponding experimental results.

	1 n	2 η_0	3 γ	4 μ_p	5 κ_v	6 $\eta_0\ \kappa_v$	7 Experimental value of K at 0° C.
Air ..	0.76	17×10^{-5}	1.41	0.24	0.1702	29×10^{-6}	55×10^{-6}
CO_2	0.92	14×10^{-5}	1.30	0.20	0.154	21×10^{-6}	31×10^{-6}
N_2 ..	0.74	16×10^{-5}	1.41	0.24	0.1702	27×10^{-6}	52×10^{-6}
O_2 ..	0.79	18×10^{-5}	1.41	0.21	0.149	27×10^{-6}	56×10^{-6}
CO ..	0.74	16×10^{-5}	1.41	0.24	0.1702	27×10^{-6}	50×10^{-6}
H_2 ..	0.63	8×10^{-5}	1.41	3.4	2.41	193×10^{-6}	330×10^{-6}

In this table K is in C.G.S. units, that is, it means the number of calories flowing per second across 1 square centimetre when the temperature gradient falls at the rate of 1 deg. Cent. per centimetre.

The general expression (1) shows that the value of K is variable, since it varies jointly with η and κ_v, each of which is variable. From the above table it will be seen that n may be taken equal to ¾ without serious error, so that

$$\eta \propto \mathrm{T}^{\frac{3}{4}}$$

The variation of the specific heat is much smaller, and for the permanent gases almost negligible, in comparison with the variation of η, at any rate at all ordinary temperatures. As indicating the magnitude of the variation, the following data may be quoted from an Appendix, by Professor Callendar, to the British Association Report on Gaseous Explosions, presented at the Dublin meeting in 1908.

κ_p for air between the limits of 0 deg. and 100 deg. Cent. is given by

$$0.2431\,(1 + 0.00005\,t).$$

For nitrogen between 840 deg. and 1340 deg. Cent.,

$$0.2350\,(1 + 0.00008\,t).$$

A much larger variation is given for CO_2. Thus, quoting the values determined by Swann,

κ_p at 0 deg. Cent. is 0.1973, and at 100 deg. Cent. it is 0.2213, an increase of 0·024 for a change of temperature of 100 deg. Cent.

For practical purposes the value of K may be found approximately by assuming that the specific heat at constant volume remains constant with the temperature, and that the coefficient of viscosity varies as the ¾ power of the absolute temperature, and then using these assumptions with the experimental values given in the seventh column of the table. Thus, required the value of K for air at 500 deg. Cent. The absolute temperature of the air would be 500 + 273, so that

$$\mathrm{K} = 55 \times 10^{-6}\left(\frac{773}{273}\right)^{\frac{3}{4}} = 120 \times 10^{-6}$$

or more than twice the value at 0 deg. Cent.

Experiments giving conductivity of water.—Recent experiments have been made by Professor Chattock and Mr. Milnes in 1899. Special arrangements were made to prevent heat being transmitted by convection. A thin film of water was heated from the top. The conductivity was found to be 0.001433 C.G.S. units at 20 deg. Cent., corresponding to 0.001865 foot-pound-second units at 68 deg. Fah. This may be compared with previous results.

	K	Temperature. Deg. Fah.
Lundguist	0.00223	108
Winkelmann	0.00200	57
Weber	0.00161	4[illegible]
Weber	0.00186	75
Lees	0.00177	77
Lees	0.00153	116

Professor C. von Bach made an interesting study with a locomobile boiler. The temperature of the water in different layers was recorded during the period of heating up ; that is, when no definite circulation had commenced, and he found a difference of 252 deg. Fah. between the bottom and the top layers of the water.

When ebullition takes place in a boiler the presence of steam bubbles on the heating surface adds a new element to the problem of heat transmission, since they offer a large resistance to the passage of heat. Brillié suggested that rapid circulation not only serves to brush away the steam bubbles, but also lowers the percentage of bubbles present per volume of water passing the heating surface.

Steam-extracting tubes also serve the double purpose of increasing the circulation and removing the steam bubbles from the heating surface as soon as they are formed.

(*To be continued*).

It is stated that out of 1412 kiloms. of electric tramways in Russia, 1169 kiloms. belong to Belgian companies, the remainder being in the hands of municipalities.

LIQUID FUEL IN ITS ECONOMIC ASPECTS.

THE introductory lecture to the courses on Fuel at the Sir John Cass Technical Institute was given by Mr. J. S. S. Brame, Lecturer on Fuel, on Monday, October 11th, when the chair was taken by Sir Boverton Redwood, D.Sc., who, in introducing the lecturer, said that it would be superfluous to point out the responsibilities devolving upon all those who in various capacities were called upon to control the industrial use of fuel. Fortunately, there was now a general recognition of the fact that in the matter of fuel we had in the past been disgraceful spendthrifts, squandering our capital in such a manner that we had often obtained only a small proportion of the benefit which it is capable of giving. We were now becoming alive to the fact that our fuel capital, solid, liquid and gaseous, was within measurable distance of exhaustion, and that we must husband our resources if we were to avoid bankruptcy at an early date. The cheery optimist might tell us to rest secure in the conviction that some substitute for our present fuel would be discovered in time to avert disaster, but he did not think that any of those in the room would accept that advice, or consider that it absolved us from the duty of so using what remained of our fuel as to get the highest efficiency in the shape of work with a given consumption.

Mr. Brame took as the title for his lecture "Liquid Fuel and its Economic Aspects." He said that the use of liquid fuel for power purposes had within recent years attracted much attention in this country. It was only within comparatively recent times that great advances had been made in its utilisation in internal combustion engines, a use which had had far-reaching results. The petrol engine was, of course, a pure liquid-fuel motor, and the advances directly attributable to this one form of liquid fuel included the introduction of the motor car, the submarine for naval purposes, and, lastly, had led to the solving of those problems of flight which man had hoped to accomplish for many years.

As a fuel for steam raising, oils of high calorific value, cheapness, and high flash point were demanded, whilst for internal combustion engines oils of high volatility were generally requisite, in order that they might readily form explosive mixtures with air in the cylinder. For the external combustion of oil fuels some spraying or "atomising" device was now practically universally adopted, some systems depending on steam injection, others on air, and another type, which was rapidly finding extended use, especially for marine purposes, on the spraying action obtained through the oil being forced under pressure through small orifices in the burner. The provision of a suitable spraying burner was, however, a matter of no great difficulty. To obtain complete and smokeless combustion great attention had to be paid to the furnace arrangements, and early troubles largely arose from lack of proper attention to this point. Smokeless combustion could now be ensured.

Briefly, the advantages of liquid fuel over coal might be summarised as superior evaporation to coal in the ratio of 1.6 to 1; ease of handling; the facility it afforded for stowing on ships in situations where coal could not possibly be stored; and that less space was required for it than for coal, one ton of oil requiring only some 38 cubic feet, whilst coal requires some 43 cubic feet per ton. There are also numerous other minor advantages. The many advantages of liquid fuel had created such enthusiasm in its favour that the important questions of supply and prices had frequently been overlooked. The total oil supplies of the world, taking the figures for 1907, amounted to 34,569,500 tons, which in terms of coal, since the oil had such superior calorific value, would be equivalent to 51,854,250 tons of the latter fuel, or only one-fifth of the coal output of this country alone. Further, but a portion of the crude petroleum was suitable for fuel. Liquid fuel, therefore, could not compete with coal, and was not a fuel for general use, but for employment in special cases. For naval purposes most Powers were now following the lead given by Great Britain in its adoption.

For use in internal combustion engines the lighter petroleum distillates were, continued the lecturer, almost universally employed. Our annual importation of petrol had now reached the total of some 33,500,000 gallons. By the introduction of the spray carburettor a heavier grade of petrol could now be utilised—a factor of considerable economic importance as regarded supplies. Further, since the calorific value of petrols of varying gravity was practically the same per unit weight—20,000 British thermal units—it followed that, as they were bought by volume, the heavier grades were the more economical.

Paraffin-driven motors were valuable engines for many purposes, notably where a portable engine was required, or for boats where safety was a factor of great importance. Paraffin engines worked best at constant speeds, and were not suitable for cars. One important point with all engines using petroleum oils was that high compressions were out of the question, since at little over 4.5 atmospheres there was a risk of premature ignition, and hence the efficiencies obtained were low.

As petrol substitutes the claims of benzine (or benzol) and alcohol must be considered. Benzine was produced in very large quantities from both gas and coke-oven tar, and its present price was low, about 6½d. per gallon. The calorific value per unit weight was 18,540 British thermal units, but per unit volume, owing to its higher gravity, it had a higher value than many petrols. In practice, benzol gave most excellent results without any special alteration of the carburetter designed for petrol, a 40 horse-power six-cylinder Napier car having covered 22.65 miles per gallon of benzol as against 18.14 miles on petrol. Slight trouble might be anticipated in very cold weather, but usually there was no difficulty in starting the engine if a little petrol were first got through the carburetter.

Alcohol, the only fuel which we could actually manufacture from materials derived from other sources than coal, peat, or petroleum, was of special interest. The importance of alcohol and the great aid which its production on a large scale would give to agriculture, had led to the possibilities of its use being carefully studied by Commissions in Germany, France, and America. For motor use it had many advantages over petrol or benzine; it is far less inflammable, and if a fire did arise, it could more easily be extinguished. Moreover, its combustion left no evil-smelling products; engines ran more quietly on alcohol, and it would stand higher compressions in the cylinder, thereby giving such greater efficiency that the effect of its low calorific value was almost counterbalanced. For equal weights the calorific value of petrol to alcohol is 20,000 to 11,000 British thermal units, a ratio of 1.8 to 1, but if considered by volume the ratio was reduced to 1.6 to 1. Since the thermal efficiency of alcohol was greater than that of petrol in the ratio of 3 to 2, it was evident that volume for volume the same power could be obtained from alcohol as from petrol.

At present the cost of alcohol was, it was explained, prohibitive, and although in seasons when a heavy yield of raw material—chiefly potatoes—was obtained, the cost of production was comparatively low; yet with charges such as are necessarily imposed through Revenue supervision, quite independent of duty, it was unlikely that it could for many years reach the position of a commercial fuel. As pointed out by Professor Lewes, for use in submarines alcohol would be an ideal fluid on account of its great safety, and, in order to obtain all possible security for those engaged on this dangerous duty, expense was a matter of very minor importance.

THE DONCASTER AERONAUTICAL MEETING.

THE first meeting of aeronauts to be held in this country opened at Doncaster last Friday, October 15th. A course having a total length of 1 mile 3½ furlongs had been laid out on the grounds of the racecourse close to the town. In shape the path of flight is a seven-sided irregular polygon, its corners being all obtuse, with one exception, where the aeronauts have to negotiate a turn of about 60 deg.

When the meeting opened eleven aeronauts had intimated their intention of taking part in the various competitions. These were as follows:—Cody, on his own design of biplane; Roger Sommer, with a Farman biplane; Edward Mines, on a Mines biplane; Schreck, on a Wright biplane; Saunier, on a Chauvière monoplane; and Delagrange, Le Blon, Molon, Prevoteau, Windham, and Count der Burch, on Blériot monoplanes. The prizes included the Bradford Cup for the best flight over ten circuits of the course, the Doncaster Cup for the highest aggregate over all flights, the Leeds Cup for the best flight extending over forty-five minutes, and many others.

On the opening day rain fell until late in the afternoon, so that all attempts at flight had to be abandoned. Captain Windham and Mr. Cody towards the close of the day brought out their machines, intending to make trial flights, but the former met with disaster almost immediately, a strong gust of wind catching his aeroplane and snapping its framework. Captain Windham himself fortunately escaped unhurt. Mr. Cody's engine worked badly, and he was unable to rise from the ground.

During the following day the weather conditions had improved somewhat, although there was still a high wind, which prevented anything but trial flights being carried out in the earlier part of the day. Mr. Cody was again unfortunate, and in attempting to avoid one of the posts marking the course he became upset in a sand bunker, badly damaging his machine and sustaining some slight personal injury. Towards 3 p.m., the wind having lessened, M. Delagrange started on his first attempt for the speed prize. At a height of about 50ft. he flew 5 miles 750 yards in 10 min. 48.2 sec. M. Sommer, competing for the same prize, then flew 2¼ miles at a rate of about 22 miles per hour. M. Delagrange next attempted a high flight, and reached an altitude which was estimated at 250ft.

The Wright machine, of which M. Schreck was pilot, had been fitted with a wheeled starting chassis in place of the usual runners adopted on this design. This machine was tested during the day, but was found to be badly balanced and was withdrawn for repairs. A flight by M. Sommer next attracted attention, when he accomplished 5 miles 750 yards in 12 min. Other flights of the day were those of M. Le Blon, 2 miles 1140 yards in 5 min. 14.4 sec., and M. Molon, 3 miles 50 yards in 6 min. 9 sec. As a result of the day's work, M. Delagrange was awarded the silver cup and 1500f. for the Inauguration Prize, while M. Sommer received 500f.

On Monday a strong breeze again prevented flying during the morning. M Delagrange and M. Sommer attempted to do so, but the difficulties due to a wind of 20 miles per hour proved too great.

In the afternoon the conditions were more suitable, and M. Sommer started the serious flying of the day, performing four circuits at a low altitude. He next entered for the ten circuits for the Bradford Cup, but, rain beginning to fall, he and M. Delagrange, who had also entered, were compelled to descend after completing five laps. Captain Windham was again unfortunate. While bringing his machine from its shed he collided with a motor car and damaged the framework in much the same manner as on the first day. A good flight by M. Le Blon then took place. At a height varying from 30ft. to 80ft. he circled the course ten times in 20 min. 20.5 sec. and continued for 4¾ circuits before descending, thereby winning the Bradford Cup and £40. M. Le Blon's time and distance were officially given as 22 miles 295 yards in 30 min. After dark M. Sommer flew eleven rounds, or 16½ miles in 28 min. 14.6 sec., his time for the ten rounds being 25 min. 30.4 sec. During the day a new entry was received, Captain Lovelace appearing with his Blériot monoplane.

The earlier part of Tuesday was again devoid of results, and throughout the entire day the high wind seriously interfered with the aeronauts' work. Mr. Cody, having repaired his machine, made several attempts at flight, but owing to defects in his engine these were all confined to short distances. The contest for the Leeds Cup next engaged interest, when MM. Le Blon and Sommer started simultaneously on their flights for this prize. The high wind prevented either from remaining in the air for the required time, M. Sommer flying 7½ miles in 11 min. 22 sec., and M. Le Blon 14¾ miles in 20 min. 37 sec. M. Sommer later made a second attempt for the Leeds Cup, and in spite of rain falling at the time, succeeded in flying over the course four times. The Leeds Cup contest had therefore to be continued on the following day. For the Doncaster Cup M. Sommer at this time led the competition with 74 miles to his credit, while M. Le Blon was second with 40 miles.

During the whole of Wednesday the force of the wind entirely prevented any attempts being made to go on with the various competitions. From the hour of opening till darkness set in no competitor succeeded in flying a complete round of the course. After dusk M. Sommer, who has done most of his previous successful flying by moonlight succeeded in getting off and remained in the air for 9 min. 45 sec., in which time he traversed 5 miles 1495 yards. With this exception no flights took place on this day which are in any way worthy of record.

THE IRON, COAL, AND GENERAL TRADES OF BIRMINGHAM, WOLVERHAMPTON, AND OTHER DISTRICTS.

(*From our own Correspondent.*)

After the Quarterly Meeting.

MANUFACTURED iron prices since the quarterly meeting have undergone very little change. Common bars are £5 17s. 6d. to £6, unmarked merchant bars £6 2s. 6d. to £6 5s. now, marked bars £8, second grade marked bars £7, and Earl Dudley's bar iron £8 12s. 6d. for his Lordship's L.W.R O. brand. Hoops are £6 15s., and gas tube strip iron £6 5s. to £6 7s. 6d., less 2½ per cent. now. It is, however, very difficult to ascertain what is the actual selling price at which gas tube strip orders are going through, since, owing to continued fear of Belgian competition, it is pretty well understood on the market that makers are allowed by the Association to undersell the standard when necessary to prevent orders going on to the Continent.

Galvanised Iron Going Strong.

Black sheets for galvanisers and for merchant purposes are, strange to say, still making very poor prices. They do not rise above £7 2s. 6d., or £7 5s. for doubles, and £7 15s. to £7 17s. 6d. for trebles—a level at which they have stood now for a very long time. The finished product, *i.e.*, galvanised sheets themselves, however, are improving in value, and makers will not now accept anything less than £11 to £11 5s. per ton. Some firms, indeed, demand £11 10s. Some amount of underselling by merchants is still complained of, but it is believed that there will be an end to this when they have unloaded their excess stocks which they purchased when prices fell to £10 10s. and £10 15s. in open market. Galvanisers keep very well occupied on shipping orders, and the outgoings for last month to all parts made a remarkably good showing. The total shipments were about 41,000 tons, or 10,500 tons larger than a year ago. It is exceedingly gratifying, too, as evidencing a very healthy demand, that the aggregate exports of galvanised corrugated material for the nine completed months of this year are 64,000 tons in excess of those of a year ago.

Tinned Sheet Iron.

The Staffordshire Tinned Sheet Makers' Association have held their usual quarterly conference under the chairmanship of Mr. S. L. Dore. The following prices have been officially re-affirmed:—Best charcoal tinned sheets, 30s. per cwt.; best cokes (singles), 28s. per cwt.; and Staffordshire tin-plates, 22s. to 28s. per box. It was reported that trade in the last-named material was "quite brisk."

Pig Iron Steady.

Pig iron still rules steady, whether Midland or Staffordshire brands are spoken of, and prices are firm, though new business is slack. With coal and coke advancing, makers cannot, however, afford to court new contracts by offering concessions to consumers. Current values on the open market at Birmingham this week are as follows:—Forge pig iron: Staffordshire common, 47s. to 48s.; part-mine, 50s. 6d. to 51s. 6d.; best all-mine forge, 85s.; foundry, 90s.; cold blast, 115s.; Northamptonshire, 49s. to 50s.; Derbyshire, 50s. to 51s.; North Staffordshire forge, 51s. 6d. to 52s. 6d.; best, 58s. to 59s.

The Steel Trade.

It is reported that the British Steel Joist Association are taking steps to strengthen their organisation, and, if possible, prevent underselling by merchants, which has of late been a good deal complained of in some quarters. It is explained that merchants, by holding their orders, have been able to buy on such good terms as to enable them to undersell makers in respect of small and medium sized orders. The raw steel market is somewhat quiet just now. It is reported that Belgian billets have been sold delivered in the district over the first quarter of 1910 at from £4 10s. to £4 12s. 6d. per ton, against £4 15s., the present British price delivered Midlands. Rolled steel is quoted this week—local and district manufacture—at:—Angles, £5 17s. 6d. to £6; girder plates, £6 to £6 2s. 6d.; boiler plates, £7 5s.; joists, £5 15s. to £6; mild bars, £6 7s. 6d. to £6 17s. 6d.

NOTES FROM LANCASHIRE.

(*From our own Correspondent.*)

MANCHESTER, Thursday.

An Uneventful Meeting.

THERE was a fair attendance on the Iron Exchange on Tuesday. It was very difficult, however, to gauge the situation. The Birmingham meeting had left a confident tone, but opinions here were varied. Generally speaking, prices had a downward tendency, and this was to some extent confirmed by the offerings of merchants. On the other hand, makers' prices remained generally unchanged, and approximate to the lower prices of last week. There was a tendency to recovery in hematite, and also in Middlesbrough brands. Forge iron was a shade lower as compared with last week.

Finished Iron and Steel.

There is absolutely no new feature to report. Foreign billets are scarce, and merchants are seeking eagerly for parcels to cover contracts already made. Prices of foreign are nearer to English billets than has been the case for a long time past.

Copper, Lead, Tin.

Manufactured was very dull, and prices tend downwards. There was, however, no quotable change to report. Lead: Sheets firm. Tin: English ingots a shade lower.

Quotations.

Lincolnshire, No. 3 foundry, 56s.; Staffordshire, 54s.; Derbyshire, 55s.; Middlesbrough, open brands, 60s. 6d. Scotch: Gartsherrie, 62s. 6d.; Glengarnock, 62s; Eglinton, 60s. 6d., delivered Manchester. West Coast hematite, 63s.; East Coast ditto, 60s., both f.o.t. Delivered Heysham: Gartsherrie, 60s. 6d.; Glengarnock, 60s.; Eglinton, 58s. 6d. Delivered Preston: Gartsherrie, 61s. 6d.; Glengarnock, 61s.; Eglinton, 59s. 6d. Finished iron: Bars, £6 10s.; hoops, £7 12s. 6d.; sheets, £7 15s. to £8. Steel: Bars, £6 2s. 6d. to £6 5s.; Lancashire hoops, £7 5s.; Staffordshire ditto, £6 17s. 6d. to £7; sheets, £7 17s. 6d. to £8; boiler plates, £7 5s. to £7 7s. 6d.; plates for tank, girder, and bridge work, £6 5s. to £6 7s. 6d.; English billets, £4 12s. 6d. to £4 15s.; foreign ditto, £4 10s. to £4 15s.; cold-drawn steel, £9 10s. to £9 15s. Copper: Sheets, £71; tough ingot, £62; best selected, £62 per ton. Copper tubes, 8½d.; brass tubes, 6⅞d.; condenser, 7⅞d.; rolled brass, 6¼d.; brass wire, 6½d.; brass turning rods, 6½d.; yellow metal, 6d. per lb. Sheet lead, £17 per ton. English tin ingots, £136 per ton.

The Lancashire Coal Trade.

The dullness already noticed in this trade is becoming more pronounced. The attendance on the Coal Exchange on

Tuesday was meagre in the extreme. Indeed, it has not been smaller for a long time past. Trade was extremely dull in domestic fuel, as also slack and steam coal generally. There was a shade more being done in the shipping department, but beyond this the market was featureless. Quotations are as follows:—Best Lancashire for domestic purposes, 14s. 2d. to 15s. 8d.; seconds, 12s. 2d. to 13s. 2d.; common, 10s. to 11s. 2d.; best burgy, 10s. 6d.; round furnace coal, 11s. 6d.; best slack, 9s. 6d.; medium, 9s.; common, 7s. 6d., at the pit. Coal for bunkering purposes, screened, 11s. to 11s. 6d.; unscreened, 10s. 6d., delivered Manchester Ship Canal.

BARROW-IN-FURNESS, Thursday.

Hematites.

After a brief depression in the hematite iron trade last week, there have since been signs of improvement in the demand, and more business has been done at somewhat higher prices. Makers are quoting 62s. net f.o.b. for mixed Bessemer numbers nominal. It was reported last week that they were in one or two instances disposed to sell at 60s. 6d., but business in warrant iron has been done at this figure, and sellers are now asking 62s. net cash. There is a better feeling all round, as it is considered probable that the giving out of large orders by the Admiralty in the course of a few weeks will mean a big demand for hematite iron. There is also the prospect that a fuller business will arise from other sources, including continental. Makers remain well sold forward in the majority of cases, and none of the iron now being produced is going into stock. Warrant stocks total at the low figure of 15,851 tons. A good trade is being done in special hematite iron, and some large sales are reported of ferro-manganese and spiegeleisen. Sales of scrap iron are well maintained. Iron ore is quiet at 12s., 14s. 6d., and 18s. for ordinary, medium, and best descriptions net at mines. Some large cargoes of foreign ores have lately been imported.

Steel.

There are better prospects in the steel trade. Makers are still able to keep their rail mills in regular employ, and the demand for rails is such as justifies the hope that they will continue to do so. Merchant steel is in moderate demand, but the mills have worked better of late. There is no change in the shipbuilding material market, but makers are expecting fuller inquiries. Ship plates are at £6 per ton.

Shipbuilding and Engineering.

The work of tendering for important orders in the market for warships, merchant ships, and marine engineering was never busier than at present, and the belief is entertained that these will lead to brisk trade in the early future.

Shipping and Coal.

The shipments of iron and steel from West Coast ports last week amounted to 12,820 tons—iron 2925 tons, and steel 9895 tons—against 13,009 tons for the corresponding period of last year, a decrease of 189 tons. For the year to date the shipments aggregate 490,853 tons, against 390,762 tons for the corresponding period of last year, an increase of 100,091 tons. Coal and coke steady. Blast furnace coke is now at 22s. 6d. per ton, delivered at West Coast furnaces.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

Steam Coal Easier.

THE drawing to a close of the Baltic shipping season is placing more steam coal at the disposal of coalowners for industrial purposes. At present there does not appear to be a great surplus in the market, and prices have not receded more than 6d. per ton from what was asked for when the shipping season was active. The rates now ruling are at 8s. 6d. to 9s. per ton. We do not hear of contracts being fixed as yet for next year, coalowners, no doubt, expecting that values will advance later on, the indications pointing that way. The weight exported from Hull for the week ending 12th October amounted to 77,900 tons, which compares with 64,773 tons for the corresponding period of last year. Hamburg, with 9244 tons, heads the list, Pernau is second with 6827 tons, and Cronstadt third with 4007 tons.

House Coal Rather Firmer.

The tendency in domestic fuel is distinctly upward. Unfortunately for the coalowners the fluctuations in the weather do not warrant a unanimous official advance, but orders for supplies wanted for forward delivery are not taken at less than 1s. advance on current quotations. The principal business continues to be done in the higher grades. Rates ruling for present delivery are from 11s. 6d. to 13s. per ton for best Barnsley, secondary qualities from 10s. to 11s. per ton.

Small Coal and Coke—A Steady Trade,

Small coal moves freely, and former rates are firmly maintained. Best slacks make from 4s. 6d. to 5s. 6d. per ton, the output being readily absorbed by market requirements. There is not so much being done in the lower grades of slacks. The firmness noted last week in coke is fully maintained, and 13s. a ton is talked of for best washed for forward contracts. Current business is being done at 12s. 6d. per ton for best washed, and 11s. to 11s. 6d. per ton for unwashed.

The Iron Market.

Conditions are still unsatisfactory. Business is much restricted, as consumption is not equal to supply, and hence the slackness in taking deliveries. Buyers are not eager to accept deliveries through want of specifications. Official quotations remain unchanged:—Hematites, West Coast, 68s. to 70s. per ton; East Coast, 65s. to 67s. per ton, both net, delivered in Sheffield and Rotherham. Lincolnshire, No. 3 foundry, 52s. 6d. per ton; No. 4 foundry, 51s. 6d. per ton; No. 4 forge, 51s. 6d. per ton; No. 5 forge, mottled and white, 51s. 6d. per ton; basic, 52s. 6d. per ton, all net, delivered in Sheffield and Rotherham. In Lincolnshire irons makers are disposed to urge acceptance of deliveries more freely, with the result that more iron is going out than was the case a week or two ago, but there is, as stated, a lack of specifications to use it up as rapidly as could be wished. Several of the buyers are open to purchase for next year, and makers are willing to sell only at a premium of 1s. 6d. to 2s. per ton on current quotations for the first six months of 1910. Derbyshire No. 3 foundry remains at 52s per ton, and No. 4 forge at 50s. 6d. per ton, both net, delivered in Sheffield and Rotherham. From Derby and district the heavy branches of the iron trade are reported to be without material change, although, it is added, the new specifications coming to hand point to a more vigorous business. At the bridge and girder works operations are not fully going. Several of the Derbyshire iron makers are not pushing business, having little to offer, though being well sold forward.

Bars, Hoops, and Sheets.

No signs of early activity are as yet perceptible in these departments, and quotations remain as formerly given, bars making £6 10s. per ton, hoops £7 10s. per ton, and sheets £8 10s. per ton. The rolling mills, forges and tilts are by no means fully occupied.

Military, Railway, and Marine Material.

Reports have appeared that the four contingent Dreadnoughts were likely to be placed at some early date. It will be remembered that the first period given for these battleships was about April next. In the natural order of things we are getting nearer to that date, and the work already in hand is fast approaching completion. The various firms interested in shipbuilding, armour, and armament, will be pleased to have the orders to follow immediately on the present work now rapidly being finished. So far, however, as local firms are affected, there is no sign of the work being placed in the immediate future. More inquiries are reported for railway material, as well as for engineering requirements; new orders for railway material, however, do not appear to be so much for fresh work as for replacement of existing stock, but they are larger in extent than has been experienced for some time past. Orders for marine work still continue scanty. The inquiries received some time ago do not appear to have shown any great result, and the cessation of summer shipping has its effect, throwing more vessels idle.

Steel.

Steel for tools, and of high qualities, is still in fair demand, partly on export account to America and the Colonies. The United States demand for high-speed and the higher grades of carbon crucible steel, referred to last week, is fully maintained. The home trade in several quarters shows signs of increased animation, though there remains abundant room for further improvement generally.

The Lighter Trades.

Although there is some change for the better in lighter steel and steel products with several distant markets, the general condition of the lighter industries leaves much to be desired. The file trade is in a very languid condition, while the edge and joinery tool industries, through several causes, including the stagnation in house building in the larger centres of populations, are much depressed. The demand for hand tools has been greatly diminished through the larger use of machine joinery, a department in which there has of late been marked development. We do not hear of improvement in the cutlery trades generally, though the Colonial demand has been better recently. The silver and electro-plate firms in several instances are fairly well off for work, electro-platers having of late been somewhat busier, on Colonial and home account, than was the case earlier in the year.

NORTH OF ENGLAND.

(*From our own Correspondent.*)

Cleveland Pig Iron.

IT cannot be reported that a large amount of business has been done this week in Cleveland pig iron; on the contrary, there is a decided lull, but that is not weakening prices, for it is recognised that the conditions and prospects of trade have not altered for the worst in the slightest degree, and the reasons for believing that the depression is passing away, and for expecting a strong revival of trade over next year, if not before the close of 1909, are as manifest as ever. It is the usual experience in every upward movement to have at intervals lulls in buying. Reports of some improvement in business come from almost all the leading markets, and the change for the better appears, not in the iron and steel industry alone, but in other important trades. The official figures issued by the Board of Trade indicate that in most principal countries this year's business shows an improvement on that of last year. At home the statistics show that there is less unemployment. In this district works generally are more fully occupied than they have been for almost two years, prices are in all cases tending upwards, shipments increase, and there is more disposition shown among speculators to operate in warrants, notwithstanding that the further advance in the Bank rate has made it more expensive to do so where monetary accommodation has to be arranged. But undoubtedly confidence is increasing, especially in view of the fact that the revival is making its appearance in the finished branches of the iron and steel trades, it being inferred from that that the improvement is mainly genuine, and not the outcome of mere speculation, though there is a good deal of that so far as Cleveland warrants are concerned; on account of this latter fact, the prices of Cleveland pig iron, it is argued, are higher than they would have been if the upward movement had been influenced by actual consumptive demand alone. Altogether, the prospects must be accounted favourable, so much so that producers are not in any hurry to commit themselves to contracts for delivery much into next year, whereas consumers, on the contrary, are rather anxious to buy forward, as they will probably have to pay considerably more than present rates if they wait. A good deal of No. 3 could be sold for delivery over the first quarter of 1910, if makers would accept anything like the figures they are asking for prompt delivery, but naturally they are not prepared to do that in the face of a rising market. No. 3 Cleveland pig iron for early f.o.b. delivery has generally been sold this week at 52s. per ton, No. 1 at 54s. 3d., No. 4 foundry at 50s. 6d., and No. 4 forge at 50s., with 6d. to 9d. more for delivery over the next three months.

Local Trade with America.

Inquiries keep coming from the United States for Cleveland pig iron, but this week they do not seem to have been followed by actual orders, sellers asking more than consumers over there are prepared to give, as they can get American iron on better terms. People have apparently made up their minds that American consumers will have to come to Cleveland for large supplies of pig iron, and that probably before the end of the current year, so that they may not be short in the winter season. Unusual attention is therefore directed to the reports from the States, and the tone of these is strongly reflected on our own market. Though the American output of pig iron is on a larger scale than was ever before known, some of the founders in the Eastern States are reported to have difficulty in securing all the iron they need, and thus traders here have subtantial grounds for expecting large shipments from this district to the States. The first cargo of Cleveland pig iron sold to the United States since the current revival set in was despatched towards the close of last week, the steamer Glenesk taking 4600 tons of G.W.L. iron from the wharf of the makers—Messrs. Wilsons, Pease and Co., Tees Ironworks, Middlesbrough, for conveyance to Boston. This week the steamer Kylakin is loading for America 5000 tons of G.W.L. and Ormesby pig iron from the works of Messrs. Wilsons, Pease and Co and Messrs. Cochrane and Co. The steamer Gresham has been chartered to carry a mixed cargo from the Tees to Philadelphia, including 1000 tons of Cleveland pig iron, a quantity of spiegel, and 2500 tons of steel crop ends. The rate of freight for the pig iron is 5s. 9d. per ton, and for the crop ends 6s. 9d. per ton. It is calculated that 15,000 tons of steel scrap have been sold to the States by firms in this district, and a further large trade in this is looked for. Palmer's Shipbuilding and Iron Company has shipped 3000 tons of hematite pig iron from Jarrow in the steamer Dundonian for Halifax, N.S., and has to send another 3000 tons to the same destination.

Hematite Pig Iron.

Consumers of East Coast hematite pig iron are not buying much at present, but that does not weaken the prices, as the producers are well supplied with orders, and have excellent prospects, so that there is no hurry about selling forward. Deliveries are heavy, and stocks are not increasing. Makers are quoting 60s. per ton for mixed numbers prompt delivery; but there are still a few second hands who will accept 59s. 6d. per ton for small lots to be supplied within the next three weeks. Not many are disposed to quote for 1910 delivery, as they cannot get quotations for materials, particularly ore, and thus cannot judge what the cost of production may be. For the first quarter of next year at least 62s. 6d. per ton would have to be paid. Rubio ore for early delivery is at 17s. per ton c.i.f. Middlesbrough, but merchants are not prepared to quote for next year, as the Spaniards will not fix their prices for 1910. The price of coke is increasing, and some sellers are asking for next half-year considerably more than the present prompt price, which is 17s. to 17s. 3d. per ton delivered at the furnaces at Middlesbrough.

Pig Iron Shipments.

The exports of pig iron from the Cleveland district are excellent this month, and that is one of the best features of the trade. Not in any month this year have the shipments been so good, and, moreover, they exceed those of the corresponding period of last year. They show a heavy increase to oversea destinations; in fact, these are 50 per cent. better than those of last month, and 30 per cent. more than in October last year. The total exports this month to 20th were 77,278 tons, as compared with 58,047 tons last month; 64,971 tons in October last year, and 104,409 tons in October, 1907, all to 20th.

Pig Iron Stocks.

Cleveland pig iron is going less rapidly into Connal's public store than in the early part of the month, and if shipments continue brisk it may become necessary to draw upon the store. On Wednesday the quantity of Cleveland pig iron held was 332,870 tons, an increase of 18,895 tons this month. The stock consisted of 307,704 tons of No. 3, 22,256 tons of No. 4 foundry; and 2910 tons of iron undeliverable as standard.

Manufactured Iron and Steel.

The demand generally is showing improvement, and works are for the most part running more regularly than for the last two years. But no changes in prices can be reported. Steel and iron ship plates are at £6, steel ship angles at £5 7s. 6d., iron ship angles at £7, packing iron and steel at £5 5s., steel bars at £6, iron bars at £7, steel hoops at £6 5s., steel strip at £6 2s. 6d., steel sheets (singles) at £7 10s., and steel joists at £5 15s., all less 2½ per cent. f.o.t. Galvanised and corrugated sheets are in particularly good request, and there are large shipments of these and structional steel to India, South America, and Japan. The prices are lower than when the combination broke up three months ago, but are higher than the figures to which they then fell, £10 15s. to £11 5s., less 4 per cent. f.o.b., being now quoted for 24 gauge in bundles. Heavy steel rails are in quiet request at £5 5s. net f.o.b.

Shipbuilding.

The improvement in shipbuilding is maintained, and builders are able to realise somewhat better prices. The Tyne Iron Shipbuilding Company has received orders from Whitby owners for three steamers—two of 6200 tons each, dead weight, for the International Steamship Company, and the third, which will be of similar dimensions, for the Rowland and Marwood Shipping Company. The Sunderland Shipbuilding Company has contracted to build a cargo steamer of 2000 tons dead weight for Norwegian owners, and two steamers of 10,000 tons each, also for Norwegian owners, are expected to be built on the Tyne; indeed, negotiations are now in progress. A sister vessel to the Tortona, just completed by Messrs. Swan, Hunter, and Wigham-Richardson, at Wallsend, for the Cairn line, Newcastle, is likely to be built at the same yard. The vessels are for the Italian-Canada emigrant trade. The number of vessels laid up in the Tyne is now 49 against 50 last week, and will not increase if the improving tendency of freights is maintained, but if the closing of the Baltic leads to reductions in freight in other directions we must look for an increase, especially with the higher insurance rates that are now in force.

Coal and Coke.

The steam coal market is very quiet as far as buying for early delivery is concerned, but there is more inquiry for supplies for 1910 delivery, and higher prices are quoted than are accepted for prompt. Thus 10s. 9d. f.o.b. is paid for best qualities, but business has been done at as high a figure as 12s. 9d. for delivery over next year, and 6s. for smalls. Some of the steam coal pits are irregularly employed this month, and there are considerable lots offered by second hands. Gas coals are in fair request at 10s. 9d. for best, and 10s. for seconds. Italian consumers have lately bought a good deal of Durham gas coals. Coking coals are in brisker request both for home consumption and export, and the prices for prompt delivery are firm at 9s. 6d. to 10s. Furnace coke is being sold at from 17s. to 17s. 3d. delivered at Middlesbrough works.

NOTES FROM SCOTLAND.

(*From our own Correspondent.*)

Business with Canada and the United States.

THE recent upward movement in the prices of iron was admittedly due in a large degree to reports of considerable quantities of iron being required for shipment to America and Canada, and something like evidence is now forthcoming to show that American influences have largely affected our market in the last few months. It would appear from reports now current on 'Change that about the time when the prices of pig iron began to rise, American speculators, or perhaps home operators, through American sources, became possessed of some 15,000 to 20,000 tons of warrants at near bottom prices. From this time reports of extensive American requirements were industriously circulated, and the prices accordingly mounted up, until the time came when it was considered judicious for those who purchased at bottom prices to unload, which it is now understood they have done and netted handsome profits. That prices of warrants did not recede further under the operation is attributed partly to the increasing interest the public has been taking in iron speculation, and also to the fact that there has really to some extent been a genuine improvement in demand, the results of which are beginning to appear in shipments to the States and Canada, and in a general improvement in the foreign demand. Hitherto ten cargoes of Cleveland iron—one of them whole raw iron, and the other partly raw and manufactured — have been dispatched. Another steamer has been chartered to take a cargo of pig iron from the English North-East Coast to Halifax, the freight being 6s. 6d. per ton, and it is stated that further business of this nature is probable. These and other similar transactions are apparently exercising a steadying effect on the market.

The Glasgow Iron Market.

There has been less life in pig iron warrants since last report, some meetings of the "Iron Ring" being almost without recorded business. Cleveland warrants have sold from 51s. 8d. to 51s. 10½d. cash, 51s. 8½d. to 52s. 2½d. one month, and 52s. 6d. to 52s. 9d. three months. Business has also been done in the same class of iron at 52s. for delivery in fourteen days, and 52s. 2½d. twenty-nine days.

Scotch Makers' Iron.

The business in Scotch pig iron is again more active, there being fair inquiries for abroad, and a good business with

English consumers. The output has been temporarily reduced by the extinction of four furnaces at Dalmellington Ironworks for repairs. There are now 78 furnaces in blast in Scotland, compared with 82 last week and 76 at this time last year, and of the total 35 are making ordinary, 38 hematite, and 5 basic iron. Monkland pig iron is quoted f.a.s. at Glasgow, No. 1, 58s. 6d.; No. 3, 56s. 6d.; Carnbroe, No. 1, 61s.; No. 3, 58s.; Clyde, No. 1, 63s.; No. 3, 58s.; Gartsherrie and Calder, Nos. 1, 63s. 6d.; Nos. 3, 58s. 6d.; Langloan, No. 1, 65s.; No. 3, 60s.; Summerlee, No. 1, 65s. 6d.; No. 3, 60s.; Coltness, No. 1, 90s.; No. 3, 59s. 6d.; Eglinton, at Ardrossan or Troon, No. 1, 58s. 6d.; No. 3, 56s. 6d.; Glengarnock, at Ardrossan, No. 1, 65s.; No. 3, 59s. 6d.; Dalmellington, at Ayr, No. 1, 62s.; No. 3, 57s.; Shotts, at Glasgow or Leith, No. 1, 63s.; No. 3, 58s.; Carron, at Grangemouth, No. 1, 65s. 6d.; No. 3, 59s. 6d. per ton.

Hematite Ore and Pig Iron.

The report that several hundred thousand tons of Spanish ore has been contracted for over next year to be delivered at United States ports has tended still further to strengthen the ore market, and the values of ore for delivery over 1910 are quoted several shillings per ton higher, while current freights are better than for a considerable time. A dozen steamers reached the Clyde with hematite ore in the past six days. Merchants have been quoting Scotch hematite pigs 63s. 6d. per ton for delivery at the West of Scotland steel works, and they have, no doubt, contracts arranged a considerable time ago which enable them to sell at this figure; but makers are reported to be asking 1s. 6d. more money. Cumberland hematite has been done in our market this week at 61s. 6d. for delivery in fourteen days, and 61s. 4½d. one month.

Pig Iron Shipments.

The shipments of pig iron from Scottish ports in the past week amounted to 7195 tons, compared with 4728 in the corresponding week of last year. The United States took 1456 tons, Canada 725, South America 150, Holland 560, Australia 160, Italy 200, Belgium 110, India 75, Germany 70, China and Japan 165, other countries 270, the coastwise shipments being 3252 tons, against 1936 in the corresponding week. The arrivals at Grangemouth of pig iron from Cleveland and district have been 12,522 tons, being 2485 tons more than in the corresponding week of last year.

Finished Iron and Steel.

There are fair inquiries for steel goods, and especially from Canada, with which an increasing business is being done. Considerable purchases of steel manufactures are reported to have been made within the last few days for prompt despatch, so as to reach Canada before the close of the navigation. Home orders for steel are as scarce as ever, specifications for shipbuilding material being very difficult to obtain in anything like sufficient quantity to keep machinery constantly running. As inquiries are numerous for structural material of various descriptions for abroad, there seems a prospect of better employment ere long; indeed, at present there is a large business being done in the lighter descriptions of sheet bars, slabs, and joists. Sheets, black and galvanised, are in demand for Canada, India, China, and Japan, and there has recently been a considerable rise in the prices, single sheets now being quoted £7 to £7 2s. 6d. and doubles £7 17s. 6d. per ton, less the usual 5 per cent. discount. There is no improvement in the malleable iron department, and the works have a great deal of idle time.

The Coal Trade.

Business is quiet in the coal trade as a whole, for while good qualities of ell coal are in better demand, other sorts are meeting with a slow inquiry. Shipments coastwise are rather heavier in the last few days, but the export trade is dull, notwithstanding that the end of the season is approaching in Baltic and not a few other continental ports. There is practically no change this week in coal prices.

WALES AND ADJOINING COUNTIES.

(*From our own Correspondent.*)

Last Week's Coal Trade.

THE severe weather had much to do in rendering trade peculiarly and injuriously affected. It was known that a fair demand existed for best coal, and that bookings had been effected, but, as a member on Cardiff 'Change stated, at times it was impossible for vessels to come in, and all along the south coast it was imperative to weather in the roadsteads to escape destruction. No one recollects so long a continuance of tempestuous weather. Hopes are expressed that, when once milder weather begins, a good reaction will set in, especially as the production of coal since the Eight Hours Act has been materially affected. It is creditable to the ports that, in despite of all difficulties, Newport last week shipped close upon 60,000 tons, Swansea 78,000, and Port Talbot showed a fair increase. Cardiff cleared only eight vessels, with a tonnage of about 25,000 tons, one day this week.

Present State of the Coal Trade.

Business slow, both for prompt and forward delivery. On 'Change no improvement was reported, and is not likely to occur until delayed tonnage comes in. One hopeful feature of the situation is that forward business is firm. Coalowners evidently regard the condition as temporary, and hold to their quotations. There was some little concession to be had, but not of note. It was reported that sales had been effected for less than 17s. best steam. This occasioned no surprise, and one or two isolated cases failed to weaken sellers' resolution to wait until the storms abate, when some of the old authorities anticipate a brisk demand. Latest prices for large steam steady at 17s.; second class not so firm. Monmouthshire unsteady. Lower figures accepted for small, principally to clear. Latest:—Best large steam, 17s. to 17s. 6d.; best seconds, 16s. 3d. to 16s. 6d.; seconds, 15s. 9d. to 16s. 3d.; ordinaries, 15s. to 15s. 6d.; best drys, 16s. 3d. to 16s. 9d.; ordinary drys, 14s. to 14s. 3d.; best washed nuts, 14s. to 15s.; seconds, 13s. to 13s. 6d.; best washed peas, 12s. 6d. to 13s.; seconds, 11s. to 12s.; very best smalls, 8s. 6d. to 9s.; best ordinaries, 6s. 6d. to 7s. 3d.; inferior sorts, 5s. 9d. to 6s. 3d.; very best Monmouthshire black vein, 15s. 3d. to 15s. 6d.; ordinary Western Valleys, 14s. 3d. to 14s. 6d.; best Eastern Valleys, 13s. to 13s. 6d.; seconds, 12s. 6d. to 13s. Bituminous coal: Very best households, 17s. to 18s.; best ordinaries, 15s. to 16s.; No. 3 Rhondda, 17s. 3d. to 17s. 6d.; brush, 13s. 6d. to 13s. 9d.; smalls, 10s. to 10s. 6d.; No. 2 Rhondda, 12s. 3d. to 12s. 6d.; through, 9s. 6d. to 10s. 3d.; smalls, 7s. 3d. to 7s. 6d. Patent fuel, 15s. to 16s. Pitwood, 18s. 3d. to 18s. 9d. Coke: Special foundry, 24s. 6d. to 28s.; foundry, 19s. to 22s.; furnace, 17s. 3d. to 18s.

Newport, Mon.

Latest:—Prompt tonnage scarce. No immediate improvement likely. Easy for prompt, but forward business held firmly for large and small. Certain improvement expected after the abatement of storms. Best Newport black vein, 15s. to 15s. 3d.; Western Valleys, 14s. to 14s. 3d.; Eastern Valleys, 12s. 9d. to 13s. 3d.; other sorts, 12s. 3d. to 12s. 6d.; best smalls, 6s. 9d. to 7s. 3d.; seconds, 6s. 3d. to 6s. 6d.; inferiors, 5s. 9d. to 6s. 3d. Bituminous coal: Best house, 15s. to 15s. 6d.; seconds, 14s. to 14s. 6d. Patent fuel, 15s. to 15s. 6d. Coke: Foundry, 18s. 6d. to 19s.; furnace, 17s. to 17s. 6d. Pitwood, 18s. 3d. to 18s. 6d.

Swansea Coal.

Very little alteration from last week. Tonnage supplies below the mark. More free coal for delivery, Swansea large selling at slight reduction. Latest:—Best malting, 24s. to 25s. net; second malting, 21s. 6d. to 22s. 6d. net; big vein, 18s. to 20s., less 2½; machine-made cobbles, 23s. 6d. to 24s. 6d. net; red vein, 12s. 6d. to 13s. 6d.; Paris nuts, 27s. to 28s. net; French nuts, 27s. to 28s. net; German nuts, 27s. to 28s. net; beans, 17s. 6d. to 18s. net; machine-made large peas, 11s. to 12s. 6d. net; fine peas, 10s. 6d. to 11s. net; rubbly culm, 5s. 3d. to 5s. 6d., less 2½; duff, 2s. 6d. to 3s. net. Other coals: Best large steam, 17s. to 18s., less 2½; seconds, 14s. 6d. to 15s., less 2½; bunkers, 9s. 6d. to 10s. 6d., less 2½; small, 7s. 6d. to 9s. 6d., less 2½. Bituminous coal: No. 3 Rhondda, large, 18s. to 18s. 6d., less 2½; through, 14s. 9d. to 15s. 6d., less 2½; small, 10s. 6d. to 11s, less 2½. Patent fuel, 13s. 6d. to 14s., less 2½. Rubbly culm improving.

Iron and Steel.

Some dumping continues at the Welsh ports, principally Newport. At the beginning of the week 1712 tons steel came from Bruges. Pig iron came in strongly; Swansea imported 2000 tons; 970 tons came from Grimsby, 650 tons came from Middlesbrough, and several large cargoes of iron ore, principally from Bilbao. Ebbw Vale received 7000 tons. Guest, Keen and Co., one cargo from Bilbao, and one from Horullo. Latest prices at Swansea:—Pig iron: Hematite, mixed numbers, 61s. 3d. cash and month; Middlesbrough, 51s. 11d. cash, 52s. 3d. month; Scotch. 57s. 10½d. cash and month; Welsh hematite, 67s. to 68s. d.d.; East Coast hematite, 65s. to 67s. c.i.f.; Siemens steel bars, £4 15s. to £4 17s. 6d. per ton; Bessemer, £4 15s. per ton. Other quotations: Copper, £57 18s. 9d. cash, and £58 18s. 9d. three months. Lead: English, £13 16s. 3d.; Spanish, £13 6s. 3d.; spelter, £23 5s.; silver, 23½d. per oz.

Tin-plate.

There has been no abatement in the prosperous condition of the tin-plate trade. Last week high figures were reached in connection with the Swansea trade. The receipts from the works, indicating an active industry, totalled 103,020 boxes, while the shipment reached 112,664 boxes, leaving stocks at 120,155 boxes. Not only is present trade encouraging, but prospective trade continues in a very satisfactory state. The sheet and tin-plate mills in operation last month were 453, or nine mills more than in the previous month, and seven more than in the corresponding month of last year; but it must be noted that the produce per mill is much greater than formerly; 20,000 boxes tin formed the imports on the 16th to New York from Cardiff. Latest quotations, Swansea:—Block tin, £138 17s. 6d. cash and £140 7s. 6d. three months. Ordinary tin-plate official quotations:—I.C. × 14 × 112 sheets, 12s. 4½d. to 12s. 6d.: Bessemer and Siemens ternes, 22s C.A. roofing sheets, £8 10s. to £8 15s per ton; big sheets for galvanising, £8 10s.; finished black plate, £9 10s. to £9 15s.; galvanised sheets 24 g., £11 to £11 5s. per ton. Latest tin-plate market very firm, with particularly good inquiry for next year. Mannesmann in full work, and all foundries and engineering shops busy.

The Afternoon Shift Problem for Colliers.

A special meeting of the Rhondda colliers was held at Porth on Monday, when there was a full gathering of Lodges. The crucial question about the afternoon shift was carefully debated. As Mr. Watts Morgan explained, the simple issue was whether the colliers should confine the filling of coal to the night shift, or allow the workmen liberty at the various collieries to make any arrangement they liked. The decision of the meeting, by a large majority, was that no permission be given to colliers working on double shifts, in headings, to work on the afternoon shift instead of the night shift.

Earth Slip at Swansea Dock.

On Tuesday there was a further slip at the King's Dock, Swansea. It appeared that while some trucks were on a part of the inner face of the sea embankment the earth gave way, carrying nine trucks with it. It is now stated that the slip was purely local, and did not affect the stability of the wall. The opening is to be in November.

The Floods in South Wales.

The avoidance of anything like serious disaster through the great floods which have occurred in South Wales is marked testimony to the ability shown in the engineering construction of the various reservoirs, &c., connected with the chief towns. That of the Beacon Reservoir, for the supply of Cardiff, demanded an exceptionally substantial bulwark for the mass of water stores open to the storms which dash against it from the Beacons; but it has stood well, and No. 3 Reservoir, which will be in the bed of Cwm Taff, a valley like an enlarged ravine, promises to yield a similar measure of security. The Aberdare Valley has been a great sufferer from the floods, and large tracts flooded, much harvesting spoiled, bridges and roads destroyed, will entail a grave expenditure on the counties of Brecon and Glamorgan.

Great Dock and River Enterprise at Newport.

Preliminary steps are being taken to carry out an important river scheme in connection with the docks at Newport.

Llanelly.

The consent of the Board of Trade has been obtained to the harbour scheme. A portion of the proposed scheme will cost £3250. One of the features is the construction of a spur retaining wall, but the consent of the ratepayers is to be obtained for the expenditure.

AMERICAN NOTES.

(*From our own Correspondent.*)

New York, October 13th.

THE next large steel rail order will come from the New York Central Railroad, and the stated requirements are 250,000 tons. The 200,000-ton order recently placed by the Pennsylvania Company will be divided between the Pennsylvania, Bethlehem, Lackawanna, Cambria, and the Carnegie Steel Companies, the allotment to the latter being 80,000 tons. The Illinois Steel Company and the Gary plant have now orders exceeding 500,000 tons, the last order being for 70,000 tons placed by a western company. Other systems are expected to place their orders soon. The unexpectedly heavy demand for coke has enabled the coke makers to advance the price of furnace coke to 2.90 dols. per ton. A general advance is imminent even from this extreme figure. Large coke consumers are anxious to cover their estimated requirements for the first half of this year. Steel bars have also moved up and the advancing tendency in both iron and steel is general. The independent structural steel makers have advanced to 1.60. A scarcity of basic and Bessemer pig has suddenly developed owing to some heavy orders that have just been precipitated upon the market. The requirements of agricultural implement manufacturers are increasing because of the opening up of new areas for wheat and corn culture. Orders for structural steel for September amounted to 85,000 tons. The tin-plate mills are now making a record output. The sheet mills are gathering in business for delivery during the first quarter of next year. The pay rolls of the Carnegie Steel Company now reach 300,000 dols. every two weeks. The news from the Delaware shipyards is that they will be in the market before the end of the week for large orders for shipbuilding material. There are many reasons for saying that the volume of steel orders for the rest of the year will exceed the orders of any like period for over two years.

Some of the large electrical equipment companies are back in the market once more for various grades of pig iron to cover large orders for supplies which have been recently secured. The smaller industries are coming into the market in an encouraging way for tools, equipment, and shop machinery, which in the aggregate will constitute quite an important factor. A by no means insignificant demand for equipment is coming from the builders of automobiles. The exports of copper for the past week were 7125 tons. Imports 1660 tons. Domestic movement in copper is light; most consumers are pretty well supplied for the present. Many interesting developments are occurring in the copper-producing fields, particularly in Mexico, where large supplies of copper are in sight and await the rather expensive development which the engineers have pointed out. The latest copper developments in Alaska are also full of encouragement, but in that locality the question of railroad development is involved. Arrangements have been made for the prosecution of building next spring which will make transportation of mineral products cheap and efficient to shipping points on the coast.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

THE Daimler Company announces that it has had to take larger premises for its hire department at 78, Marylebone-lane, W.C. Telephone numbers: 10,223 and 10,224 Central.

MR. JAMES F. GILL has opened an office at Scottish Provident Buildings, 25, Castle-street, Liverpool, as a consulting mechanical engineer, specialising in power installations and transmissions, and also in general economy tests.

IN a few days' time J. H. and W. Bell, Limited, bridge contractors, Liverpool, will send out the remainder of men and plant to Patagonia for the purpose of carrying out a contract for the erection of a three-span steel bridge over the river Gallegos and about two miles of roadmaking.

CONTRACTS.—The Westinghouse Company is lighting the aviation grounds at Blackpool with thirty-six of its "Arcturus" flame arc lamps. These have outdoor choking coils for running the lamps four in series on a 200-volt 83-period circuit.

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—The annual meeting of the American Society of Mechanical Engineers will be held in the Engineering Societies' Building, New York December 7th to 10th, 1909. Papers are to be presented on electric driving, discussing the economic as well as the technical phases of the subject; upon apparatus for the measurement of flow of air, steam, and water; tests of lubricating oils, steam-turbine nozzles, and steam turbines; governing rolling-mill engines; the use of moist fuels; boiler joints; pump valves and a new type of pile driver, and other engineering subjects. In conjunction with the Hudson-Fulton celebration, which was held in New York the latter part of September, an exhibit was prepared in the rooms of the American Society of Mechanical Engineers, in which were shown models of the Clermont, by Fulton; the Phœnix, built by John Stevens; one of John Fitch's early boats; and by contrast a model of the Deutschland, of the Hamburg-American Line. Original drawings by Fulton were also exhibited with an oil portrait of Fulton, painted by himself, and various other objects; interesting models relating to the development of marine engineering; and the work of leading marine engineers, including interesting models showing the inventions of John Ericsson.

INSTITUTE OF ELECTRICAL ENGINEERS: GLASGOW STUDENTS' SECTION.—At the opening meeting of the session of this body held in the Technical College, George-street, Glasgow, on 15th inst., Mr. H. A. Mavor, the new chairman, delivered an opening address dealing with the electric propulsion of ships by means of a combination of steam turbines, electric generators, and motors, and screw propellers. The speaker contended that, as the advantages of this system of propulsion were not apparent from general principles, marine engineers were very sceptical regarding it. He pointed out that a constant speed of ship did not involve a constant power, as the power for any fixed speed altered with load, tide, wind, &c., so that an efficient change gear would result in great economy. With direct steam drives sub-division of the plant was impossible, whereas electric driving effectively lent itself to this. The method favoured by Mr. Mavor consisted of high-pressure and low-pressure turbines driving generators having different frequencies, these generators being connected to a motor having a different stator winding for each generator, and each winding having a different number of poles. Thus a series of propeller speeds could be obtained with constant speed of the turbines. In this arrangement there would be no resistances or other wasteful devices used for obtaining speed variation, and the switchgear would be very simple, as no synchronising apparatus would be required. Mr. Mavor also explained a method of proportioning the number of poles on the different windings, so as to prevent an electromotive force being induced between the windings.

YORKSHIRE ENGINEMEN'S ASSOCIATION.—The Yorkshire County Enginemen's and Motormen's Protection Association came into existence in August, 1859. On Saturday, at Barnsley, the members celebrated the jubilee, and subsequently attended a meeting at which Mr. T. W. Casey, the general president, occupied the chair. Mr. J. Green, in an interesting review of the history of the organisation, stated that the Society was formed at Stairfoot, and that of the original members only one, Mr. Francis Handley, was now alive, he having a continuous record, extending over forty-nine years and six months. There were to-day 920 members on the books. Mr. Green pointed out as a most gratifying feature of the Society's existence, that they had never had to appeal for support to any of their kindred associations, but had often rendered support to others. The President said the fundamental principles that underlay the work of their Society were peace and harmony and happy relations between employers and employed. That was the fundamental principle of their union, and should be of all unions. Mr. Thomas Watson, general secretary of the Lancashire Enginemen's Association, stated that at collieries only one accident occurred to about every three million windings. That was a credit to the men who had charge of the winding engines, who every day of their lives had in their direct charge the lives of more men than were in the British Army, who were lowered into the bowels of the earth with the precision of the best piece of mechanism that was ever constructed. That this was done was not wholly due to the makers of the engines, although they had it on record from the Royal Commissioners' Report on Mines that the winding engine of to-day was not as difficult to look after as it used to be. He said that was not correct What the winding engineman had to deal with to-day, compared with what he had to deal with forty years ago, demanded a finer judgment, for they often lowered at one winding almost as many men as used to be employed in a single pit forty years ago, and to tell a man in charge of the machinery that winding was not as difficult as it used to be, was trifling with his intelligence. He urged the desirability of federation amongst the enginemen of all counties, making the condition that if there was a possibility of one section having provision made for them through the House of Commons, that other sections should not stand in the way because they were not included. With regard to the eight hours proposal, Mr. Watson said that 50 per cent. of the Lancashire owners were individually in favour of granting enginemen an eight hours' day, but, spoken to collectively, they said the subject was not worth discussion. Mr. Watson further urged that there should be a uniform code throughout the kingdom of signals for raising and lowering men. The Royal Commission was agreed upon this point, and he was sorry they were not so agreed on the subject of an eight hours day.

NOTES FROM GERMANY, FRANCE, BELGIUM, &c.

(*From our own Correspondent.*)

Rheinland-Westphalia.

More firmness has been shown in the iron and steel trade, and demand is improving generally, although, of course, some departments are still very scantily supplied with fresh work. In the Siegerland, for instance, pig iron remains without animation, but increasing firmness could be noticed here also. Forward orders fetch better prices. Hoops have twice been raised M. 2 50 p.t., owing to strong demand. Several mills are reported to be largely sold forward. Further improvement can be stated to have taken place in the plate trade, and a more enterprising spirit is generally prevailing. Several orders for this year and for delivery in 1910 have been booked lately, prices varying between M. 120 to M. 122.50 p.t., according to quantity and time of delivery. The question of forming a Union of Steel Mills has again been ventilated.

The Silesian Iron Market.

The amount of work secured during the week was rather extensive, and more life is shown generally. Bars, both at works and in Breslau stores, have been advanced M. 5 p.t. on the 11th inst.

Steel Convention.

Deliveries of the Steel Convention in September of this year were 438,904 t., as against 419,016 t. in August, and against 404,608 t. in September, 1908. This shows an increase of 19,888 t. as against August of present year, and a rise of 34,296 t. against September, 1908. Of the deliveries in September of this year 136,487 t. were semi-finished steel, as against 127,648 t. in September, 1908; railway material: 165.225 t., against 170,702 t. in September last year; sectional iron: 137,192 t., as compared with 106,258 t. in September, 1908.

List Rates.

The following are the present quotations per ton free at works:—Raw spathose ore, M. 10.90; roasted ditto, M. 15.50; Nassau red iron ore, M. 11.50 p.t. net at mines; spiegeleisen, 10 to 12 per cent. grade, M. 60 to M. 63; white forge pig, M. 55; iron for steelmaking, M. 56 to M. 58; German Bessemer, M. 58 to M. 60; basic, free place of consumption, M. 48 to M. 50; Luxemburg forge pig, M. 44 to M. 46; Luxemburg foundry pig No. 3, M. 47 to M. 49; German foundry pig No. 1, M. 56 to M 58; No. 3, M. 55 to M. 57; German hematite, M. 57 to M. 59; common bars in basic, M. 98 to M. 104; iron bars, M. 122.50 to M. 125; hoops, M. 122.50 to M. 125; steel plates, M. 106 to M. 112; boiler plates, M. 116 to M. 122; sheets, M. 120 to M. 125; wire rods, M. 127.50.

Coal in Germany.

Silesian coalowners are doing a fairly good trade both in engine and house coal, and exports to Austria-Hungary have increased. In Rheinland-Westphalia only a moderate trade is reported, no improvement having been felt yet. On the contrary, deliveries in September show a further falling off, those in the coal shipping ports in the Ruhr district being estimated at 150,000 t. to 200,000 t. lower than in August. October will probably show an improvement, at least for coke, the reduced rates causing consumers to buy more freely. In gas coal a slightly better trade was done.

Austria-Hungary.

The position of trade is rather unfavourable, as so very little fresh work is given out. A fairly steady demand is maintained for manufactured iron. In pit coal, as well as in brown coal, moderate sales only are effected. Exports in Bohemian brown coal to Saxony have decreased in the third quarter, while deliveries in German coal to Saxony show an improvement.

Upward Tendency in France.

A very healthy tone characterises the French iron market, orders coming to hand regularly. There has been no marked change in quotations. The French Girder Convention, which, together with the Belgian and German Steel Convention, forms the International Girder Convention, has been prolonged, according to the *Moniteur des Intérêts Matériels*, for another two years. The Girder Syndicate has suspended the usual winter bounties. It speaks well for the condition of the wire trade that the Drawn Wire Convention has refused to grant concessions in price, contemplating, it is said, a rise in quotations in the immediate future. Horseshoe rates have been advanced 1f. p.t. The French coal trade is thoroughly firm, demand improving steadily.

Belgian Iron Industry.

The general aspect is more hopeful, and increasing animation was reported from various departments, and this has enabled producers to realise better prices than could be obtained in September. A regular business has been done on foreign account. In semi-finished steel and in bars consumption has increased upon the week and plates likewise are improving, both as regards prices and demand. There is no change whatever to report in the coal trade of Belgium; list rates remain the same as before, while inquiry and demand are steady.

LAUNCHES AND TRIAL TRIPS.

Bellucia, steel screw steamer; built by D. and W. Henderson and Co., Limited; to the order of Bell Brothers and Co., Glasgow; dimensions, 400ft. by 51ft. by 28ft.; to carry 7200 tons; engines, triple-expansion, 25in., 41in, 68in. by 48in. stroke; constructed by the builders; trial trip, October 16th.

Tortona, steel screw steamer; built by Swan, Hunter and Wigham Richardson, Limited; to the order of the Cairn Line of Steamships, Limited; dimensions, 464ft. by 54ft. 2½in. by 40ft.; to carry 8600 tons; engines constructed by Palmer's Shipbuilding and Iron Company, of Jarrow; trial trip, October 18th.

Bassam, steel screw steamer; built by Irvine's Shipbuilding and Dry Docks Company, Limited; to the order of Elder, Dempster and Co., Liverpool; dimensions, 355ft. by 46ft. by 25ft. 3in.; engines, triple-expansion, 25in., 40in., 67in. by 45in. stroke, pressure 180 lb.; constructed by Richardsons, Westgarth and Co., Limited; launch, October 14th.

Breynton, steel screw steamer; built by Wm. Gray and Co., Limited; to the order of Ralph E. Morel and Co., Cardiff; dimensions, 376ft. 6in. by 50ft. 9in. by 28ft. 4½in.; engines, triple-expansion, 26in., 42in., 70in. by 45in. stroke, pressure 180 lb.; constructed by the builders; trial trip, October 9th.

Dale Moor, turret steamer; built by W. Doxford and Sons, Limited; to the order of Walter Runciman and Co., of Newcastle; dimensions, 350ft. by 51ft. by 26½ft.; to carry 7100 tons; engines, triple-expansion, 26in., 42in., 68in. by 45in. stroke; constructed by the builders; launch, September 30th.

Rissy, steel screw steamer; built by the Laxevaags Engineering and Shipbuilding Company; to the order of Mr. Sigvart Rasmussen, of Haugesund; dimensions, 239ft. 6in. by 35ft. by 16ft. 10in.; engines, size of cylinders, 16in., 25in., 43in. by 30in. stroke pressure 175 lb.; constructed by the builders; launch, October 5th.

BRITISH PATENT SPECIFICATIONS.

When an invention is communicated from abroad the name and address of the Communicator is printed in italics.

When the abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent-office Sale Branch, 25, Southampton-buildings, Chancery-lane, London, W.C., at 8d. each.

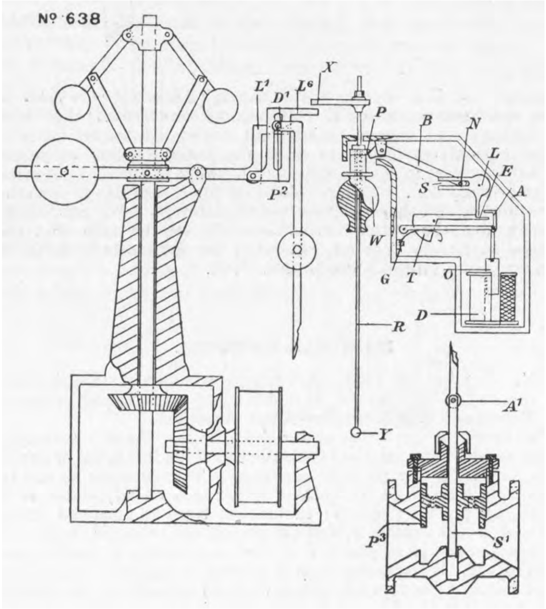
The first date given is the date of application; the second date at the end of the abridgment is the date of the advertisement of the acceptance of the complete specification.

Any person may on any of the grounds mentioned in the Acts, within two months of the date given at the end of the abridgment, give notice at the Patent-office of opposition to the grant of a Patent.

STEAM ENGINES.

638. January 11th, 1909.—Emergency Safety Device for Stopping Steam or Gas Engines, Turbines, and the like, Robert George Holt, engineer, 131, Spring-lane, and James William Booth, Victoria-street, both of Radcliffe, Lancashire.

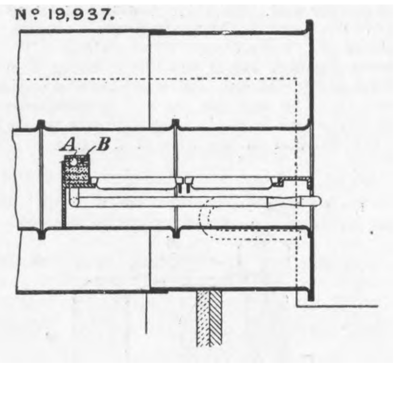
The instrument is used in circuit with a Leclanche battery, pushes being placed in close proximity to any hazardous positions (to be found in mills and manufactories) for use in emergency. When in operation, the solenoid D attracts core O, the arm A strikes an extension E on the trigger T, and the lever L is released, the weight W, rod R, and the striking-piece X overbalance the levers B and L, then fall till the striking-piece X engages the slotted link L 6, which is moved when the weight W engages the ball end Y of the rod R. The link L 6 moves a pin P 2, which engages a depression D 1 on the end of lever L 1; a weighted rod fixed to pin P 2 and hinged to spindle of valve at A 1 falls, and the valve passage is closed by the piston P 3, which is secured to the spindle S 1. The steam or gas supply is now stopped, and the engine ceases to move. To re-set the motion, weight W is turned half a revolution, lifted up the rod R, engages a collar, lifts the said rod R with piece X till the collar is stopped by the casing, then twisted back, and the projection P placed on lever B.—*September 29th*, 1909.


Nº 638

STEAM GENERATORS.

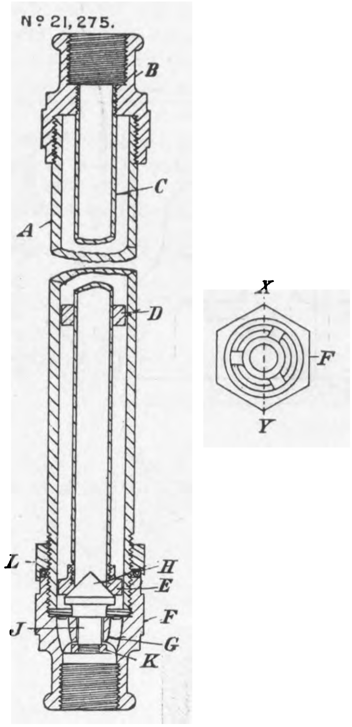
19,937. September 22nd, 1908.—Improvements in Smoke-consuming Appliances for Steam Boiler and other Furnaces, Charles Edward Whitton, of 9, Bedford-row, London.

With a view to splitting up the heated air into numerous small jets and thereby ensuring its thorough mixture with the furnace gases, the conduit A which supplies the furnace with heated air is formed with one or more rows of cylindrical holes. Each of these holes is fitted with a tube or ferrule B which may be removable and which projects to a greater or less extent into the interior of the conduit A and terminates in a bevelled end, the latter facing in the direction to meet the air supply. As these tubes are situated each at a greater distance from the source of the air supply the obliquity of their cut faces increases, with the result that they project further and further into the air conduit; each presenting a greater area for the interception of air. In this manner the loss of pressure which occurs towards the more remote portion of the air conduit is compensated for and the volume of air discharged from the respective conduit outlets approximately equalised. The apices of the obliquely cut collecting tubes may be bent over to meet the air stream and to form a hooded orifice for its collection. There are seven other illustrations.—*September 29th*, 1909.


Nº 19,937.

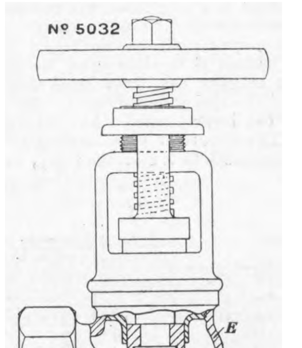
21,275. October 8th, 1908.—Improvements in or connected with Steam Traps, William Eagar Plummer, William Marsdon Kermode, and Charles St. Clair Pummer, all of Soho Works, Thornton-road, Bradford.

The steam trap consists of an outer iron tube A provided at the trap inlet with an annular casting B, while inside the iron tube A and secured to this annular casting B is an inner tube C of brass so arranged that steam entering the trap enters the brass tube C without coming into contact with the iron tube A. The brass tube C is provided with series of collars D making a sliding fit with the interior of the iron tube A, which prevents steam from getting between the tubes C and A and slowing the action of the trap. At the other end of the brass tube C there is arranged a valve seating E also making a sliding fit with the iron tube A. An annular casting F shown in plan, and in sectional elevation —on the line X Y—is screwed on the other end of the iron tube A, which casting is provided with a bridge piece G carrying a conical valve H, the stem J of which has a thread to receive a nut K for holding the valve in the bridge G against longitudinal movement without preventing it being free to rotate. The trap is adjusted to its working position by turning the steam on and allowing the brass tube C to expand to its fullest extent, when the annular casting F carrying the valve H is screwed up till the valve rests firmly against the valve seating E of the brass tube C, when in this position the casting F is locked by a lock-nut L on the iron tube A.—*September 29th*, 1909.


Nº 21,275.

5032. March 2nd, 1909.—Improvements in Renewable Seats for Steam Valves and the like, William Ernest Talbot, of 40, Eccleston-place, Belgravia, London, S.W.

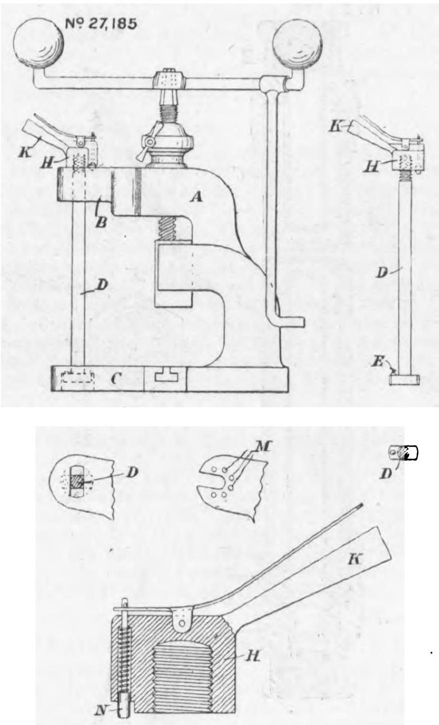
The object of this invention is to provide a simple fitting for new valves or for replacing seatings in old valve shells. The form shown comprises a nipple end A on which a thread K is cut—which is arranged to screw into the valve shell E—a screwed end B and a flange C, while D is a hole of varying or uniform diameter through the fitting. A steam-tight joint may be made at F between the valve shell E and the flange C of the renewable seating. One end G, remote from the flange C, is faced or turned to form the actual seat of the valve H, and the reverse end R may be machined to form a fresh seat when the end G has been worn down too far to be re-turned. In the case of a valve shell fitted with a flange and bolt holes at J, the flange C of the renewable seating may have corresponding bolt holes so that the two flanges J and C are adapted to be bolted together, and the screw thread K may be dispensed with if desired. The thread on the end B forms a convenient coupling to the steam pipe without the aid of a separate nipple. The single-ended modification of the seating shown below the illustration just referred to consists of a cylinder or nipple having an internal thread M, an external thread K¹, and a flange C¹, and a hole of a uniform or varying diameter D¹. The end G¹, remote from the flange C¹, is shown as adapted to form the seat for a "mushroom" valve, and the thread M may be used as a coupling to the steam pipe. There is also another illustration.—*September 29th*, 1909.


Nº 5032

MACHINE TOOLS AND SHOP APPLIANCES.

27,185. December 15th, 1908.—Improvements in or connected with Screw Presses, Frank Sweeney, of Parkfield-road Works, Parkfield-road, Saltley, Birmingham.

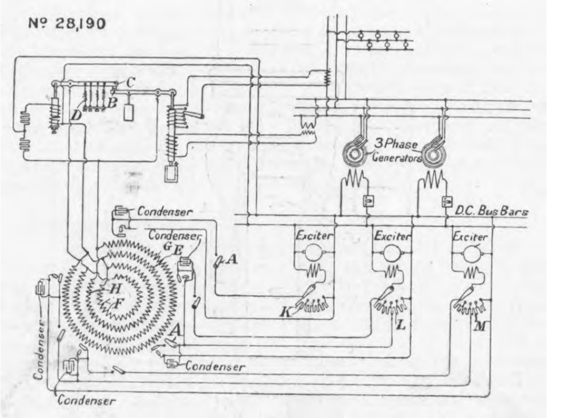
This invention has reference to the detachable arm, and its object is to provide an improved construction and arrangement whereby the arm may be attached or detached in a much simpler and quicker manner than hitherto. In the engravings A is the general frame of the press, at the upper part of which is formed the projecting lug B. At the base a somewhat similar lug or extension C is formed. D is the bolt which constitutes what is generally termed the "auxiliary arm," which is intended to support the strain equally each side the operating screw. The lower end of the bolt D is made with a T-shaped head, and corresponding therewith a T-shaped hole is cast in the base part of the press through which the head may be passed and then turned at right angles in an enlarged underneath space. Preferably means are provided in the form of a stop or stops to prevent further rotation, such, for instance, as the peg E on the head taking into a corresponding hole in the base of the press. At the upper end of the press frame the extended lug B is provided with the open slot, into which the bolt D may be passed This end of the bolt is screw threaded, and accommodated with a screw nut H which is provided with a spanner-like handle K. Around this open slot hole a number of locking holes M are made, and in accordance therewith a spring lever or the like catch N is mounted upon or connected to the said nut which shall engage with such holes so as to prevent any possible unscrewing of the said nut.—*September 29th*, 1909.


Nº 27,185

DYNAMOS AND MOTORS.

28,190. December 24th, 1908.—IMPROVEMENTS IN ELECTRIC VOLTAGE REGULATORS, *Allen Augustus Tirrill, of Schenectady, New York, U.S.A.*

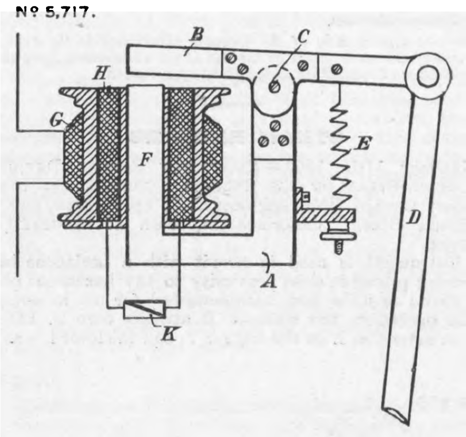
There are four illustrations with this specification, which are needed to make the invention clear. The diagram of connections shown, however, may enable the general principle of operation to be understood to some extent. First, the shunt circuits across the exciter field rheostats are opened by means of switches A, and these rheostats are adjusted to a point that will reduce the alternating current voltage considerably below normal. From this the alternating control magnet will be weakened and its core will fall and cause the contact B to close upon the upper contact C. The direct current magnet has been weakened simultaneously with the other, and the spring or springs D attached to its lever have pulled down the lever towards the lever of the alternating current magnet. The closure of these floating contacts closes the circuit of the winding sections E F of the relay, which oppose the permanently connected winding sections G H, and this demagnetises the relay cores, allowing their armatures to be released and permitting their springs (not shown) to close the relay contacts. Then, by closing the switches in the exciter shunt circuits, and thereby effecting a short circuiting of the rheostats K, L, M the voltage of the exciters will immediately rise and cause a rise in the voltage of the generators. This will strengthen the control magnets, and when the voltage reaches the value for which they have been adjusted the main contacts B C will open, thus breaking the circuit of one set of the relay winding sections and permitting the permanently connected set to magnetise the cores and open the relay contacts. This throws the full resistance of the resistances K, L, M into the field circuits of the exciters, which tends to lower the voltage again. This cycle of operations is continued at a high rate of speed owing to the sensitiveness of the direct current control magnet; and the result is to maintain a steady exciter voltage which will be increased or diminished according to the demands of the system.—*September 29th*, 1909.


Nº 28,190

SWITCH GEAR.

5717. March 9th, 1909.—IMPROVEMENTS IN AND RELATING TO PROTECTIVE DEVICES FOR ALTERNATING-CURRENT SYSTEMS, the *Allgemeine Elektricitäts-Gesellschaft, of Friedrich Karl-Ufer 2-4, Berlin, Germany.*

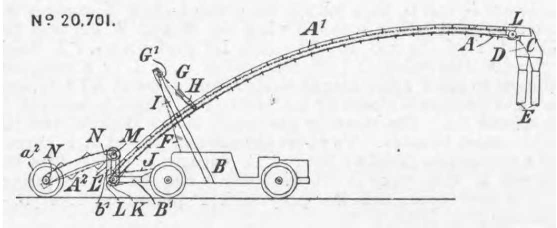
According to this invention, an excess current time limit device is used for alternating-current systems, comprising a releasing magnet, having a primary winding carrying the working current and a secondary winding in inductive relation to the said primary winding, and short-circuited through a thermostatic device in such a manner that on the occurrence of excess current the short circuit is broken, and the releasing magnet operates the cut-out. In the accompanying engraving A indicates the core of a magnet, having an armature B pivoted at C, and connected in any suitable way, as, for instance, by the rod or link D, with the tripping mechanism of the switch gear of the circuit to be protected. The armature is normally held in the position shown in the drawing by means of the spring E. Upon the limb F of this magnet two coils are wound, one of which—namely, coil G—is traversed by the high potential current, and forms the primary of a transformer. The secondary coil H is short-circuited through a fuse hot wire relay or other thermostatic device K. It will be understood that with this arrangement there is insufficient flux in the magnetic circuit under normal conditions to close the armature, but when the current increases in the secondary coil, owing to a rise of potential in the primary coil, the thermostatic device K operates to open the short-circuit, and thereby cause the armature to move and consequently trip the switch mechanism. It will be seen that the renewal of the fuse K or adjustment of the thermostatic device is rendered quite safe.—*September 29th*, 1909.


Nº 5,717.

MISCELLANEOUS.

20,701. October 1st, 1908.—APPARATUS FOR CONVEYING, SCREENING, AND DELIVERING MATERIALS OF ALL KINDS, Andrew Robertson, of 208, Market-street, Aberdeen.

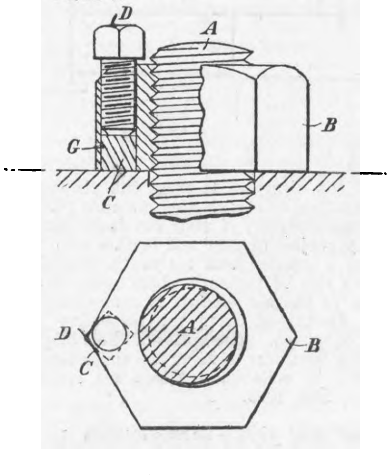
The conveyor A carries at its end a hopper C and a screening device as at D, and may have attached to it flexible tubes or chutes E for delivering the material conveyed. The conveyor A and its supporting framework A^1, both of which may be adjustable as to length, are pivotally secured in bracket arms B^1 attached to the rear end of the vehicle B, and are raised and lowered as desired by means of a rope or chain F or the like passing around rollers or pulleys G, G^1 respectively on a stirrup H secured to the conveyor frame A^1 and on an upright frame I secured to the vehicle, said chain F or the like passing, if desired, around a drum geared to the main shaft of the motor or engine of the vehicle, which motor or engine is preferably situated at the rear of the vehicle. A supplemental conveyor A^2, supported on wheels a^2 and pivoted on a shaft M supported by extensions b^1 of the arms B^1 at the rear end of the vehicle, feeds the material to be conveyed, screened, or delivered to the main conveyor A^1. Means are provided for driving the conveyor A, and the power required is preferably supplied from the motor or engine of the vehicle, as by means of a chain J or the like adapted to drive the shaft K on one of the drums L around which the conveyor A passes. The conveyor A^2, which may be adjustable as to length and as to its position relative to the conveyor A, is driven from the shaft K by means of a chain L^1 or the like, which operates the shaft M of one of the drums N around which the said conveyor A^2 passes.—*September 29th*, 1909.


Nº 20,701.

23,334.—November 2nd, 1908.—IMPROVEMENTS IN AND RELATING TO MEANS FOR LOCKING NUTS ON BOLTS AND THE LIKE, James Bowack, of 45A, Temple-road, Cricklewood, N.W., Middlesex.

A represents the bolt and B the nut, C being a movable piece which is fitted within the nut, and which acts in conjunction with the set screw D. The movable piece C is situated at the lower end of a hole G, which is made longitudinally through the nut—that is to say, parallel to the axis of the bolt A. This hole is tapped at its upper part and receives the set screw D. With this construction the nut can be tightened on to a flange or the like H, and the set screw then screwed up so as to force the movable piece C on to the surface of the flange H, thereby locking the nut in place. In some cases a spring may be substituted for the movable piece C. If found necessary, the set screw can be counter-sunk into the nut or any other suitable known means employed to prevent them turning or slacking.—*September 29th* 1909.

Nº 23,334.

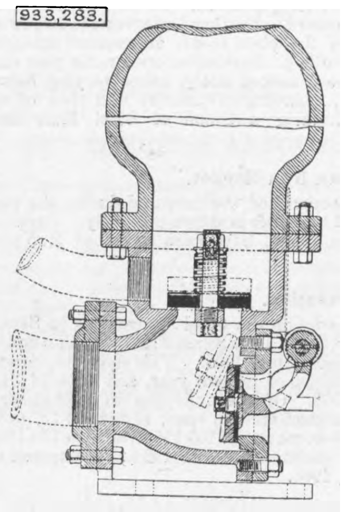


SELECTED AMERICAN PATENTS.

(*From the United States Patent-office Official Gazette.*)

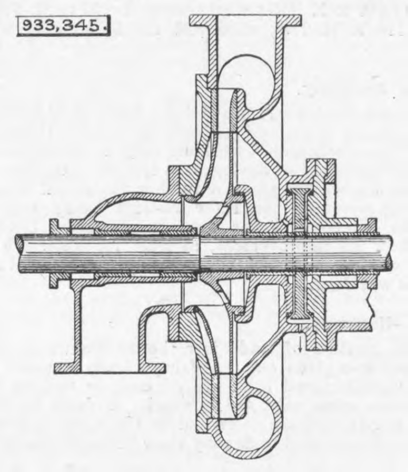
933,283. HYDRAULIC RAM, *P. E. Alger, Portland, Oreg., assignor to Columbia Engineering Work, Portland, Oreg., a Corporation of Oregon.—Filed April 13th*, 1907.

This patent is for the general arrangement as shown, and the use of a coiled leaf spring to open the waste valve after the blow has been struck. There is only one claim.


933,283.

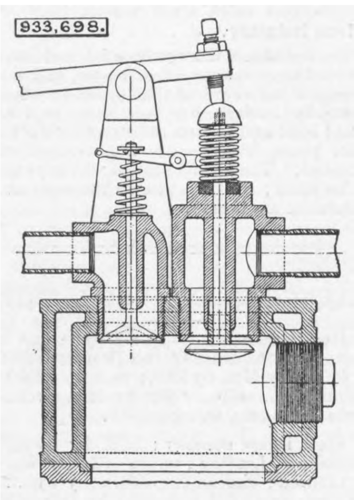
933,345. BALANCING DEVICE FOR CENTRIFUGAL AND SIMILAR PUMPS, BLOWERS, AND THE LIKE. *W. Scheurmann, Newark-on-Trent, England, assignor to H. R. Worthington, a Corporation of New Jersey.—Filed October 15th*, 1908.

This patent is for the combination with a rotating shaft of a pressure disc or piston moving axially with the shaft, fixed abutments on opposite sides of the disc forming fluid chambers on opposite sides of the disc reduced through a portion of their diameter to form pressure surfaces of different radii on opposite sides of the disc, and supply and discharge passages for circulating balancing fluid between said surfaces on opposite sides of the disc independently of each other. There are three claims.


933,345.

933,698. VALVE, *G. L. Crook, Indianapolis, Ind., assignor to Atlas Engine Works, Trustee, Indianapolis, Ind., a Corporation of Indiana.—Filed September 24th*, 1908.

The patent is for an exhaust valve structure comprising a main hollow body having a non-corrodible valve stem guide counterbored at its lower end, a valve having a corrodible stem passing through the guide and its counterbore, and a sleeve of non-corrodible material secured to the stem adjacent the valve, and fitting the counterbore of the guide. There is only one claim.


933,698.

A CONSULAR report dealing with the trade of Brazil during the year 1908 states that the increase in value of imports of machinery is well marked. In 1903 £1,232,251 worth was imported, and in 1907 the value was £3,463,678. United States machinery has always been popular in Brazil, and United States makers, broadly speaking, have about maintained their position, the heavy increase in 1906 and 1907 being due in a large measure to the electric light and power plants of Rio and Bahia, as well as to sundry smaller plants erected at various places in the interior. It is probable that a part of the increase is also due to imports of boot and shoe machinery. The local boot and shoe trade has flourished greatly under the present tariff, and many firms have erected United States machines. Once more however, it is evident that, setting aside the United States for the reasons just stated, the only country showing an increased ratio in this class is the German Empire.

NOTES ON THE DESIGN OF SHAFTS, WITH SPECIAL REFERENCE TO HIGH-SPEED ELECTRIC GENERATORS.

By H. H. JEFFCOTT.

No. II.*

So far we have been considering the shaft bent in a single loop. We may, however, consider it bent into two loops. In this case, if the speed is such that the distance between the bearings corresponds to equality of centrifugal and elastic forces, we have a permanent displacement. The shaft has now three nodes, one at each bearing and one at an intermediate point.

This speed is the second whirling speed, and is higher than that for one loop between bearings. Similarly, there are higher whirling speeds, the number and positions of which depend on the loading and constants for the shaft.

Some formulæ will be given subsequently by which the whirling speeds may be determined for the most general case of a shaft on two bearings loaded in any manner, and in which the unbalanced magnetic load arising in dynamos is included. Further, the case in which the shaft is, in addition, subject to end thrust will be considered.

6. Professor Dunkerley, in his paper on "Experiments on Whirling Speeds of Variously Supported Shafts and Loads," has proposed a method for approximately obtaining the first whirling speed in cases of complex loads. Recently Dr. Chree has gone through Dunkerley's work, treating it from a mathematical standpoint, using the equations of energy. He has obtained approximate solutions of the equations, but has chiefly concerned himself with the particular cases of loading previously experimented on by Dunkerley, *e.g.*, one or two pulleys on a massless or massive shaft variously supported. He has indicated, however, how the method may be applied to the determination of the first whirling speed in the most general case. Further, Dr. Chree has thrown much light on the physical aspect of the problem, and has very clearly pointed out the connection between the whirling speed and the period of lateral vibration.

On the Continent, too, particular cases have been worked out by Professor Föppl; and Stodola, in his book "Die Dampfturbinen," enumerates the solutions of various cases, such as a single load on a massless shaft, and a uniform unloaded massive shaft. The general case, however, does not appear to have been adequately treated.

Various formulæ have been given for calculating the first whirling speed of a dynamo shaft. The one which appears to be most in use (*Electrical World and Engineer*, 1903) is whirling speed in revolutions per minute $= 300\sqrt{\frac{1}{\delta}}$, where δ is the static deflection in centimetres produced at the centre of the shaft by the total load supposed concentrated there. Another way of using the formula is to take δ as the maximum static deflection at any point due to the actual load. We will see that in general both rules give too low values of the speed, the amount by which they are too low depending on the loads and on their distribution.

The method employed for obtaining the formulæ given in the following pages consists in considering the shaft rotating and slightly deflected, and then equating the centrifugal and magnetic forces to the elastic forces of restitution. The shaft will then be in dynamic equilibrium. The speed or speeds thence deduced will, as we have already seen, be whirling speeds. In order to obtain the speeds from these equations, it is necessary in the general case—in which the moment of inertia of the load is included—either to solve a long determinantal equation, or else to obtain the curve of displacement of the neutral axis of the shaft. In the general case, to obtain this curve exactly is practically impossible, so, instead, a curve approximately coinciding with the actual curve of displacement has been assumed. This greatly facilitates the solution, and gives a sufficiently approximate result.

7. If we consider a shaft A B of uniform section supported at its ends by bearings and under a given force perpendicular to its length at a given point P in it, and, further, to have given bending couples applied at the points A, B, P, whose axes are perpendicular to the plane of the force and A B, we can readily, by the ordinary theory of beams, arrive at expressions for the displacements of the neutral axis at any point in A P or in P B. If the shaft be not of uniform section, similar expressions may be derived. Further, in the case of the uniform shaft, let us imagine that, instead of one force and couple at an intermediate point, there are forces and couples at two or more intermediate points P_1, P_2, &c. Thus the shaft is under parallel forces at P_1, P_2, &c., and couples at A, B, P_1, P_2, &c. To obtain the displacement at any point of the neutral axis in this case, we apply Hooke's law, which states that stress is proportional to the corresponding strain. Hence the displacement at any point due to a number of parallel forces on the shaft is equal to the algebraic sum of the displacements at that point due to each load separately. Accordingly, to get the displacement of any point in A P_1, we have only to add the displacements at that point for the force and couple at P_1, at P_2, &c., and for the couples at A and B. For any point in P_1, P_2, we have to add the displacements due to the force and couple at P_1 (as given by the expression for the displacement in P_1B), and at P_2, &c. (as given by expressions for displacement in A P_2, &c.). In this way the displacement at any point, or the curve of displacement of the neutral axis, may be obtained.

Let X and M be the force and couple respectively at any loaded point P distant z from one bearing (A, taken as origin). Let u_r be the displacement at a point z_r, due to a number (n) of such forces and couples, and let M_o and $M^1{}_o$ be the bending couples applied at the ends A and B. Let l be the length of the shaft A B, I its moment of inertia of cross section about a line perpendicular to the plane of bending intersecting the neutral axis, and let E be Young's Modulus. Then

$$\begin{aligned}6\,\mathrm{E\,I}\,l\,u_r = {} & (l - z_r)\,\Sigma_o^r\left\{\mathrm{X}\,z\,(2\,l\,z_r - z^2{}_r - z^2) - \mathrm{M}(3\,z^2 - 2\,l\,z_r + z^2{}_r)\right\}\\ & + z_r\,\Sigma_r^n\Big[\mathrm{X}\,(l - z)(2\,l\,z - z^2 - z^2{}_r) - \mathrm{M}\left\{l^2 - z^2{}_r - 3(l - z)^2\right\}\Big]\\ & + \mathrm{M}_o\,z_r\,(l - z_r)(2\,l - z_r) - \mathrm{M}^1{}_o\,z_r\,(l^2 - z^2{}_r);\end{aligned}$$

where Σ_o^r includes all the loads (X and M) from o to z_r, and Σ_r^n includes those from z_r to l.

8. We may now further suppose all the forces and couples (X and M) to be due to rotation—and magnetic unbalanced pull—so that if m be the mass of the load at the point P and u its displacement, we have $\mathrm{X} = m\,\omega^2 u$, and $\mathrm{M} = -\,m\,k^2\omega^2\left(\frac{d\,u}{d\,z}\right)$, where ω is the angular velocity of rotation, and k is the radius of gyration of the mass about a line perpendicular to the plane of bending and intersecting the axis of the shaft. For small displacements the unbalanced magnetic pull may be taken as G u, where G is a constant depending on the magnetic design of the machine.

Finally, if the shaft be massive (mass per unit length equal to m), and carry a number of loads m_1, m_2, &c., at points z_1, z_2, &c., and if the radii of gyration of the sections of the masses about axes perpendicular to the plane of bending intersecting the neutral axis be k for the shaft, and k_1 k_2, &c., for the loads; and if the magnetic pull be exerted at some (other) points z_1, z_2, &c., and uniformly throughout a region l' to l''; we can write our displacement equation of the neutral axis in the form.

$$\begin{aligned}\phi\,u_r = {} & \omega^2\int_o^{z_r}\left\{m\,\mathrm{A}'_r\,u + m\,k^2\,\mathrm{B}'_r\,\frac{d\,u}{d\,z}\right\}d\,z\\ & + \omega^2\int_{z_r}^{l}\left\{m\,\mathrm{A}_r\,u + m\,k^2\,\mathrm{B}_r\,\frac{d\,u}{d\,z}\right\}d\,z\\ & + \omega^2\,\Sigma_{s=o}^{s=r}\left\{m_s\,\mathrm{A}'_{rs}\,u_s + m_s\,k^2{}_s\,\mathrm{B}'_{rs}\left(\frac{d\,u}{d\,z}\right)_s\right\}\\ & + \omega^2\,\Sigma_{s=r}^{s=n}\left\{m_s\,\mathrm{A}_{rs}\,u_s + m_s\,k^2{}_s\,\mathrm{B}_{rs}\left(\frac{d\,u}{d\,z}\right)_s\right\}\\ & + \mathrm{G}\int_{l'}^{z_r}\mathrm{A}'_r\,u\,d\,z + \mathrm{G}\int_{z_r}^{l''}\mathrm{A}_r\,u\,d\,z\\ & + \Sigma_{s=o}^{s=r}\,\mathrm{G\,A}'_{rs}\,u_s + \Sigma_{s=r}^{s=n}\,\mathrm{G\,A}_{rs}\,u_s\\ & + \mathrm{M}_o\,z_r\,(l - z_r)(2\,l - z_r) - \mathrm{M}'_o\,z_r\,(l^2 - z^2{}_r),\end{aligned}$$

where

$$\begin{aligned}\mathrm{A}'_r &= z\,(l - z_r)(2\,l\,z_r - z^2{}_r - z^2);\\ \mathrm{A}_r &= z_r\,(l - z)(2\,l\,z - z^2 - z^2{}_r).\\ \mathrm{A}'_{rs} &= z_s\,(l - z_r)(2\,l\,z_r - z^2{}_r - z^2{}_s);\\ \mathrm{A}_{rs} &= z_r\,(l - z_s)(2\,l\,z_s - z^2{}_s - z^2{}_r).\\ \mathrm{B}'_r &= (l - z_r)(3\,z^2 - 2\,l\,z_r + z^2{}_r);\\ \mathrm{B}_r &= z_r\left\{l^2 - z^2{}_r - 3(l - z)^2\right\},\\ \mathrm{B}'_{rs} &= (l - z_r)(3\,z^2{}_s - 2\,l\,z_r + z^2{}_r);\\ \mathrm{B}_{rs} &= z_r\left\{l^2 - z^2{}_r - 3(l - z_s)^2\right\}.\end{aligned}$$

And $\phi = 6\,\mathrm{E\,I}\,l$.

It remains to choose $u = f(z)$ to satisfy the end conditions and to fit the above equation for one or more values of z. The relation thus obtained will give one or more values of ω^2.

9. In the case of a horizontal shaft the action of gravity causes the neutral axis to become curved. If the shaft rotate the neutral axis remains curved in the vertical plane. We shall see later that if the longitudinal vibration speed be passed the shaft would tend to straighten from its gravitationally deflected position. If, now, a small disturbing force displaces the neutral axis from this gravitational position it will in general be brought back to this position unless the speed is a whirling speed; *i.e.*, unless the centrifugal and elastic forces are in equilibrium, in which case each point of the displaced neutral axis rotates about the gravitational position. Thus, in determining the conditions of whirling of a horizontal shaft we may omit the force of gravity from the case, and take u as the displacement from the gravitational position of the neutral axis instead of from its unstrained position, and $\frac{d\,u}{d\,z}$ as the tangent of the angle between the centrifugally displaced and the gravitational positions. This will be understood in what follows.

10. It is interesting to compare this centrifugal displacement curve (in which the force exerted by each mass depends on the displacement it experiences) with that due to gravity (in which the forces do not depend on the displacements). The latter equation may be written similarly in the form

$$\begin{aligned}\phi\,u_r = {} & g\int_o^{z_r} m\,\mathrm{A}'_r\,d\,z + g\int_{z_r}^{l} m\,\mathrm{A}_r\,d\,z\\ & + g\,\Sigma_{s=o}^{s=r}\,m_s\,\mathrm{A}'_{rs} + g\,\Sigma_{s=r}^{s=n}\,m_s\,\mathrm{A}_{rs}.\end{aligned}$$

For purposes of comparison of these curves we will take two loads m_1, m_2 at z_1, z_2; and in the following particular cases we find

$z_1 = \frac{1}{4}\,l$, $z_2 = \frac{1}{2}\,l$, $m_1 = m_2$; gravitational $\frac{u_1}{u_2} = 0.74$;

centrifugal $\frac{u_1}{u_2} = 0.732$.

$z_1 = \frac{1}{4}\,l$, $z_2 = \frac{1}{2}\,l$, $m_1 = \frac{1}{2}\,m_2$ gravitational $\frac{u_1}{u_2} = 0.722$;

centrifugal $\frac{u_1}{u_2} = 0{\cdot}714$.

$z_1 = \frac{1}{8}\,l$, $z_2 = \frac{1}{2}\,l$, $m_1 = m_2$; gravitational $\frac{u_1}{u_2} = 0.409$;

centrifugal $\frac{u_1}{u_2} = 0.388$.

Thus the curves appear to be similar, and we may obtain an approximate solution by using the gravitational equation to determine u_s and $\left(\frac{d\,u}{d\,z}\right)_s$ at every loaded point z_s.

Substituting these values of u in the general centrifugal equation—section 8—we obtain an equation for ω^2, the first whirling speed.

11. To facilitate calculation we may tabulate A_{rs}, A'_{rs} B_{rs}, B'_{rs}—section 8. Put $t = \frac{z}{l}$.

$$\frac{\mathrm{A}_{rs}}{l^4} = t_r\,(1 - t_s)(2\,t_s - t^2{}_s - t^2{}_r).$$

Table of values of $\frac{\mathrm{A}_{rs}}{l^4}$ for t_r equal to—

Value of t_s	0.0	.1	.2	.3	4	.5	.6	.7	.8	.9	1.0
0.0 ..	0										
.1 ..	0	.0162									
.2 ..	0	.0280	.0512								
.3 ..	0	.0350	.0658	.0882							
.4 ..	0	.0378	.0720	.0990	.1152						
.5 ..	0	.0370	.0710	.0990	.1180	.1250					
.6 ..	0	.0332	.0640	.0900	.1088	.1180	.1152				
.7 ..	0	.0270	.0522	.0738	.0900	.0990	.0990	.0882			
.8 ..	0	.0190	.0368	.0522	.0640	.0710	.0720	.0658	.0512		
.9 ..	0	.0098	.0190	.0270	.0332	.0370	.0378	.0350	.0280	.0162	
1.0 ..	0	0	0	0	0	0	0	0	0	0	0

$$\frac{\mathrm{A}'_{rs}}{l^4} = t\,(1 - t_r)(2\,t_r - t^2{}_r - t^2{}_s).$$

Table of values of $\frac{\mathrm{A}'_{rs}}{l^4}$ for t_r equal to—

Value of t_s	0.0	.1	.2	.3	.4	.5	.6	.7	.8	.9	1.0
0.0 ..	0	0	0	0	0	0	0	0	0	0	0
.1 ..		.0162	.0280	.0350	.0378	.0370	.0332	.0270	.0190	.0098	0
.2 ..			.0512	.0658	.0720	.0710	.0640	.0522	.0368	.0190	0
.3 ..				.0882	.0990	.0990	.0900	.0738	.0522	.0270	0
.4 ..					.1152	.1180	.1088	.0900	.0640	.0332	0
.5 ..						.1250	.1180	.0990	.0710	.0370	0
.6 ..							.1152	.0990	.0720	.0378	0
.7 ..								.0882	.0658	.0350	0
.8 ..									.0512	.0280	0
.9 ..										.0162	0
1.0 ..											0

$$\frac{\mathrm{B}_{rs}}{l^3} = t_r\left\{1 - t^2{}_r - 3\,(1 - t_s)^2\right\}.$$

Table of values of $\frac{\mathrm{B}_{rs}}{l^3}$ for t_r equal to—

Value of t_s	0.0	.1	.2	.3	.4	.5	.6	.7	.8	.9	1.0
0.0 ..	0										
.1 ..	0	−.144									
.2 ..	0	−.093	−.192								
.3 ..	0	−.048	−.102	−.168							
.4 ..	0	−.009	−.024	−.051	−.096						
.5 ..	0	+.024	+.042	+.048	+.036	.000					
.6 ..	0	+.051	+.096	+.129	+.144	+.135	+.096				
.7 ..	0	+.072	+.138	+.192	+.228	+.240	+.222	+.168			
.8 ..	0	+.087	+.168	+.237	+.288	+.315	+.312	+.273	+.192		
.9 ..	0	+.096	+.186	+.264	+.324	+.360	+.366	+.336	+.264	+.144	
1.0 ..	0	+.099	+.192	+.273	+.336	+.375	+.384	+.357	+.288	+.171	0

$$\frac{\mathrm{B}'_{rs}}{l^3} = (1 - t_r)(3\,t^2{}_s - 2\,t_r + t^2{}_r).$$

Table of values of $\frac{\mathrm{B}'_{rs}}{l^3}$ for t_r equal to—

Value of t_s	0.0	.1	.2	.3	4.	.5	.6	.7	.8	.9	1.0
0.0 ..	0	−.171	−.288	−.357	−.384	−.375	−.336	−.273	−.192	−.099	0
.1 ..		−.144	−.264	−.336	−.366	−.360	−.324	−.264	−.186	−.096	0
.2 ..			−.192	−.273	−.312	−.315	−.288	−.237	−.168	−.087	0
.3 ..				−.168	−.222	−.240	−.228	−.192	−.138	−.072	0
.4 ..					−.096	−.135	−.144	−.129	−.096	−.051	0
.5 ..						.000	−.036	−.048	−.042	−.024	0
.6 ..							+.096	+.051	+.024	+.009	0
.7 ..								+.168	+.102	+.048	0
.8 ..									+.192	+.093	0
.9 ..										+.144	0
1.0 ..											0

12. More generally we may assume for $u = f(z)$ an algebraic expression with undetermined coefficients. Thus we may take $u = a\,z + b\,z^2 + c\,z^4$, in which the coefficients a, b, c are determined by the conditions to be satisfied at the ends, and by imposing the restriction that this curve shall coincide with the centrifugal displacement curve at one intermediate point z_r. By eliminating these coefficients in this manner we obtain an equation of the first degree in ω^2, giving the first whirling speed. If we take coincidence at the middle point, $z_r = \frac{1}{2}\,l$, and we finally obtain by elimination of a, b, c:—

$$\begin{aligned}& m\,\omega^2\,l^8\,(0.134\,\mathrm{M}_o - 0.05666\,\mathrm{M}'_o)\\ & - m\,\omega^2\,k^2\,l^6\,(1.3188\,\mathrm{M}_o - 0.5562\,\mathrm{M}'_o)\\ & + \Sigma_o^{\frac{1}{2}l}\,(m_s\,\omega^2 + \mathrm{G})\,z^2{}_s\,(\tfrac{3}{4}\,l^2 - z^2{}_s)\left\{l^3\,(5\,\mathrm{M}_o - \mathrm{M}'_o) - 6\,\mathrm{M}_o\,l^2\,z_s + (\mathrm{M}_o + \mathrm{M}'_o)\,z^3{}_s\right\}\\ & + \Sigma_{\frac{1}{2}l}^{l}\,(m_s\,\omega^2 + \mathrm{G})\,z_s\,(l - z_s)(2\,l\,z_s - z^2{}_s - \tfrac{1}{4}\,l^2)\left\{l^3\,(5\,\mathrm{M}_o - \mathrm{M}'_o) - 6\,\mathrm{M}_o\,l^2\,z_s + (\mathrm{M}_o + \mathrm{M}'_o)\,z^3{}_s\right\}\\ & + 3\,\omega^2\,\Sigma_o^{\frac{1}{2}l}\,m_s\,k^2{}_s\,(z^2{}_s - \tfrac{1}{4}\,l^2)\left\{l^3\,(5\,\mathrm{M}_o - \mathrm{M}'_o) - 12\,\mathrm{M}_o\,l^2\,z_s + 4\,(\mathrm{M}_o + \mathrm{M}'_o)\,z^3{}_s\right\}\\ & + 3\,\omega^2\,\Sigma_{\frac{1}{2}l}^{l}\,m_s\,k^2{}_s\left\{\tfrac{1}{4}\,l^2 - (l - z_s)^2\right\}\left\{l^3\,(5\,\mathrm{M}_o - \mathrm{M}'_o) - 12\,\mathrm{M}_o\,l^2\,z_s + 4\,(\mathrm{M}_o + \mathrm{M}'_o)\,z^3{}_s\right\}\\ & - \frac{15}{4}\,\mathrm{E\,I}\,l^4\,(\mathrm{M}_o + \mathrm{M}'_o) = o;\end{aligned}$$

from which ω, the first whirling speed, may be deduced.

13. If the first two whirling speeds were required we would introduce an additional undetermined coefficient into the assumed displacement equation, *e.g.*, $u = a\,z + b\,z^2 + c\,z^4 + d\,z^5$. Here, coincidence between this curve and the actual displacement curve is to be imposed

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* No. I. appeared October 22nd.

at two intermediate points (chosen near the centres of the two loops into which the shaft bends at the second whirling speed), and in a similar manner after eliminating *a*, *b*, *c*, *d* from the resulting equations, and the equations of end conditions, there results a quadratic in ω^2 whose roots are the first two whirling speeds. And so on, the number of undetermined coefficients to be introduced depending on the number of whirling speeds it is desired to determine.

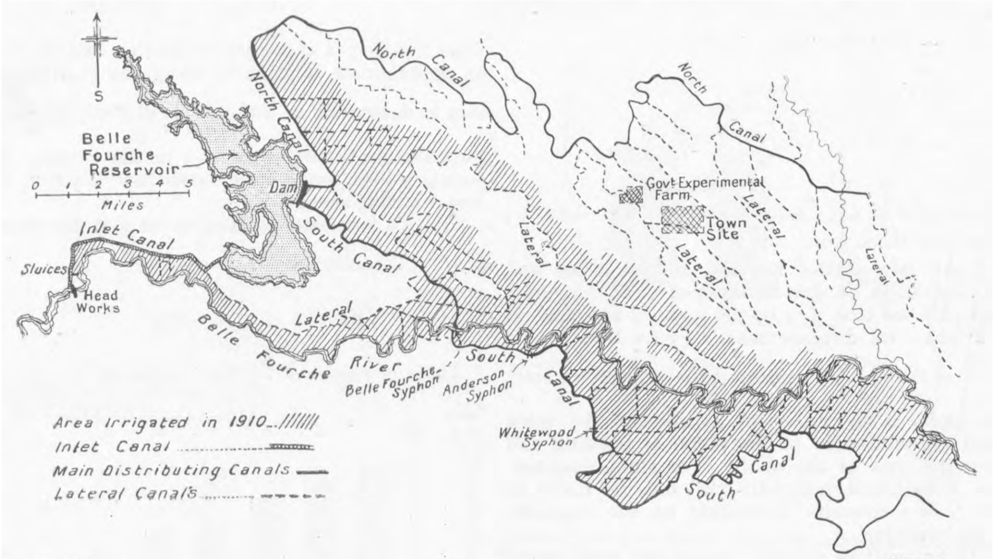

Fig. 32—THE BELLE FOURCHE DRAINAGE DISTRICT AND ITS WORKS

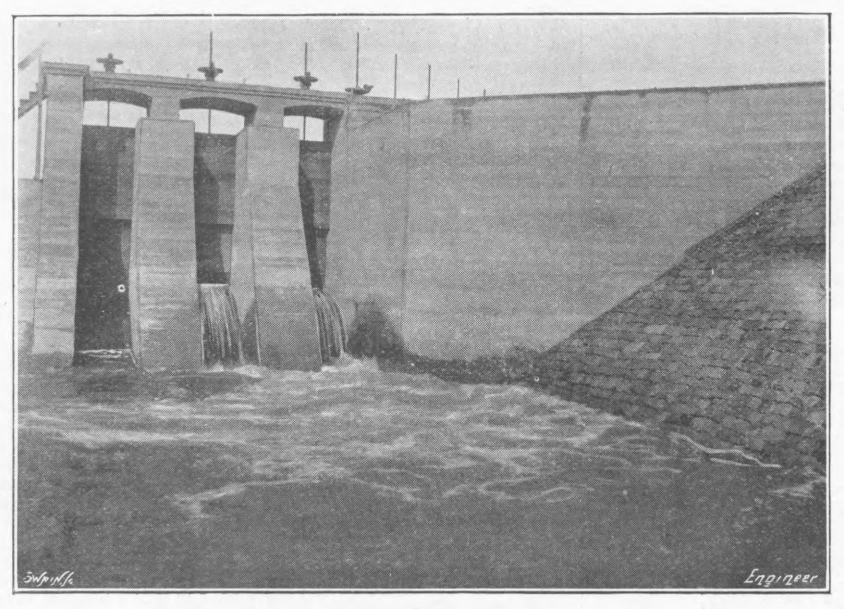

Fig. 33—SLUICE GATES OF THE INLET CANAL

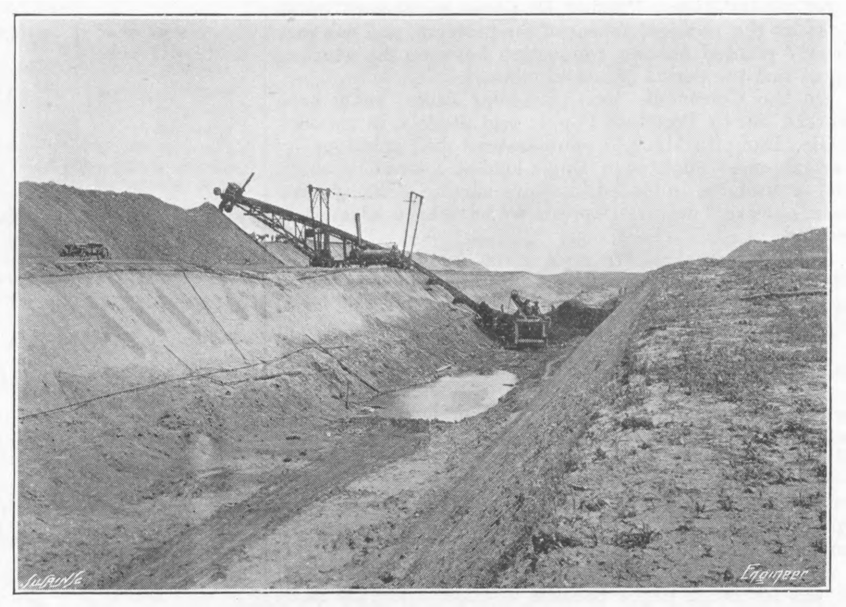

Fig. 34—EXCAVATION AND SPOIL BANK OF INLET CANAL

IRRIGATION WORKS OF THE UNITED STATES GOVERNMENT.

No. V.*

We turn now to the consideration of some of the projects in which water is taken direct from rivers of large and equable flow, diversion dams being built to turn water into the irrigation canals, weirs and sluices to provide for the passage of flood water without unduly raising the water level above the dam being provided.

THE BELLE FOURCHE DISTRICT.

The Belle Fourche scheme irrigates about 100,000 acres of land in South Dakota, the average elevation of the district being 2600ft. to 3000ft. above sea-level. The climate has an extreme temperature range from 30 deg. below to 100 deg. above zero, Fah., but, as noted already, the sensible variation is considerably less, owing to the dryness of the atmosphere. The average annual rainfall is 15in. The soil ranges from clay to sandy loam, underlaid by blue shale at a depth of some 40ft. It is very fertile, but requires about 2 acre-feet per acre per annum in addition to the rainfall. Fruits and vegetables are raised, but the main crops are alfalfa and native hay. Cattle and sheep in large numbers are pastured in summer on the open ranges surrounding the irrigated district, and the hay and alfalfa grown on the latter are in great demand for winter feeding.

The main irrigation works comprise a diversion dam in the Belle Fourche River, diverting water into a large inlet canal 6½ miles long. This discharges into a reservoir formed by closing one end of a depression between two hills by means of a long earth embankment. The map—Fig. 32—shows the arrangement of the various works. At the left are the diversion dam and the headworks of the inlet canal, just beyond which is a weir and wasteway from the canal to the river. The inlet canal discharges into the reservoir, and two main irrigation canals lead out from this, with numerous laterals. Within the district are a new town and a Government experimental farm. The shaded area will all be under irrigation next year.

The diversion dam in the Belle Fourche River has a concrete weir 400ft. long and 23ft. high, flanked by an earth embankment across low land. At ordinary stages of the water level it diverts the entire flow of the river into the canal, which has a capacity of 1650 cubic feet per second. Flood flows, which reach 20,000 cubic feet per second, pass over the weir, and are excluded from the canal by the head gates. This main canal is 6½ miles long, 40ft. wide on the bottom, and 70ft. wide at high-water level, carrying a depth of 10ft. of water. It is excavated mainly in clay and shale, and the heaviest cutting is 43ft. deep. The gradient is uniformly 1 in 5000. Fig. 33 is a view of the sluice gates at the headworks of the canal. Fig. 34 shows the method of excavating the canal. The earth was excavated by the large steam navvy at the left, the bucket of which loaded alternately two cars running on an incline, which travelled along to keep pace with the work. A cable and winding engine hauled the loaded cars to a tipple or dumping platform at the top, and the view shows a load being dumped upon the spoil bank.

To provide against an excess of water in this inlet canal, a weir or waterway is built in one side of the canal bank just beyond the headworks. Water passing over this weir flows into a concrete-lined channel, which returns the water to the river at a point below the dam. This weir and wasteway are shown in Fig. 35. Another type of wasteway which is used on the main irrigation canals is shown in Fig. 36. This has a balanced gate attached to rocking arms ending in segmental racks, which gear with straight racks carried by brackets in the side walls. When the water level reaches the top of the gate the gate swings backward, allowing water to pass beneath it until the head is lowered, when it closes automatically. The travel of the gate is limited by one of the concrete beams which span the wasteways and carry a bridge floor.

The reservoir is eight miles long, with an average depth of 60ft. and an area of 8000 acres. It has a capacity of about 215,000 acre-feet, equivalent to 70 billion gallons. The embankment which forms it is thrown across a tributary of the Belle Fourche River. It is 6500ft. long, being somewhat irregular in plan, in order to take advantage of the higher ground, and so save in the amount of earthwork; the straight parts are connected by curves of 1430ft. and 1910ft. radius. It is built on heavy clay soil, and has no core wall. The base was ploughed and a trench cut for a cut-off wall. The dam was then built in layers 6in. thick, all stones over 6in. in size being removed before rolling. The material was deposited from wagons or carts, spread by levelling machines to a uniform thickness, then sprinkled and well rolled with 20-ton traction engines and 12-ton steam road rollers. Sections of the dam, including the gatehouse and discharge conduit, are shown in Fig. 37.

The clay is well covered by gravel on the slopes, and the water side is paved with concrete blocks or slabs weighing 3000 lb., laid on a well-rammed bed of gravel 2ft. thick. The down-stream side is covered with 12in. of loam, which was fertilised and seeded to form a heavy sod. The slopes are 2 to 1, changing to 3 to 1 at the bottom of the water face, and 1 to 1 at the top, this steeper slope being used to break the waves. There is a 10ft. berme near the bottom of the water slope to hold the concrete paving. On the rear or down-stream side there are 10ft. bermes at vertical intervals of 30ft. A concrete conduit is laid through the dam.

A waste way or weir is provided which is semicircular

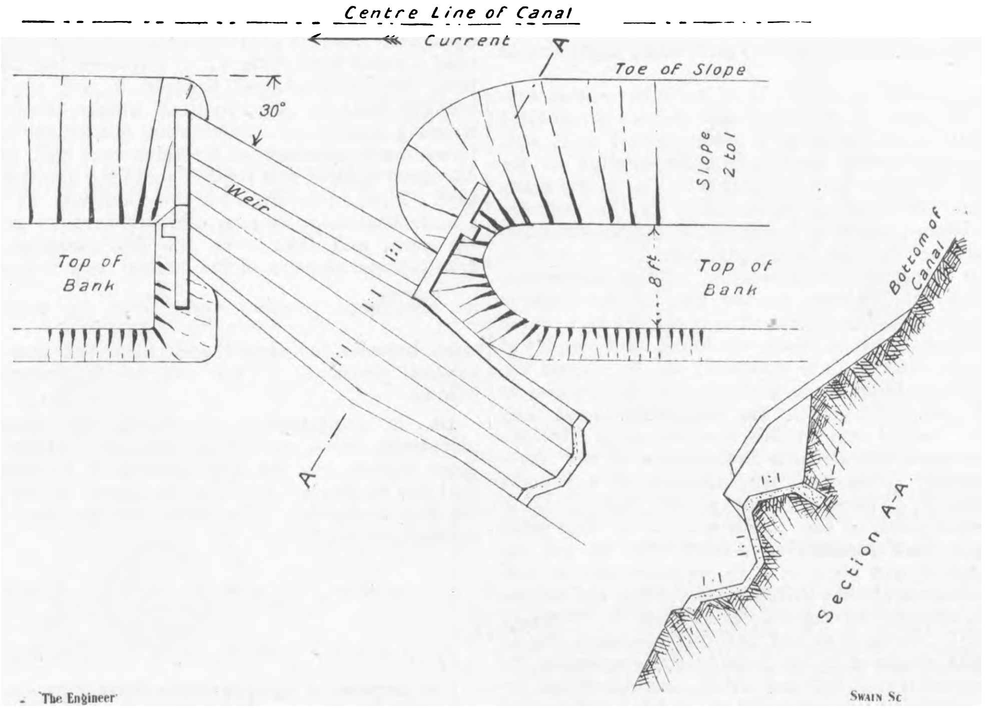

Fig. 35—WEIR AND WASTEWAY ON INLET CANAL

in plan, curving up into the reservoir, and having a radius of 100ft. This is of concrete, and its lower side ends in a kite-shaped basin which forms the entrance to a waste channel having a bottom width of 50ft.

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* No. IV. appeared October 15th.

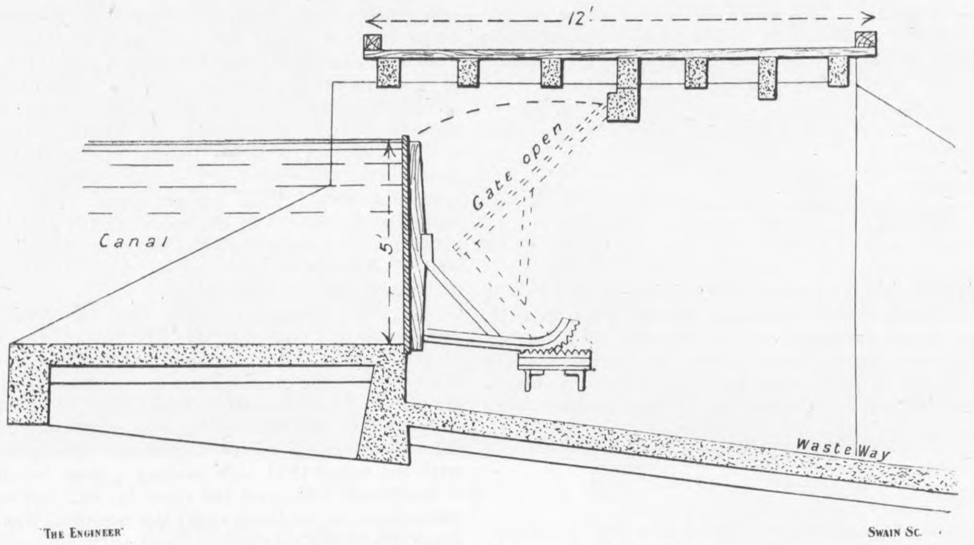


Fig. 36—BALANCED AUTOMATIC SLUICE GATE

Two irrigation canals lead out of the reservoir. The north canal is 45 miles long, 32ft. wide on the bottom, and carries 7ft. of water.

The south canal is 45 miles long, 18ft. wide on the bottom, and carries 5½ft. of water. It has one tunnel, 1310ft. long, driven through shale and lined with concrete. It is 9ft. square in cross section, and is approached by 1500ft. length of canal lined with concrete, and built on the slope of a steep side hill. The canal is carried under the Belle Fourche River and Anderson Creek by two inverted syphons of reinforced concrete construction, as shown by the map—Fig. 32. The syphon under the river is 8ft. inside diameter and 3600ft. long; the other is 500ft. long. There will be about 150 miles of lateral canals.

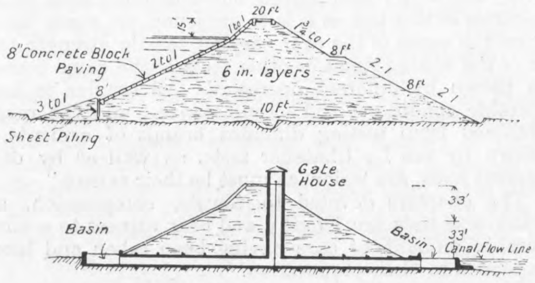


Fig. 37—SECTION OF EMBANKMENT

The materials encountered in the canals were shale, clay, sandy loam and gravel, the north canal being mainly in heavy clay. The excavation was done partly by wheeled-scrapers hauled by horses, and partly by grading machines hauled by traction engines or by horses. Steam excavators were used in the deep 40ft. cuttings, and loaded the material into railway tip wagons.

The syphon carrying the south main canal under the Belle Fourche River and its valley is 3600ft. long. It drops 65ft. in the first 200ft., and has then an easy slope to the river, where there is a sharp fall and rise, and then a rise of 30ft. in 200ft. up the other side of the valley. There is a total fall of 90ft., and a rise of 45ft., the fall in the hydraulic gradient being 45ft. Fig. 38 shows the design of the inlet and outlet chambers. The syphon is a 5ft. circular conduit of concrete, anchored at each change of gradient by a concrete collar 10½ft. diameter. The ends open into concrete chambers, and the intake chamber is fitted with screen racks to exclude dirt and floating material. The outlet chamber has a weir wall across it, with movable flash boards on top to adjust the water level of the basin. A drain and blow-off, with 24in. gate valve, is placed at one of the low points, with a small centrifugal drain pump driven by a 3 horse-power petrol engine. The syphon under Anderson Creek is 8ft. diameter, with a drop of 45ft., but the hydraulic gradient is practically horizontal. Its length is about 500ft.

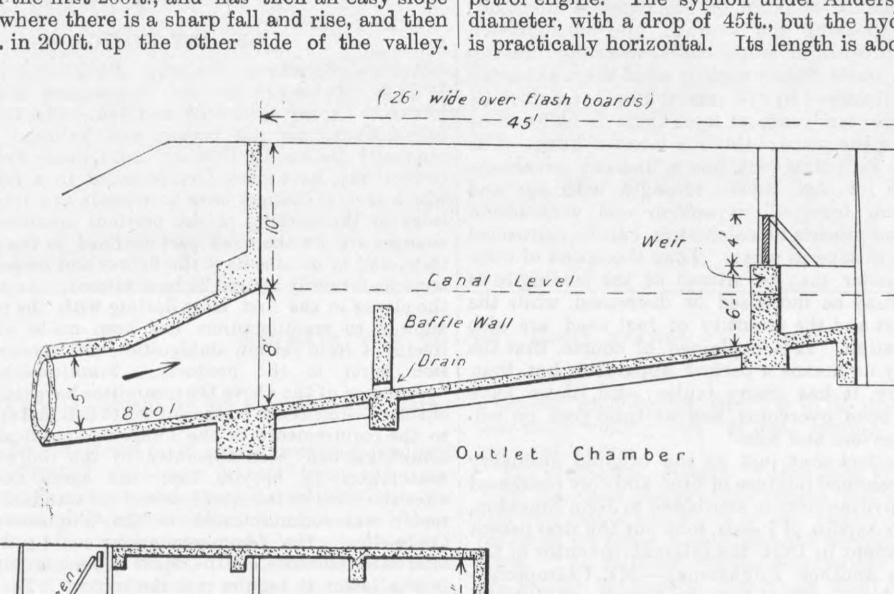


Fig. 38—INLET AND OUTLET CHAMBERS OF SYPHON

THE MINIDOKA DISTRICT.

The Minidoka irrigation district, in Idaho, provides for the irrigation of about 150,000 acres in the valley of the Snake River, the average elevation of which is 4200ft. above sea level. The average rainfall is 15in. to 19in., and the temperature range is from 12 to 96 deg. Fah. The watershed area is 17,900 square miles, and the run-off at the dam is about 5 million acre-feet. In the district there are 75,000 acres above the gravity canals, and provision is made for pumping water to high-line canals for irrigation.

The principal engineering feature is the diversion dam built across the river to divert the water into the canals. This is a rock embankment, 650ft. long and 50ft. high, with a backing of gravel and earth. At each end of the dam are the concrete headworks of a main canal. When the rock embankment was first completed the floods raised the water to within 3ft. of the crest of the weir, and the leakage—distributed evenly along the dam—was about 1000 cubic feet per second. A railway line was laid upon the embankment, and gravel and earth were dumped upon the down-stream side from wagons. At first a large part of this material was washed away, but it gradually filled the voids and interstices until finally the dam became water-tight.

Fig. 39 shows the dam—at the left, the headworks for a future hydro-electric station, a concrete weir, and the headworks of the canal. Fig. 40 is a view of these headworks from the canal, with the hand-operated regulating gates.

A feature of the dam and headworks is the utilisation of the water power. A concrete wall or dam between the canal headworks and the embankment has openings for penstocks 10ft. diameter leading into a power-house on the down-stream side, as shown in Fig. 39. There are five vertical shaft turbines, each having a 1200-kilowatt alternator on top of the shaft. There are also three 120-kilowatt continuous-current exciters with water wheels. The main turbines or water wheels develo 1800 horse-power at 200 revolutions; those for the exciters develop 180 horse-power at 425 revolutions. They are all of the inward flow, axial discharge single-runner type.

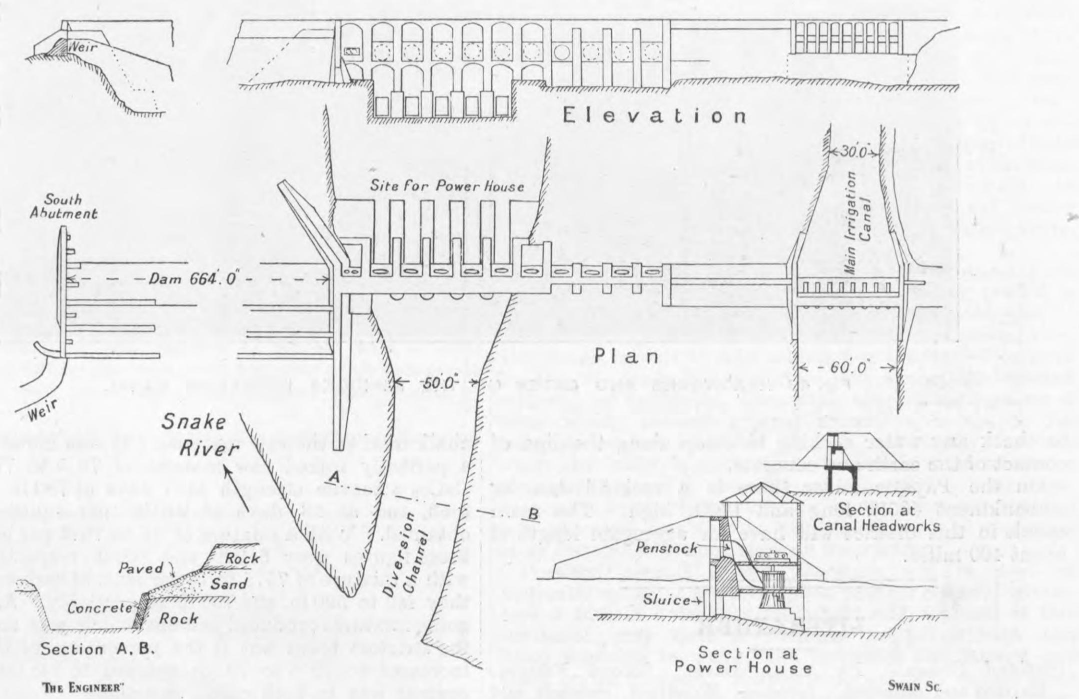


Fig. 39—PLAN OF DAM, HEADWORKS, &c., MINIDOKA DISTRICT

This generating station supplies current to three pumping stations, which raise water from the main canals to high-line canals at a higher level. These have synchronous motors on the vertical shafts of centrifugal pumps. There are eight pumps of 125 cubic feet per second, and one of 75 cubic feet per second capacity, all with a lift of 30ft. There are also three 6in. top-suction centrifugal pumps. The velocity of water in the canals is about 2ft. per second.

The main canal is in a lava rock cutting for two miles, the depth of cut being from 4ft. to 25ft. Here it is 30ft. wide on the bottom, with side slopes of 1½ to 1, and 10ft. depth of water. Beyond this it is in sandy soil, with a bottom width of 46ft., and side slopes of 3 to 1. Where the sides are in embankment the banks have a top width of 14ft. and an outer slope of 2 to 1. There was great seepage in this soil, so the slopes were cut away for 12in., and the sandy soil covered with a 12in. blanket of clay.

THE PAYETTE-BOISE DISTRICT.

The Payette-Boise district, also in Idaho, provides for the irrigation of about 400,000 acres in the valleys of the Payette, Boise and Snake rivers. The average elevation is much lower than that of the Minidoka district, being from 2200ft. to 2800ft. above sea level, with an extreme temperature range of 9 deg. to 104 deg. Fah., and an average annual rainfall of 14½in. About 300,000 acres of this district are sandy desert land.

The dam on the Boise River is completed, and on February 22nd, 1909, the sluice gates were closed, and the water diverted into one of the main canals. This dam is of concrete, with large quarry blocks embedded in it as "pudding stones." It is 45ft. high, with a movable crest, 1ft. high for a length of 216ft. Next to this weir portion is a 30ft. channel for loop, and then an 8ft. channel for fish, this latter having zigzag steps to allow fish to ascend against the current. Next to the fishway is a 60ft. length of dam, followed by the concrete headworks of the canal. A depressed channel leads to two tunnels under the 60ft. length, these being 6ft. by 10ft. in section and fitted with gates. Below the dam the tunnels curve towards the river and terminate in the concrete abutment.

The canal headworks have eight openings 5ft. wide, fitted with gates 9ft. high. The canal is 40ft. wide on the bottom, with side slopes 1½ to 1, and carries 8ft. of water. Its capacity is 1500 cubic feet per second. Provision is made for enlarging it to a width of 70ft. and a capacity of 2700 cubic feet. It will be used during the winter and early spring to fill a reservoir formed by closing the outlets of a natural basin with embankments, and during the summer it will be used for direct irrigation. The reservoir has an area of 10,000 acres and a capacity of 186,000 acre-feet. The embankments are 30ft. to 68ft. high, 4000ft. and 7500ft. in length. The top width is 20ft., and the slopes are 3 to 1 on the water side and 2 to 1 on the rear side. The main part is of earth and gravel, faced with clay on the water face—protected by 3ft. of clean coarse gravel, and coarse gravel on the rear side. The site is ploughed in each case, and has trenches 4ft. deep for cut-off walls.

Through one embankment extends a concrete outlet having four channels 6ft. diameter closed by gates. The outlet itself is a rectangular mass 9ft. high and 33ft. wide, and at intervals of 20ft. it has diaphragms 19ft. by 43ft. to check any water seeking to creep along the line of contact of the earth and concrete.

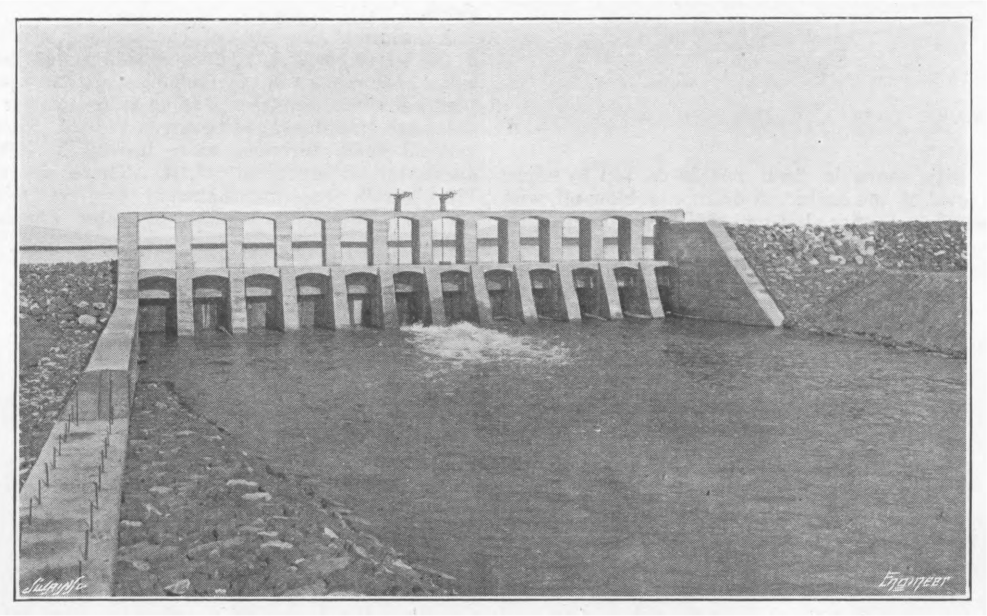


Fig. 40—HEADWORKS AND GATES OF THE MINIDOKA IRRIGATION CANAL

On the Payette River there is a rock-fill dam or embankment 400ft. long and 100ft. high. The main canals in this district will have an aggregate length of about 400 miles.

LITERATURE.

Portland Cement. By A. C. Davis. Second Edition. Revised and enlarged. London: Woodford, Fawcett and Co. 1909.

While nominally a second edition, this is practically an entirely new work. The matter contained in the first edition was a reprint of a series of articles which had been contributed to the *Stone Trades Journal*. "The entire contents"—to quote the publishers' note—"of this second edition have been re-written and brought up to date by the insertion of matter dealing with the latest available information concerning the manufacture and testing of Portland cement. . . ." As a fact, the newer volume is a great deal more bulky—not that that in itself is a recommendation—and contains a great deal more information than the first. Much, if not all, that was in the first appears in the second edition, though in an expanded form, and there is a great deal more in the latter than was contained in the former.

There are several points referred to in the introduction which are worthy of notice. The first is the disability under which British manufacturers have had to work by reason of "most divergent, multifarious, and fastidious specifications." To these are attributed the losses of our export trading rather than to the alleged "invincible independence of the English manufacturer," to the difficulty there has been in the past "to get manufacturers to alter their habits as to chemical proportions, or their methods of burning and grinding," or to the allegation that they have been too ready to force their experience upon their customers. The advent of the British Standard Specification and the adoption of uniform methods of testing are unstintedly welcomed. The maker is now free to turn his undivided attention to the perfection of details.

The book is divided into an introduction, fourteen chapters, and three appendices. The titles of the chapters are as follows:—"Definition and Constitution," "Raw Materials," "Raw Materials—Grinding and Mixing," "Estimation and Analysis of Raw Materials," "Burning or Calcining," "Clinker Grinding," "Chemical Tests," "Sampling, Testing, and Uses," "Fineness and Sieving," "Tests for Bushel Weight and Specific Gravity," "Setting," "Soundness, Contraction, and Expansion," "Tensile Strength Tests," and "Compression and Transverse Tests." The appendices deal with the British standard and other specifications, useful tables, and a list of manufacturers in England and Wales, with the outputs of their works. It would be impossible to discuss in detail the various portions of the book, and we must content ourselves with referring to one or two matters only.

Stress is laid upon the paramount necessity of using a correct mixture of raw materials for the manufacture of good cement. It is pointed out that in some cases the natural earth has a composition which is very nearly correct, but not nearly enough. To burn such deposits without any correction means the production of a cement which is unreliable. The permissible variation in the quantities of the constituents is not wide. The analysis of a prepared mixture of raw materials for the manufacture of cement may be approximately as follows:—

Carbonate of lime	76·35
Silica	13·46
Alumina	5·33
Iron oxide	1·69
Magnesia	1·94
Sulphuric anhydride	0·31
Potash, soda, &c.	0·92
	100·00

Roughly speaking, a mixture containing from 74 to 77 per cent. of chalk should produce a cement of fair quality, but a very small variation in the quantity of this constituent is found appreciably to alter the tensile strength of a cement. A series of tests bearing on this point were recently carried out at Cambridge by the author, using chalk marl as the raw material. It was found that with a perfectly mixed raw material of 76.5 to 77 per cent. $CaCo_3$ a tensile strength at 7 days of 780 lb. per square inch, and at 28 days of 940 lb. per square inch was obtained. With a mixture of 76 to 76.5 per cent. $CaCo_3$, these figures were 610 lb. and 800 lb. respectively, while with a mixture of 75.5 to 76 per cent. of carbonate of lime they fell to 520 lb. and 730 lb. respectively. All the foregoing mixtures produced cement which was sound under the strictest tests, but if the percentage of $CaCo_3$ were increased to 78.5 to 79 or reduced to 74, the resulting cement was in both cases unsound.

The chapter devoted to burning the clinker contains a historical sketch, in which reference is made to the various kilns. The dome or bottle kiln, and the chamber, Batchelor, Dietsch, Hoffman, Aalborg, Schneider, and the Stein kilns, come in for more or less detailed mention; and generally speaking the average fuel consumption of each is given, with, in some cases, sectional illustrations. But Mr. Davis clearly regards all of them as having been entirely outclassed by the rotary kiln. Nor does he consider that for ten years at least there is likely to be anything to take the place of this the latest of kilns. The product from it, he points out, has a distinct advantage in quality, both for high tensile strength with age and absolute freedom from all expansion and contraction tendencies. The process of calcination can be controlled to a nicety and in several ways. Thus the speed of rotation of the cylinder may be altered or the feeding in of raw materials may be increased or decreased, while the force of the blast and the quantity of fuel used are also capable of variation. It is explained, of course, that the rotary kiln is by no means a perfect apparatus, but that, on the contrary, it has many faults; still, these have many of them been overcome, and as time goes on will no doubt become less and less.

It is a curious fact that just as the original discovery in 1757 that a calcined mixture of lime and clay possessed the property of hydraulicity is attributed to John Smeaton, and that Joseph Aspdin, of Leeds, took out the first patent for Portland cement in 1824, the original inventor of the rotary kiln was another Englishman—Mr. Crampton—who in 1877 took out patents for "the burning of Portland and other such like cement in revolving furnaces heated by the gases resulting from the combustion of coal or carbonaceous material. . . ." It is explained, however, that it is doubtful whether the idea got very much further than the Patent-office; nor did much greater luck befall the efforts of Mr. Frederick Ransome, who took out a patent in 1885 for developments in the process, including the use of dried materials, though his process was certainly worked in several places. As so often has been the case, we have invented a process in this country and then left foreigners to bring it to perfection. In the United States and on the Continent the rotary kiln has been employed to a far greater extent than it has hitherto been in this country; but as things are now trending, we doubt if this state of affairs will continue for long.

The various processes necessary for the selection, testing, and preparation and burning of the raw material, for the cooling and grinding of the clinker, and for the testing of the finished cement, are all dealt with in considerable detail, and there is but little comment to make upon them. The paper by Professor Fisher, of Hanover, on the operation of grinding materials in ball mills, is reproduced, with its illustrations, and will doubtless be of interest to those who have not hitherto had an opportunity of studying it. The author remarks, when dealing with the question of fineness of grinding, that a fine cement is used with greater safety in work, is of a quick-setting nature, and is found to develop its tensile strength in much shorter periods than a coarsely ground product. In considering the neat tensile tests of a finely ground cement, it will be found, he says, that there are only slight differences between the three and seven-day tests. This, it is explained, "is the result of the active particles being the more readily and immediately attacked after the gauging of the briquettes." The necessity of having a high percentage of "flour" in the cement is also commented on.

Mr. Davis insists strongly that the setting time of a cement should be accurately known. If the setting time be not specified, it may happen that a too quickly setting material for the particular work in hand is inadvertently supplied. In such a case it may turn out that when it is brought into use the setting has commenced even before the wet mixing of the aggregate and cement is completed, with the result that this setting action being unnoticed, is interfered with, and the material will not again set for some days, or, at least, until the moisture has thoroughly dried out of the mixture. Even then its cohesive value is so greatly reduced as to render the cement practically useless. This, it is pointed out, is a common occurrence, and may easily be avoided by a systematic testing of activity. The rate of setting should first be ascertained, and care then taken that no greater bulk of mortar is mixed than can be used before the setting commences.

A good deal of space is devoted to the Le Chatelier test for expansion, and upon it the author remarks that there can be no disputing as to the value of this test in ascertaining the expansion of cements, but whether the practical soundness of a cement is to be definitely gauged by these expansion results is quite a debatable point, and "this, doubtless, is more the bone of contention—although not so clearly put forward by its agitators—than is the futility of the test itself." "It is," he continues, "of as little use to try and assign one common cause to the vagaries of this test as it is to propound an exact theory upon the cause of the ever varying tensile strength tests or of the setting times or other tests of the same cement as shown by different operators. All are due to innumerable conditions and circumstances, and the results obtained from testing different brands of cements, as shown by the Le Chatelier tests, as well as by other cement tests, are legion, as must be their causes."

The chapters devoted to tensile, compression, and transverse tests are lengthy, and bear witness to a considerable amount of care having been taken and labour expended in their preparation.

The study of Portland cement possesses something in the nature of a fascinating spell, and Mr. Davis has come deeply under its influence. In the present work he has dealt with the subject from practically every point of view, and, for the most part, with clear sighted and dispassionate judgment. He has succeeded in compiling a book which will certainly appeal even to the lay mind, while also being useful as a work of reference. We are somewhat surprised, however, that no mention has been made, as far as we have been able to discover, of slag cement. Some of the historical portions will be read with much interest, and the book, as a whole, will be found distinctly readable.

SHORT NOTICE.

British Standard Railway Rails and Fish-plates. London: Published for the Engineering Standards Committee by Crosby Lockwood and Son.—The British Standard Specifications for flat bottom and bullhead railway rails, originally issued in October, 1904, and February, 1905, respectively, have since been re-issued in a revised form, in which several changes have been made as a result of a knowledge of the working of the previous specifications. These changes are for the most part confined to the provisions for tests, and in no case have the figures and proportions for the sections formerly arrived at been altered. An amendment to the clause in the first issue dealing with the rolling margin allowed to manufacturers has been made with a view to freeing it from certain ambiguities, and rendering the provision fairer to the producer. Simultaneously with the appearance of the above the committee have issued the results of their deliberations on the subject of fish-plates for rails rolled to the requirements of the foregoing specifications. A sub-committee had been appointed by the Railway Engineers' Association to inquire into the same subject shortly after the issue of the specifications for standard rails, and its report was communicated to the Engineering Standards Committee. The recommendations contained therein were afterwards embodied in the report of the committee appointed by the latter to inquire into the subject. The price of each of the three specifications is 10s. 6d. net, a figure rendered necessary by the large amount of work devoted to their preparation.

BOOKS RECEIVED.

The Glasgow and West of Scotland Technical College Calendar for 1909-10.

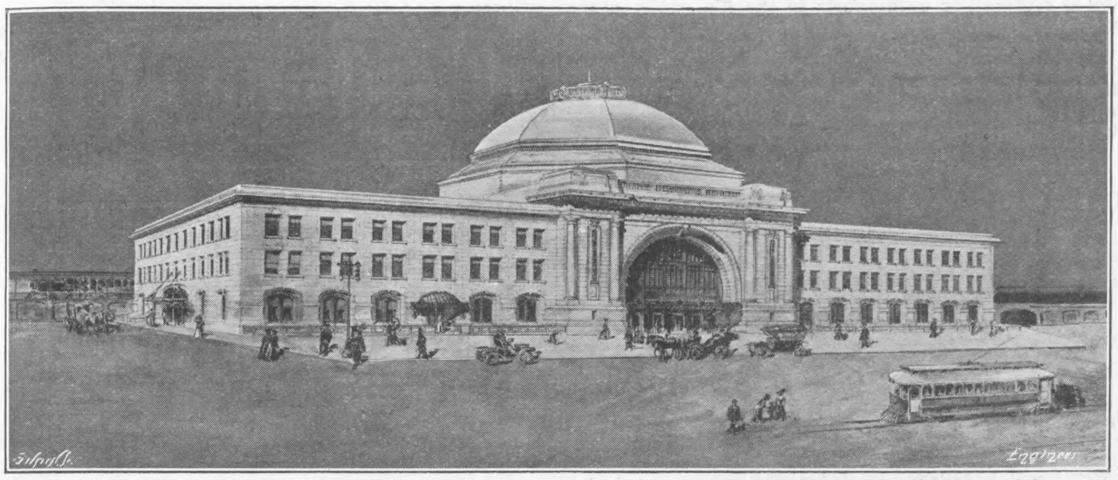
Spon's Workshop Receipts. Vol. II. Dyes—Japanning. London: E. and F. N. Spon, Limited. Price 3s. net.

Wireless Telephone Construction. By N. Harrison. London: E. and F. N. Spon, Limited. Price 1s. 6d. net.

The Conquest of the Air. By Alphonse Bergeh. London: William Heinemann, 21, Bedford-street, W.C. Price 12s. 6d. net.

Co-ordinate Geometry Applied to Land Surveying. By W. Pilkington, M. Inst. C.E. London: E. and F. N. Spon, Limited. Price 1s. 6d. net.

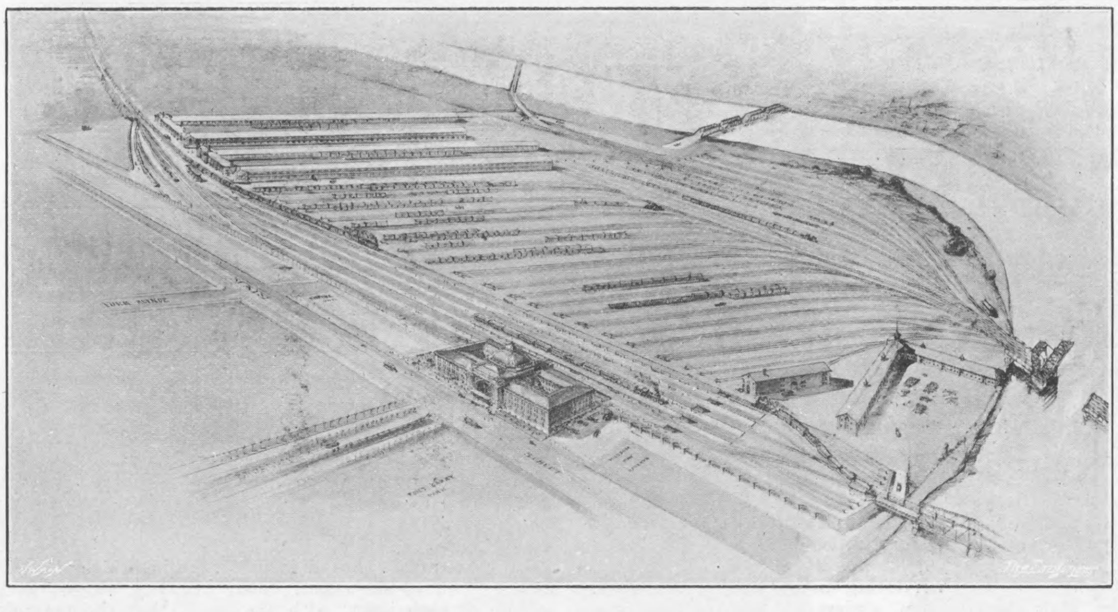
FORT GARRY STATION, WINNIPEG



FORT GARRY STATION, WINNIPEG.

There is much in the history of Winnipeg that is fascinating. It lies at the junction of the Red and Assiniboine rivers, 40 miles south of Lake Winnipeg and 60 miles north of the boundary line between the United States and Canada, and almost midway between the Atlantic and Pacific oceans. It was long one of the frontier trading posts of the Hudson Bay Company, one of whose forts—Lower Fort Garry—is still standing, and another of which has given its name to the new station we are about to describe. In 1870 the population was 215, four years later it was 1869, which grew to 19,574 in 1885 and to 39,384 in 1898. In 1902 it was 56,603, and since then has more than doubled itself, as two years ago it was 111,717.

A new Union station and terminal yard are being constructed by the Canadian Northern for the joint use of of itself and the Grand Trunk Pacific. These will occupy an area of about 70 acres, and are situated close to the centre of the city. The passenger station is directly opposite the fine thoroughfare known as Broadway. This, as will be judged from the illustration above, will be an imposing structure, built entirely of native Tyndall Manitoba stone, and having a length of 350ft. along Main-street, and a depth from Main-street to the tracks of 140ft. The larger portion will consist of three stories and a basement, surmounted in the centre and opposite Broadway by a dome 100ft. above street level.



BIRD'S-EYE VIEW OF FORT GARRY STATION

The main floor at street level covers over 36,000 square feet. The outgoing passenger passes from the main entrance through a stone and marble vestibule into the ticket lobby or rotunda, where he finds the ticket and "baggage" checking offices, telephone and telegraph "booths," and newspaper and cigar stalls. The circular floor is of mosaic and is 90ft. in diameter, whilst the walls, 90ft. high, are of stone and marble, and capped by a stone vault beneath the dome. No seats or other impedimenta are placed here, but those passengers who have to wait will pass through glass doors on the north side into the waiting room, which will cover about 10,000 square feet, and the walls of which will be embellished with the coats of arms, executed in gold leaf and colours, of the various provinces of the Dominion.

Between the waiting room and Main-street will be a restaurant and dining rooms. These have entrances off Main-street also. On the opposite side of the waiting room will be separate rooms for men and women, with the usual accommodation. At the north end will be a carriage way, 50ft. wide, with an entrance into the waiting room. Access to the platforms will be by means of a subway leading off a vestibule to the east of the ticket lobby. The subway is 50ft. wide, and there are staircases on each side leading to the platforms, which are 10ft. above the level of the main floor of the station. By means of gates and railings, arriving passengers will be separated from those departing.

The whole of the space on the main floor on the south side will, for the present, be devoted to baggage purposes, which later will be dealt with under the station proper, and below this is the accommodation for emigrants, of whom a large number passes through Winnipeg annually. They will enter from Main-street by separate entrances, and also so leave for the trains. The accommodation includes a waiting room, lunch counter, laundry and bathroom. Under the central portion of the main floor are stores, and north of these are a barber's shop, the restaurant's kitchen, and the boiler and engine-rooms. The basement will be surrounded by an open air-way, 10ft. wide. Above the main floor are two other floors to be used as offices, and provision has been made in the foundations and steel work for six further floors.

There will be four platforms and eight through passenger lines and two through goods lines. The platforms will be 20ft. wide and 1650ft. long, sufficient for two trains at each platform. Lifts will be provided on each platform to give access to a subway 15ft. wide for dealing with baggage.

The goods yard will contain 42 tracks, with a total capacity of 830 freight cars, and, together with the goods warehouse, will form one of the largest goods yards in existence.

The present main line crosses the Assiniboine River on a wooden draw-bridge, which is to be replaced by a steel four-track rolling lift bridge, having two separately operated leaves.

The architects, Messrs. Warren and Wetmore, of New York, have had charge of the design, and will supervise the carrying out of the whole of the work. To them we are indebted for these details and the accompanying illustrations. The railroad officers responsible for the scheme are Messrs. Mackenzie, Mann and MacLeod, of the Canadian Northern Railway, and Messrs. Hays, Morse and Kelliher, of the Grand Trunk Pacific.

OBSERVATIONS ON MATERIALS FOR BINDING MORTAR.

By ANTON HAMBLOCH, Andernach-on-the-Rhine.

In the preparation of the strongest mortars used for building purposes, four mineral products are at the present time employed in Europe as binding and cementing materials. They are: Lime, hydraulic lime, Portland cement, tuff (trass).

It is not intended to enter here into long and scientific explanations, since most of them are doubtless well known to users of building materials. But a few simple remarks on the characteristics of these substances and the conditions under which they gradually harden and impart strength to mortar may, it is thought, be found acceptable and useful.

Lime.—When ordinary limestone, marble, or chalk (carbonate of lime) is burnt in a kiln, it loses a large proportion of the carbonic acid gas which it originally contained. When this burnt lime is slaked in water, being converted into caustic lime, it shows such great avidity to absorb the water that a considerable amount of heat is developed. After this caustic lime is made into mortar through a further addition of water and sand, and—in conjunction with brick or other stone—is built into walls, and so on, its hardening process takes place mainly in this way: The water contents of the mortar slowly evaporating, the lime first shrinks and tightens round the sand particles. A small portion of it slowly combines with what soluble silicic acid there may be in the sand. But by far the larger part of the lime gradually absorbs carbonic acid gas from the air, being finally re-converted into its original form, that of carbonate of lime. For this reason ordinary lime is also called air lime, and mortars prepared from ordinary lime are called air mortars. They have the disadvantage of remaining soft (for an astonishingly long time in some instances) in very thick walls, which air cannot penetrate.

To counteract not only this drawback in air mortar, but also in order materially to shorten the time required for its hardening, it is expedient to mix with it some highly silicious material. Tuff, or trass, is probably the best of the silicious substances available for this purpose. And only in combination with such highly silicious material can air mortar be exposed to the action of water—that is to say, can safely and effectively be used for hydraulic purposes.

Hydraulic lime.—Hydraulic lime is lime which has the property of hardening in water when air is excluded. Formerly any limestone containing carbonate of magnesia to an appreciable degree was considered unfit for building purposes. But it has been found that so-called dolomitic limestones, containing—besides carbonate of lime and some silicic acid—even large percentages of carbonate of magnesia, when properly burnt, make excellent hydraulic mortar. This is due to the ability, not only of the silicic acid, but also of the carbonate of magnesia they contain, to harden in water in conjunction with lime. At the same time, dolomitic limes make also very good air mortar. They resist particularly well the influence of rain and water in buildings above ground. Their exclusive use in the manufacture of German pumice brick, for instance, clearly shows this. Hydraulic lime has the further advantage of hardening more quickly than air-lime. In some cases the addition of a highly silicious material, like tuff, to hydraulic mortar may also be called for, its use depending on the composition of the lime, as well as on the purpose which the mortar is to serve. In Germany hydraulic lime, with an addition of tuff, is now alone employed by the Government for canalisation works, and its use meets with the best of success.

Portland cement.—The nature and components of Portland cement are well known, and its hardening process is—practically, at least—so thoroughly understood that it would seem superfluous here to speak of it in a general way. But it may be well to draw attention to the fact—discovered by Dr. W. Michaëlis, of Berlin—that almost all Portland cements, in hardening, liberate an appreciable quantity of lime, which, through gradual lixiviation, is apt to disintegrate cement concrete. This is particularly the case when the latter is submerged in water. If it occurs in structures exposed to the action of sea water, it becomes an even more serious defect, the salt in the sea water entering into chemical combination with the lime, and becoming more destructive to concrete than fresh water.

Portland cement should, therefore, not be used in hydraulic works of any description without a liberal admixture of tuff, in order that the silicic acid contents of this substance may form a chemical compound with free lime, insoluble in water, and neutralise the latter's bad effect on the concrete. Furthermore, tuff will impart great elasticity to otherwise rigid cement concrete structures, particularly those constructed of reinforced concrete. The rigidity of concrete is probably one of the main reasons for the frequent occurrence of breaks in water reservoirs, irrigation dams, canal locks, and other hydraulic works which are exposed to high pressure.

Tuff (trass).—Although tuff is a term in use for quite a variety of volcanic products found in a petrified state, it is applied particularly to a certain species of lava. This kind of tuff is identical with puzzolano earth, which has been extracted from very ancient times in the vicinity of Mount Vesuvius. It also occurs in the valley of the Rhine, in Germany, in Greece, in Asia, and in Central and South America. That tuff was extensively used by the ancient Romans is illustrated by a number of their fortifications and aqueducts still existing in various parts of the European Continent and of Great Britain. In the mortar found in these buildings the presence of tuff can still clearly be demonstrated. Their power of resistance to the inroads of time is a wonder to our architects. Immense hydraulic works in Holland several centuries old also bear witness to the stability and strength of tuff. Tuff contains a predominant amount of soluble silicic acid. As explained above, this readily unites with lime, and in that combination has the faculty of hardening under the action of water. Tuff congeals more slowly than Portland cement, but it gradually becomes fully as hard as the latter. It materially assists the petrifying process of mortar and concrete, not only when above ground and exposed to the air, but even more so when immersed in water. For building purposes tuff is used in its natural state. It is ground to a powder, which in Germany is called trass. It resists frost perfectly, and stored away is not affected by moisture. Tuff is of lighter weight, and therefore of greater bulk, denser, much more elastic, and cheaper in price than Portland cement, and it is claimed for it that there is to-day no binding material for our various mortars known to equal it in effectiveness. For the construction especially of such hydraulic works as dry docks, quays, canals, bridges, breakwaters, &c., it would appear to be not only a most welcome but in many cases an indispensable adjunct to mortar.

An invention which has just been patented in Berlin by F. van der Wonde has for its object, states the *Post Office Electrical Engineers' Journal*, the adaptation of wireless telegraphy to multiplex working. The antenna is joined to a spiral device carrying a number of contact arms, which, when revolved, makes the following connections:—(A) Transmitter joined up; (B) antenna earthed; (C) transmitter cut out; (D) receiver joined up; (E) earth disconnected; (F) receiver cut out. The speed of action is such that several revolutions take place during the time necessary for the sending of a Morse dot.

FERRO-CONCRETE BRIDGE OVER THE RIVER WANSBECK.

UNTIL a very few weeks ago the only means of communication for any class of traffic from bank to bank of the river Wansbeck at Stakeford, near the North Seaton Station of the North-Eastern Railway Company, was by way of a ford, which was of a very treacherous character, especially during periods of flood. During recent times the need for better facilities became increasingly felt, and a local committee was therefore formed some years ago for the purpose of raising funds for the construction of a bridge. In due course Messrs. D. Balfour and Son, civil engineers, of London and Newcastle-upon-Tyne, were commissioned to prepare a definite project for the structure, and, having considered the relative merits of steel and ferro-concrete, recommended the latter for adoption. As the estimated cost of steel work amounted to £12,000 and that of ferro-concrete was only £8000, the initial economy of the latter naturally appealed to the committee, the result being that the tender of Brims and Co., of Newcastle-upon-Tyne, authorised Hennebique contractors, was accepted. The ultimate saving to the ratepayers will, it is hoped, be considerably in excess of the £4000 mentioned above as represented by the difference of first cost, since ferro-concrete structures obviate the expenditure necessary in painting and otherwise maintaining steel bridges.

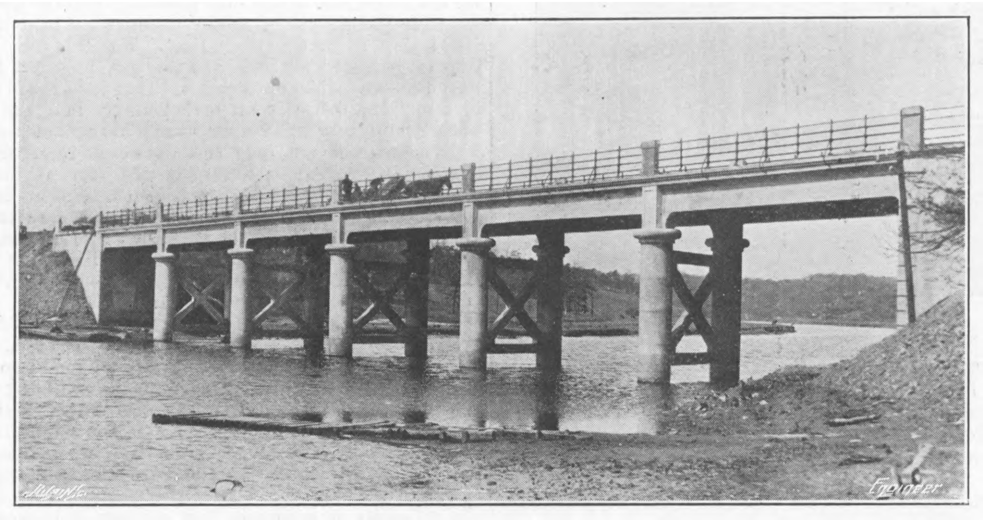
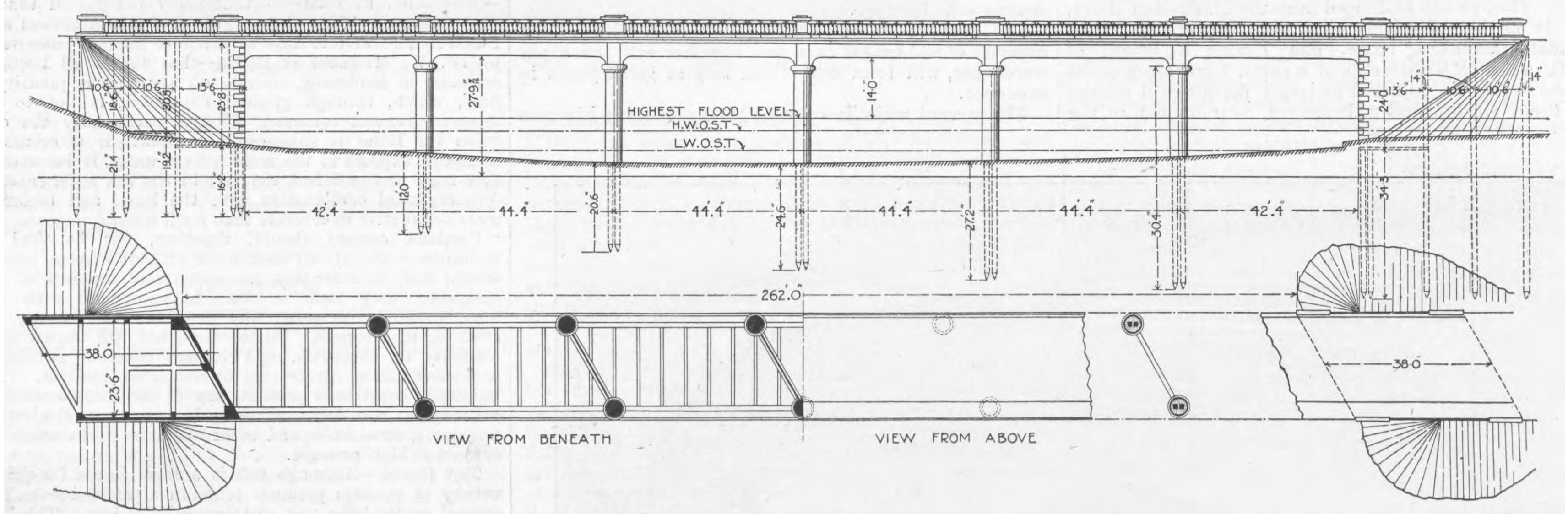


Fig. 1—GENERAL VIEW OF THE COMPLETED BRIDGE

A general view of the new bridge, which is 264ft. long between abutments and 24ft. wide between the parapets, is given in Fig. 1. The structure includes six girder spans carried by ferro-concrete abutments and piers, the latter consisting of Mouchel cylinders braced by diagonals and in monolithic connection with the superstructure. The main girders and transverse beams are connected by a continuous deck slab with cantilever extensions for the parapets, and the road surface is formed of tar macadam laid over the ferro-concrete decking.

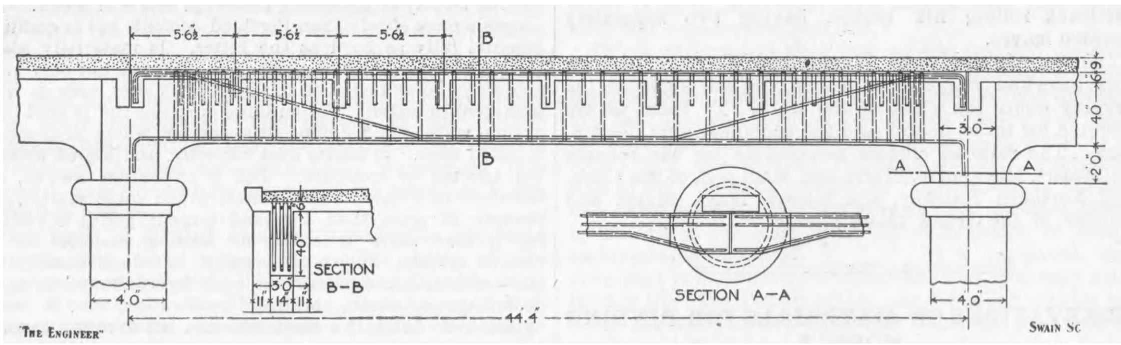


"The Engineer" Swain Sc.

Fig. 2—ELEVATION AND PLAN OF THE BRIDGE

The design of the bridge is shown in elevation and plan in Fig. 2. The abutments are founded on Hennebique piles 14in. square, driven through gravel, sand, and clay to a solid stratum of yellow sandstone overlying harder rock, the piles having been driven to depths ranging from about 20ft. to 40ft. below the surface level. As indicated by the section at the left hand of Fig. 2, each abutment is a framed caisson of ferro-concrete with interior bracing, the whole being filled with earth and stones to form a solid foundation for the roadway. The heads of the piles are connected by longitudinal and transverse beams, and from these rise the columns acting as stiffeners or counterforts to the 6in. walls of the abutments. The tops of the columns and wall slabs are connected by coping beams at the road level, the general nature of the construction being further illustrated by Fig. 7, which is reproduced from a photograph of one abutment taken before the caisson was filled with earth. Fig. 4 includes sections giving details of the reinforcement, and showing particularly the manner in which the principal bars in each member are passed into and securely anchored into the concrete of adjoining members, thus providing metallic connection, in addition to the monolithic bonding of the concrete throughout. Each of the five river piers comprises two cylinders with transverse bracing above water level. The two piles 14in. square projecting below the cylinders were driven down to hard sandstone beneath the river bed, over them were lowered the hollow ferro-concrete cylinders of 48in. diameter, previously moulded in the contractors' yard, and the interior spaces were filled in by well-rammed concrete reinforced with longitudinal steel bars. The piles were continued above water level in the form of square columns, also encased by hollow cylinders and a filling of ferro-concrete, the result being a solid cylindrical column about 22ft. long by 4ft. diameter. Figs. 5, 8, and 9 are reproductions from photographic views taken during the execution of the work.

The main longitudinal girders of the six river spans measure 44ft. in length between the centres of the supports by 40in. depth and 14in. in width. They are of typical Hennebique design, with bent and straight bars alternately, and vertical stirrups as web reinforcement. Details of the reinforcement are made clear by the longitudinal and transverse sections in Figs. 3 and 4, and engraving, Fig. 6. The transverse beams connecting the main girders are 18in. deep by 8in. wide, and spaced 5ft. 6in. apart, centre to centre, dividing the decking into panels of 20ft. by 5ft. 6in. Except where thickened in the form of cantilevers for the footpath and parapets, the deck slab is 6in. in thickness, and extends continuously from end to end and from side to side of each span of the structure, forming a thin horizontal beam of enormous lateral strength, and adding very greatly to the solidity and resistance of the bridge. The decking provides space for a roadway with the net width of 18ft. 6in., and a footpath 4ft. wide, the parapets consisting of mild steel railings.



"The Engineer" Swain Sc.

Fig. 3—LONGITUDINAL SECTION SHOWING REINFORCEMENT

It should be noted that the site of the bridge is over colliery workings, which may possibly cause subsidence at some future time. In view of this contingency, the engineers decided to construct the main girders in independent spans instead of following the usual practice of making the girders continuous from end to end of the bridge. This method of design involved an increase of cost proportionate to the greater bending moment for continuous spans, but it is intended to have the effect of obviating any local injury in the event of settlement in the strata beneath the foundations.

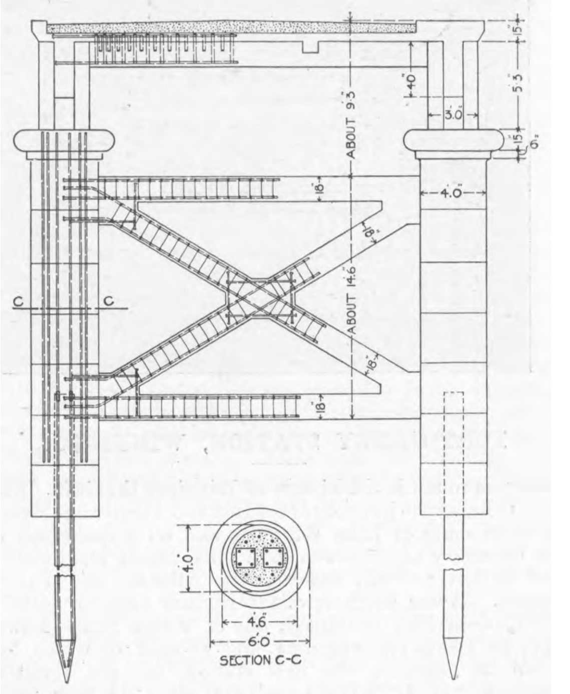


Fig. 4—TRANSVERSE SECTION SHOWING REINFORCEMENT

Stakeford Bridge was designed for a moving load of a 30-ton steam roller or two 15-ton steam rollers, in addition to a dead superload of 1 cwt. per square foot. In August last an official test of the structure was conducted under the superintendence of Dr. A. W. Brightmore, M. Inst. C.E., a Local Government Board inspector. The bridge was tested first by two 16-ton steam rollers standing abreast at the middle of each span, with the result that the maximum deflection was in no case greater than ⅛in. The rollers were then steamed along the roadway at varying rates of speed, the maximum deflection again being within ⅛in. A deflection of ¾in. was permitted by the terms of the specification. There was, we understand a total absence of perceptible vibration under the moving load of the two steam rollers. The approach roads are over 1600ft. in length, partly in cutting and filling, with creosoted fences on both sides and kerbed footpaths, as shown in Fig. 10.

MANCHESTER ASSOCIATION OF ENGINEERS.

"THE Mechanism of Cotton-spinning Machinery" was the title of a most instructive paper read before the members of this association on Saturday last by Mr. W. H. Cook. After first describing the construction and characteristic features of the raw material used in producing cotton yarns, and also those of the finished article, the author, with the aid of lantern slides and admirable diagrams, proceeded to explain the construction and mechanism of the machinery employed in a modern mill. Commencing with the bale breaker, the author went through the chief mechanical motions of the opener and scutcher, which remove the impurities, the carding engine, the drawing frame, with its sensitive stop motion, the slubbing frame, with the ingenious differential motion invented by a parson named Holdsworth in the eighteenth century, to the spinning machinery, in which the material is converted into yarn. The spinning is done on one of three types of machine, namely, the flyer throstle, the ring frame, and the mule. Incidentally, it was

FERRO-CONCRETE BRIDGE OVER THE RIVER WANSBECK

(For description see page 444)

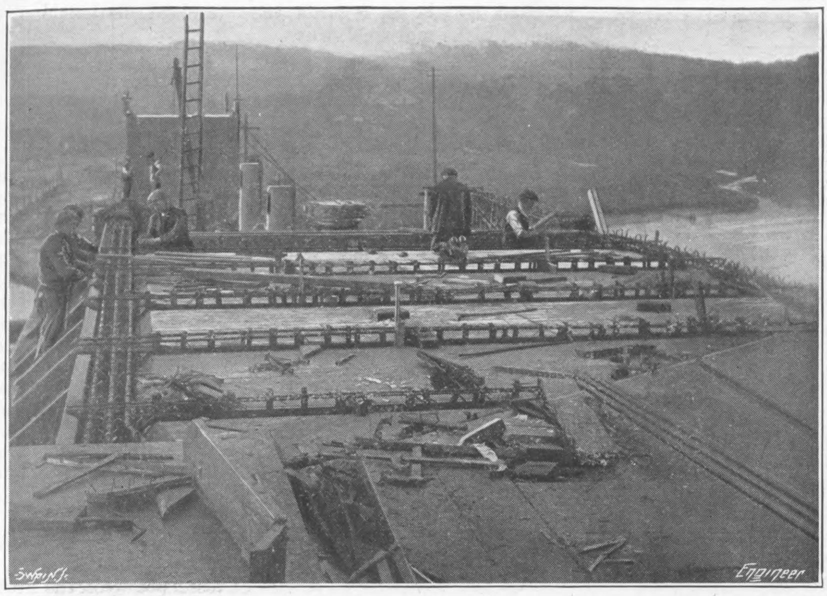


Fig. 5—MAIN AND SECONDARY GIRDERS READY FOR FLOORING

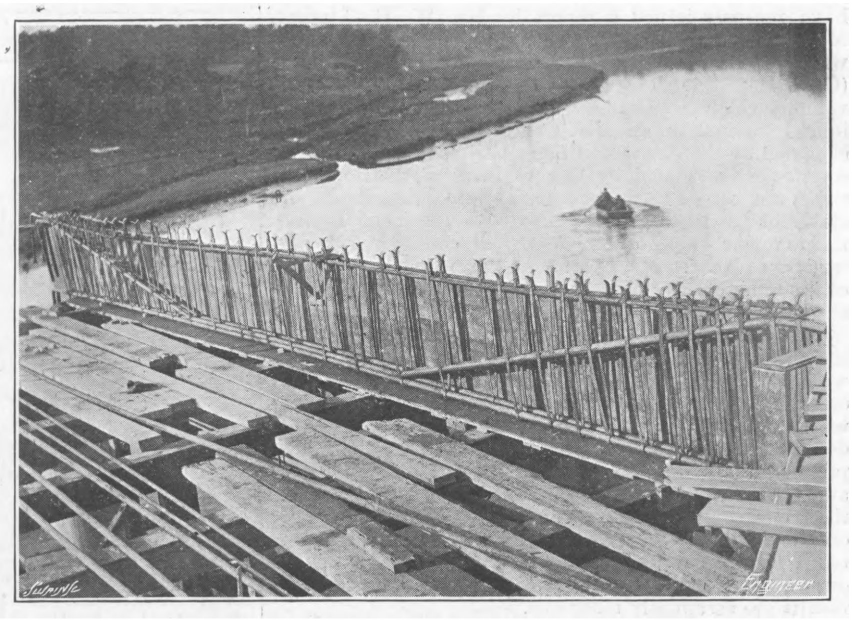


Fig. 6—MAIN GIRDER, WEST SIDE—RODS AND STIRRUPS IN POSITION

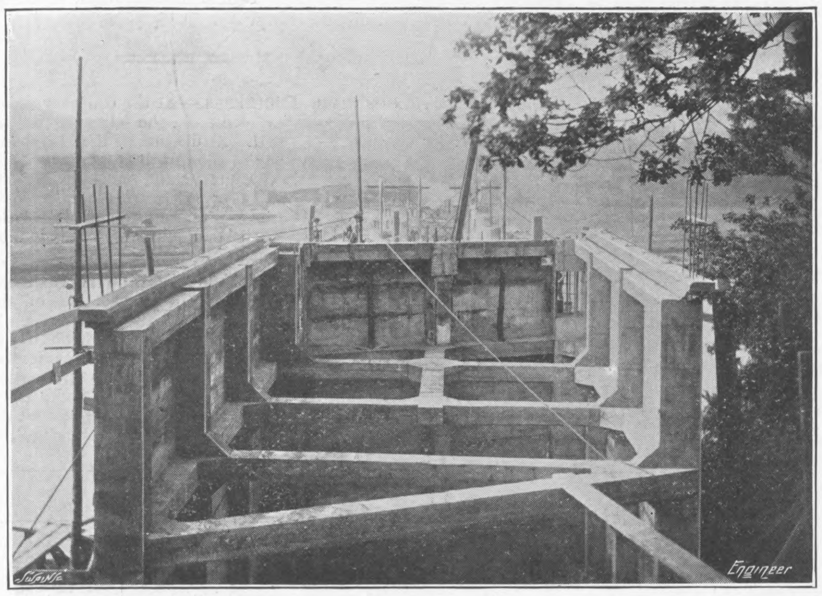


Fig. 7—NORTH ABUTMENT, OCTOBER 7th, 1908

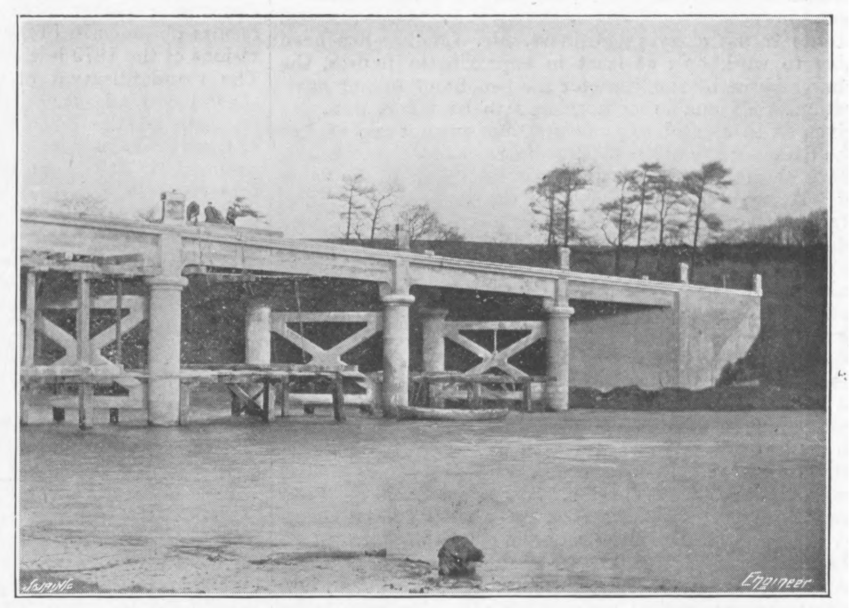


Fig. 8—GENERAL VIEW DURING ERECTION, JANUARY 7th, 1909

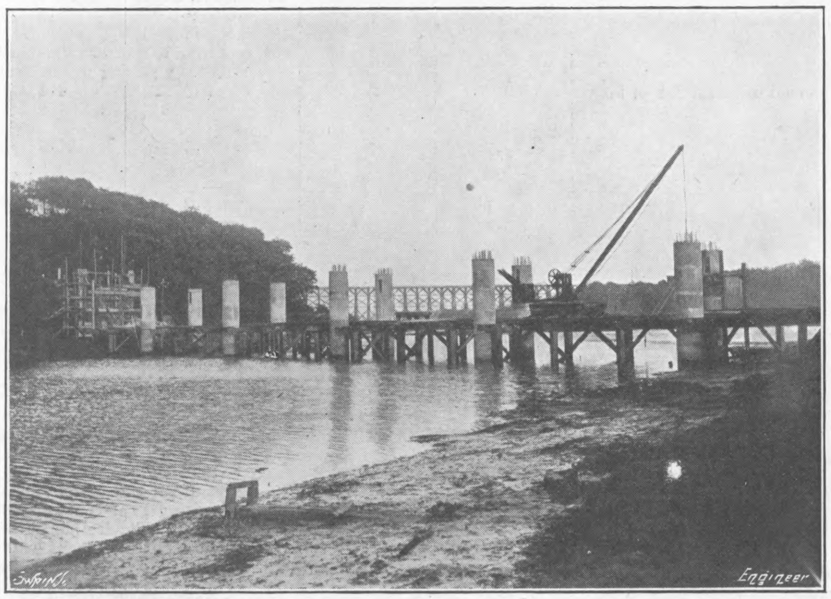


Fig. 9—VIEW SHOWING PIERS, SEPTEMBER 17th, 1908

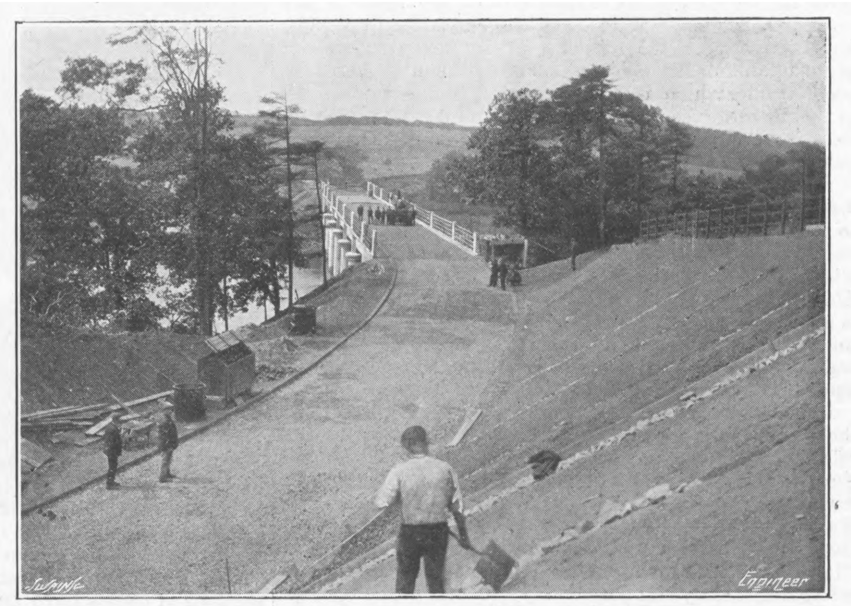


Fig. 10—LOOKING ALONG THE COMPLETED BRIDGE, SEPTEMBER 11th, 1909

mentioned that the flyer throstle is becoming obsolete, and that the ring frame will, in course of time, replace the mule in countries where the yarns are not shipped in the form of cops. For yarns of the finer qualities, and in countries like our own, where such a large amount of yarn is sold in the form of cops, either for weft to be sent to the weaver or for shipment, the mule will continue to be used. The ring frame possesses many advantages, such as simplicity of construction and action, unskilled labour can attend to it, greater production, and the larger number of spindles which can be put in a given space. Its great drawback is its inability to spin on the bare spindles, but the author has no faith in the production of a continuous-spinning machine in which tubes are not used.

With regard to the mule, the author ventured the opinion that this machine is unequalled as a collection of ingenious motions by any other machine in use. Standing in front of the mule, the rollers may be observed drawing out the roving; the carriage, which may contain as many as 1400 spindles, is then seen to recede from the rollers at the correct speed. The spindles in the meantime are making about 11,000 revolutions per minute, twisting the yarn to give it strength, and when this part of the process is finished all the motions are put out of action. Other motions then come into action to reverse the spindles and wind off a certain length of yarn, which is kept taut by means of faller wires, almost human in their treatment of the tender material. The carriage is next drawn in by another set of motions, and the cops are formed in such a way that they can be handled, packed, and shipped, unpacked, and yet during all these processes they keep their form without any support whatsoever. This machine, which was invented by Richard Roberts, makes about five inward and outward runs per minute, can produce yarns from the coarsest counts to counts so fine that 300 miles of length are required to weigh 1 lb., and will continue in operation year in and year out without any serious break-down for very many years.

Being of a descriptive nature, the paper did not call forth any discussion, and a cordial vote of thanks to the author, proposed by the president, Mr. J. H. Stubbs, concluded the meeting.

The report for 1908 by the Commissioner of Customs at Tientsin states that a new port for Manchuria has been proposed, and is actually being surveyed at Halutao, seven miles from Lienshan, a station on the Imperial Railways of North China, which is 94 miles nearer to Mukden than Chinwangtao, and 70 miles nearer than Dairen. The harbour is situated near a fertile grain-growing district, and in the neighbourhood an exceedingly good quality of coal is found, at present only worked by Chinese methods. Last winter was not severe enough to test whether the proposed port is free from ice, but the natives of the place state that it is. The fact that there are 30ft. of water at low tide and a rise of 10ft. at spring tides seems to confirm the natives' statement. A breakwater will have to be built as a protection to the south-west winds of summer, but otherwise the harbour is said to be naturally complete.

THE ROYAL COMMISSION ON CANALS AND WATERWAYS.

No. XIV.[*]

The Royal Commission on Canals and Waterways have recently issued a report by Mr. W. H. Lindley, M. Inst. C.E., their assistant commissioner, on the waterways of France, Belgium, Germany, and Holland (Cd. 4841). The Report and appendices form a bulky volume, which is crammed with information concerning inland navigation on the Continent which has been collected by the Assistant Commissioner in the course of a series of visits paid by him to most of the important rivers and canals in the countries enumerated above, and statistics furnished by the various Government Departments under whose control nearly all continental waterways are placed. Mr. Lindley also furnishes an account of the tours of inspection on the Continent undertaken by the Commissioners in the summer of 1907 and 1908.

The report forms an exhaustive book of reference on the present condition of the waterways in the countries we have named, and supplies many illustrations of the essential and important differences in the conditions under which inland navigations are worked in the United Kingdom and on the Continent. This dissimilarity, although principally physical, extends also to economic conditions, and clearly proves the statement, which we have more than once emphasised, that comparison of the results obtained at home and abroad cannot be made on an equal basis, and that arguments in favour of the development of our own waterways based on continental statistics and results are essentially fallacious.

One of the most interesting features of the report is the information given on the question of the cost to the State of the assistance given to water-borne traffic in the countries with which the volume deals. The waterways being in most cases placed by the State at the free disposal of the traffic carrying business, Mr. Lindley has been able to work out, at least in approximate figures, the charge borne by the State for the benefit of inland navigation. To enable comparisons to be made, data are given as to capital expenditure and current expenses of the State for the other means of transport, the railways. General public opinion on the Continent as to the value of waterways is best shown by the steps proposed and the monies granted by the Governments for their future improvement and development. Judging from the information Mr. Lindley has collected, the waterways generally are considered worthy of very careful attention and extensive development, and anyone who has studied the question, even superficially, must come to the conclusion that the fostering of these means of communication is largely justified, even though it is only effected at great national expenditure. What is so often lost sight of in this country when reference is made to continental waterways is the extent of this charge which is borne by the State, and the proportion it bears to the volume of traffic. In France, where all State controlled waterways are free, the annual charge borne by the State for the benefit of the water-borne traffic of the country is £2,750,000, which includes interest on a capital expenditure of £61,600,000, and an annual maintenance charge of about £600,000. The total traffic on the State waterways amounts to 3100 million ton-miles, and the annual cost to the State is, therefore, equivalent to .21d. per ton-mile. In comparison with these figures the capital expenditure of the State in the form of subsidies to railways, and guaranteed dividends, amounts to over 185 millions, or an annual charge of about 6½ millions in respect of 9900 million ton-miles of goods traffic, which is equivalent to .16d. per ton-mile. It will be observed that the traffic and capital outlay on railways are just about three times the corresponding values for waterways.

In Belgium the State places the waterways at the disposal of the freight carrier, charging dues which suffice to cover the greater part of the cost of maintenance and current improvement. The total capital expenditure is £15,810,000, and the net annual charge to the State £560,000. The traffic on the State controlled waterways is about 595 million ton-miles at a cost of .23d. per ton-mile. State railways, on the other hand, represent a capital of nearly 86 millions, and provide a net income equivalent to 4.4 per cent. on the capital outlay.

In Germany the conditions differ in many respects from those obtaining in France and Belgium, owing to the relatively high proportion of efficient open-river navigations in the first-named country. Comparing the figures for open and canalised waterways in Prussia, we find that the capitalised outlay is £26,501,600, and the total annual charge for maintenance and interest in excess of revenue is £1,391,090. The maintenance charge alone exceeds the revenue by nearly half a million. The total traffic reaches 8000 million ton-miles annually, representing a cost to the State of .042d. per ton-mile. This low figure is due to the large natural rivers and their heavy traffic, and, if we eliminate the figures for the Rhine and Elbe, the annual charge per ton-mile is raised to about .10d. per ton-mile. It is probable this, a calculation based on the figures for canals only, would give results very similar to those quoted for France and Belgium respectively. The Prussian State Railways—21,300 miles of line—represents a capital expenditure of £457,200,000 (1905) and the goods traffic 20,660 millions of ton-miles, while the revenue, after deduction of administration, working and maintenance expenses, represents about 7½ per cent. on the capital outlay. The natural waterways in Prussia are free from dues, and the dues charged on canalised rivers and canals provide sufficient to yield only a small surplus over the cost of maintenance and working. It is, however, proposed to impose dues on the natural waterways for the purpose of meeting some part of the expenditure on improvements, and to increase some of the dues on canals. The preponderance in France and Belgium of canals and canalised rivers, and in Germany of free rivers, is shown in the small table which we quote below. The table also indicates the relative fall per mile and the number of locks in the several countries. Comparison of these figures with some of those given in our previous articles for English canals is instructive and interesting.

Country and character of waterway.	Principal lines.				Total length of waterways in miles.
	Length in miles.	Height overcome.	Number of locks.	Fall in feet per mile.	
France—		ft.			
Free rivers ..	796	1800	—	2·25	10,350 (7485 frequented)
Canalised rivers	970	1135	185	1·17	
Canals, excluding Paris canals	1703	9674	1097	5·70	
Belgium—					
Free rivers ...	75	—	—	—	1345 (1615 frequented)
Canalised rivers	307	465	70	1·52	
Canals	334	1445	141 and 4 lifts	4·30	
Germany—					
Free rivers	1948	2451	—	1·26	6200
Canalised rivers	425	633	78	1·49	
Canals	895	3175	359 and 1 lift	3·55	

The report indicates the marked tendency in France, Belgium, and Germany to increase the carrying capacity of the boats. In France the law of 1879 has resulted in the standardisation of boats and inland waterways, with the exception of the Seine up to Paris. The 300-ton boat is now the accepted standard, and barges of smaller carrying capacity are gradually disappearing. The results obtained in France as a consequence of the provisions of the 1879 law have been eminently satisfactory. The standardisation of the waterways to the 300-ton type has made it possible for boats of this size to navigate all the principal waterways, and has thus led to a considerable development of the water-borne traffic throughout the country. The minimum dimensions prescribed by the 1879 law were adopted in the first instance, but as the result of experience, while the dimensions of the 300-ton boat have been retained, the cross sections of the canals and the dimensions of the locks have been still further increased in many cases. The Canal du Nord, which is about to be constructed by the French Government at a cost of £2,880,000, or £48,000 per mile, embodies the principles of design now considered best by French engineers, on the basis of their experience of dealing with a large traffic transported in 300-ton boats of the standard type. Particulars of the proposed canal are given in the report. The same tendency towards the standardisation of the 300-ton boat is evinced in the south-western waterways of Belgium which have been adapted or are being adapted to barges of this type. On the North-Eastern lines of Belgium, forming the water communication with Holland and with the Rhine, the larger type of boat, carrying up to 485 tons, circulates, and its use is being extended, while still larger types of these boats, with a carrying capacity up to 2000 tons, frequent the Scheldt at Antwerp. As in France, the dimensions of locks and the cross-sections of canals have been increased to keep pace with the extended use of the larger types of boat.

German practice exhibits the same tendency to increase in the dimensions of boats as is found in France and Belgium, but owing to the large size of boats navigating the natural waterways, notably the Rhine, Elbe, &c., the growth in dimensions has been more marked, and the standard now adopted for the new canals is 600 tons for boats west of Berlin, and 400-ton boats east of Berlin. Provision is made in the new works for subsequent increase to 800 tons and 600 tons capacity west and east of Berlin respectively.

In all three countries improvements have been effected in recent years by increasing the lift of locks and thereby reducing the number. At the same time the traffic capacities of many canals have been augmented by the extensive use of twin, tandem and train locks; special arrangements for filling and emptying the locks to ensure more rapid manœuvring; special appliances, fenders and mechanically-driven spills and the like, for accelerating the entrance and exit of boats, and water-saving arrangements where the question of water supply presents difficulties. Higher speed of travel, and, incidentally, the reduction of the deleterious influences on the banks of canals has been obtained by increasing the area of the cross section of many canals in relation to the immersed cross section of the boat, and especially the depth under the boat.

The larger table, No. II., which we reprint in full from the report, summarises the latest practice on the continental locked canals as regards the standard dimensions of boats, locks and waterways.

	France.	Belgium.	Germany.	
BOATS.				
Carrying capacity, tons	300	300	400	600
Length, ft.	126	126	180	213
Breadth, ft.	16·4	16·4	26·25	26·25
Draught, ft.	5·9	5·9 to 6·9	4·6	5·75
CROSS-SECTION OF CANAL.				
(*a*) Width at water-level, ft.	70	62	92	102
(*b*) Width at bottom, ft.	33	34·5	62 at 6·6ft. depth	52·5
(*c*) Depth, ft.	8·2 and 9·85 at higher water level	7·9	6·6 to 9·2 (parabolic form) with provision to increase the depth by 1·65ft. by raising water level	8·2
Relation of cross section of canal to immersed cross section of boat	4·3 to 5·5	3·75	5·0	4·4
DIMENSIONS OF LOCKS.				
(*a*) Width, ft.	19·7	17	31·5	31·5
(*b*) Useful length, single, ft.	133	134	186	220
(*c*) Useful length, tandem, ft.	280	—	—	—
(*d*) Depth over sill, ft.	8·2 to 9·85	9·5	8·2	9·85
Clearance in width	3·3	0·6	5·25	5·25
CLEARANCE UNDER THE BOAT.				
In canal, ft.	2·3 to 3·95	2·0 to 1·0	4·6	2·45
In locks, ft.	2·3 to 3·95	3·6 to 2·6	3·6	4·1

SHIPBUILDING NOTES.

In reading the technical descriptions of vessels now constructed, one is struck by the absence of a type which once enjoyed a considerable vogue. We refer to vessels built with web frames, which, while now employed in vessels intended to carry oil in bulk, have almost disappeared so far as ordinary cargo steamers are concerned. No doubt contributory causes to that disappearance were the cost of construction and the diminution of hold capacity. But apart from that, it is true also that web frame ships have not had, from those responsible for scantlings, the favourable treatment that other forms of construction, now popular, have received. In nearly all cases the intermediate frames and side stringers were made very much heavier than was at all necessary. We feel that there are many modifications of the web frame system which are at once practicable and economical, and we hope to refer to these in the near future.

We notice that the Forth Shipping Company—Messrs. Andrew Weir and Co., London, Glasgow, and Middlesbrough—has decided to extend its service of vessels between the Forth and Tees so as to include Boston, Lincs., and thus bring the districts it serves at present into touch with the Midland Counties. The first sailing from Boston is fixed for 30th inst., and the sailing days will be:—From Grangemouth, Monday; from Leith, Tuesday; from Middlesbrough, Wednesday; and from Boston, Saturday.

The Institution of Civil Engineers.—At the ordinary meeting on Tuesday, the 9th November, at 8 p.m., the following papers will be read:—"The Single-phase Electrification of the Heysham, Morecambe, and Lancaster Branch of the Midland Railway," by J. Dalziel and J. Sayers; "The Equipment and Working Results of the Mersey Railway under Steam and Electric Traction," by Joshua Shaw, M. Inst. C.E. It is also proposed to submit for discussion at a later date a paper entitled "Marine Propulsion by Electric Motors," by Henry Alexander Mavor, M. Inst. C.E.

Institution of Automobile Engineers: Graduates' Section, London Branch.—The first ordinary general meeting of the London Branch of the Graduates' Section for the session 1909-10 was held on Tuesday, 19th October, 1909, at 8 o'clock p.m., at 1, Albemarle-street, W. The chair was taken by the president of the Institution, Dr. H. S. Hele-Shaw, F.R.S., and an interesting paper was read by the chairman of the Section, Mr. Charles E. G. House, entitled "Indicators for Petrol Engines," illustrated by lantern slides. The discussion was opened by Mr. H. Burchall, in which the following gentlemen took part:—Messrs. R. H. Deane, R. B. Hayles, L. H. Baskerville-Cosway, F. A. Beecham, and the chairman.

Fall of a Railway Bridge.—Early on Wednesday morning an accident occurred on the South-Eastern and Chatham Railway Company's system which might easily have been disastrous to many lives. Between the stations of Ticehurst Road and Etchingham, on the company's line from London to Hastings, the route crosses the river Rother on a small brick-built bridge. The Rother at this point is rarely more than a stream 6ft. wide, but the recent heavy rains had apparently affected the foundations of the bridge. It would appear that the engine and some of the front trucks of a goods train had got safely across the bridge, when it collapsed, throwing the engine and tender off the line and sending some of the trucks into the river. The driver, stoker, and guard were uninjured, and immediately took steps to prevent further accidents. During the day breakdown gangs from Ashford worked at the wreckage, the ordinary traffic being meanwhile diverted.

Institution of Civil Engineers.—The Council of the Institution of Civil Engineers have made the following awards for the year 1908-1909:—Telford Gold Medals to Prof. B. Hopkinson, M.A., B.Sc. (Cambridge), and Mr. G. R. G. Conway (Monterey, Mexico); Watt Gold Medals to Messrs. D. A. Matheson (Glasgow) and W. C. Popplewell, M.Sc. (Stockport); George Stephenson Gold Medals to Messrs. E. H. Tabor (London) and A. J. Knowles, B.A. (Cairo); the "Indian" Premium and a Telford Premium to Mr. T. R. Nolan, B.E. (India); Telford Premiums to Messrs. S. J. Reed (Newcastle), C. T. Purdy (New York), L. A. B. Wade (Sydney), G. Hobbs (Accra, West Africa), W. Cleaver (Port Talbot), J. D. W. Ball (London), Prof. A. H. Gibson, D.Sc. (Dundee), and R. D. Gwyther, M.Sc. (Buenos Ayres); the "James Forrest" Medal and a Miller Prize to Mr. J. A. Wotherspoon (Glasgow); the Miller Scholarship to Mr. J. A. Orrell (Manchester); the "James Prescott Joule" Medal and Miller Prizes to Messrs. W. E. Fisher and E. B. Wood (London); Miller Prizes to Messrs. W. E. R. Gurney (London), E. G. L. Lovegrove (London), J. Purser (Birmingham), G. C. Minnitt (Manchester), S. F. Deacon (Manchester), C. H. Bradley and A. E. Marshall (Birmingham).

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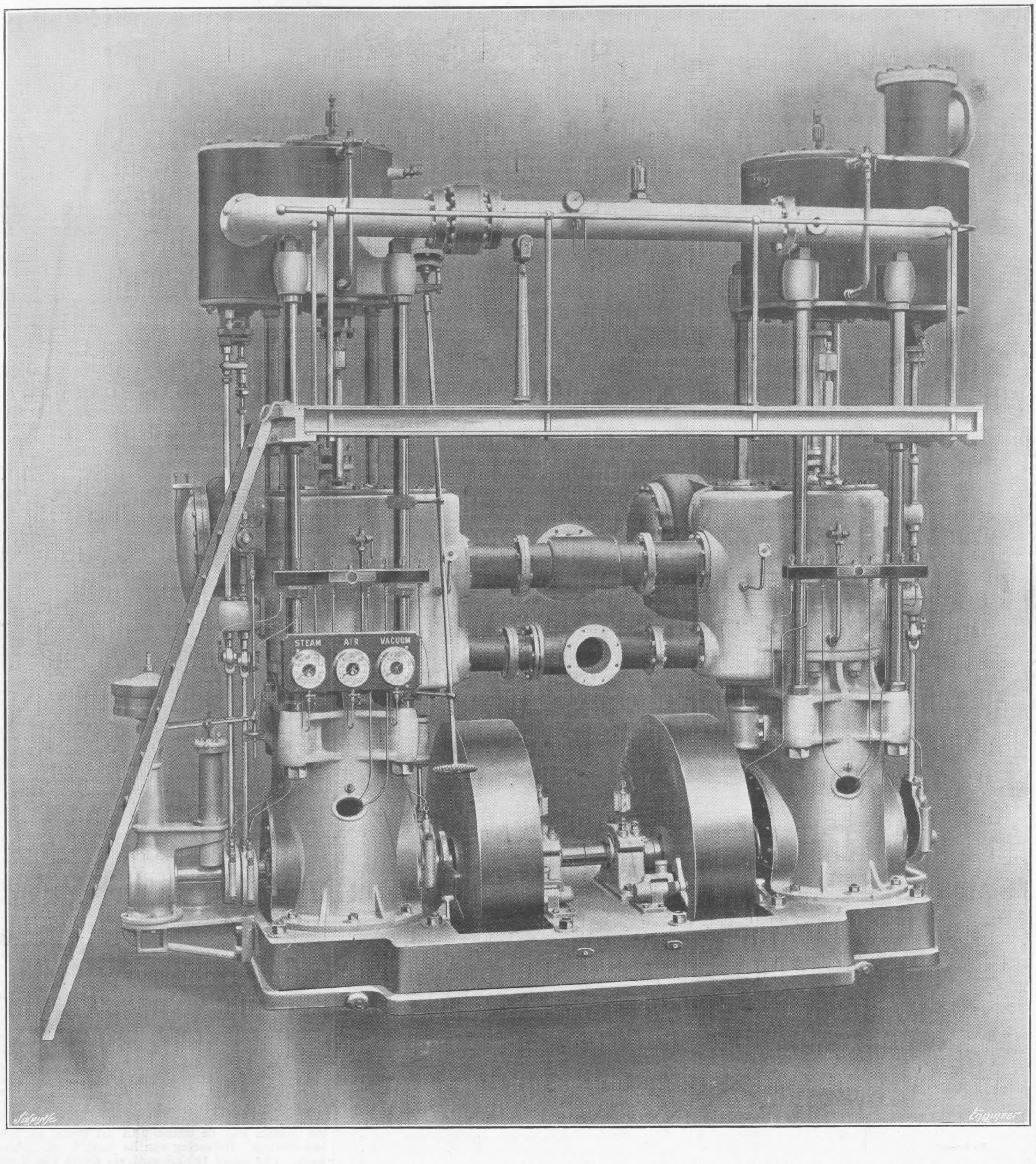
[*] No. XIII. appeared December 11th, 1908.

CROSS-COMPOUND TWO-STAGE AIR COMPRESSOR

W. H. BAILEY AND CO., LIMITED, ENGINEERS, MANCHESTER



CROSS-COMPOUND TWO-STAGE AIR COMPRESSOR.

AN air compressor embracing several features which are out of the ordinary has recently been constructed for the Ashford works of the South-Eastern and Chatham Railway Company by W. H. Bailey and Co., Limited, Manchester. It is of the vertical tandem compound type, with Köster's valve gear, and is capable of dealing with about 1000 cubic feet of free air per minute, compressing it to 100 lb. per square inch. The general arrangement of the plant is seen in the engraving on this page, while our two-page Supplement shows the details of construction clearly. One of the essential features of the design is the combination of air cylinders and steam cylinders in such a way that the whole can be operated together as a compound machine or either pair separately as desired, each half compressing the air in two stages. Moreover, the steam cylinders being mounted above the air cylinders, can expand independently, and the air cylinders can be entirely removed without disturbing the steam cylinders. Both the steam cylinders and the air cylinders are provided with piston valves, and the point of cut-off for the steam to the high-pressure cylinder is ingeniously governed by the speed and the air pressure, while it can be adjusted during the operation of the plant through variable expansion gear.

The valve gear for each air cylinder is operated by means of an excentric from the crank shaft. Free air is drawn into the space on top of the differential compressor piston through the upper port, the piston valve being above the port at the time. When the air piston arrives at the end of its stroke the piston valve in descending closes the top port, and on the return stroke the air drawn in as above mentioned is compressed on the up-stroke of the large piston to about 27 lb. per square inch. The piston valve then descends, and the top port is uncovered to allow the compressed air to flow past the spring valve at the top to the intercooler. This concludes the first stage of the operation. The air next passes from the intercooler to the suction side of the small high-pressure end of the piston, which is an annular space representing the difference in the diameters. When the piston descends, the second and final stage of compression to 100 lb. per square inch is effected. A movement of the piston valve next allows the compressed air to be discharged into the delivery pipe. There are three fixed points in the compression cycle, namely, the opening of the inlet, the closing of the inlet, and the closing of the discharge, which are positively and mechanically controlled. The opening of the discharge, which is the only variable point in the cycle, is controlled by an automatic spring valve, which, however, is relieved of the necessity of quick and therefore noisy closing. During the suction stroke of either piston, the lower or upper valve occupies the space between the cylinder port and the spring valve, reducing clearance to a minimum by discharging the compressed air left in the space through the delivery valves. The makers claim that the proportions of the cylinders are such that the load on both sides is balanced.

The exhaust steam from the low-pressure cylinder is condensed in a surface condenser mounted over an independent air pump of the Bailey-Davidson type. The bearings and connecting-rod ends are lubricated by means of a pump, which circulates the oil, and the crosshead of the differential air piston is oiled by the special telescopic arrangement fitted in the cover of the cylinder, as clearly shown in the detail sectional view on the Supplement.

The following are the leading particulars of the plant :—

H.P. steam cylinder..	400 mm. dia.
L.P. steam cylinder	600 mm. dia.
Differential air pistons	515 and 415 mm. dia.
Stroke	450 mm.
Capacity, 950 cubic feet of free air per minute when running at a speed of 155 revs. per min.	
Volumetric efficiency	93% to 96%
Mechanical efficiency	88%

We are informed that the consumption of saturated steam is 18 lb. per indicated horse-power per hour, but that these machines operating with superheated steam show a much lower consumption. Indicator diagrams taken from the air cylinders show that there is a practically unrestricted flow of air on the suction side, while the wave-like delivery curve points to a very low resistance on the part of the valves and inter-cooler.

ELECTRICITY WORKS AT STEPNEY

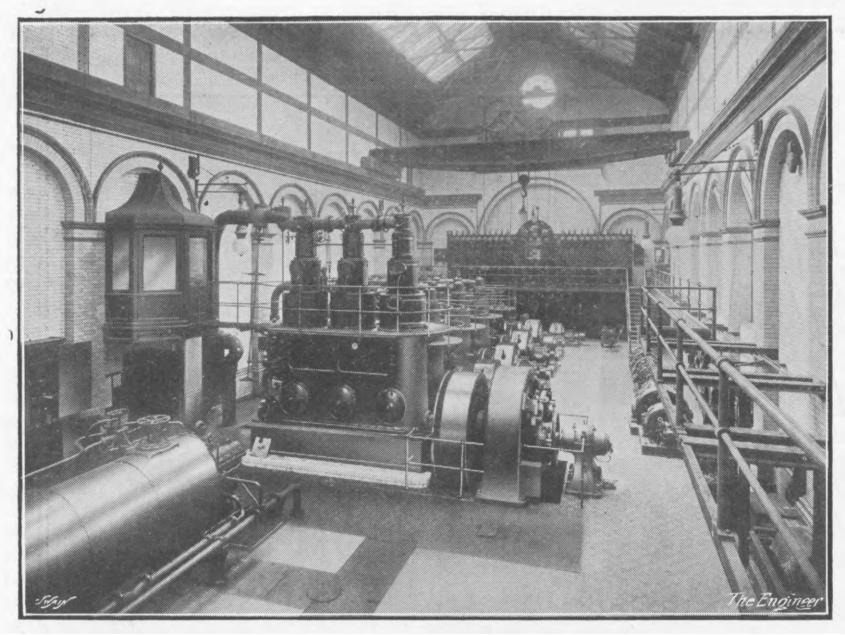


Fig. 1—INTERIOR OF OSBORN-STREET GENERATING STATION

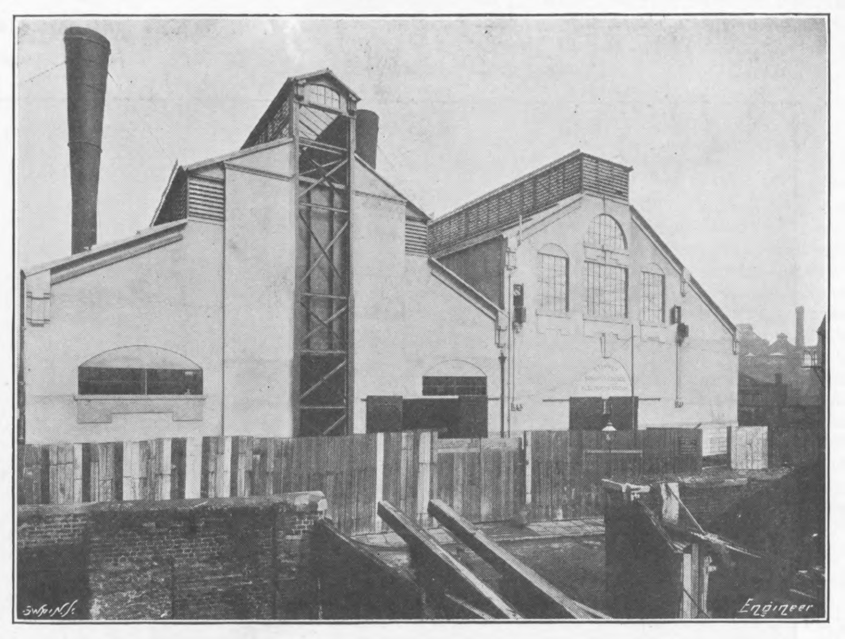


Fig. 2—EXTERIOR OF BLYTH'S WHARF GENERATING STATION

THE STEPNEY ELECTRICITY WORKS.

In the year 1892 the Whitechapel Board of Works obtained a Provisional Order for the supply of electricity to Whitechapel, and six years later it was decided to erect a generating station for the electric lighting and power distribution of that area. Mr. Arthur Wright was appointed consulting engineer, a scheme was drawn up, plant was purchased and erected, and on December 16th, 1899, current was switched on to the mains. At that time the machinery was housed in a small temporary building, but it was afterwards transferred into a properly constructed power-house in Osborne-street, Whitechapel, which has since been extended, and from time to time new plant has been added to cope with the rapidly increasing load. The area for which this station was originally intended was greatly increased, when in the year 1900 the London Government Act, 1899, came into operation and the newly formed Stepney Borough Council took over the Whitechapel Order and also the Provisional Orders obtained by the Limehouse Board of Works and the Mile End Old Town and St. George's-in-the-East Vestries. This ultimately gave rise to the extension of the Osborn-street building and to the purchase of two 1000-kilowatt turbines and the necessary boilers to operate them. Thus the power station in Osborn-street which was originally intended for supplying electricity to Whitechapel has now to deal with Stepney, and it is consequently known as the Stepney Borough Council's Electricity Works. That this station would ultimately prove altogether inadequate for its work soon became apparent, and, in consequence, in 1903 the Council purchased a site known as Blyth's Wharf, which is situated on the riverside at Limehouse. Circumstances over which the Council had no control, however, prevented them from making use of the site until several years later. One thing which retarded the building of a new power station was the uncertainty created by the promotion of a series of London Power Bills, but in 1907 it became evident that no bulk supply scheme, even if sanctioned by Parliament, could be ready in time to assist Stepney. The borough electrical engineer, Mr. C. P. Tapper, was therefore called upon to report upon the proposed Blyth's Wharf scheme. His report was duly approved by the Council, and in the autumn of 1908 the buildings were commenced.

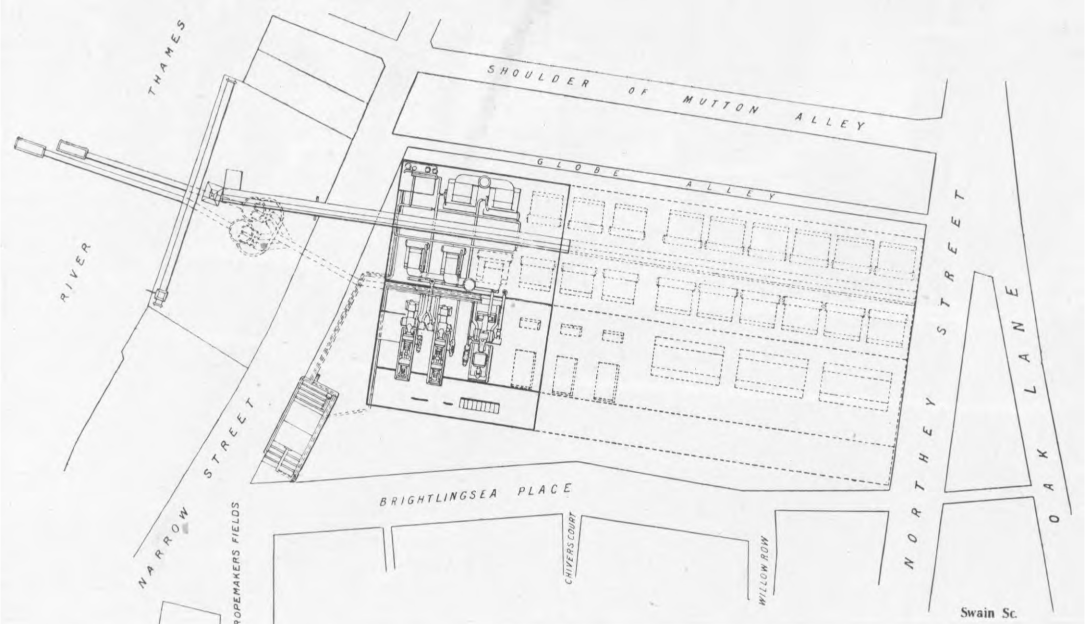


Fig. 3—PLAN OF BLYTH'S WHARF GENERATING STATION

Here it should be mentioned that the Stepney Electricity Works has an exceptionally good motor load, which needless to say has augmented its success very considerably. The manner in which the motor load has increased since the year 1900 is somewhat remarkable for a London station. In 1900 the motors connected to the mains represented about 80 horse-power, whilst the aggregate figure for to-day is approximately 6125. Stepney is a busy place, containing as it does numerous small factories of various kinds in which the electric motor is able to play a prominent part. Its area amounts to approximately 1900 acres, with about 91 miles of streets.

When the original scheme for the electric lighting of Whitechapel was drawn up the three-wire system was decided upon, and the Osborn-street station, as will be seen from our illustration—Fig. 1—is a typical example of its class. The voltage between the outers is 480, and there is therefore 240 volts on each side of the system. All the reciprocating engines are of the Willans type, and five out of the six of these engines which the station contains are coupled to Mather and Platt dynamos. There is one balancing set of 120 kilowatts, four main generating sets of 275 kilowatts each, and one of 500 kilowatts. The dynamo of the latter set is by Dick, Kerr, and Co. The erection of this 500-kilowatt set used up the last piece of available space in the station, and the next step was to take down one of the end walls and to enlarge the building to double its original size. Then two 1000-kilowatt Parsons turbines were put down, thus giving the station a total generating capacity of 3720 kilowatts. That the Osborn-street station is erected in a suitable spot for the area which it was originally intended to provide for, there is but little doubt, but its position for the supply of electricity to the Borough of Stepney cannot be regarded as satisfactory, even had it been possible to make the building hold the requisite plant. In the first place, all coal has to be conveyed to the works in carts, and, secondly, owing to no water being available other than that obtained from the mains, condensing on a commercial basis became impracticable. The question of condensing was obviously of far less importance when the station only contained reciprocating engines, but the effect which the practice of running turbines non-condensing has on the steam consumption is by no means beneficial. Nothwithstanding the adverse conditions under which the Osborn-street station has been running, however, the works costs have remained remarkably low, which can, no doubt, be attributed to the discretion exercised by the engineers in the manipulation of the plant. The boilers at this station are considerably below the level of the engine-room, and one good feature about this arrangement is that water rarely, if ever, finds its way into the engine cylinders. As the station stands to-day, there are six Babcock boilers of the land type, each having a steam-raising capacity of 11,000 lb. per hour; also a marine type boiler by the same makers, with a capacity of 22,000 lb. per hour. The steam pressure is 200 lb. per square inch. The marine boiler and two of the land type are fitted with underfeed stokers, whilst the remainder of the boilers are hand-fired. Forced draught is supplied to the mechanically-fired boilers by means of a fan supplied by Musgrave and Co. The large marine boiler is fitted with a superheater, the superheated steam being mixed with the saturated steam, as is now customary practice in quite a large number of stations. Eventually the marine boiler will be transferred to the new station at Blyth's Wharf. Two Green's economisers are provided in the main flue at the base of the chimney stack. There are two compound Weir feed pumps, each capable of dealing with 10,000 gallons of water per hour. In addition to the economisers previously referred to there are also two exhaust steam feed-water heaters, which were supplied by Royles, Limited, of Irlam, Manchester. Very large coal bunkers are provided at the Osborn-street station, which, before the Blyth's Wharf building was completed, served the useful purpose of providing space for the reception of two marine boilers. These have since been transferred to the new station, which we shall refer to later. Coal is supplied to the mechanically-fired boilers from overhead.

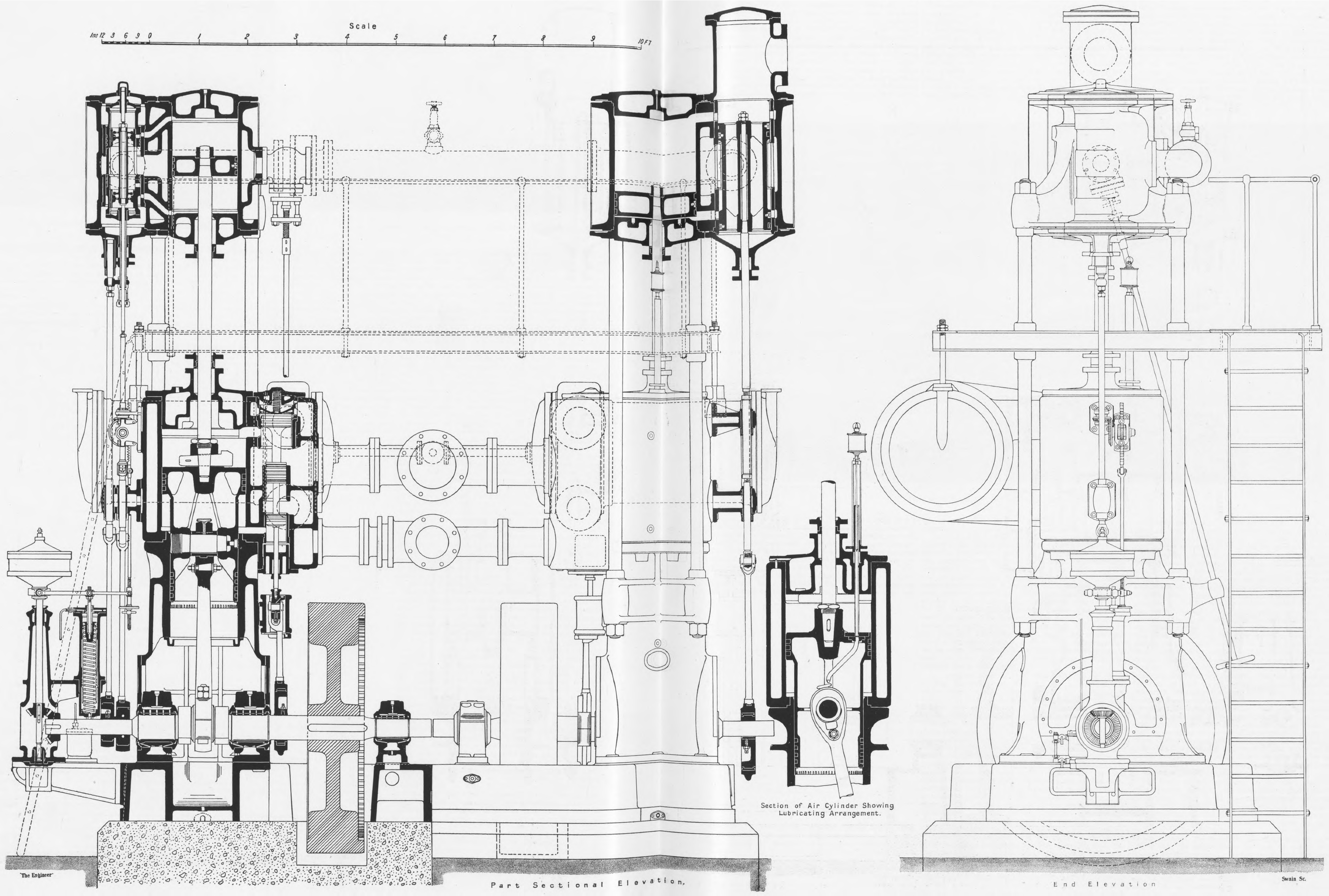
The Osborn-street station has a refuse destructor, but it is not under the control of the electricity department. Steam is supplied from this destructor to the electricity department, and it is paid for according to the units which it generates. One 275-kilowatt set is always running on the separate destructor main. The water is treated at this station by means of a Reisert water softener, which was supplied by Royles, of Manchester. At present the storage tank capacity is 40,000 gallons.

Turning now to the electrical equipment, the continuous-current switchboard is of the ordinary plug type, with the neutral panel in the centre and the positive and negative panels on the right and left respectively. To maintain the correct pressure at all points of the network during the evening load it is necessary to run four different sets of bus bars. There is an extra high-pressure bar, a high-pressure bar, a medium-pressure bar and a low-pressure bar. There are, naturally, pilot wires for the various feeders by means which the pressure at the feeding points on each side of the system can be tested. In all there are twenty-two feeders. Balancing can be carried out in several ways. The small 120-kilowatt set drives two dynamos in series, with a tapping taken off from the connection between the two machines. The same applies to the two 1000-kilowatt turbine sets, one of which has, it should be mentioned, been transferred to the new generating station at Blyth's Wharf. It should be mentioned that the electric generators which these turbines drive are of the double current type, supplying direct current and three-phase alternating current from the same armature. The useful purpose which this class of machine will serve at Stepney will be apparent later. There is also a Mather and Platt motor balancer and a feeder booster by Bruce, Peebles and Co. The latter consists of two generators driven by a motor in the centre. Each of the generators is capable of delivering 600 ampères at 50 volts. Thus feeders on both sides of the system can be boosted with this machine.

With a large motor load such as Stepney has, it is by no means surprising that trouble has been experienced in maintaining a steady pressure during that period of the day when most of the motors are in use. This difficulty, however, has been overcome by the employment of a Tirrill regulator, supplied by the British Thomson-Houston Company, of Rugby. Mr. Tirrill, the inventor of this apparatus, conceived the idea of accomplishing automatic

VERTICAL CROSS COMPOUND TWO-STAGE AIR COMPRESSOR

W. H. BAILEY AND CO., LIMITED, MANCHESTER, ENGINEERS


Scale
Ins 12 3 6 9 0 1 2 3 4 5 6 7 8 9 10 FT
"The Engineer"
Swain Sc.

Section of Air Cylinder Showing Lubricating Arrangement.

Part Sectional Elevation.

End Elevation

voltage regulation by periodically short-circuiting the field rheostats. This is done by light vibrating contacts with very little inertia. The relative length of time during which the rheostats are short-circuited or active determines the average value of the field current, and, consequently, the voltage of the machines. The leads from the field rheostats are short-circuited between the metal tips marked relay contacts in the diagram—Fig. 5—a condenser being connected across these contacts to prevent sparking. The closing and opening of these contacts is done by the differentially-wound electro-magnet controlled by the main contacts, which are also marked on the diagram. These main contacts are closed and opened by the control electro-magnet connected across the main bus bars. The action of the regulator is as follows:—Suppose the main contacts to be open, then the left-hand side only of the differential magnet is energised. It opens the relay contacts and puts the field rheostats into circuit. The terminal volts of the machines immediately drop below normal. This reduces the current in the control magnet, and the spring above it closes the main contacts. A current then flows through the right-hand branch of the differentially-wound magnet and destroys its magnetism. The spring above closes the relay contacts and short-circuits the field rheostats. The voltage rises above normal, the main contacts are again opened, and the operations of the two electro-magnets are repeated in the same order. Both contacts are repeatedly vibrating, the periods during which the relay contacts are closed adjust themselves automatically so as to maintain a constant voltage of the machines. The generator shown in the diagram, it will be observed, has a series winding, but the device is equally applicable to shunt-wound machines. Excellent results, we are informed, have been obtained at Stepney with the Tirrill regulator, which may be regarded as very satisfactory considering the nature of the load. The diagram is merely intended to explain the action of the device, and does not show the precise arrangement at the station under consideration.

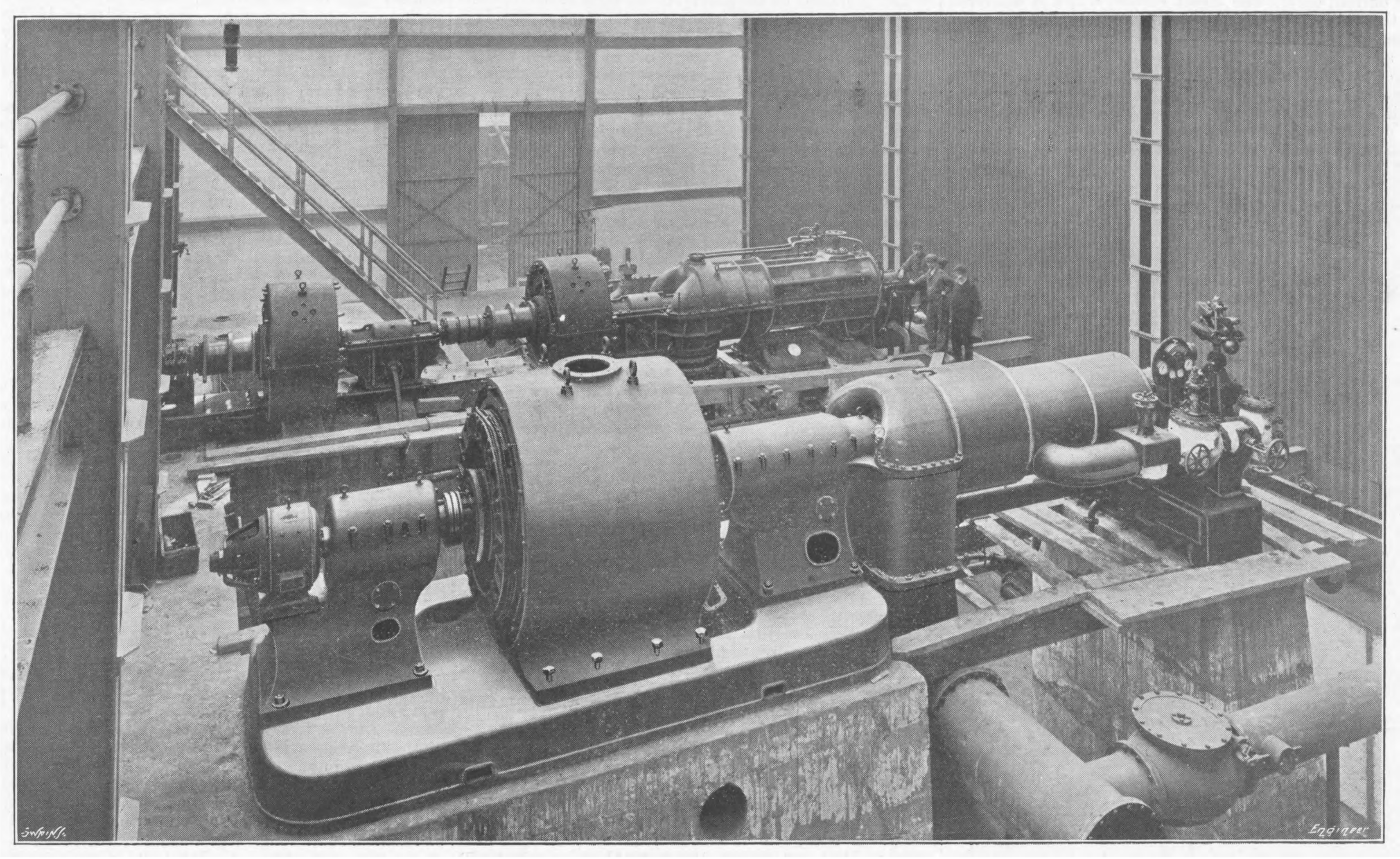


Fig. 4—INTERIOR OF THE ENGINE-ROOM AT BLYTH'S WHARF

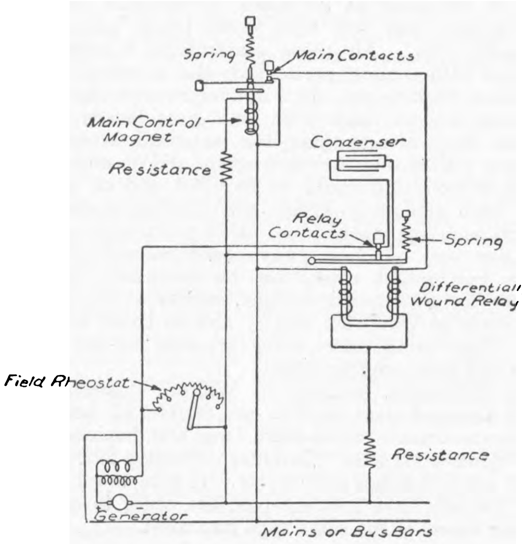


Fig. 5—DIAGRAM OF REGULATOR CONNECTIONS

Two 1000-kilowatt Bruce-Peebles motor converters, which will eventually be supplied with high-tension current from Blyth's Wharf, have been erected in this station. This current will be converted into direct current and supplied to the Osborn-street bus bars. In both cases three-phase current at 6000 volts is supplied direct to the stator windings, and 480 volts are obtained on the direct-current side. Eventually the remaining Parsons turbine at Osborn-street will be transferred to Blyth's Wharf, when one-half of the Osborn-street building will be available for converting machinery. At present the converters are erected in temporary positions, and current is being taken through one of these machines from the Poplar station, and is being paid for at the rate of ·7d. per unit at the generating end. A small battery is provided for use in case of emergency lighting and for excitation purposes.

The plan, Fig. 3, of the new station, which was formally opened by the Mayor of Stepney on Wednesday last, shows that it is situated in a much more convenient spot than the Osborn-street station. Being built directly by the riverside, it has the advantage of cheap sea-borne coal, and an ample supply of condensing water, so that the steam turbines which it contains can be worked under the best possible conditions. The buildings, which were erected by the Fulham Steel Works, to the designs of Mr. M. W. Jameson, the borough engineer, consist of a steel structure with ferro-concrete walls. The boiler-house and engine-room are respectively 63ft. wide by 91ft. long and 67ft. wide by 91ft. long. The north walls are of a temporary nature, so that when necessary they can be taken down and the building extended to make room for more plant. The dotted lines in the plan indicate future extensions.

An exterior view of the new building is given in Fig. 2, whilst Fig. 4 shows the interior of the engine-room, which latter, it will be gathered, is designed in accordance with latest practice, the condensers and air and circulating pumps being placed in pits below the turbines. At present the engine-room contains a Willans-Parsons turbine coupled to a three-phase alternator, the latter having been supplied by Bruce, Peebles and Co. This machine is capable of developing 2000 kilowatts at a pressure between phases of 6600 volts, with a power factor of .85. The periodicity is 50 cycles per second. The exciter, it will be observed, is coupled to the alternator shaft. A somewhat unusual method of energising the field of this exciter has been adopted, its field leads being connected to two points on a resistance joined across the direct-current supply. In other words, the field strength of the exciter is varied by means of a potentiometer. Thus in the event of a shut down on the alternator, the exciter volts will rise with the speed, and no time will be lost in waiting for the magnets to become energised. The speed of the set is 1500 revolutions per minute, and the alternator thus has two pairs of poles. The normal output of the set can be obtained with a steam pressure of 180 lb. and a vacuum of 27in. The superheat is specified as 120 deg. Fah. The other set in this station is a 1000-kilowatt Parsons turbine coupled to two generators, one being a continuous-current machine, whilst the other supplies both three-phase and continuous current. This set, as previously stated, has been transferred from the old station. The remaining set at Osborn-street of the same kind will be transferred to Blyth's Wharf later. The condensers, which are of the Contraflo type, were also supplied by Willans and Robinson. For the 1000-kilowatt Parsons turbines there are two condensers, one for each set, each being capable of dealing with 20,000 lb. of steam per hour, and they are guaranteed to maintain a vacuum of 28½in. with the barometer at 30in., and the circulating water at the inlet with a temperature of 60 deg. Fah. Each condenser has 2200 square feet of cooling surface. The air pumps of these condensers are of the three-throw Edwards type. The diameter of the plungers is 15in. The stroke is 9in. For the 2000-kilowatt set a condenser, capable of dealing with 36,000 lb. of steam per hour, has been put down. It has a cooling surface of 3400 square feet. The air pumps for this condenser are also of the Edwards type, and as in the case of those previously referred to, were supplied by Willans and Robinson, Limited. The diameter of the plungers is 17in., the stroke is 10in. All the pumps used in connection with the condensers are driven by continuous-current electric motors. As will be gathered from the plan, in order to draw the circulating water from the river there are two wells. These are each 12ft. in diameter and 34ft. deep. The circulating pipes extend nearly 150ft. into the river. These pipes are 3ft. in diameter, and are arranged on the Bowden system, so that the direction of the water flowing in the pipes can be reversed. For delivering the circulating water three Rees Roturbo self-regulating pumps are to be employed. A pump of this type is also to be put down for supplying water for oil-cooling purposes, and another for draining the sump, all these pumps being coupled to Rees-Parker continuous-current motors. The large turbine is served by a pump capable of delivering 192,000 gallons per hour against heads varying from 15ft. to 55ft. The two 1000-kilowatt turbines are each served by a Roturbo pump capable of delivering 108,000 gallons per hour under similar conditions. The motors are of the enclosed type, and are connected to the outers of the direct-current system. They are provided with commutating poles, and can consequently run with fixed brushes at all loads. A starting panel for the motor of each pump is to be provided, having an enclosed starter, double-pole switch and fuses, shunt rheostat and ammeter, the whole of the switch gear being enclosed. It is interesting to note that Stepney is the fifth large power station on the Thames to adopt the Rees-Roturbo pump.

We have already referred to the fact that the 1000-kilowatt Parsons sets each drive double-current generators. That is to say, continuous-current machines with tappings taken off from the armatures and connected to slip rings on the shafts. Therefore, assuming the direct-current terminal volts of these machines to be 240, which is the normal pressure, the voltage between phases at the slip rings will be 240 × .61 = 146. To enable these machines to supply high-tension current to Osborn-street for driving the motor converters, or to run in parallel with the large alternator, the British Transformer Company, of Hayes, Middlesex, is supplying a set of Berry transformers. Three single-phase transformers, each of 166 kilovolt-ampères capacity, are to be connected in mesh on the primary and secondary sides] They will raise the pressure from 145 volts to 6000 volts, and to compensate for the drop in the mains when 160 volts is applied to the primary 6600 volts will be available at the secondary. Intermediate voltages will, of course, be in the same ratio. This system of coupling single-phase units in mesh for a three-phase supply reduces the number of spares to a minimum, since if one transformer fails it can be disconnected, and the other two can be used on a lighter load. At full load, and 25 per eent. overload, the efficiency of these transformers is 98.7 per cent., and at half load it is 98.5 per cent., and the drop in volts at any power factor does not exceed 2.2 per cent.

It will be gathered that these double-current generators will be able to deliver direct current to the bus bars in the new station, and at the same time to supply alternating current for operating the motor converters at Osborn-street, but it should not be forgotten that there is a fixed ratio between the alternating and direct-current voltages of these machines. They can also supply direct or alternating current only. The direct current which is delivered to the bus bars at Blyth's Wharf will naturally have the effect of reducing the large amount of boosting which is at present being done at Osborn-street, since the two stations feed the same network, and they are a considerable distance apart. The alternating current switchboard at the new station and that used at Osborn-street for switching the high-tension current on to the stators of the motor converters has been supplied by Reyrolle and Co., Limited, of Hebburn-on-Tyne. This type of switchgear was described in our issue of October 23rd, 1908, and it will be unnecessary for us to deal with it in detail here. It is interesting to note that, although the Reyrolle switchgear is extensively used in Northumberland, Durham, and other provinces, this is the first time it has been put into use in London. At Osborn-street provision has been made for starting the motor converters on the direct-current side, in which case they will be synchronised in the usual manner, the high-tension board having been provided with a synchronising instrument. Motor converters are admirably suited for Stepney, since their efficiency is higher than that of a motor generator, and they can change direct current into alternating current without the use of additional plant to govern the speed. As is now well known, all the high-tension conductors on the Reyrolle switchgear are completely enclosed in cast iron chambers and embedded either in insulating compound or in oil. The switches are of the carriage type, and whilst the conductors are alive it is impossible to touch them. When the movable contacts are withdrawn from their sockets, folding doors close over the orifices in which connection to the bus bars was made. The ironclad portion of the gear is mounted behind a control board, which latter carries all the instruments and relays. A bulk supply switch is provided by means of which it will be possible to link Stepney up with other electricity supply undertakings. The Mertz-Price system of protection is being adopted, not only for the protection of the feeders, but also of the generators and step-up transformers. Briefly, this system of protection is based upon the fact that the current which is led into any sound section must be similar in every respect to the current which is led out of that section, and by the insertion of current transformers at each end a balance of the secondary voltages is obtained. This state of equilibrium is only destroyed when a fault occurs between the protecting transformers, and it is the destroying of the balance which causes the switch on the faulty section to be opened. A full description of the Price-Mertz system was also given in our issue for October 23rd, 1908. The low-tension switchboards erected at the new station were constructed by Crompton and Co., of Chelmsford, and they were designed by the borough electrical engineer, Mr. C. P. Tapper. The positive switchboard at Blyth's Wharf is erected on the gallery, to the right of the Reyrolle gear, whilst the negative board is on the floor level. It is a plug board with vertical bars on the front and four sets of horizontal bars at the back, which enables the various feeders to be worked at different pressures. Each dynamo has a wattmeter and ammeter and single pole quick break switches with renewable contacts. At the end of the board additional vertical bars are provided, by means of which any number of horizontal bars at the back can be connected together. All the dynamo and feeder ampèremeters and voltmeters are of the edgewise scale type. The main switch in the dynamo circuits on the negative side is provided with automatic cut-outs. Crompton continuous-current switchboards are also to be erected at Osborn-street.

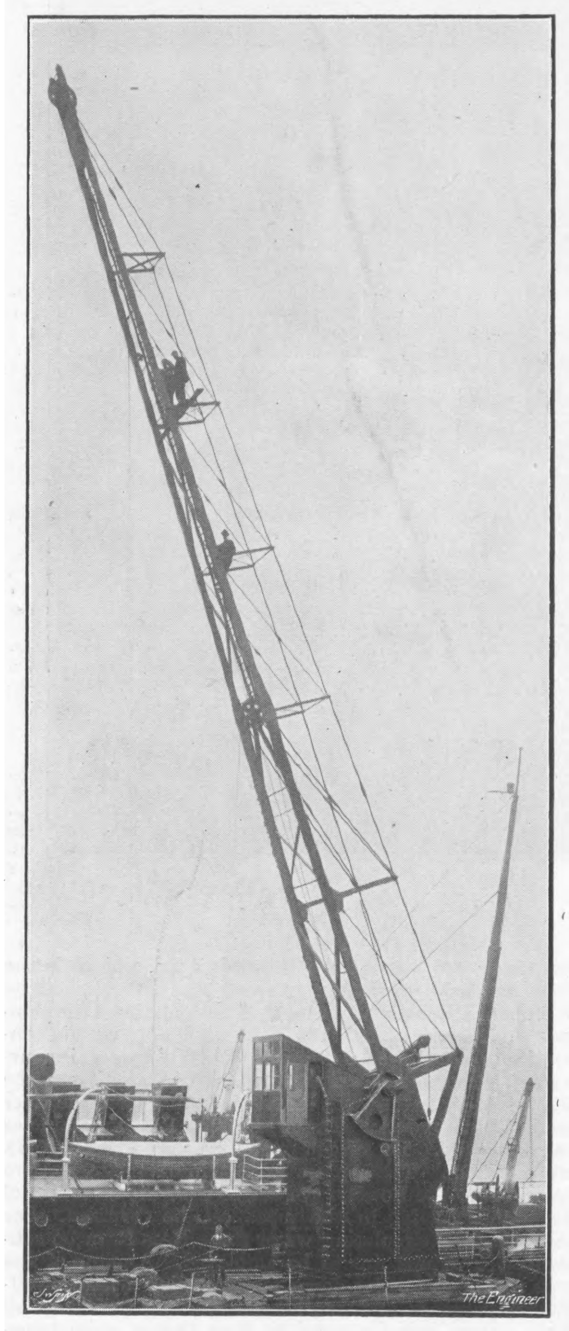


Fig. 6—ELECTRIC LUFFING CRANE

At present the boiler-house at Blyth's Wharf contains three marine type Babcock boilers; one is capable of evaporating 22,000 lb. of water per hour, whilst the other two boilers each have a capacity of 11,000 lb. per hour. Underfeed stokers are fitted to the large boiler, which is supplied with forced draught by means of a motor-driven fan. The other two boilers have chain grates, and work with the Pratt system of induced draught. It is this system which gives rise to the cone-shaped chimney stacks to be seen in the exterior view—Fig. 2—these nozzle-formed chimneys giving rise to an injector action. The present coal bunker capacity is 1000 tons. A Weir feed pump, with a capacity of 10,000 gallons per hour, provides the boilers with water. At present a cold feed is being used, but we understand that economisers will eventually be erected. An Archbutt Deeley water softening plant has been transferred to Blyth's Wharf from the Osborn-street station, together with storage tanks capable of holding 40,000 gallons of water.

It is anticipated that there will shortly be a considerable demand for power a long the riverside for the operation of cranes used for the loading and unloading of ships. A number of large electric cranes have already been erected for this purpose, and they are giving great satisfaction. Our illustration—Fig. 6—shows a Waygood's new electric luffing crane at the British and Foreign Wharf. It is of the pedestal type, and is fitted with lifting, luffing and slewing gear. It is worked by three electric motors of 8, 12 and 40 horse-power. It has a maximum and minimum rake of 80ft. and 30ft. respectively, and is capable of raising loads up to 30 cwt. at a speed of 240ft. per minute, and alternatively, loads up to 6 tons at a speed of 60ft. per minute when working with a rake of about 32ft. The undertaking has been carried out to the designs of the borough electrical engineer, Mr. C. P. Tapper.

THE DONCASTER AERONAUTICAL MEETING.

No. II.*

The Doncaster aeronautical meeting was continued on Monday and Tuesday of this week, instead of terminating—as it would had the weather been favourable last week—on Saturday. On Thursday and Friday there were no attempts at flights owing to the very boisterous wind, and Saturday was also practically a blank day, the only machine which left its shed being Captain Lovelace's Blériot monoplane, but which, after having travelled about 200 yards at an even height of 25ft., struck the ground, damaging the propeller and chassis. Later in the day, presumably to appease the 22,000 people gathered at the aerodrome in the expectation of witnessing some flights, there was a parade of most of the machines which were then in a serviceable condition. As events proved, Monday and Tuesday gave the best results, the weather conditions proving quite favourable. Early on Monday morning Mr. Cody travelled about 2 miles 1500 yards, but owing to a defect in his engine suddenly came to earth. M. Sommer completed two rounds. M. Delagrange on his Blériot flew a furlong in 10⅘ sec., but it was left to M. Le Blon to provide the excitement of the day. In the early afternoon in the face of a fitful wind he attempted a flight on his Blériot machine, but was caught by a strong side wind when attempting to round one of the curves of the aerodrome. He had a narrow escape from injuring himself, and cleverly avoided dashing into a line of spectators, but his aeroplane was seriously damaged, and he made no further attempts during the meeting. Sommer and Delagrange made a series of successful flights, the latter's total distance for the day being 7 miles 495 yards in 10 min. 44⅖ sec., and that of M. Sommer 7 miles 495 yards in 10 min. 58⅕ sec., and 5 miles 1595 yards in 9 min. 7½ sec.

On Tuesday, the concluding day, when the air was cold and still, the first flight was made by Sommer, who was in the air 15 min. 8⅕ sec., and flew 9 miles 57 yards. Delagrange, on a Blériot machine fitted with a Gnome engine, gave one of the finest exhibitions of the whole meeting; he sprang lightly from the ground after a 30 yards run and rose gracefully to a height of about 100ft.. After making a great sweep inside the pylons and round the judges' box, he travelled high and wonderfully fast, each turn being taken with extreme accuracy. His first round was covered in 1 min. 53 sec., whilst the official timing for the second was 1 min. 49 sec.; his engine, which had in previous flights caused trouble, worked splendidly. His third round was made in 1 min. 47⅕ sec., an excellent performance, and comparing favourably with the 12½ miles in 15 min. 50⅗ sec. set up by Curtis at Rheims and with Blériot's 6¼ miles in 7 min. 47⅘ sec. Delagrange flew a fourth round before descending, and his total distance of 5 miles 1095 yards was covered in 7 min. 11⅕ sec. Molon then essayed an attempt, using a Blériot monoplane fitted with an ordinary Anzani type engine, and remained in the air 4 min. 46⅕ sec., travelling 2 miles 1435 yards. Sommer followed with a second flight, and completed twenty rounds Before descending for want of petrol he achieved the longest flight of the morning, beating le Blon's previous performance by five rounds. He flew 29 miles 1575 yards in 44 min. 43 sec., and with a better petrol supply he would probably have equalled Farman's record at Blackpool; his engine ran perfectly, and the wind had no swaying tendency upon the planes of the machine. To him goes the Doncaster Cup, awarded for the greatest aggregate distance of the meeting, a total of 136 miles 280 yards. Flights have been made on six of the ten days of the meeting.

To sum up, only four of the aviators did anything at all worthy of record. Sommer has been the most consistent, and Delagrange the most daring. Le Blon, little known before the Doncaster meeting, has covered 39 miles 1745 yards; Delagrange, 39 miles 795 yards; and Molon, 17 miles 1525 yards. Cody is the only English aviator who has done anything at all, but as he never steered his machine round the pylons of the official course, no record appears of his performances. Captains Lovelace and Maitland, both with standard aeroplanes, have not yet developed the necessary skill to fly them, and Mines never looked like leaving the ground with his somewhat extraordinary biplane. The failures were not, however, confined to English aviators, as Schreck failed to do anything with his new Wright biplane, whilst Count Von Der Burgh failed to get a flight with his Blériot monoplane, and Saunier did not put his Chauviere twin-propeller machine to any practical test, and has, it is understood, disposed of it to a Manchester purchaser to be remodelled. The total attendance was about 160,000, and a deficiency of about £3000 is anticipated.

TWO NEW BRITISH WARSHIPS.

Yesterday two more ships for the British Navy were launched, the cruiser-battleship Indefatigable at Devonport, and the cruiser Gloucester on the Clyde. The designs for the former represent the latest development of the Invincible idea, and although before she enters her first commission still more powerful vessels will be on the stocks, she will for a time be the most powerful cruiser in the world. The Invincible and her sisters, the first cruisers to have an all-big-gun armament, are, it will be recalled, 560ft. long, with a beam of 78½ft., and a displacement of 17,250 tons. The Indefatigable, which for the moment stands alone, is 20ft. longer, 1ft. broader, and displaces 18,000 tons. She is designed also to exceed the speed of the three sisters by one knot, as she is expected to attain 26 knots, and with that object in view her turbines will develop 45,000 horse-power. Her armament and its arrangement will be similar to that of the Invincible, but she will carry twenty 4in. guns in place of sixteen, the main guns being 12in. fifty-calibre pieces paired in barbettes with heavy shields as before.

What is to be the next step in the progress of British cruisers is not generally known, the Admiralty having preserved the secret well so far, but it is said that the next vessel will be 600ft. long will displace 25,000 tons, will be propelled at 30 knots by turbines of 70,000 horse-power, and will have eight 13½in. guns instead of eight 12in. All these statements require to be received with caution, particularly the assertion that she will carry 13½in. guns. It is not improbable that further advances will be made with 12in. guns before the very serious step of changing the standard armament is adopted. Moreover, special forgings and an entirely new design of mounting would be required, and as far as we have been able to ascertain, the principal makers have not yet been approached on either point, save in a very tentative way. It has always been recognised that a bigger gun might some day be necessary, and gun-makers have prepared designs, whilst a 13½ gun has been made at Woolwich, and is now on board the Excellent. There is, therefore, some grounds for the rumour, but it still lacks confirmation.

The Gloucester, launched by William Beardmore and Co., is a second-class cruiser, one of five, all being built by private firms. She is 453ft. long, and displaces something under 5000 tons. Turbines indicating 22,000 horse-power will propel her at 25 knots. It is reported that the same builders have just received the order to construct another vessel of the same type improved.

According to the *Electrical World*, as the result of an inquiry made by a committee of the American Street and Inter-urban Railway Engineering Association, it has been ascertained that practically all the larger electric railway companies now make use of high-grade carbon brushes and grooved commutators. During the past year the brush manufacturers have made a decided improvement in the quality and uniformity of their products. As a result of the use of grooved commutators and high-grade brushes, commutator troubles have been reduced by about 50 per cent.

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* No. I. appeared October 22nd.

RAILWAY MATTERS.

A REPORT from Santiago de Chile states that an important contract was signed on Tuesday by a British syndicate to construct 750 kiloms. of railway in Chile. The cost will, it is reported, be over £3,000,000, and the work is to be completed in four years.

THE monthly report of passenger train performance on the New York steam railways for August, 1909, shows that 65,312 trains were operated, of which 87 per cent. were "on time" at division terminals. In August, 1908, there were operated 62,397 trains, of which 78 per cent. were on time.

FROM a report of comparative tests made by an American trunk line on the new ferro-titanium steel rails and those of the Bessemer type, it is noted that the wear on the former showed 1.45 lb. per yard, as against 4.18 lb. per yard on the latter, which is nearly 300 per cent. in favour of the new alloy steel.

THE *Oesterreichischer Zentral Anzeiger* notifies that the Communal authorities of Bozen, in making their financial arrangements for the future, have included a sum of 1,800,000 kronen (£75.000) for the construction of tramways in Meran and Bozen, and 600,000 kronen (£25,000) for the building of a theatre.

SOME time ago it was proposed that parliamentary sanction should be obtained by the London County Council to a scheme for running a service of trackless trolley cars beneath the Blackwall and Rotherhithe tunnels. It is now recommended that no further steps be taken in the matter, as the Council are aware that the system is still in an experimental stage.

THE *Bulletin Commercial* (Brussels) of 16th October announces, on the authority of the Belgian Consul at Batavia, that the Legislature of the Dutch East Indies intend to arrange for the construction of a number of large locomotives for service in 1911. The new locomotives are to weigh 90 tons, and are intended to take the place of those at present in use, which weigh 52 tons.

IN his presidential address to the American Street and Inter-urban Railway Association, Mr. Shaw, at Denver, said that in round numbers there are 1250 street and inter-urban railway companies in America, with a total of 35,000 miles of single track and 75,000 passenger cars. The total number of passengers carried annually is 10,000,000,000, and the gross annual income is 440,000,000 dollars.

IT is sometimes difficult when necessary to use a car jack on unpaved sections of the line to find a firm foundation upon which to work. To avoid trouble from this condition, the motormen of the Grosse Berliner Street Railways have been advised to take a motor trap-door from the car for a jack base. The men are also provided with small wooden blocks to keep the door in a horizontal plane where the roadway is very uneven.

THE *Bollettino Finanze, Ferrovie* (Rome) of 14th October reports that the Italian Government have arranged for a representative to proceed to Massaua for the purpose of going into the question of improved facilities at that port. The same delegate will also make investigations as to the most suitable spot in Benadir for the construction of a harbour which shall serve as a base for the railway about to be built through the interior.

THE *Boletin Oficial* of 16th September publishes a decree approving a contract between the Argentine Ministerio de Obras Públicas and the Empresa del Ferrocarril del Sud (Buenos Aires Great Southern Railway Company, Limited), by which, in return for certain alterations in former concessions to the company, the latter undertakes to extend the Juancho railway from the neighbourhood of Laguna Góngora to meet the line from Maipú to Mar del Plata.

THE *Gazzetta Ufficiale* of 14th October publishes the text of a contract entered into between the Italian Government and the "Società per le Ferrovie Adriatico-Appennino," of Milan, under the terms of which the latter is empowered to construct and work a steam railway, in nine sections, from Ortona to Castel di Sangro, with a total length of 148 kiloms. (92 miles). The cost of construction and initial equipment of rolling stock is estimated at 25,334,514 lire (£1,013,400). The concession is for a term of 70 years, and during 50 years the concessionary company will receive an annual state subsidy of 8500 lire (£340) per kilom.

IT is reported that a large wireless telegraph and telephone station is to be erected at the Omaha shops of the Union Pacific Railway, where Dr. Frederick H. Millener will conduct wireless telegraph and telephone experiments. Dr. Millener hopes to develop wireless telephony to such an extent as to permit railway officials to keep in touch with trains, and thus govern their movements from sixty to one hundred miles from Omaha. If the system is developed as he expects, it will be possible for passengers on moving trains to carry on telephonic conversation within a radius of one hundred miles of Omaha.

EXPERIMENTS with concrete telegraph poles by the Pennsylvania Railway have met with such success that the executive officials of the line have decided gradually to extend their use over the Fort Wayne, Panhandle, and other lines west. Before many months it is possible that old wooden poles along the lines in that vicinity will be replaced by concrete. No definite sum of money has been put aside for this purpose, but it is understood that the engineering department has been given orders to prepare to use concrete poles. The instruction and improvement programme for 1910, which will be decided upon shortly, is expected to include orders to place many miles of concrete poles on the lines west.

ACCORDING to the *Times*, a new electric line from Chezery to Bellegarde, on the Geneva-Lyons route, will shortly be opened by the P.L.M. Railway Company. The bridges on the line are fine examples of engineering skill. The first viaduct from Bellegarde to Chezery, across the little river Valserine, consists of seven arches, each 18 metres wide and 45 metres high. A little further the line crosses a gorge of the same stream, which is spanned by an immense viaduct 82 metres in height and 80 metres in width, in a single span, with no intermediate supports. It is called the Moulin des Pierres viaduct, and is stated to be the largest in France. M. Picard, a French engineer, of Bourg, designed and constructed it.

THE summary of Australian States Railway reports shows that the revenue for the year ended June 30th was the greatest in the history of the Commonwealth, notwithstanding the recent reductions in freights, and extensions of railways to new districts. There are 14,846 miles of railway now open, which shows an increase of 2000 miles. Since 1891 the railway tracks of Victoria, New South Wales, and Queensland average 3500 miles for each State, while South Australia has 2000 miles. The gross earnings for the year amounted to £14,737,388 and expenses to £8,706,060, leaving a working profit of £6,031,328. Interest charges amounted to £5,074,363 on a capital of £143,865,852, leaving nearly one million sterling to swell public revenue.

SOME electric motor coaches are being built for suburban service on the New York, New Haven and Hartford Railway. These cars are designed to operate on both the 11,000-volt-alternating-current overhead system used on the main line and on the 600-volt direct-current, third-rail section used near the New York terminus. The cars are intended to pull trailers, and are equipped with four series-compensated motors. These and the step-down auto-transformers are supplied with forced ventilation from the blower system. When the equipment is operated under forced ventilation the one-hour rating of each motor is 200 horse-power. Each car is guaranteed to haul two 50-ton trailers, and when so operating will accelerate normally at a rate of 0.7 miles per hour per second.

NOTES AND MEMORANDA.

IT is estimated that the German Empire has nearly 35,000,000 acres of forest, of which 31.9 per cent. belongs to the State. German forestry on scientific lines has resulted in raising the average yield of wood per acre from 20 cubic feet in 1830 to 65 cubic feet in 1904. During the same period it has trebled the proportion of the sawn timber secured from the average cut. In fifty-four years it increased the money returns from an average acre of forest sevenfold, yet to-day the forests are in better condition than ever before.

AN article in the *Génie Civil* states that seventy-eight electric furnaces now exist in the steel works of the world, of which thirty-five are on the induction and forty-three on the arc principle. Fourteen are Kjellin furnaces, eleven Stassano, ten Röchling-Rodenhauser, three Elecktrometall Society (Sweden), and one each Colby, Hiorth, Keller, Schneider, and Wallin. There is a steady and marked tendency to increase the capacity of these furnaces, some of those already constructed holding as much as eight to ten tons.

A TYPE of Leclanché battery has been patented in France in which the present electrolyte of sal ammoniac is replaced by chloride of manganese. It is claimed that the cell holds up much better in this case, and that it can be short-circuited without harm. It has no consumption on open circuit. The internal resistance of the battery is low, and it has a large effective yield. Besides the liquid does not freeze in extreme cold. A novel feature lies in the fact that the exhausted battery can be regenerated by charging it by an outside current.

To secure accurate information with reference to the weather conditions, Dr. William Shaw, Director of the Meteorological Office of Great Britain, has been travelling in Western Canada. With reference to the alleged general changes in the climate, owing to the settlement of the country, Dr. Shaw is sceptical. He states that he has observed that the people of all localities are under the impression that the climate of their district is undergoing a change. The statistics do not, however, bear out this idea. There are oscillations, but no permanent changes in the climate.

THE hilly territory of Trieste, it is stated in a consular report on that district, is covered by pointed stones which prevent any cultivation, and some years ago the *Società Agraria* offered prizes for those who would remove them and thus change the waste ground to meadows. The work has now been going on for some years, and every autumn a commission ascertains the area of the proposed redemption and the difficulties to be encountered, and fixes the prize to be given. In spring it again visits the improved grounds and pays the prizes if deserved. This year in the different parishes 66 peasants improved 44 acres, and received £208.

THE smelter production of lead in the United States in 1908, as given by C. E. Siebenthal, of the United States Geological Survey, under the date of May 24th, was 408,523 tons of 2000 lb., against 442,015 tons in 1907, and 418,699 tons in 1906. The production of refined primary lead, which embraced all desilvered lead produced in the country, and the pig lead recovered from Mississippi Valley lead ores was 396 433 tons, against 414,189 tons in 1907, and 404,669 tons in 1906. The antimonial lead produced was 13,629 tons, and the recovered or secondary lead 18,283 tons. In 1908 the lead smelted from domestic ores was 310,762 tons, and from foreign ores and foreign base bullion—almost wholly Mexican—97,761 tons.

HEAVY explosions in the sewers of a portion of New York City containing many garages, states a contemporary, again draw attention to the danger of allowing petrol to enter sewers. Some of these explosions were so violent as to resemble the explosion of a small boiler. Manhole covers were blown into the air, windows in the neighbourhood were shattered, and a number of persons injured. The sewers of the city discharge into tide water, and at high tide the sewage in them backs up in some cases. It is probable that petrol floated on the surface of the sewage when the latter was backed up by high tide, and its vapour was ignited by a spark that might have been due to several causes. While such explosions will not follow every discharge of petrol into sewers, their occasional occurrence and the possibility of much serious injury from them, states our contemporary, are a justification for rigid rules efficiently enforced to prevent the practice.

THE following notes concerning the storage of California or crude oil in concrete reservoirs were recently given in *Concrete*. A 1,000,000-barrel reservoir, lined with concrete, has recently been completed at Port Richmond, Cal., and one of 800,000-barrel capacity is under construction near Bakersfield. The practice is to excavate the earth, which in most fields is a sandy loam, porous and very dry, to about one-third the depth of the proposed reservoir. With the material removed, a levee is built round the excavation, having side slopes of 1 : 1½ on both faces. The bottom and sides are then covered with about 3in. of concrete, often reinforced with expanded metal or some equivalent. Small cracks that occur at the junction of the sides and bottom and along the line between the cut and the embankment soon become filled with sediment and are believed to permit the leakage of very little oil. A number of such structures in Southern California has recently been examined and no signs of depreciation in the quality of the concrete were found.

THE bond between concrete and steel, as influenced by repeated loading, has been investigated by Professor B. Kirsch, of Vienna, and a summary of the work was presented to the Copenhagen Congress of the International Association for Testing Materials. The bars were plain, 20 mm. square, some rusty and some bright, and were tested by embedding one end in a 1 : 3 Portland cement mortar cube of 20 cm. edge. The adhesion surface was 125 square centimetres, and the load applied was 150 kilos., amounting to 1.2 kilos. per square centimetre, or 17 lb. per square inch of bonding surface. The load was applied fifty times, this limit being set because Professor Kirsch believes that any loosening of the bar, if noticeable, would become apparent after a few applications. The experiments on specimens one month and three months old convinced Professor Kirsch that a repeated load of 17 lb. per square inch does not produce any alteration in the adhesion, either with bright or rusty bars. The cubes, on the completion of the adhesion experiments, were tested in compression, the rods being left in them, and developed strengths of 1520 lb. and 1790 lb. per square inch for the one-month and three-month cubes respectively.

AN interesting discussion, aroused by the storm of September 25th, has been going on in *Nature* and elsewhere, between Sir Oliver Lodge and Dr. C. Chree. The former claims that the phenomena are consistent with and strongly support the theory that such storms are due to the emission of vast multitudes of electrons from the surface of the sun during a solar eruption, as evidenced by the appearance of "spots on the sun." The stream of electrons, projected at an immense velocity in the form of a conical beam, has a magnetic effect calculated to be equivalent to that of hundreds of millions of ampères, and as the beam passes over or near the earth, the magnetic disturbances pass from positive, through zero, to negative. Dr. Chree points out, however, that the disturbances are not limited to the declination, as Sir Oliver appears tacitly to assume, but take place also both in the meridian and in the vertical component of the earth's magnetic force, and the storm does not correspond to a disturbing force in a fixed direction, waxing and waning, but is irregular and oscillatory. Moreover, the average duration of such storms is not 9 hours, but 30 hours. Dr. Chree does not combat or support the emission theories, but calls for reservation of judgment and minute study of the records with an unbiassed mind.

MISCELLANEA.

BOTH Italy and Austria are reported to have decided upon the construction of new bases for their future Dreadnought fleets, Italy at Ancona, and Austria at a place yet to be selected. At present each country has a four-battleship programme projected.

A SUBWAY for Vienna is projected, according to the *Zeitschrift des Oesterreichischen Ingenieur Vereines*. This new system, which, if built, will be the first subway in the city, is designed to run in two lines, crossing each other at right angles in the centre of the city. The project at present calls for municipal ownership and the construction of a large power plant, from which light and power are to be sold.

THE report by Major Cooper-Key, Chief Inspector of Explosives, on the explosion at the gunpowder factory at Fernilee, Derbyshire, on August 12th, which caused the loss of three lives, was recently issued. Major Cooper-Key comes to the conclusion that the accident was due to a hard foreign body passing through the "rolls" of the corning machine. He adds that there is no evidence to show whether the foreign body was carried into the building in one of the barrels, or fell from the roof, or was part of the machine itself.

WE hear that the Admiralty have approved of draughtsmen and others temporarily employed at the Admiralty being paid for overtime while on duty there, in all cases in which the extra time worked is tolerably continuous. Payment, however, is to be made primarily from the grants made for ships building or repairing at the respective yards to which those concerned belong, and, therefore, notification of this decision has been sent to the several dockyards. It has hitherto been the rule to regard overtime in these cases as being covered by the allowance, additional to pay, granted to men serving at the Admiralty.

THE torpedo-boat destroyer Santa Catharina, the eighth of the ten destroyers ordered by the Brazilian Government from Jarrow and Co., Limited, of Glasgow, was successfully launched on Monday, the ceremony being performed by Senhora Boiteux, wife of Captain H. Boiteux, Secretary of the Brazilian Naval Commission. The Santa Catharina is 240ft. in length by 23ft. 6in. beam, and will be fitted with two sets of a triple-expansion four-cylinder engines and two double-ended Yarrow boilers, each boiler supplying steam for about 4000 horse-power. The guaranteed speed is 27 knots, being the same as the destroyers recently ordered by the Brazilian Government.

ACCORDING to the *Electrical Review*, the Admiralty have decided to erect a wireless telegraph station at Wick. An acre of ground has been leased, and provision will be made for a staff of twelve men. The station is to be equipped with the latest appliances for long-distance communication, and is expected to be in working order early next year. It is reported that the airship Zeppelin III. has been proved capable of communicating by wireless telegraphy with stations at a distance of 300 miles. Nevertheless, the experts consider that, to ensure successful communication, wood must be substituted for aluminium in the construction of the frames of airships of the rigid type.

WE hear that the Delaware is now undergoing standardisation tests and will soon be placed in commission, this being the first American battleship of the Dreadnought type. She has a displacement of 20,000 tons, 25,000 horse-power, and a contract speed of 21 knots, which she has already exceeded in one of her trials. She mounts ten 12in. guns, and is protected by unusually heavy armour. The United States is to have four battleships of the Delaware type, the others being the North Dakota, a sister ship, which will undergo trials this week, and the Florida and Utah, of 21,500 tons, which are now one-third completed. These are to be followed by the Arkansas and Wyoming, of 26,000 tons, with twelve 12in. guns.

THE British Consul for Lyons, in his annual report, which has just been issued by the Foreign-office, after referring to the falling off in the demand for high-powered pleasure motors, goes on as follows:—"This falling off caused many manufacturers to turn their attention to a hitherto neglected branch of the industry, the commercial motor vehicle, from the post-office van and the taxicab to the powerful lorry enabling heavy loads of wine, flour, &c., to be carried over long distances without breaking bulk. The motor omnibus or char-à-banc is now a familiar sight in the Dauphine and Savoy Alps, and has done much to open up to tourists beautiful districts hitherto scarcely known. This and other forms of the commercial motor seem capable of almost infinite development."

NATIONAL forestry operations in Italy have been carried on for forty years, and a report just issued by the Secretary of Agriculture of that country shows that the Government are conducting a vigorous policy of afforestation in order to remedy the ruinous conditions which followed the destruction of trees in the past. During the last thirty years 122,000 acres of Government land have been planted in twenty-five provinces, of which area 69,000 acres were planted in 1907, and this work is being carried on so rapidly that only about 36,000 acres of Government land now needs planting. The Government have also distributed great numbers of young trees and seeds for planting private property. Work of such an expensive nature in a country where the demands for national funds are so numerous and pressing as in Italy is a significant commentary on the value set upon afforestation where the experience of many centuries furnishes considerable information of unquestioned value regarding matters of this nature.

WE in England have had so little experience with electrical transmission by means of overhead wires that it is interesting to note the troubles experienced by the Ferndale Collieries in South Wales, as described by Mr. W. H. Patchell, the consulting engineer to the scheme. The chief trouble was caused by the failure of the insulators. These were of porcelain carried on iron stems and cemented to the stem with sulphur and glass cement. The cement and the iron swelled up under the influence of hot weather, and cracked or completely burst the insulators. If rain followed it frequently penetrated the cracks and formed a semi or intermittent short-circuit from the line to earth. This set up electrical surging in the line and burnt up several instruments and disabled other apparatus. In some American transmission lines the insulator is screwed on to the pin with a fairly slack fit to permit of slight differences of expansion, and a lead nut is cast inside the insulator in order to prevent unduly high local pressures between pin and insulator.

AT the Stafford Rural District Council on Saturday, October 23rd, a sub-committee was appointed to confer with a committee of the Stafford Town Council, with the object of obtaining evidence as to the alleged smoke nuisance caused by the large quantities of smoke emitted by the chemical works. Mr. W. Peach said there was another question which it might be advisable to consider. The pumping of brine by the various salt companies at the Common had rapidly developed lately. Brine was being pumped continuously in large quantities, and in view of possible subsidences in consequence of the abstraction of the brine it was a matter which should receive attention. He understood that in other salt districts there were what were called compensation areas, in which those who were pumping the brine contributed to a compensation fund. In all probability, in the course of time, there would be subsidences at Stafford, as in other districts where brine was pumped, and he should like the question of forming a compensation area at Stafford, if it were at all possible, to be taken into consideration. The clerk said he had no knowledge what had been done in other places, but he would make inquiries,

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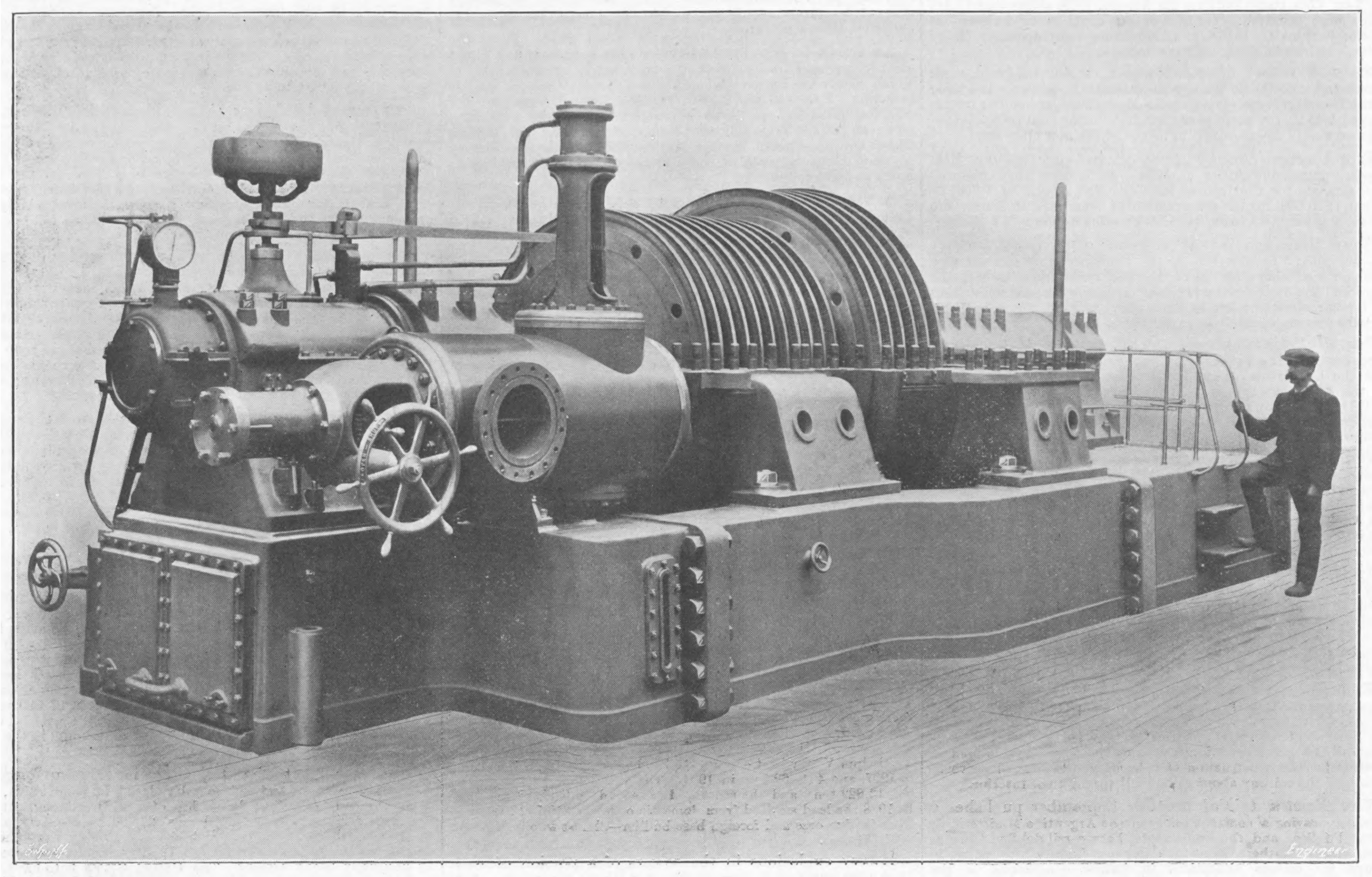

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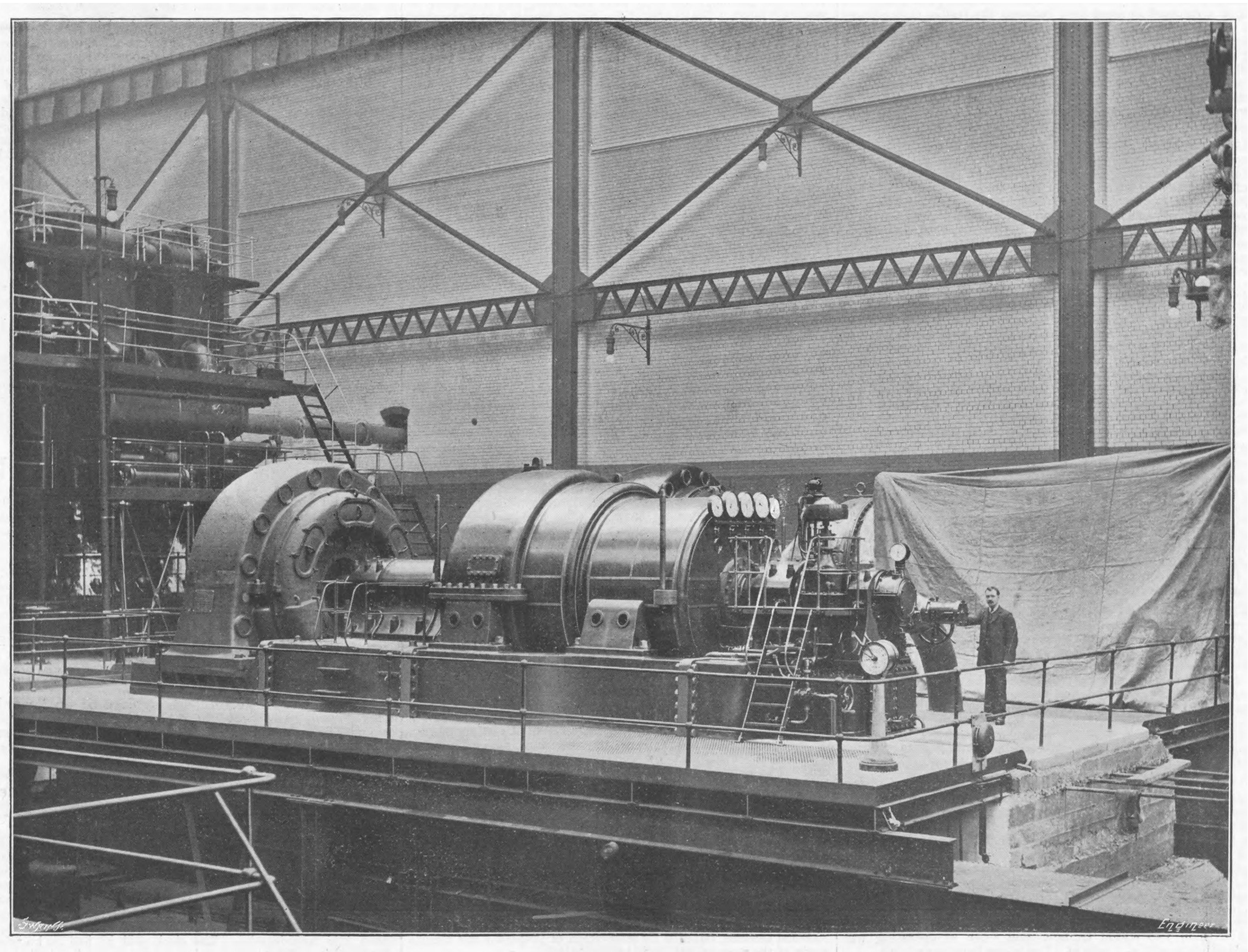

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⁂ *With this week's number is issued, as a Supplement, a Two-page Drawing of a Vertical Cross Compound Two-stage Air Compressor Every copy as issued by the Publisher includes a copy of this Supplement, and subscribers are requested to notify the fact should they not receive it.*

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TO CORRESPONDENTS.

☛ *In order to avoid trouble and confusion we find it necessary to inform correspondents that letters of inquiry addressed to the public, and intended for insertion in this column, must in all cases be accompanied by a large envelope legibly directed by the writer to himself, and stamped, in order that answers received by us may be forwarded to their destination. No notice can be taken of communications which do not comply with these instructions.*

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☛ ***We cannot undertake to return drawings or manuscripts; we must therefore, request correspondents to keep copies.***

REPLIES.

W. L. V.—The question which is the most economical intermediate receiver pressure is one about which much controversy takes place. If you raise the pressure in your receiver then the ratio of expansion in the high-pressure cylinder will be diminished if the effective pressure is to remain unchanged, because the back pressure will be augmented. More work will then be done in the low-pressure cylinder. If you reduce the intermediate pressure, more work will be done in the high-pressure cylinder and less in the low, unless you alter the point of cut-off in it. Probably, but not certainly the steam consumption will be the same in either case. If you can get diagrams taken under both conditions and combine them you will learn more at a glance than any book can teach you. You can, however, with advantage study the article in Clark's "Rules, Tables, and Memoranda," beginning at page 849. On page 869 you will find a complete answer to your question, but it is far too long to reproduce here.

MEETINGS NEXT WEEK.

Geologists' Association, London.—Friday, November 5th, at 8 p.m., in the Library of University College, Gower-street, W.C. Conversazione.

Civil and Mechanical Engineers' Society.—Thursday, November 4th, at 8 p.m., at the Caxton Hall, Westminster, S.W. Paper, "Technical Popular Fallacies," by A. S. E. Ackermann.

The Institution of Civil Engineers.—Tuesday, November 2nd, at 8 p.m., at Great George-street, Westminster, S.W. Ordinary meeting. Address by Mr. James C. Inglis, the President.

DEATH.

On the 25th October, at 3, Stanway-gardens, Acton, of pneumonia, Malcolm Graham, C.E., aged 61 years.

THE ENGINEER.

OCTOBER 29, 1909.

Standardisation as a Principle.

This article has little or nothing to do with the work of standard committees. Not much has hitherto been said concerning the ideas which lie at the root of all practical applications of a principle. A consideration of one or two of them is not out of place at an epoch when standards of all kinds are daily growing in popularity. There are two fundamental reasons for the establishment of standards. The first may be said to be purely commercial. It is concerned with the daily life of all communities. The second is mechanical or scientific. It is necessary to an advanced state of civilisation. The first types of standards are measures of length, weight, volume, or value. Thus, among Hottentots so many cows represent the standard value of a wife. With civilisation comes the yard or the metre, the gallon or the litre, the pound or the kilogramme, and so on. This standardisation is of the utmost value, for reasons which need no setting forth for our readers.

At first sight it would appear that the establishment of engineering or mechanical standards would be as essential an attribute of advanced civilisation as are commercial standards. This, however, is not so. The standardisation of everything has been warmly advocated, and at all events interesting, if not convincing, arguments have been urged in its favour. The fatal objection is that universal standardisation would be fatal to progress; with its introduction originality would be killed on the spot. The range of the principle is limited. If we push it beyond that limit we shall do mischief. Let us cite an example. The Engineering Standards Committee have fixed on certain types of locomotive as standard engines for working traffic on Indian railways. There is no fault to find with them. They are, no doubt, well-designed engines, quite suitable to the work they have to do. But no man whose brains had not become fossilised would dare to assert that no better engines could ever be produced. The advantage of having standard engines is that they may be built to stock, and so certain commercial benefits can be assured. But beyond this it is not easy to see what is gained; while the absolute prohibition of new designs would be the most unwise thing conceivable from the point of view of the locomotive superintendent and the traffic manager. It is useful to have standard rail sections, standard sleepers, and multitudes of other things; but there is a wide difference between utility and imperative necessity. To establish standards is one thing; to compel all men to fall down and worship them is quite another. If we examine the position with some care, it will soon be seen that standardisation is at its best in details, at its worst in complete designs. A standard for the proportions of cement concrete may be very useful. A standard for the dimensions of monoliths for the construction of harbours would be ridiculous. Whitworth's screw threads are simply invaluable. To fix the diameters of piston-rods in relation to the size of the pistons would be to go beyond the range of the principle. Minute standardisation is constantly advocated on the ground that it permits of the replacing with facility of the parts of a machine worn out or broken. In point of fact, while it may do this in one case out of ten, in the other nine it will not. A pin is worn, and must be replaced. A new pin, precisely the original size of the old one, is ordered, and obtained easily enough; but it will not fit because the holes in which it works are also worn. Standardisation has narrow limits in matters that concern repairs and renewals.

But standardisation is not confined to the practice of civil or mechanical engineering. It is rapidly coming to be the rule in technical education. Professor Perry has spoken out on this point, but he is as one crying in a wilderness. There are standard books, standard methods of teaching, standard methods of examination—mostly wholly unintelligent—standard formulæ, standard tables—all useful servants, but the worst possible masters. Mr. Henry Adams, President of the Association of Engineers-in-Charge, took for the thesis of his inaugural address recently delivered "Standardisation." We commend the following quotation to our readers:—"The publication of a good text-book in any subject tends to standardise the work in that subject, and to some extent to cramp the minds of the students by giving the impression of finality. Although there are undoubted advantages in standardisation, it chiefly helps the average man, and aids economical production; while the man of intellect is more or less hampered by having a rigid model set up for him beyond which he may not pass. The whole tendency of modern education and official regulation is to make one man as much like another as possible, to stamp out individuality and to discount common sense. I have had not a little to do with technical education, and in a small way have attempted to stem the tide of the current reliance on rules and formulæ. I have always advised students to try to understand the principles, and then the formulæ would follow of their own accord without being a burden to the memory. My remark to a student on one occasion shows what I mean. He was troubled about a formula for some simple thing, and in remonstrating I said, 'If you were in a stokehold when a gauge glass burst, you would want a formula to help you out of danger.'" Who has not met the young man who answered a statement of a fact with, "What is the formula for it?"

It requires little consideration to show that if rules and regulations existed for everything, or even to a considerable extent, no high order of intellect would be required for the conduct of any business. It is because much can be done by rule that a host of men succeed in earning a living as engineers. They have little or no originality, and they are never asked to originate anything. The men who make history, whether in pure science or in engineering, are just those who refuse to be trammelled by rules and formulæ and cut-and-dried methods of doing or designing or making things. The man who works to rules, without any real understanding of what is the foundation on which they are based, and what they involve, can only be regarded as a copyist. He bears the same relation to the true engineer that Watt's carving machine does to a sculptor. A very average man could build a petrol motor from a few sketches and a table of dimensions; but it is to the last degree unlikely that he could effect the smallest improvement. It must never be forgotten that standardisation invariably follows invention. It is never co-ordinate with it. It never stimulates it or helps it in any way. The same ground is always gone over. History constantly repeats itself. There were no standards for the dimensions of the first railway engine. The first dynamos were built without any attempt at standardising a design, or even the dimension of parts. We have now flying machines. We presume that they will be standardised some time in the not distant future.

Writing particularly in the interests of our younger readers, we warn them against attaching an exaggerated value to that method of working in mental grooves, one aspect of which is the reduction of everything to a fixed standard. Obedience is an excellent, an indispensable thing; but it should always be intelligent. The use of a text-book formula without understanding what it implies, how it came to be prepared, and what are its limitations, may land the user in a catastrophe. It is, of course, far easier to take things for granted, to assume that so long as you stick to "Molesworth" you cannot go wrong. But engineering skill, reputation, and honour are not for those who take things easy. Standardisation is a word of large application. The student must always keep its limitations steadily in view; and in doing this he will be greatly helped if he will take the trouble to think out for himself the nature of the principles which are involved in the construction of any standard whatever, whether of prices, or morals, or screw threads, or rail sections, or office management.

The Steel Trust.

THE future of the United States Steel Corporation, whether viewed from a Stock Exchange or a steel market standpoint, is a matter of profound consequence, for if one-half of what we hear about it is true, it is not only going to earn enormous profits for its shareholders in the near future, but it is going to be in a position to undersell British and other steel makers in the world's markets. The productive capacity of the Steel Trust furnaces and mills already exceeds the combined capacity of all the iron and steel works in Great Britain, and it is being increased. If, as is likely, the day again comes when the United States home demand falls far short of the productive capacity of the works, Trust and independent, and if, as is asserted, the Trust can make steel more cheaply than any other concern in the world, British and other iron and steel producers can prepare for competition of a volume and character unprecedented. Let us see.

In the first place, note a message received from New York a few days ago. It is stated that the famous price maintenance agreement, or understanding, which existed between the Steel Trust and the leading "independents" during the recent period of depression, has been renewed, and that there will be amicable working between the rivals in the future. This announcement will strengthen the belief entertained in some quarters that the day is not far distant when the Steel Trust will control the whole American industry. Indeed, it is distinctly stated that it will soon have the whole business in its own hands. But will it? Let us take a glance backward. When first the Trust was organised, it was freely asserted that it would soon absorb all the American concerns worth absorbing. That was in 1901. But, as a matter of fact, it has a smaller share of the United States iron and steel trade now than it had then. Its first full calendar year was 1902; its last, of course, was 1908; but as 1908 was a year of deep depression it does not lend itself to a fair comparison. We will take, therefore, 1907. That the Steel Trust not only failed to attain its main object—the absorption of the entire trade—but actually receded further from it, between 1902 and 1907, is proved by the following figures showing the proportion of total United States output made by the Steel Trust:—

	1902. Per cent.	1907. Per cent.
Iron ore	45.1	43.3
Pig iron	44.3	41.7
Bessemer steel...	73.9	64.7
Open-hearth steel	52.4	47.9
Bessemer rails	65.4	51.6
Structural shapes	57.9	54.9
Plates and sheets	59.4	55.8
Wire rods	71.5	71.5

The 1908 figures give the Trust a slightly better result than those for 1907, but it is still making a smaller proportion of the total American output than it did in the early days. Although it has largely increased its productive capacity, its rivals have increased theirs still more largely. Relatively to the total trade of the country, and comparatively to the progress of its rivals, the Trust has lost ground.

Now, if the Trust has failed to absorb its rivals in the past, what prospect has it of absorbing them in the future? If it does absorb them, and obtain a monopoly, what prospect has it of earning large dividends for its shareholders? If the American home demand again falls below productive capacity, what prospect has it of obtaining a big trade in exports? This question is of the greatest interest in this country. And, if the Trust continues to work amicably with its rivals without absorbing them—if it and the independents are to sell at identical prices—how are the Trust and its shareholders going to fare? Replies to these questions depend, in the main, upon the *real status* of the Corporation as a competitor with, and a dividend earner in relation to, its rivals at home and abroad. The basic and cardinal question is this: Can the Trust produce steel more cheaply than its contemporaries? We unhesitatingly assert that it cannot, and in our opinion it will not obtain anything approaching a monopoly in its own markets; it will not absorb the independents; and in competition with the independents at home it will not be able to earn big profits; while abroad it will be able to do very little in competition with British and German steel makers.

In order to see that there is now very little prospect of the Trust absorbing its independent neighbours we have only to consider briefly the question of iron ore supplies on the one hand and finance on the other. It may be recalled that a little while ago the Trust directors made a great parade of the acquisition of the famous Hill ore lands in Minnesota. The "Hill lease," as it was termed, gave the Trust a monopoly of nearly all the best ore available, and strengthened its position enormously, so it was claimed. But it is more than probable that the Hill lease will prove a bad bargain. To begin with, the royalty starts at 85 cents per ton, and rises to 1 dol. 19 cents within ten years. On top of this extravagant private royalty—a charge amounting to practically 2 dols. per ton of pig iron—the Minnesota Legislature is threatening to impose a special tax of 20 cents a ton on all ore mined in that State. These charges—a high royalty and a tax—upon the Trust's ore supply, in view of certain new circumstances which have arisen, must strike a blow at the very foundations of the Corporation. This ore has to come down the Lakes, which are closed to traffic for nearly half the year. Now, first we have a charge of practically a dollar a ton in the ground. To get this ore out of the ground costs about 50 cents a ton, and the cost of mining is increasing continually. This makes, roughly, a dollar and a-half a ton at the mine, with the prospect of a State tax added. To get the ore to the Lake steamers costs another 70 cents, to take it down to Erie Port costs 60 cents, and to get it to Pittsburg and district furnaces costs another 70 cents. These charges render the cheap production of pig iron impossible. And that is the cardinal point in the whole business.

If, as the Trust directors seemed to assume, the ore contained in the Hill lease had been the only good ore available, the deal would not have been so bad. But it so happened that when the Trust was burdening itself with high royalty charges, in the hope of cutting out the independents, and was making a great noise about it, enormous reserves of ore were being discovered elsewhere, in more convenient places than Minnesota, and some of the independent steel makers were quietly mapping out claims in them. And these claims have been secured upon highly favourable terms. The net result is that the independents are now better assured of cheap and abundant supplies of ore than the Trust is, and will be able to produce iron and steel at a less cost than the big Corporation. The leading independents, besides enjoying ample, convenient and cheap ore supplies, have their mills and management quite as efficient as the Trust. Besides this, their capital charges are much lighter, so that we may safely say that, while the independents are equally as strong as the Trust mechanically, they are much stronger commercially and financially. If, therefore, the Trust has failed to absorb the independents and kill competition in the past, it is not likely to succeed now that the independents are stronger and more independent, while the Trust itself is weaker.

Reciprocity in the Working of Patents.

THE compulsory working clause in the Patents and Designs Act, 1907, continues to occupy attention in other countries, the latest instance being represented by the attitude assumed by the International Association for the Protection of Industrial Rights at the recent conference held at Nancy, which is to be followed by a conference at Washington. It is extraordinary that so much consideration should still be given abroad to the subject of compulsory working when it is remembered that the system has been in operation in Germany and elsewhere for a number of years past, and the method is consequently by no means a novelty. But it is particularly this section of the English Act which continues to disturb manufacturers in a few other countries, and which has led, as mentioned on a previous occasion, to proposals for the revision of the patent legislation in the United States in a similar direction, whilst France is still occupied with a scheme for the introduction of compulsory working. The grievances, or alleged grievances of foreign holders of English patents do not lie specially in the fact that the inventions must be worked in the United Kingdom if the patents are to be preserved, but they are rather based upon financial and commercial considerations. At present these particular holders have large works in their respective countries, which are equipped for production on a large or bulk scale, thus enabling them to turn out products cheaply, and supply both home and external markets. But the moment when the necessity of manufacturing in another country is imposed, the financial question comes into play in the sense that capital has to be provided for the acquisition of a site, the erection of buildings, and the purchase of plant and machinery. When the establishment has been completed the commercial problem manifests itself, inasmuch as the prospective output is intended, primarily at all events, for the English home market, although the export trade would naturally also be available. The comparatively small establishment would probably produce less cheaply than the parent works in the original country of origin, but it must not be forgotten that branches of foreign works were erected in this country prior to the passing of the Act of 1907.

The recent Nancy conference of the International Association for the Protection of Industrial Rights would like to put an end to all questions of compulsory working as between one country and another. A report was submitted on the subject giving opinions which the author had obtained from a number of the leading English patent agents, and the information is stated to have presented valuable indications for the further extension of the principle of international agreements with regard to compulsory working. The conference eventually adopted two resolutions on the question. The first, which referred to all countries in general, expressed the wish that compulsory working should disappear from international relations, but that in any case uniformity in legislation should be sought at the next conference at Washington. In this event the conference submitted that it was desirable that working in one country in the international community should be placed on a level with working in all other countries; and that the non-working of a patent should not result in revocation, but should take the form of working by means of compulsory licences. The second resolution, which particularly applies to the United Kingdom, expressed the opinion that in any case revocation should not be effected if the patentee proves that, although he has offered to grant a licence, the proposal has been declined. It was also contended that working should be regarded as adequate if the patentee manufactured at least the same number of articles in each country as he exported to the country concerned.

It is impossible to foresee what may happen in the future with regard to agreements between different nations on the subject of compulsory working. Mutual arrangements exist, we believe, between Germany on the one hand and Switzerland and Italy on the other, and a fresh agreement was concluded a few months ago between Germany and the United States, but until the latter country proceeds to legislation, so as to enforce the working of patents, the Americans are under no necessity to carry out manufacturing under their Teutonic patents in Germany. The French Patent Bill still remains under consideration, and Germans express the hope that a reciprocal arrangement of an improved form may be arrived at in this particular case. As far as the United Kingdom is concerned it is obviously too early to say definitely what the eventual results of compelling foreign owners of English patents to carry out the identical duty which is imposed upon native holders will be, but so far the position may be regarded as satisfactory from the point of view of the new works already established, or in progress, and in the provision of employment for British workers, and there is no reason to fear that the movement in this direction will not continue. If the United Kingdom were on an equality with other countries—equal in imposing high duties on imports from other lands—it would be possible to discuss the question of mutual relations in other respects, but as this is not the case any idea of the abandonment of compulsory working of patents should not receive serious consideration in the United Kingdom. Nor is it at all probable that the problem of compulsory licences in lieu of revocation will again occupy attention in this country, as past experience has proved that the method of such licences is a costly and tedious process which has been ably superseded by compulsory working or the loss of patents by cancellation. Of course, where British Colonies are concerned, the position is quite different, as they grant preferential treatment to goods procured from the United Kingdom and are branches of the Mother Country, and reciprocity in the treatment of patents between them should consequently prevail instead of the scheme proposed by the Australian Commonwealth. The action of the English Chambers of Commerce in seeking to secure reciprocal treatment between the United Kingdom and Australia is in the circumstances one which should receive substantial support in this country.

BLACKPOOL AVIATION WEEK.

No. II.*

Owing to the atrocious weather which set in at Blackpool on Thursday of last week there only remains one flight to record since our last report, namely, that made by Mr. Latham on Friday on his Antoinette biplane. This has been already so fully described in the Press that we need make no further reference to it here except to add our meed of praise to the aviator for his remarkable skill and pluck. These qualities are emphasised by the fact that previously during the week a wind of 15 miles an hour was considered too severe a test for the machines, and likely to end seriously for the aviators themselves. As is now well known, the wind in which Mr. Latham made his memorable flight has been variously estimated at between 28 and 40 miles per hour. The performance would also seem to disprove the hitherto accepted theory that the monoplane form of construction is more suitable for speed under calm conditions than for flying in high winds. It certainly would appear that the monoplane, if otherwise as efficient, offers a smaller surface to adverse winds than the biplane with tails and main planes boxed in. So little is known at present regarding the best form of planes for flying, that it would be unsafe to venture an opinion as to whether the bird-like formation, as in the Antoinette, or the flatter rectangular plane of the biplane is the more efficient. The question of plane area is one which enters into the argument too. The superposed planes of the Voisin, Farman, and other machines of this type no doubt give a greater supporting area than the single planes, and probably enable a machine to lift better, but it has already been shown that the area of the lifting planes beyond certain limits is more or less dependent on the speed of the machine, or, in other words, the power of the engine. At the Rheims meeting, for instance, M. Bleriot with his monoplane achieved a much higher speed, after tearing off a strip from the back edge of his planes.

Another feature which M. Levavasseur has introduced into the Antoinette is the upward slope of the planes from the body of the machine. This system of construction is claimed to give greater automatic lateral stability by the action of the balancing couple produced by the difference between the upward components of the pressure supporting the wings when the machine tends to turn out of equilibrium. In other words, the upward component tending to lift the plane decreases as that plane approaches towards the vertical, and *vice versâ*. The planes are very effectively trussed, and the ailerons, forming a prolongation of the main wing surface, are connected so that by means of a lever they can be brought into positions at right angles, one up and one down, as desired, when turning. All the rudders are at the stern, the elevating rudder being horizontal, while for turning there are two vertical rudders. The aviator's position is more comfortable than in the biplanes, and is on a level with the wings, and fairly well protected in case of collision. The vertical rudder at the rear is operated by a foot lever and cables, the elevating rudder by means of a hand wheel at the driver's side, whilst another hand wheel operates the ailerons. We alluded to the engine and system of cooling last week.

Briefly, the aeroplanes seen at Blackpool were of three main types, namely, mono, bi and triplanes. Of these the biplane was most adequately represented, the design being based more or less on Wright Brothers' machine. It may be well to give first the main characteristics of the Wright biplane. They comprise two large superimposed sustaining plates, two smaller parallel horizontal planes in a frame at the front, and pivoted to give the necessary elevating power; and two small vertical planes carried in a frame at the rear, pivoted vertically to act as a rudder. The framework and stays are made of timber, and the whole is mounted upon long wooden skates, which are curved up in front to carry the elevator planes. The petrol motor is situated near the forward edge of the lower main plane, but slightly on one side of the centre line of the machine, being balanced by the weight of the driver on the other side of the centre line. The motor drives two large two-bladed propellers in the rear by means of chains, the ratio of the sprockets being such that the propellers revolve at about 450 revolutions per minute when the engine is making 1500 revolutions. The machine is steered by two levers, one of which operates the front elevating planes and the other works the tips of the main planes, and the vertical rudder simultaneously. By altering the angle of incidence on either end of the main planes quick turning and lateral balance are combined.

The Voisin aeroplane, which, in the hands of M. Rougier, at Blackpool, showed remarkable soaring powers, has features in common with the Wright machine. It is practically a box kite with a horizontal elevating plane in front, and a vertical rudder in the open rectangular cell at the back. In reality there are five main parts, namely, the two main planes which are divided vertically into three cells; the fuselage or forward frame which carries the engine, driver's seat, and the mechanism; the rear cell, or tail, containing the vertical rudder; the main framework; and the tubular metal chassis, in which are the wheels for use in running along the earth. The main planes measure 32ft. 9in. by 6ft. 6in., and are spaced 6ft. 6in. apart. They are slightly curved in width, but are practically straight lengthwise. The front edge of the main planes dips somewhat, and the curvature to the rear edge is parabolic, imitating fairly closely a section of a bird's wing. That is to say, the top of the plane is convex and the lower surface concave. It is not clear whether the air, after striking the front edge, follows along the top and bottom surfaces, or whether it follows the concave lower surface and creates a partial vacuum above the plane. The framework of the plane is of wood, hickory being a suitable timber, and the longitudinal members are connected by a series of transverse members. The front edge is thicker, and the whole is covered with a waterproof textile material. The two main planes are identical in form, and are made rigid by means of vertical wooden stanchions, secured by metal joints and stiffened by means of wire stays. The ends are enclosed by vertical strips of canvas, and the whole is divided into three cells, of which the centre one is the largest, by means of vertical canvas partitions.

The rear cell, in which the vertical canvas rudder is placed, is similarly formed, but much smaller in size, and the distance between the rear of the forward planes and the front edge of the tail frame is about 13ft. The fuselage has a rectangular wooden framework covered with cloth, and carries at its rear end the 60 horse-power eight-cylindered E.N.V. motor, of which an illustration appeared in The Engineer, in the current volume, page 342. The cylinders are arranged in pairs, V fashion, and all the valves are actuated by one cam shaft. It is a compact and light form of engine for this class of work. To reduce weight the cylinders are turned and bored out of steel. They are 105 mm. bore by 110 mm. stroke, and the total weight is said to be less than 300—or 5 lb. per horse-power developed. The two-bladed propeller is secured directly on an extension of the crank shaft. The elevating planes at the front of the fuselage are constructed similarly to the main planes, and each measures 6ft. 6in. long by 3ft. wide. They are pivoted horizontally and their inclination is altered by means of a hand wheel and square shaft arrangement, the aviator being seated in the fuselage in front of the engine. By pushing or pulling the hand wheel the elevating plane is moved up or down, while by turning the hand wheel the rudder is moved through the medium of a flexible wire cable. The engine is started by turning the propeller by hand. It should be mentioned that the engine has copper water-jackets. Another Voisin machine at Blackpool was fitted with a 4-cylinder Itala engine.

The Farman biplane, which was flown at Blackpool by Mr. H. Farman and M. Paulhan in turns, differs from the Voisin in one or two essential features. It has two main superimposed planes without the vertical partitions. It has also a tail in which the two side walls of the cell are pivoted to form two rudders. This tail is carried by a rectangular wooden framework, but the fuselage of the Voisin is absent. Instead of this two > shaped wooden frames project out in front of the main planes and carry a hinged elevating plane which is operated by the aviator. The two main planes measure 34ft. 6in. from tip to tip. In addition to the elevating plane flaps or "ailerons" are hinged from the back edges of the main planes, and these can be manipulated by the driver to ensure lateral stability. The engine employed at Blackpool with highly successful results was a 50 horse-power Gnome, which has seven air-cooled cylinders radiating from a circular crank chamber. The crank shaft is a fixture, while the cylinders, which measure 110 mm. by 120 mm., revolve round it, carrying with them the two-bladed propeller. The axis of the whole is the crank shaft, which has a single throw, secured in bearings in the centre of the two end plates bolted to the face of the hub. In the head of each cylinder the exhaust valve is placed and is operated by a rocker arm. The induction valve, on the other hand, is in the top of the piston, the charge passing from the carburetter through the hollow crank shaft into the crank casing, and thence to the cylinders through the pistons. Lubrication is forced. The seven connecting-rods are attached to the single crank pin in an ingenious manner. There is one main connecting-rod, whose lower end terminates in two steel discs which encircle the crank pin. There are six holes arranged circumferentially through each of the two discs to receive the ends of secondary connecting-rods, and within the hollow face of each disc is a large ball bearing carrying all the connecting-rods on the crank shaft. The gudgeon pin for each connecting-rod is carried in a separate piece screwed into the head of the piston. The total weight of this engine is about 165 lb., or less than 3½ lb. per horse-power. For aerial purposes this system of air-cooled cylinders seems to answer all requirements, as there was no apparent falling off in power of the motor when Mr. Farman made a non-stop flight of over 47 miles with his aeroplane the other day.

The engine is situated on a suitable frame and attached to the centre of the lower plane. The driver's position is not altogether comfortable. It is in front of the engine and about the front of the lower plane. The steel tubular chassis, unlike those on some of the aeroplanes, allows a good wide wheel base, and provides a combination of skates and wheels. The tail is prevented from touching the earth by means of a couple of small wheels in a suitable frame.

In Mr. A. V. Roe's triplane there are three superimposed main planes, each measuring 20ft. long and 3ft. 7in. wide. A light V-shaped frame or body connects these planes with a tail 10ft. wide and the same depth as the main planes. The planes are 3ft. 2in. apart, and the overall length 23ft., the total surface being 320 square feet. The main planes are mounted on a two-wheeled steel chassis, and a 10 horse-power J.A.P. two-cylinder engine is fitted in the longitudinal frame below the intermediate main plane. This engine drives a four-bladed wooden propeller by a chain at a reduced speed. The chief features of novelty of this aeroplane are the method of bracing and warping the main planes to control the vertical and side movements. The warping of the main planes is effected by levers and rods without cords or wires, and necessitates very light stanchions. The rear vertical rudder is moved by a rotary movement of the wheel. It is early to write of the prospects of this type of construction, as the machine, which made several ineffectual attempts at flight at Blackpool, is obviously under-powered, while the position, form, and speed of the propeller seem to require alteration. The framing, too, seems much too light for practical work.

Among the monoplanes, in addition to the well-known continental types, namely, the Blériot and the Antoinette, two or three new designs were exhibited, one by Mr. A. E. Creese, of East Dulwich, weighing 4¾ cwt., has a plane area of 160 square feet, the motive power for a two-bladed tractor screw being provided by an Anzani 30 horse-power three-cylinder engine, having cylinders 105 mm. by 130 mm., weighing 130 lb., and giving its power at 1500 revolutions per minute. The frame of the machine is of ash, the chief members being bored out hollow. In addition to the main planes the machine has a rear fixed plane and steering planes at the stern. The main planes are fitted with ailerons. The chassis on which the machine is mounted is of original design, the chief tubular members being provided with air-cushioned plungers to soften the shock to the machine in alighting. Another aeroplane of English construction, called the Neale, has a plane area of 140 square feet without the flappers. This has a 10 horse-power J.A.P. engine, driving a tractor screw 7ft. diameter by 6ft. pitch through spur-reducing gearing. When the engine is running at 2000 revolutions the screw makes 580 revolutions per minute. At this speed we are informed that a thrust of 57 lb. is exerted. The rudder is of sail cloth pivoted vertically on the main canvas tail plane, and measures 4ft. by 1ft., while elevating planes are pivoted horizontally at the tail. A peculiar feature of this aeroplane is the position of the driver's seat. This is suspended beneath the main frame, obviously with the object of lowering the centre of gravity. The whole machine weighs 400 lb., and although it resembles the monoplane in front elevation is really a triplane.

Mr. Saunderson, of Bedford, had a monoplane constructed according to his own ideas, and weighing 600 lb. The engine also is of his own construction, and exceptionally heavy for this class of work. It has three air-cooled cylinders arranged fan fashion, and gives about 30 horse-power, but its weight is 300 lb. It drives a tractor propeller direct. The framework is built up of bamboo canes united together by aluminium castings. The framework and chassis give the impression of offering too much resistance to the air. In fact, without wishing in any way to disparage British inventiveness, it must be admitted that the Englishmen would have been well advised if they had carried out more experiments before putting in appearance against the experts from the Continent. In their anxiety to come before the public as aeronautical experts they have brought upon themselves ridicule, and they would do well before entering such competitions in the future to "take a line" from the continental aeroplanes.

Owing entirely to the bad weather there will be a financial loss, which, has, however, been more than repaid by the immense influx of visitors to Blackpool and the district around. The prizes awarded in the several competitions were as follows:—(1) Blackpool Grand Prize for longest distance: First (£2000), Farman, who flew 47 miles 1184 yards; second (£720), Rougier; third (£280), Paulhan. (2) General Merit Prize (£300): Latham. (3) Speed Prize: First (£400), Farman; second (£100), Paulhan. (4) The *Manchester Guardian* Cup and £100 for slowest circuit: Latham. The prize of £50 for competitors' assistants was won by Rougier's men.

OBITUARY.

RICHARD LAYBOURNE.

One of the veterans of the industries of Newport, Mon., Mr. Laybourne, died at Malpas on Monday, in his eighty-fifth year. He was the second son of Jacob Laybourne, of Nafferton Lodge, East Yorkshire, and beginning life as an engineer, served his apprenticeship at the Hareshaw Ironworks, Northumberland. In 1847 he was employed at Wilson and Co.'s railway foundry, Leeds; first in the shops and subsequently as chief draughtsman. In the latter capacity he visited Hanover to inspect the railway, and designed engines for the Hanoverian Government. In 1852 he was appointed assistant locomotive engineer to the London and North-Western Railway at Wolverton. Two years later he settled in Monmouthshire as locomotive and carriage and wagon superintendent for the Monmouthshire Railway Company. In 1855 he introduced the cast iron brake block in place of wood. Having served the Monmouthshire Railway for fourteen years, he was appointed general manager of the Rhymney Iron Company, and designed and erected Bessemer steel works and plant capable of producing 1000 tons per week. He filled with credit several local offices, and in 1878 he became identified with the management of the Isca Foundry and Engineering Company at Newport. Here, again, he took an active part in local and colliery management, and in 1894 he was High Sheriff of Monmouthshire. He was a prominent member of the Institute of Civil Engineers and a Past-president of the South Wales Institute of Engineers. He had travelled extensively in France, Spain, Germany, in Canada, and the United States, and was unusually well informed, and one of the most urbane and interesting of men. In the management of the Isca foundry he is succeeded by his son.

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* No. I. appeared October 22nd.

6000-KILOWATT TURBO-ALTERNATOR.

THE Manchester Corporation have just installed in their power station a second steam turbine set of which we are enabled to give illustrations on this and on page 452. The turbine is of the Howden-Zoelly pattern, built by James Howden and Co., Limited, Glasgow. It is designed on the multi-stage impulse principle, and comprises a cast iron cylindrical casing divided along the horizontal centre line and containing fixed guide wheels. These are in halves and arranged so that their upper portions can be easily removed along with the upper portion of the casing. The expansion of the steam takes place entirely in the guide blades fixed in the stationary diaphragms, no expansion taking place in the rotating vanes, so that the steam pressures on the entrance and exit sides of the wheels are about the same. This reduces endwise thrust and necessitates no special means of balancing. The rotors are made of forged Siemens-Martin steel, machined and polished all over. The blades are of 5 per cent. nickel steel, and they are securely held by a special attachment, with the exception of a few discs in the high-pressure stages where the blades are short, taken from the root to the tip. Distance pieces cunningly shaped by milling cutters are placed between each pair of blades, and the whole is secured by a ring piece secured to the main wheel by rivets. The wheels are accurately balanced, and the radial clearance at the tips of the blades is 5 mm. The shaft is bored throughout its length, and where it passes through the turbine casing is fitted with stuffing-boxes and packings which are readily accessible for examination and adjustment when required.

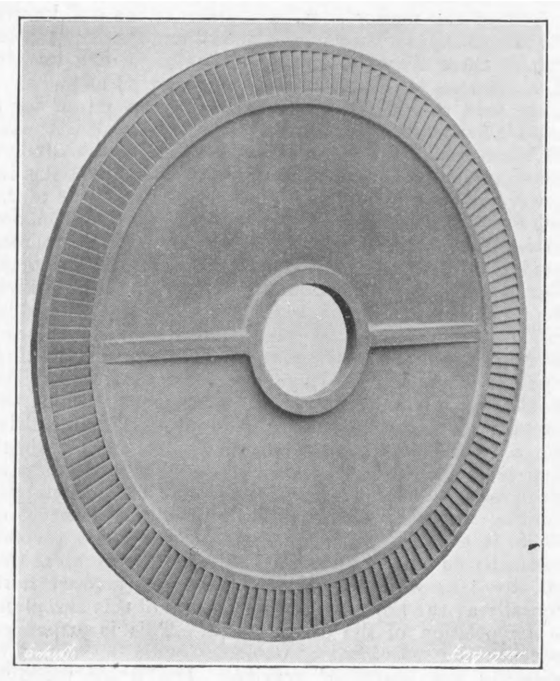


Fig. 1—GUIDE WHEEL OF L.P. STAGE

As will be observed from the illustrations, the bearings are independent of the turbine casing, and are thus unaffected by the high temperature due to the steam. They are of great length and are lubricated with oil under pressure, supplied from a rotary pump driven from the governor shaft. The bed-plate is of box section, provided with flanges and bolt holes for coupling to the generator bed-plate. The governor end of the bed-plate forms an oil reservoir and settling tank, a series of tubes with cold water circulation being provided inside the tank to keep the oil at a suitable temperature. The thrust block is fixed in the main bearing block at the low-pressure end, and consists of a number of collars turned on the turbine shaft working in white metal-lined grooves in the bush of the main bearing. The governing is on the servo-motor principle. A centrifugal governor driven by spiral gearing from the turbine shaft actuates a controlling valve, which in turn regulates a supply of oil under pressure to a piston, the latter being in direct communication with the throttle valve. The governor itself is thus relieved of the stress due to actuating the heavy throttle valve. The pressure of oil is supplied by a positive action valveless pump contained in the same chamber as the pump which furnishes the lubricant for the bearings. For the governor gear the oil pressure is 80 lb. per square inch. By these means the variation of the speed of the rotor between full and no loads is approximately 1 per cent., and under no circumstances of load variation is there any tendency to hunt.

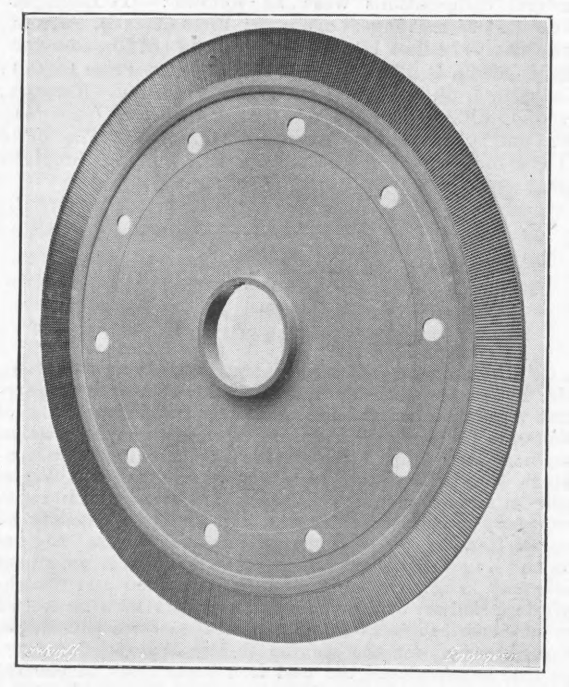


Fig. 2—RUNNING WHEEL OF L.P. STAGE

A speed-regulating gear is fitted to the throttle valve, which is actuated either by hand or by the small electric motor shown in the general view of the machine. The governor, we are informed, has proved exceptionally sensitive when the set is working in parallel with the other set, and its sensitiveness has had a beneficial effect on the station voltage. The speed of the machine is 1000 revolutions per minute. A supplementary governor is provided, which shuts down the supply of steam should the speed rise to 10 per cent. above the normal. This governor acts by means of a trip gear, and enables the main stop valve to be instantly closed by a powerful spring, the impact of the valve on its seating being cushioned by an air piston. This piston is contained in a cylinder shown at the extreme right hand of the illustration. A noteworthy feature in the running so far has been the very slight leakage of air into the turbine casing through the glands, thus facilitating the maintenance of a high vacuum even when using high temperature of circulating water.

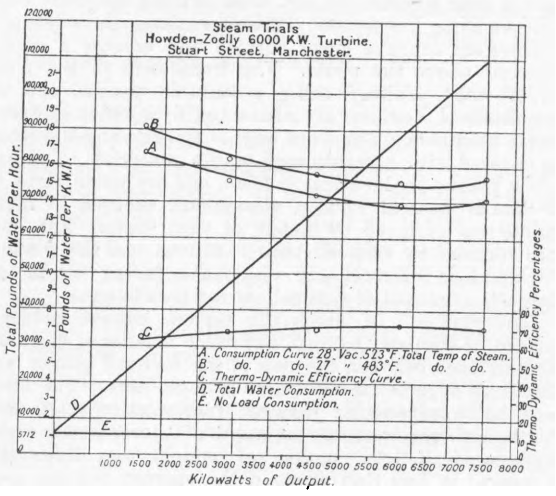


Fig. 3—TEST CURVES

The machine drives a Siemens three-phase 50-cycle alternator with six poles, the mean voltage being 6500. The turbine and generator are connected by a geared flexible coupling. The alternator is ventilated by a fan, which draws air by means of a duct through a special filtering arrangement situated in a chamber outside. Twenty-one thousand cubic feet of air per minute are delivered at a pressure of 2½in. of water to the rotor, returning through the stator frame to another duct, which carries it out of the building. The condensing plant has been supplied by Richardsons, Westgarth and Co., Limited, and consists of a Contraflo condenser with a surface of 10,500 square feet. There is one set of electrically driven three-throw Edwards air pumps. The water has a static head of 30ft., and is drawn, and not forced, through the condenser, the pump being attached to the discharge pipe.

By the courtesy of Mr. S. L. Pearce, the Chief Engineer to the Manchester Corporation, we are enabled to append the tabulated results of the steam consumption trials recently carried out at Stuart-street station, together with a plotted curve, Fig. 3. The figures show high efficiencies at light loads.

HOWDEN (ZOELLY) SIEMENS 6000 K.W. TURBO-ALTERNATOR.

Summary of Steam Consumptions, &c.

In lb. per K.W.H., measured at alternator terminals, excluding auxiliaries.

Col. I.—Howden's guarantee with 27in. vacuum. Total steam temperature, 523 deg. Fah. (140 deg. Fah. superheat). Barometer, 30in.
Col. II.—Howden's guarantee corrected to 28in. vacuum. Total steam temperature, 523 deg. Fah. (140 deg. Fah. superheat). Barometer, 30in.
Col. III.—Actual test results with 27in. vacuum. Total steam temperature, 514/532 deg. Fah. Barometer, 30in.
Col. IV.—Actual test results corrected to 28in. vacuum. Total steam temperature, 514/532 deg. Fah. Barometer, 30in.
Col. V.—Results of Col. IV. corrected for a total steam temperature of 523 deg. Fah. (140 deg. Fah. superheat). Barometer 30in.
Col. VI.—Results of Col. III. corrected for a total steam temperature of 483 deg. Fah. (100 deg. Fah. superheat). Barometer, 30in.
Col. VII.—Alternator efficiencies.
Col. VIII.—Thermo dynamic efficiencies.

	Col. I.	II.	III.	IV.	V.	VI.	VII.	VIII.
							p.c.	p.c.
Overload, 25 p.c. ..	15.1	14.4	14.9	14.2	14.1	15.3	96.4	70
Full load	14.4	13.7	14.6	13.9	13.8	15.0	96.2	71.5
¾ load..	15.4	14.6	15.0	14.3	14.4	15.6	95.1	69.4
⅓ load..	16.7	15.9	15.9	15.1	15.2	16.4	93	67.8
¼ load..	19.8	18.8	17.5	16.7	16.7	18.1	87.5	64.5

HOWDEN-SIEMENS 6000 K.W. TURBO-ALTERNATOR, STUART-STREET.

Percentages, Thermodynamic Efficiencies.

	Col. I. Zoelly entropy chart Mr. Todd.	Col. II. Zoelly entropy chart. Howden and Co.	Col. III. M.C.E.W. figures, Stoney's basis.	Col. IV. Col. III. corrected for alternator efficiencies.
Overload, 25 p.c.	68.3	68.7	67.5	70.0
Full load	69.5	71.0	69.2	71.5
load..	66.9	66.5	66.25	69.4
½ load..	61.5	65.3	63.3	67.8
¼ load..	56.7	63.3	56.8	64.5

The following results were obtained with tests at various loads:—

Load. K W.	Duration of test. hrs.	Water per kilowatt-hour.	Mean efficiency. per cent.
7500	3	14.916	70.0
6000	6	14.598	71·5
4500	3	15.04	69.4
3000	3	15.927	67.8
1500	3	17.57	64.5

The details of the tests in which these results were obtained are set out in the following table, which contains a large amount of interesting data :—

HOWDEN-SIEMENS TURBO ALTERNATOR.

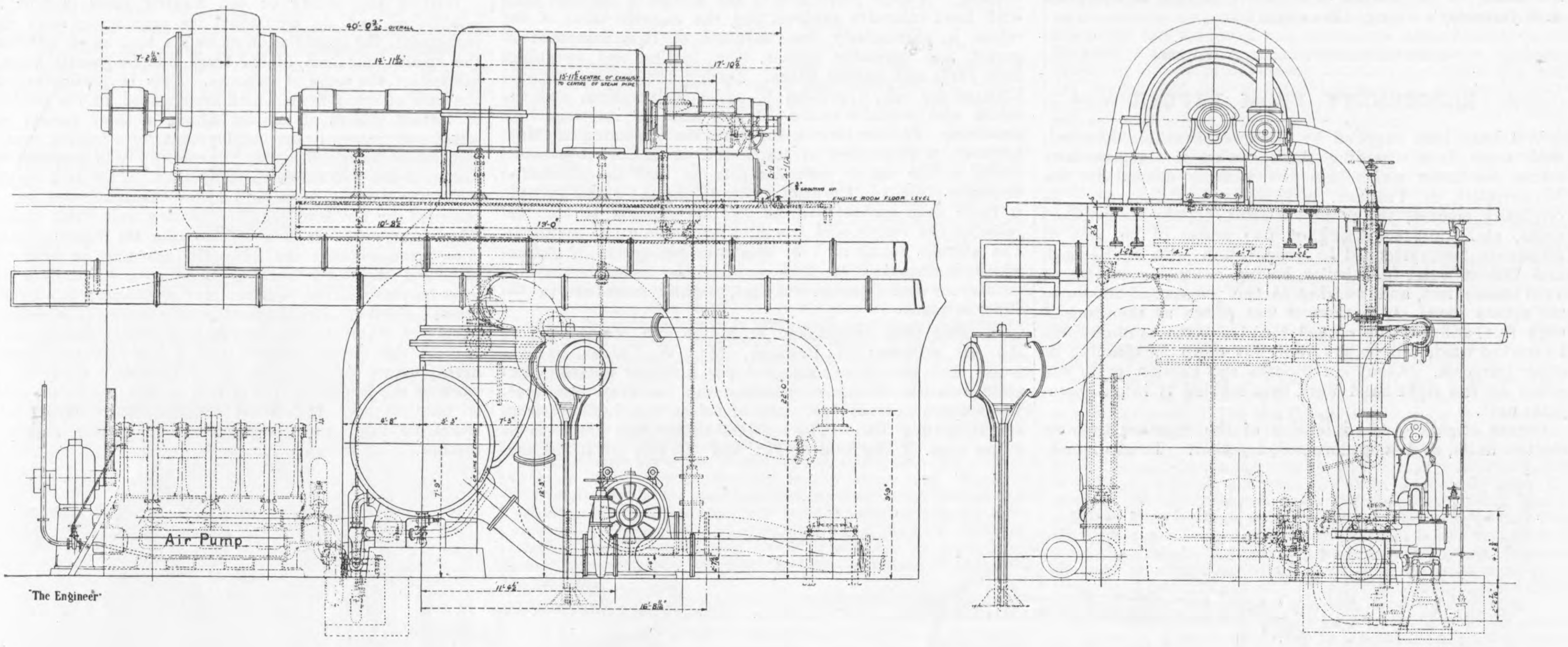
Summary of Tests.

		3 hours. 7500 K.W.	6 hours. 6000 K.W.	3 hours. 4500 K.W.	3 hours 3000 K.W.	3 hours. 1500 K.W.
	TURBINE.					
1	Mean steam pressure at stop valve, lb.	184.5	188	188.7	189	189
2	,, ,, temperature at stop valve, deg. Fah.	514	520.2	532	521	524
3	,, ,, pressure at steam chest, lb.	167·5	141.8	94.5	65.5	30
4	,, superheat, deg. Fah.	132.7	137.2	149	138	141
5	,, temperature at exhaust, deg. Fah.	109.7	107.6	99	97.3	88
6	,, vacuum, in inches of mercury	27.26	26.73	27.8	27.81	28.25
7	,, barometer, in inches of mercury	29.7	29.32	29.7	29.7	29.5
8	,, vacuum corrected to 30in. barometer, in inches of mercury	27.56	27.41	28.1	28.11	28.75
	CONDENSER.					
9	Mean circulating pump, inlet, deg. Fah.	75.8	76.5	74.7	80	75.1
10	,, ,, ,, outlet, deg. Fah.	97	95.5	90.5	90	81
11	,, air pump discharge, deg. Fah.	91	91.5	89.5	91.5	83.8
12	,, current—circulating pump, amp.	540	500	490	500	500
13	,, ,, —air pump, amp.	35	33	33	32	32
14	,, ,, —hot well pump, amp.	20	19.5	18.25	18	17
	GENERATOR.					
15	Mean voltage	6,470	6,445	6,450	6,450	6,400
16	,, current—phase 1, amp.	668	573	452	360	156
17	,, ,, ,, 2, amp.	668	576	452	360	156
18	,, ,, ,, 3, amp.	688	590	465	370	156
19	,, idle current, amp.	0	162	193	158	35
20	,, power factor (from int. wattmeter)	1.0	.97	.885	.77	.91
20a	,, ,, ,, (from Items 17 and 19)	1.0	.96	.905	.9	.975
21	,, indicated kilowatts	7,490	6,380	4,515	3,100	1,560
22	,, air to alternator—inlet, deg. Fah.	63	64	60.5	59.5	61
23	,, ,, ,, —outlet, deg. Fah.	129.7	128.5	120	119	113.5
24	,, ,, ,, —pressure, in.	2.57	2.5	2.4	2.4	2.4
25	,, ,, ,, —motor amp.	51	48	43	42	42
26	,, field current, amp.	109	—	119	111	86.5
	KILOWATTS USED ON AUXILIARIES.					
27	Condenser pumps, K.W.	360	376.2	356.6	333.3	346.6
28	Alternator—fan motor, K.W.	21.4		18	16.8	18.1
29	,, —field excitation, K.W.	22.9	25.6	25	23.3	18.2
30	Total	404.3	401.8	399.6	373.4	382.9
31	Total weight of water registered on "Lea" recorder (condensate + spray water), lb.	395,800	679,260	257,815	212,425	150,876
32	Total weight of water per hour, lb.	131,933.3	113,210	85,938.3	70,808	50,292
33	Spray water per hour—from water meter, lb.	22,833	—	21,000	22,233	22,500
34	,, ,, ,, —deduct 1 per cent. correction, lb.	228	—	210	222	225
35	,, ,, ,, —difference	22,605	21,900	20,790	22,011	22,275
36	Total water from hotwell (No. 32 less No. 35), lb.	109,328.3	—	65,148.3	48,797	28,017
37	,, kilowatt hours generated	22,600	38,300	13,700	9,700	5,200
38	,, ,, ,, per hour	7,533.3	6,383.3	4,566.6	3,222.3	1,733.3
39	Water per kilowatt hour per hour (No. 36 ÷ 38), lb.	14.51	14.305	14.26	15.09	16.16
40	Correction for barometer add	.28	2.05	5.5	5.55	8.75
41	Item 39 + Item 40, lb.	14.916	14.598	15.04	15.927	17.57
42	Thermodynamic efficiency, B.Th.U.	338.7	337.6	343.8	338.3	342.7
43	Efficiency, per cent.	67.5	69.2	66.25	63.3	56.8
44	Allowing for alternator efficiency, per cent.	70	71.5	69.4	67.8	64.5

In an open circuit trial of ¾ hour's duration with full excitation the following figures were registered :—

	TURBINE.	
1	Mean steam pressure at stop valve,	186 lb.
2	,, ,, temperature..	494 deg. Fah.
3	,, ,, pressure at steam chest	4 lb.
4	,, superheat	115 deg. Fah.
5	,, temperature at exhaust	113 ,,
6	,, vacuum	26.65 in. Hg.
7	,, barometer	29.55 ,,
8	,, vacuum, corrected to 30in. barometer	27.1 ,,
	ALTERNATOR.	
9	Mean voltage	6500 volts
10	,, field current	82 amps.
	KILOWATTS USED ON AUXILIARIES.	
11	Condenser pumps	320 K.W.
12	Alternator—fan motor	18·1 ,,
13	,, —field excitation	17.2 ,,
14	Total	355.3 ,,
15	Total weight of water registered on "Lea" recorder (condensate + spray water)	19,608 lb.
16	Total weight of water per hour	26,144 ,,
17	Spray water per hour—from water meter..	20,666 ,,
18	,, ,, ,, —less 1 per cent. correction	206 ,,
19	,, ,, ,, —difference	20,460 ,,
20	Water from hotwell per hour (No. 16 less 19	5,684 ,,

6000-KILOWATT TURBO-ALTERNATOR



'The Engineer'

Swain Sc.

This figure of 5684 when corrected for a vacuum of 27.0 instead of 27.1 gives the amount of water from the hot well under guarantee conditions as 5712 lb. The rise in temperature after a six hours' full load test at 6000 kilowatts was 72 deg. Fah. in both stator and rotor.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND.

THE first general meeting of the fifty-third session of the Institution of Engineers and Shipbuilders in Scotland was held in the large Lecture Hall of the Institution, Elmbank-crescent, Glasgow, on the 26th inst., when the new President, Mr. C. P. Hogg, M. Inst. C.E., occupied the chair, after being formally inducted by Mr. James Gilchrist, in the unavoidable absence of Mr. John Ward, the retiring president.

After some routine business, and the formal admission of a number of new members, the report of the Council for session 1908-09 was submitted and approved. The report states that during the past session the Institution has made satisfactory progress both from a numerical and financial point of view. The additions to the roll include 67 members, 28 associate members, 17 associates, and 40 students; while 6 associate members and 4 students passed into the members' section, and 11 students were transferred to the class of associate members. On account of deaths, resignations, and deletions, the membership was decreased by 102, thus leaving a net increase of 50 on the roll; the full strength of which is 1650. During the session the number of day students attending the Glasgow and West of Scotland Technical College was 487, and of evening students 4502. As regards the engineering side of the college work, the report states that the most interesting development was the adoption of a scheme for enabling apprentices to attend the college during the winter session, returning to the works during the summer. Seventy-six engineering and shipbuilding firms in the district expressed their willingness to allow selected apprentices facilities for carrying out a scheme of college study conjointly with practical work, and some of the firms agreed to recognise wholly or partially the time spent in college as part of the apprenticeship period, contingent upon satisfactory reports in each case being received. Another important change was the reorganisation of the examination system hitherto in force. This change consisted in the abolition of special final examinations, and a student's position each session will be determined by the examiners after a review of his whole work for that, and if need be, for the previous sessions. This review will take account of examinations, drawings, practical work as shown by laboratory books, and other class work. Part of the work for the final year will be the preparation of a design, the composition of a thesis, or the like, done, not under examination conditions, but as nearly as possible under those which obtain in every-day professional life. Adequate tests of progress and proficiency will thus be made without giving to examination results a preponderating importance. The arrangements made with the School Board of Glasgow and other continuation class authorities for the organisation of the work leading to the college continued to work very satisfactorily. The number of centres at which affiliated classes were held last session was thirty-four. These classes were scattered over an area which included Greenock, Stirling, Alloa, and Kilmarnock. The treasurer's statement, which is appended to the report, shows that the surplus revenue for the session ended September 30th is £484.

The President in his address briefly reviewed some of the outstanding developments in engineering science and practice during the last hundred years or so, and directed attention to some of the pressing problems of the future. There were, he said, two great demands on the engineer of the present day —one to give cheap transport for goods, and the other rapid transit for passengers. It was not until the latter half of the eighteenth century that there was any attempt in this country to provide canals for inland transport. After the advent of railways the use of canals decreased to some extent, and under stress of competition not a few of them passed under the control of railway companies. Industrial competition with the nations of the world had forced attention to the necessity of reducing to a minimum the carriage of both raw material and manufactured goods. The Royal Commission appointed in 1906—with Lord Shuttleworth as chairman—to inquire into the canals and inland navigation of the United Kingdom had been much impressed by the canal systems on the Continent, and it would be surprising if the report to be issued shortly did not recommend great improvements in the existing canals of this country, through routes and rates, and better communication with the leading shipping ports. The nationalisation of canals was a far more urgent problem awaiting solution than the nationalisation of railways. A Government system of canals, open to all traders on payment of fixed tolls, would do much to revive many of this country's flagging industries. After referring to the Suez Canal, the Manchester Ship Canal, the ship canal being constructed across the Isthmus of Panama, and to the scepticism with which the first-named was at first regarded by many, Mr. Hogg proceeded to refer to the various schemes proposed for a ship canal between the Forth and the Clyde. If the Government, he said, should resolve to grant a subsidy for the construction of such a canal it would appear to be the better policy to support the scheme which would afford the greatest benefit to the industries of the country.

Of notable successes achieved by engineers in the improvement of waterways Mr. Hogg instanced the Clyde as perhaps the most remarkable of all, and gave facts and figures illustrating the development and present importance of the river and the harbour of Glasgow. Referring to the existing dock accommodation, he said that the continued increase in the size of ships demanded still greater facilities for dry-docking, and the Clyde Trust had at present under consideration the desirability of providing a much larger graving dock than the largest at present existing. Whether the Government should assist in the construction of graving docks, capable of accommodating the largest class of battleships, was a question now receiving close attention. Mr. Hogg then traced briefly the development in steam navigation and the size and power of ships from the Comet downwards to the Lusitania, and said that since the day of Brunel and Scott Russell, who, with the Great Eastern, had taken too big a step in advance, as many other men with big ideas had done, the naval architect had progressed gradually, until now the available depth of water in various ports seemed to be the limiting factor in design and construction.

Proceeding to speak of railways and tramways, Mr. Hogg said that it was computed that there existed in the world to-day upwards of half a million miles of railways—a length sufficient to put a girdle twenty times round the earth. All had been constructed within the last 100 years, and the greater portion within the last 50 years. What this half a million miles of railways meant in the industrial development of the world might be better conceived if a few statistics were given from the Board of Trade Report on Railways in the United Kingdom for the year 1908. The paid up capital on the railway companies, excluding nominal additions due to consolidations and conversions, is 1114 million pounds. The total length of the railways is 23,205 miles, of which 12,926 miles are double line or more. The following table sets out the receipts and net earnings:—

	£
Receipts:—	
Passenger traffic	51,664,000
Goods traffic	58,888,000
Miscellaneous	9,342,000
Total	£119,894,000
Working expenditure..	76,408,000
Net earnings	£43,486,000

The net earnings average a modest dividend of about $3\frac{1}{3}$ per cent. on the total paid up capital.

The supersession of that very efficient machine—the steam locomotive—is still a long way off. Electric traction has practically captured the whole of the tramway traffic, for for which it was admirably adapted; but its adoption on railways had been very slow. There were, however, in the United Kingdom 200 miles—single track—of railways partly worked by electric traction, and 204 miles—single track—solely worked by electric traction, the latter chiefly on the tube railways of London. There were 88 electric locomotives in this country, 52 of which were on the City and South of London Railway, the pioneer railway of its kind. Electric traction on railways was making much greater progress abroad, where, partly owing to hydro-electric installations, and partly owing to fewer legal restrictions on high-voltage lines, it operated under more favourable conditions. The first street tramway in this country was laid down in 1860 at Birkenhead. The form of rail first adopted—the step rail—was much against the development of tramways, and practically the whole system had been constructed within the last thirty or forty years. In the United Kingdom in 1908, when steam had given place to electricity, there were 2464 miles of tramways in operation. Electric traction on tramways at the present time had nearly ousted all other forms. Of the 2464 miles of tramways 2286 miles were, he said, electric, 52 miles were steam, 28 miles were cable, 4 miles were gas-motor, and 94 miles were horse traction.

During the last thirty-six years progress in electrical work had probably been greater than in any other branch of engineering. Central power stations and hydro-electric installations had brought down the cost per Board of Trade unit, and improvements in long-distance transmission had contributed to the development of many industries. Electric motor driving for engineering workshops had many advantages, and it was being applied even to steel rolling mills. The electric furnace, too, was coming to the help of the metallurgist, and quite recently a hydro-electric power plant had been constructed to manufacture nitrates from atmospheric nitrogen. Coal was mined in this country to the extent of 270 million tons per annum, of which 63 million tons were exported to other countries. In view of the probable exhaustion of coal —possibly in the near future—it behoved engineers to make the most of hydro-electric installations and other methods of obtaining energy. In matters of this kind the physicist was the true pioneer and the engineer a humble follower.

After reference to the progress in methods of construction connected with bridges, tunnels, dock and quay walls, Mr. Hogg stated that steel was superior to wrought iron in almost every respect, and it was gradually displacing it for many purposes, although it was more liable to corrosion. Metallurgists could produce a rustless steel—nickel steel—which had greater elasticity and tensile strength than ordinary mild steel, but the price per ton was still prohibitive for all but the highest class of work. How to make a rustless steel at a moderate price was one of the problems of the future. Of all the changes in the methods of construction within the province of the civil engineers, in recent years none had been more prominently advocated than the use of reinforced concrete. Various systems of reinforcement were in use, and much ingenuity had been expended on designs for structures of every kind, even for water pipes under pressure in place of cast iron pipes. It was specially well suited for wharves and buildings of the warehouse class, and it had been adopted for bridges under favourable conditions, but, unfortunately, there was a disposition to advocate its use under all conceivable circumstances, which, in the end, could only retard its more general adoption. It demanded, he said, more than ordinary care in its construction, because any exposure of the steel reinforcement must inevitably lead to corrosion and ultimate loss of strength.

Looking back on achievements in engineering and shipbuilding within the last hundred years, it must be owned that the probabilities were against another such era as that century of marvel—the nineteenth. An honest appreciation of the facts compelled the view that the curve of progress was no longer the soaring graph of some decades back. The engineer of to-day was probably more imbued with the spirit that makes for advance than any of his predecessors had been, but they had had the inestimable advantage of finding themselves practically upon virgin soil. The sphere of the engineer of to-day was largely to expand ideas already formulated and to improve existing types. The nineteenth century demonstrated how to utilise the great forces of Nature; the problem of the twentieth would largely be how to do so most efficiently. There was a definite limit to efficiency—100 per cent.—and it was only in the initial stages of development that the brilliant advantages of last century were possible. Marvels of scientific development in the branch of engineering concerned with telegraphy would, no doubt, be achieved in days to come, but could any conceivable advance compare with the stride constituted by the essential invention itself? Even the introduction of wireless telegraphy, marvellous as it was and useful as it had proved itself, seemed but a trifling refinement when one thought of the revolution in life and thought wrought by the first fruits of the parent idea. In all this there was intended no suggestion of laying down our arms. There were still scientific worlds to conquer. and it had only been endeavoured to indicate that those left were in the inevitable nature of things difficult of conquest, and capable only of being subdued by degrees. Aviation, the storage of electricity, the utilisation of the solar rays for power, the fixation of nitrogen, all these suggested lines of possible achievement, and, indeed, no aspirant need be without a fruitful field to work in. But to-day's work was necessarily of the nature of intensive culture as compared with yesterday's tilling of the virgin soil.

ELECTRICITY FROM REFUSE.

WE have been supplied by Meldrum Brothers, Limited, with some data regarding the operation of a regenerative refuse destructor which this firm recently erected for the Municipality of Prahran, a suburb of Melbourne. As originally erected, the plant consisted of two independent units, each unit consisting of two grates of an area of 50 square feet, arranged in conjunction with a Babcock and Wilcox water-tube boiler, having a heating surface of 1426 square feet, and working at the pressure of 200 lb. to the square inch. A regenerator was placed at the back of each flue, and was so arranged that the furnaces might still be worked when the boilers were shut down for cleaning or other purposes. About six months ago another grate was added to the right-hand unit, thus making it into a three-grate unit.

It was originally the intention of the engineer to work the two units, as first constructed, together. It was found, however, that the capacity of the plant was such that one unit would deal with the whole of the refuse in two shifts, and wishing to dispose of it in a single shift, the above-mentioned extension was made, an offal-charging hearth being also added at the same side. The whole of the refuse is now being dealt with in one unit, namely, the three-grate unit, and a continuous high temperature obtained, with consequent steadier steaming.

The regenerator consists of a number of cast iron tubes, so arranged that the hot gases of combustion, after traversing through the boilers in the usual manner, pass through these, thus heating the air for combustion which is drawn in round the exterior of the tubes. It is then passed through the air conduit to the blowers, having been heated to a temperature of 250 to 350 deg. Fah. The regenerator also acts as a dust catcher, since the gases are divided up into a number of small streams in their passage through the tubes, and the fine dust is deposited in the chamber beneath.

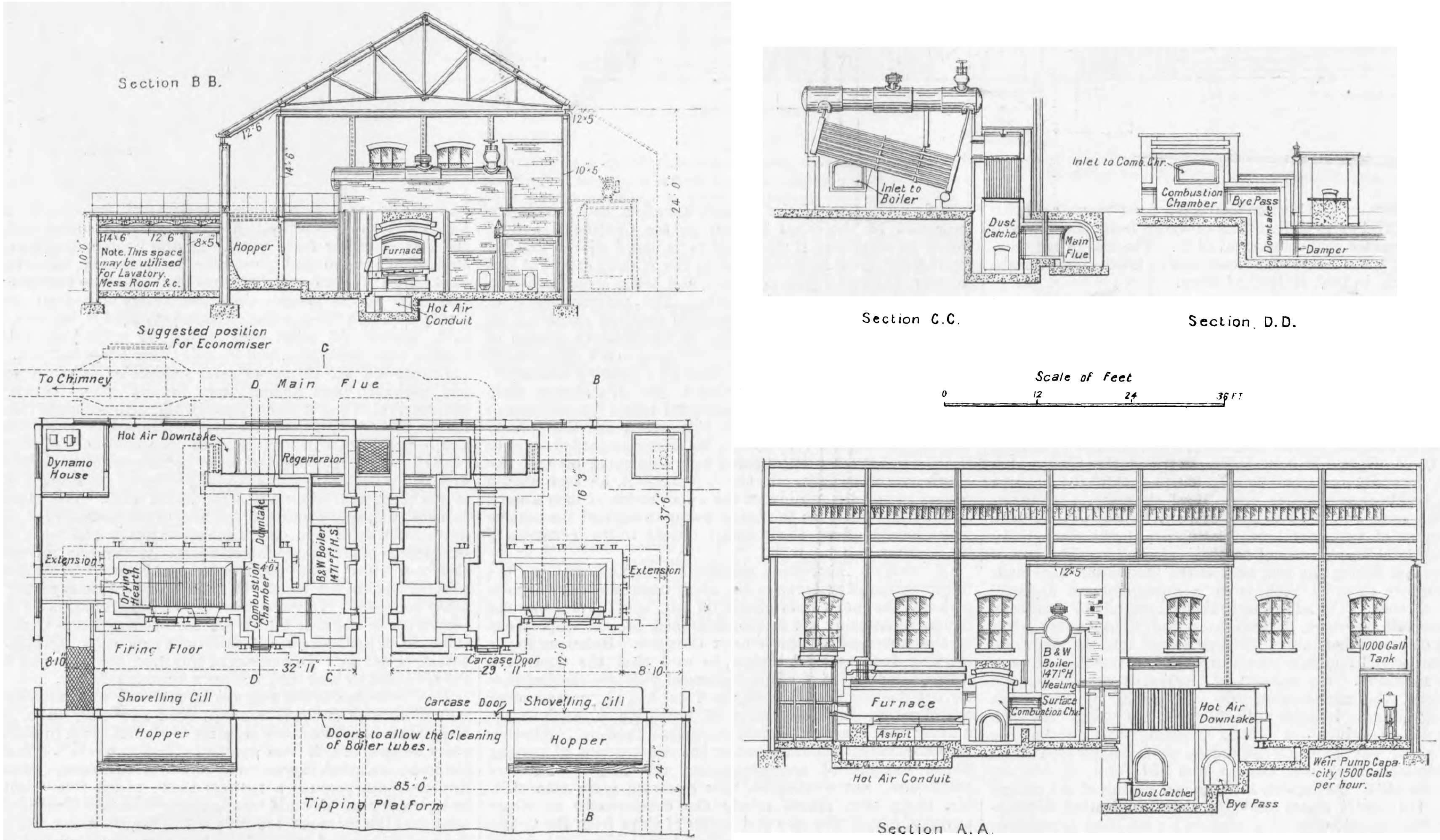
The forced draught consists of Meldrum steam jet blowers, which force the air previously heated in the regenerator into each enclosed ashpit compartment. One grate is cleaned and charged while the others are in an incandescent state, and it is stated that as the gases must commingle in the furnaces and the combustion chambers, which are also subject to the radiant heat of the incandescent brickwork, complete immunity from noxious chimney emanation is obtained.

A drawing showing the arrangement of the plant is given above, and we have been provided with the table below showing the amount of refuse burnt and the quantity of electricity produced during last July.

The power plant at first consisted of a high-speed direct coupled engine and dynamo for lighting the works yard, &c., and also included a mortar mill, clinker crusher, and grading machine, driven by a 25 horse-power engine. Since this plant was put down, additional plant, which consists of a 125-kilowatt generator direct coupled to a 186 horse-power Allen engine and Rowe's feed-water heater, has been installed by a Melbourne firm. Arrangements have now been entered into with the Electric Lighting and Traction Company for the sale of electrical energy at ½d. per Board of Trade unit, and it is expected that 300,000 units will be generated in twelve months, which at the above price will produce £625 per annum.

A few words regarding the refuse itself may not be out of place. It is removed bi-weekly, and varies in quantity from 20 to 30 tons per day, the average throughout the year being 26 tons per day. All the material, both public and private, is passed over a weighbridge and the weights recorded before burning. A large proportion of the houses in the area dealt with have extensive gardens, and the calorific value of the refuse is particularly low, as much of it is composed of garden and vegetable matter, tins, bottles, and sweepings from yards and garden paths. During the summer months little or no ash is present to assist incineration, and the refuse also contains some 40 per cent. of its weight in moisture. For the six months from the beginning of May, however, a proportion of cinder and small coal is present, owing to the use of domestic fires, so that the additional moisture present in the atmosphere during the winter months is more than counterbalanced by this addition to the fuel value of the refuse, and the fires are more easily managed. The average result of 1 lb. of steam per pound of refuse, which is regarded as more or less the standard in this country, is also obtained—in fact, slightly exceeded—in the Prahran plant.

In some tests undertaken in March and May, 1908, by the city engineer of Prahran, Mr. W. Calder, it was found that the refuse consumed per hour per square foot of grate area was 85 lb.—or nearly a ton per grate per hour. The water evaporated per 1 lb. of refuse was 1.055 lb. from and at 212 deg. Fah. The residual clinker was found to be 28 per cent. of the total weight, and the soft ash in the ash-pits 3.6 per cent. Under ordinary circumstances no extra fuel is necessary except for re-lighting the fires when the plant has been closed down, and the furnaces cooled. The fuel then employed is coke breeze.



REFUSE DESTRUCTOR AT PRAHRAN, NEAR MELBOURNE

Table showing the Quantity of Refuse Burnt and the Amount of Electricity Generated at the Prahran Refuse Destructor during the Month of July, 1909.

Date, July, 1909.	Weight.				Time.	Units gen.	Units per hour.	Units per ton.
1st	21	19	0	0	8.10	930	113.83	42.36
2nd	23	7	2	0	8.25	860	102.17	36.79
3rd	15	15	3	14	5.50	640	108.54	40.50
5th	34	14	1	0	12.20	1,340	108.65	38.60
6th	28	12	3	21	10.10	1,150	113.11	40.16
7th	24	1	2	14	9.25	1,120	118.95	46.51
8th	23	8	2	0	7.55	940	118.73	40.13
9th	23	16	0	14	8.35	1,000	116.50	43.70
10th	16	4	0	0	6.15	690	110.40	42.59
12th	35	11	3	14	11.45	1,390	118.29	39.08
13th	27	14	3	14	9.30	1,130	118.94	40.76
14th	23	4	2	0	8.30	1,010	118.82	43.48
15th	22	13	3	0	8.45	1,050	120.00	46.25
16th	23	17	1	14	8.45	1,000	114.28	41.89
17th	16	3	0	0	5.55	670	113.24	41.48
19th	34	9	1	14	11.10	1,150	102.98	33.36
20th	28	4	2	7	9.40	1,130	116.89	40.03
21st	26	9	0	0	9.55	1 150	115.97	46.80
22nd	25	12	3	14	9.20	1 050	112.50	40.95
23rd	22	17	0	14	8.00	930	116.25	40.74
24th	16	9	0	14	6.40	760	114.00	46.17
26th	34	8	1	0	13.25	1,610	120.00	46.78
27th	26	16	0	0	10.30	1,230	117.14	45.67
28th	22	17	2	0	9.35	1,100	114.78	48.08
29th	24	4	1	21	10.5	1,170	116.03	48.30
30th	22	4	0	0	8.25	990	117.62	44.59
31st	15	4	2	14	5.45	680	118.26	44.64
Total	661	2	0	7		27,870	114.69 avg.	42.60 avg.

Summary.

Total weight of refuse burned for month	661 2 0 7
Electricity generated in B.T.U. for month	27,870 units
Units generated per ton of refuse (average)	42.6
Revenue for month at ½d. per B.T. unit	£58 1s. 3d.

THE INSTITUTION OF ELECTRICAL ENGINEERS.—The meetings of this Institution will recommence on Thursday, the 11th of November, when the premiums awarded for papers read or published during the past session will be presented, and the President, Dr. Gisbert Kapp, will deliver his opening address.

A COMBINED STEAM HAMMER AND FORGING PRESS.

WHILE the utility of the forging press is now quite established, and its reputation for satisfactory work clearly recognised, the installation of such a tool as an addition to the steam hammers of the forge has frequently been prohibited on the score of expense. This is particularly so in the case of many firms which are engaged in the production of certain classes of articles which by their variety would afford only intermittent employment for a forging press. A solution of these difficulties has recently been proposed in the design of the tool herewith illustrated. This is a combined hydraulic forging press and steam hammer, and has been patented by Mr. Fielding, of Fielding and Platt, Limited, Gloucester, who are now undertaking its manufacture. It is so arranged that the hydraulic gear may be held out of play, and the steam hammer alone used, while, by a simple lever movement, the hammer may be changed to a hydraulic press. Further arrangements are provided whereby the supply of water to the hydraulic cylinder during the idle part of the stroke is taken from a low-pressure source, the high-pressure supply being called upon only to do the final work on the forging. In addition to this, the steam cylinder is used to give the power for the return stroke of the hydraulic ram, thus economising the water supply still further.

In Fig. 1 an example of this tool is illustrated. In this case the framework is of the double standard type, and carries the steam cylinder at its upper end, the cylinder casting being formed with an extended flange, so as to provide a bridge across the tops of the columns to which it is bolted. Half-way down between the uprights the hydraulic cylinder is bolted, the side flanges of which bear along their top edges against shoulders formed on the pillars, so that the upward thrust on the cylinder when the press is in action is taken by these and not entirely by the bolts. Lower down the pillars have bolted to them adjustable V guides in which the tup works. This tup is provided with a removable block, and in place of this special dies can be substituted for the particular work in hand. On a casting bolted between the uprights and forming their base is placed the anvil block, which can also be removed and in its place a die block substituted. The press ram of which the conical nose is seen projecting from the lower end of the hydraulic cylinder is provided at its upper end with a hollow tail rod, which is carried through a gland in the upper cover. Passing through this tail rod and the ram itself the piston-rod from the steam cylinder is connected directly to the tup. When the tool is in use as a hammer the hydraulic ram is supported by struts pivoted from points on the upper surfaces of the tup guides. In the engraving these struts are shown in position supporting the ram, and otherwise the tool is represented in use as a steam hammer. A driving handle similar to that employed in an ordinary steam hammer, with the exception of the trigger catch shown, controls the hammer valve, which is of the usual balanced piston type, safety tappet gear being provided to cushion the up-stroke.

When it is desired to convert the hammer into a press the tup is raised by the action of the steam until it bears against the nose of the hydraulic ram. A slight further rise then permits the supporting struts to be withdrawn by means of the hand lever seen on the right of the illustration just above the driving handle. Simultaneous movement of the struts is given by the tie rod shown crossing the ram nose. The act of withdrawing the struts connects the driving handle to the rod controlling the hydraulic valve. For this purpose a horizontal tie rod passes from the right-hand strut to a point on the hydraulic valve rod, which rod is capable of swinging through a small angle on either side of the vertical. The lower end of the valve rod is enlarged to a square section, and is provided with a slot which engages with a pin on the double-bossed arm carried at the end of the driving handle. In this manner both the steam valve and the hydraulic valve are controllable from the same handle when the tool is in action as a press. The struts being thus withdrawn and the hydraulic valve connected up, the operator exhausts the steam from the lower end of the steam cylinder, and allows the tup, ram and steam piston to descend. In doing this low-pressure water is drawn into the hydraulic cylinder from the reservoir shown on the right of the engraving.

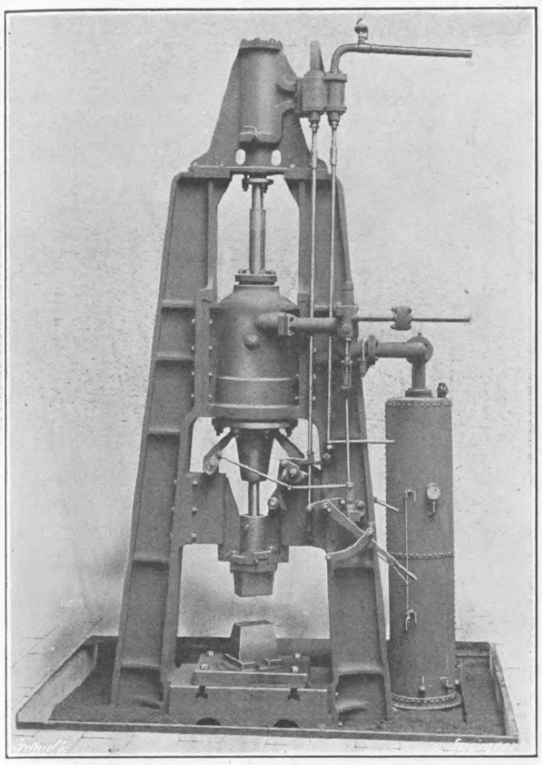


Fig. 1—COMBINED HAMMER AND PRESS

The use of high-pressure water during the idle part of the stroke is thus avoided, as it is only admitted to the cylinder to give the final pressure, a slight further movement of the driving handle controlling its admission. To assist the flow of low-pressure water from the reservoir into the cylinder pressure is maintained in the former by means of compressed air.

In a modified form of this tool—see Fig. 2—the steam cylinder is placed below the hydraulic cylinder and other alterations made. The hydraulic ram in this case is solid, and is held out of action by admitting pressure to the underside of the collar shown on it, thus avoiding the use of the strut gear described in connection with the first form. A simple slide valve placed alongside the steam hammer valve controls the change from hammer to press. In one position of this slide valve pressure is admitted to the underside of the ram, and the steam piston is free to act alone. In the other position the ram and steam piston act together, and have the same movements as in the previous case.

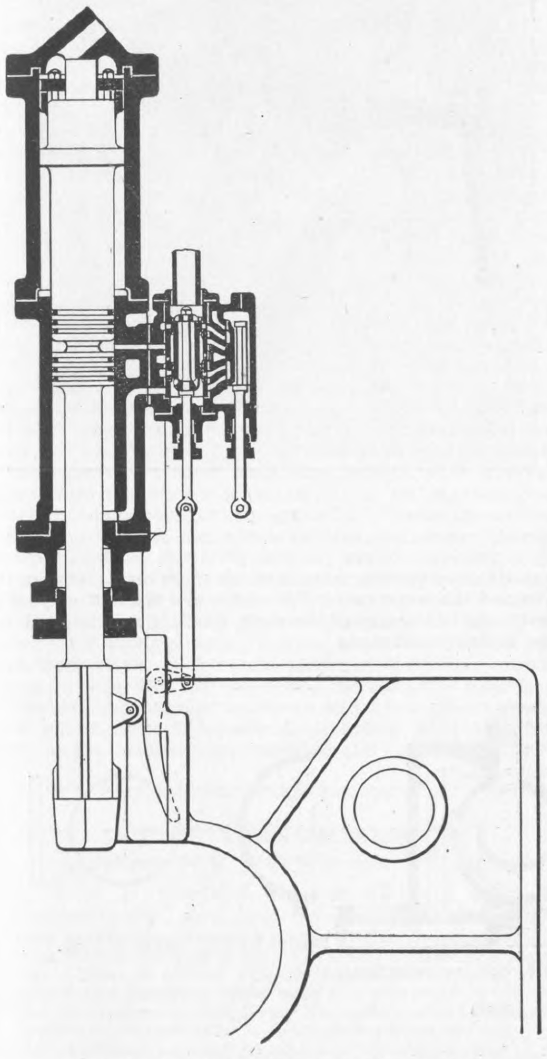


Fig. 2—COMBINED HAMMER AND PRESS

LETTERS TO THE EDITOR.

(We do not hold ourselves responsible for the opinions of our correspondents.)

BRITISH LOCOMOTIVE PRACTICE OF TO-DAY.

Sir,—I was surprised to learn from Mr. Chas. W. Dauncey's letter that he had such a vague idea regarding the value of cylinder ratio as applied to locomotives. He does not appear to be aware that there are two methods of increasing the cylinder ratio. For instance, an increase may be effected by a reduction in the area of the high-pressure cylinders, such as adopted in British locomotive practice. On the other hand, ratio may be increased by enlarging the low-pressure in excess of the high-pressure cylinder, such as I suggested. In the former case the power would fall off with every reduction in the area of the high-pressure cylinder, and in the latter it would be enhanced with every increase in the area of the low-pressure cylinder.

Mr. Dauncey states that Messrs. King, Brewer, Dearberg, and he, himself, have pointed out that the failure of compounding in this country has been chiefly due to the adoption of too low a ratio. None of these correspondents have made any attempt to demonstrate how it becomes practicable to enhance the power of a locomotive by increasing the ratio from low to high-pressure cylinders. Mr. Dauncey points out that cylinders 24in. diameter are the largest permissible. If increasing the ratio of locomotive cylinders is any advantage, is it not strange that the De Glehn type of engines have 15in. high-pressure cylinders, when a higher ratio could be had by the use of cylinders 14in. diameter?

Mr. Dauncey takes me to task for suggesting 24in. low-pressure cylinders while retaining the 19in. high-pressure ones. Surely he will admit that I was forced to do this owing to the restriction in British gauge, and not from any consideration of cylinder ratio. Personally, I cannot see what cylinder ratio has to do with the question, as the same power could be attained by passing the boiler steam directly through the 24in. cylinders, if this were practicable.

I will now offer a few maxims for consideration which may assist your correspondents to follow my views. These are as follows:—

(1) The locomotive boiler is the measure of power of the engine.

(2) The power of the simple engine is that obtained by referring the steam to the high-pressure cylinders.

(3) The advantage to be derived from compounding an engine is to be able to make use of the boiler steam on a piston area greatly in excess of that practicable with the simple engine.

(4) The power of the compound engine is that obtained by referring the steam to the low-pressure cylinders.

If correspondents will keep the above points in view when replying to this letter there may be some hopes of bringing this vexed question to a final issue.

I will now give my views with reference to the above, and try to show that the question of increasing the power of the locomotive is not by any means so difficult a problem as some may imagine.

I will begin by grouping (1) and (2). I think everyone will admit that the boiler is the measure of power of a locomotive, and that the modern boiler is capable of supplying steam freely to high-pressure cylinders 19in. diameter. It is a well-known fact that a cylinder capacity of 21in. overtaxes the boiler, consequently we must admit that the simple engine has come to the end of its tether, nor can a subdivision of cylinders help matters.

I will now deal with (3) and (4). Let us assume that a simple engine with 19in. cylinders has to be converted to compound. In the first place, we must not lose sight of the fact that the simple engine is able to make use of all the available boiler steam in the 19in. cylinders. In designing a compound engine its success depends whether a basis has been adopted which will allow the power to be enhanced when the cylinder ratio is increased. If we adopt a basis which will cause the power of the engine to be reduced with every increase in cylinder ratio, such as is applied to British locomotive practice, it follows that with every step the ratio is increased the power will be correspondingly reduced. The explanation is that less steam will have been used from the boiler. In plain words, we will have designed a compound engine, which—unlike the simple engine—cannot be worked up to the limit of its boiler power, and consequently must prove a failure.

It appears to me obvious that if a compound engine is to be made a success we must take the boiler power as a basis. This means that the high-pressure cylinders must remain. Say we add two 21in. low-pressure cylinders; the addition of these two cylinders—unlike the simple engine—will in no way overtax the boiler. Not only so, but it will be found practicable to go on increasing the diameter of the low-pressure cylinder up to as high as 30in., thus enhancing the power of the engine up to a maximum, while expanding the steam to a low terminal pressure. Quite a different story to that of British locomotive practice, which is unable to make use of all the available boiler steam when working under certain conditions.

Mr. Dauncey states my system is likely to remain one on paper. He does not appear to be aware that an engine with two 20in. high-pressure cylinders has been tried and found successful, although the ratio was only 1 to 1·25, the boiler having only 1232ft. heating surface.

I trust the foregoing remarks will make clear to Mr. Dauncey that the failure in compounding is not due to the adoption of too low a ratio, but rather to the cylinders of the simple engine having been accepted as a basis for a low-pressure cylinder without any consideration to the boiler power.

It may be interesting to Mr. Dauncey to learn that it is practicable to have the advantage of cylinders 30in. diameter without having to make use of six cylinders. This can be accomplished by referring the steam to the combined high and low-pressure cylinders of a 19in. and 24in. cylinder compound.

In conclusion, if the successor to Mr. Deeley has been following up this discussion, and intends to adopt the retrograde step suggested by Mr. Dauncey, he will, at least, have had the advantage of studying both sides of the question.

Argaith, Dumbreck, October 25th. **John Riekie.**

THE DEVELOPMENT OF THE GAS ENGINE.

Sir,—Referring to the article headed "The Development of the Gas Engine," in your last issue, I, as a practical expert in gas engines, would like to state my views on this interesting subject. I am bound to say that you, in trying to formulate the law of cost of large gas engines, as compared with small gas engines, have come to some very erroneous conclusions. You hold that a large double-acting engine—or a large engine with several cylinders—must have a lower speed than a single-acting engine. This is by no means correct; as a matter of fact, the reverse is the case. Taking any single-acting and any double-acting engine, the maximum speed of the piston of the former will be found to be about 500-1100ft. per minute, and the maximum speed of the latter about 1260ft. per minute. According to your article, the causes which are bound to lessen the speed of a double-acting engine are of a two-fold nature, whereas the fact is that a single-acting gas engine and a double-acting gas engine—each, for instance, of, say, 300 horse-power—are in most cases both built for exactly the same number of revolutions, *i.e.*, about 160 per minute. These two statements do not tally.

The above-mentioned conclusion being wrong, the assumptions on which it is based must be equally wrong. That is to say, the speed of any given piston engine is by no means limited by its reciprocating weights, but only by the maximum speed admitted—according to experience—to the sliding piston rings and the sliding surface. The figures given by me above illustrate this general experience, and the reason why single-acting gas engines run at a lower piston speed than the double-acting engines is that they generally have no crosshead, whereas good large gas engines have free sliding pistons. Furthermore, it is a mistake to say that the reciprocating weights of a double-acting engine are increased owing to the piston and piston-rod water-jackets. They will not be increased by an ounce, because the weights which the designer has to put into the piston and piston-rods depend solely on the diameter of the cylinder, *i.e.*, on the maximum power developed. Moreover, it is out of date to say that the outlet valve of a large gas engine must be water-cooled because in advanced designs ordinary mushroom valves have for years been used for inlet as well as outlet valves, with large gas engines.

Another important statement is that the double-acting and multiple cylinder principle makes the curve of cost ascend, because it doubles the parts and necessitates external guides. If you are convinced that this law is a correct one, I would suggest a method of making—instead of double-acting steam engines—single-acting engines like small gas engines, because this would save double parts and external guides. Though it would be quite possible to carry out that design without injuring the steam engine principle, no one does it, because for many obvious reasons the cost would be greatly increased. As to the cost of the piston-rod cooling device to which you also refer, I am acquainted with designs of that description, the total cost whereof is about 0.01 per cent. of the price of the whole engine. I cannot believe that that would raise the curve of cost.

As far as is possible, in a short letter, to give some law regulating the curve of cost of gas engines, I would here mention some of its chief points. The first thing I would say is that the prices of small gas engines differ largely, according to their quality and to the efficiency of the makers. Taking first-class small engines, it must be said that their average price differs very little from that of large gas engines, and when the units become very large, the average cost of the engine again becomes lower, being almost equal to that of single-acting engines. The real reasons that small gas engines are cheaper than large ones is not the nature of the design, but the fact that to a great extent they have become a wholesale article, whereas large gas engines are built in comparatively small numbers and only by first-class manufacturers at high factory charges, as is the case also with large steam engines.

If we consider the cost of large gas engines from a more practical point of view, we find that it is becoming almost identical with that of large steam engines and turbines, whereas the cost of the fuel consumed by it is from 2 to 2½ less. Therefore you are greatly mistaken in saying that there is an advantage in using large gas engines only where waste gases—like coke-oven waste gases and blast furnace waste gases—can be used.

There are numerous cases where producer gas plants are very profitable, and during the last four years a great number of plants of this kind have been created, working extremely well and lucratively. But to go further into this point would take up too much space here.

With reference to the statement about the thermal conditions of different gases, I would point out that producer gas is not, as you seem to think, to be considered as a gas of high calorific value, because its calorific value differs very little from that of blast furnace gas, being only about 125 B.Th.U. per cubic foot, whereas the calorific value of blast furnace gas is about 100 B.Th.U. per cubic foot.

As regards the gases of high calorific value, such as coke-oven gas with about 450 and town (lighting) gas with about 500 B.Th.U. per cubic foot, and their thermal conditions, we may say that all anxiety which may prevail here should disappear, considering the numerous engines of large units which are working splendidly in this country and all over the world, with coke-oven waste gas and other gases of high calorific value.

Your suggestion for the use of cast steel cylinders is very interesting, but it seems to me that the casting would be fraught with difficulties. On the other hand, and according to my experience, I do not consider this necessary, because a highly perfected cast iron cylinder stands the stresses very well indeed, and there are some designers who already know very well how to cope with the difficulties met with.

London October 26th. **David Neustadter.**

THE INVENTION OF THE STEAMBOAT.

Sir,—Referring to your editorial note beneath my letter of the 22nd inst. *re* Dr. Denys Papin (1707), it may be of interest to your readers to know that a paper was read by Dr. Elterland at the Bordeaux International Congress on July 5th, 1907, upon "Papin and the Invention of the Steamboat," the report of which states:—"Although Papin invented the low and high-pressure steam engine, and was the first to build practical models of both, he did not build a steam-propelled boat. He had, however, the intention of building one, and made the necessary trials with a paddle-propelled boat. He proposed his scheme to the Royal Society of London, but this Society did not entertain the matter. No existing documents can be adduced as a proof that Papin's paddle boat was propelled by steam."

Unless this very clear statement can be proved as unreliable, then I claim that Jonathan Hulls was unquestionably the "inventor of the steam boat," as it strengthens rather than weakens his claim to the honour, to which official proof is still available. And in support of Jonathan Hulls I would mention that in an exhibit made by the Institute of Marine Engineers at the International Exhibition, Shepherd's Bush, his portrait as "the inventor of the steam boat" was very prominent. I can produce the opinion of many writers supporting J. Hulls—but the two official documents I have are of much greater value.

Even the editor of the *Scientific American* in his "Hudson-Fulton Celebration" issue of September 25th practically admits Hulls' claim, and quotes an extract from Admiral Preble's—of the U.S. Navy—book on the "Origin and Development of Steam Navigation." Thus: "There can be no doubt of his—Hulls—having been the first inventor of an ingenious and practicable mechanism for propelling vessels by a condensing steam engine and by paddle wheels."

The editor shows an elaborated design of Hulls' boat, but has fallen into the common error by describing it as "proposed, but never built." **J. Hooper Hulls.**

Manor Park, Essex, October 26th.

CENTRIFUGAL FORCE.

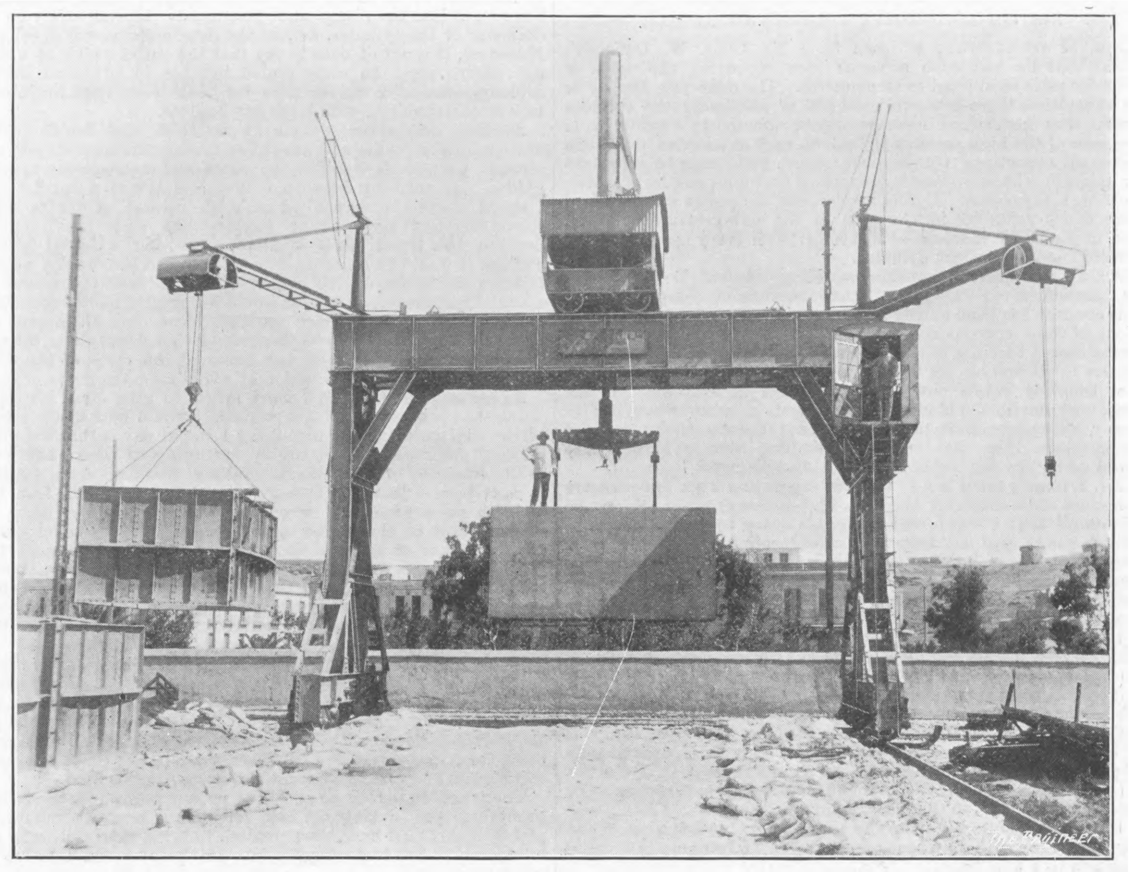
Sir,—In answer to "Pater's" letter I would point out that two forces acting on a body at right angles cannot possibly balance. If they could, and did, in the case of his stone at the end of a string, the stone would have no motion. What actually takes place when a stone attached to a string is whirled round is that the stone is trying to move off in a straight line tangental to its circular path, but this line of movement is being constantly modified by the pull in the string; as soon as the string breaks this modifying force exists no longer, and the stone travels away in a straight line at right angles to the string at the point where it broke. **Herbert L. Brown.**

Wallington, Surrey, October 22nd.

The Midland Institute of Mining, Civil, and Mechanical Engineers.—A general meeting of the members of the Institute will be held at the Philosophical Hall, Leeds, on Tuesday, November 9th, at 3.30 p.m. The following paper will be read:—"Recovery of Power from Exhaust Steam," by W. M. Sanderson. The annual dinner will be held in the Metropole Hotel at 6.30 p.m.

GOLIATH CRANE AT MELILLA

APPLEBYS LIMITED, LONDON, ENGINEERS



ENGINEERING AT MELILLA.

As a good deal of interest is now concentrated in Melilla owing to the war between the Spanish and the Moors, we think it will not be out of place to describe the engineering work that is being carried out there.

Melilla, originally a small fortified rock town, has of late years been enlarged by building a new town on the flat ground to its south. The trade also had to some extent increased by dealings with the Moors, and by the increased garrison sent there by the Spaniards.

Unfortunately, the coast offers no protection for vessels from the strong easterly gales so frequent in the South Mediterranean Sea, and at present vessels have to run 30 miles to the east so as to get protection in these circumstances from the Chaferine Islands. The Spanish Government therefore arranged to build a protection pier, some 500 metres in length, of heavy concrete blocks, so as to allow all vessels to lie in safe anchorage in the worst weather. Contracts were made with a large Spanish firm for the whole work, which was begun last year, and was in full swing when the war started.

A block yard was laid out along the coast between the beach and the park or gardens, and a railway was laid some two miles in length up to the limestone quarries, with a branch up the river to obtain sand and stones of smaller size. The larger stones from the quarries up to ten tons in weight are kept for placing at the foot of the pier wall; while the smaller stones are brought to an electrically driven stone crusher, where they are crushed and screened for the concrete mixing. This narrow gauge railway is worked by steam locomotives and side-tip wagons, but after dumping the load the stones are picked up and carried to the crusher by Moorish labour. The concrete is mixed by machinery consisting of a revolving barrel taking $\frac{1}{4}$ to $\frac{1}{3}$ cubic metre each charge. The concrete is discharged into small hopper wagons carried on a double bogie flat wagon which is pulled by an electric locomotive along a narrow elevated railway between the block moulds, but at such a height that the hopper wagons can be pushed off on to cross rails which run temporarily over the tops of the moulding boxes, and so discharge the concrete into the moulds. Before commencing to fill in the concrete, cement troughs, circular in form, are set in position with cast iron tops to take the tee heads of the lifting rods and distribute the weight. The moulding boxes are of steel plate strengthened by angle irons and a fish-bellied rib in the centre of each side. They are bolted together at the corners, and these bolts are loosened after the blocks are sufficiently set for the removal of the box to a new position.

It is in the crane for lifting the blocks and changing these boxes that the chief novelty is seen. This crane, as will be gathered from the accompanying engraving, is of the Goliath type. It was designed and constructed by Applebys Limited, and it lifts the 80-ton blocks by a direct vertical screw kept from turning by means of a crosshead guide which runs in a chimney above. This chimney is arranged to lower down to a horizontal position, so as to allow the Goliath to pass from one line of rails to the next and under the live electric wires above. The nut for the hoisting screw is turned by means of a worm wheel and worm running in an oil bath and driven by a 50-horse electric motor coupled direct on to the worm shaft. The nut rests on a cast steel foundation, and has a spherical joint, to allow the weight to swing freely both in lifting and in travelling. The whole is carried on a travelling crab worked by an independent motor.

The Goliath is arranged to travel over two rows of blocks placed end to end, and has independent travelling motor gear. At each end of the main girders a special feature is introduced in the shape of an auxiliary pillar crane with electric hoisting motor fixed at the jib end to lift three tons—the weight of the empty moulding boxes. With these cranes auxiliary boxes can be lifted from the adjacent row outside the Goliath track and placed in any of the next three rows, and the system is found to facilitate the work very much both in manœuvring the boxes and also in placing the lifting rods in the blocks.

To change the Goliath from one track to the next it is travelled to rails beyond the block lines, which rails run the full length of the yard. Here four corner wheels set at right angles to the travelling wheels are lowered by means of a screw and ratchet spanner, and the whole crane lifted off the ordinary travelling wheels. A block truck left in the centre of these rails is coupled up to the lower girders of the gantry by means of four push-rods, and the Goliath is then pushed along to its new position by means of the block truck, which is also propelled by electricity. By having double sets of collecting trolley poles it is only necessary to have half the number of aërial wires. The whole of the movements, except that of the cross travelling of the Goliath, are worked from the driver's cabin.

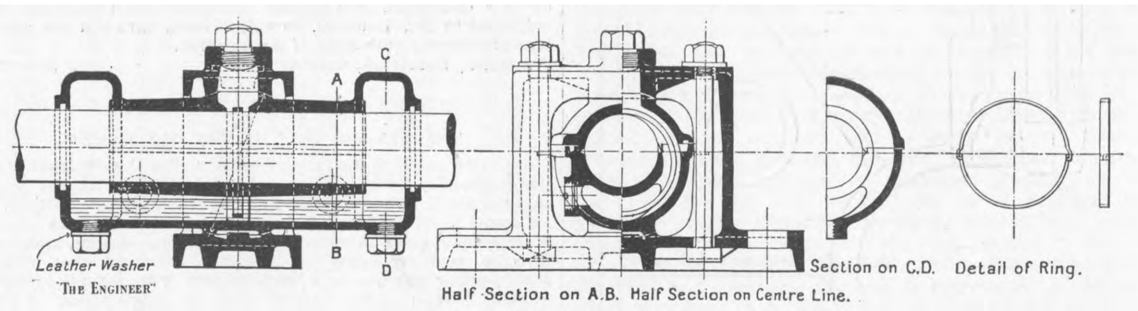
The blocks when placed on the transporter trucks run down on a 5ft. 6in. gauge railway to the point where the pier commences and are ready to be placed in position by divers.

Electric power is generated at the power station at the block yard by means of a single steam generating set driven by a Belliss and Morcom engine. The whole plant was thought out and planned by the contractor's engineer, Sr. Arrigunaga, of the Compania Trasatlantica. The current used is 500 volts continuous for all machines and railways, except, of course, for the steam locomotives above referred to.

SELF-OILING BEARING.

An improved form of swivelling self-oiling bearing, which is being introduced by the firm of Kynoch, Limited, Birmingham, is illustrated herewith. The bearing is of the ring pattern and is made for shafts from 1¼in. to 4in. diameter, with wearing surfaces 3½ diameters long. It has a large reservoir capacity so that it may require but little attention for replenishment with oil. A sight hole is provided through which the height of the oil in the reservoir can be observed, while the removable screwed plug in the top of the pedestal affords a ready means for inspecting the oil ring during operation. Glands are fitted to the bearings to prevent oil creeping along the shafting and to exclude dust, and a channel conveys any oil which leaks through the joint back to the reservoir. To simplify erection the parts are all made in halves, as will be seen from the transverse sections, and a peculiar feature of the construction is that the centre part of the bearing which allows it to adjust itself to the shafting is placed below the centre of the latter, thus reducing the weight and size of the bearing and pedestal—an advantage where space is limited. These bearings are supplied with pedestals, hangers, brackets or any other fitting.

Since the roller bearing made by this firm was described in The Engineer some time ago, several improvements in its design have been effected, particularly in the form of the cage which holds the rollers in place. The cage is now made of steel in two parts and slots are provided in the end ring which separate the lines of rollers from one another. The rollers themselves are now supported on steel rods instead of on the wooden sticks formerly used. The general results are a stiffer bearing, less chance of the rollers getting out of alignment, and more uniform wear.



SELF-OILING BEARING

A NEW VICE.

To meet the demand for a vice which is capable of securely holding long and awkward objects, the firm of M. Glover and Co., of Holbeck-lane, Leeds, has recently introduced the new type shown in the accompanying illustrations. It is believed that this vice will fill a long-felt want, since its design allows of long and otherwise awkward pieces of work being held in a much better manner than is usually possible with the ordinary types in general use. It will be seen from the illustrations, Figs. 1 and 2, that the vice is designed to enable it to be fixed at an angle instead of in the upright position as is usual, and that, in consequence, there is much more room between the jaws and the screw case. The screw and the bottom part is clearly out of the way of the work, which is a distinct advantage in many instances.

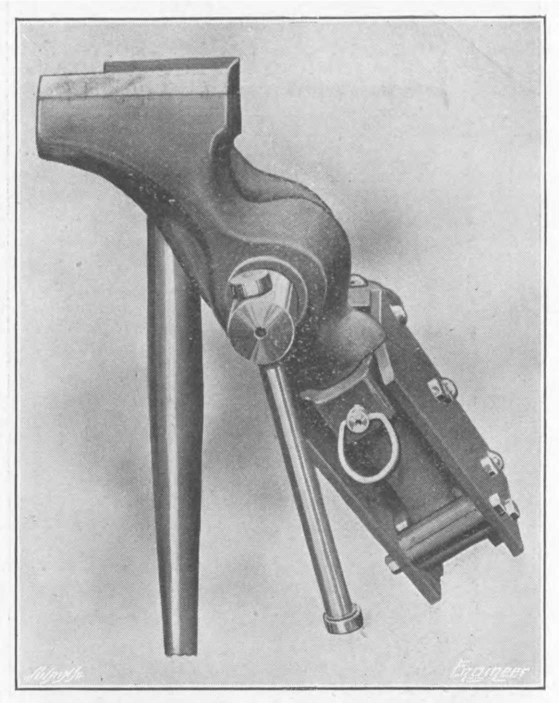


Fig. 1

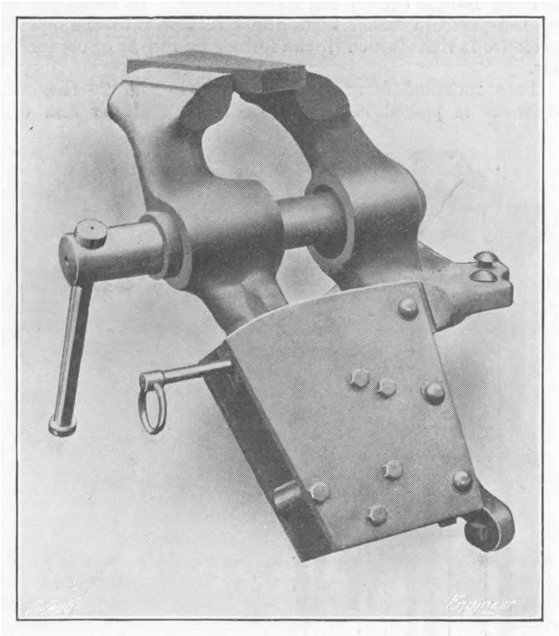
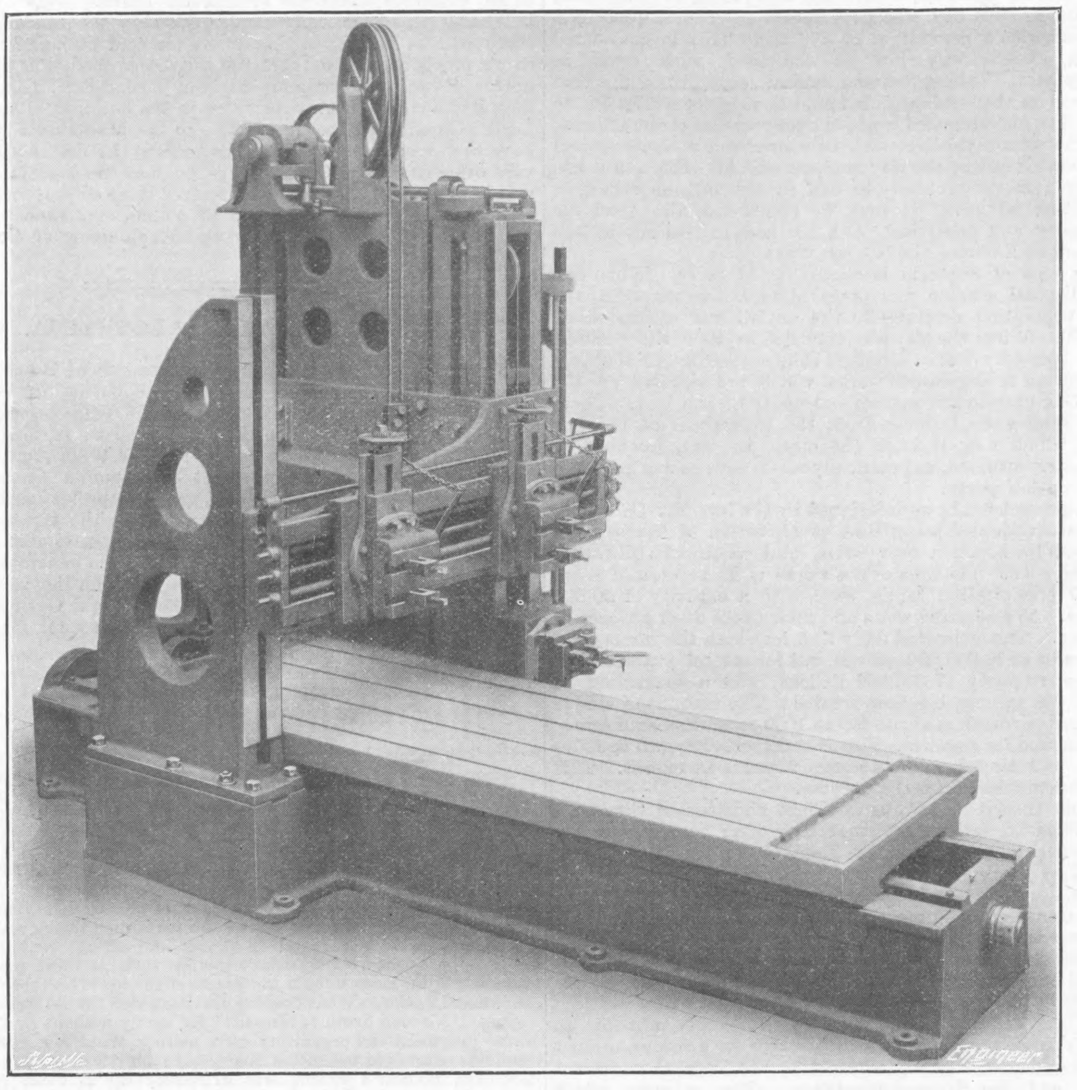


Fig. 2

There is another feature about this vice which is equally, if not more, important than that already referred to. It is that the outside jaw is capable of turning, it being provided with a ball-and-socket joint. Thus, by removing the pin to be seen just below the handle of the vice the outside jaw is free to turn in either direction, and the vice will consequently hold taper work. The illustration Fig. 2 shows a piece of tapered metal clamped in the jaws. These vices are fitted with steel jaws, and it will be gathered that they are built for heavy work. Four standard sizes are manufactured by the firm, the width of the jaws being 4¾in., 5½in., 6¼in., and 7⅛in.

OPEN-SIDE PLANING MACHINE

HULSE AND CO., LIMITED, MANCHESTER, ENGINEERS



OPEN-SIDE PLANING MACHINE.

THE open-side screw planing machine of which we give an illustration on this page weighs approximately 22 tons, and is capable of planing work 10ft. long, 4ft. wide by 4ft. high. The advantages claimed for this type of tool by the makers, Hulse and Co., Limited, Salford, Manchester, are that, whilst being as stiff and rigid as an ordinary machine, it is capable of planing over double the width and of operating on large pieces of irregular form which are usually dealt with on a much larger and more expensive tool. Ease of setting is also an advantage of some importance. The machine provides three cutting speeds, namely, 20ft., 30ft., and 40ft. per minute, by means of a gear-box with a constant return speed of 100ft. per minute. The outer support for the cross slide shown is, of course, readily removable, and is furnished as an extra when desired. There are two tool-boxes on the cross slide and one side tool-box. The bed is of box form, 15ft. long, with wide flat bearing surfaces, side strip and adjusting screws being provided for taking up wear, while the lubrication is effected by rollers. The table has T grooves planed out of the solid, and is traversed by a double-threaded steel screw of large diameter working in a long gun-metal nut. This also has provision for good lubrication. Other features of the machine are fast and loose pulleys, with improved strap shifting motion; adjustable stops for regulating the length of the stroke and automatically reversing the motion; self-acting variable and reversible feed mechanism operated independently of the table motion; massive upright of box form keyed and bolted to the bed, and having a wide face to give the necessary stability to the cross slide; counter-balanced cross slide and power mechanism for raising the latter; self-acting relieving motion to the tools on the cross slide during the quick return stroke of the table; counter-balanced side tool box self-acting horizontally with hand horizontal and angular traverse; and machine-cut gearing throughout. The independent self-acting feeds vary from $\frac{1}{32}$in. to $\frac{3}{4}$in. for horizontal, vertical, and angular planing.

HEAT TRANSMISSION.*

By Professor W. E. DALBY, Member, of London.

(*Concluded from page* 433.)

Conductivity of the metal plate.—In measuring the conductivity of metals, experiments must be devised which do not require the assumption that the faces of the metal are at the same temperature as the medium in contact with it. Lord Kelvin remarks, in discussing the coefficients of conductivity of metals found by Clement, Peclet, and Angstrom, that, taking Angstrom's value to be correct for copper, Clement's value is two hundred times too small, and Peclet's five times too small, this because the temperature of the metallic surfaces was assumed to be the same as the temperature of the medium in contact with them. Lord Kelvin further points out that the conductivity of iron is 80 times that of water and the conductivity of copper 500 times that of water; the conductivity of iron is 3500 times that of air and of copper 20,000 times that of air. Hence, although the water or the air at the very interface of the medium and the metal may be nearly at the same temperature as the metal, the temperature at a point in the medium a little way from the surface of the metal must differ considerably from the temperature of the metal itself.

It is interesting to apply these figures to a hypothetical case of a copper plate 1in. thick coated with a film of water on the one side and a film of air on the other side, each film being $\frac{1}{200}$in. thick, in order to find the proportion in which the temperature head must be divided between the different elements of the path, so as to determine a flow of heat. Calling the resistance of the copper plate unity, the resistance of the air film will be $20{,}000/200 = 100$, and the resistance of the water film $= 500/200 = 2.5$. The total head will therefore be proportional to $100 + 1 + 2.5 = 103.5$, showing that about 97 per cent. of the whole is required to overcome the resistance of the gas film, 1 per cent. the plate, and 2 per cent. the water film.

These illustrative figures indicate the order of magnitudes concerned in the films and in the distribution of temperature head, and there is evidence to show that this order of magnitude is not far wrong.

Practically this shows that the material of which the fire-box and flue is constructed makes very little difference to the transmission of heat, and that iron or steel tubes are as good as copper tubes in this respect.

(*a*) *The conductivity at the interface*—"*penetrability.*"—There is a definite joint resistance to the flow of heat at places where two dissimilar metals, or a metal and a gas or a metal and a liquid, are in contact. Thus, when a hole is drilled in a plate, and the hole is filled with fusible metal, the temperature at which the metal melts is not necessarily the temperature of the plate in which it rests, because of the temperature head required to force the heat across the surface where the two dissimilar metals are in contact. This point may be illustrated by an experiment mentioned in a paper by Mr. Anderson in 1884. If a copper bar be made up one half of screwed joints, the other half of solid bar, and if this composite bar be heated in the middle of its length, it will be found that thermometers inserted at equal intervals along the bar rise more rapidly along the solid half, showing that the joints resist the flow of heat. Again, those who are familiar with the smith's shop, are aware that defects in metal, invisible when cold, show themselves when the metal is heated, by the difference of luminosity caused by imperfect conduction through the defective portions.

Fourier mentions penetrability in his analytical theory of heat. Smoluchowski gives a whole paper on penetrability in connection with the conduction of heat through rarefied gases. Dr. Stoney also mentions penetrability in connection with the conduction of heat through a Crookes' layer or gas film.

(*b*) *Conductivity through the metal.*—"*permeability.*"—Various methods have been employed to experimentally determine the conductivity of metals, and a list is given of the workers on the subject.

Conductivity of oil, grease, scale, &c.—Although many papers have been written on the effect of grease, scale, &c., on the boiler plates, only one to my knowledge contains definite information regarding the conductivity of oil and scale, and this was written in 1902 by W. E. Ernst, an Austrian engineer. Plates of scale were held between copper plates and the temperatures of the plates were measured. In order to obtain good surface contact glycerine was squeezed between the plates, an allowance being made for this in the calculations. Ten different scales were tried, and their conductivities ranged from 0.00407 to 0.01 foot-pound-second units, depending upon the porosity and density of the scale.

	Conductivity.	
	Calories per cm². per deg. Cent. difference of temperature.	Observer.
Iron.	$0.209\,(1 - 0.00147\,t)$	Forbes
,,	0.197 (1 − 0.00[illegible]2 *t*)	Tait
,,	$0.175\,(1 - 0.0015\,t)$	R. W. Stewart
,,	0.164	Neumann
,,	$0.199\,(1 - 0.00287\,t)$	Angström
Copper.	$1.08\,(1 + 0.0013\,t)$	Tait
,,	$0.71\,(1 + 0.0014\,t)$	,,
,,	1.108	Neumann
,,	$1.027\,(1 - 0.00214\,t)$	Angström
,,	$0.985\,(1 - 0.00152\,t)$	,,
,,	$1.12\,(1 - 0.001\,t)$	R. W. Stewart
,,	0.9594 between 10° and 97°	J. H. Gray
,,	0.8884	,,
,,	0.8612	,,
Brass.	0.27 between 25° and 35°	Lees

The conductivity of fats, oils, coal tar, and anti-scale compounds are given, and these values are lower, and range from 0.000377 to 0.000421 foot-pound-second units. The temperature of the boiler plate is also given. With a coating of the worst scale 2 mm. thick, the temperature of the plate was lower than that found with a coating of the anti-scaling mixture.

The earliest experiments on the effect of scale on the transmission of heat are those of W. J. Hirsch, and it may be of interest to give some of his conclusions, namely:—That any fatty deposit on the internal surface of a boiler greatly impedes the transmission of heat; that the easier the deposit is decomposed by heat the more likely are the plates to overheat, and that a deposit of vegetable grease is therefore more dangerous than one of mineral oil.

Professor L. P. Breckenridge made some experiments on a locomotive boiler with the view of finding the efficiency before and after cleaning. He recorded a loss of 9.55 per cent. efficiency with scale $\frac{1}{32}$in. to $\frac{3}{64}$in. thick, and deduced that loss due to scale varies as 1.5 times the square root of the thickness of the scale.

Valuable tests on the effect of scale were begun by L. E. Schmidt in 1901. The experiments were carried out with great care, and lasted several years. The conclusions briefly were these:—The loss of heat transmission due to scale of about $\frac{1}{8}$ thickness may vary in individual cases from insignificant amounts to as much as 12 per cent.; the loss increases somewhat with the thickness of the scale, but not directly as the thickness; the mechanical structure of the scale has a greater influence on the loss than the thickness, and chemical composition, except in so far as it affects the structure of the scale, has no direct influence on the heat-transmitting qualities.

Sir John Durston's experiments concerning the effect of grease have already been referred to above.

FACTORS AFFECTING THE CONDUCTIVITY OF THE ELEMENTS IN THE PATH.

On the possibilities of destroying the gas and water film.—The permanence of the several parts of the conducting path has been postulated in the preceding remarks, but it will be quite clear that if these films be completely or even partially destroyed the head required to effect the heat transmission from the gas to the water across the plate will be considerably reduced.

One of the most potent factors in disturbing the gas film is the velocity with which the gases move through the tubes, and the importance of this consideration has received increased recognition in later times. In fact, it is not too much to say that most of the work in connection with heat transmission since the time of Rankine shows attempts to introduce a velocity factor variable into the expressions.

General development of the velocity term.—Professor Reynolds wrote a remarkable paper in 1875, suggesting that the transmission depended upon the diffusibility of the gases.

Professor Ser, 1888, gives the equation for the quantity of heat transmitted by convection as:—

$$F = f\sqrt{v}\,(t - \theta)\,Sz;$$

where

F = B.Th.U. transmitted.
f = coefficient of convection.
v = velocity of gases.
t = temperature of hot body (gases).
θ = temperature of surrounding body (plates).
S = total heating surface.
z = time.

Professor Mollier, 1897, gives the coefficient of transmission for boilers as:—

$$K = k + \frac{R_1}{F\cdot z\cdot(t_1 - t_2)};$$

where

t_1 = temperature of radiating body.
t_2 = temperature of absorbing body.
z = time.
F = area of surface to which heat is radiated.
K = coefficient of total heat transmitted.
k = coefficient of convection $= 2 + 2\sqrt{B}$.
B = weight of fuel burned per unit area—that is, a velocity factor.
R_1 = heat transmitted by radiation.

Professor Werner, 1883, uses a formula depending upon the rate of combustion—that is, upon the rate at which air is supplied to the furnace, and, therefore, the velocity of the gases is implicitly considered.

Halliday, 1898, suggests that the velocity of the gases breaks up this film.

J. Perry, 1898, gives a formula where the heat transmitted depends on velocity.

Hudson, THE ENGINEER, Volume lxx., p. 523, 1890, proposes a formula where the transmission depends upon the square root of the velocity.

B.Th.U. transmitted per square foot per degree F. per hour in tubes or flues

$$= \frac{T_g + T_s + 922}{2} \times \frac{\sqrt{v}}{B};$$

where

T_g = absolute temperature of flue gases, degrees F.
T_s = absolute temperature of steam, degrees F.
v = velocity of gases in feet per second.
B = coefficient of transmission.

Carcanagues, 1896, describes experiments of his own, where water is cooled by means of air passing through brass tubes. The tables show a vast increase in the heat transmitted with increase of the velocity of the air.

Brillié, 1897, says:—$H = K(T - t_1)$ where K depends on the velocity of the gases, if p = weight of coal burned per hour square metre grate; $K = 2\sqrt{p}$.

Professor Lewes, 1894, mentions the effect of velocity.

Hydraulic mean depth of the flue.—This is a factor which seems to have some importance.

Professor Smith in 1887, in giving a formula for S, required heating surface, adds a note that it should be multiplied by $(1 + 0.08d)$, where d is the hydraulic mean depth of the tube or the flue through which the gases pass. The gases nearest the surface must be coolest and lie in concentric rings getting hotter towards the core; hence, since the transmission of heat depends on the surface temperature, and the temperature of the flue being only an average temperature, it follows that the efficiency must increase with a decrease in the size of the flue. On this account the boiler efficiency may fairly be considered as less than that reckoned by an amount proportional roughly at least to the reciprocal of the mean hydraulic depth. This must not, of course, be carried too far, as with small tubes the resistance to the passage of the gases is much increased; moreover, the sudden cooling effect on the gases is liable to extinguish the flame.

The effect of velocity on the water film.—The effect of forcing water across the heating surface with a high velocity is to break up the water film, hence the importance of good circulation. There are many papers dealing with this subject and the closely allied one of good circulation. In fact, velocity of water flow and good circulation are two aspects of the same problem, namely, that of destroying the water film clinging to the plate.

Austin, in 1902, calculated the resistance of the water film, and found that it was equal to the resistance of 10 cm. of iron when the water was still, 0.75 when boiling and stirring. He calculate the thickness to be 0.004in. Other experiments on the water film were made by L. Holborn and W. Dittenberger in 1900, Dr. H. Claassen in 1902, and Dr. Russner in 1903. Papers on the effect of velocity or good water circulation on the transmission of heat have been written by Joule, 1861; Nichol, 1875; Anderson, 1876 ("Proceedings" Inst. C E., Vol. 48, page 257); Hagemann, 1883; Prof. Ser, 1887; Thornycroft, 1895; Normand, 1895 and 1896 ("Transactions" Inst. Nav. Arch., Vol. 37, page 276); Stanton, 1897; Brillié, 1898; Macfarlane Gray, 1898; Halliday, 1899; Carpenter, 1901; Yarrow, 1901; Hepburn and Hildrith, 1901; Paul Fuchs, 1904 (Zeitsch. Verein. deut. Ing., Vol. 48, page 379).

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* The Institution of Mechanical Engineers.

CONCLUSIONS.

Absence of complete data concerning the mechanism of distribution.—It must be confessed that notwithstanding the large number of researches and papers bearing on the subject of heat transmission there is a general absence of complete data regarding the actual phenomena occurring in a steam boiler when working under the ordinary conditions of practice. No data exists, for instance, which gives the temperature gradients at different parts of a boiler flue with accuracy; isolated experiments furnish incomplete data from which the gradient may be roughly imagined, but researches and papers alike have had very little influence in modifying the general design of steam boilers. The Cornish boiler is still of the same design as it was a century ago. The Lancashire boiler has been scarcely modified in any essential particular. The locomotive boiler of to-day is a magnified type of the Rocket boiler. The most important development of recent years has been in the gradual introduction and perfecting of the water-tube type, but even in this modern product the essential features of the old types persist. This general absence of complete data is in no way due to the lack of endeavour or to the dearth of able and distinguished men in this field of research, but rather to the inherent difficulties of the problem and to the enormous cost of carrying out complete experiments upon a large boiler under the ordinary working conditions. Many valuable experiments on boilers have been made of the kind which have been made classical in the published researches and experiments of Kennedy and Donkin, but these experiments are incomplete in the sense that the temperature distribution in the apparatus was not one of the objects of the experiments. We can all appreciate the formidable difficulties which surround this kind of investigation when we think of the enormous rate at which hot gases give up their heat. As an example, in 1884 some experiments were made on the Orleans Railway with a locomotive boiler. The temperature in the fire-box was 2912 deg. Fah., and in the smoke-box 752 deg. Fah., corresponding to a drop of temperature of 2160 deg. Fah. along a tube length of 16.4ft. The velocity of the gases was 164ft. per second, so that the gases traversed the tubes in one-tenth of a second, and the heating surface therefore was sufficiently efficient to cause this large drop of temperature, namely, 2160 deg. in one-tenth of a second. The costly nature of the experiments may be gathered from a recently published set made by the Steam Engineering Division of the Technological Branch of the United States Geological Survey, an abstract of which is given in the Journal of the Western Society of Engineers, U.S.A., vol. 12, pp. 285 and 661, 1907. These experiments cost 100,000 dols., and cover a large part of the field of research in connection with this subject. Some of them were made on small multitubular boilers, heated electrically. It may be desirable to give here a brief account of the experiments. Stefan's law was used to calculate the proportion of heat transmitted by radiation, and the transmission by conduction and convection was assumed to vary as the difference of temperature. Groups of from 15 to 30 tests were made under constant conditions, the groups forming a series in which the conditions of working were varied for each group. The effect of varying the initial temperature and the flue dimensions was studied, together with the relation between the velocity of the air passing over the heating surface and the rate of heat transmission. The results show—(1) That the heat absorbed by the boiler varies almost directly as the calculated velocity of the air. (2) That the rate of heat absorption does not rise as fast as the increase in initial temperature.

The curves given show that as the velocity of the air increases the true boiler efficiency of the boiler drops at first very rapidly, but after a certain velocity is reached it becomes nearly constant with a low initial temperature, and varies little with a higher initial temperature. The velocity at which for any initial temperature the true boiler efficiency curve becomes nearly horizontal is called the critical velocity, and the critical velocity varies with the initial temperature. These experiments are well worth careful study.

The most complete set of experiments made on a locomotive boiler is that recently conducted by Professor Goss, and published by the Carnegie Institute of Washington in 1907. The boiler was of the usual American locomotive type belonging to a 4-4-0 engine, and contained 1322 square feet of heating surface. Ninety-seven individual experiments were made, divided into six groups, the boiler pressure being maintained constant in each group, and ranging from 120 to 240 pounds per square inch. In each group the cut-off of steam in the cylinder was varied. The records furnish a mine of exact information concerning the working of a locomotive boiler from the practical point of view.

Professor Nicolson, in a paper before the Junior Engineers, records and discusses some experiments he has made in connection with a Cornish boiler which lead him to recommend radical changes in boiler design.

In none of these recent experiments, however, has any attempt been made to measure directly the temperature gradient.

RECOMMENDATIONS.

Considering the mass of work which has already been done, the century of accumulated practical experience in the design, construction, and working of steam boilers, the numbers of able engineers who have devoted their attention to boiler construction and design, and the distinguished men who to-day control and influence the industry, it would almost seem that present practice represents the survival of the fittest, and that there is hardly a necessity for further research. But recent years have been fruitful in researches in other directions, and Professor Callendar, by his brilliant work in platinum thermometry, has placed at the disposal of engineers a practical way of measuring temperatures unknown to early experimenters. We have now a means of accurately measuring the temperatures at different parts of a boiler directly. The author ventures to suggest, therefore, that a research might be undertaken by the Institution, in which steam boilers of different types working under practical conditions may be made the subject of experiments in which all the elements of their working are measured, together with temperature measurements for the purpose of establishing the temperature gradients at different parts of the heating surface. Such a research would be very costly, but would be well worthy of the Institution.

The author cannot conclude without making grateful acknowledgments to Mr. H. C. A. Thieme for the able assistance he has rendered. An accomplished linguist and an indefatigable and conscientious worker, his aid in producing this report has been invaluable. The pile of abstracts referred to in the report, which are now in the library, indicate the untiring devotion with which Mr. Thieme has worked in the interests of the Institution.

THE Los Angeles and Mount Washington Railway Company, in June, 1909, began operating a novel cable road, which is 3000ft. long, and has grades in some places of 42 per cent. The road was built by estate dealers to make available choice property situated on the top of a hill between Los Angeles and Pasadena. At the lower end of the incline railway passengers transfer to and from the cars of the Los Angeles Railway.

SEWAGE DISPOSAL IN SHEFFIELD.

THE first section of the new extensions of the Sewage Disposal Works at Sheffield was formally opened yesterday. The cost of the present scheme, together with that of the works previously in existence, will, when everything is completed, work out at £401,099, which represents an expenditure of 17s. per head with a population of 470,000. This is considered to be satisfactorily low as compared with costs in other places. Taking fourteen typical large towns, the cost per head on the same basis is found to vary from 27s. 7d. to 73s. The experimental work, the preparation of the scheme, and the administrative work in connection with it have all been carried out by the city engineer and his staff, and it has not been found necessary to call in any outside expert or consulting advice. It may be mentioned also that the laboratory and analytical work has been carried out by the ordinary staff during the last ten years.

The area of Sheffield is about 23,662 acres. When the new disposal scheme was prepared in December, 1904, the total population draining to the outfall was estimated at 400,000. When the city was extended in 1900 the position of the boundary was so arranged that practically all the area could drain to the sewage works, which are situated on the river Don outside the eastern extremity of the city. These works receive the drainage from the watersheds of the five rivers which flow through the city. In fact, Sheffield is fortunately situated, as practically all its sewage can gravitate to the outfall works.

The present works were designed by the late Mr. G. Asing, the system adopted being lime precipitation of the sewage, followed by aëration over weirs, and continuous filtration through coke. The area of the works is 23 acres, and there are 30 precipitation tanks, each with a capacity of 50,000 gallons. The aërating weirs and filter tanks cover an area of 1½ acres. The estimated daily flow for which the works were designed was 10,000,000 gallons, but for several years a flow of approximately 17,000,000 gallons, and a maximum of 22,000,000 gallons, has been treated. The amount of sludge produced per week is about 800 to 1000 tons when sufficiently consolidated for removal. This is transported by rail to Kilnhurst, and tipped on land about 22 acres in extent. This land was purchased for the purpose.

When the existing works were first constructed they were considered so satisfactory that they were copied by other large cities; but later on the Local Government Board and the West Riding Rivers Board have been pressing the authorities to employ better means of treatment, the attitude taken up being that lime precipitation only brought about a clarification and not an efficient purification of the sewage. Accordingly, a long series of biological experiments was carried out, and it was ultimately decided to adopt a scheme consisting in its main features of continuous flow settling tanks on contact beds. At first it is only proposed to employ single contact; but further beds for a second contact can be added if they are required by the Local Government Board and the River Authorities. The scheme, which includes the remodelling of the present works, comprises (1) a new outfall sewer and main valve chamber, (2) two new catchpits and alterations to the two existing catchpits, (3) nine new settling tanks and the conversion of the existing tank area into 8 additional tanks; (4) deepening the two existing sludge wells and remodelling the pumping plant; (5) 60 half-acre contact beds; (6) 16 acres of storm beds; (7) bridge and syphons across the river Don; and (8) roads, railways, &c. The total estimated cost is £270,369—exclusive of land and second contact beds—and hitherto £181,120 has been borrowed. The finished works will be capable of dealing with 64½ million gallons in 24 hours, this large provision being necessary, since the Local Government Board now insist on six times the dry-weather flow being treated during periods of storm. At the present time 24 of the beds are completed in construction and 12 are filled with clinker ready for working.

THE NEW STEAMSHIP FOR THE CUNARD LINE.

IN THE ENGINEER of September 3rd reference was made to the various inaccurate statements which had then been put into circulation by several of the daily and weekly newspapers relative to the new steamship which the Cunard Company recently decided to add to its fleet. We stated that, although the contracts for the hull and machinery were let at the end of August to Swan, Hunter and Wigham Richardson, Limited, and the Wallsend Slipway and Engineering Company, Limited, no decision had then been come to respecting the precise dimensions of the vessel or the type of its machinery. These details have now been settled. The new vessel will have a length between perpendiculars of 600ft., a length overall of 622ft., a moulded breadth of 71ft., and a moulded depth to the bridge deck of 52ft. 3in. The loaded draught will be about 29ft. 6in., giving a displacement of about 24,500 tons, and a deadweight capacity of approximately 10,000 tons. The propelling machinery will consist of twin-screw quadruple-expansion engines, balanced on the Yarrow, Schlick and Tweedy system, with four cranks to each set. There will be six double-ended boilers working at a pressure of 210 lb. per square inch. The total indicated horse-power will be about 12,500. Before deciding to adopt twin-screw reciprocating engines the Cunard Company consulted the builders of the hull and engines as to the relative merits of this type of engine and turbines, and a combined system of high-pressure engines and low-pressure turbines. It is understood that one of the leading factors in the ultimate adoption of the reciprocating engines was that, whilst these are less costly, they are slightly more convenient than are engines with four propellers for docking purposes at Liverpool. The vessel will be classed 100 A1 at Lloyd's, with special survey, and she will strictly conform with the emigrant and passenger regulations of the British and United States Governments. In general design the new steamship will be a handsome and comfortable addition to the Cunard fleet. She will have two pole masts and two funnels. The ship is primarily intended for the Liverpool-Boston service, and in certain seasons she will make voyages to the Mediterranean, chiefly to take part in the emigrant trade between Hungary, Austria, Italy, and North America. There will be provided passenger accommodation about 250 first-class, 500 second-class, and 1400 third-class, and in addition there will be a further space for about 900 more emigrants, berths for whom will be fitted so soon as required. All the public rooms and the state-rooms will be commodious, and the ventilation, baths, and sanitary arrangements will be elaborated with great care. In addition to a wireless telegraphy installation, the new vessel will be fitted throughout with a complete electrical plant, including a powerful seachlight, and there will be an elaborate telephone system on board. Water-tight bulkheads will practically render the ship unsinkable, and there will be a refrigerating plant for cold storage for the ship's provisions and for carrying perishable foodstuffs in one hold. Swan, Hunter and Wigham Richardson, Limited, have had a considerable experience in the building of vessels for the Cunard fleet, as, in addition to the Mauretania, there have been completed during recent years at the Wallsend shipyard other successful Cunard ships, such as the Ivernia, Carpathia, and the Ultonia, and for each of these ships—with the exception of the Ultonia—the propelling machinery was built by the Wallsend Slipway and Engineering Company, Limited.

A BATTLESHIP FOR ARGENTINA.

ARGENTINA, fired no doubt by the example of Brazil, has determined to have at least one first-class battleship, and is now making inquiries for a ship of about 18,000 tons, with an all-big-gun armament. The details are not yet decided, but the main armament will be either 12in. or 9 2in., and probably the former, the arrangement being similar to that of the Minas Geraes and Sao Paulo, and the protection being nearly the same. An interesting fact is that the turrets are to be fitted with supplementary electrical gear on similar lines to the Invincible, the power for which will be generated by oil engines, so that they may be employed when the vessel is not under steam. It is understood that several German as well as British firms have been invited to tender for this vessel.

MATTHEW BOULTON CENTENARY.

FIFTEEN hundred men attended on Sunday, 17th inst., a service commemorative of the Matthew Boulton Centenary. This was held at the Soho Hill Chapel in connection with the men's movement there. Mr. George Tangye presided, and supporting him were Sir Oliver Lodge, Mr. Matthew Boulton, of Tew Park, Oxfordshire, great-grandson of the pioneer engineer, the Rev. James Wylie, and members of the Handsworth magistracy and District Council.

The chairman said it was close by that chapel that Boulton, Watt, and Murdock lived and died and performed their great and beneficent work—work for which all men and nations would never cease to bless them. Industrial triumphs such as those men accomplished did more to bind the people of the world together than armies and navies. What Boulton did illustrated the old scriptural saying, "No man liveth to himself," for surely without Boulton's sound judgment and organising gifts neither Watt nor Murdock would have brought to fruition their great achievements. A quotation from Boulton's writing was extremely up to date. "Let taxes," he said, "be laid upon luxuries, upon vices, and if you like upon property; tax riches when got, but not the means of getting them." He commended to them Matthew Boulton's unfailing industry, his generous sympathy with suffering, and above all his hopeful, joyous spirit.

Sir Oliver Lodge said they could not separate Boulton from the other two men with whom he worked. It was impossible to consider Boulton apart from James Watt. Their fame went together. Undoubtedly James Watt was the greater man, for he was one of the greatest scientific men of the world. Born of the poorest people, his life was for the greater part one long struggle. The workmen of his day did not give him a fair chance. He was not allowed to work until the University of Glasgow gave him a chance to pursue his inventions while he went on with the scientific instrument making by which he lived. He (Sir Oliver) was often struck with the great ability of some men engaged in this and similar handicraft occupations. He often felt that, with a chance, a helping hand, an opening, they might do a great deal more for the world than their present opportunities permitted. He hoped that gradually the conditions of society would be so improved that this might be made possible. It was a fearful waste for any social arrangements to curb and harass the few men of genius who were vouchsafed to it. Watt overcame untoward circumstances in the end, but it was through the help of Matthew Boulton that he did it. He came to Birmingham about the middle of the eighteenth century, attracted there by the skill of the artisans; for in those days Birmingham men were splendid handicraftsmen. In a sense Matthew Boulton was the father of modern industry. The factory system, for better or for worse, had not then been organised. It was, at any rate, at first a great help, and they noted with pride that the factory system was born not many hundred yards from that place—at Soho. There Boulton set up the first great works which inaugurated the modern system of manager, and foreman, and high organisation. It was in connection with that factory that Watt was attracted there, and ultimately was taken into partnership by Boulton. Watt was a scholar, a student, a quiet, shy, peaceful man of genius, not very well qualified to get on in the rough-and-tumble of the world, and inured to poverty. Boulton had become by this time a man of means, influence, generosity, hospitality. His home near there was a centre of enlightenment. He entertained Royalty; all manner of scholars who came to Birmingham made their way to Boulton's house. He had been called "the princely Boulton." The great debt they owed him, however, was that he had faith in Watt, that he helped him over his difficulties, that he risked a great amount of money, put in a great amount of work, and especially buoyed him up with encouragement. To Watt, Boulton was always a sheet anchor of hope, full of courage and determination, buoying him up with unswerving faith, invincible hope. Boulton was also the founder of the local Mint, he started many industries, was an active man of commerce, and a brilliant man of affairs. When they came to think of what the steam engine had done, they might say it was the basis, in some respects, of modern civilisation. The steam engine might sound a secular subject for a Sunday afternoon discussion. Christianity had taught them that nothing was common or secular. There was no real distinction between secular and sacred, except the vile, and everything was noble if it was properly used. It depended upon the use to which they put it. The steam engine might be called the engine of peace. It had made intercourse possible throughout the world and established friendly relations between nations who in other days knew nothing of each other, and therefore felt hostile to each other. The more they knew about the man and the nation the less they wanted to fight them.—*Birmingham Daily Post.*

ELECTRICITY IN MINES.—The Home Secretary has appointed a departmental committee to inquire into the working of the existing special rules for the use of electricity in mines, and to consider whether any, and if so, what, amendments are required. The committee is composed of:—Mr. R. A. S. Redmayne, his Majesty's Chief Inspector of Mines, chairman; Mr. Charles H. Merz, and Mr. Robert Nelson, his Majesty's Electrical Inspector of Mines. Correspondence may be addressed to Mr. Nelson at the Home-office,

THE IRON, COAL, AND GENERAL TRADES OF BIRMINGHAM, WOLVERHAMPTON, AND OTHER DISTRICTS.

(*From our own Correspondent.*)

Iron Trade Situation.

The political situation was the hindering cause at to-day's (Thursday's) Birmingham iron market. Consumers of all the commodities offered used this as an excuse for not ordering in other than small lots. The quarterly meeting still seems to have stirred trade very little, and in the manufactured iron branches over and above any other departments of the market the works are conspicuously insufficiently provided with orders. The present should be the busiest time of the year, and the works should be pushed to get stuff out; but this pleasant condition is lacking at date.

Continental Import and Bar Iron,

The bar iron makers are not experiencing a demand adequate to the capabilities of the output of the mills. Best sorts continue in steady call for cable and other superior sorts, notwithstanding the competition of mild steel, at £8 per ton, with 12s. 6d. extra for the make of Lord Ward. Second grade branded qualities are £7. Merchant unmarked bars keep at £6 2s. 6d. to £6 5s. per ton, and common £6, or rather less. The revival in the manufactured iron and steel trades of the Continent is favourable to the local chances of the last-named branch, since South Staffordshire common bar makers will now have a better opportunity of keeping orders at home. But, when all is said and done, Belgian bar prices in particular will take a lot of beating, and it is a great temptation to some of the district industries to use up this material.

Sheets Quieter.

The galvanised sheet trade, there is some reason to fear, is not doing fully so well as lately. Demand seems to be losing ground a little, and galvanisers are less busy, in respect of new orders at any rate, than they have recently been. This afternoon some of the larger houses seemed, in consequence, to be scarcely so firm in their quotations. The competition of the merchants in offering prompt supplies at terms below makers' has also weakened the market. Buyers cannot now generally be induced to pay makers' figures of £11 5s. to £11 10s. for 24 w.g. corrugated sheets, f.o.b. Liverpool, or equal, save under very exceptional circumstances. There were plenty of good sheets obtainable on the Exchange at fully 5s. per ton below the first-named figure, to say nothing of the £11 10s. quotation. Spelter is firm, recent improved prices being maintained. Good qualities are quoted £23 2s. 6d. to £23 5s. London, and special sorts £23 10s. to £24. The black sheet trade for merchant and galvanising purposes, whether iron or steel be spoken of, is decidedly slack, and some of the works are not engaged more than three or four days a week. Prices as a result do not rise above £7 for 20 w.g., £7 2s. 6d. to £7 5s. for 24 w.g., and £7 15s. to £7 17s, 6d. for 27 and 28 w.g. black material ready for going into the galvanising pots.

Other Prices.

Current prices of other descriptions of rolled iron are £6 15s. for hoops, £6 5s. and £6 7s. 6d. for tube strip, according to size of orders, £6 15s. to £7 for rivet iron, and £7 for nail rods.

Raw Iron.

Pig iron prices, whether of Staffordshire or Midland sorts, are fairly maintained, notwithstanding a distinct paucity of fresh buying by consumers hereabouts. This strength of the raw iron trade was, indeed, this afternoon altogether the best feature of the Birmingham market, and buyers must not expect to see prices much lower, with hard coke values tending upwards as now. Much was made by some Midland sellers, who can ship easily by America, of the buying which, it is understood, is going on in some other parts of the kingdom, but older hands hesitated to place too much reliance upon the prophecies indulged concerning an expansion of the present demand into considerably larger proportions. Current values were named as:—Common forge iron (Staffordshire make), 47s. to 48s.; part-mine, 50s. 6d. to 51s. 6d.; best hot air all-mine, 85s.; and foundry all-mine, 90s. per ton. Midland pigs were: Northampton forge, 49s. to 50s.; Derbyshire, 50s. to 51s.; and North Staffordshire, 51s. 6d. to 52s. 6d. ordinary, 58s. to 59s. best.

Steel.

There is no conspicuous change in the steel trade. Increased orders would be very welcome for some of the finished products of the local mills, which, when the bridge and roofing and railway wagon and kindred engineering trades are in a satisfactory condition as regards the arrival of paying contracts in good numbers, made up of home and oversea demands alike, are always busy. Happily, the call for steel half products is generally good at date—decidedly better than the inquiry for manufactured material. Quotations are:—Bessemer sheet bars, £4 15s.; Siemens sheet bars, £4 17s. 6d.; angles, £5 17s. 6d. to £6; girder plates, £6 to £6 2s. 6d.; boiler plates, £7 5s.; joists, £5 15s. to £6; mild bars, £6 7s. 6d. to £6 17s. 6d. It is reported that, following the example set by the British joist makers, the continental joist firms have just raised their basis price from £5 to £5 4s. per ton f.o.b. This, it is understood, brings the price of continental joists to £4 11s. to £4 14s. f.o.b. Antwerp, while for general export business the price ranges from £4 15s. per ton upwards.

Advance in Chilled Rolls.

The South Staffordshire Ironfounders' Association have resolved to advance the price of chilled iron and steelworks rolls, part-chilled rolls, and soft rolls 10s. per ton, and of grain and grooved rolls, and all other iron and steelworks forge castings 5s. per ton. The advance is the direct result of the step which the Staffordshire all-mine pig iron makers took a couple of months ago in declaring an increase in prices of 5s. per ton. For some weeks the founders have been complaining of the higher prices which they have had to pay for the best foundry irons of other districts. It is anticipated that roll prices in the Middlesbrough district will now also be declared up.

NOTES FROM LANCASHIRE.

(*From our own Correspondent.*)

MANCHESTER, Thursday.

Gloomy Outlook in Pig Iron.

THE month closes with a gloomy outlook so far as pig iron is concerned. In the opening week there was a buoyant feeling, caused by strong American advices, coupled with reported sales for shipment thence. This to some extent reacted here, but on the easier advices from the States there was some decline. In English brands, such as Lincolnshire, Staffordshire, and Derbyshire, there has not been much change, but Middlesbrough shows a decline at the close of 1s. to 1s. 6d. per ton. On the other hand, owing to scarcity, Glengarnock was quoted 1s. per ton more for delivery here, and that has been maintained, but Eglinton and Gartsherrie are 6d. to 9d. lower. Dalmellington has not been quoted since the beginning of September. West Coast hematite shows the greatest decline—about 2s. per ton as compared with the opening weeks of October, but the close is somewhat better—East Coast is practically unchanged, and fairly steady, but Scotch is 6d. under the price of the beginning of the month. Forge iron has been somewhat dull, and is generally 1s. 6d. per ton lower, but 6d. higher than in the middle of September. Altogether, the tone on the Iron Exchange here on Tuesday was dull, and no great business was reported in any department.

Finished Iron and Steel.

Although manufacturing fuel has been advanced in the Lancashire district, there has been no move on the part of makers in the direction of higher prices. It is probable that the state of the market does not warrant any advance. Steel is in fair demand for semi-manufactured stuff, but finished is rather quiet.

Copper, Brass, Lead, and Tin.

Copper and brass remain practically unchanged, with slow inquiry all round. Lead, steady. Tin, English ingots a shade lower on the week.

Quotations.

Lincolnshire, No. 3 foundry, 56s.; Staffordshire, 54s.; Derbyshire, 55s.; Middlesbrough, open brands, 60s. 1d. Scotch: Gartsherrie, 62s. 6d.; Glengarnock, 62s; Eglinton, 60s., delivered Manchester. West Coast hematite, 62s.; East Coast ditto, 60s., both f.o.t. Delivered Heysham: Gartsherrie, 60s. 6d.; Glengarnock, 60s.; Eglinton, 58s. Delivered Preston: Gartsherrie, 61s. 6d.; Glengarnock, 61s.; Eglinton, 59s. Finished iron: Bars, £6 10s.; hoops, £7 12s. 6d.; sheets, £7 15s. to £8. Steel: Bars, £6 2s. 6d. to £6 5s.; Lancashire hoops, £7 5s.; Staffordshire ditto, £6 17s. 6d. to £7; sheets, £7 17s. 6d. to £8; boiler plates, £7 5s. to £7 7s. 6d.; plates for tank, girder, and bridge work, £6 5s. to £6 7s. 6d.; English billets, £4 12s. 6d. to £4 15s.; foreign ditto, £4 10s. to £4 15s.; cold-drawn steel, £9 10s. to £9 15s. Copper: Sheets, £70; tough ingot, £61 10s.; best selected, £61 10s. per ton. Copper tubes, 8½d.; brass tubes, 6⅞d.; condenser, 7⅞d.; rolled brass, 6¼d.; brass wire, 6½d.; brass turning rods, 6½d.; yellow metal, 5⅞d. per lb. Sheet lead, £17 per ton. English tin ingots, £135 10s. per ton.

The Lancashire Coal Trade.

An important meeting of colliery proprietors was held in Manchester on Tuesday, and it was decided that no advance should be made in the price of house coal. This will be regarded with satisfaction by merchants, and infuse greater confidence in the local trade. The recent advance in steam and manufacturing coal, however, will be maintained for the present. Meanwhile quotations are repeated.

BARROW-IN-FURNESS, Thursday.

Hematites.

There is not much change to note in the hematite pig iron trade. The demand for prompt deliveries remains quiet, but there are many inquiries for deliveries in the early months of next year, and these are growing, as buyers begin to recognise the practical certainty that an expansion of business must ere long assert itself. This is assured from a variety of sources, among which may be mentioned the increased activity in naval shipbuilding which will ensue in the course of two or three months and the reopening of business relations with America. An order for 4000 tons of hematite iron for America has been booked this week, and it is generally believed this is but the forerunner of other orders which are likely to follow. Of late not much business has been done with the Continent, but it is stated that German and other buyers will soon require fuller deliveries of metal. On the other hand, there is a good business at present in crude iron for steel-making purposes, and there is anticipated to be an expansion of requirements under this head. Special hematite iron is in fuller request, and there is a steady trade in ferro-manganese and spiegeleisen. Prices are steady at 62s. 6d. for mixed Bessemer numbers net f.o.b., and 63s. to 65s. three months. Warrant iron, 61s. 6d. net cash sellers. Iron ore is in better demand at late prices.

Steel.

There is continued activity in the Bessemer department of the steel trade, and orders are coming in which seem to justify the belief that the mills will be kept going on full time for an indefinite period. Heavy rails remain at £5 5s. per ton. Merchant steel is in better request. Plates are not being made in this district at present, but it is anticipated that orders will soon be more plentiful at prices which will enable makers to restart their mills. Ship plates are at £6 net cash.

Shipbuilding and Engineering.

Shipbuilders are busier than they have been for some time past, but are still in need of orders, and lately they have been tendering for some heavy work on home and foreign account. The British battleship Vanguard left Barrow for her trials on Thursday. She was laid down in April of last year, and represents the record of construction of a heavy battleship like this. H.M.S. Liverpool will be launched at Barrow on Saturday. Engineers will be very busy soon in all departments.

Shipping and Coal.

The exports of iron and steel from West Coast ports last week amounted to 13,165 tons—iron 6765 tons, and steel 6400 tons—against 6077 tons in the corresponding week of last year, an increase of 7088 tons. The shipments up to date aggregate at 504,018 tons, against 396,839 tons for the corresponding period of last year, an increase of 107,179 tons. Coal and coke are firmer, and in better demand.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

The Business Position.

MOST of the collieries are working good time. The cessation of shipping orders, however, has thrown a number on shorter working than was the case some weeks back. The frequent stoppages since July 1st have caused a few arrears in manufacturing and railway orders, and it is chiefly these that are providing work. In the general trades of the city, both heavy and light, affairs are very much as previously reported. The iron market is practically featureless. It has been thought that the reduction in duty in the United States on pig iron would enlarge the area of export, and inquiries have been received from places farther inland than previously; but the trade has not yet come to hand.

Steam Coal—Next Year's Contracts.

There is no change to report in steam coal. Inquiries are being made for next year, but we do not hear of any contracts being recorded as yet. It is expected that better prices will be obtained for next year's trade than have been realised in the past twelve months. It is not anticipated that there will be an equal quantity of coal to be disposed of, owing chiefly to the diminished output through the operation of the Eight Hours Act, which in Yorkshire and Derbyshire, it is estimated, will affect the tonnage brought to bank from 10 to 15 per cent. The shipping season, so far as the Baltic is concerned, may be said to be practically closed. A fair business continues to be done with continental and more distant markets.

House Coal Continues Firm.

House coal is more freely inquired for this week, owing to the accession of more seasonable weather. The advance usual at this period of the year, 1s. per ton, is being obtained, but no official pronouncement of a general rise in quotations has yet been made. We do not hear, however, of any forward buying. The present demand is, for the most part, in the superior qualities, best Barnsley making from 11s. 6d. to 13s. per ton, and secondary sorts from 10s. to 11s. per ton. Gas fuels are in very steady delivery, and the weights forwarded are increasing, as is usual at this season of the year.

Good Demand for Small Coal and Coke.

The deliveries to the textile districts of Lancashire and Yorkshire are fully maintained, the qualities of small coal used for steam-producing purposes there commanding from 4s. 6d. to 5s. 6d. per ton, with a ready market for all that is produced. Inferior material, however, continues to be in light request. Coke is steady, with a firm tendency, the increase of 6d. per ton on best washed, making the price 13s. per ton for forward contracts, being realised. Business for present requirements is done at former rates—12s. 6d. per ton for best washed and 11s. to 11s. 6d. per ton for unwashed.

Iron Prices Unchanged.

Hematites continue pretty much as reported last week, West Coast making 68s. to 70s. per ton; East Coast, 65s. to 67s. per ton, both net, delivered in Sheffield and Rotherham. The business in hematites is still restricted to immediate requirements, there being little done on forward account. The Lincolnshire Ironmasters' Association meet on the 29th inst., but we do not hear that any change is anticipated, the feeling being that lowering of prices would not induce further buying, and there is no prospect of putting them up. Deliveries are somewhat better this week, but they are probably going partly into stock, as there is still a lack of specifications to work up the raw material. There is not much iron for disposal just now, makers being well sold forward and shipping having been a litter brisker. Quotations:—Lincolnshire, No. 3 foundry, 52s. 6d. per ton; No. 4 foundry, 51s. 6d. per ton; No. 4 forge, 51s. 6d. per ton; No. 5 forge, mottled and white, 51s. 6d. per ton; basic, 52s. 6d. per ton, delivered in Sheffield and Rotherham. Business for next year is only accepted by makers at a premium of 1s. 6d. to 2s. per ton on current quotations for the first six months of 1910. A little more is doing in Derbyshire irons, but makers are not pressing sales at all, what is doing being chiefly the renewing of contracts, which are somewhat more frequent. Derbyshire, No. 3 foundry, 52s. per ton; No. 4 forge, 50s. 6d. per ton, both net, delivered in Sheffield and Rotherham.

Finished Iron, &c.

Quietude still pervades the finished iron and kindred departments. Bar iron and hoops very dull, with little indication of any improvement in the early future. Bars, £6 10s. per ton; hoops, £7 10s. per ton; sheets, £8 10s. per ton. From Derby and district it is reported that foundry work is slack, with less doing in heavy water pipes and fittings, but electrical fittings, such as standards, stanchions, &c., well called for.

The Heavy Industries.

The large establishments at the East End continue as formerly reported. Nothing further has yet been heard of the earlier placing of the four contingent Dreadnoughts referred to last week. With regard to that report, the opinion we hear expressed is that probably the original date given for placing these battleships, which was about April next, will be adhered to. Inquiries for engineering and marine castings are a little more general, and several manufacturers are working better time, mostly on repair orders or replacements. Very little new work of an important character is at present in the market. Railway material is again somewhat less in demand, the larger orders for replacements already mentioned having been worked off. The market for railway manufactures is dull, both on home and foreign account. The better qualities of steel continue in fair demand, both for home and foreign consumption, but nothing of a nature to keep plants in full operation.

NORTH OF ENGLAND.

(*From our own Correspondent.*)

Shipbuilding.

GOOD accounts are given from all parts of the district about the condition of the shipbuilding industry. There is a most promising revival, and prospects are decidedly favourable. The upward tendency of prices is bringing forward a good many of the owners of steamship lines, who are getting rid of their older vessels and substituting new first-class steamers which can be run economically and realise profits at rates of freight which would mean loss to the old steamers. What is also strengthening the shipbuilding trade is the large tonnage of war vessels that are building or to be built for our own and other Governments. That helps to fill up the yards, and enables builders to secure better prices for merchant steamers. Among the important orders expected to be given out very shortly are those for the additional four Dreadnoughts for the British Admiralty, also for two floating docks. The Argentine Government are about to order two Dreadnoughts, and it is expected that Canada and Australia will have some orders to give out. In respect to merchant steamers, Messrs. Swan, Hunter and Wigham Richardson, on the Tyne, have secured an order for a large steamer for the Transport Maritimes of Marseilles, and contracts have been entered into for the building at Sir W. G. Armstrong, Whitworth and Co.'s Walker Yard of four 10,000-ton iron ore carriers, two for P. A. Grön, of Sandefjord, and two for Herr Klaveness, of Christiania. In view of the good time, which it is fully anticipated is now coming, extensions of shipyards on Tyneside are being proceeded with. Armstrongs are enlarging their Walker yard, and Messrs. R. and W. Hawthorn, Leslie and Co., at St. Peter's, have decided to add the repairing yard of the late Tyne General Ferry Company to their premises. The Wallsend Slipway and Engineering Company is replacing its old sheer legs by a large cantilever crane. On the Tees the shipping community are agitating for the provision of better facilities at Middlesbrough Dock, especially for the bunkering of steamers and for the erection of coaling staiths in the river. It is held that the existing dock will have to be extended, or new docks or deep water wharves constructed down below Eston and nearer the sea.

Cleveland Pig Iron.

This week has been a quiet one, but it cannot be reported that the actual condition or prospects of the pig iron trade are any less favourable. The cause of the slackness is the state of the money market. The further advance of the Bank rate to 5 per cent. has somewhat disorganised business, and buyers have thought it best to hold off. The action of the Bank has certainly had the effect of curtailing speculative transactions, and weak holders of pig iron warrants have been keen to sell out during the last few days, more especially as they might probably have to wait longer than they have expected before profits could be realised. The reports from the United States are not quite so highly coloured as they have been, and this week inquiries from consumers and merchants over there have become less numerous, while no further orders have been booked. So far the quantity of iron sold from this district to the States has been small, but traders believe that a large tonnage will before long be called for, as though production over there is considerably in excess of the maximum of 1907, and yet some consumers have difficulty in getting all that they need. It is the expectation of what the United States will require from this country that reconciles traders to the rapid accumulation of the stock of Cleveland pig iron in Connal's store, and certainly if America buys on anything like the scale that was reported in 1906 and 1907, Connal's stock would soon be reduced to small dimensions again. The advance in the Bank rate has not, however, weakened prices of pig iron to the extent anticipated, and there is some recovery of tone to be reported. No. 3 Cleveland G.M.B. pig iron for early f.o.b. delivery has mostly been sold this week at 51s. 6d. per ton, while for delivery over the first quarter of next year 52s. 3d. was the rate, though there were some brands forthcoming at 52s. for forward. No. 1 for prompt delivery realises 54s.; No. 4 foundry, 50s.; No. 4 forge, 49s. 6d.; mottled, 49s.; and white, 48s. 6d. Cleveland warrants have fluctuated about 51s. 3d. cash buyers, but it is noticeable that the contango for three months, which has hitherto been about 8d. per ton, has this week been as high as 1s. 2d. per ton.

Hematite Pig Iron.

Few orders have been secured this week, but makers are well off for contracts, and prices are as strong as ever, because prospects are altogether encouraging, and consumers are only following their usual course, buying heavily for a short time and then doing no more for weeks. The state of the branches of industry which consume hematite pig iron is showing marked improvement, and it is likely that no difficulty will be experienced in disposing of all the hematite iron that is produced. Quotations are steady, and are not affected by speculation, there being no stocks with which to gamble. The export demand is increasing, and good shipments have been made to the United States, Canada, and Italy. Makers are asking 60s. per ton for early deliveries of mixed numbers, while 62s. 6d. is the figure for the first quarter of next year, and 65s. for the first half-year. Very little iron can be got from second hands now at 59s. 6d. for immediate delivery, for most merchants are as firm as the makers themselves. Rubio ore is nominally at 17s. per ton c.i.f. Tees for prompt delivery. For next year's delivery sellers will not quote. Coke prices are increasing, as a more active trade is being done both on home and export account. Most sellers have put furnace coke for early delivery equal to Middlesbrough up to 17s. 3d. per ton.

Shipments of Pig Iron.

Among the most satisfactory features of the pig iron trade are the large shipments; they are this month the best of any reported in any month this year except April, and are likely to continue good for the next three or four weeks if the weather keeps open. Shippers are getting away all the iron they can without delay, as the ports in Northern Europe will soon be closed. The exports this month have reached 107,492 tons, as compared with 81,075 tons last month, 86,017 tons in October last year, and 124,144 tons in October, 1907, all to 27th.

Pig Iron Stocks.

The stock of Cleveland pig iron in Connal's public store continues to increase, but not so rapidly as in the first half of the month, and it is hoped that before long the stock will be substantially reduced, as it was in 1906, when the American demand sprang up. The stock held on Wednesday was 336.078 tons, an increase this month of 22,103 tons. It consisted of 309,893 tons of No. 3; 23,275 tons of other iron deliverable as standard; and 2190 tons of iron undeliverable as standard. Makers are believed to be reducing their stocks, but definite particulars are not obtainable.

Manufactured Iron and Steel.

The position of producers of finished iron and steel may be described as generally favourable; they are more fully supplied with orders than has been the case for a long time, and certainly the output at most works has satisfactorily increased. But that has not led to any advances in quotations, for consumers are still slow about paying the rates that are now asked. Steel and iron ship plates are at £6; steel ship angles, £5 7s. 6d.; iron ship angles, £7; steel bars, £6; iron bars, £7; packing iron and steel, £5 5s.; steel hoops, £6 5s.; steel strip, £6 2s. 6d.; steel sheets (singles), £7 10s.; iron ship rivets, £7 10s; steel joists, £5 12s. 6d., all for fair quantities, f.o.t., less 2½ per cent. Galvanised and corrugated iron or steel sheets are at £11 5s., less 4 per cent. f.o.b. Where consumers only are wanted, buyers have to pay more than the above-named prices. Heavy steel rails are steady at £5 5s. net f.o.b., and cast iron railway chairs are at £3 10s. net f.o.b. Somewhat active exports of rails, galvanised sheets, joists, and bars are reported. Mr. Douglas Upton, who was formerly at the Stockton Malleable Works, and afterwards iron and steel works manager at Palmer's Shipbuilding and Iron Company's works at Jarrow-on-Tyne, has been appointed works manager at the Newport Rolling Mills, Middlesbrough.

Coal and Coke.

This month the steam coal trade in the North-East of England has been quiet, pressure of demand has slackened considerably, and easier prices now rule. Best steam coal can readily be got at 10s. 3d. per ton; seconds at 9s; and smalls vary from 4s. 9d. to 6s. 3d., all f.o.b.; figures half-a-crown per ton below those reported in the spring and early summer. German coal, of which there are large stocks, especially in Westphalia, are competing strongly with Durham and Northumberland coal, and the colliery owners there have secured orders for next year from customers who have always hitherto bought from this district. German sellers are accepting very low prices; lower than English firms would take. Gas coals are in fair request, and the supply is not in excess of the requirements; for best qualities 10s. 10½d. per ton f.o.b. is being realised, or more than will be given for steam coals, while seconds are at 10s. Coking coals are selling freely, especially for export, and 9s. 6d. to 10s. can be realised for them. The price of furnace coke has gone up to 17s. 3d. per ton delivered at Middlesbrough up to the end of the year.

NOTES FROM SCOTLAND.

(*From our own Correspondent.*)

The Business Outlook.

The impression gains ground that there is not likely to be a boom in business at present, apart from what may happen in the speculative markets. It is regarded as all but certain that whatever improvement takes place in mercantile and industrial circles will be gradual, and probably subject to occasional arrest, if not reaction. The increase in the Bank rate, which is already curbing the rising speculative excitement, will also, it is feared, tend somewhat to retard the natural expansion of legitimate enterprise; but the upward movement in the prices of raw material has been checked, so that manufacturers are, for the time at least, relieved from the apprehension that rapid increase of costs would make profitable contracts impossible. It is probable, therefore, that the halt in the iron and other markets may prove advantageous rather than otherwise.

The Pig Iron Market.

The prices of warrants fell off to some extent at the end of last week as a result of dearer money. Carrying of warrants was rendered more onerous, and it was understood that holders in some cases were anxious to get out of their commitments. But the fall in prices did not go beyond 6d. to 8d. per ton, and about a half of this was recovered early in the week. Business has been done in Cleveland warrants since last report from 51s. 7½d. to 50s. 11d., from 51s. 4d. to 51s. 1d. and 51s. cash; at 51s. 10d. to 51s. 3½d., rising to 51s. 8d., and back to 51s. 6d. one month; the three months' fluctuations being 52s. 7½d. to 52s. 1d. and 52s. 5½d. to 52s. 4½d. Sales for fixed dates took place at 51s. 4d. for delivery in eleven days, 51s. 3½d. fifteen days, 51s. 6d. sixteen days, and 51s. 3d. twenty-two days. There has been more demand for future delivery than for cash, and this is regarded as a favourable feature of the market. A report that a large amount of Cleveland iron had been secured for Germany through London merchants has helped to steady the market, which will, it is believed, for some time be subject to occasional depression from realisations that will take place by holders obliged from monetary considerations to dispose of their warrants.

Scotch Makers' Iron.

The inquiry for Scotch pig iron appears to be on a moderate scale. The quantities sent abroad are still too small to justify the reports of large purchases current some time ago. Fresh business on home account is quiet, but the makers are understood to have good contracts in hand that were formerly arranged. The four furnaces that were put out at Dalmellington Ironworks several weeks ago for repairs are again in operation. There are now 42 furnaces making hematite, 35 ordinary, and 5 basic iron, the total of 82 furnaces thus in operation in Scotland, comparing with 78 last week and 77 at this time last year. Prices of makers' iron are generally steady. Govan, f.a.s. at Glasgow, No. 1, is quoted 58s. 6d.; No. 3, 56s.; Monkland, No. 1, 58s. 6d.; No. 3, 56s. 6d.; Carnbroe, No. 1, 61s.; No. 3, 58s.; Clyde, No. 1, 63s.; No. 3, 58s.; Gartsherrie and Calder, Nos. 1, 63s. 6d.; Nos. 3, 58s. 6d.; Langloan, No. 1, 65s.; No. 3, 60s.; Summerlee, No. 1, 65s. 6d.; No. 3, 60s.; Coltness, No. 1, 90s.; No. 3, 59s. 6d.; Eglinton, at Ardrossan or Troon, No. 1, 58s. 6d.; No. 3, 56s. 6d.; Glengarnock, at Ardrossan, No. 1, 65s.; No. 3, 59s. 6d.; Dalmellington, at Ayr, No. 1, 62s; No. 3, 57s.; Shotts, at Glasgow or Leith, No. 1, 63s 6d.; No. 3, 58s 6d.; Carron, at Grangemouth, No. 1, 65s. 6d.; No. 3, 59s. 6d. per ton.

Hematite Pig Iron.

It was reported on 'Change in Glasgow that a local firm had contracted to supply 4000 tons of Cleveland hematite pig iron to consumers in the United States. The iron is to be despatched in the early part of next year in convenient lots by the ordinary liners as it may be required. This transaction, it will be seen, does not suggest that there is any extensive or immediate demand for British iron in the United States; but it may be a case that will suggest other business of a similar nature, if, indeed, it is not one of several that may be already either arranged or in contemplation. The needs of America and relative prices will regulate and possibly minimise the export of British iron to the States. There has been little or no inquiry for Cumberland hematite, but the price of warrants has in the last few days fallen 6d. per ton to 60s. 9d. Scotch hematite warrants are quoted by merchants 63s. 6d. for delivery at the West of Scotland steel works, but it is understood that makers, or at least some of them, are asking 1s. to 1s. 6d. more.

Pig Iron Shipments.

The current shipments of Scotch pig iron are small, amounting in the past week to only 4961 tons, which is 1386 tons less than in the same week last year. Arrivals of Cleveland pig iron in Scotland were also light, amounting to 6649 tons, compared with 7960 tons in the corresponding week of 1908.

Finished Iron and Steel.

There has been a moderate inquiry for steel this week, but the specifications available for shipbuilding material are still disappointing, and the work on the whole is insufficient to keep machinery regularly employed. The demand for miscellaneous goods for export is encouraging, and the impression is growing that ere long there will be a better business in the steel industry. Finished iron is dull, and works are still obliged to run short time.

The Coal Trade.

The coal trade is still indifferently employed in some districts, whilst in others the increased call for household sorts has been reducing idle days and giving a little more tone to the business. Shipments have turned out better than was expected, and prices of shipping coal are without material alteration.

WALES AND ADJOINING COUNTIES.

(*From our own Correspondent.*)

Last Week's Coal Trade.

On several days there was a great falling off in the number of vessels cleared at Cardiff, and one peculiarity was—few vessels and large cargoes. One day 7000 tons coal went to Colombo and 7000 to Port Said, and on the same day four vessels were cleared with 5000 tons each and two with 4000. That Welsh coal is in demand has been several times shown by great clearance, such as 90,000 tons dispatched at the close of last week, but the regular and prompt business was small; contract business at times was large. Business was very seriously blocked by the weather, which throughout has been of a stormy character, and though the list of damaged shipping was not a long one, the interference with trade and general upset at collieries, offices, and docks were marked. Pit stoppages were frequent and accumulation of wagons very great in all quarters. Prices were not much affected, coalowners relying upon a speedy change, and though quotations were given out as usual - round about 17s. for best steam—there was not much difficulty in getting slight concessions. Swansea fared better than other ports in its dispatch, and the trade was satisfactory, showing an increase of 10,000 tons, as compared with corresponding week. Steam, seconds—Cardiff and Newport—and smalls showed weakness; bunker smalls fairly steady. Bituminous coal has not had much animation, such as is usually experienced when winter supplies are in consideration. This, again, is due to the weather. Next month is expected to strengthen house coal.

Latest Coal Quotations at Cardiff.

The continuance of storms is again telling seriously upon the port; the number of vessels in dock is lower than has been the case for a long time. Sharp rise is taking place in pitwood. Best smalls are steadier. Best steam coal, 16s. 9d. to 17s. 3d.; best seconds, 16s. to 16s. 3d.; seconds, 15s. 6d. to 16s.; ordinaries, 14s. 9d. to 15s. 3d.; best drys, 16s. to 16s. 6d.; ordinary drys, 14s. to 14s. 3d.; best washed nuts, 14s. to 14s. 6d.; seconds, 13s. to 13s. 6d.; best washed peas, 12s. 6d. to 13s.; seconds, 11s. to 12s.; very best smalls, 8s. 3d. to 8s. 9d.; best ordinaries, 6s. 6d. to 7s. 3d.; inferior sorts, 6s. to 6s. 3d.; very best Monmouthshire black vein, 15s. to 15s. 6d.; ordinary Western Valleys, 14s. to 14s. 6d.; best Eastern Valleys, 13s. to 13s. 6d.; seconds, 12s. 6d. to 13s. Bituminous coal: Very best households, 17s. to 18s.; best ordinaries, 15s. to 16s.; No. 3 Rhondda, 17s. 3d. to 17s. 6d.; brush, 13s. 6d. to 13s. 9d.; smalls, 10s. to 10s. 6d.; No. 2 Rhondda, 12s. to 12s. 6d.; through, 9s. 6d. to 10s.; smalls, 7s. to 7s. 3d. Patent fuel, 15s. to 16s. Pitwood, 19s. 3d. to 19s. 9d. Coke: Special foundry, 24s. 6d. to 28s.; foundry, 19s. to 22s.; furnace, 17s. 3d. to 18s.

Newport Coal Trade.

Latest tonnage arrivals very small. Port is suffering from severe weather. Steam coal market weaker, but little change in forward quotations. Coal supplies heavy and much shortage of wagons. Best Newport black vein, 14s. 9d. to 15s. 3d.; Western Valleys, 13s. 9d. to 14s. 3d.; Eastern Valleys, 12s. 9d. to 13s. 3d.; other sorts, 12s. 3d. to 12s. 6d.; best smalls, 6s. 9d. to 7s. 3d.; seconds, 6s. 3d. to 6s. 6d.; inferiors, 5s. 9d. to 6s. 3d. Bituminous coal: Best house coal, 15s. to 15s. 6d.; seconds, 14s. to 14s. 6d. Patent fuel, 15s. to 15s. 6d. Coke: Foundry, 18s. 6d. to 19s.; furnace, 17s. to 17s. 6d. Pitwood, 19s. 3d. to 19s. 9d.

Swansea Coal—Anthracite.

Bad weather has hampered trade to some extent. The effect of the weather has been to throw a good deal of coal upon the market, and values have weakened. Beans are firm, rubbly culm weak, duff very dull, and orders are in great request to clear wagons. Latest:—Best malting, 24s. to 25s., hand-picked, net; second malting, large, 21s. 6d. to 22s. 6d. net; big vein, 18s. to 20s., less 2½; red vein, 12s. 6d. to 13s. 6d., less 2½; machine-made cobbles, 23s. 6d. to 24s. 6d. net; Paris nuts, 26s. to 27s. net; French nuts, 26s. to 27s. net; German nuts, same; beans, 17s. 6d. to 18s. 6d. net; machine-made large peas, 11s. to 12s. 6d. net: fine peas, 10s. 6d. to 11s. net; rubbly culm, 5s. 3d. to 5s. 6d., less 2½; duff. 2s. 6d. to 3s. Other coals: Best steam, 17s. to 18s.; seconds, 14s. 6d. to 15s.; bunkers, 9s. 6d. to 10s. 6d.; small, 7s. 6d. to 9s. 6d. Bituminous: No. 3 Rhondda, 18s. to 18s. 6d.; through, 14s. 9d. to 15s. 6d.; small, 10s. 6d. to 11s., all less 2½. Patent fuel, 13s. 6d. to 14s. less 2½.

New Coal Contracts.

The Paris-Lyons-Mediterranée Railway authorities have contracted with the Société Commerciale for 81,000 tons Newport large coal at about 26f., delivery December to August next, Marseilles; and with Pyman, Watson and Co. for 79,000 tons Cardiff or Newport smalls at 21.25f., delivery between January and December next. They are also understood to have bought 36,000 tons Cardiff Crown Arrow and Star patent fuel on the basis of 25f., delivered into trucks. The coals to be shipped are principally Monmouthshire ordinary Western Valleys for Newport loading. A late quotation for these is 14s. to 14s. 3d. It was said on 'Change that 25 80f. has been named as the figure for large coal in the P.L.M. contract; but uncertainty exists, and trustworthy figures are not expected until the close of the week.

Iron and Steel.

Severe depression continues. The dispatch of cargoes of rails was limited to one, and the import of steel and of pig iron was very limited. Blaenavon and Ebbw Vale received an average quantity of iron ore. In the Llanelly district it was currently reported that there was an improvement in the steel trade, a stiffening of prices being noted. The local works are in full operation; 100 tons of coke went from Cardiff to Bombay this week, and another large cargo later. At the Dowlais works, where now and then large cargoes of rails have been dispatched on the Indian railway account, the slackness of work is shown by the employment of men being confined to one or two days per week. Reports were current in Dowlais this week that an important fresh area of coal, including some of the lower seams, has been won. This, if true, will be a welcome addition to the seams now being worked. At Smith's Exchange, Swansea, the following prices were quoted:—Pig iron: Hematite, mixed numbers, 60s. 9d. cash and month; Middlesbrough, 51s. 3d. cash, 51s. 7d. month; Scotch, 57s. 3d. cash and month; Welsh hematite, 66s. to 67s. 6d. delivered; East Coast hematite, 64s. to 65s. c.i.f.; steel bars, £4 15s. per ton, Siemens; Bessemer, £4 12s. 6d. to £4 15s. Other quotations:—Block tin, £138 7s. 6d. cash, £140 2s. 6d. three months; copper, £56 8s. 9d. cash, £57s. 10s. three months; lead, English, £13 12s. 6d.; Spanish, £13 2s. 6d.; spelter, £23 5s.; silver, 23¼d. per ounce; Rubio ore, 16s. 6d. to 17s., Cardiff and Newport.

Tin-plate.

This industry continues active and prosperous. Fully 90,000 boxes were received from the works, and 117,943 boxes were shipped, stocks remaining at 93,082 boxes. In the Swansea district the yield of steel ingots compared well with any similar period of the past quarter, but the outside demand for tin bars was much below the regular capacity of the bar rolling mills of the district. Working in such cases has been irregular—four or five days only have been worked. The machinery and tin mills recently erected at the Midland tin-plate works give fullest satisfaction. At Llanelly the extensions of St. David's tin-plate works are now complete. Fires were lit for the first time under the new boilers on Friday, and it is expected that rolling will begin in four of the new mills in three weeks' time. Here, as elsewhere, the tin-plate market continues firm. Inquiries are numerous and prices well maintained.

Latest Prices Swansea.

Continuance of a steady market. No change in prices or in general conditions. Ordinary Bessemer plate, I.C. 20 × 112 sheets, 12s. 4½d. to 12s. 6d. Siemens the same. I.C. ternes, 28 × 20 × 112, 22s.; C.A. roofing sheets, £8 10s. to £8 15s. per ton; big sheets for galvanising, £8 10s.; finished black plates, £9 10s. to £9 15s.; galvanised sheets, 24 g., £11 to £11 5s.

Question of Overtime Payments in Coal.

At a conciliation meeting in Cardiff on Tuesday an agreement was satisfactorily settled upon by the committee that, in all cases of dispute in regard to the payment for overtime, the men should be paid for two months from the date at which the dispute should have been referred to the joint committee. In the event of the workmen being found to be in the wrong they will receive no payment. At the conclusion it was asked if the workmen would settle the cases at the collieries, and the reply was they could, and that it would be desirable.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

The National Electrical Manufacturers' Association.—The next Committee meeting of this Association will be held on Tuesday, November 9th, at Balfour House, Finsbury-pavement, E.C.

Blackstone and Co., Limited, of Stamford, were awarded a diploma for their new patented side-delivery rake at the special field trials held by the judges of the Royal Agricultural Society of Germany in September last in connection with the annual exhibition.

The Council of the Bristol University, with the concurrence of the Society of Merchant Venturers, has appointed Mr. Albert Player Isaac Cotterell, M. Inst. C.E., as Lecturer on Sanitary Engineering in the Faculty of Engineering, which is provided and maintained in the Merchant Venturers' Technical College.

Contracts.—André Citroën and Co. have just received a large order for their machine-cut double helical gears in connection with South African hoists.—The Stirling Boiler Company, Limited, informs us that it has secured repeat orders for seven boilers, as follows:—Two for the Indian State Railways, two for the Fulham Electricity Works, and one each for the Copenhagen Tramways, the Newcastle and District Electric Lighting Company, Limited, and the Borough of Partick. It has also received orders from the Ashton-under-Lyne Electricity Works, and the General Post-office for one boiler each.—We are advised by Fawcett, Preston and Co., Limited, of Liverpool, that they are the successful tenderers for the complete machinery and other plant for the sugar factory which is about to be installed on the banks of the Buzi River near Beira, Portuguese East Africa, by the Beira Rubber and Sugar Estates, Limited, of London. The factory is designed to treat 700 tons of cane per day, and will be provided with an eleven-roller cane mill.—The Ryknield Motor Company, Limited, Burton-on-Trent, informs us that it has secured from the Compagnie Générale des Autobus, of Brussels, an order for forty motor omnibus chassis. The first twenty of these will be of 35 horse-power, the second twenty probably of 45.

NOTES FROM GERMANY, FRANCE, BELGIUM, &c.

(*From our own Correspondent.*)

Rheinland-Westphalia.

An improving condition in the iron trade has generally been noticed. Even those that are inclined to take a somewhat gloomy view cannot deny that increasing life has been felt in all the principal trades. For bars M. 170 p.t. is being asked, and this shows that a better position prevails. From the Saar and Mosel district also good accounts are being received, and further advances in price have taken place, the minimum quotation for bars being M. 100 p.t. free Neunkirchen. The German plate market shows a fairly bright aspect. Sheets stand at M. 125 p.t. free Siegen, and for orders in the first quarter of next year M. 127.50 p.t. and even M. 130 p.t. are given. Common plates continue somewhat dull, and they cannot realise more than M. 108 p.t. free Dillingen; for heavy orders in ship plates M. 103 50 to 105 p.t. remains the basis quotation free Siegen. It is reported from Siegen that, owing to increasing demand from the blast furnace works, the reduction in the output of iron ore will probably be 30 per cent. instead of 40 per cent. from the beginning of November. More life is, on the whole, being felt in the manufactured iron and steel department, and in crude iron likewise a better business was done, although the market is still influenced by over-production. American orders have come in more freely of late; an order of 15,000 t. basic has just been booked for Philadelphia, to be delivered in spring, 1910. The prices quoted are still low.

Iron and Steel in Silesia.

Latest accounts state the transactions on the iron and steel market to have been more healthy, most branches reporting increasing employment, and deliveries have been heavier than before. Stocks in raw and in finished iron have been reduced. Both consumers and dealers show more confidence, and this has led to increasing inquiry, including next year. List rates have shown an upward tendency. Upper Silesian dealers raised the price for merchant bars M. 5 p.t., and Berlin dealers are reported to have done the same. On the 15th inst. the German Brass Syndicate was finally dissolved.

Coal and Coke.

The German coal market is exceedingly stiff. A slight but general improvement is noticeable in all descriptions of fuel. According to a report from Essen, the reduction of 40 per cent. for coke, 20 per cent. for coal, and 20 per cent. for briquettes are also to prevail during November and December.

Austria-Hungary.

The iron market is firm, and shows animation as regards building material, the conditions all round being more favourable than a few weeks ago. Also in the coal industry a good inquiry was reported to be coming in for engine as well as for house coal; prices are stiffening.

Satisfactory Accounts from Belgium.

Makers of iron and steel give rather encouraging accounts of the business they have been doing during the last few weeks, and it is gratifying to state that export prices are, on an average, 5s. higher than at the period of depression some time ago. Crude iron shows a slight upward tendency, especially for basic, which is realising 67f. instead of 66f. p.t. last month. Foundry pig as well as forge pig remain unaltered, 60f. to 65f. p.t. being quoted. The production of pig iron during the past nine months shows an increase of 34 per cent., against the corresponding period last year, 1,180,240 t. being produced, against 822,510 t. last year, which is equal to a rise in output of 297,730 t. Of 44 existing blast furnaces 37 only are in blow at present, with a daily make of 4682 t. In the Charleroi district 4 blast furnaces have been blown out, and 3 in the Liège district. In spite of this, inland output in pig iron appears insufficient and the import of crude pig iron from abroad is steadily increasing. The business in scrap iron has shown a remarkable improvement, after a prolonged period of dulness. Inland demand for semi-finished steel is quiet, but on foreign account a good inquiry comes in; basis quotation is 76s. to 78s. f.o.b. Antwerp. A slight change in the prices for bars can be stated, bars in basic realising 1s. p.t. more now than iron bars; list rates for the former being £4 14s. to £4 15s.: while for the latter £4 13s. is quoted; inland prices remain 125f. to 127f. p.t., as before. The plate trade shows a bright aspect, and is firm as regards quotations, £5 2s. 6d. being paid for steel plates, while iron plates are quoted £5 6s. p.t. The coal market in Belgium is firm. The State Railways Administration has now decided about its requirements in coal, and 154 lots have been placed, instead of 120 lots small coal; also in briquettes 34 instead of 30 lots were given out, and 15 lots steam coal instead of 9 lots, as first reported. To foreign firms 15 lots are granted, and the inland producers have noted with satisfaction that the low foreign offers in briquettes have not met with consideration.

AMERICAN NOTES.

(*From our own Correspondent.*)

New York, October 22nd.

Further orders for steel rails are reported. The United States Steel Corporation booked orders last week for 100,000 tons, divided as follows:- 53,000 tons to the Carnegie Mills; 42,000 went to the Gelinois Steel Mills and to Gary, of which 20,000 are open-hearth. All the other rail mills secured business which is not reported to-day. Most of these rails are for the Norfolk and Western and the Missouri Pacific, which latter company is taking up a great deal of its worn-out road bed. The next branch of the steel industry that is exceptionally active is car building. Orders booked for steel cars during the past two weeks amount to 3000. Besides these very large orders contracts have just been placed for nine Lake vessels to be built next year. The shipbuilders are also inquiring for winter deliveries of material. The builders of cars, boats and ships are insisting on absolute promptness in delivery. They will enrol their capacity to the very utmost. The Pennsylvania Railroad Company is in the market for 6000 tons of tie plates and other track supplies. Consumers of tin-plates are ordering heavily for first quarter 1910. Steel plates for next quarter are advanced to 1 55.

Eastern buyers of steel billets have requests for large quantities at Western Pennsylvania mills, and the orders cannot be accepted at present. The result is that already premiums are offered, and especially on plates and shapes. In consequence of this over-sold condition, certain consumers on the Atlantic Coast are now in correspondence with German billet makers, and makers of semi-finished steel, with a view of depending on them for emergency requirements. In fact, it is understood one small order has already been placed. Not only may coast buyers seek German aid, but the possibility of Pittsburgh manufacturers buying abroad is entertained.

The developments in the metals have been unimportant. The larger consumers of copper are well supplied. The large amounts of copper held for speculative purposes indicates an unloading, with corresponding weakness. The advance in money rates is making holders more willing to unload. Copper is held at $13\frac{1}{8}$ to to $13\frac{1}{4}$. Arrivals of tin to date this month, 1185 tons, with 3255 tons afloat, most of which is due October 31st.

BRITISH PATENT SPECIFICATIONS.

When an invention is communicated from abroad the name and address of the Communicator is printed in italics.

When the abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent-office Sale Branch, 25, Southampton-buildings, Chancery-lane, London, W.C., at 8d. each.

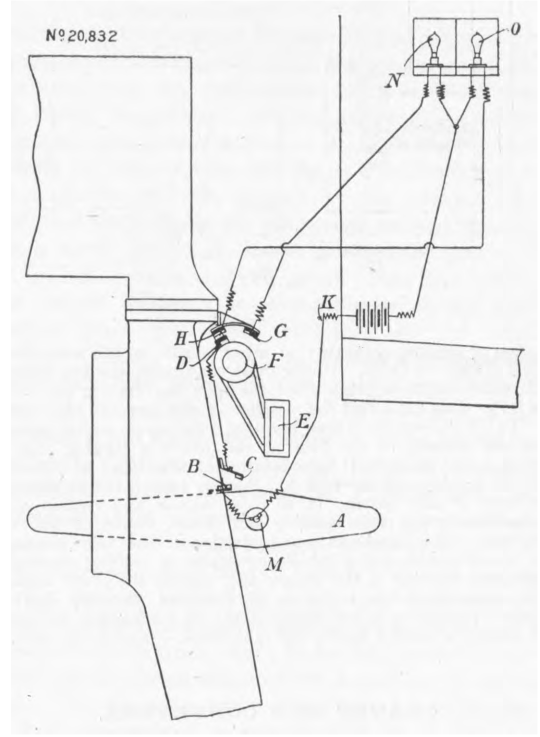
The first date given is the date of application; the second date at the end of the abridgment is the date of the advertisement of the acceptance of the complete specification.

Any person may on any of the grounds mentioned in the Acts, within two months of the date given at the end of the abridgment, give notice at the Patent-office of opposition to the grant of a Patent.

STEAM ENGINES.

20,832. October 2nd, 1908.—Appliance for Indicating at any Desired Place the Direction of Rotation and the Speed of the Revolutions of the Engines, William Bruce Thompson, of Thornbank, Dundee, Forfar, Scotland.

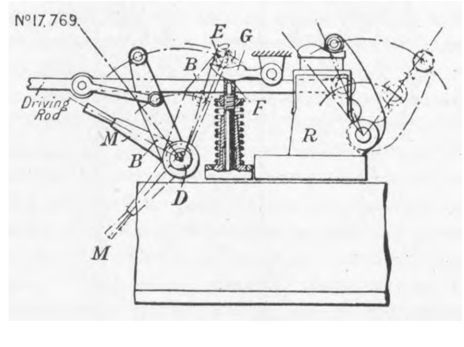
In marine engines, such as is shown on the engravings, a make-and-break device may be fitted on the crank shaft or on any other suitable rotary or reciprocatory part. A convenient arrangement is shown on the engravings, and consists in fitting on the side lever A a pin or contact piece B, which vibrates with the lever and touches a contact piece C in electrical connection with the contact piece D on the wiper lever E carried by the weigh or reversing shaft F, so that when the engine is going ahead the contact piece B touches the contact piece C, which at that time is in electrical contact with the "ahead" contact piece G, and conversely according to the position of the wiper levers. In the engraving the wiper lever E is set for "astern," and the contact piece B makes and breaks contact with the contact piece C, which is at that time in electrical contact with H. The wire K from the battery is led to the contact piece B *viâ* the shaft M, in order that there may be as little movement on it as possible. All these parts should be suitably insulated. Sometimes a cam or cams on the crank shaft can be used to give the same result. When the engine is going ahead the lamp N is alternately lighted and extinguished for each revolution, and when going astern the other lamp O performs a like function. The revolutions per minute of the engine can be obtained by counting the flashes of the lamp and taking the time by a watch.—*October 6th*, 1909.



INTERNAL COMBUSTION ENGINES.

17,769. August 24th, 1908.—Improvements in Valve Gear for Internal Combustion Engines, *Siegfried Barth, of* 43, *Brend Amourstrasse, Düsseldorf, Obercassel, Germany.*

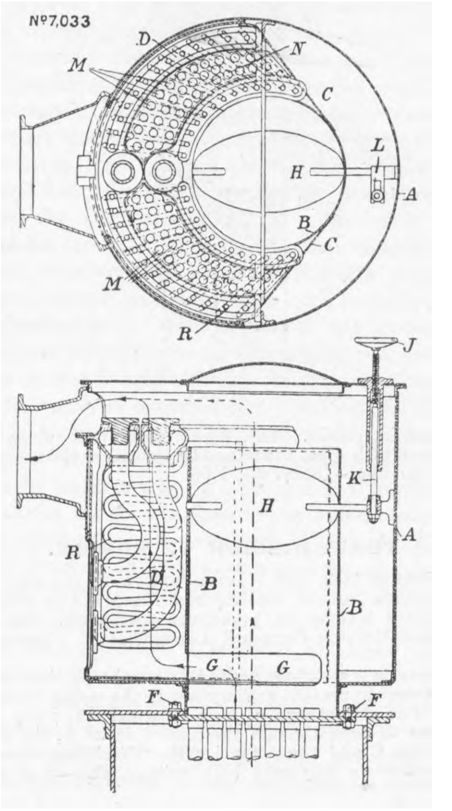
This invention relates to valve gear for operating the air valves of Diesel engines. The improved device operates in the following manner:—When the engine is to be started the lever B is thrown over by means of the handle M and the cam D from its inoperative position indicated by the uppermost circular line to the operative position shown in full lines, so that as the lever B moves to and fro with the driving-rod A it actuates the starting or pressure air valve F by means of the cam lever G. When the engine is running after having been started, the handle M is thrown back to the position shown in dotted lines, thereby lifting the lever by means of the cam D, and the roller E is thus brought out of reach of the cam lever G. At the same time when the engine is making its first few rotations the explosion chamber receives its charge or charges of combustible fluid (through a valve not shown), and compressed air supplied from the pump or reservoir through the valve R.—*October 6th*, 1909.



STEAM GENERATORS.

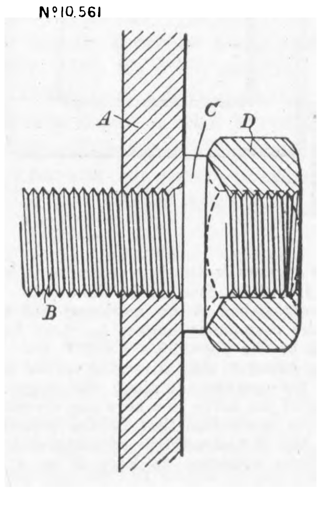
7033. March 24th, 1909.—Improvements in Superheaters for Steam Boilers, Frederick Howard Livens, and Eduard Jacobsen, both of Ruston, Proctor and Co., Limited, Sheaf Ironworks, Lincoln.

Inside a smoke-box A, of about the same diameter as the boiler, another cylindrical tube B B of the same diameter as the hole in the end plate of the boiler, is constructed and fastened to the end of the smoke-box next to the boiler by an angle ring, and to the cylindrical part by two plates C C, whereby a semicircular box D is formed, which contains the superheating tubes. The cylindrical part B protrudes through the smoke-box, thus forming a space between boiler and smoke-box which allows access to the bolts and nuts F, which secure the removable part of the boiler to the shell, the bolts are therefore protected from the smoke-box gases, and the tube system can be withdrawn without interfering with the superheater. The gases leaving the boiler tubes pass, if the damper plate H is closed, by means of holes or passages G in the tube B, to the superheater chamber containing the superheater tubes R, and thence through the holes M M of plates N N into the chimney, as shown by arrow. Plates N N with holes M M are provided to secure an even distribution of the gases. If the damper plate H is open, the gases pass from the boiler tubes through tube B and into the chimney, as shown by dotted arrow, so that the hot gases do not pass through superheater chamber D. The damper plate is actuated by means of hand-wheel J, spindle K, and lever L.—*October 6th*, 1909.



10,561. May 4th, 1909.—Improvements in Locomotive Stays and the like, Richard Mountford Deeley, of Melbourne House, Osmaston-road, Derby.

According to this invention the stay is provided with a collar integral with the stay on the fire side of the fire-box wall or other stayed plate and with a screw-threaded extension for the reception of a cap or nut which is screwed thereon and is preferably hollowed out on the side adjacent to the collar so as to enclose the latter partially or completely. The invention is illustrated in its preferred form, in which A is the fire-box wall, B is the stay, which as shown is screwed into the wall so that the collar C on the fire-box end of the stay is drawn against the wall to make a steam-tight joint. The collar may be coned as shown on its outer face down to the diameter of the screw-threaded extension of the stay on which the nut D having a similarly coned base is screwed over the collar so as to protect the latter from the action of the fire. Whenever necessary the nut D is taken off and renewed.—*October 6th*, 1909.

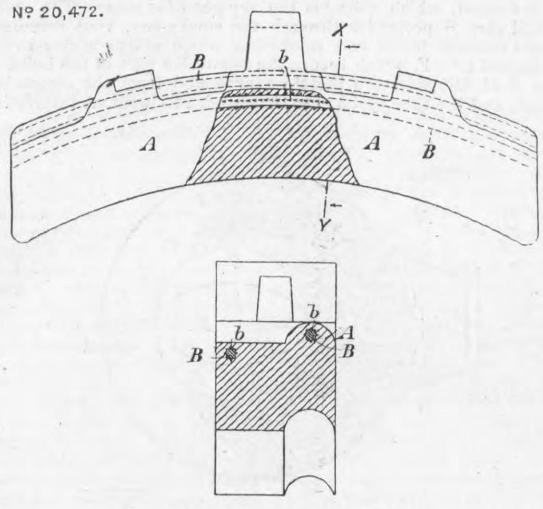


TRAMWAYS AND RAILWAYS.

20,472. September 29th, 1909.—Improvements in Brake Blocks, Electric Collector Shoes, and the like, John Wrench Taylor, of Taylor, Jones and Co., Limited, Padeswood Ironworks, near Mold, Flint.

The object of this invention is to so make the block or shoe that in the event of its breaking (due to a flaw, or wear and tear, or other cause) the broken part will not drop off, and thus any danger of the broken part of the shoe falling on to the rails, and of the train or car being derailed thereby, is avoided, and the shoe can be worn down without danger in the event of breakage. In carrying the invention into effect the brake block such as A (or its refill, in the case of a refill block) is provided with cores or insertions consisting of one or more strips or bars B of steel or wrought iron, which extend the whole or part of the length of the block or its refill. These bars are inserted in the mould when the block is being cast, so that they become embedded in the cast iron, and prevent any part of the block if broken from separating from the other part of the block. The bars B are preferably made jagged, or with nogs or depressions in them, so that the molten iron when being cast will engage or interlock therewith, and form one solid mass which cannot be separated when in use, even though the cast iron portion cracks. The jagged edges are shown at *b*. The invention can with equal advantage be applied to electric collector shoes and the like.—*October 6th*, 1909.

Nº 20,472.



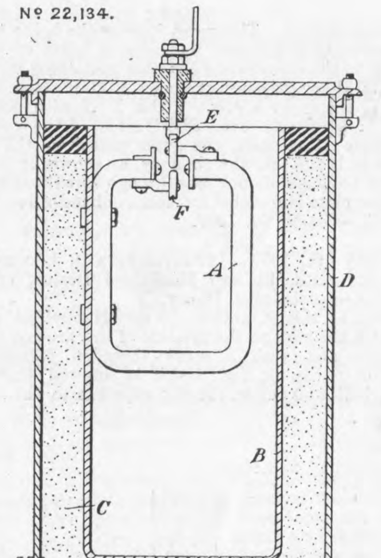
Section on the line X.Y.

TRANSMISSION OF POWER.

22,134. October 19th, 1908.—Improvements in and relating to Protective Devices for Electric Distribution Systems of the Type Known as Lightning Arresters, The British Thomson-Houston Company, Limited, of 83, Cannon-street, E.C.

The operation is as follows:—Under normal conditions the spark gap is sufficient to prevent a grounding of the system through the arrester. But a discharge of high potential will jump the gap and proceed to earth through the magnet frame A, the inner jar B, the filling C and the outer jar D. The filling, however, is readily conductive only at a high voltage, and when the low voltage dynamic current on the line attempts to follow the lightning discharge it will be checked by the filling. Any arc which may have been established at the spark gap will be extinguished by the field of the permanent magnet A, whose flux is across the gap. The shape of the electrodes E and F also assist in extinguishing the arc, owing to their diverging curved edges, the spark being blown by the magnet out along said edges, which operate after the manner of the horns in a horn-gap arrester. The action of this arrester is much like that of the electrical aluminium arrester, but it has the advantages of using a dry material and requiring but little attention to keep it in working order.—*October 6th*, 1909.

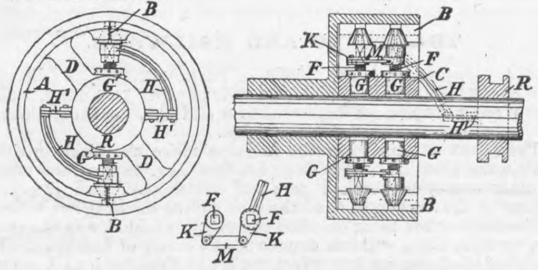
Nº 22,134.



24,964. November 20th, 1908.—Improvements in Clutches for Transmitting Rotary Motion, William Murphy, of the firm of F. Reddaway and Company, Limited, of Cheltenham-street, Pendleton, Manchester.

An expansion ring A is used having two or it might be more cuts or slits B across its periphery at convenient intervals and connected to a boss C by arms D. Along such cuts two rotary wedges are used abreast, as shown, or more than two of such rotary wedges placed abreast. The conical heads of such rotary wedges are disposed within recesses in the expansion ring passing through the cross cuts, and they are actuated by screws F either outwardly, as shown, or inwardly, to expand the cuts or slits in the expansion ring. The nuts G for the screws F are also made rotatable in the boss C to compensate for wear or to obtain perfect adjustment when assembling the parts. To actuate the rotary wedges, one of each pair is rotated by a lever H, the boss of which is mounted on a squared part of the screw F, the lever being connected to a link H^1, pivoted to a slidable boss R on the shaft. As the boss R is slid on the shaft towards or from the clutch the screws F are rotated in one direction or the other to engage or disengage the the clutch, as will be understood. The other or others of the rotary wedges are coupled together by levers K and links M so that they are similarly rotated. A modification is also dealt with. —*October 6th*, 1909.

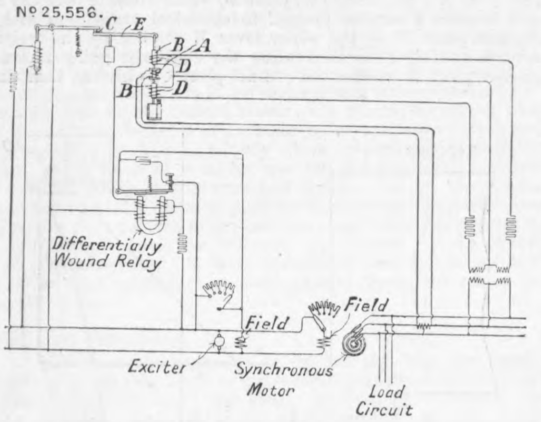
Nº 24,964.



25,556. November 26th, 1908.—Improvements in and relating to the Regulation of the Power Factor in Systems of Alternating Electric Distribution, the British Thomson-Houston Company, Limited, of 83, Cannon-street, London, E.C., engineers.

This invention relates to alternating current systems of distribution in which the phase relation between the current and potential is regulated by a synchronous motor or the like. The invention has especial reference to means for automatically regulating the field magnetisation of such synchronous machines. In carrying out the invention a modified Tirrill regulator is employed. The operation is as follows:—Suppose that the synchronous motor is running without load, and the floating control contacts C and other parts are adjusted so that the synchronous motor is excited to such a value as to give neither leading or lagging currents; in other words, let the power factor of the system be unity. Under these conditions, the two potential coils exert an equal attractive force upon the floating coil A, and the latter does not affect the position of the cores B and contact C. But if the supply system becomes unbalanced, so, for instance, that the current in the floating coil becomes lagging, then the pull of one of the coils D becomes greater than that of the other, and the floating coil moves down, thereby raising the contact C on the lever E and causing it to close sooner and remain closed longer than in the rapid opening and closing action of the Tirrill regulator. This causes an over-excitation of the field winding of the synchronous motor which generates a leading current to counteract the lag in the system and restore the power factor to unity, providing the motor is of sufficient capacity and the inherent regulation is sufficiently close. For a leading current on the system, a reverse action will take place.—*October 6th*, 1909.

Nº 25,556.

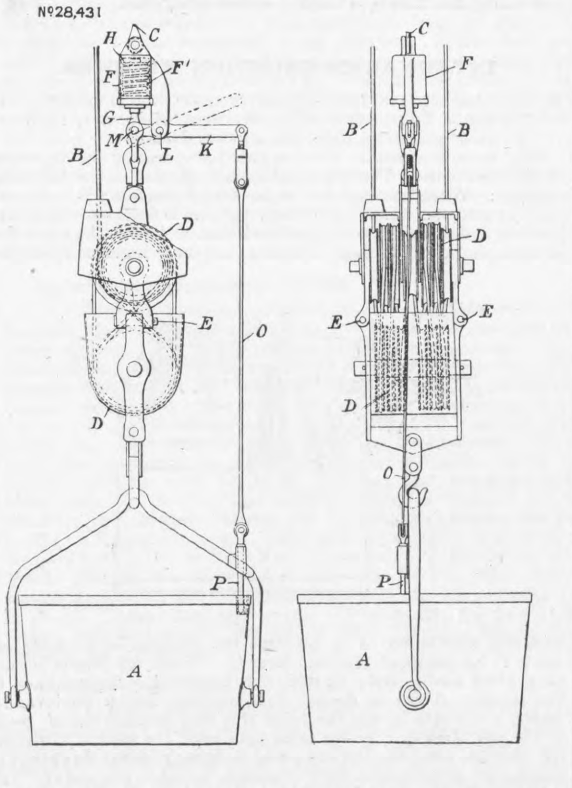


CRANES AND CONVEYORS.

28,431. December 30th, 1908.—Improvements in Apparatus for Transferring Coal and other Materials, Sir W. G. Armstrong, Whitworth and Co., Limited, manufacturing engineers, and Roger Wright, all of Elswick Works, Newcastle-upon-Tyne.

In some places where a grab plant is available it is convenient for certain purposes to replace the grab by a skip or bucket and to manipulate it by the same ropes as the grab. This invention relates to an arrangement in which this is done with a grab of any type worked by two ropes or chains, one for lifting, lowering and closing the grab, and the other for opening it. The engravings show a grab apparatus of an ordinary type in which the grab has been replaced by the bucket A. B B are the ropes employed for lifting, lowering and closing the grab, and C the rope for opening it. D D are the grab blocks which for the purpose of the present invention are connected together by the pins E E. As shown, the end of the rope C is fixed to a casing F containing a spring F^1 and the upper block D is suspended from the rod G fixed to the plate H resting on the top of the spring F^1. K is a lever pivoted at L to the casing F, and having one end pivoted at M to the rod G whilst the other end is connected by the line O to the bolt P by which the bracket is prevented from tipping. If the rope C is held whilst the ropes B are slacked the weight of the loaded bucket comes on the spring F^1 and compressing it turns the lever into the position shown in dotted lines, thereby withdrawing the bolt P and allowing the bucket to tip.—*October 6th*, 1909.

Nº28,431



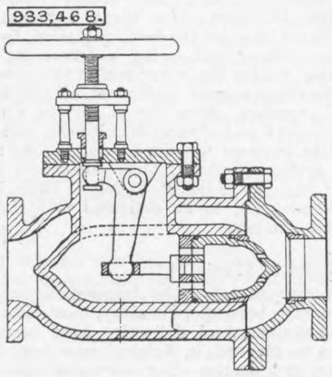
SELECTED AMERICAN PATENTS.

(*From the United States Patent-office Official Gazette.*)

933,468. Equilibrium Stop-valve, *J. Koenig, Riga, Russia.—Filed October 8th*, 1908.

This is an ingenious device. A relieving casing is placed in the valve casing, and concentrically arranged around the pipe axis with a concentric annular space for the flow of the fluid therebetween. There is a slidably arranged valve cone on the exterior of the relieving casing, whose movement axis coincides with the pipe axis. An angle lever is provided for giving movement to the valve cone. There are three claims.

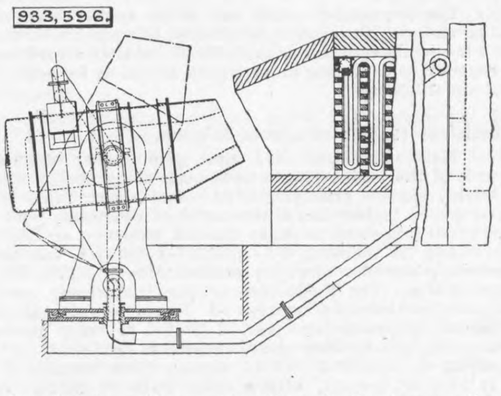
933,468.



933,596. Process for the Manufacture of Steel, *G. J. Stock, Darlington, England.—Filed July 1st*, 1909.

In the production of steel by means of a Bessemer or pneumatic converter arranged in combination with an economiser, the process of melting a charge of metal in the converter by means of fuel forced into said converter through the tuyeres thereof, allowing the hot products of combustion to pass through the economiser, then tilting the converter and blowing air therethrough, and heating the air by the economiser during the blowing operation. There are two claims.

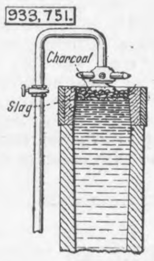
933,596.



933,751. Method for Making Sound Metal Ingots and other Castings, *R. A. Hadfield, Sheffield, England.—Filed May 12th*, 1906.

The invention consists in casting the metal, placing a layer of slag on top of it, adding solid fuel above the slag, and directing a downward blast of air against this fuel to promote its combustion and keep the metal in a fluid condition. There are two claims.

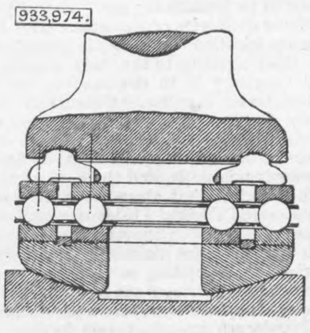
933,751.



933,974. Footstep Ball Bearing, *M. Gohlke, Berlin, Germany, assignor to Deutsche Waffen-und Munitionsfabriken, Berlin, Germany.—Filed July 30th*, 1908.

This patent is for the combination of two rows of balls concentrically arranged, two race rings, and a pressure member comprising a series of sections adapted to move slightly with relation to each other, this pressure member resting on the race rings, and being adapted to transmit pressure substantially axially. The pressure member has a reduced bearing face upon its opposite side adapted to receive one of the pressure parts of the bearing and having its sections connected together on their inner sides. There are three claims.

933,974.



OCTOBER.

The opening of the Admiralty Harbour at Dover by H.R.H. the Prince of Wales on October the 15th marked the completion of twelve years' work on the construction of what is the most extensive entirely artificial harbour in the world, with the single exception of the harbour at Colombo; 690 acres of water are enclosed by three magnificent breakwaters, which represent a combined length of over two miles. The breakwaters are for the most part founded in a depth of 40ft. and over at low water, and the bulk of the underwater work is so great that at half tide about one-fourth only of the total cubic contents is visible above the water level. The harbour has been constructed with two entrances, one on the south and the other on the east, the wall between, known as the south breakwater, being an island structure 4212ft. in length. We described the undertaking in some detail in our issue of the 15th October. The engineers for the work, Messrs. Coode, Son and Matthews, and the contractors, S. Pearson and Son, Limited, are to be congratulated on the satisfactory completion of this vast undertaking, which has been carried out with remarkable freedom from storm damage during construction and with a very low percentage of accidents to workmen. The harbour, although primarily intended as a naval base and rendezvous, is also being used to a considerable extent by large Atlantic liners, and the Admiralty have handed over to the Dover Harbour Commissioners the greater part of the Admiralty Pier Extension, which in future will be used for commercial purposes, in exchange for the Prince of Wales Pier, which is to be devoted to the use of the fleet. The total expenditure on the Admiralty Harbour works up to the present has amounted to under £4,000,000. Messrs. Pearson are now engaged in carrying out improvements for the Dover Harbour Commissioners at a cost of £400,000, which will facilitate the working of cross-Channel traffic, and add to the comfort and convenience of passengers.

Considerable attention is being given by the Canadian Government and commercial interests to the improvement of the St. Lawrence Navigation and the provision of increased dock accommodation in the river. At the recent meeting of the British Association in Canada, Sir William White, the president of the engineering section, devoted a large part of his address to the condition of the St. Lawrence River, and Col. Anderson, the chief engineer of the Canadian Department of Marine and Fisheries, contributed a valuable paper on the improvements in the navigation which have been effected in recent years. The dredging operations which are now in progress between Montreal and Quebec will, it is hoped, provide a minimum depth in the ship channel of 30ft. at low water. With the exception of a couple of short reaches this minimum depth has now been secured throughout the entire 160 miles of the navigation, and the completion of the work is expected to be reached next year. When this standard has been secured throughout, further deepening of 35ft. is to be effected. Before the dredging of the river was undertaken the depth in parts of the channel was only 10ft. at low water. From Quebec to the sea the river is navigable, except at low water by any vessel afloat, and at only two points is the depth less than 40ft. at low water. These shallows are being deepened to a minimum of 40ft. at low tide. The recent advent of the White Star liners Laurentic and Magentic, each of 15,000 tons, in the St. Lawrence has called attention to the lack of graving dock and repairing accommodation for large vessels on the river, and it is now announced that Harland and Wolff, Limited, will construct a large dry dock near Quebec, together with a repairing yard, on a scale adequate to accommodate either super-Dreadnoughts or Transatlantic liners of the largest size. The Dominion Government, it is stated, will give a subsidy of £9000 a year for 20 years in connection with the enterprise. The construction of a similar large graving dock at either St. Johns or Halifax is also talked about, and the Montreal Harbour Commission have before them two alternative schemes for large harbour and quay extensions, one of which is likely to be adopted at an early date.

Enterprising people who are willing to invest their capital in schemes depending for their success upon the efficiency of Zeppelin airships are apparently not difficult to find in Germany. Projects for the institution of regular pleasure cruises have already been described in these columns. Reports published at the beginning of the month show that the financing of another airship company, whose Zeppelin cruisers are to make regular pleasure trips from Hamburg to England, to the North Sea bathing places, and to Frankfort o.M., is now assured. The major part of the capital of the Hamburger Luftschiff-fahrt-Gesellschaft—Hamburg Airship Company—amounting to 3½ million marks, will be subscribed by Hamburg financiers. Two new airships, Z IV. and Z V., are to be constructed for this company. Another enterprise for which the Zeppelin Airship Company is responsible has recently been the subject of much comment. This is the *Deutsche Gesellschaft fur Erforschung des Polargebietes*—German Society for the Exploration of the Polar Regions. Geheimrat Hergesell, one of the promoters of this society, visited Christiania this month with the object of soliciting Amundsen's co-operation in the proposed researches in the frozen zone. Geheimrat Hergesell stated that observations of the atmospheric conditions prevailing in all parts of the globe would be organised. These observations, which are to take place simultaneously, will also be made in the polar regions, and will be carried out by the aid of kites. On account of its purely scientific character, Geheimrat Hergesell described the Zeppelin expedition as being of more importance to science than the expeditions of Cook and Peary, and thinks that Zeppelin airships will be found more useful to science than to war.

Driven to the verge of despair by the never-ceasing frustrations of its efforts to obtain the powers enabling it to proceed with the construction of its overhead lines, the Berlin suspension railway company — Berliner Hochbahngesellschaft—has taken a step which is of far-reaching importance, inasmuch as its ultimate fate in the city of Berlin will be decided by the result. Two years have passed since the suspension railway company built a short section of line in a congested part of the city in the endeavour to prove that the contentions raised against the unsightliness of the superstructure were groundless, but the city of Berlin has never found its way to grant the concession sought for. The company has many arguments in favour of the scheme, and, as its patience is now exhausted, it has made representations to the courts with a view to gaining its end by coercive measures. According to a certain clause in Prussian law, any municipality that refuses to permit the construction of railway lines that would redound to the benefit of the public, may be forced to do so. Having played its last card as far as the city of Berlin is concerned, the suspension railway company is, whilst it awaits results, centering its hopes on an application made to the neighbouring city of Rixdorf for the permission to build a suspension railway there. The company has pointed out that cheap fares and the underground construction of lines cannot be combined. As a forcible argument for overhead construction, it has offered a cheaper tariff than it would be possible to institute on an underground line. Under it passengers will be able to travel the whole length of the proposed line, a distance of about 10 kiloms., for ten pfennigs—about a penny.

Discontented patentees on this side of the pond are very fond of holding up the American Patent-office as an example of how things should be done. We hope the Selden patent case, decided a few weeks ago in the American law courts, has not escaped their attention. In 1879 one Selden applied for a patent for a vehicle propelled by an internal combustion engine, through the intermediary of reducing gear; it was a very elemental form of motor car. By the method of amendments, which is possible under United States law, he kept this patent hanging on for many years, and it was finally granted in 1895. An American patent holds for seventeen years, and is dated, not from the day of application, as with us, but from the day on which it is issued, so that Selden has protection till 1912. His patent, which has now been upheld as a master patent, was secured some time ago by the Pope Manufacturing Company, acting in conjunction with a number of American motor car builders, with the result that they are now in a position to levy a toll on all outside the ring, and to prohibit the importation or sale of any motor cars of a kind covered by Selden's patent—that is to say, practically all ordinary cars—for nearly three years. What effect this will have on the trade remains to be seen, but we shall be surprised if so extraordinary a case does not lead to a revision of the law.

The present position of the seven different Berlin electric railways built, under construction, and projected, was explained at a meeting of the German Society of Electrical Engineers—Elektrotechnischer Verein—held on the 26th of the month. The seven different railways are the Elektrische Hoch-und-Untergrundbahn, Charlottenburger Bahn, Wilmersdorfer Bahn, Schöneberger Bahn, Nord-Süd Bahn, Dahlemer Bahn and Schwebebahn (suspension railway). Of the lines, the first only is in operation; it is also being extended. The Wilmersdorf and Schöneberg lines are under construction. The ultimate fate of the rest has, it appears, not yet been fully decided. At the above-mentioned meeting the absence of a single authority invested with necessary powers to control the development of all the railways and tramways in Berlin and its suburbs was greatly deplored. It was held that if Berlin were possessed of a body like the Public Service Commission of New York, which regulates the development of all the railways of that city, the controversy and strife prevailing between the various city councils of greater Berlin with respect to the routes of the various lines and much clashing of interests could be avoided. It was further stated that the most recent electric railway projects were born more of the ambition of the suburbs concerned than of necessity. Of all the municipalities in question, the City of Berlin was considered to have assumed the most inglorious rôle, the construction of lines that are absolutely necessary, and that should have been commenced long ago, being unduly postponed by her undecidedness. With regard to the elevated and underground railway already existing, it was mentioned that the railway triangle, at the one corner of which the disastrous accident occurred last year, is to be abolished as soon as the construction of the new lines is far enough advanced. In the meantime special safety appliances fixed to the trains are being used, and the trains are run slower at the dangerous spots to prevent a recurrence of similar accidents. In response to some disparaging remarks relating to the railway triangle the chairman, Herr von Siemens, said that the railway triangle has been the subject of much unjust criticism. It was this triangle that rendered it possible to make the first elevated and underground electric railway a financial success. As regards the danger incurred by the presence of the triangle, this, said Herr von Siemens, is no greater than that constantly existing on large numbers of other railways, and if greater is desired, it will be necessary to recast the laws dealing with the least permissible degree of safety on railways generally.

Just as November, 1896, will always remain famous for the first great motor car run in this country, so October, 1909, will be handed down as a red-letter month in connection with mechanical flight or "aerial automobilism." Those who were privileged to attend both the motor car trip to Brighton in 1896 and the recent flying meeting at Blackpool must have been struck by the fact that the French nation is just as far ahead of the British in aerial navigation as it was thirteen years ago in motor mechanism. The analogy is not brought forward in disparagement of British brains, but rather the contrary, for at the present time as good a motor car is produced in this country as in France, and we doubt not that in aeroplane design equally rapid strides will be made. We are, however, not so sanguine concerning the future of aerial navigation as a sporting spectacle. When a flying machine has once left the earth and has achieved a certain altitude, the interest in its future flight is chiefly limited to speculation as to when and how it will descend. But for the present the French aviators have an opportunity of amassing princely fortunes, of which they are not slow to take advantage.

During the last few years the question of the best method of driving cotton mills has been brought into prominence by the claims which electrical engineers have put forward for the electric drive. The advantages claimed for electricity have sometimes been demonstrated by comparing a brand new factory with electric driving with a more ancient one in which steam power alone is used. When the Special Committee of Inquiry of the Bradford Engineering Society was formed some two years ago to investigate and report on the subject, millowners felt that they would at last obtain some reliable information to guide them in future installations. The Committee appointed as its chairman Professor G. F. Charnock, and embraced a number of gentlemen of recognised ability, both in mechanical and electrical engineering. Its preliminary report, issued in October, will not encourage factory managers to scrap direct mechanical drives in favour of electric motors. The Committee decided first of all to carry out certain experiments, with the object of determining the actual cyclical variation occurring in prime movers and electric motors, and also in shafting and machinery driven by them. After exhaustive trials carried out in mills, in which various driving conditions existed, the Committee have come to the conclusion that "in good installations there is practically no difference in cyclical variation between mechanical and electrical transmission when measured at the end nearest the main drive." The report even pronounces further in favour of mechanical transmission, by stating that there is less loss in this case in modern mills of ordinary dimensions where the power is generated on site. Of course, there are many obvious instances where, for example the plan of the buildings is irregular, involving difficult angles of drives or awkward arrangement of machinery, where the electrical motor can lay claim to decided advantages. In such cases no mechanical engineer with an open mind would think of disputing the suitability of electricity as the motive power.

ALTHOUGH the general technical equipment of the Austro-Hungarian army has recently been brought to a high point of efficiency, the War-office in Vienna has so far paid little attention to the wonderful developments in the field of aviation. It is proposed now, however, to remedy this seeming neglect, and the next Delegations will be asked to vote a considerable sum for the creation of a military airship flotilla. Part of the money will be spent upon a Military Aeronautical Institute at the Imperial Engineering Academy at Fischamend, near Pressburg, and the rest upon dirigible airships and flying machines. At present the authorities have ordered trial balloons, one each of the Parseval, Lebaudy, and Bayard-Clement types, and are experimenting with flying machines of the Farman, Wright, and Blériot patterns. It is hoped that the Parseval balloon will be ready in a fortnight, and the Lebaudy balloon is to be delivered before the end of the year. But whilst the Austrian military authorities may have been a little slow in adopting the newest inventions in the navigation of the air, it is only fair to say that their ballooning department has long enjoyed a foremost place among the great continental armies. Ballooning has been taken up with great zest by a large number of officers, and some notable ascents have been made.

THERE have been several naval events of importance during the month. The Indefatigable, Gloucester, and Liverpool have all been launched, and just one day before the month began the battleship Neptune was sent into the water. The latter vessel is the eighth of the Dreadnought class and an advance on anything which has gone before her, being able to fire all of her ten 12in. guns on each broadside. The Indefatigable, which was built at Devonport, belongs to the class of what are known as the Dreadnought cruisers, and she will be, for some time at all events, the most powerful cruiser in the world. It is expected that she will when finished be capable of steaming at 26 knots, and her turbine engines are to develop no less than 45,000 horse-power. The Gloucester and Liverpool are second-class cruisers belonging to what is known as the Bristol Class. There are in all to be five of them, and they are all being constructed by private firms. Their displacement is about 5000 tons, and their indicated horse-power of 22,000 will give them, it is expected, a speed of 25 knots. Meanwhile, a good deal has been heard about the four contingent Dreadnoughts and their proposed armament, and we gather that tenders for these vessels have already been received by the Admiralty. So far, however, there has been no official announcement concerning them; nor has there been any public pronouncement as to the calibre of the big guns with which they will be furnished.

SHEFFIELD, like many others of our great centres of population, is in course of remodelling its sewage disposal works. It is only twenty-three years ago that the sewage of the city was allowed to find its way untreated into rivers and water-courses, but in 1886 works which had cost over £150,000 were completed, and so excellent were they considered that they were copied practically in their entirety by such places as Glasgow and Bradford. But times change, and so do the demands of the Local Government Board and of the various River Boards. The original treatment consisted of chemical precipitation, followed by aëration over weirs, and continuous filtration over coke. The effluent obtained was, however, not considered good enough to satisfy modern requirements, and various schemes were suggested to improve it. Land treatment was for various reasons out of the question. A lengthy series of experiments was then carried out, with the result that it was decided that Sheffield sewage could be satisfactorily treated by continuous-flow settling tanks and contact beds, and an extensive scheme was drawn up, approved by the authorities in 1905, and commenced. During last month the first portion of this was completed. At present only single contact is to be tried, but provision is made for secondary beds if they are required. It is worthy of note that the work has all been carried out by the city officials without any aid from outside.

DURING the month Glasgow celebrated the fiftieth anniversary of the bringing of water from Loch Katrine into the city. It was as long ago as October 14th, 1859, that the important engineering works embodied in this scheme were declared open by the late Queen Victoria herself. The changes since that time have been enormous. Large as was the population in the water area of Glasgow at that time, it is much larger now. Fifty years ago the number of persons supplied was 439,901; now it is 1,117,229—an increase of 250 per cent. The average daily supply was then 14,675,000 gallons; now it is sometimes over 60,800,000—over four times as much; and as far as Loch Katrine is concerned, Glasgow is getting near the end of her resources. Consequently steps are being taken to include the waters of Loch Arklet in the supply system, and when the necessary works for this are completed a daily supply of 75,000,000 gallons of water will be available. This at 35 gallons a head—the amount used in the city for domestic purposes—represents a quantity sufficient for a population of over 2,000,000 persons. Part of last month's ceremony consisted in the unveiling, by the surviving members of the bodyguard of Volunteers who had attended Queen Victoria, of a memorial tablet commemorating the event of fifty years ago.

DURING the last few weeks accidents in collieries have been distressingly frequent. The first took place on October 1st, when an explosion occurred in the Birch Rock Colliery, Pontardulais, South Wales, by which two men were killed and four injured. In this pit naked lights are ordinarily used, and it is surmised that a "blower" of gas was encountered. One hundred men were at work at the time. On the 6th 30 men lost their lives by an explosion in the Wellington Mine, Vancouver Island. On the 20th an explosion occurred in the Bell Hill Coal Pit No. 2, about two miles from Auchinleck, in Ayrshire, Seventy men were under ground when it happened, and four of these were killed. Another explosion took place on the 23rd at the Caodean Colliery, Trimsaran, near Llanelly. In this eight men were injured, most of them only slightly. On the 26th 15 men and boys were imprisoned for some hours in the Redheugh Colliery at Newcastle through the fouling of a winding rope. Two men were jerked out of the cage and fell some distance, being badly bruised. On the 29th there was an explosion at the Darran Colliery, Deri, near Bargoed, South Wales, and about 25 men were either burned to death or suffocated, a distressing circumstance being that, of a party of rescuers, several, including the manager and under-manager, perished. A fire occurred at the Penrhiwcieber Colliery, near Merthyr Tydfil, on the 30th. In this case all were fortunately rescued save one man who, in the confusion, was killed by some runaway trams. The cause of the fire is supposed to have been a spark from a motor or the fusing of an electric wire. In many instances lately colliery explosions have been wrongly or rightly attributed to the electric apparatus, and it is full time that the truth or untruth of such allegations was investigated. We refer to this matter in another column. All will join in wishing for the reduction of accidents in collieries, and in desiring to see the matter thoroughly thrashed out.

ON Wednesday, October 27th, the Stepney Borough Council's new electric generating station at Blyth's Wharf, Limehouse, was formally opened by the Mayor of Stepney. There is but little doubt that this station, which affords an excellent example of modern practice, will ultimately have a very considerable output, for the area which it is to supply is an exceptionally good one from the point of view of motor load—a possession which but few London stations enjoy. An interesting feature about the scheme lies in the use of double-current generators, which are able to supply either direct or alternating current or both. Although it appears somewhat improbable that it will be found necessary to increase the capacity of the new station by the addition of more machines of this type, the engineers acted very wisely in purchasing the double-current generators which are now in use, particularly in view of the uncertain position in which they were placed. The excellent situation of the Blyth's Wharf power-house should be the means of making the Stepney electricity undertaking even more successful than hitherto, notwithstanding the fact that it has always occupied a high position on the list of London stations.

AT the end of the month a new reservoir capable of holding 50,000,000 gallons was put into service by the Corporation of Bury. This reservoir is 173ft. higher than any of the existing reservoirs in the area concerned, and the additional head of water will, it is considered, enable the most highly placed houses to be supplied by gravitation. Incidentally, it may be remarked that though it holds up but a comparatively small body of water, the earthen embankment is peculiar in several ways. Its height above the level of the course of the stream it impounds is, for example, no less than 115ft., and it covers an area of 17,600 square yards, being 530ft. long and 550ft. wide at its widest part. It contains as much as 164,000 cubic yards of material.

GERMAN SHIPYARDS.

No. III.*

THE BREMER VULKAN AT VEGESACK.

THE present joint stock company known as the "Bremer Vulkan" arose out of the shipyard founded in 1805 at Grohn, near Vegesack, by the naval architect, Johann Lange, a gifted and energetic man. Under his management the undertaking prospered to such an extent that to the time of his death in 1844, 200 ocean-going wooden sailing vessels and 330 smaller craft had been built—for those days no inconsiderable achievement. The name of Johann Lange deserves to be remembered for another reason, as it was he who built the first German steamship. This was in 1817, or only a short time after the first appearance of such vessels elsewhere, and following immediately on the inauguration of a regular service of the British steamboat on the Clyde. This wooden vessel, the drawings of which are still preserved, was 85ft. in length, 14ft. broad, and had a draught of 3ft. As Germany at this time possessed no facilities for the construction of engines and boilers, the making of these was entrusted to Boulton and Watt, at Soho. This steamer was employed for passenger work on the river Weser, and kept up a regular service until 1833. During 1837 Lange constructed two dry docks at Bremerhaven, the dimensions of these docks being at that time regarded as exceptionally large. These docks were sold in 1895 to the Aktiengesellschaft G. Seebeck, of Bremerhaven.

At the death of Johann Lange the yard already employed as many as 600 workmen. In 1865 the construction of iron vessels also was undertaken, and this new industry, though at first making but slow progress, soon developed to large proportions. Side by side with steel ships, however, wooden vessels continued to be built until 1870. The first iron vessel to leave the slip was the river steamer Gutenberg, and soon after the Simson and the Smidt, vessels of 2200 tons, the former of which was in the service of the Norddeutscher Lloyd until only a few years ago, were built. To meet the expenditure entailed in providing the yard with modern tools and in extending it, the firm transformed on the 23rd October, 1893, into the Aktiengesellschaft Bremer Vulkan Schiffbau and Maschinenfabrik. The old Lange Yard was at that time in possession of five building slips, extensive platers' sheds, smiths' and joiners' shops, a foundry, and boiler and engine building works. The new Bremer Vulkan Company, which at first undertook the construction of steam trawlers and small cargo steamers, was soon forced to enlarge its works. Unfortunately, natural limitations were soon set to further extensions of the yard by the nature of the site itself. In view of this the Bremer Vulkan in 1895 bought the yard of the Bremer Schiffsbau-Gesellschaft vorm. H. F. Ullrichs, in Vegesack, for about £25,000, and reconstructed it, at the same time lengthening the slips and enlarging the rest of the works. In 1896 the whole of the undertakings of the company were transferred to the new site, the old yard at Grohn being made over to the newly founded Bremen Vegesacker Fischerei Gesellschaft. The new yard had an area of 25 acres, and a water frontage of 930 yards. In view of the steady increase of orders being received from the more important shipping companies for large ocean-going cargo and passenger steamers, the new site had in its turn also to be extended a few years later. For this purpose a considerable tract of ground extending down stream adjacent to the yard was bought, and to this the entire shipbuilding operations were transferred in 1902 and 1903, six new slips being then available—see Fig. 1. At the present time the old works of the Bremer Schiffsbau-Gesellschaft are only used as a timber-storing yard. The total site area now amounts to 80 acres, and the water frontage to 1640 yards. About 3000 workmen and 100 officials find employment in the various departments.

The shipbuilding and engine-building departments are completely separated. The engine-building workshops are situated in the old yard, with the axes of their bays pointing towards the outfitting quay. These shops comprise the material store, the moulding shop, the foundry, the fitting and erecting shops, the general store, the boiler shop, and the copper shop. Keeping along the outfitting quay, these are followed by the shipyard fitting shop and the joiners' shop; and, further, in the down-stream direction, by the six building slips, which are set diagonally to the course of the river. In close proximity to the heads of the slips, and at about right angles to them, lie the large shipyard platers' sheds, the plate and angle store, the moulding loft, the bending slabs and the furnaces, the smithy, and the central power station. At the entrance to the old yard is a long building containing the general offices. These comprise rooms for the commercial department and the drawing-offices of the engine works department, while the shipyard drawing-office and the time office are in a new building at the main entrance to the new yard. Through this entrance there passes the branch line from the State Railway. The material for the engine department is handled by electric locomotives on a separate line of rails, which runs in a curve behind the shipyard smithy, the power station, and the workshops of the engine-building department, as far as the timber-yard at the extreme end of the site, after which it passes between the outfitting quay and the various workshops to be supplied. On account of the narrowness of the ground a turntable is arranged in front of each of the shops, so that the trucks can be led into these right under the overhead travelling cranes. By the same line of rails the material, which has been supplied from without ready for shipment, is brought to the crane at the outfitting quay, or to the building slips. On the other hand, the trucks containing the shipbuilding material reach the branch line by means of a turntable arranged on a space of ground lying between the shipyard platers' sheds and the angle smithy. From here they make their way to the plate and angle storing ground.

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* No. II. appeared October 22nd.

In addition to these lines a main line goes past the shipyard platers' sheds, with branches to the building slips and a branch leading past the slips between the loft, bending slabs, smithy, and central power station.

All the lines are connected to one another by means of transverse lines, the junction being in general effected by means of a turntable. In the same way short sidings branching from the main line are, in all the workshops, led under the overhead travelling cranes. Each line is arranged for both standard and narrow gauge. Deliveries of material are in the main effected by means of the branch line from the State Railway referred to above, but the waterway is sometimes used for this purpose.

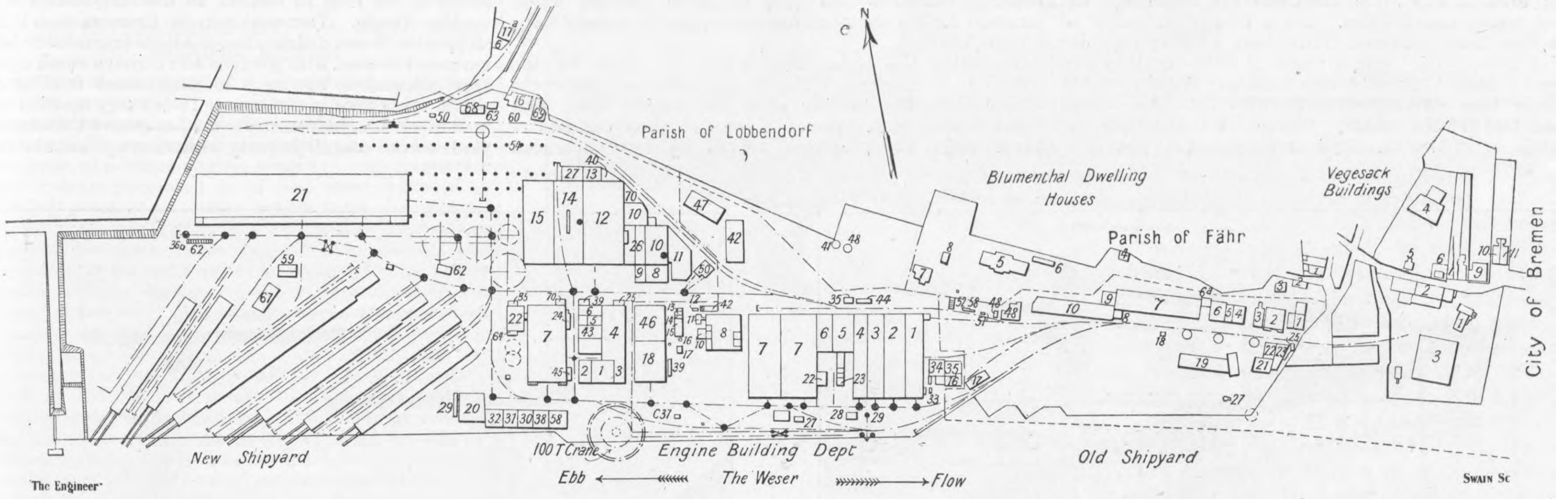

Fig. 1—GENERAL PLAN OF THE BREMER VULKAN SHIPYARD

A.—*Old Shipbuilding Department.*

1. Sawmill
2. Joiners' shop
3. Planing shed
4. Rivet store
5. Shed for iron shipbuilding materials
6. Store
6a. Protective roof
7. Platers' sheds
8. Tool store
9. Intermediate electric station
10. Smithy for the platers' sheds
15. Iron store
16. Iron store
17. Platers' sheds
18. Foremen's cabin
19. Work sheds
20. Timber store sheds
21. Timber store sheds
22. Timber store sheds
23. Sawmill with cellar
24. Time-office and bicycle shed
25. Gate-house
27. Lavatory
48. Office buildings
49. Coal store
50. Lamp-room
51. Benzine store
52. Spirit store

B.—*Engine Department.*

1. Fitting shop
2. Large erecting shop
3. Small erecting shop
4. Turning shop
5. Smithy
6. Boiler and engine-house
7. Boiler shop
9. Ironfoundry
10. Loam shed
11. Brassfinishing shop and communication way
12. Tool-making shop
13. Charcoal store
14. Moulding sand store
15. Coke store
16. Iron store shed with crane
17. Moulding sand store
18. Coppersmiths' shop
22. Lavatories
23. Store sheds
24. Store sheds
25. Store sheds
26. Store sheds
27. Iron scrap store
28. Office
29. Shear legs cabin
31. Time-office
32. Painters' shop
33. Gate-house
34. General store
35. Iron bars
36. Accumulator-house
39. Lavatories
40. Old reservoir
41. New reservoir
42. Pattern shop
44. Heating arrangements
45. Coal store
46. Casting, finishing shop
47. Pattern store
49. Moulders' cabin

C.—*New Shipbuilding Department.*

1. General store
2. Painters' shop
3. Repairing shop
4. Fitting shop
5. Tool store
6. Smiths' shop
7. Joiners' shop
7a. Drying stove
8. Engine-house
9. Accumulator-room
10. Boiler-house
10a. Chimney
11. Coal store
12. Smithy
13. Galvanising shop
14. Bending slabs and furnace-house
15. Moulding loft
16. Gate-house with entry
17a. Yard overseer's house
17b. Wash-house
20. Timber store sheds
21. Platers' sheds
21a. Tool store
22. Rivet and cement store
24. Lavatories
25. Lavatories
26. Repairing shop
27. Lavatories
29. Lavatories
30. Timber store shed
31. Timber store shed
32. Timber store shed
33. Lavatories
36. Benzine store
37. Foremen's cabin
38. Timber store shed
39. Coal store
40. Coal store
43. Plumbers' shop
44. Pipe store
45. Wash-house
46. Heating appliances
50. Railway servants' cabin
51. Locomotive shed
52. Scrap store shed
53. Coal store
54. Piece goods shed
56. Refreshment hall
58. Timber store shed
59. Compressed air
59a. Dynamo station
59b. Tool store
60. Bicycle-room
62. Office
63. Time-office
64. Tool dispensary
65. Electric swing crane
66. Electric swing crane
67. Tool shed
68. Time and piece-work office
69. Bicycle-room
70. Coal store
71. Engine-house

D.—*Dwelling Houses in the Parish of Blumenthal.*

1. Officials' dwelling-house
2. Dining hall
3. Foremen's dwelling-house
4. Foremen's dwelling house
5. Dining and lodging-house
6. Outhouses
7. Officials' dwelling-house
8. Stable

E.—*Buildings in Vegesack.*

1. Manager's house
2. Office
3. Timber store shed
4. Store-house
5. Foremen's dwelling-house
6. Foremen's dwelling-house
7. Dwelling-house
8. Dwelling-house
9. Dwelling-house
10. Officials' dwelling-house
11. Officials' dwelling-house

The shipyard machine tools are arranged in two bays of 79ft. and 39ft. 6in. clear width by 574ft. in length, lying parallel with one another—see Fig. 2. The large bay is partly open towards the slips and a roof of 19ft. 8in. in breadth, under which the smaller machine tools are placed, is built out from it. The larger plate and angle bending machines, the arrangement of which may be seen from Fig. 2, are in the large bay, while the marking off and fitting takes place in the smaller one. The heavy machine tools and those that stand by themselves are separately driven by electricity, while those at the sides are worked from a line of shafting. A hydraulic plate-bending machine at the end of the bay has a length of 34ft. 6in., and is served by two special cranes, each with an outreach of 33ft. and a height of 16ft. 6in.

Each of the bays is traversed from end to end by three overhead cranes of 5 tons carrying capacity, which were supplied by the Märkische Maschinenfabrik Ludw. Stuckenholz, of Wetter a. d. Ruhr. The supporting girders of these cranes are extended out beyond the machine sheds on pillars as far as the bending slabs and furnaces, so that the cranes can command the whole of the open space lying between, which serves as a storing place for plates and angles. In the middle of it lies the railway line mentioned above, so that the transport facilities from the trucks to the storing ground on the one hand, and from the storing ground to the various shipyard workshops on the other, are exceedingly good. The space on the northern side of the platers' sheds is also in part used as a material storing ground, and is likewise commanded throughout its length by an overhead crane. It is so arranged that in case of need an extension of the platers' sheds may easily be made.

To work the southernmost part of the material store ground which would otherwise be out of range, four swinging cranes, also from Stuckenholz, each of two tons carrying capacity and 33ft. radius, are provided.

The stock yard is traversed by several lines of rails both in the longitudinal and in the transverse direction. At the east end lie the bending slabs, the furnace, the shipyard smithy, and the moulding loft. For the transport of material in these shops a standard-gauge line runs through between the slabs, while a narrow-gauge line runs through the smithy between the small bending blocks, the fires, and the steam hammers.

The furnace has a length of 82ft., and has four fires at the side. The frame-bending blocks are provided with two movable winches worked by hand for bending the heavy beams. Behind the shipyard smithy lies the central power station, in which are installed four steam engines of a total horse-power of 3250, directly coupled to a like number of dynamos. Current at 500 volts is here generated for the use of the machine tools, the cranes, and the lighting circuits. As a stand-by four accumulator batteries of a total of 3300 ampère-hours are provided, which in the case of a breakdown can keep the yard machinery going for three hours. The steam is produced by ten boilers of an aggregate heating surface of 10,760 square feet. The pneumatic tools receive their power from three compressors supplied by the Ingersoll Sergeant Drill Company, one of which can compress 1060 cubic feet, the two others each 2120 cubic feet of air per minute to 103 lb. per square inch. An extensive system of piping distributes the compressed air to all parts of the yard and to the slips.

Between the last-named workshops and the bank of the Weser lie the shipyard fitting shop and the galvanising shop, which like the other shops are provided with all the most up-to-date tools, among which are a hot-air drying stove, and a chip and sawdust exhauster, which draws off the sawdust and chips from all the tools, delivering it to the boilers of the power-house, where it is used as fuel.

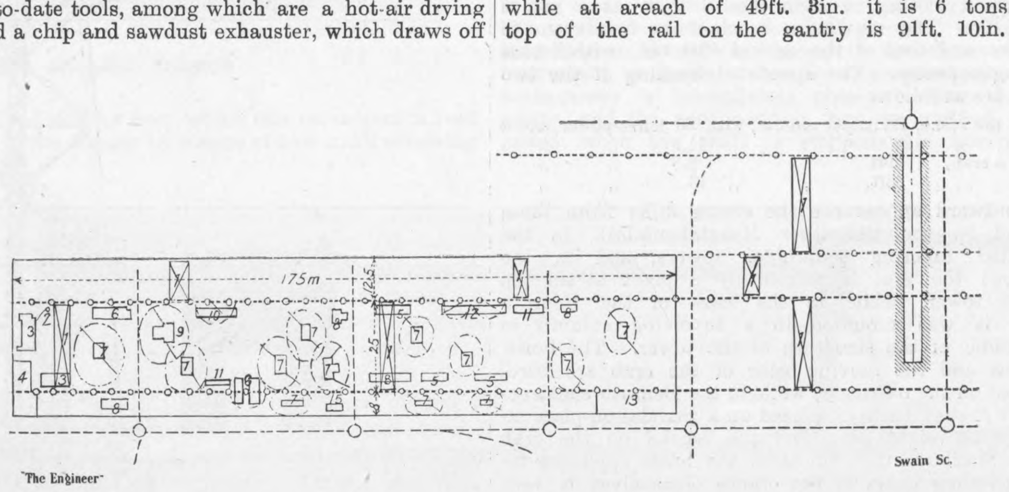

Fig. 2—PLATERS' SHED

1.	Travelling crane	Ludwig Stuckenholz
2.	Cranes	Bechem and Keetmann
3.	Hydraulic flanging machine	Ernst Schiess
4.	Hydraulic plant	Ernst Schiess
5.	Planing machine	Bennie and Son
6.	Tapering machine	Breuer and Schuhmacher
7.	Shearing and punching machines	Ernst Schiess
8.	Rolls	Various firms
9.	Shearing and punching machines	Bennie and Son
10.	Countersinking machines	Breuer and Schuhmacher
11.	Tapering machine	Breuer and Schuhmacher
12.	Countersinking machine	Breuer and Schuhmacher
13.	Tool dispensary	—
14.	Manhole punch	Ernst Schiess
15.	Joggling machine	Hugh Smith and Co.
16.	Loading ramp	—

To the west of the joiners' shop, further down the river, are the six building slips, set diagonally to the bank. In case of necessity two more slips can be constructed to the west of these. The floors of all the six slips are of concrete, and in the case of four of them the blocks are "reinforced," those of the other two being of the ordinary material. The construction of the slips, which, we may here observe, is the one universally adopted in Germany, has given every satisfaction, as it is found to be better suited to support the great weights of the modern vessels than the older method of longitudinal and transverse baulks of timber laid on piles. The great local pressures occurring during the construction and launching of the vessels are easily supported by the 40in. reinforced cement slabs.

For serving the two most easterly slips, 1 and 2, a gantry is built between these carrying a crane-path, 607ft. in length, with a gauge width of 21ft. 4in., and along this two double-armed outriggers can travel. These are shown in Fig. 3. The jibs are so arranged that the crab can pass to and fro over their whole length. To prevent the occurrence of undesirable stresses a movable counter-weight is provided, which takes such positions with reference to the crab, that for every radius the load to be moved is partly balanced, and the general conditions made as favourable as possible. The extreme reach to each side is 82ft. 10in., and the lifting capacity with the crab in this position is 3 tons, while at a reach of 49ft. 3in. it is 6 tons. The top of the rail on the gantry is 91ft. 10in. above the floor of the slip, the highest position of the hook being 109ft. from the same plane. The speed of travelling of the crane is 197ft. per min.; that of the crab, 98ft. 6in. per min.; and that of the hook, 49ft. 3in. per min. Although the hook of each crane can reach over the whole breadth of two vessels occupying the slips, between which the gantry is erected, it is found impossible to make the most of this in practice, since the crane cannot be used for both vessels at once. Even when the two cranes are used together it is not possible to work two vessels independently at the same time, since each crane hampers the movements of the other in the longitudinal direction. A further drawback lies in the fact that the load to be moved is out of all proportion to the whole, the weight of the cranes amounting to 128 tons, so that the current required, and therewith also the cost of working, is disproportionately high. The material is brought to the slips by light locomotive cranes having carrying capacities of 3 and 5½ tons.

Since, as shown above, the simultaneous working of two vessels by means of the double outrigger cranes did not prove successful, two travelling cantilever cranes were subsequently installed on the side of the gantry lying towards slip No. 2, and these can reach over the vessel under construction. At a maximum radius of 39ft. 9½in. these cantilever cranes have a lifting capacity of 1.5 tons, while with a reach of 29ft. 6in. they can carry 2.5 tons. Originally there were four swinging cranes of three tons carrying capacity, with 18ft. 8in. radius at the foot of the gantry on each side to take the material as it arrived. This arrangement did not, however, prove successful, and as the cranes were often in the way they were removed, and the material was then picked up directly by the locomotive cranes and transferred to the hooks of the main cranes. The whole plant was made by the Duisburger Maschinenbau A. G. vormals Bechem und Keetmann, of Duisburg. For the reasons given above, the gantry cranes are now used only for working the No. I. slip, while one side of slip No. II. is served by the cantilever cranes. The other side of slip No. 2 and the four other slips are worked by seven swinging tower-cranes. Two of these were supplied by the Benrather Maschinenfabrik, and are throughout constructed exactly like those, already described, of the Aktiengesellschaft Weser.*

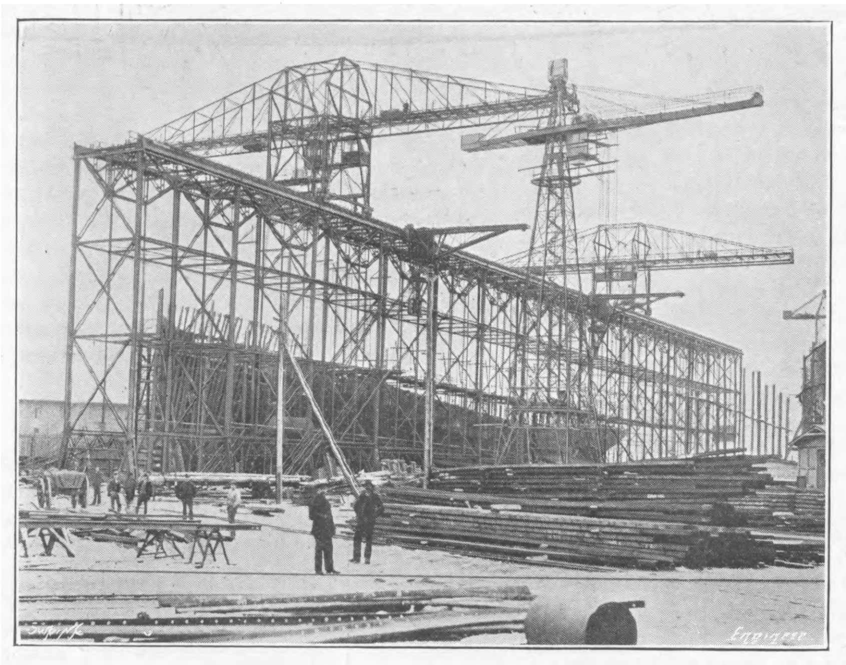

Fig. 3—SHIPBUILDING GANTRY AND CRANES

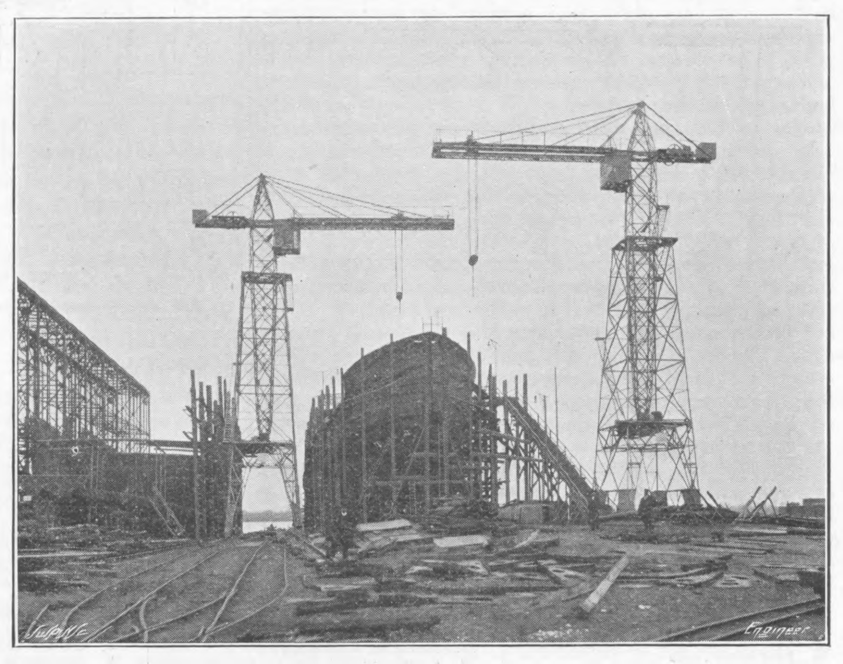

Fig. 4—SHIPYARD TOWER CRANES

Two other revolving tower cranes were supplied by the Duisburg Maschinenbau Aktiengesellschaft — see Fig. 3 in the foreground—one of them having a gauge of 16ft. 6in., and the other of 19ft. 8¼in. The highest position of the hook is in the case of the first of these 82ft. 4in., and in that of the second 88ft. 11in., the carrying capacity being in each case 6 tons, at a radius of 29ft. 6in. The maximum reach of the first crane is 65ft. 7in., and that of the second 52ft. 6in., with 2 tons carrying capacity. The speeds of working of the two cranes are as follows :—

Moving	the crane,	197ft.	per minute,	with	60	horse-power	motor
Turning	,,	230ft.	,,	,,	11.5	,,	,,
Moving a crab,		49ft.	,,	,,	6.8	,,	,,
Lifting		66ft.	,,	,,	40	,,	,,

In outward appearance the cranes differ from those supplied by the Benrather Maschinenfabrik, in the four-sided tapering pyramidal towers, and in the fact that the arm is carried by a pivot at the top of the tower, while in the case of the Benrath cranes it was mounted in a revolving column in the middle of the structure of the tower. The hoisting gear and the moving gear of the crab are here arranged on the outrigger, while in the Benrath construction the first of these is placed on a foundation-plate on the counterweight arm, and the second on the crab itself. Similarly, in both cases the brake appliance for the travelling gears of the cranes themselves is very carefully worked out, and great care is taken to provide sufficient stability. Good braking arrangements are all the more necessary for the Bremer Vulkan, since the declivity of the track is 1 in 60, while in the case of the Aktiengesellschaft Weser it is only 1 in 90.

The three other tower cranes were supplied by the Märkische Aktiengesellschaft Ludwig Stuckenholz —see Fig. 4. Two of these have gauges of 19ft. 8¼in. and the third a gauge of 16ft. 6in. Their carrying capacity, at a radius of 29ft. 6in., is six tons. The jib is mounted on a revolving column, which in the lower part of the tower runs on a ring of rollers and is moved by friction gear in order to prevent breakdowns in case of a sudden stop to the motion of the crane. The hoisting gear is arranged on the counterweight arm and that of the crab on this part itself. On the riveting space lying between the shipyard workshops and the slips, several portable cranes are provided to work the heavy hydraulic riveters.

The eastern part of the yard, *i.e.*, the ground belonging to the former Ullrichs' yard, is occupied by the engine department, all the shops of which are fitted with up-to-date machinery. Here, as in the case of the shipyard shops, everything is done to enable several large orders to be carried through in the shortest possible time. The first shop is the boiler smithy, and consists of three bays, worked by three overhead travelling cranes of 25 to 26 tons carrying capacity. The boiler-shells are bent by a set of rolls which can turn out cylindrical sections of 16ft. 6in. diameter by 9ft. 10in. in breadth in plate thickness up to $\frac{25}{32}$nds of an inch. Twelve large drilling machines and four hydraulic riveters afford facilities for the simultaneous production of several large size boilers.

Following the boiler shop come the shops for the building of engines. These are the engine-works fitting shop, the turning shop, the engine shop, and the erecting shop. The last named shop consists of three large bays, and is served by four overhead travelling cranes, two of which can each lift 75 tons. The series is concluded by the ironfoundry, with the casting shop, the pattern shop, and the store.

For the fitting out of the vessels there are two shearleg cranes of the older pattern, and a revolving tower crane supplied by the Benrather Maschinenfabrik capable of lifting 100 tons at a radius of 56ft., and 46 tons at 84ft. 4in. As may be seen from Fig. 5, the crane consists of a tower which merges above into the jib; the tower rests on twelve trolleys, each of which has four running wheels. Four of these trolleys are each driven by a motor of 12 horse-power. In the centre of the base is a pivot let into the foundation, and on this the crane revolves. For raising the load there are two motors, each of 26 horse-power. With a load of 100 tons the speed of lifting is 4ft. 1¼in. per minute, for one of 50 tons it is 8ft. 2½in. per minute. In addition to the main crab there is an auxiliary crab capable of raising 7½ tons. Provision is made for turning the crane through an angle of 360 deg. in ten minutes; the speed of the crab is 19ft. 8in. per minute, with a motor of 12 horse-power.

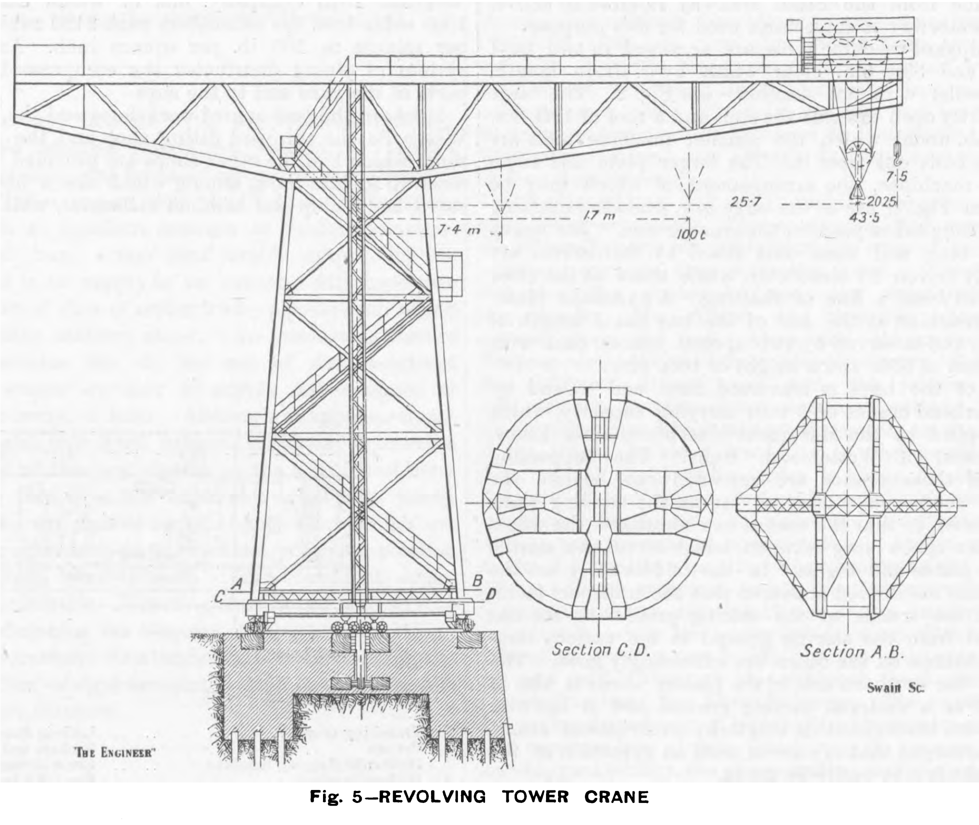

Fig. 5—REVOLVING TOWER CRANE

All the buildings in the yard are built in accordance with modern experience, and are throughout fire-proof. A fire brigade has been organised, and is provided with excellent extinguishing and rescuing apparatus. Numerous hydrants are installed inside the works, and are fed by a water service belonging to the establishment.

A yard sick fund is provided for the workmen and clerks, with three doctors, two of whom hold their consultations in a specially arranged room in the general office building of the shipyard department. For first aid in cases of accident a certified dresser is constantly in the yard.

For workmen who live at a distance from the yard two canteens and dining houses are provided, while the policy of the firm in respect to dwelling-houses is also worthy of note. The workmen in Bremen, and, indeed, all over the Weser district, live in single tenement or double tenement houses, with gardens and perhaps small agricultural allotments, the large lodging-houses familiar elsewhere being here in disfavour. Thus every married workman who belonged formerly to the Lange and Ullrichs shipyards owned a small property with some agricultural stock. The reliability of the old staff of workmen which the Bremer Vulkan took over at its foundation depended a good deal upon this peculiarity. When the yard was enlarged many additional workmen had to be engaged, and it was desirable that these also should become as independent as possible. On the other hand, there was a want of dwelling accommodation for unmarried men and for the younger officials. A bachelors' home was accordingly instituted, and a building society was called into being, the necessary funds for which were advanced by the Staatlicher Landesversicherungs-Anstalt Hannover, To prevent land speculation, a large estate was bought in the neighbouring parish of Blumenthal, and the lots made over to the building society at cost price. The society, thus strongly supported, has developed in a highly satisfactory manner, and has enabled the workmen, by an instalment system, to obtain possession of one of these small estates.

Since its reconstruction in 1893, the Bremer Vulkan has built about 180 vessels. In addition to about 60 vessels for the steam trawling and herring fishing industries which at first formed the main part of the company's operations, the work turned out has included cargo and passenger steamers of about 10,000 tons carrying capacity for the Norddeutscher Lloyd, the Hamburg-Amerika Linie, the Deutsche Dampfschiffahrts-gesellschaft, the "Hansa" and "Argo" Companies, the Woermannlinie, the Oldenburg-Portugiesische Dampfschiffs-Rhederei, the Ost-Afrika Linie, &c. War or other vessels for the Imperial navy have not so far been built by the Bremer Vulkan, but the up-to-date arrangement of its works would unquestionably enable this company to take a place in the ranks of those that do such work. In repairing work the Bremer Vulkan takes no part, but the whole energy of the yard is directed towards new work, for the rapid turning out of which it has won a high reputation.

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* See THE ENGINEER for October 22nd.

SOME INVESTIGATIONS WITH A NEW FORM OF TORSION METER.

In the line of conversion of heat produced by combustion, into power, there are several points at which measurements may be made to ascertain the output of the system. Those generally accepted are, in the case for instance, of a steam engine, weight of coal consumed, weight of steam generated, or of feed-water delivered to the boiler, pressure of steam acting upon the pistons, combined with speed of piston, and brake horse-power delivered to the shaft. Obviously the last, where it can be measured, is the one most to be desired, for the others all suffer loss, the amount of which depends upon the efficiency of the boiler and engine, before final conversion into usefully applied power. Hence arises the importance attaching to brake horse-power. To measure this for large units is an exceedingly difficult operation, but a solution of the difficulty is found in the application of torsion meters which measure the amount of twist given to the shafting when power is being transmitted. In the case of turbine shafting, or shafting driven by electro-motors, where the torsion is very nearly uniform, the problem has been attacked in different ways—with a greater or less degree of success. Several forms of torsion meter and the methods by which the twist of the shafting obtained from them is converted into horse-power, have been described in previous issues of THE ENGINEER.[*]

A considerable number of tests upon running shafting have been made in recent years upon ships built by Messrs. William Denny and Bros., Dumbarton, with the result that a new kind of torsion indicator has been evolved, which is simple in form, and whose management and use are within the scope of any engineer. Fig. 1 represents the Denny-Edgecombe torsion indicator now being placed on the market, as designed for shafting with uniform torsion. By its means an engineer running turbine machinery can in a few minutes ascertain the brake horse-power, or more correctly, perhaps, the shaft horse-power, being delivered by his engine. The instrument as shown was tested, along with two other types of torsion meter, upon the shafting of the Lancashire and Yorkshire and London and North-Western Railway Company's turbine steamers, Duke of Cumberland and Duke of Argyll. All the instruments were upon the same shaft during the speed trials, and the new torsion indicator gave complete satisfaction.

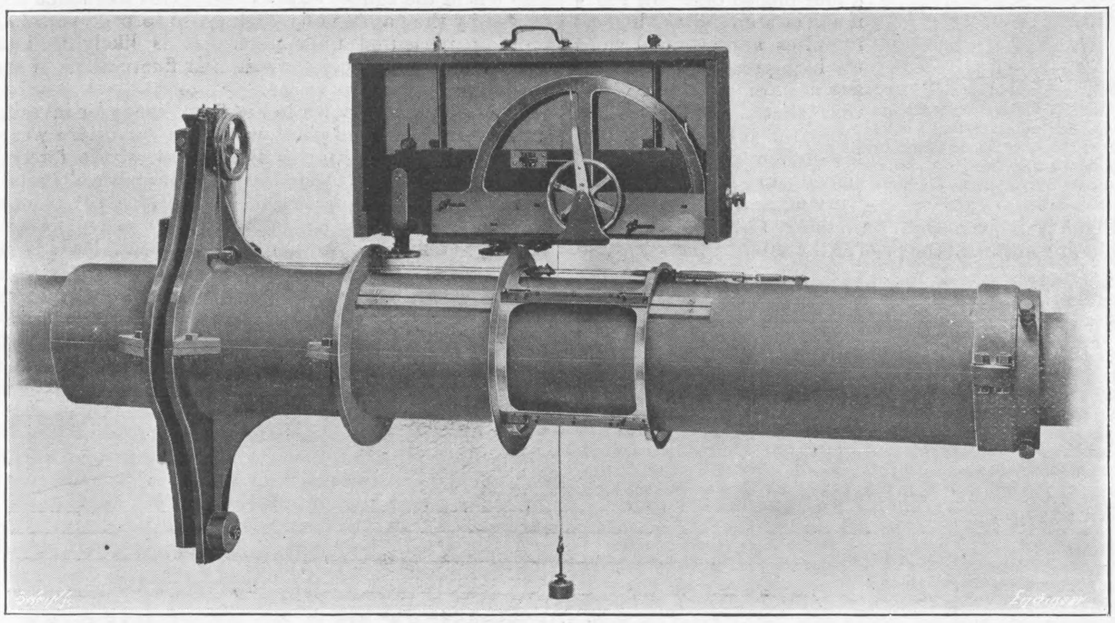

Fig. 1—DENNY-EDGECOMBE TORSION METER FOR UNIFORM TORSION

It consists of a split cast iron tube, secured upon the shaft, revolving with it, and carrying at one end multiplying gear upon an arm. A corresponding standing arm is secured upon the shaft, and carries a small fine-toothed quadrant which engages with the multiplying gear on the arm of the tube. The multiplying gear has a light aluminium drum, which moves an endless flexible wire, and converts the torsional movement of the shaft, after multiplication by the small gearing, into longitudinal movement along the tube. Running easily upon the tube is a very light aluminium traveller, which is secured to the wire by a grip, and so acquires the same motion. As the torsion in the shaft is increased, the standing arm is moved relatively to the arm of the tube, which is, of course, quite unaffected by torsion, and thus the light traveller moves correspondingly along the tube. The traveller has an accurately turned flange, which corresponds with a similar base flange cast upon the tube. It will be seen that if there be any longitudinal movement of the shafting due to expansion, or other causes, both the base flange and the light traveller flange move together, and the distance between them is unaltered by anything else than torsion of the shafting. The movement of the traveller flange relatively to the base flange, when multiplied by the number of revolutions per minute, is a measure of the power. The indicator from which this movement is read is applied to the flanges by means of two small revolving wheels, which run against their turned surfaces. One of these wheels is attached to the body of the indicator, and by means of a small spring is kept in direct contact with the base flange. The other small wheel is upon a slide on the indicator, and is held against the flange by a tension weight. The slide in the indicator box, to which the wheel is attached, is connected by a flexible wire to a small drum carrying a pointer moving over a graduated scale. When the shaft is at rest, or moving very slowly without torsion, the two small wheels are held against their respective flanges, and the indicator is adjusted by means provided for the purpose, so that the pointer stands at zero. The wheels may then be secured in such a position that they are quite out of contact with the flanges, and the indicator box may be locked up and left. When it is desired to read the power being transmitted, the wheels are allowed to run each upon its respective flange. The indication read on the scale, multiplied by the number of revolutions per minute, is the shaft horse-power. The wheels are then again fixed in the out-of-gear position, and the box left locked up.

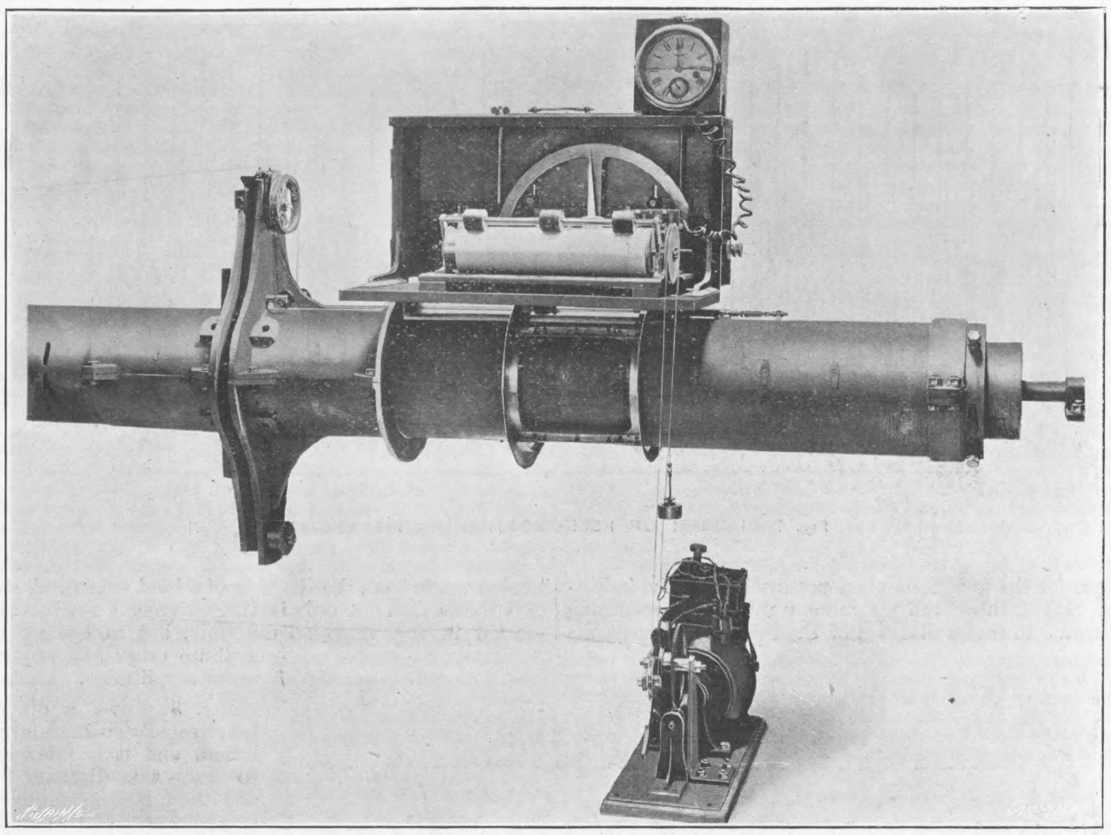

Fig. 2—TORSION METER FITTED WITH RECORDING APPARATUS

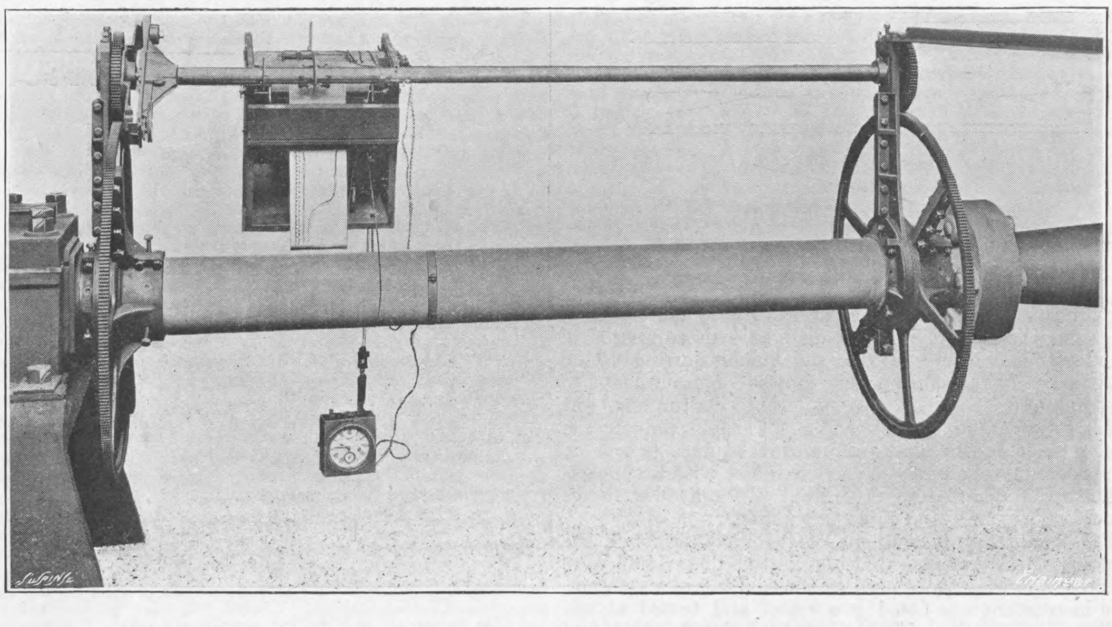

Fig. 3—TORSION METER FOR RECIPROCATING ENGINES

A light protective casing of wood or sheet iron should be fitted all round the instrument, except at the indicator box, which is carried on supports from the ground, or the hull of a ship, in such a way that it can be easily lifted in or out of place for examination or repair of any part, should it be necessary. A special scale has to be supplied to suit each particular case in which the indicator is applied. If the scale be divided in inches, or any other fixed unit, then the shaft-horse-power with N revolutions and a scale reading of X is N × X × K. The value of K varies for different instruments and shafts. It is most accurately obtained by a torsional test of the shaft before it is placed in position. A very close approximation to its value may, however, be made from many actual tests made with other shafts, and in any case a day to day comparison of the output with the steam pressure, at the high-pressure turbine, for instance, can be made and logged by the engineer. The instrument is simple and easily understood; the shaft horse-power is immediately obtained either ahead or astern, and the zero position may be verified or adjusted when the shaft is stopped. Its accuracy is unaffected by lateral or longitudinal movements of the shafting in the bearings, or by any alteration in the form of hull of ships when under power; a very important matter. The wheels can be put out of gear, and only placed in contact with the revolving flanges for the few moments necessary to read the indication. Fig. 2 shows the instrument fitted with recording apparatus so that a diagram of the twist and revolutions per minute may be obtained. It is not contemplated that for every-day use this would be required, the pointer being regarded as sufficient.

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[*] THE ENGINEER, November 13th, December 11th, 1908; and January 22nd, 1909.

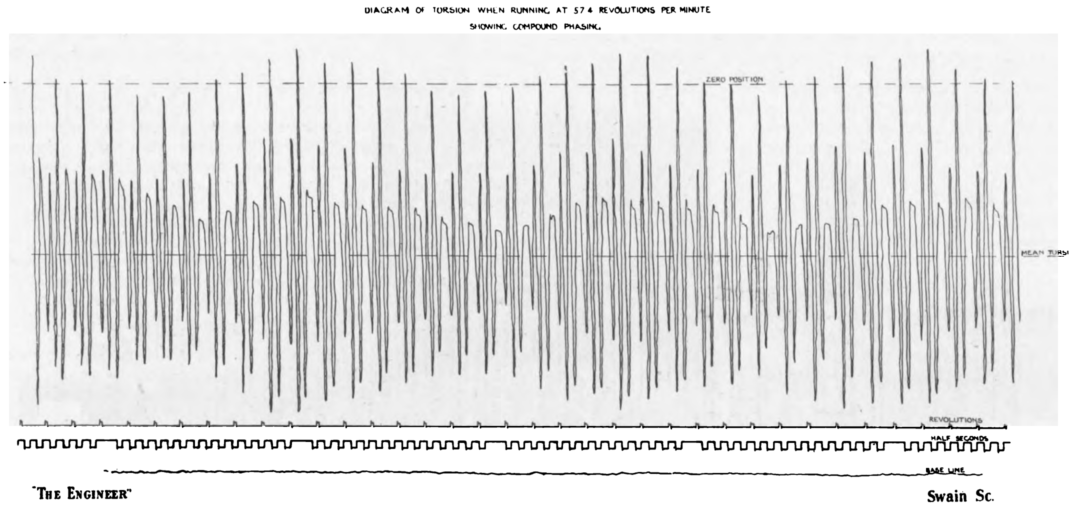

Fig. 4—DIAGRAM OF RECIPROCATING MARINE ENGINE

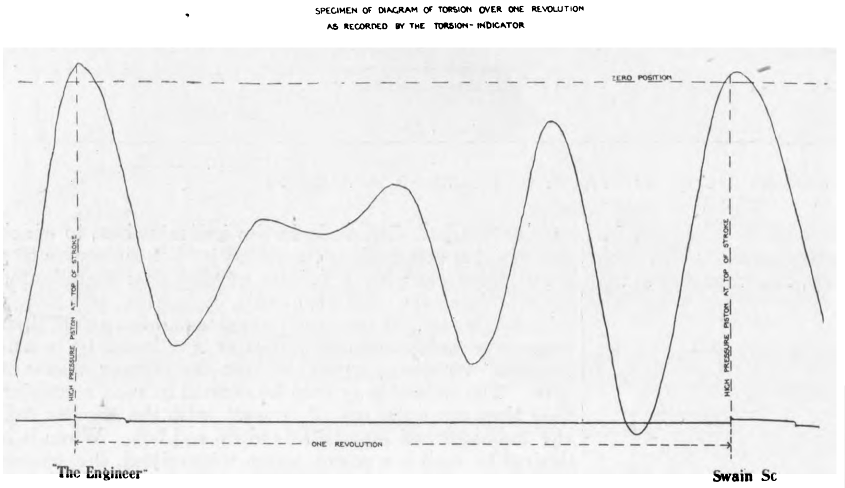

Fig. 5—DIAGRAM OF ONE REVOLUTION

This simple form of torsion indicator is the result of many experiments made with a view to discover the quality and quantity of the movements taking place in shafting when transmitting power. Obviously there is a great difference in the condition of shafting when driven by a steam turbine or electro-motor, in which case it receives many impulses per revolution; and that when driven by a reciprocating engine and receiving only two, three, or four impulses per revolution. In the latter case the torsion of the shaft is always in a state of violent fluctuation, as will be seen later. It is clear, too, that the interposition of a fly-wheel between the engine and its work, or rapid changes of load in the work itself, produce corresponding variations in the torsion to which the shafting is subjected.

When the instrument is applied to shafting driven by a reciprocating engine, it is necessary to carry the quadrant engaging the multiplying gear upon an arm composed of two laminated springs, so that the violent jarring which takes place in the shafting may not be communicated to the lighter mechanism. A different instrument was used, however, for investigating the rapid movements taking place in the shafts of marine engines driven by reciprocating machinery, a torsion meter with a counter-shaft being adopted in order that the traveller flange should be as small and light as possible.

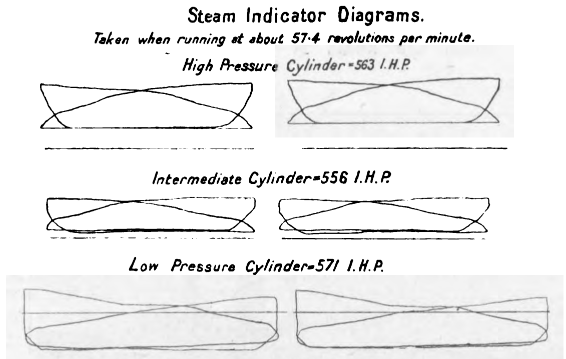

Fig. 6—INDICATOR CARDS

Fig. 3 shows an instrument of the kind, although the toothed wheels on the shafting in the illustration were much larger than those used on the shafting of a steamer. The instrument was fitted in a vessel and tested at sea during calm weather. It has also been fitted on several ships during their trials, and some results were published in THE ENGINEER in November, 1908, Vol. cvi., p. 559, showing that actual continuous diagrams of the movements had been taken with it in this country.

Fig. 4 shows the kind of diagram obtained when the ship was running steadily, and it is reproduced for the purpose of comparison with a diagram taken by the same torsion meter from the shafting of a land engine. A study of it shows that not only is there a violent reciprocating motion in the shaft all the time, but that there is a definite order and sequence in its amplitudes.

Fig. 5 shows a diagram taken rapidly during one revolution, and it is interesting to study this diagram first, and then that taken over a great number of revolutions, as in Fig. 4, when the sequence of phases produced by the synchronisation of periodicity of the shaft, engine, and propeller becomes evident. The propeller on the shaft from which these two diagrams were obtained was a four-bladed one. In Fig. 4 it will be seen that the highest impulses are attained when the high-pressure piston is at the top of its stroke, and that all the peaks of high-pressure, intermediate, and low-pressure impulses can be joined in similar curves, varying in a definite relation. In Fig. 5 it is seen that something was happening of a cushioning nature at the peak of the intermediate impulse, and the engineer of the ship thought at the time that it was caused by water in the cylinder. Curiously enough, the indicator cards taken about the same time by ordinary steam indicator do not show anything abnormal —see Fig. 6.

It is evident from these diagrams that the stresses on the shaft of an ordinary reciprocating engine when running easily in calm weather are very serious. They are greatly increased in violence when starting the ship from rest, turning with the rudder hard over, or when checking the ahead motion by reversing the propellers. Even in a turbine steamer the shaft is subject to violent oscillations—caused probably by cavitation at the propeller—when reversing rapidly from full speed ahead. But this is, of course, only of occasional occurrence, and not the regular condition of things. It is not surprising that the shafting of ships with reciprocating engines has so often failed, but rather that incipient weakness is not more often developed into an actual fracture by the rapid and violent variations in the torsion which occur even under the normal conditions of working. It may be safely inferred that the life of the shafting in turbine steamers will be much longer with ordinary conditions than that of the shafting of reciprocating engines.

In order further to examine the condition of mean torsion in reciprocating engine shafting, a spring arm was introduced to carry the multiplying quadrant. This had the effect of reducing the oscillations transmitted to a very small amount at the pencil. A feature of the torsion in one steamer when thus taken was that the mean torsion diagram, instead of being a straight line, was of a regular sinuous character, the amplitude of each wave covering several revolutions. The ship was running in calm water, but there was a slight irregular vibration of the vessel, increasing and decreasing in periods which appeared to agree with the wave periods of the mean torsion. Unfortunately, this similarity of period was not noticed in time to verify an absolute agreement. It seems only reasonable to assume that where vibration is set up there must be a corresponding absorption of power, and it is natural to expect that this would be shown in the torsion measurements if the power developed by the engine remained constant. The steam indicators giving a record of one revolution only, and the four cylinders not being necessarily indicated during the same revolution, give no information which would substantiate or refute this supposition. When the new torsion indicator was being used during the trials of the turbine steamer Duke of Argyll at Skelmorlie, a wave was formed upon the usually straight mean torsion diagram, and it corresponded in period with a slight heaving motion of the ship felt in the tunnel at the time. This was found to be caused by the passing of a high-speed torpedo vessel also running measured mile tests. It is likely that the torsion indicator would show similar fluctuations if used during rough weather at sea.

The instrument shown in Fig. 3 was made for investigations on a rolling mill plant, where the conditions were of quite a different character from those of the foregoing cases. The plant tested comprised several mills all driven from one main shaft. The motive power was a horizontal steam engine, having a very heavy fly-wheel of large diameter, to take up the peak loads which occurred for a few seconds at some stages of the mill operations. There was a part of the main shafting

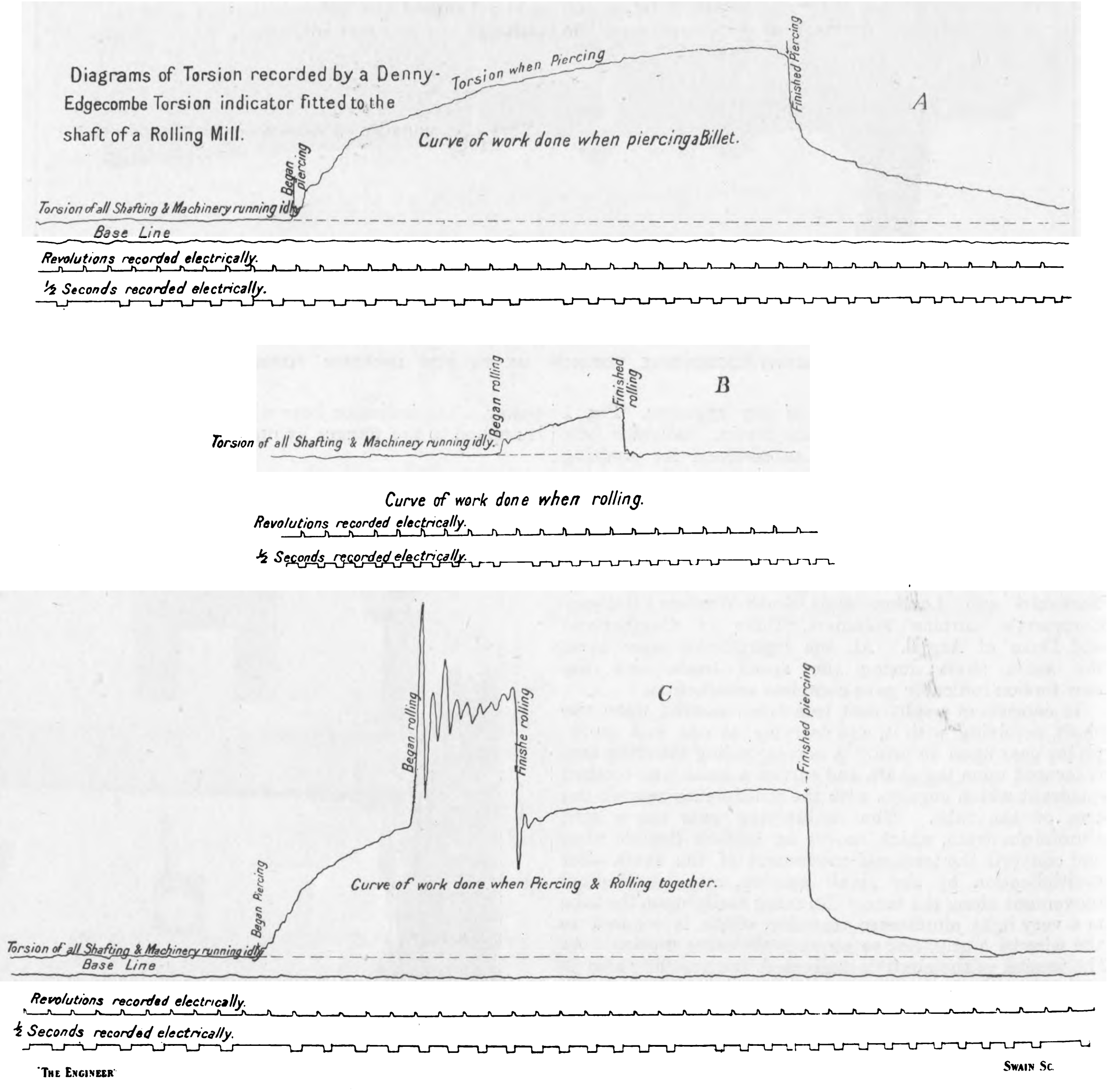

Fig. 7—DIAGRAMS TAKEN ON A ROLLING MILL

between the fly-wheel and the first mill, about 9ft. long and 9in. diameter, and upon this the torsion indicator was fitted, as shown in the illustration. As the operation of the mill or mills was intermittent, and only lasted for a few seconds at a time, it was a matter of some difficulty to estimate from the engine performance, what the work actually done amounted to. A continuous steam indicator diagram would have thrown some light upon the matter, but the revolutions being variable, the work done by the fly-wheel was more or less indeterminate. The diagrams shown in Fig. 7 were obtained from the shafting between the fly-wheel and the mills, and so give a complete record of the actual power transmitted. The method of working was to run the engine, fly-wheel, and shafting, up to as high a speed as desired, and when this was done, to put one or two or more of the mills into operation, when the revolutions fell rapidly as the momentum of the fly-wheel was absorbed. The torsion meter was arranged in such a way that the shafting drove the paper on which the diagram was taken, and by this means an indication of the varying speed of the shaft was transferred to the diagram. The diagram thus became a record of "work" done, as well as a record of revolutions per minute, and a measure of the torsional variation. It will be seen that the character of the diagrams is quite different from that of those obtained from the shafting of a reciprocating engine with no fly-wheel, and with a more or less regular load. The diagram was started when the speed of the engine and fly-wheel had been raised to its maximum, and was driving all the shafting and machinery idly. As soon as the operation of piercing a billet commenced, the diagram A, as recorded in Fig. 7, was obtained, the line of torsion falling back to its original position after the process ended. Diagrams are given for piercing alone, and for rolling alone, but, perhaps, the most interesting is C, in which case the two operations took place simultaneously. Here we see the "milling" load clearly added to the "piercing" load, with the peak load momentarily very much increased. Many diagrams such as these were taken, but the examples given are sufficient to show their common nature.

Where anything of an abnormal nature occurred, such as the sticking of a billet during its passage through the reducing rolls, the consequent increase of torsion was immediately recorded upon the diagram.

The application of the indicator to a rolling mill was a case in which the violent oscillations could not be damped out by a spring arm, for the reason that a complete record of the peak load was desired. The mean torsion would have given only an incomplete analysis of the operation. In spite of the rapidity and amount of the fluctuations, the instrument ran a whole day with only one failure of the light indicating mechanism, and this was repaired in a few minutes. Analyses of the records enabled a complete statement of all the particulars of time, load, and power during each operation to be easily made. In the case of turbine engines fitted with the new torsion indicator shown in Fig. 1 no such difficulties as the above have to be contended with, and the process of obtaining shaft horse-power is as simple as reading pressure from a pressure gauge. There is very little variation of torsion shown by the indicator even at the highest speeds on turbine shafting, and even if there were, there is no question of obtaining an incorrect reading, for the pointer will always indicate the mean torsion and not the torsion at any particular part of a revolution. Perhaps the most important point about it is, that the whole instrument is part of the shafting and is in no way affected by any movement which is not torsion. It has appealed to those engineers who have hitherto had an opportunity of seeing it in operation as a simple and practical tool. We understand that inquiries about this torsionmeter can be obtained from Mr. F. T. Edgecombe, Comely Bank, Dumbarton, N.B.

THE INSTITUTION OF CIVIL ENGINEERS.

ADDRESS OF MR. JAMES CHARLES INGLIS, PRESIDENT.[*]

I have to thank you very sincerely for the signal honour you have conferred on me in electing me as your President for a second term of office. When addressing the members last session, had I been aware that I was to have the honour of again meeting you in this position, I should have avoided so lengthy and discursive an address as I then delivered. I do not propose on this occasion to deal with any particular engineering subject, but rather to comment on the recent activities of the Institution, the professional status of the engineer, and the position he occupies in relation to certain economic questions of the day. I will, then, first refer to the generally felt want of improvement in the professional status of the civil engineer, and to what we have done to advance it. New by-laws have been framed and new regulations drawn up with the object of securing a higher and more efficient standard of training than has hitherto been required, and of governing matters of professional conduct and etiquette.

A year ago I drew attention to the desirability of promoting more definite practical training among engineering students, and especially of regulating the conditions under which proof of such training should be given to the Council as a preliminary to election. The Council studied this question long and exhaustively, and new by-laws representing their views will be submitted shortly for the decision of the members. The proposed rules are, perhaps, not so drastic as some might wish, but it was felt that in our profession the entrance should continue to be accessible, although under restricted conditions, to those whose native ability or genius may enable them to surmount a deficiency in early training of a regular character.

There still appears to linger a certain popular confusion of ideas regarding knowledge which can be tested by question and answer in ordinary examination papers, and ability to apply such knowledge intelligently to the practical problems of every-day professional life. This Institution, differing perhaps in degree, though not, it is thought, in principle, from the views sometimes entertained by other bodies on this subject, has persevered throughout in the belief that for success in the application of the great powers of Nature to the use and convenience of man, there can be, as a rule, no efficient substitute for regular training under those who are practising that art; albeit, the foundation of intelligent work in this direction lies in the possession of sound education and appropriate scientific knowledge.

These are broadly the lines upon which the Council have proceeded in formulating the proposals now before the members, a forecast of which I made a year ago. It is not to be assumed that they represent the last word upon this subject, but in the Council's judgment they meet the immediate needs of to-day. Closely connected with this is the other matter which I mentioned last year, viz., that of the engineer's personal and professional position, apart from his connection with this Institution as an organisation for the advancement of science. This matter, which has been long in the minds of the Council, has been brought somewhat to a focus in the past year, in proposals for the introduction of certain disciplinary regulations into the Institution's by-laws. Speaking broadly, there is evidence of almost complete unanimity among the members, that the principle involved in these proposed rules of conduct is one which should be accepted and adopted by the Institution. In some details these rules may be open to amendment and improvement, but the general feeling seems to be that they are in the right direction, and that formal avowal by the Institution that its members are bound by a code as defined in the rules is desirable, in the interests of the professional position which the Institution seeks to further.

I would also allude to the subject of professional fees, upon which the Council have not so far found themselves able to make any recommendation. The matter is one which is, I am aware, engaging the attention of many members; but so far the view of the Council has been that a healthy and responsible professional spirit in the Institution should achieve in a satisfactory manner the main objects that could be secured by any authorised scale of fees.

The activity of the Institution has long since ceased to be confined to its sessional period, and during the past recess we have been engaged in grappling seriously with the proposals contained in the London County Council (General Powers) Bill, 1909, as amending the Building Acts. Such parliamentary enterprise is rather foreign to the usual course of business of the Institution; but it was felt that questions were involved of great importance to engineering construction in the future, and that the views of engineers upon these questions had not been fully realised by those responsible for the new proposals. After somewhat prolonged and arduous contention before a Committee of the House of Commons, the Bill was brought into a shape which the Institution may now regard as satisfactory, and as rendering practicable the extended construction of metal-framed buildings in London. In particular, it is satisfactory to state that the important matter of appeals by engineers under the Act will be subject to an independent and expert tribunal, upon which the Institution of Civil Engineers will be represented by a member nominated by the Council.

The subject of our new Institution buildings has been advanced considerably during the recess. In July last the Council found themselves justified, by the progress of the negotiations with the Government, in inviting six selected architects to submit competitive designs for the new building, and I am now able to announce that the last of the necessary legal formalities in connection with the acquisition of the site has been disposed of, and it is hoped that building operations will be in active progress in the early part of next year.

Matters of this kind do not usually form part of a presidential address, but I have alluded to them as they are undoubtedly of very present interest to the members. Incidentally, they reflect the policy of the Council in meeting the conditions of the day, while exercising the caution and circumspection demanded when interfering with a fabric so complex in construction as this Institution.

It is, indeed, no light task to administer the affairs of an Institution whose interests lie in every civilised country of the world, and in some that are uncivilised; to guide and govern the training of its 1600 students, to regulate and control its extensive examination system, and to scrutinise and determine the qualifications for election into its body—all these matters apart from the numerous undertakings and interests of an extraneous character which have accumulated in the past and seem likely to increase in the future. During the past year our business has involved the holding of 133 meetings of the Council and various committees dealing with details of the Institution work. This is quite apart from the meetings of such organisations as the Engineering Standards Committee and other cognate bodies accommodated at the Institution, and it is obvious that only by careful arrangement of our work is it possible to deal satisfactorily with the increasing volume it presents.

It may be interesting at this time, and possibly useful, to reflect for a moment on what is meant by "the work of the Institution." It is, of course, well known that the object for which the Institution was formed was the advancement and improvement of professional engineering knowledge and skill; and whilst it may appear that some of the duties now undertaken are rather indirectly connected with this object, they must be considered from the point of view of the Institution as a corporate body and how far they are likely to be beneficial to engineering as a profession, and thereby to the whole body of members.

Above all, we do not take a narrow view of the engineering profession, whether it be in regard to the branches of inquiry undertaken by the Institution, the formation of its governing body, or the study, training, and other qualifications required of those who enter its ranks. Civil engineering has been, by reason of its extended activity, so much subdivided into groups and branches, all of them more or less overlapping, that it may be useful to consider what its origin really was. Nothing has been written on that subject more clear and authoritative than the scholarly disquisition on the origin and history of the profession of Civil Engineering by Dr. William Pole, the late honorary secretary of the Institution. This was incorporated in the "Life of Sir W. Fairbairn," which was published some thirty years ago, and as it is probably unfamiliar to the present generation I have thought it well to give an abridgment as an Appendix to this address.

With regard to the Engineering Standards Committee, to which I have previously referred, it is impossible to over-estimate the value of the results obtained by that body with the aid of its numerous sub-committees. It is now some eight years since definite steps were taken to effect standardisation, and in that period the investigations of the various committees have enabled members to realise somewhat the unsystematised condition of British manufacturing and constructional practice, the vast interests involved, and the extraordinarily wide fields served by British manufacturers. It is only when these matters are properly appreciated that an estimate can be formed of the extent of the labours of the Standards Committee.

But, immensely valuable as the work has already proved to be, it must be regarded as largely in the nature of a preliminary effort, paving the way to what will probably form a more difficult and important task, viz., the settlement of International Standards, particularly with America and Germany, the two countries in which standardisation has been most highly developed.

Naturally, different parts of the world come under the predominating commercial influence of one or other of the great industrial countries, and this carries with it a demand for the standards of manufacture—shapes or sections—of that predominating country. For instance, in Germany, the steel manufacturers' rolls are being cut for English standards, while in England, I am sure you will find, our British manufacturers are being pressed to cut German shapes. The same feature applies to American commerce.

Already an International Association for testing materials is at work, and its proceedings for August last contain the report of the Sub-committee on the "Establishment of International Specifications for Iron and Steel." The Standards Committee is represented in that Association, and it is to be hoped that the great importance of the issues involved will ensure not only a speedy determination of international standard specifications for iron and steel, but that this will be followed by international standard shapes and sections, and ultimately by standard sizes and fittings for all engineering products of world-wide use which an International Committee can determine upon.

The extension of transport facilities and the rapid development of numerous industrial States, coupled with universal demand for industrial products, endow the question of international standards with an importance almost political. It is an urgent matter which British engineers should strive to further to the utmost extent of their opportunities, which at the present juncture are great.

Another important development is the increasing use of the Institution of Civil Engineers by the great Executive Departments of the State.

Mr. Haldane and his advisers have made an important departure in obtaining from this Institution, for commissions as officers of the Reserve Force of Royal Engineers, young men who have passed our qualifying examination, and who have also had some practical experience. This course appears necessary if the Government is to avail itself of the technical and practical training developed under the conditions of civil life as compared with that acquired in an official atmosphere, and the departure provides an important link between the civil and the military organisations.

The formation of this Reserve of Officers of the Royal Engineers has now been brought to a practical issue, and I have had the pleasure of nominating for commissions two batches, each of fifteen young engineers, and of learning, by personal observation and by communication with the authorities, that these young men have very fully justified the positions to which they have been appointed. A similar number of officers will be required half-yearly in future, and the present opportunity is taken to urge upon members the importance of assisting the Institution in this patriotic enterprise by influencing eligible young engineers and engineering students to enter the corps. The position is an honourable one, and, in addition, the course of training and general experience gained thereby is so practical that the Council have had no hesitation in deciding to regard it as substantially complying, for the period of its duration, with the Institution's requirements as to practical training.

I am aware of some of the difficulties which may have to be met, but the consideration of what has already been found practicable impels one to the opinion that the supply of engineers to the Indian public works and railways abroad might with advantage be drawn from the ranks of these Reserve Royal Engineers officers, after they have given proof of the special knowledge required for their respective appointments. Such a provision would give a strength to the Reserve Officers' Corps which it does not yet possess, would add to the commercial value of the young engineers from their disciplinary experience, and would provide an ever-ready and great source of strength to the War-office in time of need.

(*To be continued*).

Royal Institution.—A general monthly meeting of the members of the Royal Institution was held on Monday afternoon, the 1st instant, the Duke of Northumberland, K.G. (President), in the chair. Mr. James Douglas was elected a member. The special thanks of the members were returned to Sir William Farrer for his donation of £50 to the Fund for the Promotion of Experimental Research at Low Temperatures. The eighty-fourth Christmas course of juvenile lectures, founded at the Royal Institution in 1826 by Michael Faraday, will be delivered this year by Mr. William Duddell, F.R.S., his subject being "Modern Electricity." The course, which will be experimentally illustrated, commences on Tuesday, December 28th, at three o'clock, and will be continued on December 30th, 1909, January 1st, 4th, 6th, and 8th, 1910.

Coventry Engineering Society.—The annual general business meeting of the Coventry Engineering Society was held on Friday, October 29th, Mr. J. G. Griffiths presiding. The balance sheet, showed an income of £116 6s. 10d., including £35 5s. 4d. brought forward from last year, and after meeting expenditure leaving a balance at the bank of £43 2s. 2d., and was adopted. Thanks were accorded the auditors, Messrs. F. B. Farrand and F. W. Burroughs, who have performed the duties for many years. Mr. Bachelor proposed, and Mr. Leech seconded, that in the members' prize papers scheme the money awards be omitted and a diploma of merit be awarded at the discretion of the committee who were to look over the papers, before these were read to the Society, and to consider and meet the members reasonable out of pocket expenses. Mr. Alfred Herbert was elected president, Mr. A. Wright hon. secretary, Mr. F. Chadwick assistant secretary, Mr. J. Bachelor treasurer, and a committee representative of the following works:—Standard Motor Company; Auto-Machinery Company; Rudge-Whitworth, Limited; Centaur Cycle and Engineering Company; Rover Cycle and Motor Company; Daimler Motor Company; Hillman, Coatalen Motor Company; Maudslay Motor Company; Deasy Motor Company; White and Poppe, Limited; Triumph Cycle Company; Coventry Ordnance Works; Swift Cycle and Motor Company; Coventry Chain Company; Humber, Limited; Selig, Sonnenthal and Co.; Monopole Cycle and Carriage Company; Webster and Bennett, Limited; Singer Motor Company; and Alfred Herbert, Limited. The lectures for the session include:—"Life in Planes and Angles," "The Work of an Ironfoundry Laboratory," "Power Tests of Machine Tools," "Forging Plant," "Colour Photography," "Manganese Bronze in Engineering," "Impressions of Automobilism in America," "Metal Cutting Tools," "Uses of Electric Motors for Driving Purposes," "Modern Applications of Electricity to Engineering," and "The Origin, Properties and Uses of Lubricating Oils."

Junior Institution of Engineers.—The annual general meeting of this Institution was recently held at the Royal United Service Institution, Whitehall. The Council's annual report, which was presented, showed that the membership had increased to 1063, eighty-five elections and transferences having taken place during the past year. Nine ordinary meetings had been held, and thirty-nine visits to works made, covering practically every branch of engineering. The summer meeting in the Midlands had proved very successful. Birmingham had been made the centre, on account of the Institution's first Local Section having been established there during the year. Other salient features in the report included reference to the Gustave Canet Lecture delivered on the twenty-fifth anniversary of the Institution by Lieut. A. Trevor Dawson, R.N., on "Engineering of Ordnance;" awards for papers, Durham Bursary; and the "Monthly Journal and Record of Transactions," the volume for the year under review consisting of 758 pages, together with illustrative plates. The scrutineers reported that the election of officers, &c., had resulted as follows:—Chairman: Mr. Geo. T. Bullock; Vice-chairmen: Mr. J. Wylie Nisbet, Mr. F. D. G. Napier; Hon. Librarian: Mr. S. V. Cooke; Hon. Auditors: Messrs. H. Norman Gray and Henry Cook; Members of Council: Messrs. G. D. Harrison, Jas. Oswald, C. H. Smith, and Percy L. Young; Provincial Members of Council: Messrs. C. T. Briggs (Newcastle-on-Tyne), Ernest King (Sheffield), R. H. Parsons (Peterborough), Eustace W. Porter (Southampton), T. P. Hosegood (Bristol), Adam Hunter (Glasgow), W. E. Lilly (Dublin), H. F. Hunt (Pembroke). The annual meeting of the Benevolent Fund then took place, the statement of accounts showing that the amount standing to its credit is £188 19s. 9d. A paper was then read by Mr. T. A. Watson, Assoc. M. Inst. C.E., Member, on "The Reinforced Concrete Construction of the New General Post-office Buildings, London." A discussion followed, in which Messrs. L. H. Rugg, Hy. Adams, H. M. Martin, P. J. Waldram, William Dunn, E. F. Etchells, R. Vawdrey, and B. E. Parry took part, and the proceedings terminated with the announcement of the ensuing meeting on the 16th November, when Engineer Vice Admiral Henry J. Oram, C.B., would deliver his presidential address on "Recent Warship Machinery."

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[*] Delivered November 2nd, 1909.

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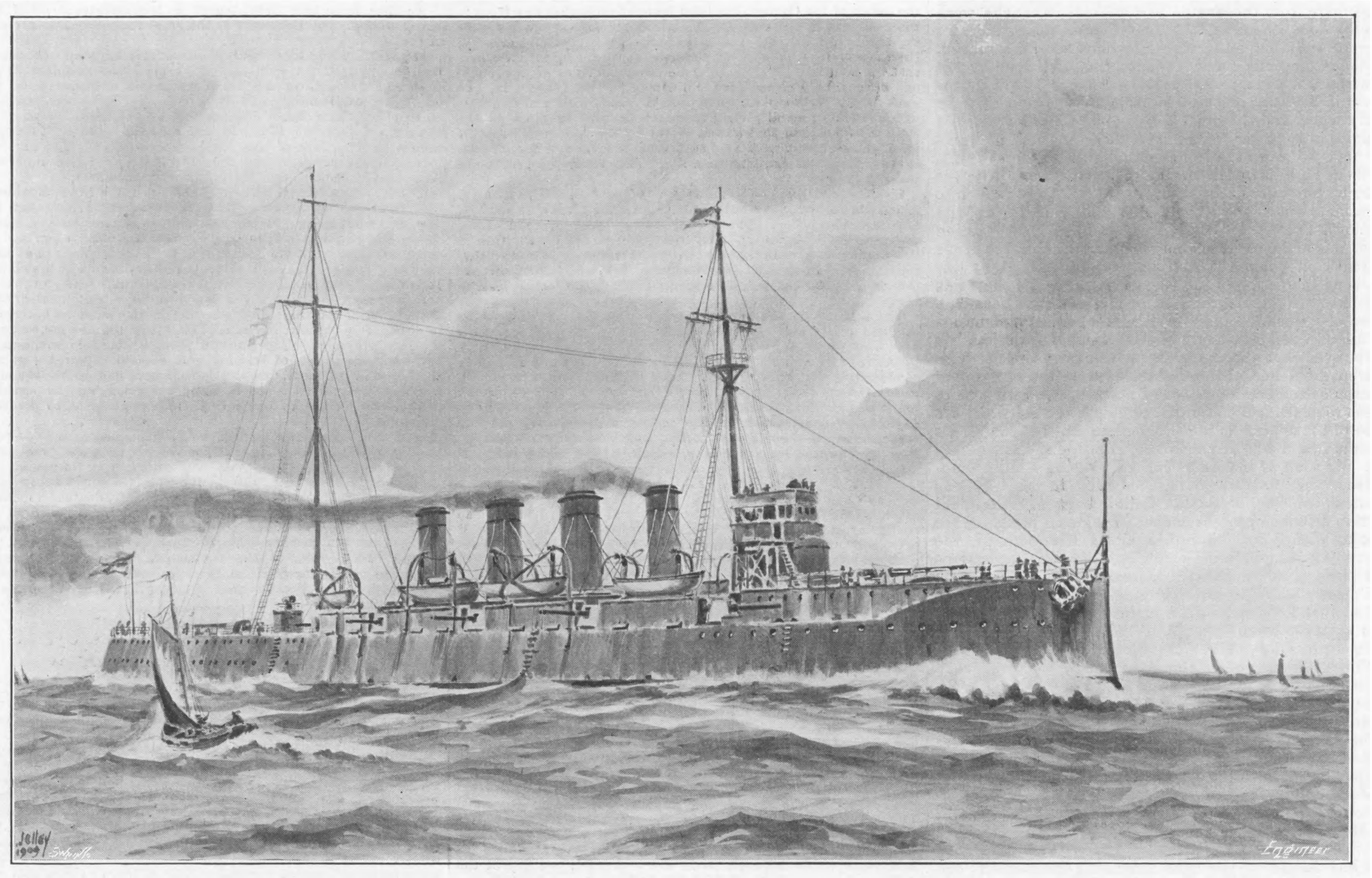


H.M.S. LIVERPOOL.

The Countess of Liverpool on Saturday performed the launching ceremonies in connection with the second-class cruiser Liverpool, which was built at Barrow by Vickers, Sons and Maxim, Limited, and of which we give an illustration above. This vessel is one of the five "Bristol" class cruisers ordered under the 1908 9 estimates, the other vessels and their builders being the Glasgow, Fairfield Shipbuilding and Engineering Company, Limited; the Bristol, John Brown and Co., Limited; the Gloucester, Wm. Beardmore and Co., Limited; and the Newcastle, Armstrong, Whitworth and Co., Limited. The Liverpool is 430ft. long, with a beam of 47ft. and a mean draught of 15¼ft. Her displacement is 4800 tons, and with Parsons turbines developing 22,000 horse-power she is expected to attain a speed of 25 knots. The turbines are being constructed by the builders, while the boilers are of the Yarrow pattern. We understand that her armament will probably consist of two 6in. and ten 4.7in. guns.

THE SCOUT MOOR RESERVOIR.

LAST week the Scout Moor high-level reservoir, which has been constructed by the Bury and District Joint Water Board, was formally opened.

Looking backward at the causes which contributed to the construction of the reservoir, we find that as long ago as 1878 Mr. J. Cartwright, in compliance with instructions from the Water Committee of Bury, investigated the conditions of the water supply to the higher portions of the Haslingden district, and reported that certain complained of defects were due to the slight difference in level between the reservoir and the district supplied, coupled with the fact that Haslingden and Bury shared the same main from Hapton reservoir, which was not sufficiently large for the dual draught. The Committee thereupon turned their attention to the improvement of the supply, and from time to time various alternative schemes were brought forward. In 1885 the Corporation of Bury promoted a Bill in Parliament to extend the time for the completion of the Ogden reservoir. The Haslingden Corporation opposed the Bill, and succeeded in getting a clause inserted which put upon the Corporation of Bury the obligation of erecting a pumping station and a service reservoir at Slates at an elevation of 950ft. above Ordnance Datum. In 1887 the Corporation of Bury obtained powers to construct a reservoir at Clough Bottom in the Whitewell Valley at an elevation of 1010ft., which was higher than that of the Hapton reservoir by 85ft. This Bill was also opposed by the Haslingden Corporation, and they succeeded in getting a clause inserted by which the Bury authorities were to be compelled to erect a pumping station if the new scheme should prove ineffective. The Clough Bottom reservoir was completed in 1896, and for a time was sufficient. In 1900, however, when some filter beds were constructed fears were entertained lest the loss of head in them would reduce the pressure, and it was decided to obtain tenders for a pumping plant. When these were received, however, they were deemed to represent so prohibitive a cost that the idea of a pumping station was abandoned, and Mr. Cartwright was directed to seek for an additional watershed in which a reservoir might be constructed at such an elevation as to allow the higher portions of Haslingden to be supplied by gravitation. Very quickly after the receipt of his instructions Mr. Cartwright was able to bring forward a scheme for constructing a reservoir in the Scout Valley at such an elevation as to ensure a supply of water under the necessary head. This scheme was approved in 1902, and in the next year powers to construct the reservoir were obtained. The tender of James Byrom, Limited, was accepted, work was commenced in 1905, and was completed last week, as already mentioned.

The reservoir is situated on the Moorland heights about six miles north-east of the borough of Bury and three and a half miles south-east of the borough of Haslingden. Its elevation is 1183ft. above sea-level, and it has a capacity of 50,000,000 gallons, with a top water area of 6 acres. The area of the gathering ground is 250 acres. The reservoir is calculated to be capable of maintaining a delivery of 250,000 gallons per day during a dry year, in addition to providing a statutory flow of 136,500 gallons of compensation water per 24 hours in the stream. The main embankment covers an area of 17,600 square yards, is 530ft. long, 550ft. wide at the widest part of the base, and 20ft. wide at the top. Its height above the level of the stream is 115ft. and it contains 164,000 cubic yards of material. The inner slope has an inclination of 3 horizontal to 1 vertical, the upper portion being pitched with heavy masonry, the lower with shingle. The outer slope has an inclination of 2½ horizontal to 1 vertical, and is benched and grass-sown.

A by-channel skirts the northerly side of the reservoir. It is 590 yards in length, 6ft. wide, and is paved throughout and protected by masonry walls. It is designed to carry away the flood waters in the heaviest storms. The waste weir is constructed in curved ashlar. It is 25ft. wide on the crest, and the ends are built into semicircular bulkheads. The by-wash is formed of a series of masonry steps terminating in a pool which is designed to break the force of the water. The walls are constructed of block in coarse masonry backed with concrete. The puddle trench is 600ft. long and 12ft. wide. Its maximum depth is 65ft. and it contains 1300 cubic yards of concrete and 10,300 cubic yards of clay puddle. The puddle wall varies in width from 23ft. at its base to 7ft. at the top and contains 9200 cubic yards of puddle. The outlet tunnel which carries the supply pipe—15in. in diameter—through the embankment is 570ft. long and 5ft. in diameter. It is built in concrete and brickwork. A valve tower constructed of concrete masonry and brick has been provided. It is 10ft. 6in. square at the bottom, and 8ft. 6in. diameter at the top bank level. Its height is 110ft., and it contains two 24in. and six 15in. sluice valves for regulating the supply and enabling the water to be drawn off at varying levels. It is connected with the embankment by a bow string wrought steel bridge 65ft. 6in. in length and 4ft. wide.

The intake is on the Whittle Brook, and the waters are carried to the reservoir in a covered conduit. The intake is built in masonry, provided with sluices designed to shut off the water in times of heavy floods. A regulating well is provided. It is a brick structure, containing an automatic valve to ensure a regular head of water on the supply mains. From this well issue two pipes—one 8in. in diameter, for the supply of Haslingden; the other 6in. in diameter, to be held in reserve for other districts. There is a meter-house, built of brick, which contains one 8in. and one 6in. Venturi meter supplied by Geo. Kent, Limited. These two latter buildings have been fixed in a position and at a level which will allow of filters being hereafter constructed without interference with the works already completed. Junctions have been provided on the supply main to permit of connections to convey the water to the filters and thence to the regulating well. The length of the conduit from the regulating well to Haslingden is 8600 yards. The storm-wall top of the inner slope of the main reservoir is 500ft. long, and the boundary wall enclosing the site is 3780ft. long and 6ft. high.

As already mentioned, James Byrom, Limited, of Bury, were the contractors for the construction of the reservoir. John Wolstenholme and Sons, of Radcliffe, supplied the valves, sluices, and other ironwork. The main from the reservoir to Edenfield was laid by Messrs. Etheridge and Clark, of Manchester, and that from Edenfield to Haslingden by Mr. H. E. Buckley, of Bradford. The cast iron mains were supplied by the Stanton Ironworks, Limited. The whole of the works were designed and carried out under the supervision of Mr. J. Cartwright, M. Inst. C.E.

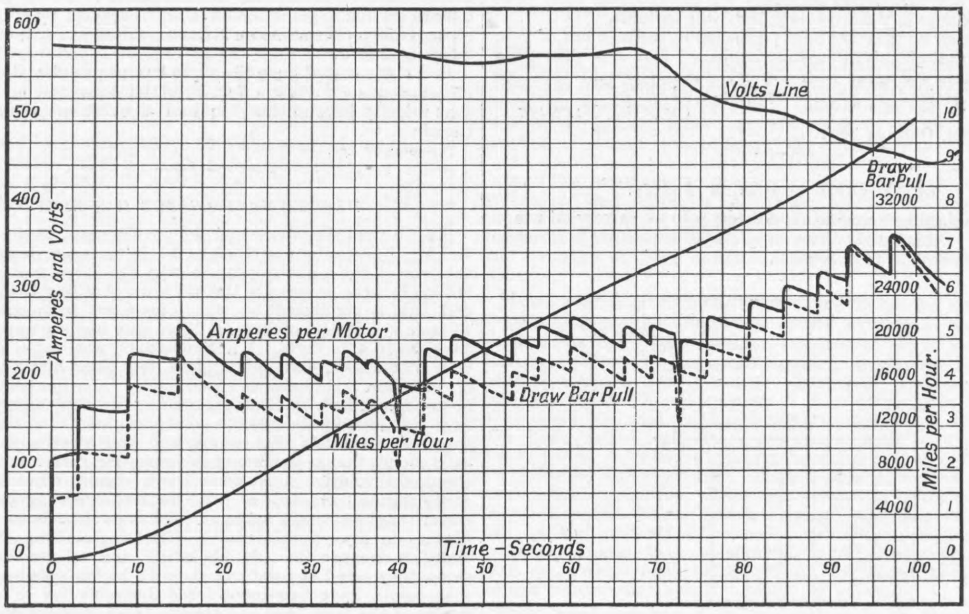
DETROIT RIVER TUNNEL ELECTRIC LOCOMOTIVE.

A SERIES of tests were some little time ago carried out by the General Electric Company and the Detroit River Tunnel Company jointly upon electric locomotive No. 7500—the first of six locomotives to be operated by the Michigan Central Railroad, one of the New York Central lines, in the tunnel under the Detroit River. The electrical equipment of this locomotive, the most powerful ever designed for operation by direct current, was built and supplied by the General Electric Company. The mechanical equipment is the product of the Schenectady Works of the American Locomotive Company.

The Detroit River Tunnel, now being completed, will connect the West Detroit yards of the Michigan Central Railroad with the New Windsor yards at Windsor, Ont. The electrified zone, embracing the tunnel with its approaches, terminal lines and sidings, will cover a distance of approximately 33,000ft. Maximum gradients are encountered on the approaches, where a 2 per cent. gradient extends for approximately 2000ft. at each end of the tunnel. The locomotives are designed for hauling both goods and passenger traffic through this tunnel and also for shunting service at the termini. The specifications according to which they were built called for a maximum service, consisting of hauling an 1800-ton trailing train, on the 2 per cent. gradient, at a speed of not less than 10 miles per hour, with two locomotives in multiple unit. Their capacity was to be such that they should be capable of repeating trips with this weight of train continuously with an interval of fifteen minutes at each end.

The locomotive is classified as an 0440-E-200-4 G E 209, which is the conventional method of stating that it is an articulated, four-axle type of electric locomotive, weighing 200,000 lb. and equipped with four G E-209 motors. The articulated running gear may be roughly considered as consisting of two four-wheel trucks coupled together; but the method of coupling and the relation of the equalising schemes on the two trucks makes it impossible to consider one truck independently of the other, so that accurately described the whole must be considered as a single running gear hinged or articulated in the middle. The truck side frames, as may be seen from the illustrations on page 478, are heavy steel castings of a truss pattern. In order to obtain the necessary weight on the driving wheels, the members of this frame are made heavier than is actually required for strength, the top member having a section of 5in. by 7in., while the other members are proportionally heavy. This gives a peculiarly massive and substantial appearance to the whole underframing. End frames and bolsters are castings of heavy box girder types rigidly bolted to the side frames and fitted in such a manner as to relieve the bolts of shear. Draught gear, buffers, and all truck frame members are calculated for buffing stresses of 500,000lb. and hauling stresses in proportion.

The suspension is of the ordinary locomotive type, the weight being carried on semi-elliptical springs resting on the journal-box saddles. The system of equalisation by which these springs are connected together is of such a character as to warrant a detailed description. The "A" end of the running gear—that is, what may be called the forward truck—is side equalised, the two springs on each side being connected together through an equalising beam. This equalises the distribution of weight between the two wheels on one side, giving to this truck a two-point support, and consequently leaving it in a condition of unstable equilibrium as regards tilting stresses—that is, stresses tending to tip the truck forward or backward. The "B" end of the running gear, or what may be called the rear truck of the locomotive, is cross equalised, the two springs on the rear axle being connected together through an equalising beam. The other two springs on this truck are independent, and are connected directly to the truck frame. This results in a three-point suspension on the rear truck, leaving it in a condition of stable equilibrium, capable of resisting stresses in any direction, whether rolling or tilting. The two trucks are coupled together by a massive hinge, so designed as to enable the rear truck to resist any tilting tendency of the forward truck. In other words, this hinge combines the two trucks into a single articulated running gear, having lateral flexibility with vertical rigidity. It will be noted from the above description that the running gear has what may be called a compound three-point suspension. The rear truck has in itself a three-point suspension, while the forward and rear trucks together form an articulated frame, having a three-point suspension, consisting of the two-point support of the forward truck and the independent equalisation of the rear truck. The braking equipment is arranged so that the action is mechanically independent on each truck. Two pairs of 12in. brake cylinders apply the brakes, and separate valves and cut-out cocks are supplied, so that the pair of cylinders controlling either truck may be cut out without affecting the other.



"THE ENGINEER" Swain Sc.

ACCELERATION CURVES

The draw-gear consists of a standard M C B vertical plane coupler with yoke, springs, and plates, designed to comply with the Railroad Company's specifications. This draw-gear, as well as the spring buffers, is mounted upon the outer end frame of the truck, an arrangement which ensures that all hauling and buffing stresses are transmitted on the same horizontal line through the draw-gear, side frames and hinge pin of the locomotive, and therefore the centre pins and platforms framing are entirely relieved of all stresses except those due to weight of cab, platform, and equipment.

Centre pins and side bearings are provided on the running gear for the support of the cab. The centre pin on the "A" end is a swivel pin, having a turning motion only, while that on the "B" end has a turning and a sliding motion. This construction allows the longitudinal motion necessary to take care of the variation in distance between the truck centre pins occurring as the locomotive passes round curves. The side bearings on the "A" end have a clearance of about ⅛in. when the cab is standing symmetrically, while those on the "B" end have a clearance of about ½in. The result of this arrangement is that, under ordinary circumstances, the cab is carried on a three-point suspension, since the side bearings on the "A" end support all normal rolling actions of the cab, the side bearings on the "B" end coming into play under abnormal conditions only.

The cab platform is built of four 10in. longitudinal channels running the whole length of the locomotive, which are tied together by the end channels and bolster plates. Such ballast as is necessary to bring the weight of the locomotive up to the required amount is bolted to the two centre sills; and the space remaining between them forms a passage leading from the blower to the motors for carrying the air for forced ventilation. A floor-plate, consisting of two sheets of ⅜in. steel, is riveted to the platform sills and serves to stiffen and square the platform framing. In the operating cab a ⅞in. wood flooring is placed over this steel floor.

The side and ends of the cab are built of ⅛in. steel plate, supported by a framework of small angles, while the roof is of No. 8 gauge steel. The main operating cab occupies the central portion of the locomotive and covers a floor space of 15ft. 6in. by 10ft. It is supplied with windows, sufficient in number to allow a practically unobstructed view in every direction. The cab contains the driver's seat and such apparatus as naturally belongs to the operating section of a locomotive. Auxiliary cabs extend from the main cab to the ends of the locomotive, and occupy a floor space of 9ft. by 6ft. each. These cabs contain the air tank, sand boxes, rheostats, and contactors. Hinged perforated doors in the sides of the auxiliary cabs, clearly shown in the illustrations, give access to the rheostats and the connections of the contactors, while folding doors between the auxiliary and main cabs allow access for inspection of the contactors. The edges of the auxiliary cabs are bolted to the platform and main cab, so that they can be readily removed when it is necessary to make more serious repairs.

The difference in width of the auxiliary and main cabs allows room for a narrow platform or running board, extending from the main cab along the sides of the auxiliary cab to the front of the locomotive. This running board is in turn protected by hand rails, running around the outside of the locomotive from one side of the main cab to the other. The doors of the main cab open to this platform, and the steps reaching the ground are arranged near the doors. One marked advantage of this construction is the unobstructed view given to the driver. It will be observed that the entire absence of cab directly in front, combined with the low roof of the auxiliary cab, allows him a clear view of the train behind, and of practically the entire stretch of line ahead.

A type C-79 controller and the operating handles for the air brakes are placed inside the main cab near the driver's seat. Sanding valves are also placed beside the driver, and over his head are switches for the headlight and control circuits. Directly in front are illuminated air gauges, ammeter, and a foot-operated lever for raising and lowering the overhead trolley. Sand pipes are arranged to sand the rails in front of the leading wheels on either truck.

A C P-26 air compressor is placed in the centre of the main cab. This is a two-stage, four-cylinder compressor, geared to a 600-volt direct-current series motor. The compressor has two low-pressure and two high-pressure cylinders, so arranged as to divide the work of compression into four equally distributed impulses per revolution. It has a piston displacement of 100 cubic feet per minute when pumping against a tank pressure of 135 lb. Ample circulating pipes are provided for cooling the air between stages and between pump and tanks, in order that the temperature may be maintained at a moderate value. The compressor is controlled by a governor, consisting of a pneumatically-operated piston, controlling the contact of the motor circuit switch, and so arranged as to close or open this circuit at any predetermined limits of pressure.

The motor equipment consists of four G E-209 motors. The G E-209 is a standard General Electric box frame motor of the commutating pole type, and has a rating of approximately 300 horse-power. At its one hour rating the motor will develop a torque of 4050 lb. at 1ft. radius. The gearing between motor and axle has a 4.37 reduction, and the driving wheels are 48in. in diameter. With this reduction each motor will develop a tractive effort of 9000 lb. at the rail head, which gives a total tractive effort for the four motors of 36,000 lb. at 12 miles per hour. The motors have an overload capacity sufficient to cause the driving wheels to slip, and the locomotive can develop at the slipping point of the wheels an instantaneous tractive effort of 50,000lb. to 60,000lb. The maximum speed of the locomotive running light upon a level track is about 35 miles per hour.

There are two gears and pinions to each motor, one at at either end of the shaft. This form of construction was used on account of the unusually heavy torque and the excessive overloads that the motors will be called upon to undergo. In large sizes of motor equipments, with a gear and pinion at only one end of the shaft, it has often been claimed that a large proportion of the wear and breakage of pinions is due to the tilting of the motors under heavy loads, which concentrates the pressure at one end of the tooth. The form of construction adopted in the Detroit locomotive is intended to eliminate any such danger.

The motor is designed for forced ventilation. Air is delivered into the motor frame at the end furthest from the commutator, passes between the fields, coils, and around the armature, and finally escapes through discharge openings arranged over the commutator. The blower used for this purpose has a capacity of 2000 cubic feet of air per minute at 2¼in. water-pressure, and is driven by a direct-current series motor. This blower delivers air to the passage between the two centre sills above described from which the ventilating ducts are tapped off to the motors at appropriate points.

The Sprague-General Electric multiple unit control is employed, with two master controllers in the main cab and the contactors in the auxiliary cab. Multiple unit connections have been supplied, so that three locomotives may be operated in multiple unit if necessary. The problem of starting and accelerating a train of from 1000 to 1500 tons, which may consist of 40 to 50 cars, is a rather delicate one. Such a train is not a rigid mass, but a long elastic body, and any inequality in the starting torque results in waves of jerking and buffing strains which are very likely to reach abnormal values in some parts of the train. Consequently the control for this locomotive was designed especially to produce a uniform increase of speed and torque during the period of acceleration. The control combinations are arranged so that the motors may be operated four in series; two in series, and two in parallel; or four in parallel. There are nine resistance steps in series, eight in series parallel, and seven in the parallel position. The curves shown herewith afford a good illustration of the results obtained by this control. It shows the speed, current, and tractive effort curves obtained in the acceleration of a train of 1578 tons, consisting of the locomotive and twenty-six freight cars, from a standstill to 10 miles per hour. It is to be noted that the maximum increase of the draw bar pull is about 6500 lb. on the first few steps, after which the maximum throughout the remainder of the acceleration is from 2000 lb. to 3000 lb. The practical effect of this smooth acceleration appears to an observer standing in the last car of such a train, in that the rear end of the train is started so gradually that the beginning of the motion is almost imperceptible. The contrast of this with the results obtained with a steam locomotive is very striking.

General data of the locomotive are given in the following table:—

Number of motors	4
Gear ratio	4.37
Number of driving wheels	8
Diameter of driving wheels	48in.
Total wheel base	27ft. 6in.
Rigid wheel base	9ft. 6in.
Length inside knuckles	39ft. 6in.
Length of main cab	15ft. 6in.
Height of cab	12ft. 6in.
Maximum height, trolley up	15ft. 6in.
,, height, trolley retracted	14ft. 10⅛in.
,, width	10ft. 2⅝in.
Width of cab	10ft. 1⅝in.
Total weight	199,000 lb.

The locomotive is equipped with third rail shoes to take current from an inverted third rail. It is also fitted with an overhead trolley, which, as stated above, can be raised or lowered by a foot-operated lever in front of the motorman.

COLLIERY ACCIDENTS IN WALES.

ON Friday last a disastrous explosion occurred at Darran, one of the leading collieries of the Rhymney Iron Company. The Darran is a house coal pit in the Vochrhiw Valley, and has been in work for about forty years. As a rule 250 men are employed, but at the time of the explosion only 45 men were below. The colliery was always regarded at a safe one, and worked with naked lights. It was under the capable general management of Mr. Wm. Smith, member of a family long conversant with the Aberdare Valley, and under whose judicious direction the seams of the district have been worked with a minimum of loss. It was fortunate that the Gilfach pit in the adjacent Rhymney Valley belongs to the same company, and is but about three miles distance, with an underground communication between, and to this fact is due the escape of fully 20 men, who retreated in that direction.

As it was, 26 men were killed, and most of these perished by the afterdamp which followed on the track of the explosion. Some of these were the band of gallant men who attempted the work of rescue. The inquest has been formally opened and adjourned, and the evidence of officials, agents, and experts is expected to yield trustworthy evidence as to the cause. The surmises current in the district are that a fall took place in the roof, liberating the gas, which, coming in contact with the naked lights, led to the explosion. Workmen who have been employed there for over thirty years say that they have never known gas in the pit, which is 113 yards deep. Another possible cause discussed is the coal dust theory. Mr. Bowen, the manager, and other officials of the colliery perished, chiefly in the effort to rescue.

On Saturday last a fire occurred at the Penrhiwceiber Colliery, in the Aberdare Valley, near Mountain Ash. For a time the lives of 30 men were in deadly peril, but by strenuous effort the whole of the men working in the colliery, from 250 to 300 in number, were able to get out in safety. The only fatality was in the case of Robert Barrow, who was run over by a journey of trams. The fire is thought to have originated in an electric motor which drives the endless rope whereby the empty trams are taken to the double parting. The colliery is one of the deep sinkings of the district, as represented by the Dowlais, Cardiff, and Treharris.

A colliery flooding took place last week in the Ystalyfera district, situated between Pontardawe and Ystalyfera. The scene of accident was the Tareni pit, owned by the South Wales Primrose Company. The workings are reached by a shaft 145 yards deep, and the pit employs about 300 men underground and 60 on the surface. The system of working is pillar and stall, and the eastermost stall is about 100 yards from the boundary of the old Ynnsgemon pit. It was here on Monday that it is supposed an inrush took place from the old workings, with the result that for a time the colliery was flooded, and hundreds of lives imperilled. It was, as stated, a race for life with the men to gain a place of safety, and the great majority did. The casualties were four men killed and injured and one missing.

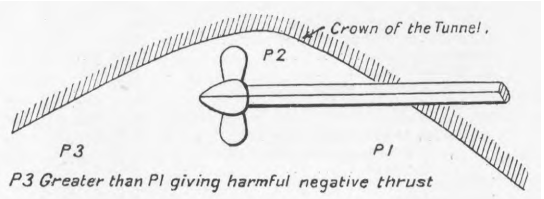
NEW CHAIRMAN OF LLOYD'S REGISTER.—The General Committee of Lloyd's Register, at a special meeting for the election of a chairman of the Society in succession to the late Mr. James Dixon, unanimously appointed Mr. Thomas L. Devitt to fill the office in question. Mr. Devitt has been a member of the Committee since 1893, and has already held for two years, in conjunction with Mr. William Lund—who was nominated for the office of chairman, together with Mr. Devitt, but who withdrew—the office of chairman of the Sub-committees of Classification of the Society. Mr. Devitt is the senior partner in the firm of Messrs. Devitt and Moore, and also a partner in the firm of Messrs. F. Green and Co., who, with Messrs. Anderson, Anderson and Co., are the managers of the Orient Steam Navigation Company, Limited. He has filled the offices of president of the Chamber of Shipping of the United Kingdom, and chairman of the General Shipowners' Society, and was a member of the Advisory Committee of the Board of Trade in connection with merchant shipping. He has also been president of the Shipping Federation since the inauguration of that body, and has recently been elected president of the International Shipping Federation.

LETTERS TO THE EDITOR.

(*We do not hold ourselves responsible for the opinions of our correspondents.*)

PROPELLERS IN TUBES.

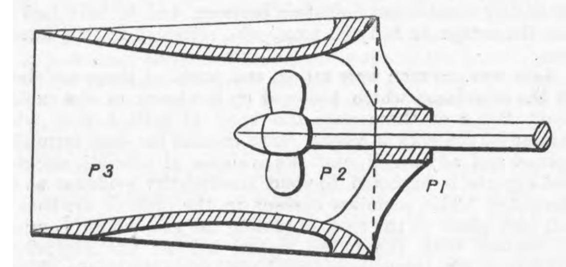
SIR,—With reference to Mr. Barnaby's second letter on the efficiency of a screw propeller revolving at the throat of a Venturi tube, which appeared in your issue of August 27th, I should like to state that in my experiments the propeller was arranged to work against a current of fairly high velocity, instead of merely rotating in stationary water, so that the frictional resistance brought upon the propeller casing did not differ very much from the amount of the resistance it would have to encounter when advancing through the water. Working with a pitch of 10¼in., the maximum speed of revolutions recorded during the experiments was at the rate of 2116 per minute, so that the relative speed of the screw through the water at the neck of the casing amounted to no less than 17 knots, including the slip. Judging from the proportions given to the propeller casing, it will not be far wrong to suppose that the inlet and discharge velocities of water were approximately 7½ knots and 10 knots respectively. The frictional resistance of water on the interior surface of the propeller casing under these conditions must have been pretty high, and may be considered to represent in some measure the actual resistance in practice ; and yet this combination was always able to indicate about 11 per cent. more thrust when compared with the same screw propeller operating singly without any casing round it, at the same expenditure of power, and that, too, at about 11 per cent. higher speed of revolutions, and therefore with proportionately less magnitude of turning moment. The frictional resistance on the exterior surface of the propeller casing is comparatively a small affair, and there is no good reason to suppose that its intensity per unit of area will be any higher than that on any other part of the ship's wetted surface, especially when it is fitted to remain in the midst of the wake current. A real obstacle in the way of employing the propeller casing would thus appear to lie not so much on the frictional resistance of water on its surface as on its interference with the general stream lines of the vessel. This kind of resistance could, however, be minimised by restricting the use of propeller casings to only the central screw of the three-shaft engines.



P3 Greater than P1 giving harmful negative thrust

Fig. 1

The gain of the indirect thrust is not confined to the axial component of water pressure acting on the exterior surface of the conical casing, as Mr. Barnaby appears to think. A greater proportion by far of the gains may be expected to result from the difference of fore and aft components of water pressure acting on the interior surface of the convergent and divergent water channel, as already illustrated in my previous letter. Comparing this system of propulsion with another one in which the propeller is made to work in a tunnel, Mr. Barnaby says that these two systems suffer from the reduction of hydrostatic pressure in analogous ways. That may be partly right, but it is not a correct view of the whole situation. With the propeller in a tunnel the flow of water has the largest cross section at the plane of the propeller disc, and tapers downward fore and aft, whilst the form of the propeller casing in the present proposition has the smallest cross section at the plane of the propeller disc, and flares out fore and aft, as shown respectively in Fig. 1 and Fig. 2. As with a centrifugal pump, so with the screw propeller, there is always an excess of hydrodynamic head on the delivery side of water over its suction side. Any excess of the water pressure abaft the screw over that in front of it would produce an indirect negative thrust on the crown of the tunnel, but this same excess of water pressure would give a useful positive thrust to the convergent and divergent propeller casing in question, as will readily be understood from the sketches. It is therefore evident that a principal defect of the tunnel propeller is not shared by the propeller in a Venturi tube. Similarly, if any other system of screw propulsion working in an entirely different manner failed to give a satisfactory result, no fault could be found with the present proposition. As for the remarks quoted by Mr. Barnaby from your contemporary, *Engineering*, I will only say that what is lost by the reduction of hydrostatic head is amply compensated for by the gain in velocity head initially given to the water.



P3 Greater than P1 giving useful positive thrust.

Fig. 2

If this reduction of hydrostatic pressure, which is accompanied with an equivalent increase in initial velocity, is termed the "cavitation," then its occurrence would certainly help a large quantity of water to reach the propeller per unit of time. Any loss entailed in the efficiency of the screw itself by this reduction of hydrostatic pressure is more than made good by the increase of indirect thrust exerted by this large quantity of water pushing the propeller casing forward as its velocity is gradually reduced at the discharge end. The useful work of the screw propeller is performed not only by an accumulation of hydrostatic pressure on the working surface of the propeller blades, but also by its reduction on their reverse surface. It is essentially an apparatus which is intended to suck in water in front and discharge it at the back. The greater the reduction of hydrostatic pressure at the screw the stronger will be the force of suction ; and the stronger the suction the higher the useful thrust of the screw propeller. Aims of the designers of screw propellers should therefore be directed towards an increased suction, so long as this is attended with a proportionate increase of useful thrust. One object of using a propeller casing of much larger diameter than the screw itself is to extend the field of suction influence without at the same time entailing the necessity of increasing the turning moment on the part of the turbine shafting.

Azabu, Tokyo, Japan, October 12th. YASUZO WADAGAKI.

BRITISH LOCOMOTIVE PRACTICE OF TO-DAY.

SIR,—Mr. Riekie ingenuously assumes that because I did not specificially mention that there are two ways of increasing cylinder ratio, I am consequently ignorant of the fact. In my contributions to this discussion I endeavour to be as brief and as concise as possible. I give your readers credit for possessing at least an elementary knowledge of the principles of locomotive operation ; so that there is really no necessity for referring to matters of common knowledge.

Mr. Riekie asserts that none of your correspondents have made any attempt to show how it becomes practicable to enhance the power of a compound locomotive by increasing the cylinder ratio. I cannot at the present moment refer to back numbers, but I remember that in one of his recent letters Mr. Brewer referred to a fine run made by a London and North-Western Railway compound 4-4-0 engine—the Benbow - in which he said that she would possibly have performed better still if her low-pressure cylinders had been considerably larger than 20½in. diameter. I agree with Mr. Brewer that such would most likely have been the case, the reason being that the mean effective pressure on the pistons would be proportionately increased.

Mr. Riekie further assumes that I am unaware that a compound locomotive has been built with two 20in. high-pressure cylinders, and a ratio of only 1 to 1.25, which, he says, was successful. Here, again, Mr. Riekie is mistaken. I believe the engine he refers to was a three-cylinder compound, and was used experimentally in India some twelve years ago. It cannot, however, have been so successful as Mr. Riekie would have us believe, seeing that the type was not perpetuated. To quote an old truism, "the proof of the pudding is in the eating," and if it was a success, how is it that more were not built?

The compound engine that I said was likely to remain a paper one was Mr. Riekie's "ideal" compound, which, in order to be successful, Mr. Riekie said must be provided with high-pressure cylinders as large as those of a simple engine and low-pressure cylinders at least two and a-half times their capacity—in other words, an engine with two 19in. and two 30in. cylinders. So far as British locomotive practice is concerned, this engine will certainly not materialise.

With regard to Mr. Riekie's concluding paragraph, if Mr. Deeley's successor takes the "retrograde" step of building simple locomotives, he will at least be in good company, for Mr. Wilson Worsdell, the capable locomotive engineer of the North-Eastern Railway, is taking a similar step.

In 1906 Mr. Wilson Worsdell designed and built two four-cylinder compound 4-4-2 express engines, Nos. 730 and 731. These were the last "Atlantic" engines built for the North-Eastern Railway. They have been successful engines in some respects, but it is evident they are not such good all-round engines as the simples. Mr. Worsdell is now building a new series of simple 4-4-2 engines which will differ from their predecessors in having smaller cylinders and a modified general outline.

It will no doubt be disappointing to Mr. Riekie and others, but there can be no doubt that compounding in this country has had its day, and our locomotive engineers will have to alter their views completely before any more compounds will be built.

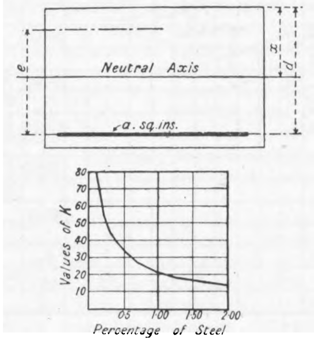
After reading all that has been published in the columns of your valuable journal on this interesting subject, I feel sure that many of your readers will agree with the Irishman who said that one type of locomotive is as good as another—and better.

CHAS. W. DAUNCEY.

Birmingham, October 30th.

REINFORCED CONCRETE BEAMS.

SIR,—As reinforced concrete is coming into more general use in this country, I think that these simple and approximate formulæ may be of interest to your readers.



The results obtained will be found to agree fairly well with those obtained by the R.I.B.A. formulæ recently published, and do not entail such lengthy calculation.

$$x = \frac{50d + 15pd}{100 + 15p}.$$

$$e = d - \frac{x}{3}.$$

$$s_s = \frac{M}{ea}.$$

$$s_c = \frac{s_s}{K}.$$

x = distance from top of beam to neutral axis.
e = effective depth of beam.
p = percentage of steel area to that of concrete above reinforcement.
a = area of steel.
s_s = stress on steel.
s_c = stress on concrete.
M = bending moment in inch-tons.

Wallington, October 29th. HERBERT L. BROWN.

PROFESSOR DALBY ON HEAT TRANSMISSION.

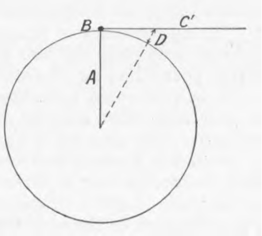
SIR,—If THE ENGINEER should do me the honour to refer to the remarks made by me last evening at the Institution of Mechanical Engineers upon the very valuable and informing paper of Professor Dalby, may I be allowed to add, with reference to the natural effect upon their respective temperatures of the much greater molecular density of the plate in comparison with that of the gas, that it appears to me we are all inclined to attach too much importance to the "drop in temperature" at the flue surface, which Professor Nicolson's diagram makes so conspicuous. After all, there *has* to be a drop. We do not want to boil off water at 1500 deg. or 2000 deg., but at 300 deg. or 350 deg., and the thermometer must show a drop somewhere between the gas and the water. Moreover, our object is not to drive "temperature" through the plate, but heat units, and we do this with fair success in good boilers, even now—that is, we find a fair proportion of the heat units in the water on the other side. One might as well complain of the heavy "loss" of volts in a transformer, though it gives us a fair equivalent in watts on the other side, as grumble because the widely scattered gas molecules, in giving up their heat to the densely-packed molecules of the iron, do not keep the latter at or anywhere near their own high temperature. Of course they do not. In electrical language we have exchanged volts for ampères, and have little to complain of. The "high-tension" heat of a few molecules has merely turned into "low-tension" heat in a much greater number. If we wiped away the malignant "gas film" from the plate altogether, we should still have nearly the old total drop in temperature, and the place where the great transformation occurs, viz., the flue side of the plate, is the right place for it. If, by doubling the speed of the gases, or by any other means, we double the number of molecular blows upon the unit of heating surface per unit of time, and so get twice as many heat units through the plate and into the water, the comparatively low temperature of the water may still be trusted to keep all parts of the plate at much the same temperature as before. The temperature gradient in the plate will be but very slightly altered, and the drop of temperature between the gas and the plate will hardly be reduced appreciably. A very great drop in temperature is inevitable, and does not by itself denote a loss of a kind which engineering can possibly grapple with. There may be a loss of "plant efficiency" through the presence of the gas film, but the drop in temperature is not the measure of this loss, or of any loss, and the drop must be there, practically to the same extent, even if the loss is done away with.

Parliament Chambers, S.W., MARK ROBINSON.
October 30th.

CENTRIFUGAL FORCE.

SIR,—Your correspondent Mr. Brown does not help me at all. He only repeats what I have already said. I am quite familiar with the centrifugal force diagram to be found in all text-books of physics. A is the string ; B is the stone ; C a tangent along which the stone wants to fly ; D is some distance through which the stone is "accelerated" by the pull of the string. I want a "graph" of the forces at B, and it seems that it cannot be drawn.

Now let me go a step further. It is a fundamental dynamic principle that a mass cannot be accelerated without doing work on it. The stone B is revolving at a steady pace through a circle whose circumference is 10ft., and weighs 5 lb. and makes 200 revolutions per minute. What is the work of acceleration? I have already been told by a friend that there is no work done. For the sake of argument let me concede that this is true. How, then, is the acceleration produced? And why is this case of acceleration an exception to other cases? To judge by current definitions and explanations like that supplied by Mr. Brown, the string pulls on the stone but the stone does not pull on the string, which is absurd.



It is obvious that once the stone has acquired a steady velocity of rotation, no further effort need be expended on maintaining that velocity beyond that required to overcome the resistance of the air.

November 1st. PATER.

DEVELOPMENT OF THE GAS ENGINE.

SIR,—I read your article on the development of the gas engine, and Mr. Neustadter's criticism of it. In the main, I agree with you that one of the principal causes why the large gas engines have not made more progress is the difficulty of selling them at a profit and this is confirmed by what one hears from the Continent, where none of the makers of large gas engines appear as yet to have made a fortune. Mr. Neustadter, who takes exception to your conclusions, does not appear very clear himself on some of his premises. He looks at speed purely from the point of view of piston speed, and, as most manufacturers know, high piston speed does not necessarily mean a cheap engine. In the main, it is speed of revolution that counts, and your conclusion is mechanically sound, that as weights of reciprocating parts are increased the speed of revolution must come down—result, a heavier and more costly engine. *Apropos* of Mr. Neustadter's suggestion to make steam engines single-acting, I had some experience with these engines in my youthful days. The single-acting engines were certainly cheaper than double-acting, and, on account of lighter parts, they could and did run at much higher speeds of revolution than would have been considered desirable for a double-acting engine of the same bore and stroke. One of the difficulties lay in keeping the pistons steam-tight, and in preventing lubricating oil from getting into the exhaust, and so into the boiler. The single-acting engine with its many excellent points did not live, though there have been endeavours from time to time to resuscitate it. The same conditions do not apply to the single-acting gas engine.

I gather from reading your article that you wisely refrain from prophecy. The future of the large gas engine is in the melting pot, but the English tendency at the present time appears to me much as you have stated, viz., keep to the single-acting cylinder, and avoid the water-jacketed piston, and obtain the larger powers by multiplication of cylinders.

A BRITISH MANUFACTURER.

THE NATIONAL ELECTRICAL MANUFACTURERS' ASSOCIATION.—We are asked to state that the time at which the committee meeting of this Association, announced in our last issue as taking place on November 9th next, will be held, is 2.30 p.m.

GLASGOW UNIVERSITY PHYSICAL SOCIETY.—The first of a series of visits to works and places of interest which has been arranged for the session 1909-10 of this Society took place on 30th ult., when a large number of members, including fifty students and four lecturers at the University, visited the laboratory at Blythswood House, established by the late Lord Blythswood. The present Lord Blythswood welcomed the visitors and conducted them over the laboratory. Amongst the large collection of valuable apparatus inspected the principal objects of interest were the notable electric generating apparatus capable of producing such a great potential difference as to give a spark of 15in. between the knobs ; a dividing machine for the production of diffraction gratings, having 15,000 lines to the inch ; a 6in. and a 15in. reflecting telescope ; a heliograph, and a miniature flying machine, which in the course of experimental flights some years ago caused quite a sensation in the Clyde district.

GLASGOW TECHNICAL COLLEGE SCIENTIFIC SOCIETY.—At a meeting of this body held in the Technical College on 30th ult., Mr. A. G. Strathearn presiding, a paper on "High-tension Switch Gear" was read by Mr. A. G. Collis. After a statement of the important practical points to be considered in the design of any type of high-tension switch gear, and the measures to be adopted in meeting the many specified conditions, a comparison was made between the two types of remote control switch gear—the mechanically and the electrically operated—and superiority was shown to rest with the latter. Diagrams were exhibited showing the connections on each switchboard, and descriptions given of the various switches, time relays, and instruments involved. The author favoured the use of overload relays on the outgoing feeders, and reverse relays on the generators. After reference to points in instrument design, and the effects of change of frequency and temperature error, he concluded by remarking on the indifference to danger evinced in many switchboard designs, and on the curious ideas of economy to be seen in some stations where the cost of the switch gear was cut to the lowest possible figure alongside of such extravagances as oak pannelling and mosaic tile flooring. A discussion followed.

RAILWAY MATTERS.

The Great Western Company's important extension line from Aynho to Ashenden, which will materially shorten the distance between Birmingham and the metropolis, is rapidly approaching completion.

New traffic records were made on the elevated and subway line in New York City during the recent Hudson-Fulton celebration. On September 28th, the day of the first parade, the lines carried 2,100,000 passengers, and on September 30th, the day of the second parade, 2,200,000.

The Prussian State Railway Department already possess upwards of seventy electric locomotives deriving their power from accumulators. These have answered so well that another thirty-three are on order, and are to be delivered for service early in the new year. The chief centre of activity is Worms, whence lines radiate to Oppenheim, Weinheim, and Bensheim. Experiments are also being carried out with a petrol-electric locomotive.

A sliding embankment on the Pennsylvania lines west of Pittsburg near Dinsmore, Pa., which had given trouble for some years, was remedied at a time when a new culvert was ut through it by driving two small tunnels entirely through the bankment and filling them with riprap. The embankment is . high and is on a sharp curve on a hillside having a slope 0 deg., down the face of which runs a small stream. When unnels pierced the core of the embankment water gushed for several hours in a stream large enough to fill a 12in. These tunnels keep the embankment drained and no ble has been experienced.

Now nearing completion is a line only 6½ miles in length which will place London in direct communication with the Royal Edward Dock at Avonmouth. It is a direct extension westwards of the new approach to Bristol, *viâ* Wootton Bassett and Badminster. Leaving that line at Stone Gifford, halfway between Patchway and Fitton Junctions, it joins an existing goods line from Avonmouth to the Severn Tunnel at Holesworth-on-Severn. The line falls 167ft. from east to west; but there is only one tunnel, that under Charlton Common, 907ft. in length. The drawings were prepared by Mr. W. Armstrong, new works engineer to the Great Western Railway Company.

According to the *Building News*, a scheme is in progress for connecting the London and South-Western Railway line at Halwill Junction with that at Great Torrington, and a Bill will be presented to Parliament in November, on behalf of the proprietors, for powers to construct the line. The route proposed is *viâ* Highampton from Halwill, with a station at Black Torrington Cross to serve the trio of adjacent villages—Black Torrington, Sheepwash, and Highampton—then on to Hatherleigh (with a station near the brick and tile works), thence *viâ* Lewer and Hele Bridge to a station for Merton and Petrockstowe, and connecting with the exisiting railway at Torrington Station.

By reason of the superiority of yellow paint under the climatic conditions existing in Panama, the Isthmian Canal Commission have decided to paint the cars on the Panama Railway yellow. In coming to this decision the commission have followed the example set by some of the leading trunk lines in the United States which have made yellow the standard colour for passenger equipment. Canary yellow has been adopted as the standard colour for the coaches, refrigerator and boxcars and all cars used in passenger service on the Panama Railway. Tests to ascertain the colour best suited to withstand the local climatic conditions, which are unusually hard on exterior paints, were made, with the result that yellow demonstrated a superior lasting quality over the other colours that were tried.

It was reported to the City Council of Liverpool at their last meeting that the Tramways Committee had decided to lay additional lines in Netherfield-road for the purpose of forming a belt route *viâ* Everton Church, Heyworth-street, Netherfield-road, and the Pierhead, thereby affording inhabitants of Netherfield-road district direct tramway communication with the pierhead. Under the Liverpool Corporation Act, 1909, the Committee have obtained parliamentary powers for the construction of new lines in Brownlow-hill, Holland-place, Towerlands-street, Edge-lane, Springfield-street, Edge-lane Drive, Broadgreen-road, and Roby-road to Roby Park, also in Townsend-lane, Longmoor-lane, Allerton-road, and Menlove-avenue, and they have given instructions for the work of laying a number of the lines to be put in hand as soon as possible.

In the House of Commons on Wednesday, October 27th, in reply to a question of Lord R. Cecil, the Master of Elibank stated that orders for rolling stock placed through the India-office with British firms amounted in 1906-7 to £2,571,000, in 1907-8 to £1,385,000, and in 1908-9 to £1,016,000. In the first of these years trade was exceptionally active, and urgent demands were made for more rolling stock, to meet which the Secretary of State granted an extra million pounds. Almost the whole of this grant, although it was eventually shared by both State railways and companies, is included in the figure given above. The other two totals relate to State railways only. Recently economy has been necessary in every branch of the administration. The Secretary of State had no information as to whether the indents for rolling stock during last year represented the full demands of managers. He undertook to refer the question to the Railway Board for any observations.

The London and North-Western Railway Company is proceeding with its local electric line between Euston and Willesden, Harrow, and Watford. At Watford Junction the station is to be enlarged, and a widening is to be carried out between Watford Junction and High-street, Watford. Work is also about to be started on the construction of a new branch line from Bushey to High-street, Watford, with an extension to Croxley Green. The new line will necessitate the construction of a high viaduct over the river Colne. The contract for the projected widening between Bushey and Harrow on the west side of the main line will be let an early date. The contract for the section between Willesden and Euston, including a tunnel about 2½ miles long under the existing lines, will not be let for some time yet to come. The new works are being carried out under the superintendence of Mr. E. C. Trench, the chief engineer, by Mr. L. Trench, the engineer for new works.

The Canadian Pacific Railway has issued a circular to its locomotive engineers urging greater care in the operation of locomotives. The circular is as follows:—"Enginemen may become traffic solicitors by adopting advanced methods of handling engines, so as not to jolt passengers in starting or stopping their trains, avoiding reckless running, and by firing lightly so as to prevent black smoke. Some exceptionally good fuel records, equal to that on average European railways, have recently been made by our engines, and if the average consumption of coal could be reduced to these special records the electrification of railways would be indefinitely postponed, because there would be no smoke nuisance, and the cost of operation by steam would be so low that the advantages of the electric railway would be removed. There is no trick in it. All that is necessary is to take full advantage of your knowledge of the district over which you are running and of your engine. (A) Shut off steam when it is not required. (B) Regulate the feed-water so that the supply will be just equal to the evaporation. (C) Fire lightly, scattering the coal well over the grate bars, so that the dust and gases from each particle of green coal will be arrested and consumed instead of being thrown out of the stack in black smoke when the engine is fired heavily."

NOTES AND MEMORANDA.

The only export tax in Mexico on minerals or mineral products is on gold or silver. All other products of the mines are exported free except for a nominal Customs charge at the port of export.

The *Telephone Engineer*, in a recent issue, describes a relay that has been devised for use with the telephone receivers of wireless telegraph systems. It consists of a step-down transformer, the secondary of which is connected to an electrolytic detector, while the primary is connected to a telephone receiver. The former has a resistance of 450 ohms, and the latter a resistance of 3 ohms. One end of a carbon rod rests on the diaphragm of the telephone receiver, while the opposite end engages a carbon block, thus forming a microphone. The second telephone is placed in circuit with this microphone and a battery, and thus reproduces the "wireless" signals so loudly that they can be heard throughout a large room.

The following method of painting a cement wall was described at a recent convention of Canadian master painters. The building had become discoloured in places, and the joints were of a different colour from the surface of the blocks. Two parts of Portland cement, together with one part of marble dust, were mixed with water to the consistency of thin paint or a thick whitewash. The wall was well wetted before the application of this paint and kept constantly wet while the material was applied, and then kept for a day in order to make the cement wash adhere to the cement surface. The wash was applied with ordinary whitewash or calcimine brushes, and a man was kept busy playing a spray on it while the work was being done. The whole secret of success lay in keeping the wall constantly wet.

To determine concrete proportions for greatest density an American writer suggests experiments with a receptacle holding 4 cubic feet, as, for example, a 15in. sewer pipe. By using two or three sizes of crushed stone properly proportioned a denser concrete may be obtained, and cement and sand saved. If there are two sizes of stone, one passing a 1½in. and the other a ¾in. ring, the latter should be screened to remove all that will pass a ¼in. screen, regarding this as sand. Then 2 cubic feet of the smaller and 2 cubic feet of the larger stone are well mixed and put into the pipe, and the top of the mixture marked on the side. A mixture of 2½ cubic feet of the larger stone and 1½ cubic feet of the smaller stone, and a number of other proportions are then tried and the one giving the least volume will give the densest and strongest concrete with the least sand and cement.

An analysis of the underground temperature at Osaka, western Japan, by Mr. T. Okada and Mr. T. Takeda, is contained in the Bulletin of the Central Meteorological Observatory of Japan, No. 2, 1909. The tables show the hourly mean temperature at depths varying from 0.0 to 0.6 metre for the years 1901-6, and the monthly mean temperature between 0.0 and 5.0 metres for the years 1895-1904. Below the surface the soil consisted of granite sand. At the depth of 60 cm. the diurnal variation is almost insignificant; the minimum occurs between 2 p.m. and 3 p.m., and the maximum between midnight and 3 a.m. The mean annual temperature increases up to a depth of 300 cm. and then decreases; at the depth of 500 cm. the minimum occurs in May and the maximum in November. The total annual heat exchange is computed to be about one-thousandth part of the total quantity of solar radiation received by the surface of the soil.

Most portions of Asia Minor are believed to be rich in mineral deposits. Some few mines have been worked and proved to be highly remunerative, but most of the mineral wealth of the country remains undeveloped. According to a recent American report, the Consular district of Trebizond, which embraces the north-east quarter of Asia Minor, has been only superficially explored, although many outcroppings of minerals have been found, and there are many places where, at some remote period, the ancient inhabitants of this region, or the Greeks and Romans, extracted ore. Their instruments were rude and their methods primitive. They rarely went far below the surface. They left around their primitive diggings quantities of ore which with modern methods of extraction would be considered worth working. Copper, iron, manganese, gold, silver, mercury, zinc, antimony, arsenic, coal, and petroleum are known to exist in this district, but to what extent remains to be seen.

The heat produced in magnet coils is dissipated by the combined action of radiation, convection, and conduction. Arnold and S. P. Thompson have deduced the formula $T = CW/A$, where T = final temperature rise, A = area of cooling surface, W = total watts consumed, C = a coefficient, depending on the type of machine, &c. Mr. G. T. Williams has determined by experiment the relative values of the component parts of the heat dissipated, by comparing the power absorbed for a certain mean temperature rise under three conditions, viz., (1) running light at normal speed in air, (2) stationary in air, (3) stationary in vacuo, and the results obtained show that nearly one-half of the heat expended in exciting field coils is dissipated by the total action of convection, while the remainder is removed by the combined action of radiation and conduction. Further, that one-half of that due to convection—*i.e.*, approximately one-quarter of the total heat dissipated—is accounted for by the fanning action of the armature.

As long as the instantaneous value of the sum of the currents in the cores is zero the voltage drop due to the armouring may be neglected. In a certain three-phase cable, for instance, the voltage drop was 23.4 per kilom. with, and 18 7 without the armouring. When, however, the instantaneous value of the sum of the currents in the cores is not zero very noticeable effects are produced. Recent experiments seem to warrant the conclusion that the iron armouring of underground cables exerts a self-regulating effect on the currents in the cores. The armouring practically prevents any excessive inequalities between the currents. In France low-tension three-phase systems of distribution with four wires are becoming common. As the neutral points of the transformers are earthed the fourth conductor is practically earthed and the current in it is very small. J. Saroleá states that he has sometimes advantageously used the lead sheath of a three-core cable as the fourth conductor. Special care has to be taken to use suitable transformers with polyphase cables in order to obtain good regulation.

In a report of the Committee on Equipment to the Convention of the American Street and Interurban Railway Engineering Association the impregnation of both new and old field coils is highly recommended. In carrying out the impregnation process with wire-wound field coils the wire is insulated with asbestos, which is held on by a thin cotton covering. The coil is wound in a form of definite dimensions. After winding, the coil is taken out of the form and wrapped with porous tape. The coil is then filled with asphaltum compound by the vacuum process. This process consists of putting the coils in an air-tight pot or kettle, the same being heated; while the coil is hot the air is exhausted from the kettle, thus taking the air out of the coil. When a good vacuum is obtained, hot melted asphaltum is allowed to flow in from another kettle, and as soon as the coils are covered with asphaltum it is turned off and air pressure is applied on top of the asphalt in the compounding kettle, and thus the asphalt is forced into all the spaces in the coil. When cooled down slightly the coils are taken out and allowed to become fairly cool. Then clamping plates are placed on the coil, both back and front, to bring the compounded coil to the exact dimensions desired. After the coil is cold the clamps are taken off, the first taping is removed, and varnished cambric insulation is put on the coil.

MISCELLANEA.

The station at Fort de l'Eau on Algiers Bay is open for commercial purposes and messages are delivered in Algiers and replies transmitted. The cost of the message is collected on shore from the person receiving, and appears somewhat high, as a message delivered recently worked out at about 10d. per word for some 200 miles.

The British Consul at Gothenburg reports that, despite labour-saving arrangements, the cost of peat production in Sweden has risen of recent years from 5s. 6d. to 8s. 4d. per ton. In view of the fact that the sale price of peat has been 9s. 5d. per ton, and that large stocks remained unsold in 1908 for a long time, finally having to be disposed of at a loss—it is clear that the peat producers are economically in a distressing position.

The Swedish Iron Commission, appointed by the Government, a short time ago appointed a Committee with the object of going into the question whether the Commission ought to provide the necessary capital for carrying on experiments on the electrical smelting of iron ore, not only for the purpose of attaining a practical solution of the problem, but partly, and perhaps chiefly, with the view of being able to make practical demonstrations of the processes and furnaces before ironmasters and other representatives of the iron industry, so as to call their attention to the advantages of the electrical process. It is estimated that a sum of 250,000 kr. (£13,833) is required in order to build the plant and to carry on the experiments long enough to ascertain the economical results.

The construction of the new war signal station at Blackhead, off the entrance to Belfast Lough, is now completed. From the station, which occupies the lofty eminence at Muddersleigh-hill, a look-out can be kept on the Channel on a clear day extending from the Isle of Man and Welsh coast on the south almost to the Clyde on the north. Adjoining the station there has been erected a semaphore about 70ft. high from which signals can be made directly to the Whitehead Coastguard Station, which is at present manned by an expert signalling staff, under Station-Officer W. J. Collins. As one of the cross-Channel cables is laid from Whitehead, the Blackhead Signal Station, when the telephonic installation is completed, will be in direct communication with the Admiralty offices in London.

According to the *Berliner Neueste Nachrichten*, during recent trials over a measured mile, the battleship Nassau equalled the performance of her sister ship the Westfalen, with a speed of twenty knots. The Nassau carried out her trials with complete armament and filled bunker, and was handled solely by men of the fleet. The journal points out that the recent British trials were held in much more favourable conditions. On the voyage from the North Sea to the Baltic, which took the vessel round the Skaw, as she was unable to pass through the Kiel Canal, the Nassau weathered a heavy storm, whereby she was given an opportunity of displaying her sea-going qualities. The Nassau and Westfalen have proved themselves the fastest German battleships afloat, and the engines exceeded the contract requirements.

At a meeting of the Thames Conservancy Board on Monday last Mr. James Bigwood, chairman of the Finance and General Purposes Committee, said that it had been expected on all hands that the banks of the Thames would become flooded during the recent heavy rains, but so great had the efficiency and care of their officials been that he was able to say that the river had not got outside its banks. The chairman (Lord Desborough) said that the whole question of the treatment of floods should be considered by the Works Committee. They had watched the rainfall very carefully, and it ought not to be impossible for the Board to frame regulations for the guidance of their officers. He thought that at present they left too much to their officers. They must bear in mind that in dealing with weirs they must begin at the bottom and work up the river. They had also to take note of the way high tides held back the whole river, and of the effect of a frost followed by a sudden thaw, which would give them a flood quite out of proportion to the amount of rain that had fallen. He thought the Works Department should study the question on the data that had been obtained.

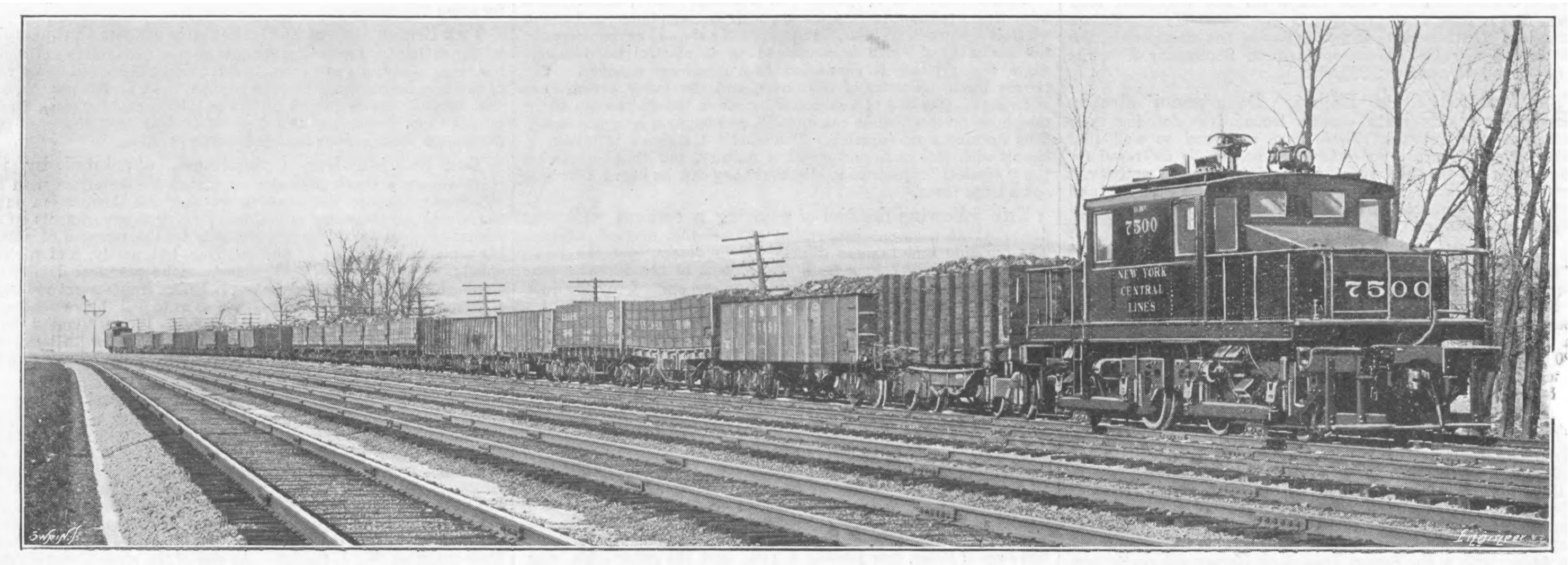
Australia, states the *Electrical Engineer*, has shown considerable enterprise both in the generation and utilisation of electricity and in the manufacture of electrical appliances. Obviously, however, there are limitations in the latter direction, seeing the scanty population of the island continent and the regrettable slowness of growth. Of late this has been brought before public notice rather conspicuously owing to the Postmaster-General of the Commonwealth deciding to make a lavish extension of slot telephone appliances, and desiring to obtain the machines from Australian manufacturers. Although two invitations have been made, not a single tender has been sent in. This is not altogether to be wondered at, states our contemporary, when one considers the expensive equipment necessary for successful manufacture. Attempts are to be made to modify the design of machines and specifications in order to tempt the local manufacture. In a matter of this kind, populous countries are naturally in a better position to supply more efficient appliances at a lower price. In this instance it is probable that the Postmaster-General will ultimately have to seek what he wants in Europe or America, or ruthlessly cripple his service.

An American consular report states that increasing attention is being devoted in German cities to all questions connected with atmospheric conditions. The fact that sunshine lessens as population becomes more dense, and especially when the activity of industrial centres expands superficially and increases in intensity, has long been noted. An increasing tendency to fog has also been observed, and both are effects of the imperfect and incomplete combustion of coal. Modern industry pays toll for this in the injury to delicate fabrics, the general depreciation in the value of many articles of trade and household use, and the increased cost of cleansing. Since the battle is waged with growing energy against tuberculosis, physicians and students of social science feel that the problem of purer air for the dwellers in cities has become one of prime importance. Statistics have been collected for some time past, which demonstrate how little sunshine falls to the lot of the residents of industrial cities, even when the sun is unobscured by smoke particles. In no German city has the loss of sunshine due to fog yet equalled that of London, where the foggy days during the three months, December, January, and February, increased from eighteen to thirty-one during the last half of the past century.

The new Commission appointed to consider rules for regulating the use of electricity in mines consists of three members. Two, Mr. R. A. S. Redmayne, chairman, and Mr. R. Nelson, are H.M. Inspectors of Mines. The third is Mr. C. H. Merz. No one, states a contemporary, is likely to take objection to any one of these individuals, but engineers would have preferred to see added to the committee one or two engineers engaged in practical mining. Government inspectors have a perfectly natural tendency to pin their faith upon elaborate rules which, in a laudable endeavour to make them cover all possible contingencies, not infrequently do more harm than good, and, further, too often embody a great deal of red tape with very little common sense. The conditions in mines which are important from an electrical point of view differ widely from mine to mine, and hence it will be exceedingly difficult to frame regulations which adequately meet the most difficult cases and yet do not press harshly on other mines. In this work, our contemporary maintains, the committee ought certainly to have had among its members those who fully understand and appreciate these matters and the practical difficulties in the way of getting the miner to acquiesce in over-elaborate regulations.

THE DETROIT RIVER TUNNEL ELECTRIFICATION

(For description see page 474)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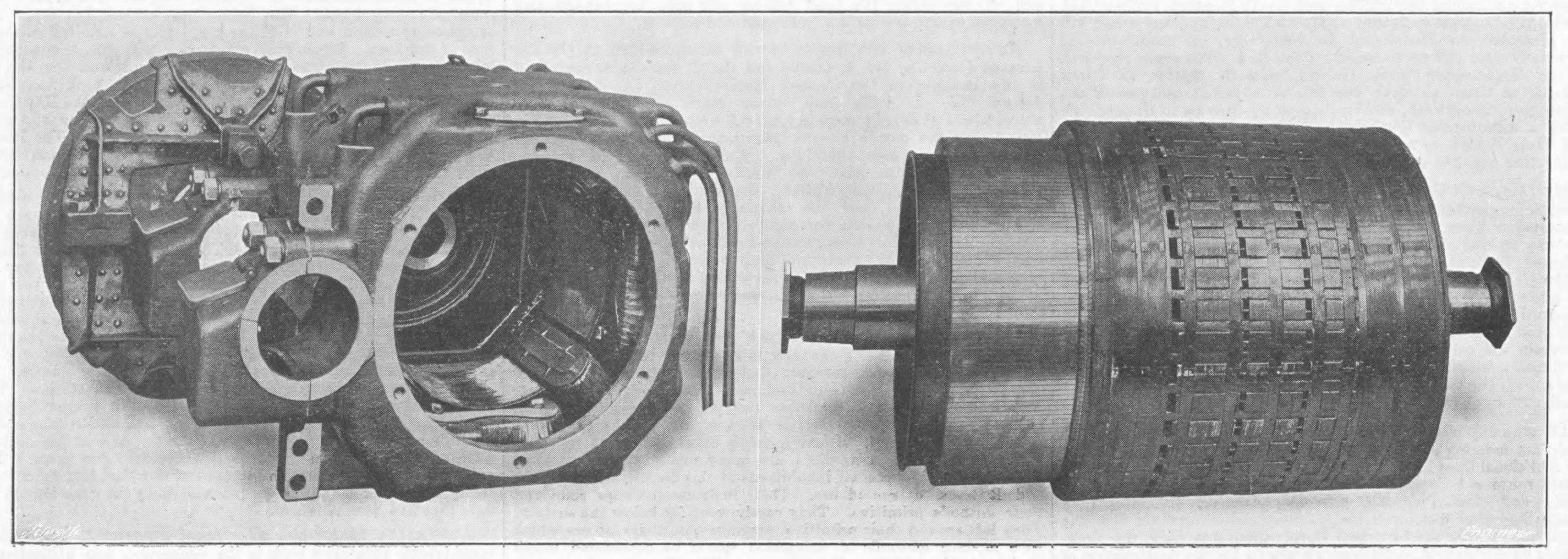
ELECTRIC LOCOMOTIVE HAULING A 1400-TON TRAIN



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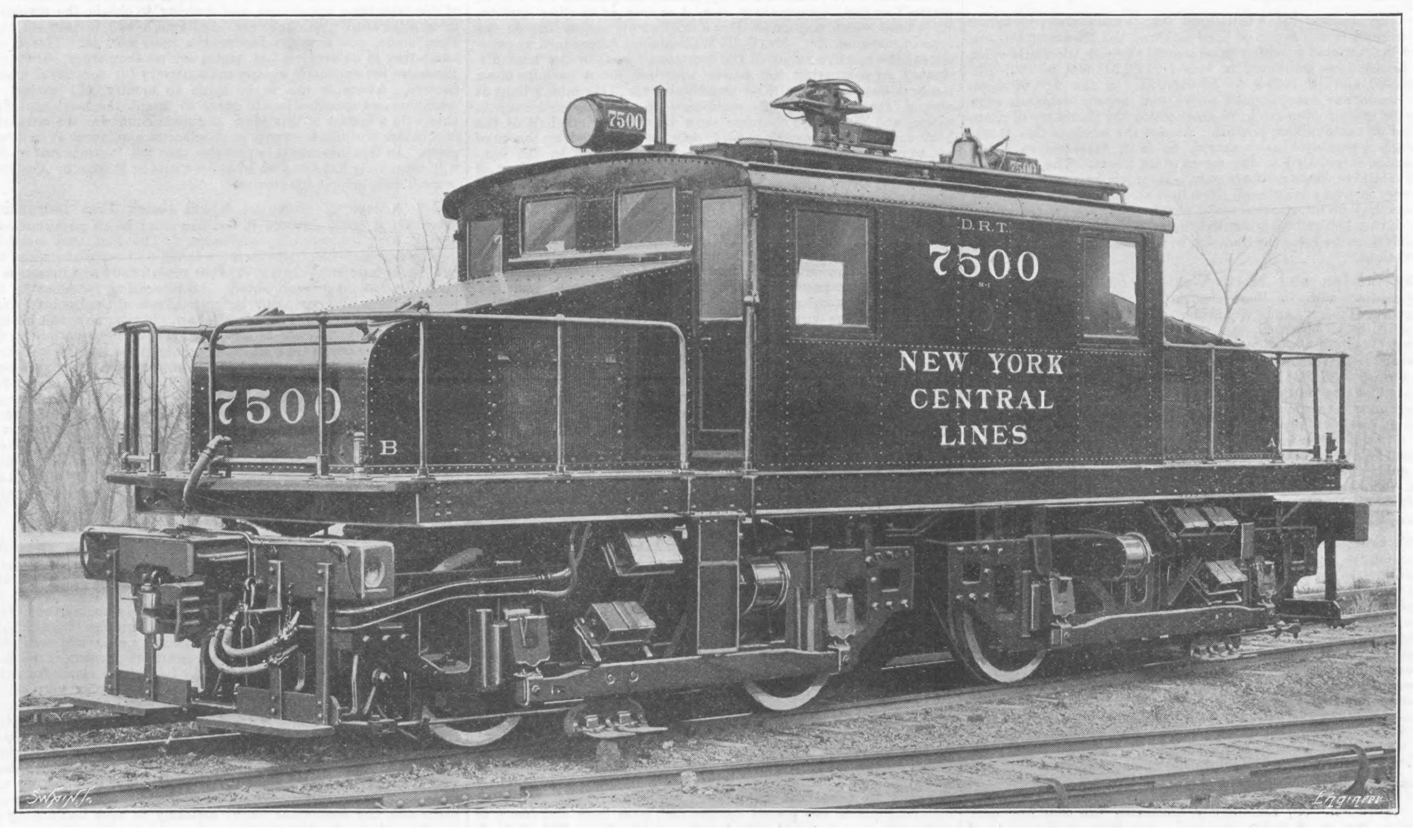
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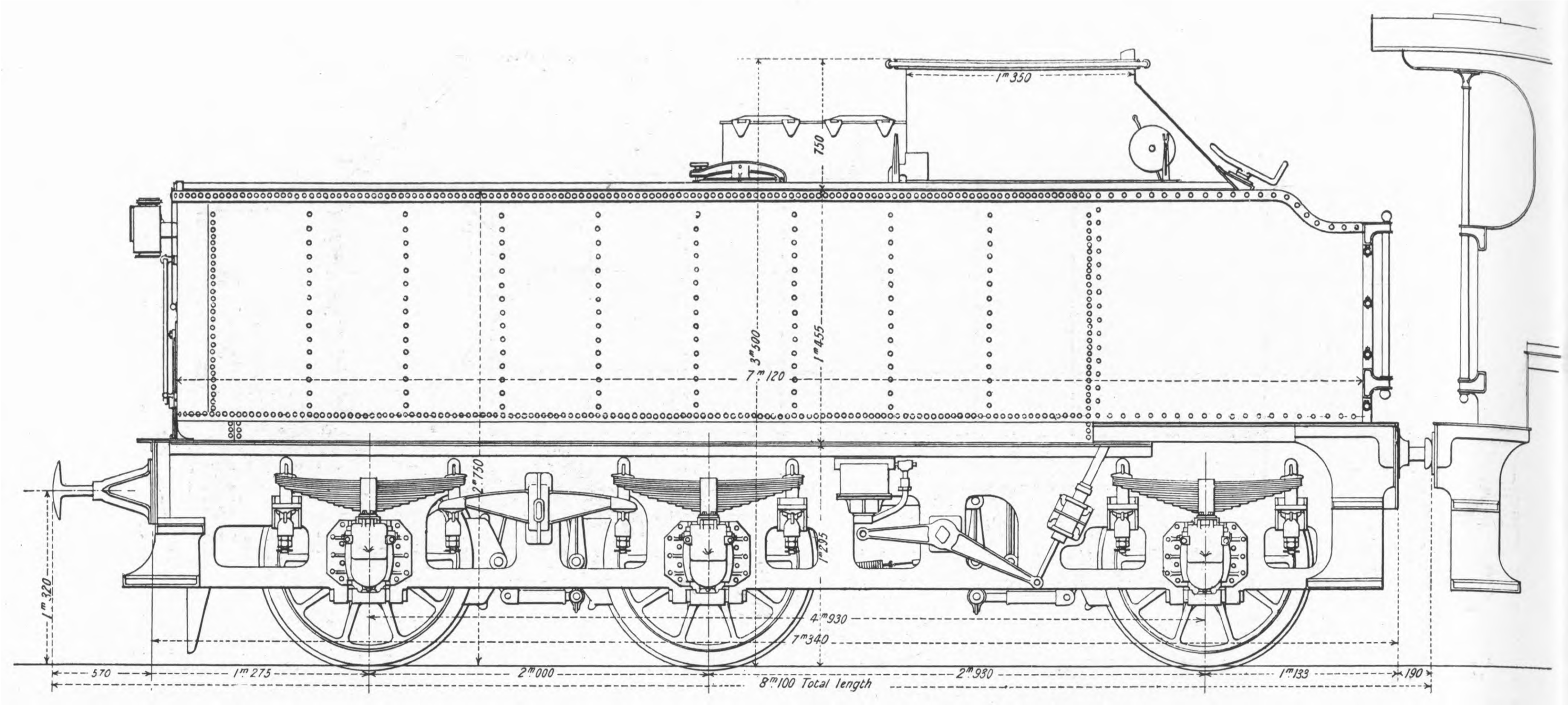
AN ELECTRIC LOCOMOTIVE

DETAILS OF SIX-COUPLED COMPOUND EXPRESS LOCOMOTIVE AND TENDER, CHEMIN DE FER DU NORD

MONSIEUR G. DU BOUSQUET, PARIS, ENGINEER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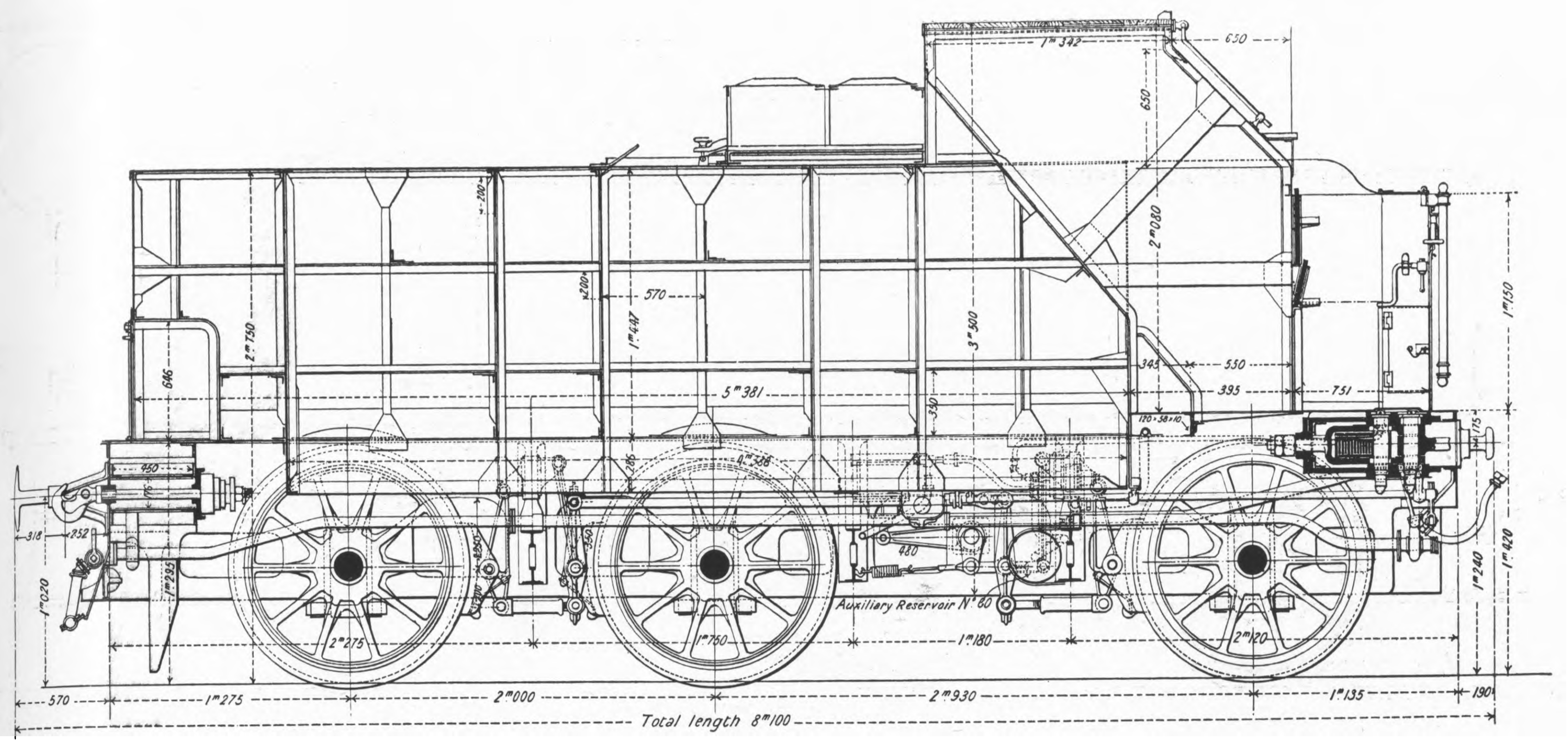
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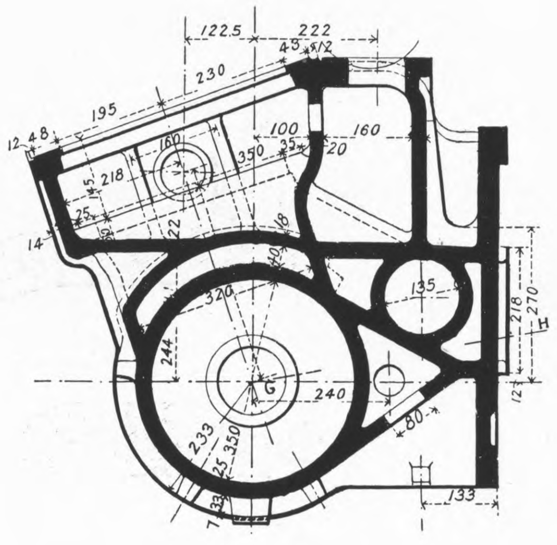

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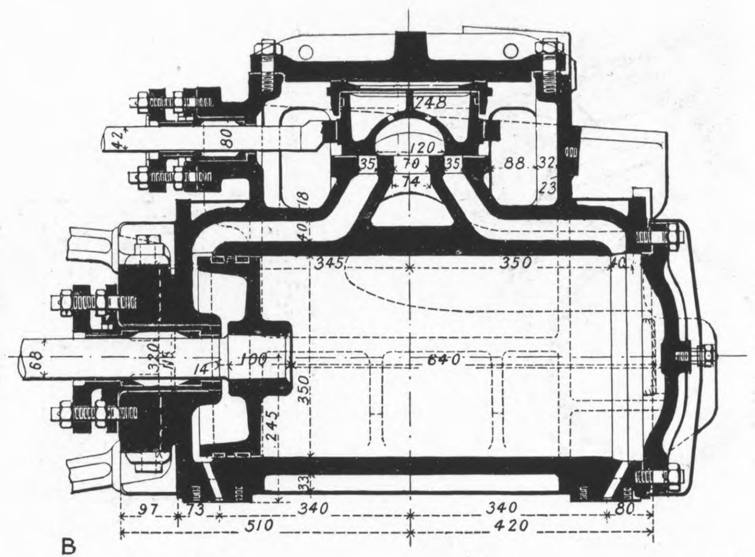

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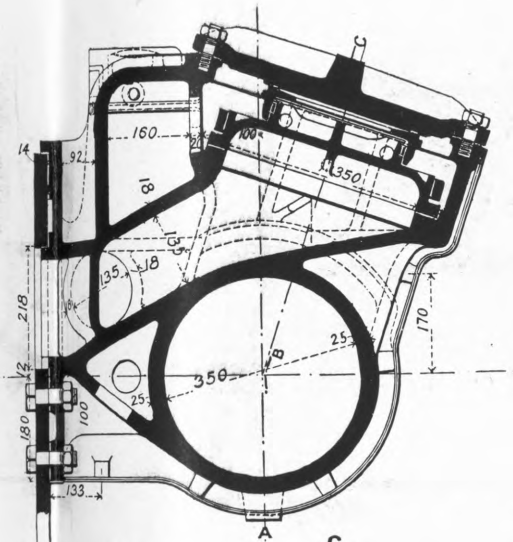

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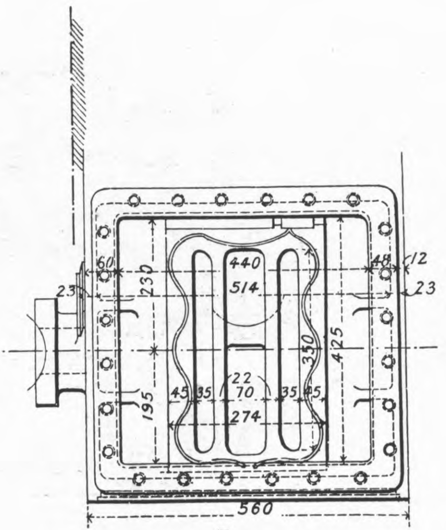

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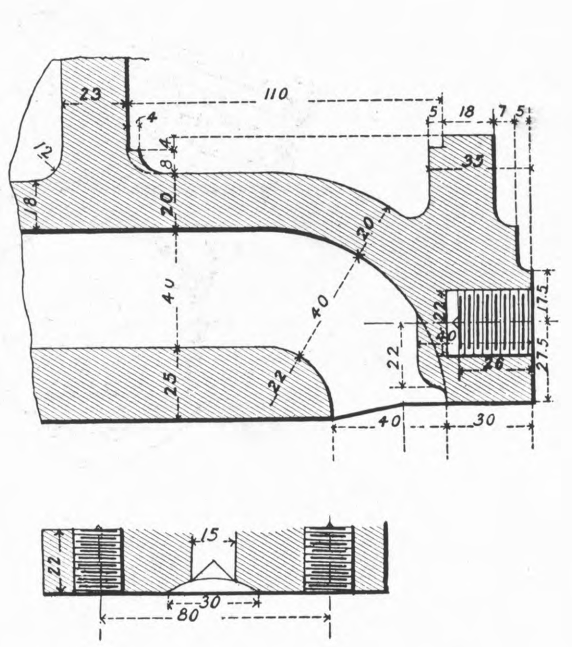

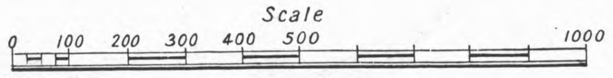
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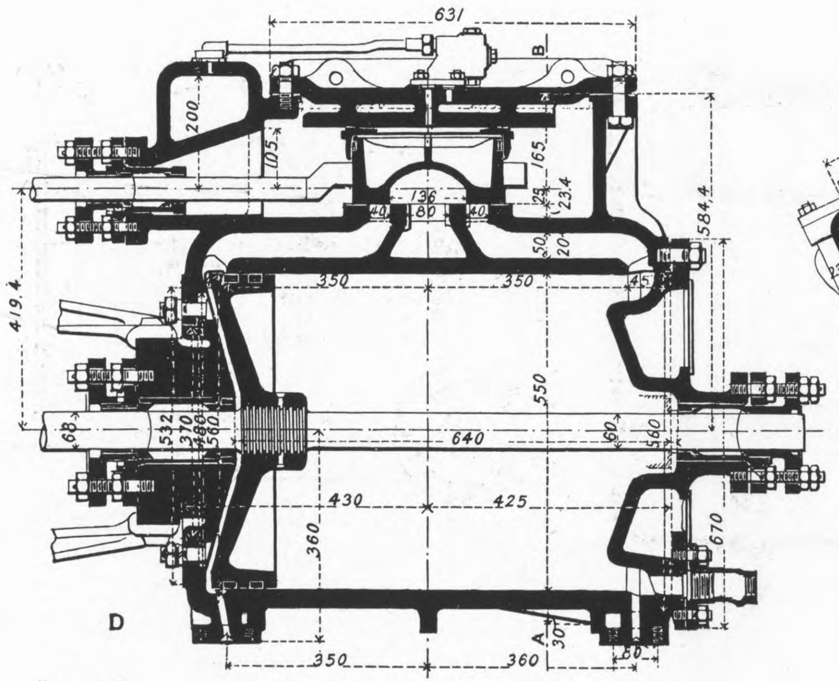

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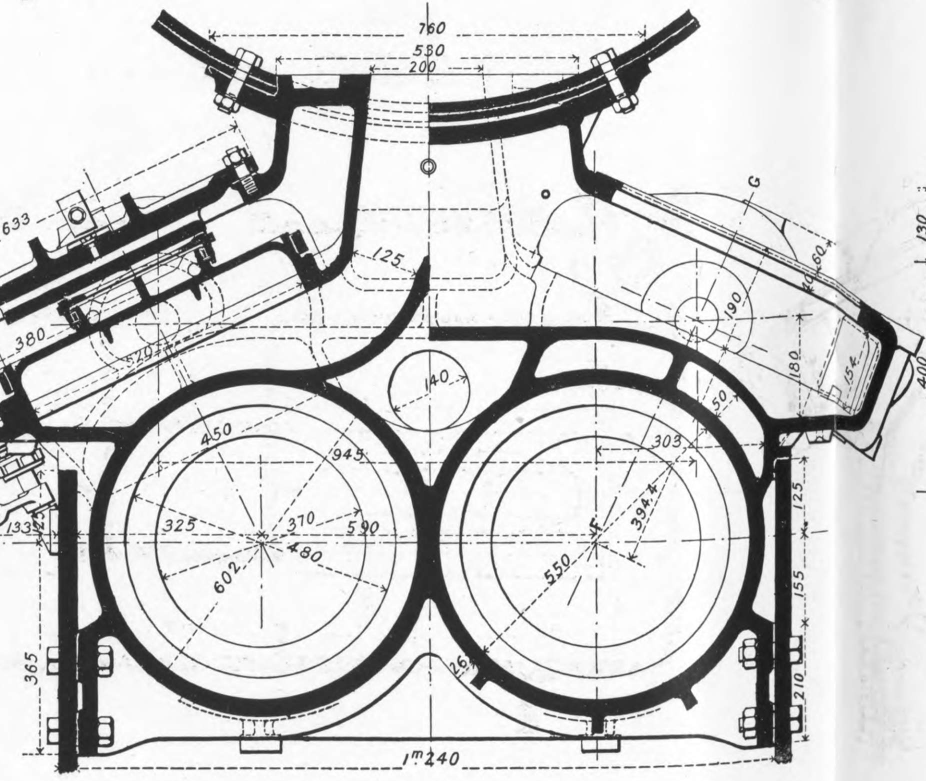

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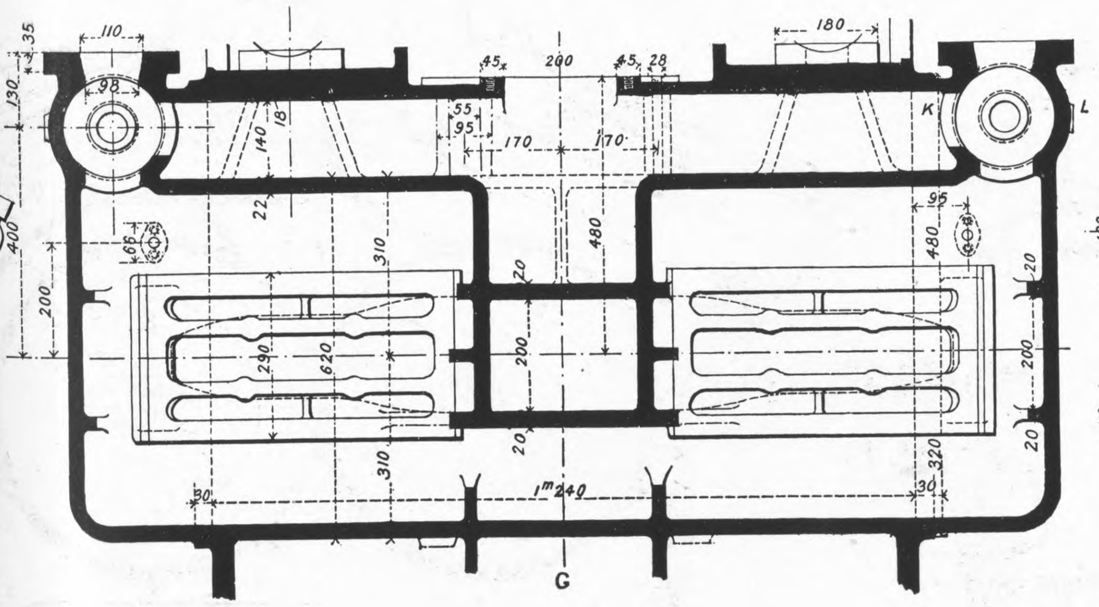

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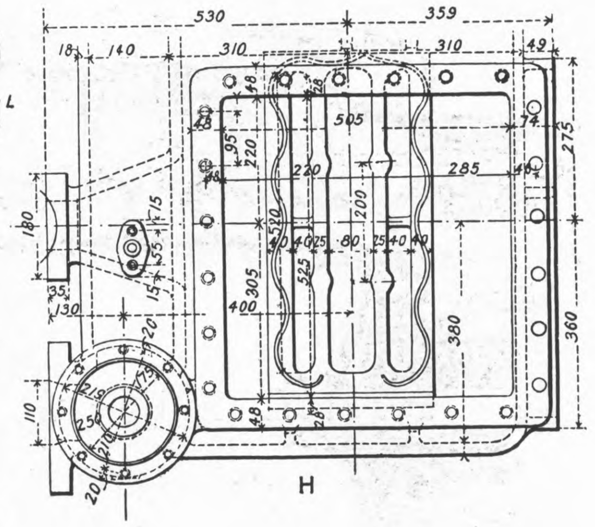

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*** *With this week's number is issued, as a Supplement, a Two-page Drawing of Details of a Six-coupled Compound Express Locomotive and Tender, Chemin de Fer du Nord. Every copy as issued by the Publisher includes a copy of this Supplement, and subscribers are requested to notify the fact should they not receive it.*

H.M.S. VANGUARD.

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TO CORRESPONDENTS.

☛ *In order to avoid trouble and confusion we find it necessary to inform correspondents that letters of inquiry addressed to the public, and intended for insertion in this column, must in all cases be accompanied by a large envelope legibly directed by the writer to himself, and stamped, in order that answers received by us may be forwarded to their destination. No notice can be taken of communications which do not comply with these instructions.*

☛ *All letters intended for insertion in* The Engineer, *or containing questions, should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

☛ *We cannot undertake to return drawings or manuscripts; we must, therefore, request correspondents to keep copies.*

REPLIES.

J. N. W.—We do not know where you will find a fully dimensioned working drawing of an aeroplane. At present makers are not anxious to give away their designs.

J. P.—We have no recollection of ever having seen ring lubrication used in the axle-boxes of rolling stock, but disc lubricators have been used, and forced lubrication is being tried on the Taff Vale Railway. See the meetings of the Institution of Mechanical Engineers at Bristol.

Cestria.—If the insulation test to which you refer is properly carried out so that all parts of the machine are subjected to, and successfully stand, the pressure named, the test would be accepted as satisfactory. It is understood, of course, that there must be power behind the pressure; that is to say, that if the insulation is broken down there must be enough power to drive current through the break. It is ordinarily the custom to measure also the insulation resistance of both field and armature.

J. N. B. (Newcastle).—There is no fixed or definite way of projecting a drawing, and none is required, all doubt being removed by putting the full title under the end view or views. Thus, "View of Right Side." To project the left end on the right side of the drawing, which used to be the recognised practice, is very inconvenient in long drawings, and the practice of projecting the end views near the ends to which they belong has arisen in consequence. In some cases also the plan is put above the elevation. There is no difficulty in reading drawings if they are properly made, whatever the arrangement of the views may be, and convenience alone need be considered.

INQUIRIES.

FOUNDRY SAND.

Sir,—Could any of your readers inform me of any process for restoring foundry sand which has been used, so that it can be used again?
November 3rd. G. P. F.

MEETINGS NEXT WEEK.

Institute of Marine Engineers.—Monday, November 8th, at 8 p.m., at 58, Romford-road, Stratford, E. Discussion on papers, "Water Hammer" and "Hydraulic Cargo Gear."

The Institution of Mechanical Engineers: Graduates' Association.—Monday, November 8th, at 8 p.m. Paper, "The Commercial Testing of Railway Materials," by Mr. T. H. Sanders.

Physical Society of London.—Friday, November 12th, at 8 p.m., at the Imperial College of Science, Imperial Institute-road, South Kensington. Papers: "On the Absorption Spectrum of Potassium Vapour," by P. V. Bevan, M.A. "Some Further Notes on the Physiological Principles underlying the Flicker Photometer," by J. S. Dow, B.Sc. "Exhibition of a Colour Perception Spectrometer," by F. W. Edridge-Green, M.D., F.R.C.S. "Tables of Ber and Bei and Ker and Kei Functions, with further Formulæ for their Computation," by H. G. Savidge.

The Institution of Civil Engineers.—Tuesday, November 9th, at 8 p.m., at Great George-street, Westminster, S.W. Ordinary meeting. Papers: "The Single-phase Electrification of the Heysham, Morecambe, and Lancaster Branch of the Midland Railway," by J. Dalziel and J. Sayers. "The Equipment and Working Results of the Mersey Railway under Steam and under Electric Traction," by Joshua Shaw. "The Effect of Electrical Operation on the Permanent Way Maintenance of Railways, as Illustrated on the Tynemouth Branches of the North-Eastern Railway," by Charles Augustus Harrison.

THE ENGINEER.

NOVEMBER 5, 1909.

Heat Transmission.

THE discussions which followed the reading of Professor Dalby's report to the Institution of Mechanical Engineers on the work that has been done relating to the transmission of heat across boiler heating surface were interesting and instructive. The instruction supplied had, however, nothing to do with the subject of the report. It concerns the way in which questions of interest to engineers are dealt with by the engineers themselves on the one hand and the physicists and the professors on the other. We have presented to us two distinct lines of thought, which are parallel at all events in that they never seem to meet. Another prominent feature of the discussion was the manifested ignorance of the history of boiler engineering. Professor Dalby, with infinite pains, and the valuable assistance of Mr. Thieme, has collected and classified an enormous amount of literature. He has prepared a general index to this, an author's index, and a subject index. "The pile of abstracts referred to in the report, which is now in the library, of the Institution, indicates the untiring devotion with which Mr. Thieme has worked in the interests of the Institution." We have the hardihood to assert that the use which will be made of these abstracts will be of the smallest. A prominent feature of the discussions was the evidence which they afforded that the abstracts contain but a mass of contradictory statements, no two of those who have done research work agreeing.

Professor Nicolson may be taken as the most advanced exponent of the theory of transmission; and he covered the blackboard with formulæ intended to enable the boiler designer to get minute information as to what takes place in the furnace, in the plates, in the water. Most of the abstracts also abound in mathematical formulæ. The intention is good, but the results are unsatisfactory in that they do not agree. We cannot ourselves conceive it possible that any boiler designer who was likely to get his boilers sold or at work would make the least use of these formulæ. Boilers are designed on entirely different methods; and proportions are based on direct precedent, not on theoretical assumption. The last thing the engineer considers is the number of thermal units which a square foot of iron plate will transmit in a minute or an hour. Experience has taught him that under normal conditions he must provide so many square feet per horse-power; and that is not only good enough for him, but it is as good as possible. On the other hand, the physicist cares nothing whatever about horse-power. His object is to construct some law of transmission, without ever thinking whether it is likely to be useful or not. We certainly do not condemn him. Far from it. He supplies a very necessary element in the work of research. But we fail to see that the Institution of Mechanical Engineers is called upon to spend much money in the pursuit of further information on the subject. It is by no means clear indeed that the members as a body are possessed with the spirit that would enable them to pursue inquiry in the right way, or to appreciate its results when obtained.

In saying this it must be understood that we draw our conclusions from the discussion. For example, every one seemed to have something to say about a gas film which intervened between flame and the plate. At another time we shall have something to say about the phenomena of heat transmission from gases. For the moment we must confine our attention to the discussion. Now it is noteworthy that while the existence of the film was taken for granted, not one syllable was said about its cause. Mr. Mark Robinson, indeed, has supplemented what he said by a letter which will be found in another page. No one asked, why is there a film? How does it come to exist? Why is it that it will no form if the metal is heated to 400 deg. Fah.? It is quietly taken for granted that if only the film could be got rid of, boiler efficiency would be enormously augmented. It would appear, therefore, that the work of the physicist, at all events, would be to determine accurately why the film is formed, and what are the reasons for its formation. The stock proposal is to cure the complaint by sweeping away the film, and this is to be done by making the gas move at a high velocity across the plate. No one was able to prove that any such sweeping ever takes place; for the circumstance that when hot gas moves fast it gives up more heat than when it moves slowly is no proof whatever that any sweeping has occurred. So far, indeed, as practice goes, we are face to face with the fact that the faster the gas moves the less is the heat handed over to the boiler.

Very elaborate reasoning was brought to bear to prove that, given high velocity in the gas, great increase of boiler efficiency would be secured. The tardy intervention of a practical engineer brought back the discussion from the clouds of surmise. He pointed out that elaborate mathematical investigation could effect nothing. The true test of boiler efficiency was the difference between the quantity of work put into the furnace in the shape of coal and that which flew up the chimney in the shape of hot air and gas. A good boiler would utilise about 75 per cent. Of the remainder about 8 per cent. would be unavoidably wasted in radiation, ashes, and so on. This left 17 per cent. as the maximum margin in which to effect economy. But of this a considerable percentage was required to maintain the draught in the chimney. If heat was not available, then a fan must be provided, which could not be worked for nothing.

It seems to have almost entirely escaped the speakers that the only result that could be secured by removing the film, and increasing the temperature of the gas in contact with the plate, would be a reduction in the size of a boiler for a given power. But it is entirely beyond question that the higher the duty got out of a boiler the shorter is its life. It is by no means to be taken for granted that small "express" boilers would be acceptable to the general steam-using public. Furthermore, the vague assumption was made that a better boiler than any now in use could be devised in the light of modern research. We believe that it is absolutely impossible to design a new type of boiler. If the incredulous reader has time to make a search among patents he will, we feel sure, admit that we are right. Failing the time for that, we would suggest an examination of a large book, "A Practical Treatise on Boilers," by N. P. Burgh, published by Spon in

1873, which contains 1163 engravings and 50 plates. The letterpress is of small account; but the untiring industry and excellent draughtsmanship of the author have supplied data covering about seven hundred and fifty different types of boiler patented at various times between the years 1663 and 1872 in Great Britain alone. We need scarcely say that this by no means covers the whole of the ground. We can confidently recommend an inspection of this book to anyone proposing to patent a boiler.

The first thing to be settled when research is undertaken is the probable utility of the inquiry. This can be regarded from two distinct points of view. In the first place, there is research undertaken to satisfy curiosity, with usually ulterior further possibilities—such inquiries, for example, as explorations on the site of Troy, or among the tombs of the ancient kings of Egypt. In the second place, we have research intended to supply information which will bestow benefits on certain sections of mankind—say, for example, steam users. The two parties—for there were two very well defined parties who took part in the discussion with which we are concerned—represented these two lines of thought. On the one side, we have further research in heat transmission advocated, we might almost say, for its own sake; on the other, because of the benefits it may bestow. It is to be noted that the proposal that considerable sums might be spent with advantage on pursuing Professor Dalby's researches met with a cold response in the body of the hall. Obviously, before any more money is expended it is desirable to settle definitely what is to be gained by the further inquiry. So far as can be seen the only thing to be expected is the getting more steam than heretofore from a given weight of boiler. Is this wanted? Are the advantages to be gained likely more than to compensate for the disadvantages? If a good case can be made out for research then let us have it by all means. But we do not think that the funds of the Institution ought to be spent solely on the gratification of curiosity, however scientific. In any case, we heartily agree with one speaker, who suggested that before anything else was done the enormous mass of literature accumulated by Professor Dalby should be put into a digestible form.

Employers and Workmen's Compensation.

THE obligations placed upon employers by the Workmen's Compensation Act, 1906, which, as will be recollected, considerably extended the scope of application of the earlier Acts of 1897 and 1900, did not terminate with the greater financial liability thereby imposed, inasmuch as it has involved them in the responsibility of making returns to the Home Office in regard to compensation paid for fatalities or injuries received. Section 12 of the Act of 1906 provides, in fact, for the submission of returns by employers in such industries as the Secretary of State may by order direct respecting the compensation paid and its amount and such other particulars as may be required. It would thus at first sight apparently represent a duplication of figures concerning accidents and injuries received in the case of railways, and already recorded in the annual returns to the Board of Trade on Accidents on Railways; of the accidents in mines registered in the annual report to the Home-office on Mines and Quarries; and of the accidents in factories as reported in the annual return to the Home-office of the Chief Inspector of Factories on the administration of the Factory Acts. But the duplication is more apparent than real, for while these particular returns include accidents of all kinds in the industries concerned, the statistics now requisitioned from employers under the Workmen's Compensation Act apply not specially to the accidents in any one year, but rather to the number of cases in which compensation is actually paid in the course of the twelve months. It therefore happens that accidents which occur in one year may form the subject of compensation in the same year, or may only be decided in the succeeding year, and in the latter event the figures would not be included in the official statistics until payment had actually taken place. It is perhaps not as generally known as it should be that the presentation of returns is compulsory under the Act, and employers are liable to prosecution who fail to make them. But as 1908 was the first complete year under the operation of the Act of 1906, no prosecutions were instituted by the Home-office authorities, although it is officially intimated that steps in this direction may have to be taken to secure the fulfilment by employers of their obligations in this respect.

It is scarcely surprising to learn—probably both on account of the lack of knowledge as to the compulsory nature of the requisition and the peculiarity of the innovation—that many thousands of employers throughout the country failed to make any return to the Home-office under the Act in question, leaving the earlier Compensation Acts and the Employers' Liability Act, 1880, out of consideration for the time being. The Secretary of State, early in January, 1908, directed that returns should be made for mines, quarries, railways, factories, harbours, docks, &c., constructional work, and shipping, it being considered that these industries afforded a possibility of obtaining figures which would be sufficiently complete and accurate to be of value. According to the recent Blue-book on the subject, the number of establishments to be dealt with ranged from 130,000 to 140,000, and the many thousands of defaulters are supposed in the majority of cases to represent the less important firms, whose returns would either have shown no cases of compensation or only a small number. How detailed the information asked for was is illustrated by the request for particulars of:—(1) The number of fatal cases in which compensation was paid during the year and the amount, distinguishing cases where persons were wholly dependent, partly dependent, or where there were no dependents; (2) the number of disablement cases in which compensation was paid and the amount, distinguishing cases continued from previous years and cases in which the first payment was made during the year; (3) the duration of the compensation in disablement cases; (4) the settlement of disablement cases by lump sum payments; and (5) the approximate average number of persons employed to whom the Act applied. If it had not been for the last request it would have been possible for the whole of the information to be furnished by insurance companies in respect of establishments which do not undertake their own risks under the Act. The particulars were, in the circumstances, supplied partly in the form of collective returns made by mutual indemnity societies, insurance companies, and employers' associations, and partly direct by individual employers to the number of 34,600, of whom over 31,000 had no cases of payment of compensation under the Act.

The very large extent to which employers have insured against risks under the Act of 1906, as compared with the practice of setting aside a certain sum annually for the purpose, is strikingly illustrated by the circumstance that the collective returns account for the bulk of the cases of compensation, namely, 69 per cent. of the fatal cases representing 71.10 per cent. of the compensation, and 73 per cent. of the disablement cases representing 74.10 per cent. of the compensation for the whole of the seven groups of industries in question. These provided employment for 7,500,000 persons, and the total amount paid as compensation was £2,080,000 in 1908 under the Act of 1906; and leaving out of account compensation paid under contracting-out schemes, under earlier Acts. It is of some interest to inquire how much the total compensation works out at per person employed according to the numbers of workers recorded in the official statistics. In the shipping trade the compensation was equivalent to 9s. 7d. per head; 6s. 3d. per head in the metal—extraction, founding, and galvanising—industry; 12s. in the engine and shipbuilding trades; not quite 17s. in mines; 8s. in quarries; and 7s. 7d. per head in the case of railways other than the clerical staff. As might be expected, the lowest amounts are represented by the textile industries, the wool branch working out at 9d. and the cotton department at 1s. 6d. per head of the persons employed, whilst the compensation in the case of docks, &c., works out at the highest rate, namely, 25s. per head. The number of cases of compensation recorded in the official statistics for the seven groups concerned is, naturally, incomplete in the absence of returns from many employers who have been brought within the scope of the Act of 1906, but as the years pass away the figures should become more valuable and more reliable. Numerous as were the cases in 1908, only a comparatively small percentage occupied the attention of the county or other courts, as the greater majority were settled by agreement, as in former years, under the earlier Acts, and it is also noteworthy that the claims made under the Employers' Liability Act are likewise diminishing, and are being replaced by friendly settlements or arbitrations under the Workmen's Compensation Acts.

The Institute of Chemistry.

IT is well known to our readers that we have consistently supported the idea of the solidarity of engineering with sister professions, and have maintained the need for sympathy in thought at all times, and for aid, indeed, when such action is practicable. The reward is sure, though not always immediate or even tangible, for the establishment of right feeling and mutual respect between different but cognate classes of workers consolidates them for defence and for advance in the face of a community often too much concerned with things purely material to give its due value to what is fundamentally the labour of the mind. Falling into the group of professions closely concerned with that of the engineer is the calling of the chemist. In a sense the two professions are correlative, as the design of highly specialised plant necessary for the successful performance of industrial chemical operations will tax the best skill of the engineer as much as the selection of the most suitable materials for every kind of mechanical structure will demand the utmost care and experience of the chemist, and when difficulties and failures arise dependent jointly on questions of design and of quality or nature of material, collaboration between the two kinds of technologist is imperative. It is thus for us a pleasurable duty to bring to the attention of engineers at large a new enterprise in which professional chemists are deeply interested, and the success of which is of public as well as of private concern.

Compared with mechanical engineering, which dates from the invention of the wheel, chemistry is a comparatively modern science. In an obscure and empirical way certain knowledge was gathered so recently as a few thousand years ago, and served as the raw material for modern chemistry now rather more than two hundred years old. In like manner the professional status of the engineer was won before that of the chemist had begun to be established, and with its larger and more immediate concern with the modern needs of the body politic, the engineering profession attained a position well assured and not without profit. In contrast the evolution of chemistry as a profession was much later, and even now is far from complete, but as is usual with young organisms, its growth at this comparatively early stage of its life history has been rapid. The Institute of Chemistry, the first body to act for the profession as a whole, and to act solely for the profession as distinguished from the science on which the profession rests, came into existence in 1877, and after many struggles not unmixed with strife, useful because invigorating, established itself in one of those sedate localities which seem naturally fitted for the habitation of learning. But the growth of London traffic and consequent street alterations is threatening these retreats, and in this particular case the demolition of one side of Bloomsbury-square will soon make the Institute homeless. Actual eviction will not take place until 1914, but in order that the work of the Institute may be carried on a new place must be found. After very close and earnest counsel, it has been decided that at any sacrifice the Institute of Chemistry must obtain a house of its own, in preparing which all expenditure shall be directed to the purpose of the Institute's work, magnificence being avoided, not from want of appreciation of the æsthetic side of life, but from a knowledge that every penny obtainable will be wanted for the most completely practical ends. The question of ways and means is a serious one, as chemists are not very numerous, nor, as a body, wealthy; but the object in view is so vital to the prosperity of the profession, that the Council of the Institute feel justified in urging its claims in the most insistent and whole-hearted manner. That the profession realises the validity of this appeal may be judged from the fact that already from a comparatively few Fellows, who have been privately approached, and before a response to the general request only just issued could be expected to occur, some £4000 have been subscribed. It is reckoned that with real economy in expenditure provision, not splendid, but adequate for the work of the Institute, can be obtained for about £15,000, and in order to ease the stress which might be felt by some members in aiding to raise this sum by immediate donations, a scheme has been formulated by which subscriptions can be spread over a term of five years, a period not too long having regard to the date of termination of the present lease. It is right to say that others than purely professional chemists, who believe that good work of this kind is of general as well as particular benefit, favour the formation of this Building Fund, and it is reasonably hoped that those industrialists, whether their work is primarily chemical or not, who have benefitted by the fact that the Institute of Chemistry has provided their works with chemists whose training and qualifications are beyond dispute, may show their appreciation of its usefulness in the highly practical manner of enlarging the scope of that usefulness. Already one eminent manufacturer, who is only in this remote way under obligation to the Institute, has given the best proof of his interest in the Buildings Fund by a substantial donation. We commend such far-sighted generosity as an example well worthy to be copied, and, if possible, excelled.

Electricity in Collieries.

In response to the growing agitation in colliery districts about the use of electricity in mines, Mr. Gladstone has appointed a Departmental Commission consisting of Mr. Redmayne, H.M. Inspector of Mines; Mr. Nelson, H.M. Electrical Inspector of Mines; and Mr. Charles H. Merz, to inquire into the working of the existing special rules, and to consider what amendments are required. The Home Secretary has not acted one moment too soon, for the most casual inquiries in the mining districts reveal the clear and unmistakable fact that electrical machinery is under the gravest suspicion, and no effort should be spared to clear away the atmosphere of doubt which is permeating the minds of numerous persons associated with mining. But in the interests of the mining and electrical industries it is of the greatest importance that the inquiry should be of the most searching and comprehensive nature. It is not sufficient to draw attention to defects of electrical machinery, important though these may be, nor do we want a series of cast iron regulations which will tend to stifle the legitimate development of electrical work in collieries, but we do desire some clear and practical indication as to the operations which can safely be carried out by electrical means. It is not our purpose at the moment to attempt to show the limitations of electricity in colliery operations, but we strongly suspect that the very facility with which it can be applied has led to a somewhat careless and haphazard introduction. We do not wish to be misunderstood, and it would be idle to attempt to depreciate the excellent work which is being accomplished by electrical means, but we fear that occasional use is made of electricity under conditions which cannot be justified either on the score of economy or safety. It is in this direction that we look for light and leading from a carefully constituted inquiry, and we trust that the recently appointed Commission will not fail in this respect. There is another aspect of the case which, we confess, causes a certain amount of uneasiness, and in this connection mine managers are not altogether blameless—we refer to the danger of using badly-designed machinery. Unfortunately, there is not much encouragement given to manufacturers to keep up the quality, and it is a deplorable fact that the extreme competition which has been prevalent in the electrical industry for some time has undoubtedly affected both design and workmanship. While this deterioration might not be of such vital importance in many of the operations carried on by electricity, it is entirely another matter when such machinery is introduced into the peculiar conditions of colliery working, where accidents mean at the least danger to life and limb. While this phase of the matter can hardly be dealt with by rules, no matter how comprehensive they may be, it is one which can be fully dealt with by mine-owners if they will insist on quality before price. If a case has been made out for a special inquiry—and we think there is little doubt of it—the Commission should be more comprehensive in its character than that now appointed. Able as are the gentlemen who compose it, we doubt whether their joint labours can do much to allay the suspicion which exists. They may draw up admirable rules, and make many valuable suggestions, but we submit that the intricate problems surrounding electrical work in collieries can never be dealt with by a mere departmental committee. The matter is one which calls for the co-operation of mining authorities, owners, managers and workers. Moreover, the electrical manufacturer can fairly demand to have a voice in the proceedings. In short, the various interests which are vitally affected by the present state of affairs should be allowed a direct representation on the Commission, and unless this course is pursued we doubt whether much good can accrue.

INSTITUTION OF MECHANICAL ENGINEERS.

No. I.

The adjourned discussion on Professor Dalby's paper on "Heat Transmission" was resumed at last Friday's meeting of the Institution of Mechanical Engineers, when the President, Mr. J. A. F. Aspinall, occupied the chair. The minutes of the previous meeting having been read and confirmed, it was announced that, owing to ill-health, Engineer Vice-Admiral Sir Albert John Durston had declined the place on the Council which he had been elected to fill on account of the resignation of Mr. George Whale. The President then called upon Mr. Mark Robinson to continue the discussion.

In his opening remarks, Mr. Robinson expressed the opinion that it would take a good man to write a better paper than that which Professor Dalby had brought before the Institution. It indicated, he thought, the lines on which further research should be made. There were two points which deserved attention. The first was the advantage of increasing the speed of the gases, and the second was the gain to be derived from increasing the speed of circulation of the water. Of these, the former was the more important. Referring to the practice of taking away the steam as soon as it was formed, as in the Cockburn boiler, the speaker said that Mr. Princep had carried out some experiments with that type of boiler, and he had hoped to hear something from that gentleman with reference to those experiments. He had tried to think out a physical conception of what went on in the tubes of boilers. He had assumed a very short length of flue, the boundary of which was one unit of heating surface. Into that tube was suddenly introduced a unit mass of gas at a certain temperature, filling the length of flue. The gas consisted of a certain number of molecules in constant movement at a certain average velocity. The movements of those molecules inflicted per unit time a certain number of blows; some were square blows and some glancing upon the unit heating surface. The object was to get as much of this molecular bombardment as possible from the gas molecules to the molecules of the iron plate. In that molecular bombardment it was the first square blow which counted the most. The fast moving gas molecule, as soon as chance gave it a square blow upon one or more of the molecules of the enclosing iron plate, imparted some of its motion to the iron molecules, and afterwards rebounded with diminished velocity. Even if it gained further energy from later collisions with its fellow gas molecules, it could never again have more than a reduced value for imparting movement to the molecules of the plate—a truth which agreed with known facts as to the extreme rapidity with which gas loses its heat as it passes along a flue. If, then, the speed of the gas passing over the heating surface were doubled, it meant that the mass of gas was doubled, and, therefore, the number of molecules. As under these conditions each molecule would spend but half as much time as before in front of the surface, it was reasonable to suppose that the surface would receive no greater total number of blows per second than before. But, inasmuch as the molecular movements were very rapid, in comparison with the movement of the gas as a whole along the flue, each molecule would have time to get in its first square blow, and thus the double mass of gas would, after all, have given to the plate twice as many of its most effective blows, though it only had half the time to do it in. The evaporative efficiency might really have been doubled approximately by speeding up the gases, and without having any recourse to any explanation in the nature of the faster sweeping away of a colder film of gas. Surprise, the speaker said, is sometimes expressed at the great difference in the temperatures of the gas and the plate where they come into contact, and a theory of a non-conducting film separating them had been involved to account for this. He did not deny the existence of a colder film. Unlike some phenomena we have to believe in, the film could be seen, but he did not think that the film was wanted to account for the difference of temperature. Temperature was merely the measurement of the motion energy of the molecules. But the motion energy of the free and fast moving gas molecules and that of the closely linked molecules of the plate were found to be widely different, for the unit of heating surface contained an enormously greater number of molecules than the gas. The heat, or molecular motion which the iron would take up, was diffused throughout the mass, and it would be drawn off at the back as fast as it entered. How was it possible, then, for each of the molecules of iron to take up from the few gas molecules which bombarded them anything like the energy of motion which the gas molecules themselves possessed? The superior mass of iron, combined with the "way out" at the back, forbade the idea, and there was little need to rely upon the non-conducting film. The film which had been observed, he ventured to suggest, was composed of the gas molecules which had just executed their bombardment. To sweep them quickly out of the way was no doubt a good thing, but they were not dense enough really to hinder the bombardment by their fellow molecules, though their presence might take the life out of the flame as it came into contact with them. At the back of the plate the molecules had a far easier job in passing on their motion to the molecules of the water, which until they were turned into steam were far more akin to the molecules of the plate than were those of the gas. So long as steam did not hinder the contact there were always water molecules waiting to receive the gentle blows of the much more densely packed molecules of iron. There was no question of bombardment or of greatly increasing the number of contacts, and therefore he believed there was not much to be done by increasing the speed of the water past the plate. He knew that many engineers thought differently, and that sometimes experiment had appeared to show remarkable results from increasing the water circulation, but if those views were wholly sound he thought that we should all long ago have fitted circulating pumps in boilers.

Professor Nicolson was the next speaker. After thanking Professor Dalby and Mr. Thieme for their valuable contribution to the bibliography of heat transmission, he said that he had found the expression for radiation deduced by the author from Poynting and Thomson's "Heat," used in the form

$$R = \left(\frac{\tau}{1000}\right)^4 \quad . \quad . \quad . \quad \text{B.Th.U.'s per square foot of fire surface per hour.} \qquad (1)$$

gave a very good approximation to all the experimental determinations, such as those of Geffroy, Henri, Lawford Fry, and others, and upon which he had tried it. In that expression τ was the fire temperature in degrees Fahrenheit absolute. The complete expression was,

$$R = 1600 \left[\left(\frac{\tau}{1000}\right)^4 - \left(\frac{\theta}{1000}\right)^4\right] \quad . \quad . \quad . \quad . \quad (1a)$$

where θ was the absolute temperature of the fire-box wall. When unlined the second term might be safely ignored. To obtain the evaporation per square foot of fire-box surface, all that was necessary was to divide R by the ratio of plate to fire surface in the fire-box and by 966. The temperature of the fire surface itself was given with considerable accuracy by the expression

$$F\,Q_o = 1600\left(\frac{\tau}{1000}\right)^4 + K p\,(A + 1)\,F\,(\tau - 521). \quad (2)$$

In that equation F represented the pounds of coal burnt per square foot of grate per hour, Q_o the British thermal units developed in the fire by each pound of coal, A the pounds of air supplied per pound of coal, and $K p$ the specific heat of products of combustion. It was easy to solve this equation (2) for τ the fire temperature either by trial and error, with a slide rule, or by a graphic method. Knowing the fire surface temperature by (2), the radiation could be calculated by (1), and the radiation evaporation from the fire-box was known. He had found that the evaporation due to convection in the fire-box—except that from the tube plate—was inconsiderable compared with that due to radiation. It was often more than made up for by the burning of volatile hydrocarbon and C O in a large fire-box, so that the gases reached the tubes with much the same temperature as they left the fire. On plotting equation (2) for various values of F, using $Q_o = Q - 50\,F$ and $A = \frac{300}{F} + 10$ as expressions for Q_o and A derived from experiment—here Q equalled the calorific value of the coal used—it would be found that τ increased to a maximum and then diminished as F increased. This was due to the fact that as the rate of firing increased less air was supplied per lb. of coal, but more CO was given off and more small coal blown out of the fire, so that the rise of temperature due to the former cause was soon overtaken by the fall due to the latter. The speaker considered it wrong to line the furnace itself with refractory material. It should, he said, be left bare, and a brick-lined or reverberatory chamber should be formed behind the fire-bridge and before heat transmission by convection in the tubes or flue commenced. Continuing, Professor Nicolson said that he thought that the author had not been fortunate in the choice he had made on page 23 of the paper of a formula for the rate of heat transmission in the tubes or flues. The formula chosen was that of Ser—the other authorities quoted, viz., Hudson and Brillié, not having themselves made any experiments—and assumed that the rate of transference was proportional only to the square root of the speed. His own experiments with two different apparatus for air, superheated steam, and water, and an experimental boiler in which the speeds and pressures varied over wide limits, gave a formula of exactly the form predicted by Osborn Reynolds in 1874, viz.:—

$$H = (A + B\,\rho\,n)\,(T - \theta) \quad . \quad . \quad . \quad (3)$$

where H represented the British thermal units transmitted per hour per square foot, ρ the density of gas—lb. per cubic foot, n the speed of the gas in feet per second, T the mean temperature of the gas in degrees Fahrenheit, and θ the mean temperature of the wall, A and B were constants. Boiler engineers could use a simpler form of that expression, viz., $H = c\,\rho\,n\,(T - \theta)$, in which C had values varying from 3 to 6. With high temperatures, narrow flues, and clean surfaces a value up to 5 or 6 would be obtained, whereas for moderate temperatures, wide flues and sooty surfaces, the constant would drop to 3, or even less. He did not propose to inflict upon them anything about his experimental boiler results. The figures he had given in his paper, read before the Junior Institution of Engineers, had been received with incredulity, and the "Thunderers" of the engineering Press had opened fire upon him, and had hoped to have silenced him. They had dared him to appeal unto Cæsar, in the person of Mr. Michael Longridge. This he had done, and he was glad to be able to say—although he had not up to that time received Mr. Longridge's figures—that those figures would substantially confirm his results in the respect that 40 lb. of water had been evaporated per hour per square foot of flue surface at the back end of a Cornish boiler.

Mr. W. H. Patchell remarked that in one part of the paper the author had suggested that a research might be undertaken by the Institution. He agreed entirely with the author's views in this matter, and called attention to the fact that Mr. Dugald Clerk in his Winnipeg paper stated that progress in gas engine efficiency was limited by our knowledge of heat flow through metals. He thought that research work of that kind, conducted by such men as Clerk, Coker, Dalby, and Hopkinson, would be the means of increasing our knowledge in this direction very considerably. Mr. Patchell went on to draw attention to the annual reports of the Institution which have been issued during recent years. The report of 1907, he said, stated that preliminary inquiries had been made which would determine the researches which could be usefully initiated. According to the annual report of 1908, information at that time was being collected on three subjects, viz., heat flow, refrigerating machinery, and steam nozzles. The speaker, after referring to the 1909 report, then urged the Council to pass the vote for the necessary funds for a research on heat transmission to be carried out. In dealing with that part of the paper where the author referred to divided boilers, the speaker said that he had recently come across an essay on the boilers of steam engines by R. Armstrong, published in 1839. It was a second edition. The writer of that essay described how

ARTESIAN WELL AT SLOUGH

C. ISLER AND CO., LIMITED, LONDON, ENGINEERS

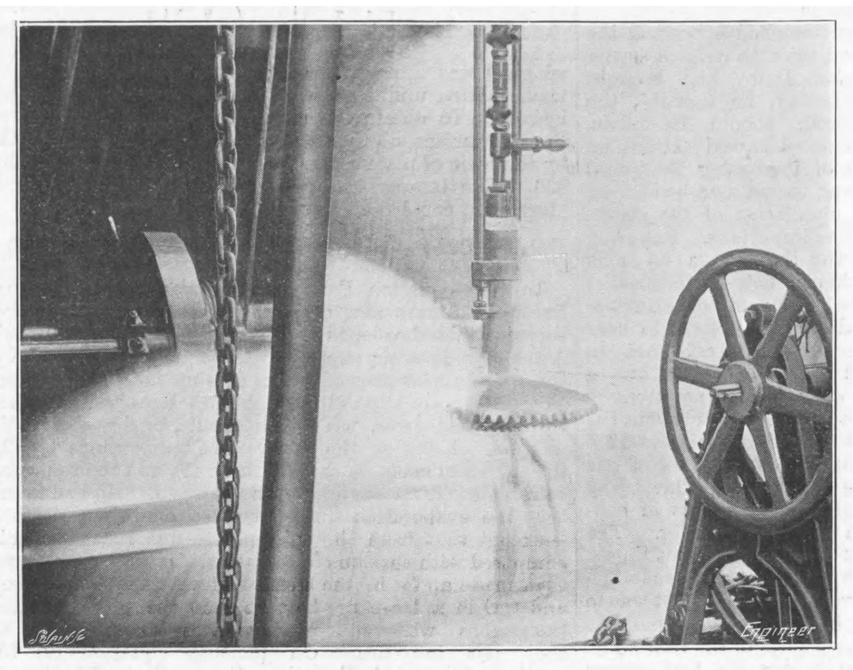

Fig. 1—DISCHARGE FROM BORE

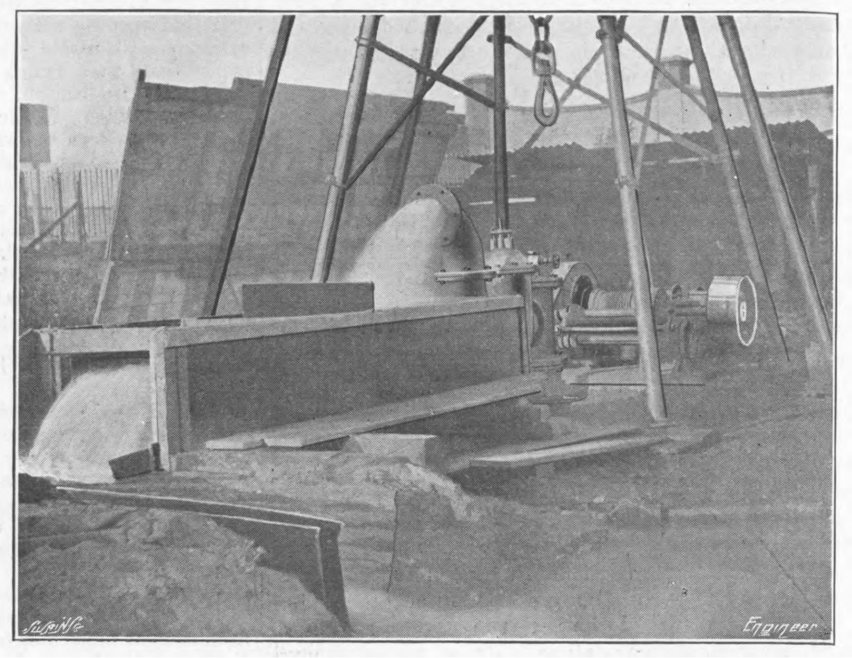

Fig. 2—DISCHARGE INTO WEIR BOX

he had lengthened a 20ft. boiler to 30ft., but the saving was very little. He also shortened a 100ft. boiler to 50ft., without diminution in output. The speaker said that he had found that boilers up to 104ft. by 5ft. 3in., and boilers of 90ft. by 8ft., were in use in cotton mills at about that time. In referring to the Cockburn boiler, Mr. Patchell remarked that he had hoped that Mr. Prinsep would give some information concerning experiments on those boilers in which that gentleman had been actively engaged. Mr. Patchell also referred to some experiments carried out by R. Stephenson on fire-boxes and tubes as used in the "Rocket" boiler.

Mr. A. T. Tannett Walker dealt principally with the value of Professor Dalby's paper, and said that it drew attention to the unfortunate position of the steam boiler, He remembered some years ago listening to a lecture on fuel, delivered by Sir William Siemens. That lecture filled him with zeal for economy in coal, and he had never lost that zeal. He thought that Professor Dalby's paper ought to set young engineers to work in the direction of improving the economy of our present steam boilers, and if it did that the paper would not have been read in vain. Continuing, the speaker drew attention to the advantages young engineers have to-day, as compared with the early workers in the field, and said that had George Stephenson had the advantage of reading books on engineering subjects he would have been saved much labour. In conclusion, the speaker remarked that he thought Professor Dalby's paper one of the most valuable contributions the Institution had received.

Professor C. H. Lees first expressed his thanks to Professor Dalby and Mr. Thieme for having collected such a vast amount of information, and said that he hoped that those gentlemen would continue their work so as to give others a clear impression of the present position. Continuing, the speaker said that the heat conducting properties of water were well known. The heat conducting properties at boiling point were not vastly different from those at other temperatures. There was no doubt that however much the water was stirred, the water film could not be got rid of, but the heat could be readily transmitted through that film. The speaker then went on to refer to the work of Dr. Stanton, who, he said, had found that the rate at which the heat was transmitted through a plate into the water in a boiler was practically independent of the pressure. Professor Lees also referred to other experiments carried out by Dr. Stanton. Then he went on to deal with the conductivity of the metal. He said that it had been found that this did not vary more than 2 per cent. from the temperature of liquid air to that of boiling water, which showed that the conductivity was not very different at any of the ordinary temperatures. Lastly, Professor Lees considered the gas film, and expressed the opinion that if engineers wished to get better results they must reduce the temperature drop due to that film.

Mr. E. R. Dolby considered the subject from the point of view of the water circulation. He first referred to a paper read in the year 1895 by Mr. R. W. Allen on "Condensing." In the experiments described in that paper, he said the water velocity was altered in various degrees in order to test the effect of the rate of heat transfer. He then went on to describe a case which he had met with in practice, and which showed that by artificially increasing the circulation of the water much better efficiency was obtained. Mr. Dolby said that some time ago he was responsible for the installation of a heating plant for a large building. It was a low-pressure plant with a cast iron boiler. After the plant had been working for some time it became necessary to add 200 square feet of heating surface, and to enable the plant to work satisfactorily under these new conditions it was decided to adopt forced circulation. Log sheets were kept of the amount of coal burnt, and of the temperature at which the plant worked. Before the additional 200 square feet of radiating surface were added from 21st October, 1907, to January 26th, 1908, 54 chaldrons of coke were used, whereas after the forced circulation was employed only 42 chaldrons were consumed in the same period and with the same temperature in the building. It was also noticed that the building heated up much more quickly after the circulating apparatus was fitted than before.

Mr. Druitt Halpin first referred to the remarks made by Mr. Wilkinson at the previous meeting. That gentleman, he said, had mentioned soaking pegs, and had made reference to the work of Mr. Wye Williams in this direction. He had also described an experiment which he himself—Mr. Wilkinson—had carried out. From what Mr. Wilkinson said, he gathered that the pegs which he used were angle pieces attached to the inside and to the outside of the vessel in which the water was heated. Mr. Wilkinson had said that he only got an increase in efficiency of 4 per cent. by using these pegs. He would call attention to the fact, however, that the form of peg employed by Mr. Wye Williams differed very considerably from those which Mr. Wilkinson employed. The pegs used by Mr. Wye Williams passed right through the plate, and they also protruded a considerable distance into the water and also into the fire-box. The pegs thus provided an enormous gathering ground and an equally good heat-absorbing surface. In referring to the system of taking off the steam from the boiler as fast as it is formed, Mr. Halpin expressed the opinion that it was the right system. Then coming to the gain to be derived from increasing the velocity of the gas, the speaker expressed praise with reference to Dr. Nicolson's paper read before the Junior Institution of Engineers. He was somewhat surprised, he said, that Mr. Mark Robinson had made no reference to that paper, since that gentleman's remarks were confined principally to the question of increasing the velocity of the gas. Possibly Mr. Robinson had not heard of the paper. Lastly, the speaker referred to the abstracts of the papers which Professor Dalby and his colleague, Mr. Thieme, had made. Those abstracts, he said, were to be found in MS. in the library of the Institution, but he wished to draw attention to the fact that they could only be read by those members who were able to attend the library, and he wished to urge the Council to find the money to have the abstracts printed in book form, to enable those in the provinces and other parts to take full advantage of them.

A DEEP ARTESIAN WELL AT SLOUGH.

EXCELLENT results have been obtained from an artesian bore-hole, which has just been completed at Horlick's Malted Milk Factory, Slough, Bucks, by the firm of C. Isler and Co., Limited. A large yield has been obtained from this bore-hole, which has been drilled to a depth of 1038ft., and has just touched the lower greensand formation. When we visited Slough, some days ago, the water was flowing at the rate of over 90,000 gallons per hour, measured over a weir, the depth of water flowing over the sill of the weir, 2ft. wide, being 8.3in. On closing the sluice valve a pressure of 45 lb. to the square inch was shown on the gauge. The water is to be conveyed through cast iron mains to the tanks at the top of Horlick's works, which are over 62ft. high, and all the water required in these works will be obtained without pumping. Obviously, the supply is also valuable for fire extinguishing purposes, as it is possible to throw a 1in. jet considerably over 60ft. in height.

The water obtained from the well has been recently analysed, and has been found to be exceedingly pure. The total hardness is only 5 deg. In the first instance it was intended to obtain the water from the chalk formation, and the contract was let with this idea. The chalk was reached at 80ft. from the surface, and the boring was carried down to a depth of 500ft., when a test was made to ascertain the yield. It was found, however, that owing to the extreme density of the chalk at this site the yield obtained was very limited.

After careful consideration it was decided to continue the boring further through the gault to the lower greensand, it being estimated that this would be touched at a depth of somewhere about 1100ft. The boring was therefore resumed and carried down to a depth of 858ft., full 18in. in diameter. Up to this point the bore-hole had only been lined through the London formation, consisting of sand and gravel and the London clay, down to the chalk, the tubes having been fixed 10ft. into the chalk. It was at this point that the first trouble in connection with the boring occurred. The contractors had been endeavouring to carry on the bore-hole through the gault without a second tier of lining tubes, and although they were to a certain extent successful in doing this, it led to serious delay and innumerable troubles. For instance, at the depth of 848ft. the crown of the rotary boring plant was completely cut off the core tube. This was caused by sharp flints dropping out of the chalk and getting down between the outside of the crown and the core tube. In one case the crown had the appearance of having been turned off in a lathe. This detached crown was 3ft. long, with a 17¾in. outside diameter, and was ⅞in. thick. Several attempts were made to remove the obstruction, and eventually the contractors succeeded in cutting away the crown. The boring was then continued. Before another 30ft. had been bored, however, a repetition of the above occurrence took place. In fact, no less than three times was the crown severed in this manner. In one case a set of tools over 20ft. long were cut off owing to the same cause, viz., fallen flints. These obstructions were, however, all eventually cleared away, and it was then decided to take special precautions against the falling in of the flints while boring through the gault, and a temporary inner lining tube was inserted to keep them back, and also to shut out the parts of the broken tools. After this had been done and the boring had been carried down to 900ft., it was found necessary to fix an internal lining tube from the surface, and 800ft. of 8½in. internal diameter tubes were put into position. After this had been done the boring was continued without further difficulty, and the work proceeded rapidly until a depth of 1035ft. had been reached. At this point the lower greensand was tapped, and almost immediately an enormous rush of water came to the surface. Fig. 1 shows the yield a few hours later.

As soon as the water was obtained it was decided to line the bore-hole right down into the greensand; and in view of the fact that such an enormous supply of water had been obtained, the 8½in. tubes were allowed to remain in position, and the bottom part of the bore-hole right into the greensand was then lined with 270ft. of 6in. tubes, which were allowed to lap into the 8½in. tubes. Eventually a sluice valve was fixed to the bore-hole when the water was controlled. Fig. 2 shows the water discharging into the weir box through the sluice valve.

There seems at present to be no limit to the output of this well. From the time of first tapping the supply to the time of closing the well the period of a fortnight elapsed, during which time the water was continually flowing day and night in this great volume. If anything, we are told, at the end of fourteen days it showed an increase rather than a decrease. Many tons of sand were thrown up, and it is estimated that something like 60 to 80 loads of sand were discharged with the water. It is a somewhat remarkable fact that this enormous yield has been obtained, bearing in mind that in several cases deep bore-holes have been put down into the lower greensand formation in the London basin, and that in many of these cases absolute failure has resulted. The work at Slough has been carried out under the supervision of Mr. F. Meyer, the contractors' director and chief engineer.

EXPRESS LOCOMOTIVE ON THE NORTHERN OF FRANCE RAILWAY.

IN our issue of October 8th last we published an article dealing with some recent locomotive performances on the Northern Railway of France. We are now enabled to give as a supplement some detailed drawings of one of the 4-6-0 engines mentioned in the article. There are also included some drawings of its tender. These engines, we may mention, were designed and built for the haulage of heavy fast trains with frequent stops, and were so fully described in the issue above referred to and in that of the 4th of June last, that we need not go into fuller details at the present moment.

WE hear that the London and North-Western Railway Company is about to embark upon an important deviation and widening between Kensal Green Tunnel and Sudbury Sidings.

STRIP ROLLING MILL AT BROMFORD IRONWORKS

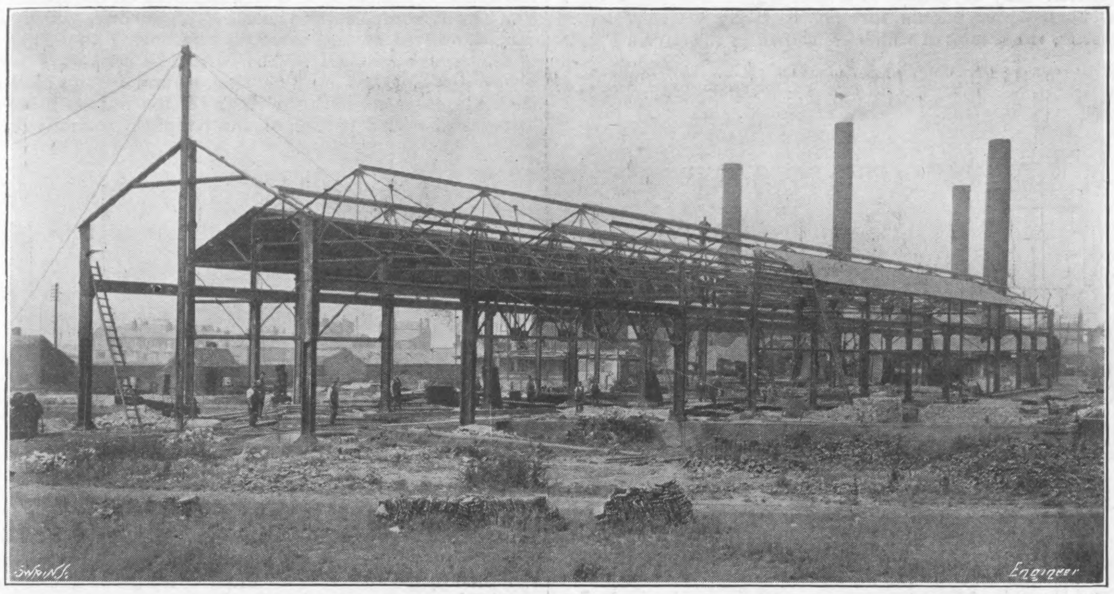

Fig. 1

STRIP ROLLING MILL.

THE continuous rolling mill has not met with much favour in this country except for the rolling of wire, but an interesting modification of the principle has been recently completed at the Bromford Ironworks, West Bromwich, a description of which will be read with interest. It is housed in an entirely new building erected especially for it, a picture of which in course of erection is given in Fig. 1. It consists, it will be seen, of two spans, one 234ft. long by 40ft. wide, containing the mill itself, and the other 284ft. by 34ft., used as a warehouse. The building has been specially constructed for the economical handling of materials. The mill itself is served with an electric crane for roll changing, an electric strip lifting crane covers the mill floor, and a three-ton Broadbent three-motor crane takes the product of the mill and loads it into wagon or boat. Since the mill is bounded on two sides by rails and on the other two sides by canal, an arm of which is crossed by the warehouse crane, the opportunities for cheap handling are exceptional. Outside the mill is bounded on two sides by a standard gauge railway, on which a three-ton electric three-motor crane by Booth Brothers runs, supplying steel to the mill and fuel to the furnaces and boilers.

The mill itself, which is shown fairly well in Fig. 2, consists of six sets of rolls spaced at different distances apart. It is used principally for rolling-tube and similar strip. Billets of a suitable size are fed into the first roll, and pass in a direct line through the complete set, issuing in the form of strip. Each pair of rolls has, of course, to run at a different speed to accommodate the increased length of the strip, and, as may be imagined, a good deal of ingenuity is required to obtain the correct speed in the surest and easiest way. The method devised by Mr. Scarf, the managing director of the company, and Mr. J. W. Hall, of Birmingham, works admirably, and is briefly as follows:—The last pair of rolls is coupled direct to the fly-wheel shaft, and runs at the speed of the engine and a slower speed than the fourth pair. The next pair, which is placed a fair distance from the last, is driven by nine 1¾ cotton ropes running on to a 17ft. 6in. wheel; the next pair, spaced 20ft. from the penultimate pair, is also driven by cotton ropes—ten on a 15ft. wheel, and the remaining three are driven by gearing driven from the last named. This gearing has been specially designed and works very satisfactorily. The bearings throughout are of the ring lubrication type. The large spacing between the last two rolls permits the strip to loop, and from beginning to end no tension is put upon it during its passage, each succeeding roll being set to run a little slower than sufficient to take up the increase in length. The last two rolls are chilled to leave a good surface, and just in front of the last pair are placed scrapers which remove all scale; they are operated pneumatically by the cylinders seen in Fig. 2. The last pair is in duplicate. The mill is driven by a vertical triple-expansion engine built by the Lilleshall Company, and having cylinders 20in., 30in. and 45in. in diameter by 33in. stroke, and is arranged for four speeds. The high-pressure cylinder is fitted with Corliss valves, the other cylinders with piston valves. All boxes are fitted with metallic packing, while the crank shaft is of exceptional strength. A special feature has been made of the lubrication, the oil being supplied from two high-level tanks, to which the oil is returned after use by centrifugal pumps. At 90 revolutions and 160 lb. pressure it develops 1100 horse-power. Steam is supplied by two Babcock and Wilcox boilers having 2255 square feet of heating surface each, while two Lancashire boilers, 30ft. by 8ft., are kept in reserve. Canal water with a hardness of about 44 index has to be used for feed, and in order to make it suitable the hardness is reduced to about 4 in a Lassen and Hjort 2000-gallon softener.

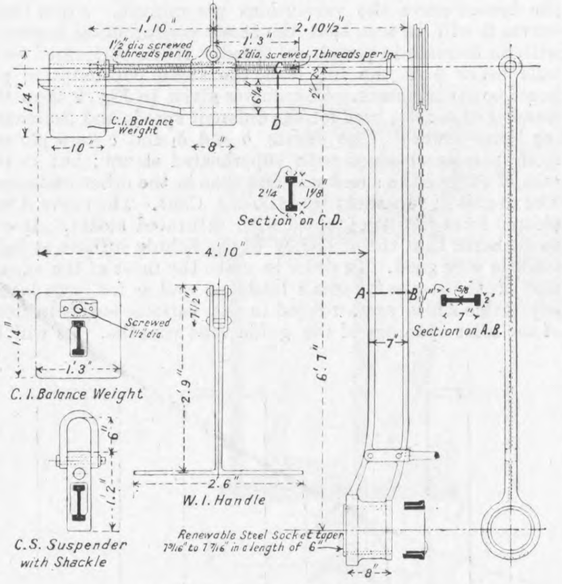

Fig. 3—APPLIANCE FOR HANDLING ROLLS

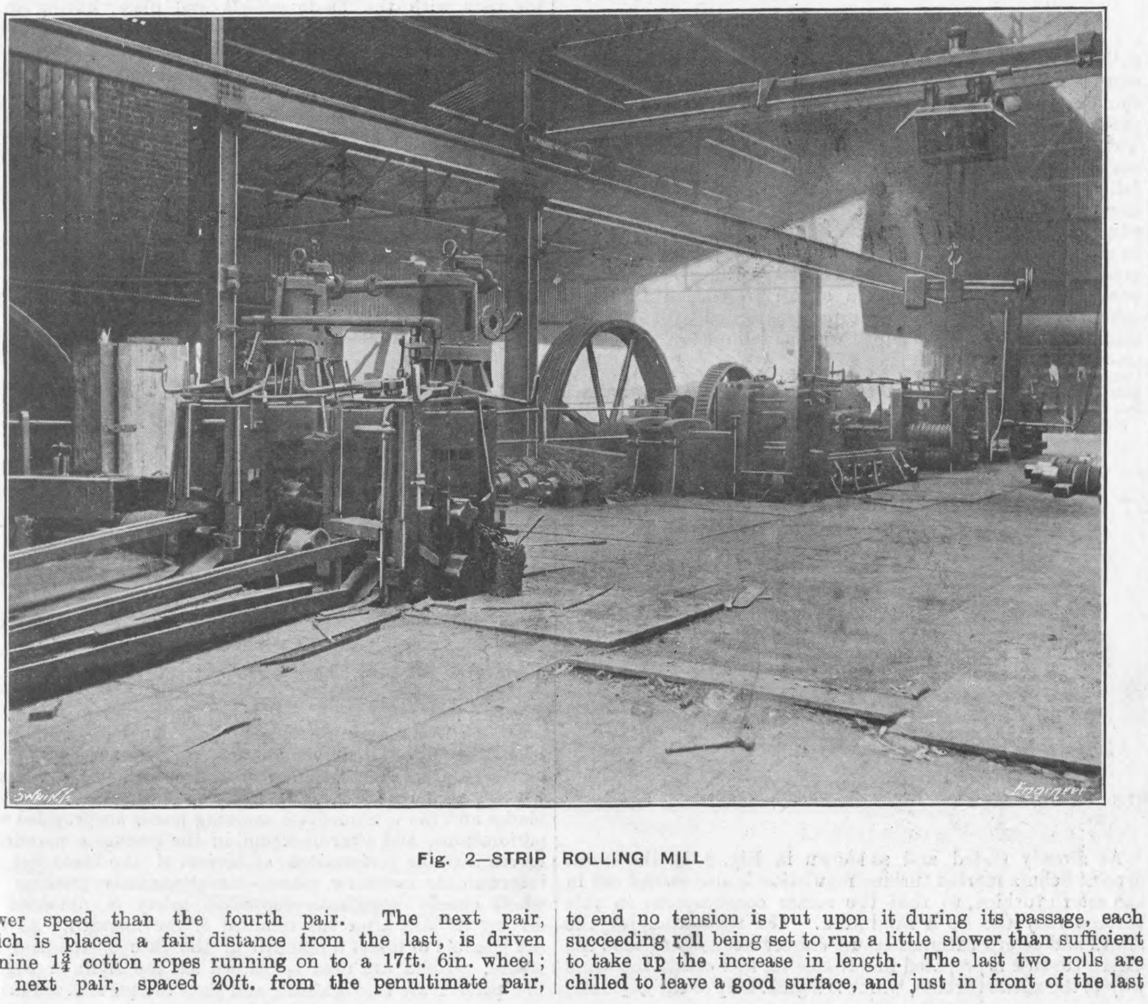

Fig. 2—STRIP ROLLING MILL

The furnaces for the mill are heated by gas, generated in an ordinary producer; they have hearths 20ft. by 6ft. 6in. The roll lathes and bundling shears are electrically driven, and the floor of the mill has been made in places of brick instead of iron plates, so that a magnetic crane may be used to lift the finished strip.

A very interesting item, designed by Mr. Scarf and Mr. Hall, is the appliance for handling rolls shown in Fig. 3. By means of this simple apparatus rolls may be changed in an extraordinarily short time. It consists of a cast steel frame of ⅂ shape, on the horizontal limb of which a counterweight may be moved by a screw. At the lower end of the vertical limb is a hole, slightly bell-mouthed, which fits freely on to the wobbler of a roll. The whole thing is hung from a ring on the horizontal limb. The roll is held quite sufficiently firmly in the hole to permit of its being withdrawn from the housing and carried about by the crane. The device is extremely simple and very effective.

We had, through the courtesy of Mr. Frederick Scarf, the pleasure of seeing the mill in operation a few weeks ago, and desire to offer him and Mr. Hall our congratulations on its design. The whole plant appears to be exceptionally efficient, and is entirely modern in its conception, reflecting great credit on its designers.

COPPER.

ENGINEERS who could use more copper, and who have not recently made arrangements for obtaining any, would probably be well advised if they now entered the market, since the present seems to be a favourable time for giving out orders before prices begin to rise again after the recent, and indeed existing, quietude. November opened with Chili bars being quoted on the London market at, cash, £57 11s. 3d. to £57 16s. 3d., and three months, £58 15s. to £59. Compared with a month ago, these prices show a drop, as regards the cash figure, of £1 18s. 9d., Chili bars, cash, having been quoted when October set in at £59 10s. to £59 15s. Those who have purchased supplies during the past month, whilst values have been at a low ebb, have probably done well, since some authorities consider that prices are likely to rise in the near future. More buying has taken place lately, apparently on American account. Producers in the States are said to be still adhering to their previous quotations, declining to go lower than recently. A more cheerful feeling prevails among producers and merchants. Increased sales of electrolytic are reported at about £59 5s., whilst strong sheets remain at £70. There is certainly plenty of room for a further improvement in the demand, as shown by the circumstance that during the last fortnight in October there was an increase of 2270 tons in stocks, and of 2745 tons in the total visible supplies, which last now amount to 99,357 tons, against 51,532 a year ago. That was the position when November opened, and it means that the visible supplies are greater than they were twelve months ago by as much as 47,825 tons, so that it is a little difficult to understand the forecasts of the optimists as regards a probable early rise in prices, unless on the supposition that the demand before long will greatly strengthen. Deliveries for October were 28,025 tons, or below those for September by 2723 tons. Yet when the general trade of the country revives copper values are pretty sure to go forward once more, [and there are, we are glad to know, indications of more movement recently in engineering and in shipbuilding. For the past two or three weeks a combination of American copper magnates has been talked of, which would take the form probably of an amalgamation of producing interests, with a possible restriction of output. The idea is by no means a new one, and it is not well to place too much reliance upon such reports, but if the project come to anything a further rise in the price of the metal—or rather we should say a recovery—is almost assured. If the metal has not yet touched bottom that point can hardly be far off. Engineers and other consumers are therefore in all probability running a risk if they continue to withhold purchases.

THE INSTITUTION OF ELECTRICAL ENGINEERS.—At the opening meeting on November 11th, a marble bust, by Hamo Thornycroft, of the late Dr. John Hopkinson, F.R.S., who was president in 1890 and in 1896, will be presented to the Institution by Professor Bertram Hopkinson, on behalf of his mother, Mrs. John Hopkinson.

INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.—A meeting of the members of the International Testing Association resident in the United Kingdom will be held at the offices of the Iron and Steel Institute on Thursday, November 18th, at 4 p.m., when the business will include the reception and consideration of a report on the Copenhagen Congress, and the nomination of representatives to the committees appointed, or about to be appointed, to study the following problems:—(*a*) The influence of slag enclosures on the properties of metallurgical products; (*b*) determination of hardness by ball or cone-pressure tests; (*c*) impact tests and apparatus for testing by impact; (*d*) methods of testing cast iron and castings; (*e*) the utilisation of the magnetic and electric properties of material in connection with mechanical testing thereof; (*f*) international specifications for iron and steel, grading of pig iron, and wrought iron pipe specifications; (*g*) nomenclature of iron and steel; (*h*) specifications for copper alloys; (*i*) cement tests; (*k*) wood tests; and (*l*) protection of metals against corrosion

THE SCHULZ STEAM TURBINE.

NOTWITHSTANDING the fact that the Schulz steam turbine has been in existence for some years, it is probably not so well known in this country as it is on the Continent, and in view of the fact that it has been steadily gaining prominence abroad, some particulars of its general construction and the special advantages claimed for it may prove of interest. Recognising that multi-stage turbines can only work economically with a full supply of steam, and that a diminution of the admission of the steam into the first stage occasioned by a reduction of the load is accompanied by a comparatively poor efficiency of the work of the steam in the turbine, Schulz set himself the task of designing a turbine which would make the most of the expansion of the steam for small loads as well as for large ones. A turbine of this type, which was used for propelling a small boat in 1900, is shown in the drawing Fig. 1. It is a compound multiple-expansion impulse parallel-flow turbine. The high-pressure section is seen on the right and the low-pressure and reversing turbines are on the left. Steam passes alternatively through guide rings and through moving blades. Slides, which will be dealt with more fully later, are provided, which act to limit the passage in the guide rings so as to control the flow of steam through the casing, according to the load. It will be noticed that the exhaust of both the high-pressure and astern turbines finds its exits through the same channel which is now the customary construction in other turbines. A drawing of the latest type of Schulz turbine suitable for marine propulsion is shown in Fig. 8, where the astern turbine is also provided with regulating gear, and there is no separate low-pressure casing. Before entering upon the details of construction, attention may be called to a test which was made on a 650 horse-power Schulz turbine, built by A. G. Weser, of Bremen, the results of which are shown in the curves Fig. 9.

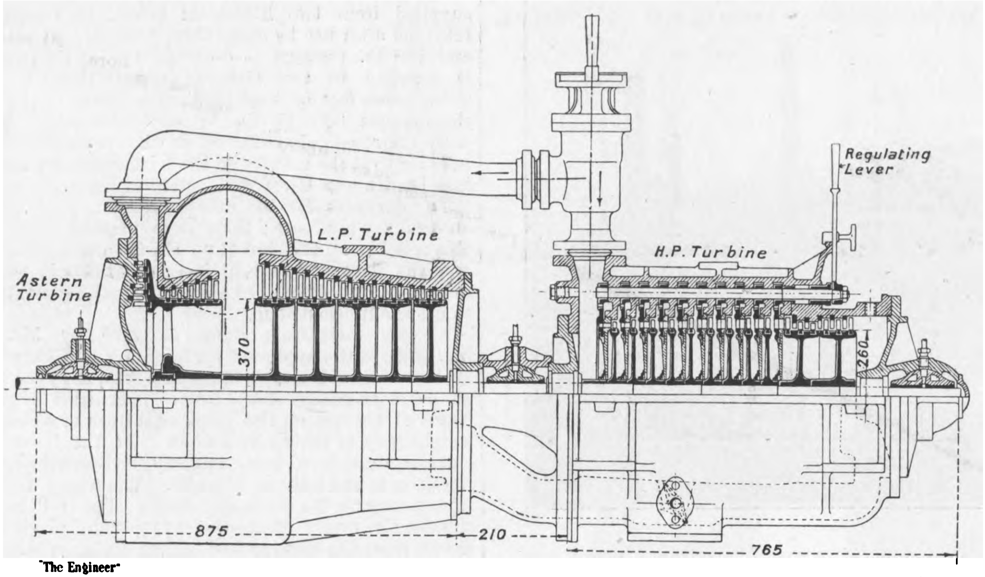

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Fig. 1—SCHULZ MARINE STEAM TURBINE

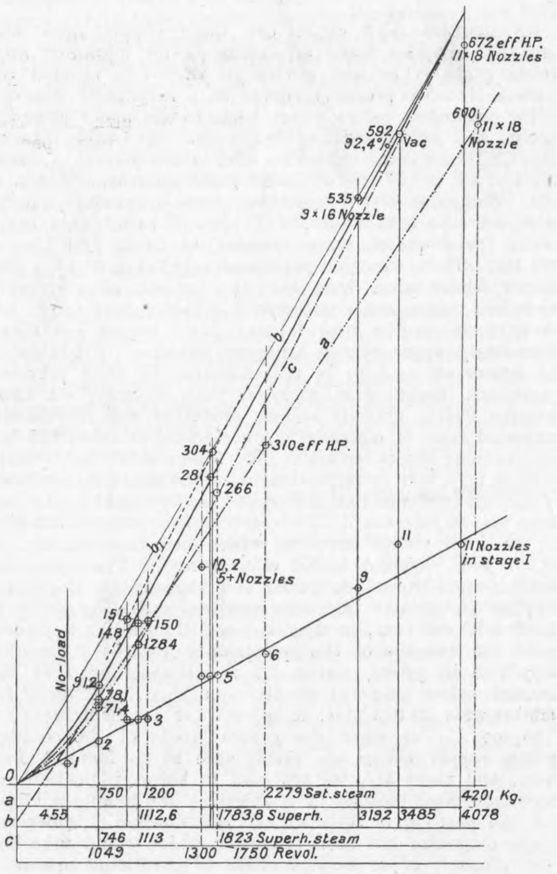

Fig. 2—CURVES OF NOZZLES AND SPEEDS

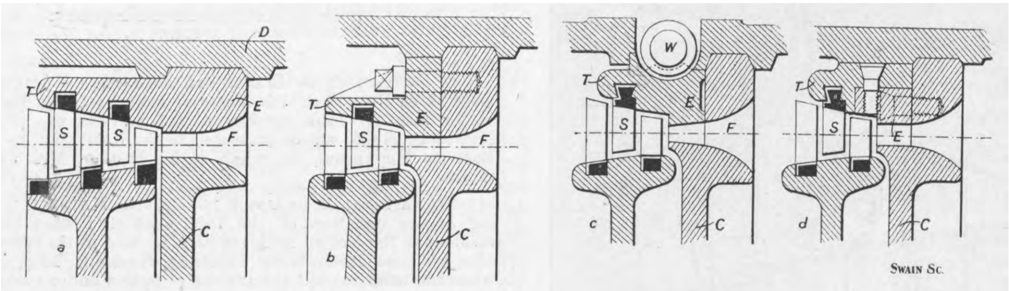

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Fig. 3—ARRANGEMENTS OF NOZZLES

The upper curve in this gives the peripheral speed of the rotor, the middle set of curves the steam consumption, and the lowest curve the revolutions per minute. From these curves it will be seen that the steam consumption decreases with an increase in peripheral speed. If the performed work falls below ⅝ of the full load, the steam consumption per horse-power increases. The curves given in Fig. 2 show the number of nozzles used for the different speeds and the resulting horse-powers. The curves b and b_1 and c were plotted from results obtained with superheated steam; but in the case of curve c the speed was less than in the other instances. The degree of superheat was 100 deg. Cent. The curve a was plotted from results obtained with saturated steam. It will be gathered that the efficiency of the Schulz turbine at light loads is very good. In order to make the most of the expansion of the steam for small loads, as well as for large loads, adjustable slides are arranged in the various stages in front of the inlet openings of the guide vane wreaths. As will be gathered from Fig. 10, the regulating device consists of circular segments operated by spur wheels, which are mounted on a spindle on top of the turbine, and in this way the fall of pressure available is fully utilised, even at the smallest loads. The regulation, according to this method, is carried out in such a manner that the steam does not work within the same fall of pressure at the different loads. For the smaller loads more of the guide passages are opened in the later regulated stages in proportion to the number opened in the first stage, so that the section of the open guide passages increases at a greater rate for small loads than for large ones. A 560 horse-power turbine, working with a steam pressure of 13 atmospheres and 90 per cent. vacuum, was tested with different loads, and the results obtained were as follows:—

Load	1/1	¾	½	¼	⅙
Drop in load per cent.	—	25 p.c.	50 p.c.	75 p.c.	83.3 p.c.
Kilos. of steam used	6	6.15	6.35	7.7	8.25
Increase in amount of steam used	—	2.5 p.c.	5.5 p.c.	28 p.c.	37 p.c.

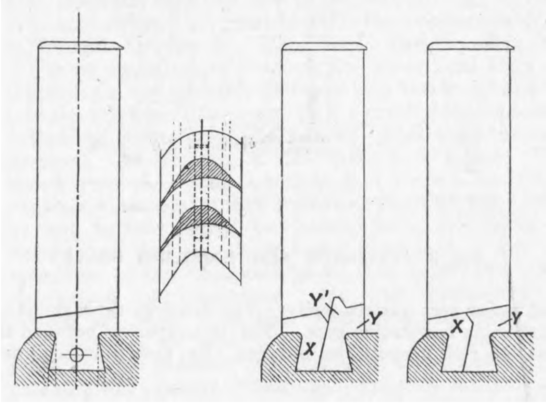

Fig. 4—TURBINE BLADES

As already stated, and as shown in Fig. 8, in the latest type of Schulz marine turbine regulation is also carried out in the astern turbine, so that the steam consumption in this turbine may also be a minimum. The regulation for the ahead and astern turbines occurs simultaneously, so that the astern turbine is prepared in advance for its work in the same way as the ahead turbine, which is a great help to the engineer.

The rotors of these turbines are of forged steel, and the various sections fit on to coned portions of the shaft, and they are secured by means of keys. The blades are not fastened directly into the stator, but into a special ring, which fits inside, as shown in Fig. 3. In the construction a the nozzle is composed of a ring mounted on the partition C. The ring E completes the nozzle F of the disc, which latter can be revolved on the shaft after removing the upper half of the turbine casing D. The carrier or support T for the blades S is mounted on this ring E, and in this case it is shown in one piece with the ring. If the nozzles F are only distributed over a portion of the periphery, radially divided annular pieces, each of which is provided with a guide blade carrier T, are connected with the partition C. In the construction b, the ring E is mounted by means of screws on the nozzle ring on the partition C. In the example c the annular piece E, which forms a portion of the nozzle situated on the partition C, is adapted to be displaced relatively to the ring by means of a worm W engaging in teeth on the annular piece. The annular piece in this case serves as a regulating valve for altering the expansion of the steam, for the blades in connection with the exit part of the nozzles are displaced with the latter. Lastly, in example d, the support T of the blades S is attached by means of screws to a separate ring or annular piece E, which latter forms a portion of the nozzles in the ring C.

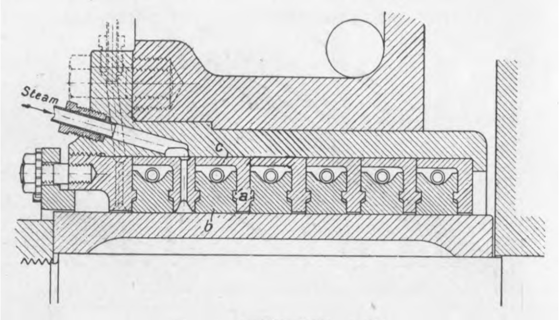

Fig. 5—STUFFING BOX

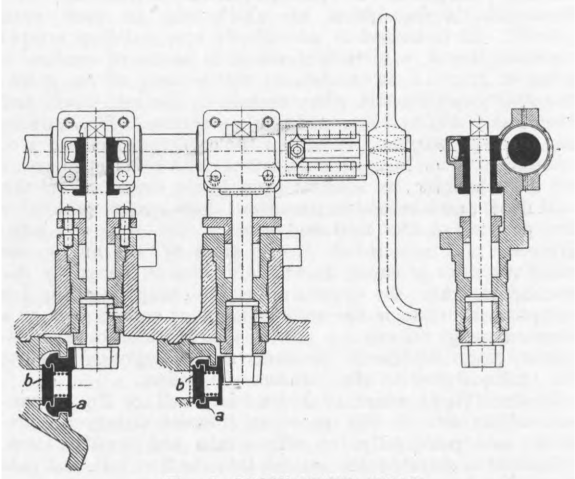

Fig. 6—REGULATING GEAR

The advantages claimed for these constructions are that the work on the interior of the casing is simplified. The casing retains its full strength, because large apertures are unnecessary, in order to allow of the insertion of separate blade supports. After the removal of the upper portion of the casing D the blade supports mounted on the disc may be turned on the turbine shaft without the latter, together with the blade wheels and discs, having to be removed from the casing. After the lower halves of the discs have been turned upwards the parts fixed thereto may be easily inspected, removed, and repaired. The blades are made of Delta metal, and as shown in Fig. 4 they are inserted in dovetail-shaped annular grooves of the wall of the carrier and of the running wheel, intermediate caulking pieces being inserted between the blades. The feet of the blades and the intermediate caulking pieces are provided with perforations, and after insertion in the grooves a mandril is driven into the perforations of several of the blade feet and intermediate caulking pieces, simultaneously pressing the whole closely together. Increased safety is obtained by driving in pins after the removal of the mandril. As it is not possible to insert a mandril in the case of the last few blades, wedges are used as shown on the right of Fig. 4. The parts Y are first inserted, and then the parts X are driven

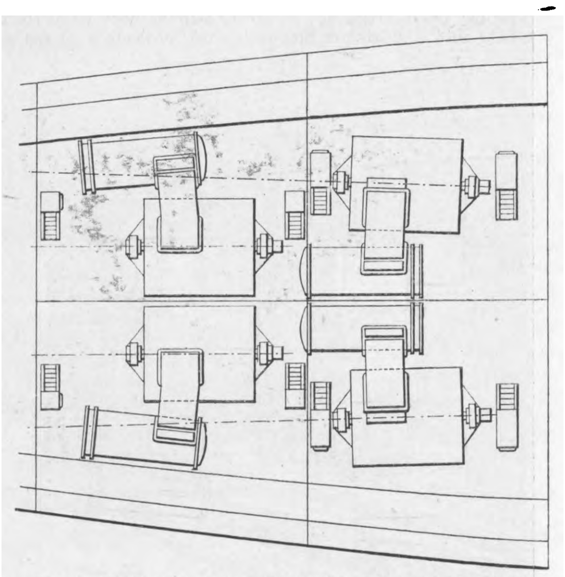

Fig. 7—TURBINE ARRANGEMENT FOR BATTLESHIP

THE SCHULZ STEAM TURBINE

(For description see page 484)

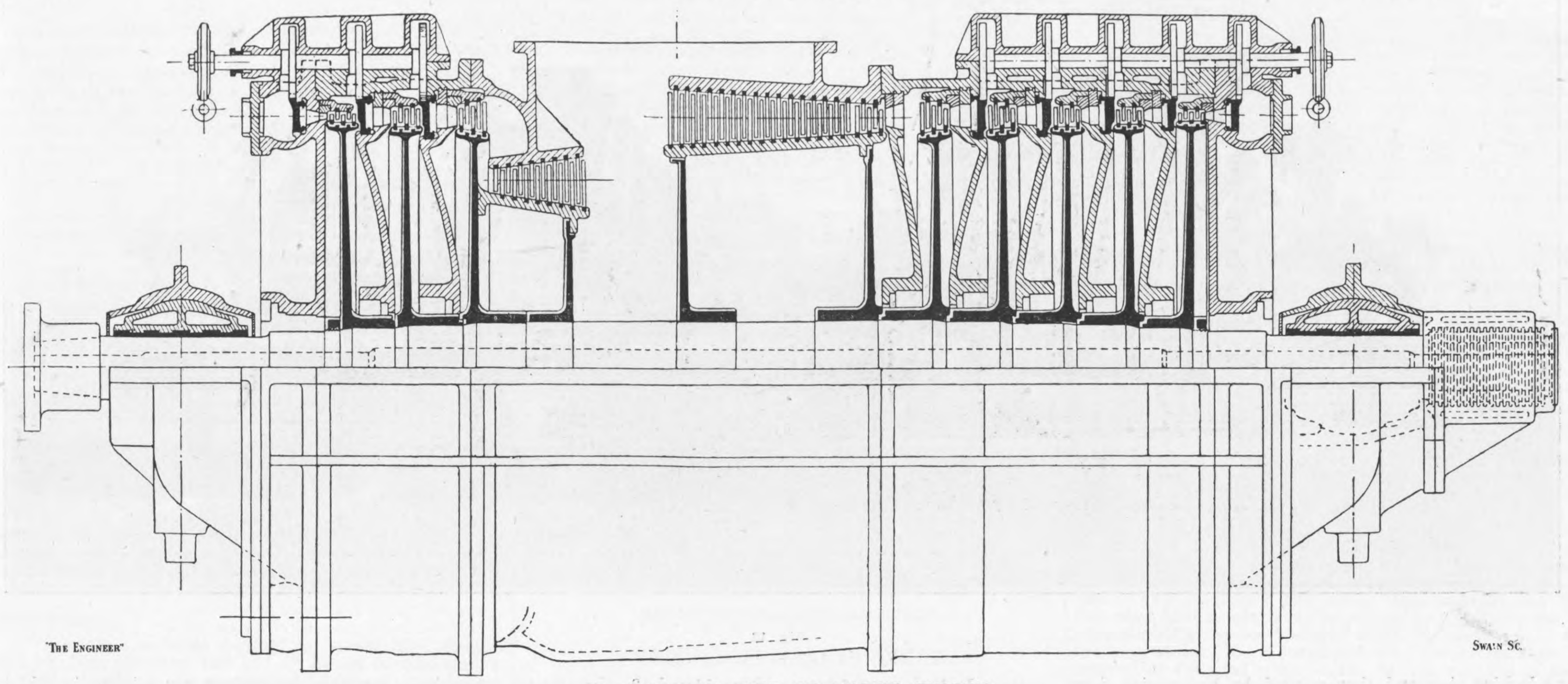
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Fig. 8—LATEST TYPE OF MARINE TURBINE

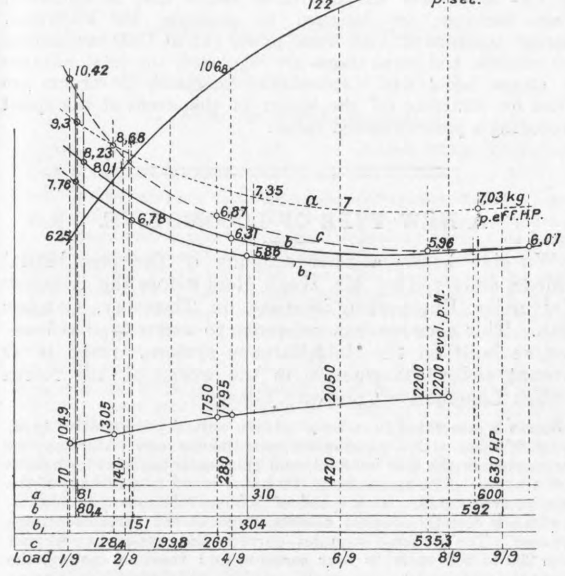

Fig. 9—RESULTS OF TESTS

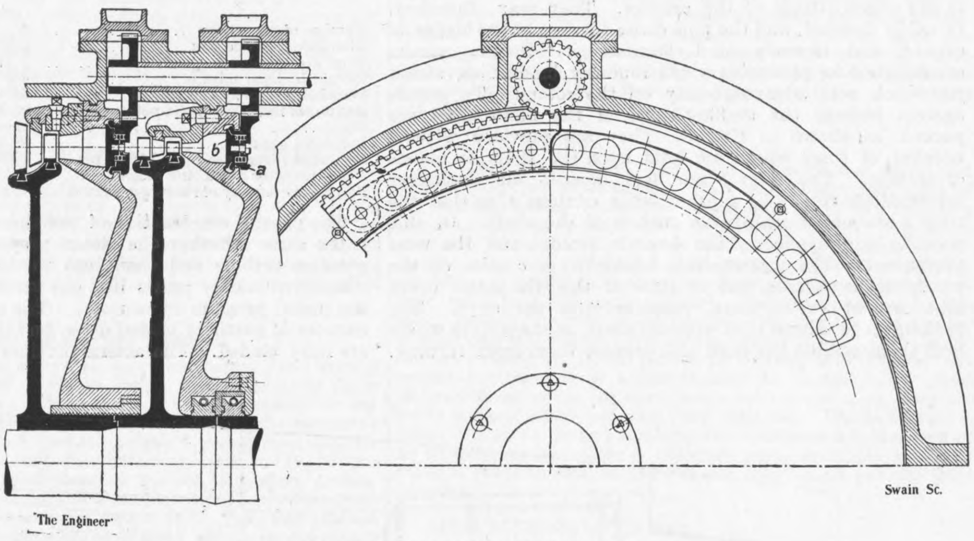
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Fig. 10—REGULATING DEVICE

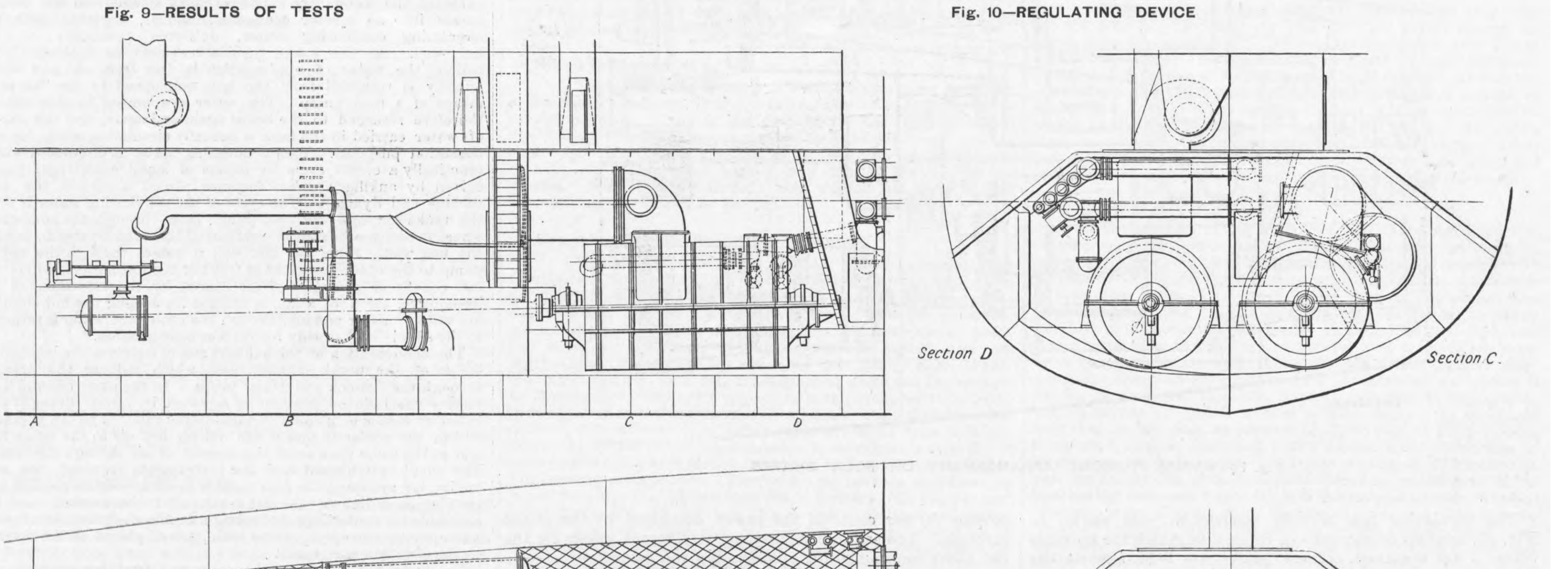
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Fig. 11—ARRANGEMENT FOR TWIN-SCREW VESSEL

110-H.P. STEAM TURBINE AND DYNAMO

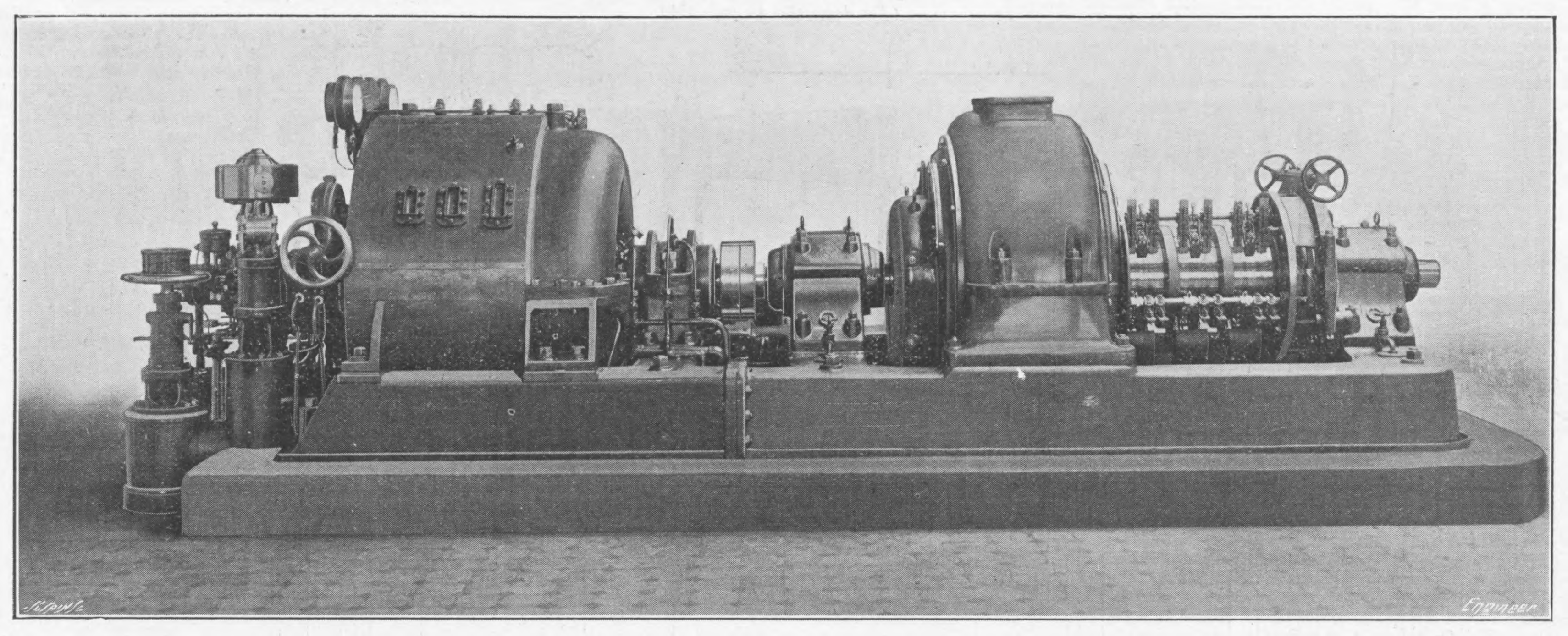


Fig. 12

in as a locking piece and then secured by hammering down the projections Y^1 of the parts Y on to and over the parts X, so that while the parts X lock the parts Y in the first place, the parts X are in turn locked by the projection Y^1. According to this method of attaching the blades in annular grooves, the feet of the blades need not be closely fitted beforehand to the undercuttings of the grooves. They may, therefore, be easily inserted, and the pins cause the feet of the blades to expand and securely bind themselves. Steam nozzles are designed for producing a continuously broadening steam jet which acts advantageously on the rotors. To ensure against leakage the stuffing-boxes of the main shaft are packed, as shown in Fig. 5. They are provided with a number of rings which are held upon the shaft by means of springs. The rings *b* are held against the stationary intermediate rings *c* by another series of rings *a*, so that the rings *b* are just touching the surface of the shaft. In this way the binding effect of the rings is avoided and the wear minimised. The intermediate bronze rings *c* take up the weight of the packing, but in spite of this the latter could take care of any unusual pressure upon the shaft. The packing rings cannot turn with the shaft, as the springs which hold them against the shaft also prevent them from turning.

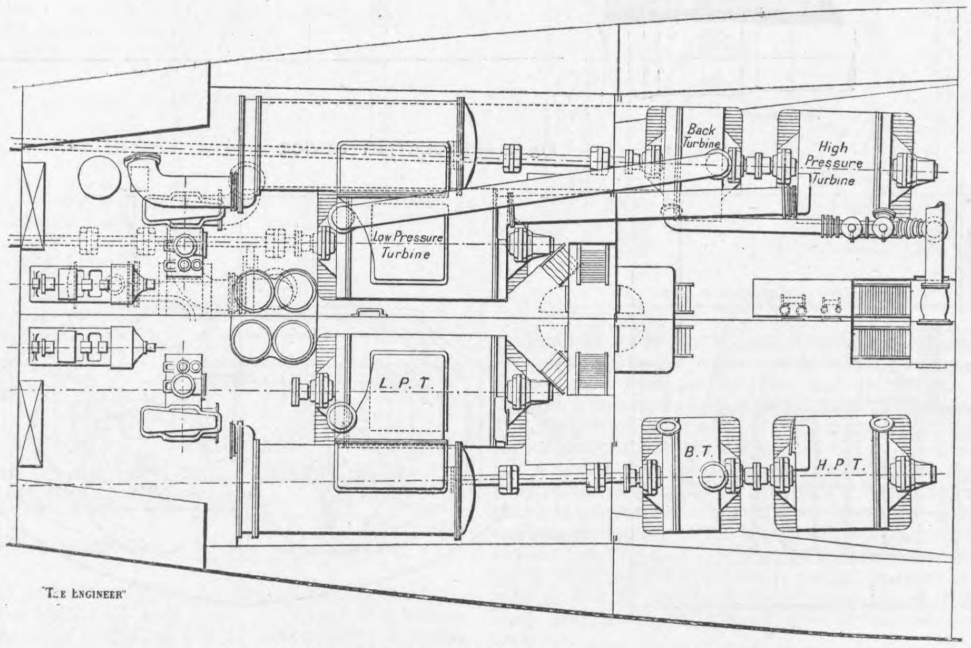


Fig. 13—MARINE TURBINE ARRANGEMENT ON FOUR SHAFTS

The regulating gear already referred to, and shown in Fig. 10, consists of segments of rings *a*, in which the movable plates *b* are mounted. These plates are held against the nozzle openings, and the plates are held in place by projecting ledges, as shown in Fig. 6. These controlling rings or valves may be actuated by a spur wheel arranged as shown in Fig. 10 or as in Fig. 6. A scale is provided to indicate the position of the slides. In order to press the packing ring *b* on the seats, springs are employed, as indicated in Fig. 6. As is customary with other marine installations, the power may be distributed over two or four propeller shafts. Fig. 7 shows the arrangement of a plant for a battleship of 50,000 horse-power, the maximum speed being 25 knots. The speed of the propellers is 230 revolutions per minute. Another arrangement where the power is distributed over four shafts is shown in Fig. 13. The arrangement is practically self-explanatory. It will be seen that two of the astern turbines are built in separate casings, whilst the other two are built within the low-pressure turbine. This is a 22,000 horse-power installation designed to distribute the power over four shafts.

A twin-screw arrangement for a 22,000 horse-power vessel is shown in Fig. 11. The turbines are similar to that shown in Fig. 8, with the astern turbines built in the same casing; there are, however, more stages than in the turbine shown in Fig. 8. This arrangement occupies a minimum amount of space. In both arrangements—Figs. 11 and 13—the amount of space available for the plant is the same. The management of both arrangements is said to be very simple, the astern turbines responding remarkably well to a change from full speed ahead to full speed astern. Detailed specifications for these two installations are given below :—

	Fig. 13.	Fig. 11.
Number of propellers	4	2
Diameter of propellers	2380 mm.	3370 mm.
Total area of blades ÷ discs	1.17	1.175
Revolutions per minute	430	313
Peripheral velocity per second	54 m.	55 m.
Maximum indicated horse-power	22,000	22,000
Slip	22 per cent.	22 per cent.
Indicated thrust	99,800 kg.	99,800 kg.
Indicated thrust per 9 cm. blade area	1.035 kg.	1.03 kg.
Mean diameter of turbine rotors	2000 mm.	2700 mm.
Peripheral velocity of rotors per second	45 m.	44.2 m.

The general construction of the ahead and astern turbines is the same whether the steam passes first into the high-pressure turbine and then into the low-pressure turbine, or whether it simply passes into one turbine and expands from the initial pressure to vacuum. The steam first acts upon a number of partially bladed discs, and then upon others which are fully bladed. The astern turbines are generally able to develop 80 per cent. of the power developed by the ahead turbines. The steam consumption at different speeds for the two above-mentioned installations is given below :—

Speed	17 kts.	25 kts.	26.5 kts.
Steam pressure	15 to 16 atmospheres		
Superheat	40 deg. Cent.	0	0
Back pressure	.06 to 09 kg.		
Effective horse-power	4200	13,000	22,000
Steam consumption per effective horse-power hour	7.1 kg.	6	6.1
	kg.	kg.	kg.
Steam per hour	29,820	108,000	134,200
Steam for auxiliaries	4300	10,300	10,800
Total steam	34,120	118,300	145,000
Coal (9-fold evaporation)	3800	13,140	16,210
Coal per effective horse-power	.9	.752	.736

Of the two arrangements shown in Figs. 13 and 11, the latter is considered by far the best, as there are only two separate turbines, as compared with six in the former arrangement.

The Schulz turbine as constructed for dynamo driving naturally differs somewhat to the marine turbine owing to the higher speeds at which turbo-driven electric generators can be run. It consists of an impulse turbine having several stages, all of which are in one casing, as is generally the case with other types. An illustration of a small set of about 110 horse-power, and running at a speed of 3400 revolutions per minute, is shown in Fig. 12. Turbines of this class have been built for 2200 revolutions per minute, in which case there are four stages per 500 horse-power; also for 2000 revolutions per minute with five stages per 500 horse-power. In the latter case the first three stages may be regulated. These turbines are designed to generate 250 kilowatts. Larger turbines of 1400 horse-power run at 1500 revolutions per minute, and three stages are regulated, the total number of stages being five. Automatic emergency governors are fitted for shutting off the steam in the event of the speed exceeding a predetermined value.

A NEW TYPE OF LOCOMOTIVE.

We give below a brief account of the presidential address delivered by Mr. Hugh Reid before the Glasgow University Engineering Society on Thursday, October 28th. This account has reference to a new type of locomotive built on the Reid-Ramsey system, which is at present under construction in the works of the North British Locomotive Company, Glasgow.

Steam is generated in a boiler of the ordinary locomotive type, which is fitted with a superheater, and the coal and water supplies are carried in the side bunkers, and side water tanks at both sides of the boiler. The steam from the boiler is led to a turbine of the impulse type running at a speed of 3000 revolutions per minute, to which is directly coupled a continuous-current variable voltage dynamo. The dynamo supplies current and pressures varying from 200 to 600 volts to four series-wound traction motors, the armatures of which are built on the four main or driving axles of the locomotive. The exhaust steam from the turbine passes into an ejector condenser, and is, together with the circulating condensing water, delivered eventually to the hot well. As the steam turbine requires no internal lubrication, the water of condensation is free from oil, and consequently is returned from the hot well direct to the boiler by means of a feed pump. The water evaporated by the boiler is therefore returned to the boiler again and again, and the supply of water carried in the tank is actually circulating water for condensation purposes. This condensing water is circulated within practically a closed cycle by means of small centrifugal pumps driven by auxiliary steam turbines placed alongside the main turbine and dynamo. The cycle of the condensing water is from the tanks through the first pump, then through the condenser, where it becomes heated in condensing the exhaust steam, then to the hot well. From the hot well it passes through the second pump to the cooler, situated in front of the locomotive, where the full benefit of the blast of air caused by the movement of the locomotive, aided by a fan, is utilised for cooling the hot circulating water. After passing through the cooler the water is returned to the supply tanks ready for further condensation.

The condensation of the exhaust steam deprives the locomotive boiler of the usual exhaust blast which induces the draught through the fire-box and boiler tubes. In the experimental locomotive the induced draught is replaced by forced draught provided by means of a small turbine-driven fan. The fan is placed within the cooler so that it will deliver hot air to the boiler fire, and at the same time assist the current of air through the cooler. The small switchboard and the instruments required, the controller for grouping the four motors in series—series-parallel and parallel, according to the draw-bar pull to be exerted—and the regulator for controlling the voltage in the electrical circuit, and consequently the speed of the train, are all placed on the driver's platform within easy reach.

The foregoing comprises the main and auxiliary machinery of this experimental locomotive. The whole is mounted upon a strong underframe, which is carried upon two eight-wheeled compound bogies so constructed that they will easily negotiate curves. Each bogie carries two of the four driving motors already referred to. As the engine is intended for express passenger main line work, it is hoped to obtain comparisons from its actual working with the performances of the reciprocating steam locomotives, especially as regards the relative consumption of fuel and water, and also as to the efficiency of transforming the energy of steam into draw-bar or train pull, as well as the relative rapidity of acceleration under the old and new systems.

Most of the component parts of this steam turbine electric locomotive have already proved themselves effective and efficient in other applications, and the novelty lies in the combination of the different elements of which the locomotive is composed. The expected results in this case should not, therefore, be so problematical as in an invention where the novelty is in the details, and it is the question of the cost of the locomotive which most troubles the patentees or raises any doubt as to its free adoption. It is only when the attempt is made to substitute an electric for a steam locomotive that we realise at what a very moderate first cost the steam locomotive can now be produced in up-to-date establishments with modern machinery and scientific organisation in comparison with any arrangement involving the use of expensive electrical apparatus.

THE IRON, COAL, AND GENERAL TRADES OF BIRMINGHAM, WOLVERHAMPTON, AND OTHER DISTRICTS.

(*From our own Correspondent.*)

Break in Pig Iron Prices.

A FEATURE which has somewhat sensationally been termed a "break" in pig iron prices is beginning to make its appearance in the raw iron trade. Producers have held on for a long while now to what must be considered, bearing in mind the state of the other sections of the market, decidedly good rates. Some of them are well booked forward, and are still quoting the old figures, but others, not so well placed for work, are making concessions to induce more business, though apparently this does not amount as yet to more than about 6d. per ton upon medium qualities, and even this allowance cannot be expected to be long operative if coke continues as dear as at present. Consumers—as they generally do in quiet times—have been complaining very much just recently that pig iron is far too high, compared with the lean prices alone obtainable for manufactured iron. This attitude has evidently not been without its effects upon some of the pig iron sellers. Open market quotations may still, however, be given as: Cinder forge, 47s. to 48s.; part-mine, 50s. 6d. to 51s. 6d.; all-mine forge, 85s.; foundry, 90s.; cold-air, 115s.; Northampton, 49s. to 50s.; Derbyshire, 50s. to 51s.; North Staffordshire forge 51s. 6d. to 52s. 6d.; best, 58s. to 59s.

Manufactured Iron.

The best bar houses continue well placed for work, and the £8 basis price is maintained, but unmarked sorts are quiet at about £6 2s. 6d. Very little is doing in plain black sheets, doubles being quoted £7 2s. 6d. to £7 5s. There is a good demand from the Argentine and from British South Africa and Australia for galvanised corrugated sheets, but the Indian demand is below par. Makers quote £11 to £11 5s. f.o.b. Liverpool.

Steel Steady.

There is a moderate demand for semi-finished steel at £4 15s. for Bessemer sheet bars and £4 17s. 6d. for Siemens. A rather better inquiry is also experienced for manufactured sorts, mild steel engineering bars being quoted £6 7s. 6d. to £6 17s. 6d.; angles, £5 17s. 6d. to £6; girder plates, £6 to £6 2s. 6d.; and boiler plates, £7 5s.

NOTES FROM LANCASHIRE.

(*From our own Correspondent.*)

MANCHESTER, Thursday.

A Stagnant Market.

THERE seems to be a consensus of opinion that the market for pig iron is stagnant. The boom which was predicted a few months ago and supported by good American advices, and which caused a large amount of speculation, has spent itself. Within a comparatively short time also has come trouble in the cotton trade, which has of itself caused a sagging tendency. On the Iron Exchange on Tuesday the attendance was about an average one, but there were few inquiries and still fewer actual orders to give out There was very keen competition for business, and prices much under makers' rates were accepted by merchants. Scotch iron was 6d. to 1s. per ton lower in second hands, and although officially there was practically no change to record in English makes, there was a good deal of undercutting stated to be going on. Still there were sanguine individuals who predicted that the relapse was only of a temporary nature, and that not only was America buying both Cleveland, Scotch, and Cumberland iron, but the demand for Germany was also good. Certainly shipments continue on a fair scale, which will probably give some colour to the idea.

Finished Iron and Steel.

There was no new feature to note in this department. Steel and steel products remain steady.

Copper, Brass, Lead, and Tin.

Raw copper had an upward tendency, but manufactured was on the quiet side, with no change in quotations to note. Lead: Sheets steady. Tin: English ingots were a shade dearer.

Quotations.

Lincolnshire, No. 3 foundry, 56s.; Staffordshire, 54s.; Derbyshire, 55s.; Middlesbrough, open brands, 60s. 1d. to 60s. 4d. Scotch: Gartsherrie, 61s. 9d.; Glengarnock, 61s. 3d. to 61s. 6d.; Eglinton, 60s., delivered Manchester. West Coast hematite, 62s. to 62s. 6d.; East Coast ditto, 60s., both f.o.t. Delivered Heysham: Gartsherrie, 59s. 9d.; Glengarnock, 59s. 3d. to 59s. 6d.; Eglinton, 58s. Delivered Preston: Gartsherrie, 60s. 9d.; Glengarnock, 60s. 3d. to 60s. 6d.; Eglinton, 59s. Finished iron: Bars, £6 10s.; hoops, £7 12s. 6d.; sheets, £7 15s. to £8. Steel: Bars, £6 2s. 6d. to £6 5s.; hoops, Lancashire, £7 5s.; ditto, Staffordshire, £6 17s. 6d. to £7; sheets, £7 17s. 6d. to £8; boiler plates, £7 5s. to £7 7s. 6d.; plates for tank, girder, and bridge work, £6 5s. to £6 7s. 6d.; English billets, £4 12s. 6d. to £4 15s.; foreign ditto, £4 10s. to £4 15s.; cold-drawn steel, £9 10s. to £9 15s. Copper: Sheets, £70; best selected, £61; tough ingot, £61 per ton. Copper tubes, 8½d.; rolled brass, 6¼d.; brass wire, 6½d.; brass turning rods, 6½d. Sheet lead, £17 per ton. English tin ingots, £135 10s. per ton.

The Lancashire Coal Trade.

There was a very quiet feeling on the Coal Exchange, and steam and manufacturing coal generally was dull. House coal had been in better demand owing to the cold spell, but its disappearance apparently does away with any hope of an advance in this department. Demand on shipping account was fairly good.

BARROW-IN-FURNESS, Thursday.

Hematites.

There is still a very quiet tone in the hematite iron trade, and the volume of business doing is not so satisfactory as of late. It is obvious, however, that the depression now experienced will only be transient, as there is abundant evidence that ere long the demand will assume larger proportions. This is having the tendency to make sellers firm, especially as they are for the most part well sold forward into the early months of next year. There has been some angling of late for prices of delivery next year, and makers are treating for these with some firmness, as they have the knowledge that in all probability higher values will soon rule. Quotations this week rule at 62s. for mixed Bessemer numbers, net f.o.b., with 63s. and 64s. three months. Warrant iron sellers are at 61s. 6d. net cash, and buyers at 61s. 3d. Stocks of iron have been increased during the week by 495 tons, and now stand at 16,341 tons. Makers are holding only a comparatively small bulk of metal. Two additional blast furnaces have been started this week, which seems to indicate that trade is improving from a maker's point of view. Several other furnaces throughout the district are ready to be put on blast at an early date so soon as there are indications of anything like a permanency in an improved demand for metal. Satisfactory reports are to hand of the trade in special hematite, ferro-manganese, spiegeliesen, and charcoal iron, and there is expected to be an improvement in all these branches. The demand for iron ore is better, on account of the increased consumption of the extra furnaces in blast. Prices remain as last quoted, ranging from 12s. to 18s. for ordinary and best sorts. Some large cargoes of hematite and manganiferous ores have lately been imported from foreign sources for reduction in the district, and there has been one cargo of brown hematite from Ireland. It is expected that a much better trade will be done locally in hematite iron ore, as not only is it largely consumed in the district, but many cargoes are shipped every week to coastwise ports.

Steel.

There is a steady trade in railway material, and the demand has lately been adequate to keep all the mills going steadily, but the report is now that difficulty is experienced in booking orders to maintain regularity of output, although the mills sometimes go on to tin-plate bars, shoe plates and other classes. Prices are steady at £5 5s. per ton net f.o.b. The trade in shipbuilding material is quiet, and orders arising at Barrow have for some time past been sent mainly to South Wales. Plates are at £6 per ton net cash.

Shipbuilding and Engineering.

Vickers, Son and Maxim booked an order from the Admiralty the other day for one of the City class of cruiser scouts, and on Saturday the firm launched one of the same type of craft, H.M.S. Liverpool. Other important work is being tendered for. Engineers are busy.

Shipping and Coal.

The exports of iron and steel from West Coast ports last week amounted to 10,533 tons, against 12,219 tons in the corresponding period of last year, a decrease of 1686 tons. The aggregate shipments this year have reached 514,551 tons, against 409,058 tons in the corresponding period of last year, an increase of 105,493 tons. Coal and coke are steadier.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

Steam Coal—Exports Diminishing.

THOUGH the Baltic trade may now be considered to be closed for the upper ports, shipments are being made for the lower reaches up to Riga. This port keeps open much longer than the more easterly, and fair shipments are still going there. This helps to keep up the price of steam coal, which is generally easier, as has been previously noted, at this time of the year. The rate ruling for steam coal for shipment is 8s. 6d. per ton. No contracts have yet been made for next year's requirements, both buyers and sellers awaiting developments. The expectation is that higher prices will rule for contracts in 1910; buyers appear reluctant to face the terms at present offered for next year by coalowners. The shortage of coal, to which we referred some time ago, dates from the 1st of July, and is now helping coalowners who are in arrears with manufacturers' requirements over that period. The official return of coal exports from Hull for the week ending 26th October last shows a weight of 50,467 tons, as compared with 64,710 tons for the corresponding week of last year. The principal market was Fiume, with 5789 tons, Rotterdam being close up with 5672 tons, and Riga third with 4940 tons.

House and Gas Coal, &c.—Active Business.

Household fuel is now in very good request, and several collieries are pressed for deliveries, owing to the increased needs of the advancing season. There seems to be no necessity for any official declaration of an advance, buyers accepting the change as a matter of course. Best Barnsley is now fetching from 12s. 6d. to 14s. per ton; secondary descriptions, 10s. 6d to 11s. 6d. per ton. There is not so much demand for the secondary grades. Deliveries under the new contracts for gas coal are now being extensively made, as is usual at this season of the year, and pits are generally working good time. The railway companies are taking very full quantities of coal, and several of them in arrear are urgent in their requirements.

Small Coal and Coke.

The market for slacks is well maintained, more especially in the better qualities, which are in firm request at from 4s. 6d. to 5s. 6d. per ton. There is less demand for the lower qualities. The inquiry for coke keeps strong, the district ovens making close upon their maximum outputs. Current quotations are 12s. 6d. per ton for best washed, and 11s. to 11s. 6d. for unwashed. For forward contracts, best washed has risen 6d. per ton, making the price 13s. per ton.

The Iron Market—Hematites Stiffening.

Hematites are somewhat stiffer. This, however, is more speculative than actual, the iron being sold going into stock. Shipping is normal; the consumption, though showing some improvement, is not up to production. Official quotations remain much the same, and sellers are not desirous of pressing sales, in the hope of higher values ruling later on. West Coast hematites, 68s. to 70s. per ton; East Coast, 65s. to 67s. per ton, both net, delivered in Sheffield and Rotherham. In Lincolnshire iron buyers appear to have purchased more freely than required in the anticipation of a brisker trade than has been realised, and deliveries now being made are more than sufficient for the specifications coming forward. A considerable quantity of basic iron is being sent into Scotland, as well as to South Wales. The current quotations for Lincolnshire pig iron are as follows:—No. 3 foundry, 52s. 6d. per ton; No. 4 foundry, 51s. 6d. per ton; No. 4 forge, 51s. 6d. per ton; No. 5 forge, mottled and white, 51s. 6d. per ton; basic, 52s. 6d. per ton—all net, delivered in Sheffield and Rotherham. For business during the first six months of next year a premium of 1s. 6d. to 2s. per ton is required on the foregoing quotations. The Derbyshire prices are unchanged, but still firm, Derbyshire No. 3 foundry making 52s. per ton, and No. 4 forge 50s. 6d. per ton, both net, delivered in Sheffield and Rotherham.

Bars, Hoops, and Sheets.

Bar and finished iron continue very depressed, and no improvement can be looked for until the home market begins to show signs of renewed activity. No indication of the much-needed change is as yet perceptible. Quotations: Bars, £6 10s. per ton; hoops, £7 10s. per ton; sheets, £8 10s. per ton. We do not find in any quarter expectation of material improvement this year.

Marine, Military, and Railway Material.

The various works engaged in these important departments of the heavy industries continue fairly occupied. Orders for marine forgings are, however, except in special cases, not very plentiful, not much new shipping for the mercantile marine being placed. A few orders are reported as having been received for military material in the way of gun forgings and shell, mostly to replace diminished stock. Railway material, on the other hand, still continues very flat in demand, and fresh orders, either for home or abroad, are scarce. Employment, therefore, is but indifferently afforded in this department. The high grades of steel are still fairly ordered, both for home and American markets.

NORTH OF ENGLAND.

(*From our own Correspondent.*)

Cleveland Pig Iron.

BUSINESS is somewhat slow this week in the Cleveland pig iron market, and makers are holding off from buying; but as producers are in a good position, and are not forced to sell, there is no weakening in prices. The competition of second hands has become less, for it being just at the beginning of the month they can wait before realising, as they have all the month in which to take delivery of the iron that falls due to them in November, and as there is some chance of their obtaining better prices for it it is apparently to their advantage to stick to the iron as long as possible. Quotations are very steady, not only for makers' iron, but also for warrants; indeed, it is a long time since there was so little change as has been noted during the past fortnight. Prospects are generally favourable, and almost every trader takes a sanguine view of the prospects for next year, whether America is a large buyer or not. The probability, however, is that Cleveland will do a good business with the United States in 1910, and already founders in the Eastern States are experiencing difficulty in getting from American producers all the pig iron they need, and this though the output in the States is now double what it was at one time last year—it is reported to be at the rate of thirty millions per annum, and practically nearly all the producing facilities in the country are being utilised. Attention here is more than ordinarily directed to the state of affairs in America, and there is good ground for expecting that much Cleveland iron will have to be shipped to Philadelphia and Baltimore next year, as was the case in 1907. Nearly all the iron that was sent then was used in the Eastern States. This week the inquiries from America for Cleveland pig iron have been very few, and no more orders are reported to have been booked. But the reports from the States are as encouraging as ever, and have a good influence on this market, as also have the large shipments of pig iron that are being made from the Tees - the best that have been shown for nearly two years. The quotation for No. 3 Cleveland G.M.B. pig iron for prompt f.o.b. delivery has been maintained for the last fortnight at 51s. 6d. per ton, while No. 1 has been at 54s.; No. 4 foundry at 50s.; No. 4 forge at 49s. 6d.; mottled at 49s.; and white at 48s. 6d. per ton, but 1s. per ton more is quoted for delivery over the first quarter of next year. Producers do not show much disposition to commit themselves to contracts for next year, as they believe that they will be able to realise a higher range of prices than consumers are at present prepared to give for forward delivery. Certainly everything points to more trade and better prices in 1910. Of the 114 blast furnaces built in the North of England 79 are now in operation, and of those which are out 15 are being rebuilt. The Tees Furnace Company has dismantled three furnaces and is building two larger furnaces on the site. The Linthorpe-Dinsdale Smelting Company has this week relighted a furnace at its Dinsdale Works, and has now three in operation out of four built.

Hematite Pig Iron.

The prospects are very good for makers of East Coast hematite pig iron, as all those who are users of this description of pig iron are finding trade more satisfactory, and will require a larger tonnage next year. Just at present, however, few orders are being given out, but that is not of much account, for producers' books are well filled for the next three months, and they can afford to wait. Like all other sellers, they are quoting more for forward than for prompt delivery. For mixed numbers for this year's delivery the price is 60s. per ton, while for the first quarter of next year it is 62s. 6d.; and for the second quarter, 65s. Rubio ore is nominally at 17s. 6d. per ton for delivery over this and next month, but there is no actual business to fix the value. Most sellers will not quote for next year's delivery, as they have not made up their minds yet what they shall ask. Where a price is asked it is much beyond anything the consumers will give, and so no business results. Coke is rising in price, as supply is hardly equal to requirements, and for furnace coke 17s. 3d. per ton must be given.

Stock of Cleveland Pig Iron.

Messrs. Connal report that on October 31st they held 335,485 tons of Cleveland pig iron in their public stores, an increase for the month of 21,510 tons, as compared with 25,473 tons in September. In July last year they held under 48,000 tons; at the end of October, 1908, no more than 88,501 tons, and at the close of the year 136,314 tons. Thus during the ten months of the current year there has been an increase of close upon 200,000 tons. At the end of October the quantity of No. 3 in the public store was 309,010 tons (increase for month 17,204 tons), of other iron deliverable as standard 23,565 tons (increase 4481 tons), and of iron undeliverable as standard 2910 tons (decrease 175 tons).

Shipments of Pig Iron.

The exports of pig iron from the Cleveland district in October were very good—brisker, indeed, than they have been in any month since February, 1908, and they contrasted strongly with the September shipments, which were very disappointing. As a matter of fact, they were 31 per cent. better than in September, the total being 126,904 tons, a quantity only exceeded in three Octobers in the history of the trade—in 1899, 1906, and 1907, and it was better than the average of October over the past ten years by 16 per cent., that average being 109,853 tons. October shipments are nearly always good because the northern navigation is nearing its close, and those who have to send iron to the ports in the Baltic are compelled to ship without delay. As compared with October last year, an increase of 23,935 tons, or 23½ per cent., is reported, but, as compared with October, 1907, a decrease of 14 per cent. has to be noted. The good shipments of October this year are chiefly due to the American demands, no less than 28,799 tons having been sent to the United States and Canada, whereas 9050 tons were dispatched in September and only 1650 tons in October last year. The deliveries to North America have been much larger this year than last, for they have reached 91,769 tons, against 25,596 tons in the first ten months of 1908. Prospects are good for further increases. German consumers have wanted comparatively little. Over 60,000 tons have been sent in a month from the Tees to German ports, but last month only 14,910 tons were dispatched, against 21,513 tons in October last year. The exports to Italy are again increasing, 10,851 tons having been sent last month. Heavier deliveries have been made to France, Belgium, Japan, and Norway and Sweden. Trade with Wales is being extended.

Manufactured Iron and Steel.

Trade continues to improve in most branches of the finished iron and steel trades, and works are employed more fully than for the last two years, but it cannot be reported that quotations have been advanced within the last few weeks. But the tendency is upwards in most branches. The better trade is reflected in the larger shipments from the Tees, for 53,053 tons of finished iron and steel (chiefly rails, galvanised sheets, joists, and hoops) were exported in October, 1909, against 35,487 tons in October, 1908; and the ten months' return was 531,833 tons this year against 482,226 tons last year.

Shipbuilding.

Improvement is reported every week now in the shipbuilding industry, and fresh orders are reported at a very satisfactory rate, especially on the Tyne, while increased prices are secured for new vessels. The order for one of the new-protected cruisers of the "City" class for the British Admiralty has been secured by Sir W. G. Armstrong, Whitworth and Co., Elswick, who have already the Newcastle in hand. At West Hartlepool Messrs. Wm. Gray and Co. have got an order for three large steamers from Messrs. F. C. Strick and Co., of London, and Messrs. William Milburn and Co., of Newcastle and London, have ordered an 8000-ton steamer from Messrs. R. and W. Hawthorn, Leslie and Co.

Coal and Coke.

It must be reported that the condition of the coal trade is disappointing at present, and, indeed, it must be described as depressed, so far as the steam coal branch is concerned. The unsatisfactory state of business may be judged by the fact that, whereas a few months ago over 13s. per ton f.o.b. was paid for best steam coal, it can be bought readily now at 10s., and it has fallen 1s. during the last month. Very seldom is steam coal obtainable at prices below those paid for gas coal, but now the latter are the dearer by fully 9d. per ton. The bad weather at sea has delayed the arrivals of steamers, and the coal that was raised to be shipped in them has had to be thrown on the market and sold at whatever price could be got. There has thus been during the past few days a large tonnage of cheap prompt coal. German competition is keenly felt, and an instance is in the Paris, Lyons and Mediterranean contract for coking coal. Hitherto it has always come to the Durham coalfield, and last year 170,000 tons were taken from this district, but this year only 70,000 tons have been allotted to Durham, and 96,000 tons to Germany. The coke trade shows a marked contrast to the coal trade; the demand is increasing, and supply is hardly equal to it. The price of furnace coke is up to 17s. 3d. per ton, delivered Middlesbrough.

NOTES FROM SCOTLAND.

(*From our own Correspondent.*)

General Business Outlook.

THERE is a quieter feeling in the speculative markets, operators having been induced to close accounts owing to dearer money and disappointment at the slowness of trade development. A great deal of capital is going into new limited liability companies, most of them having their property and interests abroad. This is, of course, a proceeding that has been usual on the part of investors, in the absence of openings for such enterprise at home, and therefore occasions no surprise. Notice is being taken, however, in commercial circles of the extraordinary extent to which rubber interests have developed during the present year. The capital being put into rubber and roller-skating companies is so great and their development so rapid and abnormal, that it is beginning to be felt that these speculations, especially the former, are being overdone, and that there is real risk of large amounts of money being lost to shareholders.

The Pig Iron Market.

The pig iron warrant market has been comparatively quiet this week. On some days hardly any business has been done. It is notable, however, that the market has so far received considerable support, else prices must have had a weaker tendency. Business has been done since last report in Cleveland warrants at 51s. to 51s. 6d. cash, 51s. 6d. to 51s. 10½d. one month. and 52s. 1d. to 52s. 6½d. three months. Transactions are also officially noted at 51s. 7d. for delivery in twelve days, and 51s. 8d. twenty-four days. The public is now giving comparatively little attention to pig iron warrants.

Scotch Makers' Iron.

The output of pig iron is being well maintained, the larger proportion of it being hematite. There are eighty-two furnaces in operation in Scotland, compared with seventy-seven at this time last year. An examination of the ironmasters' books by the official accountant shows that the prices obtained for pig iron in the last three months entitles blast furnacemen to an advance of 2½ per cent. in their wages – an extra rate which will continue to be paid during the next three months, according to agreement. The market for makers' iron is, if anything, somewhat easier this week, and although at the time of writing prices are maintained in the case of special brands, there is a little more disposition to meet the ideas of buyers. G.M.B. is 6d. per ton lower than a week ago. At Glasgow, Monkland is quoted f.a.s., No. 1, 58s.; No. 3, 56s.; Carnbroe, No. 1, 60s.; No. 3, 57s.; Clyde, No. 1, 62s. 6d.; No. 3, 57s. 6d.; Gartsherrie and Calder, Nos. 1, 63s.; Nos. 3, 58s.; Langloan and Summerlee, Nos. 1, 65s.; Nos. 3, 60s; Coltness, No. 1, 90s.; No. 3, 59s. 6d.; Eglinton, at Ardrossan or Troon, No. 1, 58s.; No. 3, 56s.; Glengarnock, at Ardrossan, No. 1, 65s.; No. 3, 60s.; Dalmellington, at Ayr, No. 1, 62s.; No. 3, 57s.; Shotts, at Glasgow or Leith, No. 1, 63s.; No. 3, 58s; Carron, at Grangemouth, No. 1, 65s. 6d.; No. 3, 59s. 6d. per ton. Stocks of pig iron are understood to be accumulating to a greater extent at the works than for some time past. There has been comparatively little disposition on the part of merchants to enter into contracts for the future delivery of pig iron. Several export contracts of this description have, indeed, been lately arranged, but they are not of great extent. There is a lack of home orders at the moment, and the tone altogether is quiet.

The Hematite Trade.

The market for hematite has continued dull, with practically no transactions in warrants, and, so far as can be ascertained, comparatively few in makers' iron. While current demand is dull, there is a disposition on the part of makers to avoid future business except at prices considerably above those now current. There has been some apprehension that hematite ore might advance in value owing to the reports of the increased supplies likely to be wanted for America. Imports of ore in the last few weeks have not been quite so large. Eleven cargoes reached the Clyde in the course of the last few days. In an earlier part of the year the imports have not infrequently amounted to about twenty cargoes a week. Merchants quote Scotch hematite pig iron 63s. 6d. per ton for delivery at the West of Scotland steel works.

Pig Iron Shipments.

The shipments of pig iron from Scottish ports in the past week were 8398 tons, being 5246 tons more than in the corresponding week of last year. The total shipments for the past ten months amount to 237,614 tons, being 11,918 tons less than in the same period of 1908. The arrivals at Grangemouth of pig iron from Cleveland and district are for the week 7155 tons, a decrease of 3410, and for the ten months 384,999, showing a decrease of 6820 tons.

The Demurrage Question.

It is now about twelve months since the Scottish railway companies raised the question of demurrage charges for the detention of railway wagons beyond a certain time judged sufficient for their discharge. Rates were fixed by the companies, and these were nominally put in force from the beginning of the present year, the institution and conduct of the system entailing much extra work and expense on the part of the railway management. The charges were from the first repudiated by the traders, who have steadily ignored them. Many conferences have been held on the subject without result, and while the railway companies desire a settlement of the matter through the Board of Trade, the traders prefer to have the matter determined by the Railway Commissioners. A serious complication has now been introduced by the railways declining to allow new wagons belonging to the traders to be placed upon their system. This resolution has arrested the building of traders' plant for the time, and the matter threatens to lead to litigation between the traders and the railway companies.

The Clyde Shipbuilding Trade.

The amount of new work now received by the shipbuilders on the Clyde for the British Admiralty has tended greatly to improve the outlook in the shipbuilding industry, and will gradually reduce the numbers of men out of employment. A fair number of mercantile contracts have also been coming to hand.

Finished Iron and Steel.

The finished iron trade continues dull, with great scarcity of employment. Steelmakers report a rather better inquiry for shipbuilding material, while a good business is being done for miscellaneous goods, and especially thin sheets for export. Interest has been evoked in steel circles by the anticipation that the great Canadian bridge contract will be in the market without delay.

The Coal Trade.

The shipping demand for coal has been moderate, and the prices are easier. House coal is in better demand for home use, and sells at steady rates.

WALES AND ADJOINING COUNTIES.

(*From our own Correspondent.*)

Last Week's Coal Trade.

THE continuance of stormy weather, and delay of expected tonnage, had again a depressing influence on the coal market, but towards the end of the week things brightened, and there seemed a prospect of a change, probably, as some imagined, for bright autumnal weather, when house coal would harden, and delayed steamers get their cargoes and be cleared. Up to mid-week the tendency was to allow 3d. per ton off steam coal quotations, and coalowners rather feared that prices might slide down into the 16s. rut. This has not taken place so far, but sales have been effected at 16s. 9d. The close of the week brought a slight improvement, though discounted by the occurrence of the Darren explosion, and of minor events. Best households are showing signs of a slight advance.

Latest Quotations Cardiff.

Mid-week the market at Cardiff had a more hopeful aspect; tonnage had improved, and it was only where wagons were needed and stocks were in excess of requirements that buyers were able to get concessions. As an authority on 'Change remarked, the tone of business is getting steadier for all descriptions of large coal. Sellers of best bunker coals were asking as much as 9s. 3d. Latest quotations:—Best large steam, 16s. 9d. to 17s. 3d.; seconds, 15s. 6d. to 16s. 3d.; ordinaries, 14s. 6d. to 15s. 3d.; best drys, 16s. to 16s. 6d.; ordinary drys, 14s. to 14s. 3d.; best washed nuts, 14s. to 14s. 6d.; seconds, 13s. to 13s. 6d.; best washed peas, 12s. 6d. to 13s.; seconds, 11s. to 12s.; very best smalls, 8s. 9d. to 9s. 3d.; best ordinaries, 6s. 9d. to 7s. 6d.; inferior kinds, 6s. to 6s. 6d.; very best Monmouthshire black vein, 15s. to 15s. 6d.; ordinary Western Valleys, 14s. 3d. to 14s. 6d.; best Eastern Valleys, 13s. 3d. to 13s. 6d.; seconds, 12s. 6d. to 13s. Bituminous coal: Very best households, 17s. to 18s.; best ordinaries, 15s. to 16s.; No. 3 Rhondda, 17s. 3d. to 17s. 6d.; brush, 13s. 6d. to 13s. 9d.; smalls, 10s. to 10s. 6d.; No. 2 Rhondda, 12s. to 12s. 6d.; through, 9s. 6d. to 10s.; smalls, 6s. 9d. to 7s. 3d. Patent fuel, 15s. to 15s. 6d. Pitwood, 19s. to 19s. 6d. Coke: Special foundry, 24s. to 27s. 6d.; foundry, 19s. to 21s.; furnace, 17s. 3d. to 18s.

Newport Coal.

The weakness of the coal trade last week was marked, and the disasters which occurred, in a district which had enjoyed long immunity from explosions since Risca and Abercarne, did not lessen coalowners' troubles. The shipments totalled about 49,000 tons foreign and 15,000 tons coastwise; values generally 3d. less to clear wagons. Pit stoppages numerous still; future deliveries, prices firm Latest:—Very best Newport black vein, 14s. 9d. to 15s. 3d.; Western Valleys, 13s. 9d. to 14s. 3d.; Eastern Valleys, 13s. to 13s. 3d.; other kinds, 12s. 3d. to 12s. 6d.; best smalls, 6s. 9d. to 7s. 3d.; seconds, 6s. 3d. to 6s. 6d.; inferiors, 5s. 9d. to 6s. 3d. Bituminous: Best house coal, 15s. to 15s. 6d.; seconds, 14s. to 14s. 6d. Patent fuel, 15s. to 15s. 3d. Coke: Foundry, 18s. 6d. to 19s.; furnace, 17s. to 17s. 6d. Pitwood, 19s. 3d. to 19s. 6d.

Swansea Coal.

The port suffered like all the Bristol Channel ports from the severe storms, and it was the subject of remark and surprise that disasters had not been more numerous and more severe in character. The trade of the port showed a great falling off, the revenue of the port indicating a difference of 30,000 tons. Latest:—The anthracite coal market this week showed no marked alteration. Swansea, large, steady; red vein, large, improved; nuts and cobbles, in demand; rubbly culm, still advancing; duff, very weak. Best anthracite, 24s. to 25s. net; second malting, large, 21s. 6d. to 22s. 6d. net; big vein, 18s. to 20s., less 2½; red vein, 12s. 6d. to 13s. 6d., less 2½; machine-made cobbles, 23s. 6d. to 24s. 6d. net; Paris nuts, 26s. to 27s. net; French nuts, 26s. to 27s. net; German nuts, 26s. to 27s. net; beans, 17s. 6d. to 18s. 6d. net; machine-made large peas, 11s. to 12s. 6d. net; fine peas, 10s. 6d. to 11s. net; rubbly culm, 5s. 3d. to 5s. 6d., less 2½; duff, 2s. 6d. to 3s. net. Steam coals: Best large, 17s. to 18s., less 2½; seconds, 14s. 6d. to 15s., less 2½; bunkers, 9s. 9d. to 10s. 6d., less 2½; smalls, 7s. 6d. to 9s. 6d., less 2½. Bituminous: No. 3 Rhondda, 18s. to 18s. 6d.; through, 14s. 9d. to 15s. 6d.; small, 10s. 6d. to 11s., all less 2½. Patent fuel, 13s. 6d. to 14s., all less 2½.

Iron and Steel.

Some relief to a stagnant kind of condition has been afforded by business in connection with India State Railways. On the 31st a quantity of rails—1835 tons—was sent from Cardiff to Kurachee, and later in the week 1400 tons general cargo and 200 tons steel sleepers left the same port for Bombay. The Dowlais works have been busier, but not to the extent hoped for. Fishplates, light colliery rails, and miscellaneous makes have been in fairly good quantities, but the usual railway orders have been delayed. Pig iron has come to Wales from Middlesbrough and Grimsby, and 1730 tons steel billets from Bruges. Bristol continues to keep a busy trade in iron with Newport. Mid-week Mordey Jones imported 1500 tons steel from Bruges to Newport, Mon. Steel and iron scrap is coming in freely; iron ore cargoes few; Swansea none, but quantities of pig iron. Latest prices: Rubio ore is down to 16s. 6d. to 17s. at Newport and Cardiff. At Swansea Metal Exchange the following quotations were given:—Pig iron: Hematite, mixed numbers, 61s. 1½d. cash and month; Middlesbrough, 51s. 4d. and 51s. 6d. month; Scotch, 57s. 4½d. cash and month; Welsh hematite, 66s. to 67s. 6d. delivered; East Coast hematite, 64s. to 65s. c.i.f. Steel bars: Siemens, £4 15s. per ton; Bessemer, £4 12s. 6d. Block tin, £138 10s. Other quotations: Copper, £57 12s. 6d. cash and £58 16s. 3d. three months; lead, English, £13 11s. 3d.; Spanish, £13 1s. 3d.; spelter, £23 3s. 9d.; silver, 23½d. per ounce. Middlesbrough is exporting to Wales steel joists, angles, and flats. Iron ore has come in to Guest and Co.

Tin-plate.

The Swansea Harbour Trust return last week was the following:—Received from works, 104,712 boxes; shipped during the week, 57,322 boxes; stocks remaining at docks and warehouses, 140,000 boxes. Briskness continues the prominent feature of the trade, and the settlement for two years between the employers and workmen is expected still further to improve its prosperous condition. Latest prices:—Ordinary tin-plates, I C., 20 × 14, 108 lb.; Bessemer primes, 12s. 4½d. to 12s. 6d. Siemens same, I.C. ternes, 28 × 20, 112 sheets, 22s. C.A. roofing sheets, £8 10s. to £8 15s. per ton. Big sheets for galvanising, £8 10s. Finished black plates, £8 10s. to £9 15s. per ton. Galvanised sheets, 24 g., £11 per ton.

Swansea Valley Industries.

Full time is being worked in the spelter factories. Six are now in regular operation, and in the nickel silver and copper establishments the same healthy condition obtains. The copper works are doing five days' work per week, and good accounts are to hand of the safety fuse factory, and the sulphuric acid work. Local foundries and engineering shops are all doing well.

Llanelly.

The market last week was rather quiet, but this was only regarded as temporary, as the principal works are well booked ahead. All mills busy, and Dafen and St. David's will soon be in healthy activity. Dumping is strong. Discussions *re* new de-tinning works are in evidence, and may lead to something.

AMERICAN NOTES.

(*From our own Correspondent.*)

PHILADELPHIA, October 27th.

THE extraordinary demand for coke has pushed prices upward to 3.25 dollars for foundry purposes, with a probability of its reaching 3.50 dollars. The entire coke-producing capacity of the country is now being strained to the utmost as far as the intention of the producer is concerned. The United States Steel Corporation estimates that 3 per cent. better returns could be had from their investment in the coke regions of Connellsville if the supply of drink could be regulated. There are 25,000 persons concerned, largely foreigners, and the corporation propose, by acting through the Pittsburg Brewing Company, of which they have gained control, to prevent the purchase of beer in kegs and barrels. The purpose is to increase the number of licensed drinking places so that all workmen can be supplied by the glass, but to stop the sale in bulk. It has been ascertained that for 72 hours after each pay day the coke ovens do not run at more than two-thirds of their capacity, and that there is scarcely a pay day when hundreds of tons of coke are not ruined by the inability to get men to care for it at that time. The corporation proposes to obtain possession of the nine breweries in the region, for which 10,000,000 dollars have been offered, and to keep all other beers out of the region. It has been shown that 75 per cent. of the crimes are committed within 48 hours after pay day. As a rule, a fair degree of temperance prevails in all iron and steel centres. This is an interesting movement, and if successfully carried out will do much to increase the output of coke and preserve the morality of the workmen. The steel industry is in a disturbed condition. The Steel Corporation are preparing to blow in two more of their blast furnaces. Prices have again advanced, and basic pig is quoted at 18.50 dollars. Bessemer has also moved up, and there is a hardening tendency in all mill products. Within a week 60,000 tons of Bessemer pig have been sold at 19 dollars at Pittsburg, and an advance to 20 dollars is threatened. This statement is hazarded on the fact that five large steel concerns will soon be obliged to come into the market for raw material. Within sixty days these companies have taken 150,000 tons out of the market. Just how or where they are to be accommodated does not at present appear. Additional furnace capacity is indicated. This necessity cannot be met under many months. It now looks as though a genuine pig iron scare is inevitable. Large orders are coming in from railroads for cars, engines, and track equipment. Finished material of all kinds has moved up within a week. Billets now command from 1 dollar to 2 dollars for early delivery. It might be mentioned incidentally that the general advance in prices in raw material has led to a shutting down of the cotton mills in North and South Carolina, throwing out 20,000 operatives.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

SIEMENS BROTHERS' DYNAMO WORKS, Limited, ask us to state that starting from the 1st inst. the address of their Supplies Department will be 39, Upper Thames-street, London, E.C. At this address they have opened a warehouse and showroom. From this date their office and stores in Abchurch-yard will be discontinued.

WE are asked by Simpson, Strickland and Co., Limited, of Dartmouth, to say that Mr. F. C. Simpson, who has taken no active part in the business of the firm for a number of years past, has now definitely retired, and that the vacancy on the Board of Directors has been filled by the appointment of the present works manager, Mr. J. E. Cooper.

BIRMINGHAM ASSOCIATION OF ENGINEERS.—The ordinary monthly meeting of the Association will be held at the Grand Hotel, Birmingham, to-morrow, Saturday, the 6th inst. The chair will be taken at 7 p.m. Paper, "Water Organisation with a view to Profit-making," by J. Batey. There will be an extra meeting on the 18th inst., when a paper on "Aerial Navigation," illustrated by lantern slides and models, will be read by Dr. A. R. Ratcliffe.

ASSOCIATION OF TEACHERS IN TECHNICAL INSTITUTIONS.—The annual meeting of this Association will be held to-morrow at St. Bride's Institute, Fleet-street, E.C. The chair will be taken at three p.m. by Mr. J. Wilson, who is to be president of the Association for the coming year. One of the principal items of business of this meeting will be the consideration of the annual report of the Council. This report will contain an abstract of the educational and professional work accomplished during the year.

CONTRACTS.—Cammell, Laird and Co., Limited, have just delivered from their Grimesthorpe Works, Sheffield, to Davy Brothers, Limited, of the same city, a steel press base casting, weighing 56½ tons, which is required for a 4500-ton forging press which the latter firm has on order for the Terni Steel Works, Italy. Cammell, Laird and Co., Limited, have also in course of manufacture a cast steel entablature for the same press, which will weigh approximately 51 tons.—Royce, Limited, have recently booked orders for two 45-ton overhead electric cranes for Canada, two 125-ton electric cranes for a Japanese dockyard, and twenty-three electric capstans for the Clyde Navigation Trustees, fourteen of the latter being of the Royce patented free barrel type.

RAILWAY DEVELOPMENT IN SOUTH YORKSHIRE.—The Rotherham, Maltby, and Laughton Railway, the construction of which was authorised in 1905, has been recently opened for goods traffic. The line, which is about twelve miles in length, begins at a point near Parkgate, where an existing branch railway belonging to the Dalton Main Collieries, Limited, was taken over by the company. Proceeding in an easterly direction, the railway extends to Braithwell, from thence in a south-easterly course to Auston, where it joins the Shireoaks and Laughton Railway. This junction gives access over the South Yorkshire joint line to the large and important colliery of Dinnington Main, and this has been one of the chief objectives of the line, as it must for the present depend primarily upon mineral traffic of the surrounding district.

NOTES FROM GERMANY, FRANCE, BELGIUM, &c.

(*From our own Correspondent.*)

The Silesian Iron Market.

A TENDENCY upwards has been noticed since the beginning of October. Orders come in more freely, and prices have shown an inclination to rise. Underquoting on the part of South and West German firms has been less keen, and consumers show their confidence in the future by placing more contracts. Many works are booked forward till far into the first quarter of 1910. A lively business is being done in girders, not merely on local, but also on foreign account. Light section rails are in good request; for heavy rails a fair number of orders were likewise received, and prospects for the spring are generally considered favourable in this department. At the pipe mills a brisk activity is going on, spring orders in gas and water pipes having, in a number of instances, been placed already, the terms of delivery are four to six weeks.

Rheinland-Westphalia.

In the various branches of the iron and steel industry advances in quotations have again taken place, and consumers have to agree to these, as the works decline to sell at the former low rates. The majority of the mills are well supplied with orders, and they will be regularly employed up to the end of December. Beyond this period few orders are placed, owing to the uncertainty as regards prices. For hoops and plates an advance of M. 5 p.t. has been resolved upon, and for wire nails a slight rise has already taken place. It is reported from Düsseldorf that the Steel Convention will maintain the present prices in the first quarter of 1910, Inland demand for sectional iron has improved during the present quarter. Existing orders on October 1st were 175,000 t. higher than on October 1st last year.

Siegerland Iron Ore.

At a meeting of producers which took place on the 28th of October, the position of the iron ore market was stated to be firm, and the outlook could be regarded as fairly good. Output of iron ore in August of this year was 148,689 t., as compared with 127,586 t. in August, 1908, and 126,137 t. in September, 1908. Shipments in August of this year have been 149,588 t., and in September 145,439 t., as compared with 103,351 t. and 107,396 t. in the two preceding years. The reduction in output has been 10 per cent. less for the last two quarters than previously.

List Rates.

The following are the latest list quotations as given from Düsseldorf on the 29th of October:—Siegerland white forge pig, M. 55 to M. 58; German Bessemer, M. 59 to M. 61; Luxemburg foundry pig No. 3, M. 49 to M. 51 p.t. free Luxemburg; German foundry pig No. 1, M 58 to M. 60; No. 3, M. 57 to M. 59; German hematite, M. 60 to M. 62; good merchant bars, common quality, M. 102 to M. 106; hoops, M. 125 to M. 130; steel plates, M. 106 to M. 112; boiler plates, M. 116 to M. 122; sheets, M. 120 to M. 125; iron wire rods, M. 127.50, all per ton free at works.

Coal in Germany.

Business on the Rhenish-Westphalian market shows more life. Coke is improving—at least, so far as the demand for house-fire purposes is concerned, blast furnace coke remaining slightly neglected. The Silesian pits are selling freely, both to consumers and dealers, and the tone of the market is firm, with a tendency upwards. The agreement between the Belgian Coke Syndicate and the Rhenish-Westphalian Coal Syndicate has been prolonged for three years more, dating from January 1st, 1910.

Austria-Hungary.

Iron and steel meet with regular though rather limited demand. The business done is not exactly an unremunerative one; still an improvement in prices is urgently desired in many branches. Coal and coke for house-fire and for gas-making purposes are readily bought, while in engine fuel a moderate trade only is done. Figures show the output in pit coal to have decreased 1,040,000 q. in September. During the last three quarters of this year the output in pit coal was only 103,450,000 q., which is 3,200,000 q. less than last year. In brown coal the decrease is more marked still, 9,100,000 q. less having been produced. Accordingly, the total decrease in the Austrian coal production is 12,300,000 q. for the first three quarters of this year as compared with last year.

Fair Accounts from France.

All the iron and steel producing districts, with the exception of the Loire department, report activity in the various trades to be improving; especially in the East departments a rise has been noticeable since the beginning of October. Producers do not care for contracts that reach far into the second quarter of 1910, because they are expecting a rise in quotations before long. Until now rates have been unremunerative and low, the improving tone being only noticeable in the general demand. Crude iron is very firm. In the Longwy district 27 blast furnaces out of 38 are in blow, in the Nancy district 38 out of 47, with a total production of 7270 t., against 6584 t. at the same period last year. Foreign sales in girders have improved. Steel castings are influenced by Belgian competition, which is very keen in this article. The wagon factories are well employed, and they have fair prospects. Confidence is returning in the coal trade, and stocks are decreasing.

Belgian Iron Trade.

Compared to the slow and rather disappointing business that was done in iron and steel during the greater part of the year, the present activity may be regarded as lively and satisfactory; a tendency upwards is shown in all the principal trades, particularly in bars, which were so long neglected. Some makers have been able to get £4 17s. p.t., but in many cases orders are taken at £4 12s. Export has improved, Rails are very stiff; in September 11,361 t. have been exported, against 5106 t. in the year before, but the total export during the first nine months of this year is only 75,883 t., as compared with 92,804 t. in the year before. Consumption in pig iron has considerably improved. During the first nine months a rise of 300,000 t., or 34 per cent., was reported in output, and import too shows an improvement, 350,096 t. having been imported during the period mentioned, as compared with 309,392 t. in 1908; 98,427 t. were imported from Luxemburg, against 28,812 t. in the year before. Supplies from France and Germany do not show any marked change. Quotations for pig iron are firm. Import in iron ore was 3,196,846 t., against only 2,510,267 t. in 1908, and 2,711,850 t. in 1907. This remarkable improvement chiefly falls to the French district Briey, import from that part having risen from 847,075 t. to 1,646,586 t. during the present year. Nothing of particular interest can be told concerning the Belgian coal market, firmness prevailing all round. Foreign trade in coal during the first nine months of this year was as follows:—Export, 3,803 615 t., against 3,470,382 t. in the previous year; import, 4,293,642 t., against 3,971,203 t. in the year before. Import from Germany was 2,450,207 t., against 2,105,3[illegible]0 t. in 1908. Export in coke was 748,464 t., import 225,006 t., while in 1908 670,262 t. were exported and 230,244 t. imported. Export in briquettes was 416,416 t., as compared with 346,099 t., while 105,319 t. were imported, against 141,073 t. in 1908.

INSTITUTION OF NAVAL ARCHITECTS.—The dates of the meetings of the Institution will fall on Wednesday, 16th March, 1910, and the two following days. A reading-room has been added to the Institution offices, and is now available for the use of members during office hours.

BRITISH PATENT SPECIFICATIONS.

When an invention is communicated from abroad the name and address of the Communicator is printed in italics.

When the abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent-office Sale Branch, 25, Southampton-buildings, Chancery-lane, London, W.C., at 8d. each.

The first date given is the date of application; the second date at the end of the abridgment is the date of the advertisement of the acceptance of the complete specification.

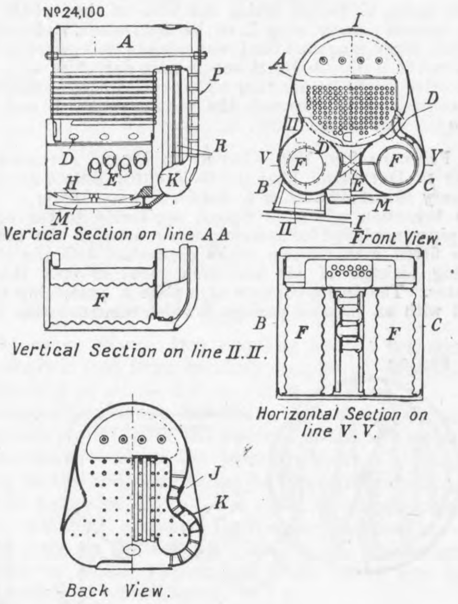
Any person may on any of the grounds mentioned in the Acts, within two months of the date given at the end of the abridgment, give notice at the Patent-office of opposition to the grant of a Patent.

STEAM GENERATORS.

24,100. November 10th, 1908.—IMPROVEMENTS IN STEAM BOILERS, *Carl Martinius Olsen, of Barkerod, near Sandefjord, Norway.*

This boiler consists of an upper large shell A which is integrally connected to two smaller lower shells B and C, and which communicates with the latter by means of apertures D formed in the boiler plate. The lower shells are connected to each other by means of obliquely disposed tubes E through which the water can circulate from one into the other. The lower shells are provided with flues F, either plain or corrugated, which are arranged excentrically so as to be more accessible from above and easier to clean. In these flues the fire-boxes are arranged. In addition to this internal firing, however, provisions are also made for external firing, in that, between the lower shells, a fire-bridge L and grate bars H are arranged. Underneath the grate H an easily withdrawable ashpan M is arranged, which, in the case of marine boilers, must be well insulated from the bottom of the ship. Behind the fire-bridge a water chamber K is arranged, which is formed on the rear wall P of the boiler, and this chamber is connected by means of a number of vertical water tubes R with the top of the boiler. The tubes R thus traverse the combustion chamber, the roof of which they, at the same time, support. The channels formed at the outer joints of the plates of the lower shells with the plate of the upper one, are converted into flues by means of insulated plates R placed tangentially to the respective shells. These flues communicate with the combustion chamber by means of openings K, whereby external heating of the sides of the boiler is effected. The flues J may also be adapted for the reception of superheaters.—*October 13th*, 1909.

Nº24,100

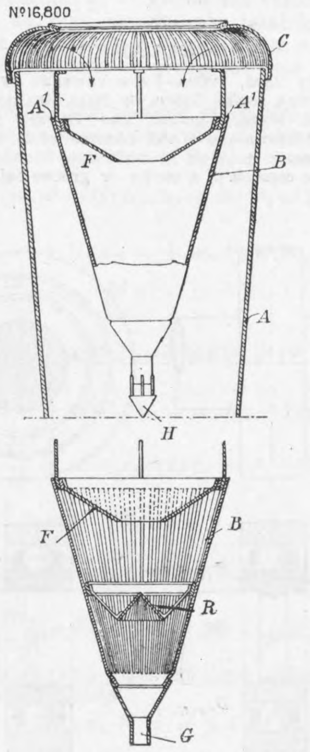


Vertical Section on line AA. Front View. Vertical Section on line II.II. Horizontal Section on line V.V. Back View.

16,800. July 19th, 1909.—IMPROVEMENTS IN SPARK ARRESTERS, *Fritz Hartmann, Engineer, of Albertstrasse, 28-29, Bromberg, Germany.*

This improved spark arrester comprises the chimney cap C and the fitting B. The latter is inserted and suitably attached in the chimney A and is so proportioned that the resulting cross sectional area of the annular passage A^1 is equal or approximately equal to the smallest cross sectional area of the inlet to the chimney, in order that the draught in the chimney may not be impaired. According to the constructional form shown in the upper engraving, the fitting B has inside it a downwardly directed, conical, annular deflector F by which the sparks after rebounding from the cap C are directed downwards in the desired direction. In order to prevent steam and sparks entering directly into the device, there is attached centrically with the spark outlet G and at a suitable distance therefrom a plate H which may be shaped optionally, *e.g.*, conically, semi-spherically, or the like. Both the peripheral and cross sectional shape of this plate may be optional, but it is necessary that a passage be provided for falling sparks between the plate and the outlet of the fitting B. Above the chimney is arranged a grate-like or sieve-like annular cap C which is of such shape that sparks impacting on it must rebound approximately along the path indicated by the arrows into the fitting B, whence they can fall through the outlet G towards the smoke-box. The constructional form, according to the lower engraving differs from that described above in that fitting B is also formed grate-like or sieve-like just as the cap C, and has within it at a certain distance from the outlet G a preferably roof-shaped or conical grate or deflector R for stopping any sparks carried upwardly and returning them to the outlet G.—*October 13th*, 1909.

Nº16,800

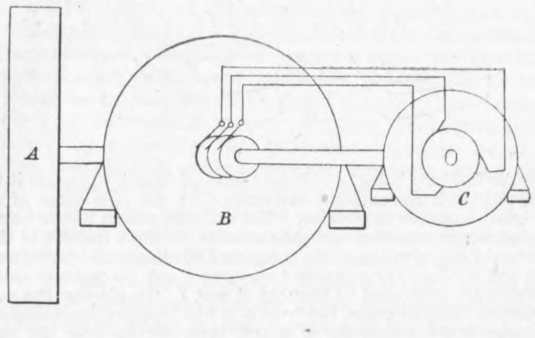


DYNAMOS AND MOTORS.

21,580. October 12th, 1908.—IMPROVEMENTS IN AND RELATING TO THE CONTROL OF DYNAMO-ELECTRIC POWER SYSTEMS, *Aktiengesellschaft, Brown, Boveri and Co., of Baden, Switzerland.*

This invention relates to the control of dynamo-electric power systems. In carrying the invention into effect in one manner, to a fly-wheel or the like is connected a normal induction machine to the slip rings of which a three-phase commutator motor is connected in cascade. This three-phase commutator motor can be regulated in such a manner as to cause the induction machine to work as a motor or as a generator with any desired conversion of energy, so as thereby to supply energy to the fly-wheel or to take energy from it as required. Such an arrangement is illustrated in one form, wherein to the induction motor B is coupled the fly-wheel A, the excitation of the motor by means of the collector motor C compelling it to give out energy or take in energy as required from the fly-wheel. The suitable excitation of the induction motor B is effected from C, which in this case is a polyphase motor. It is only by connecting the commutator machine in cascade with the induction machine that it is possible to produce an equalising of the load of the kind described, because it is not ordinarily possible to cause induction machines to give out electrical energy when they do not run at speeds above the synchronous speed. By suitable excitation of the commutator machine the induction motor can be caused to run at speeds below as well as above synchronism, and according to this invention it can be employed in both circumstances to do work as well as to absorb power. It is preferred to effect the shunt circuit excitation by means of a relay, and to operate this relay in such a manner that it will cause the induction machine to give out energy, or to absorb energy, at the exact moment required according to the conditions of working. There are two other illustrations.—*October 13th*, 1909.

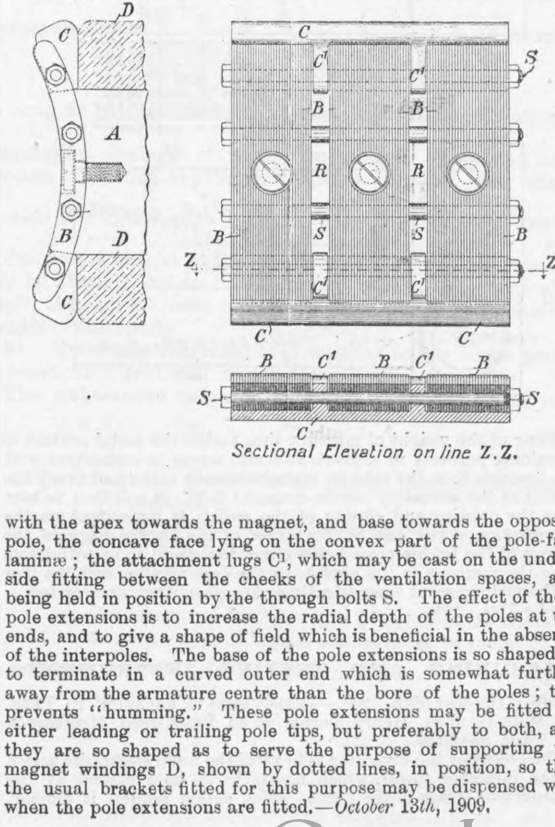
Nº21,580



28,324. December 29th, 1908.—IMPROVEMENTS IN DYNAMO-ELECTRIC MACHINES, Electromotors Limited, of Louisa-street, Openshaw, Manchester, and Ernest Greenhalgh, of 9, Tatton-road North, Heaton Chapel, Stockport.

This invention relates to dynamo-electric machines, and has reference more particularly to improvements in the poles of the field magnets of such machines. A is the field magnet to which the laminated pole piece B is attached by bolts; the several laminæ forming the pole piece are bolted together by through bolts, and the pole face is formed with ventilation spaces R between the groups of laminæ, which are separated by distance ferrules S. The pole extensions C extend across the ends of the poles, and may be solid and constructed of cast iron. In transverse cross section they are roughly of pear-shaped configuration, with the apex towards the magnet, and base towards the opposite pole, the concave face lying on the convex part of the pole-face laminæ; the attachment lugs C^1, which may be cast on the underside fitting between the cheeks of the ventilation spaces, and being held in position by the through bolts S. The effect of these pole extensions is to increase the radial depth of the poles at the ends, and to give a shape of field which is beneficial in the absence of the interpoles. The base of the pole extensions is so shaped as to terminate in a curved outer end which is somewhat further away from the armature centre than the bore of the poles; this prevents "humming." These pole extensions may be fitted to either leading or trailing pole tips, but preferably to both, and they are so shaped as to serve the purpose of supporting the magnet windings D, shown by dotted lines, in position, so that the usual brackets fitted for this purpose may be dispensed with when the pole extensions are fitted.—*October 13th*, 1909.

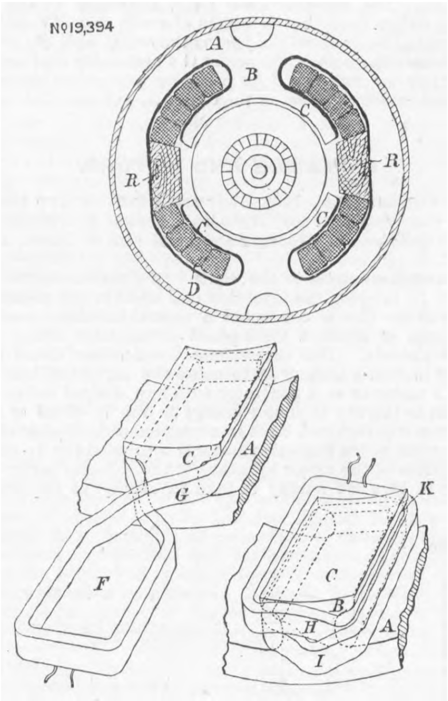
Nº28,324



Sectional Elevation on line Z.Z.

19,394. August 23rd, 1909. — IMPROVEMENTS RELATING TO DYNAMO-ELECTRIC MACHINES, *Fred Raymond Kunkel, of* 319, *Cole-street, Swissvale Station, Pitsburg, Pennsylvania, United States of America.*

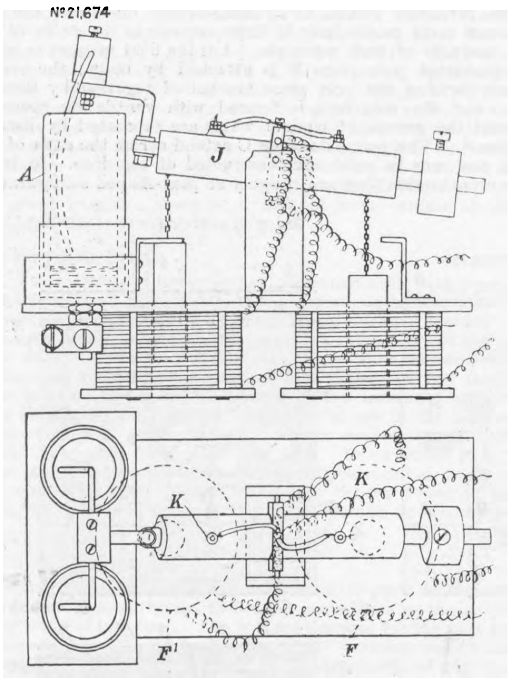
The field magnet is composed of laminated sheet steel punchings A, having integral inwardly extending polar projections B, terminating in integral portions C of ring-segment form that embrace almost the entire circumference of the armature, and the widths of which are much greater than the widths of the body portions of the projections. Each polar projection is provided with a winding D, consisting of a coil that is formed into a plurality of loops surrounding the small body portion of the projection between its extremity and the yoke of the field magnet, at least the last loop being of sufficient internal length to permit it to be applied over the enlarged extremity C of the pole piece after the other loops are in position. The coils are wound before being applied to the machine, and each consists of only a fraction of the number of convolutions of the completed windings. As indicated, each coil section may comprise two loops F and G, opposite sides of which are connected by portions H and I. In placing the coil section on the pole piece, the loop K is first applied by springing its sides apart sufficiently to enable them to slip over the end portion C of the pole piece, and the portions G and H are then bent until the loop F is in position to be pressed into place around the loop K, as indicated in the bottom engraving. After all the core sections are in position they may be held therein by means of wedge blocks R of insulating material.—*October* 13*th*, 1909.



SWITCHGEAR.

21,674. October 13th, 1908.—AN IMPROVED SWITCH FOR CONTROLLING ELECTRICAL CIRCUITS, Thomas Joseph Rorke and Edwin Rorke, both of Thames Bank Electrical Works, Barnes, Surrey.

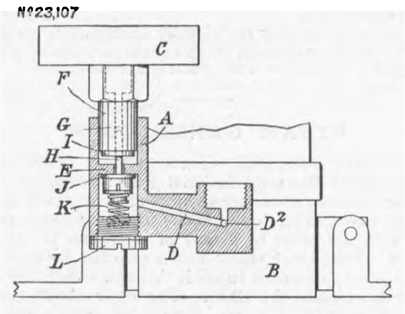
The action of the switch is as follows:—When one of the electro-magnets F or F^1 is energised the adjacent or corresponding soft iron core is pulled or drawn down and the rocking member or tube J turned or rocked about its pivot, this movement causing the mercury at one end of the tube to travel to the other end thereof, which is towards the working electro-magnet. The moving or shifting of the weight of mercury thus assists the metal contact in remaining properly in contact, and also serves in connection with the contacts K in the tube to instantaneously make and break the circuit of the actuating electro-magnets F F^1. It will thus be seen that the opening and closing of the switch is dependent on the energisation of the one or the other of the electro-magnets, the prongs of the bridge piece being either immersed in or withdrawn from the mercury in the pots A, as the case may be, and the flow of the main current consequently either permitted or arrested.—*October* 13*th*, 1909.



MEASURING AND TESTING INSTRUMENTS.

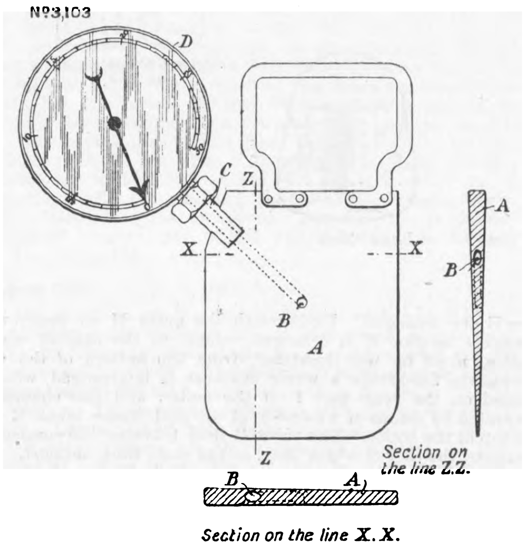
23,107. October 30th, 1908.—IMPROVEMENTS RELATING TO PRESSURE GAUGES, Henry Turner, of 43, Brook-road, Meersbrook Park, Sheffield.

The object of the invention is to avoid the usual spasmodic action of the indicator finger, which has hitherto been caused by the intermittent action of the pump, which action renders it difficult to obtain a correct and rapid reading of the gauge. The body is provided with an airway D, in connection with a passage D^2, communicating with the pump and the object to be supplied with air. In a central position in the interior of the body is an annular collar E, which forms a double valve seating for an upper and lower valve. A plunger F, having an air passage G made through it, fits into the upper end of the body A, and is prepared to carry the gauge C; it is capable of a short vertical sliding movement on being pressed downwards, and is returned to its normal and extended position by a spring action. The lower end of the air passage in the plunger is screw-threaded to engage with the valve-rod H, but in such a manner as to permit the passage of air through to the gauge. Upon the valve-rod H are fixed two valves I and J, one being above and the other below the before-mentioned annular seating. These valves are so arranged that when at rest or out of use the lower valve is held against its seating, and prevents the passage of air to the gauge. This action is performed by a coiled or other spring K, placed within the bore of the tubular body, resting against a screw plug L or its equivalent, and acting by expansion directly against the lower valve in an upward direction. The valve-rod is provided with one or more flat sides as a simple and effective means for allowing air to pass it where necessary, such as the central opening through the annular collar E and the air passage G.—*October* 13*th*, 1909.



3103. February 9th, 1909.—IMPROVED MEANS APPLICABLE FOR USE IN DETECTING LEAKAGE IN VACUUM BRAKE APPARATUS, *Henry Ernest Schmidt, of* 4, *Blücher Strasse, Berlin.*

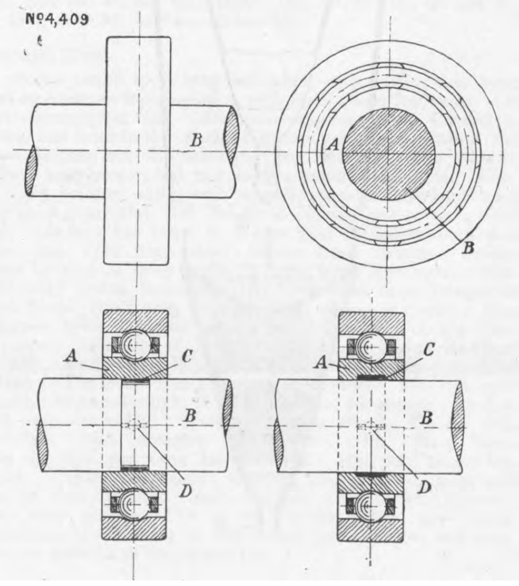
This invention relates to means, applicable to the couplings of the pipes employed for communicating between the coaches of a train fitted with vacuum brake apparatus, with the object of detecting leakage of air into such pipes or into the brake apparatus. The device consists of a plate A preferably tapered, formed with an internal passage B which communicates between the central portion of one face of the plate and a nipple C at the edge of the plate, a vacuum gauge D being attached at the latter point. In testing a length of pipe, or the brake apparatus connected therewith, for leakage, the plate A is inserted between the two members of the pipe coupling, the opening B in the face of the plate being towards the section to be tested. In this manner the gauge is placed in communication with the interior of the train pipe and the degree of vacuum therein prevailing is indicated.—*October* 13*th*, 1909.



MISCELLANEOUS.

4409. February 23rd, 1909.—IMPROVEMENTS IN THE MEANS OF SECURING THE INNER RINGS OF BALL BEARINGS TO SHAFTS, Brown and Ward, Limited, and Edward George Brown, Director of Brown and Ward, Limited, of 44, Branston-street, Birmingham.

The invention consists of a cavity or groove being made in the shaft B or inner ring A of ball-bearing A and B—see lower engravings—into which a spring C is inserted, preferably a flat or coil spring, and to get enough tension so that the inner ring A and shaft B will revolve together when in motion. The groove or cavity where C is fixed can be in the inner ring A or shaft B and the spring C is inserted in the cavity or groove where C is fixed. The bottom left-hand engraving shows ball bearing in section on shaft B into which there is a groove where spring C is inserted and held in compression against inner ring A. Peg D keeps the spring in position. The right-hand bottom engraving shows a similar section, but with the groove in inner ring A, into which the spring C is inserted. Peg D to keep spring in position as in Fig 3, but peg D in inner ring instead of in shaft B.—*October* 13*th*, 1909.

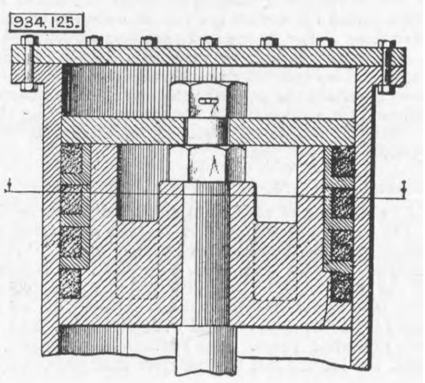


SELECTED AMERICAN PATENTS.

(*From the United States Patent-office Official Gazette.*)

934,125. PISTON PACKING, *H. A. Young, Chicago, Ill.—Filed January 6th,* 1909.

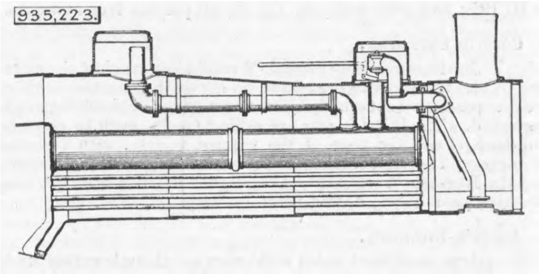
This patent is for a packing of the non-adjustable metallic type.



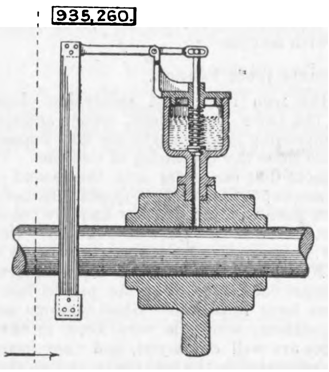
The drawing fully explains the invention. There is only one claim.

935,223. SUPERHEATER FOR LOCOMOTIVES, *O. W. Ott, Oak Park, Ill.—Filed April 8th,* 1907. *Renewed August* 21*st*, 1909.

This invention consists in placing a drum through which some of the flue tubes pass, as shown. The steam enters this drum and is superheated on its way to the cylinders. There are five claims.



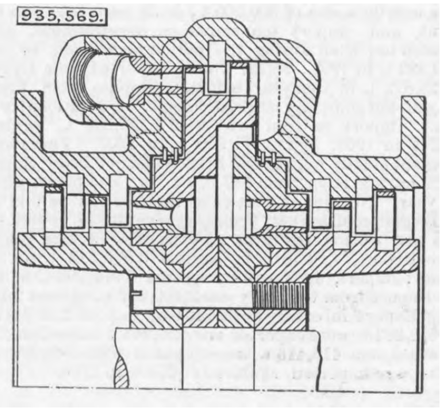
935,260. LUBRICATOR, *J. Kelly, Chicago, Ill.—Filed May 5th,* 1909.



A strap hangs in frictional contact with the shaft and shakes the valve stem so as to let oil pass. There are four claims.

935,569. ELASTIC-FLUID TURBINE, *G. Westinghouse, Pittsburg, Pa., assignor to The Westinghouse Machine Company, a Corporation of Pennsylvania.—Original application filed June 24th,* 1903. *Divided and this application filed February* 10*th*, 1908.

In combination with a single-flow impulse stage of an elastic-fluid turbine, a low-pressure reaction stage divided into two sections located on opposite sides of the centre of the turbine and through which the working fluid flows in opposite directions and a fluid passage within the turbine rotor, placing the inlets to said sections in communication one with the other. There are twenty-seven claims



NOTES ON THE DESIGN OF SHAFTS, WITH SPECIAL REFERENCE TO HIGH SPEED ELECTRIC GENERATORS.

By H. H. JEFFCOTT.

No. III.*

14. If the ends of the shaft be free from bending couples we may assume $u = a z + b z^3 + c z^4$. Impose coincidence between this and the actual displacement curve at an intermediate point z_r. Eliminate a, b, c between this equation and the end conditions, and there results an equation in ω^2, the first whirling speed.

If $z_r = \frac{1}{2} l$, we find

$$0.03860\, m\, \omega^2 l^8 - 0.3812\, m\, \omega^2 k^2 l^6$$
$$+ \Sigma_o^{\frac{1}{2} l} (m_s \omega^2 + G)\, z^2_s (0.75\, l^2 - z^2_s)(l^3 - 2\, l\, z^2_s + z^3_s)$$
$$+ \Sigma_{\frac{1}{2} l}^{l} (m_s \omega^2 + G)\, z_s (l - z_s) \left\{ 0.75\, l^2 - (l - z_s)^2 \right\} (l^3 - 2\, l\, z^2_s + z^3_s)$$
$$+ 3\, \omega^2\, \Sigma_o^{\frac{1}{2} l} m_s k^2_s (z^2_s - 0.25\, l^2)(l^3 - 6\, l\, z^2_s + 4\, z^3_s)$$
$$+ 3\, \omega^2\, \Sigma_{\frac{1}{2} l}^{l} m_s k^2_s \left\{ 0.25\, l^2 - (l - z_s)^2 \right\} (l^3 - 6\, l\, z^2_s + 4\, z^3_s)$$
$$- 3.75\, E\, I\, l^4 = o.$$

Or, if $z_r = \frac{1}{3} l$, we find

$$0.04991\, m\, \omega^2 l^8 - 0.4953\, m\, \omega^2 k^2 l^6$$
$$+ 2\, \Sigma_o^{\frac{1}{3} l} (m_s \alpha^2 + G)\, z^2_s (\tfrac{5}{9} l^2 - z^2_s)(l^3 - 2\, l\, z^2_s + z^3_s)$$
$$+ \Sigma_{\frac{1}{3} l}^{l} (m_s \omega^2 + G)\, z_s (l - z_s) \left\{ \tfrac{8}{9} l^2 - (l - z_s)^2 \right\} (l^3 - 2\, l\, z^2_s + z^3_s)$$
$$+ 2\, \omega^2\, \Sigma_o^{\frac{1}{3} l} m_s k^2_s (3\, z^2_s - \tfrac{5}{9} l^2)(l^3 - 6\, l\, z^2_s + 4\, z^3_s)$$
$$+ \omega^2\, \Sigma_{\frac{1}{3} l}^{l} m_s k^2_s \left\{ \tfrac{8}{9} l^2 - 3\,(l - z_s)^2 \right\} (l^3 - 6\, l\, z^2_s + 4\, z^3_s)$$
$$- \frac{44}{9} E\, I\, l^4 = o.$$

Both these equations give ω, the first whirling speed. In cases where the load is mainly near one end of the shaft it is advisable to use the latter equation, the former being more suited for cases where the load is chiefly near the centre.

The accuracy of the results given by these equations depends on how nearly the displacement at every loaded point in the actual case is approximated to by the assumed displacement curve; *e.g.*, take a single load at the centre of a massless shaft. With the former formula (in which $z_r = \frac{1}{2} l$) the actual and assumed displacements at the loaded point are the same, since the curves are made to coincide there, hence the equation should give a satisfactory value of ω; but with the latter equation (in which $z_r = \frac{1}{3} l$) the displacement of this assumed curve will not coincide with the actual displacement at the position of load, and hence in this particular case the latter equation will not give so accurate a result. The amount by which it is in error can be determined by comparison with the former case, or in general by comparison with the general displacement equation of Section 8 written for the particular load. Thus, we can determine how far each equation is in error when used for a load concentrated at any point, and we may choose correcting factors (q) by which the masses should be multiplied in each of the formulæ, so that when so modified the equations shall give approximately correct results. In a similar manner may be obtained correcting factors (q') by which the moments of inertia of concentrated loads must be multiplied in the two equations. These are obtained by comparison of the equations with the general equation of Section 8 after differentiation, taken for a single load of moment of inertia only. Here the parallelism of the assumed and actual displacement curves at the load points is what is of importance.

The values of q and q' are given by the following table:—

Position of load.	Load correcting factor.			
	Formula based on $z_r = \frac{1}{2} l$.		Formula based on $z_r = \frac{1}{3} l$.	
z/l.	q.	q'.	q.	q'.
0.1	1.39	1.345	1.23	1.199
.2	1.218	1.305	1.09	1.228
.3	1.10	1.694	1.011	1.860
.4	1.026	4.390	0.985	8(5)
.5	1.000	∞	1.018	∞
.6	1.026	4.390	1.081	3.770
.7	1.10	1.694	1.179	1.719
.8	1.218	1.305	1.325	1.391
.9	1.39	1.345	1.528	1.469

Hence, finally, we may write the equations

$$0.0386\, M\, \omega^2 - 0.3812\, M \frac{k^2}{l^2} \omega^2$$
$$+ \Sigma_{t=o}^{t=\frac{1}{2}} q(m_s \omega^2 + G)\, \psi_s + \Sigma_{t=\frac{1}{2}}^{t=1} q(m_s \omega^2 + G)\, \psi'_s$$
$$- \omega^2\, \Sigma_{t=o}^{t=\frac{1}{2}} q'\, m_s \frac{k^2_s}{l^2}\, \theta_s - \omega^2\, \Sigma_{t=\frac{1}{2}}^{t=1} q'\, m_s \frac{k^2_s}{l^2}\, \theta'_s$$
$$= 3.75 \frac{E\, I}{l^3}.$$

and

$$0.04991\, M\, \omega^2 - 0.4953\, M \frac{k^2}{l^2} \omega^2$$
$$+ \Sigma_{t=o}^{t=\frac{1}{3}} q(m_s \omega^2 + G)\, \chi_s + \Sigma_{t=\frac{1}{3}}^{t=} q(m_s \omega^2 + G)\, \chi'_s$$
$$- \omega^2\, \Sigma_{t=o}^{t=\frac{1}{3}} q'\, m_s \frac{k^2_s}{l^2}\, \phi_s - \omega^2\, \Sigma_{t=\frac{1}{3}}^{t=1} q'\, m_s \frac{k^2_s}{l^2}\, \phi'_s$$
$$= \frac{44}{9} \cdot \frac{E\, I}{l^3},$$

in which q and q' depend on the nature of the load, being 1 for a load uniformly distributed or concentrated at $z = \frac{1}{2} l$ (or $\frac{1}{3} l$), and having values got from the preceding table for that part of the load in excess of uniform distribution that is concentrated away from $z = \frac{1}{2} l$ (or $z = \frac{1}{3} l$). Also $\frac{z_s}{l} = t_s$, $m\, l = M$ = mass of shaft, and

$$\psi_s = t^2_s (0.75 - t^2_s)(1 - 2\, t^2_s + t^3_s)$$
$$\psi'_s = t_s (1 - t_s) \left\{ 0.75 - (1 - t_s)^2 \right\} (1 - 2\, t^2_s + t^3_s)$$
$$\theta_s = 3\,(0.25 - t^2_s)(1 - 6\, t^2_s + 4\, t^3_s)$$
$$\theta'_s = 3 \left\{ (1 - t_s)^2 - 0.25 \right\} (1 - 6\, t^2_s + 4\, t^3_s)$$
$$\chi_s = 2\, t^2_s (\tfrac{5}{9} - t^2_s)(1 - 2\, t^2_s + t^3_s)$$
$$\chi'_s = t_s (1 - t_s) \left\{ \tfrac{8}{9} - (1 - t_s)^2 \right\} (1 - 2\, t^2_s + t^3_s)$$
$$\phi_s = 2\,(\tfrac{5}{9} - 3\, t^2_s)(1 - 6\, t^2_s + 4\, t^3_s)$$
$$\phi'_s = \left\{ 3\,(1 - t_s)^2 - \tfrac{8}{9} \right\} (1 - 6\, t^2_s + 4\, t^3_s)$$

Also $N = 9.55\, \omega$ = speed in revs. per minute.

15. The values of $\psi, \theta, \chi, \phi, \psi', \theta', \chi', \phi'$ may be tabulated for various values of t.

t	ψ	ψ'	θ	θ'	χ	χ'	Φ	ϕ'
0.0	0.0		0.750		0.0		1.1111	
.05	.00186		.732		.00276		1.080	
.1	.00725		.678		.01072		0.993	
.15	.01568		.597		.0230		.857	
.2	.02635		.498		.0384		.690	
.25	.0382		.387		.0548		.506	
.3	.0503		.273		.0712		.324	
.35	.0614		.1668			0.0846		0.1645
.4	.0702		.0798			.0945		.0566
.45	.0761		.0213			.0998		.00274
.5	.0781	0.0781	0.0	0.0		.1000		.0000
.55		.0761		.0213		.0955		.0421
.6		.0702		.0798		.0859		.1210
.65		.0614		.1668		.0750		.2273
.7		.0503		.273		.0509		.351
.75		.0382		.387		.0460		.482
.8		.02635		.498		.0314		.609
.85		.01568		.597		.0187		.720
9		.00725		.678		.00862		.810
.95		.00186		.732		.00219		.870
1.0		0.0		.750		0.0		.8889

16. In cases where two whirling speeds are sought, and the shaft is free from bending couples at its ends, we may assume $u = a z + b z^3 + c z^4 + d z^5$.

Imposing coincidence between this and the actual curve at two points (near the centres of the two loops into which the shaft bends at the second whirling speed), and attending to the end conditions, we can eliminate a, b, c, d, and obtain a quadratic in ω^2, the roots of which give the first two whirling speeds. Correcting factors are not necessary here, as the assumed and actual displacement curves are in closer agreement, there being two intermediate points of coincidence.

17. If the moments of inertia of the loads have a negligible effect on the whirling speed, we omit the terms in $m\, k^2$. If, further, the ends be free from bending couples, and the mass of the shaft itself be supposed divided up into portions acting at suitable points, we find by Section 8,

$$\phi\, u_r = \Sigma_{s=o}^{s=r} (m_s \omega^2 + G)\, A'_{rs} u_s$$
$$+ \Sigma_{s=r}^{s=n} (m_s \omega^2 + G)\, A_{rs} u_s$$

Taking $r = 1, 2, 3$, &c., and writing out the equations for the loads 1, 2, 3, &c., we have

$$\phi\, u_1 = (m_1 \omega^2 + G)\, A'_{11} u_1 + (m_2 \omega^2 + G)\, A_{12} u_2 + \ldots$$
$$\phi\, u_2 = (m_1 \omega^2 + G)\, A'_{21} u_1 + (m_2 \omega^2 + G)\, A'_{22} u_2 + \ldots$$
$$\ldots \ldots \ldots \ldots$$

Hence, eliminating $u_1, u_2, u_3, \ldots$ we get

$$\left| \begin{array}{l} (m_1 \omega^2 + G)\, A'_{11} - \phi,\ (m_2 \omega^2 + G)\, A_{12}, \ldots \\ (m_1 \omega^2 + G)\, A'_{21},\ (m_2 \omega^2 + G)\, A'_{22} - \phi \ldots \\ \ldots \ldots \ldots \end{array} \right| = o$$

This is an equation in ω^2 giving the various whirling speeds. Thus we may imagine the total load divided into four or five portions, and there results an equation of the 4th or 5th degree in ω^2, giving the first four or five whirling speeds.

We may also apply this method when the moment of inertia of the load is included. By differentiating the general displacement equation of Section 8 we obtain

$$\phi\, u_r = \Sigma_{s=o}^{s=r} \left\{ (m_s \omega^2 + G)\, A'_{rs} u_s + m_s k^2_s \omega^2 B'_{rs} \left(\frac{d\, u}{d\, z}\right)_s \right\}$$
$$+ \Sigma_{s=r}^{s=n} \left\{ (m_s \omega^2 + G)\, A_{rs} u_s + m_s k^2_s \omega^2 B_{rs} \left(\frac{d\, u}{d\, z}\right)_s \right\}$$

and
$$\phi \left(\frac{d\, u}{d\, z}\right)_r$$
$$= \Sigma_{s=o}^{s=r} \left\{ (m_s \omega^2 + G)\, C'_{rs} u_s + m_s k^2_s \omega^2 D^1_{rs} \left(\frac{d\, u}{d\, z}\right)_s \right\}$$
$$+ \Sigma_{s=r}^{s=n} \left\{ (m_s \omega^2 + G)\, C_{rs} u_s + m_s k^2_s \omega^2 D_{rs} \left(\frac{d\, u}{d\, z}\right)_s \right\}$$

where
$$C_{rs} = \frac{d\, A_{rs}}{d\, z_r} = (l - z_s)(2\, l\, z_s - z^2_s - 3\, z^2_r)$$
$$C'_{rs} = \frac{d\, A'_{rs}}{d\, z_r} = (z_s \left\{ 3(l - z_r)^2 + z^2_s - l^2 \right\}$$
$$D_{rs} = \frac{d\, B_{rs}}{d\, z_r} = l^2 - 3\, z^2_r - 3(l - z_s)^2$$
$$D'_{rs} = \frac{d\, B'_{rs}}{d\, z_r} = l^2 - 3\, z^2_s - 3(l - z_r)^2$$

Take $r = 1, 2$, &c., and write out the equations for the loads 1, 2, &c., and we have

$$\phi\, u_1 = (m_1 \omega^2 + G)\, A'_{11} u_1 + (m_2 \omega^2 + G)\, A_{12} u_2 + \ldots$$
$$+ m_1 k^2_1 \omega^2 B'_{11} \left(\frac{d\, u}{d\, z}\right)_1 + m_2 k^2_2 \omega^2 B_{12} \left(\frac{d\, u}{d\, z}\right)_2 + \ldots$$
$$\phi\, u_2 = (m_1 \omega^2 + G)\, A'_{21} u_1 + (m_2 \omega^2 + G)\, A'_{22} u_2 + \ldots$$
$$+ m_1 k^2_1 \omega^2 B'_{21} \left(\frac{d\, u}{d\, z}\right)_1 + m_2 k^2_2 \omega^2 B'_{22} \left(\frac{d\, u}{d\, z}\right)_2 + \ldots$$
$$\ldots \ldots \ldots \ldots$$
$$\phi \left(\frac{d\, u}{d\, z}\right)_1 = (m_1 \omega^2 + G)\, C'_{11} u_1 + (m_2 \omega^2 + G)\, C_{12} u_2 + \ldots$$
$$+ m_1 k^2_1 \omega^2 D'_{11} \left(\frac{d\, u}{d\, z}\right)_1 + m_2 k^2_2 \omega^2 D_{12} \left(\frac{d\, u}{d\, z}\right)_2 + \ldots$$
$$\phi \left(\frac{d\, u}{d\, z}\right)_2 = (m_1 \omega^2 + G)\, C'_{21} u_1 + (m_2 \omega^2 + G)\, C'_{22} u_2 + \ldots$$
$$+ m_1 k^2_1 \omega^2 D'_{21} \left(\frac{d\, u}{d\, z}\right)_1 + m_2 k^2_2 \omega^2 D'_{22} \left(\frac{d\, u}{d\, z}\right)_2 + \ldots$$
$$\ldots \ldots \ldots \ldots$$

Hence, eliminating u_1, u_2, &c., $\left(\frac{d\, u}{d\, z}\right)_1, \left(\frac{d\, u}{d\, z}\right)_2$ &c., we find

$$\left| \begin{array}{l} (m_1 \omega^2 + G)\, A'_{11} - \phi,\ (m_2 \omega^2 + G)\, A_{12}, \ldots \\ \quad m_1 k^2_1 \omega^2 B'_{11},\ m_2 k^2_2 \omega^2 B_{12}, \ldots \\ (m_1 \omega^2 + G)\, A'_{21},\ (m_2 \omega^2 + G)\, A'_{22} - \phi, \ldots \\ \quad m_1 k^2_1 \omega^2 B'_{21},\ m_2 k^2_2 \omega^2 B'_{22} \ldots \\ \ldots \ldots \ldots \\ (m_1 \omega^2 + G)\, C'_{11},\ (m_2 \omega^2 + G)\, C_{12}, \ldots \\ \quad m_1 k^2_1 \omega^2 D'_{11} - \phi,\ m_2 k^2_2 \omega^2 D_{12} \ldots \\ (m_1 \omega^2 + G)\, C'_{21},\ (m_2 \omega^2 + G)\, C'_{22}, \ldots \\ \quad m_1 k^2_1 \omega^2 D'_{21},\ m_2 k^2_2 \omega^2 D'_{22} - \phi \ldots \\ \ldots \ldots \ldots \end{array} \right| = o$$

This equation in ω^2 gives the various whirling speeds (real and imaginary).

18. In many of the cases considered above we have assumed the ends at bearings free from bending couples. In practice there is a certain end bending couple, usually at one end. Further, the bearing itself is not perfectly rigid; there is a certain amount of give, so that the node may not be exactly at the centre of the bearing, but at a little distance outside it. Thirdly, the shaft is not in ideally perfect balance. The last two reasons make the formulæ give too high a value for ω^2, while the first, so far as the end couples oppose the centrifugal displacement, makes them give too low a value. Further, the constraints imposed by assuming the deflection curve to be of a simple kind, and, in general, not the true form, make the value obtained for the whirling speed rather too high. Possibly the first reason is the most important. Where end bending couples are considerable, the equations in which they are included should, of course, be used.

19. So far we have imagined there is no end thrust on the shaft. In the case of some types of generator (with vertical shaft) there is end thrust, and its action is to assist the centrifugal forces to keep the shaft bent.

Let us imagine that, in addition to the centrifugal and magnetic loads, the shaft is under a longitudinal compressive force Z between the bearings, and let there be no bending couples at the bearings. Then it may be shown that the displacement curve of neutral axis is given by

$$Z\, u_r = \frac{\sin a(l - z_r)}{\sin a\, l}\, \Sigma_o^r \left\{ \frac{m_s \omega^2 + G}{a} u_s \sin a\, z_s - m_s k^2_s \omega^2 \left(\frac{d\, u}{d\, z}\right)_s \cos a\, z_s \right\}$$
$$+ \frac{\sin a\, z_r}{\sin a\, l}\, \Sigma_r^n \left\{ \frac{m_s \omega^2 + G}{a} u_s \sin a(l - z_s) + m_s k^2_s \omega^2 \left(\frac{d\, u}{d\, z}\right)_s \cos a(l - z_s) \right\}$$
$$- \frac{l - z_r}{l}\, \Sigma_o^r \left\{ (m_s \omega^2 + G)\, u_s z_s - m_s k^2_s \omega^2 \left(\frac{d\, u}{d\, z}\right)_s \right\}$$
$$- \frac{z_r}{l}\, \Sigma_r^n \left\{ (m_s \omega^2 + G)\, u_s (l - z_s) + m_s k^2_s \omega^2 \left(\frac{d\, u}{d\, z}\right)_s \right\};$$

where $a = \sqrt{\frac{Z}{E\, I}}$.

20. If we examine the special case of a single load m at the centre of the span in addition to the end thrust, and if $\left(\frac{Z l^2}{E I}\right)^2$ is negligible, we find $\omega^2 = \frac{48\, E\, I}{m\, l^3 \left(1 + 0.15 \frac{Z\, l^2}{E\, I}\right)}$.

If there were no end thrust, we find from our previous equations $\Omega^2 = \frac{48\, E\, I}{m\, l^3}$. $\therefore \frac{\omega^2}{\Omega^2} = \frac{1}{1 + 0.15 \frac{Z\, l^2}{E\, I}}$. Hence, so long as $\left(\frac{Z\, l^2}{E\, I}\right)^2$ is negligible, we may, for approximate calculation, instead of using the general expression of section 19, imagine the end thrust omitted, and the masses multiplied each by $1 + 0.15 \frac{Z\, l^2}{E\, I}$. If the thrust is due to the weight of the armature and shaft, this factor will be about 1.001 to 1.01. In such cases of the vertical shaft, the thrust does not exist throughout the whole length of the shaft.

21. To obtain the value of G we may follow Knowlton (*Electrical World and Engineer*, vol. 37).

The unbalanced magnetic pull in pounds G_u weight is $k\, B^2_g\, A\, P \frac{u\, X_g}{l_g\, X}$; where

B_g = magnetic density in air gap in lines per square centimetre.
A = air gap area in square centimetres.
l_g = length of air gap in inches.
X = total ampère turns per pole.
X_g = air gap ampère turns per pole.
u = displacement from central position in inches.
k is a constant depending on the number of poles P.

Thus k is 4.48×10^{-8} for a 4 pole machine
7.01×10^{-8} „ 6 „ „
7.84×10^{-8} „ 8 „ „
8.60×10^{-8} „ 10 „ „
8.94×10^{-8} „ 12 or more pole machine.

In turbo machines the number of poles is small, and we may take as an average case the unbalanced magnetic pull in pounds weight as 75 D L u, where D is the diameter of armature, L is the length of the armature core; D, L, u being expressed in inches. Thus G = 75 D L in in.-lb. units.

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* No. II. appeared October 29th.

For more exact results the actual values of the various quantities entering the expression for unbalanced pull should be used. This total magnetic pull is applied continuously throughout the length of the armature core. Hence, in the general equation (section 8) the limits of integration l', l'' for this load should correspond to the ends of the armature core, the value of G being then 75 D, which is the load per unit length. It will, however, usually be sufficient to regard this load as composed of two or three parts acting at suitable points of the armature core length. Then, in the general formula, these isolated load terms will be used.

TIRE AND RAIL.

In the course of the discussion which followed the reading of Mr. Price Williams' paper on the life of permanent way, during the last meeting of the Iron and Steel Institute, Mr. T. Hurry Riches, locomotive superintendent of the Taff Vale Railway, said, as reported in our columns on the 15th ult., that "the author had made little allusion to a point of considerable importance, namely, the change in the class of steel used for rails which had taken place in recent years. Neither had he commented on the sectional profile of tires in comparison with that of past years. The formation of the tire had a great influence on the life of the rail, and it was an excellent thing that in recent practice closer attention had been given, and more co-ordination had arisen between the road engineer and the rolling stock engineer, with a view to securing greater harmony in the section of wheel and rail. The wear and tear of permanent way was a vital problem for railways to-day; and he hoped that the ventilation of the subject by Mr. Williams would lead to fresh efforts to improve the bearing surfaces of rails and tires."

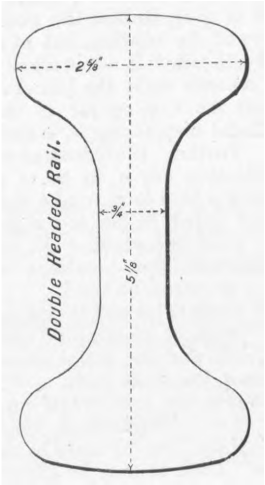


Fig. 1

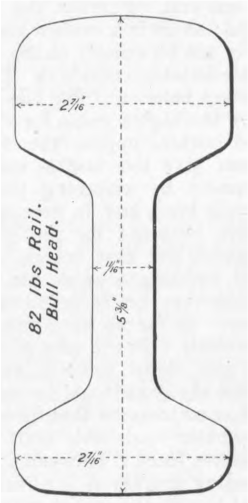


Fig. 2

What Mr. Hurry Riches has to say about railways is always worth hearing. We felt that it was desirable that more precise information should be made available to our readers, and in reply to a request on our part Mr. Hurry Riches has courteously sent us the sections Figs. 1, 2, and 3. The first of these shows the original double-headed rail laid on the Taff Vale. This type was used because it was believed that when one table was worn out the rail could be turned over and a fresh lease of life obtained. The anticipation could not be fulfilled, because the chairs always made indentations in the rails where they rested on them, and the riding over turned rails was in consequence intolerably rough. This kind of rail is now being used up by degrees in the sidings of the Taff Vale system.

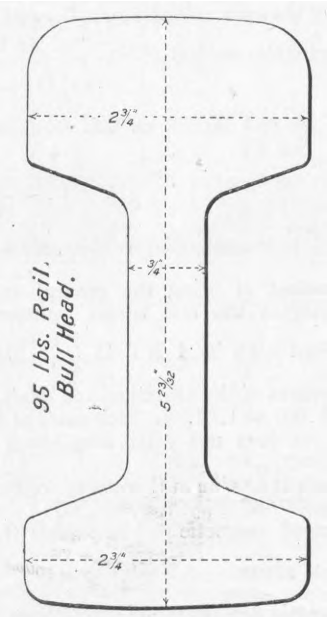


Fig. 3

Fig. 2 is a section of the 82 lb. bull-headed rail, which replaced the double-headed rail. It has done good service, but is being gradually replaced in turn by the 95 lb. rail, shown in Fig. 3. This is in all respects the rail recommended by the Standards Committee, and although for the time being we are more concerned with the form of the rail than with its composition, it is worth while to add here a few words from the Standards Committee's specification. The nominal weight of the rail is 95 lb. per yard, its calculated weight 94.59 lb. The principal dimensions are given on the engraving. Each rail must be made from an ingot not less than 12in. square at the smaller end and 14in. at the larger end, which must be cogged down into blooms, and have sufficient crop then sheared from each end to secure soundness. All straightening must be done by pressure. The rails must in composition conform to the following limits:—

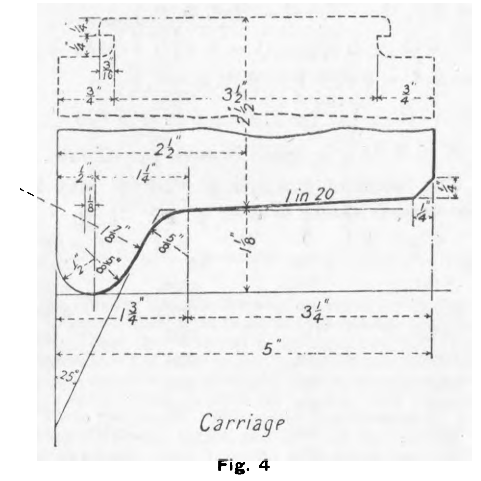


Fig. 4

Carbon … …	from 0 35 to 0.50	per cent.
Manganese …	from 0.70 to 1.00	,,
Silicon, not to exceed …	… 0.10	,,
Phosphorus, not to exceed	… 0.075	,,
Sulphur, not to exceed …	… 0.08	

The test shall comprise two blows. The tup to weigh 1 ton; the test piece, 5ft. long, to be carried on supports, 3ft. 6in. apart; the drop for the first blow shall be 7ft.; the deflection from $\frac{7}{8}$in. to $1\frac{3}{16}$in. The second drop shall be 20ft., and the deflection from 3in. to $4\frac{1}{4}$in.

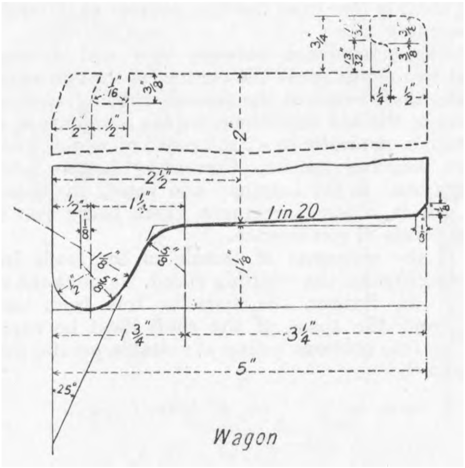


Fig. 5

Figs. 4 and 5 are sections of Taff Vale carriage and wagon tires. Fig. 4 is for normal wheels, Figs. 6 and 7 are sections of driving wheel tires. All three have been made to the Standard Committee's specification. In Fig. 8 we give a section of the standard tire and rail in use on the Great Eastern Railway. The dotted line shows the way in which the tire is thinned off to facilitate passage round curves when the engine is six-coupled. There is very little difference between this tire and that of other British railways. Thus the width of tire is almost always $5\frac{1}{2}$in. The Standards Committee recommend $5\frac{3}{4}$in. The thickness varies from 3in. to $3\frac{1}{2}$in.; the latter quite exceptional. The Standards Committee advise 3in. The coneing is in all cases 1 in 20in. The depth of the flange is always 1in. and some small fraction, such as $\frac{1}{16}$in. Quite recently M. Georges Marié, who held the position of "chef de division" on the Paris, Lyons, and Mediterranean Railway, has published an important paper on the theory of derailment and the influence of the profile of tires. To the paper we are indebted for Figs. 9, 10, and 11. The first shows a tire long in use on French railways, and nearly identical with the normal British tire. It is made up of the curve C D, struck to a circle 22 mm., or 0.866in. radius, which is followed by another portion of a circle, D E F, 14 mm., or 0.551in. radius.

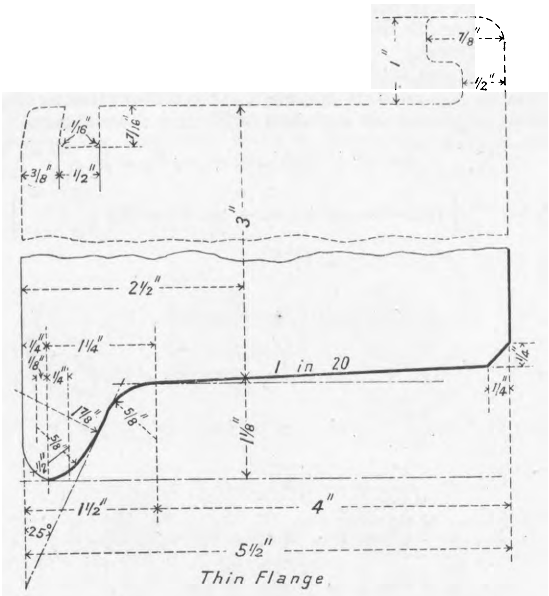


Fig. 6

Fig. 10 represents the tire used on Prussian railways. We have here first a curve C D, struck with a radius of 15 mm., or 0.591in. Then a straight line D E, making an angle β of 60 deg. with the horizontal. Then a curve E F G, struck to a radius of 13 mm., or 0.512in. Then a nearly straight portion G H, called the "Champein," which is intended to facilitate the passage of the wheel through points and crossings; that is to say, whenever the back of the wheel comes into contact with a rail. The depth of the flange is 27 mm., or 1.063in.

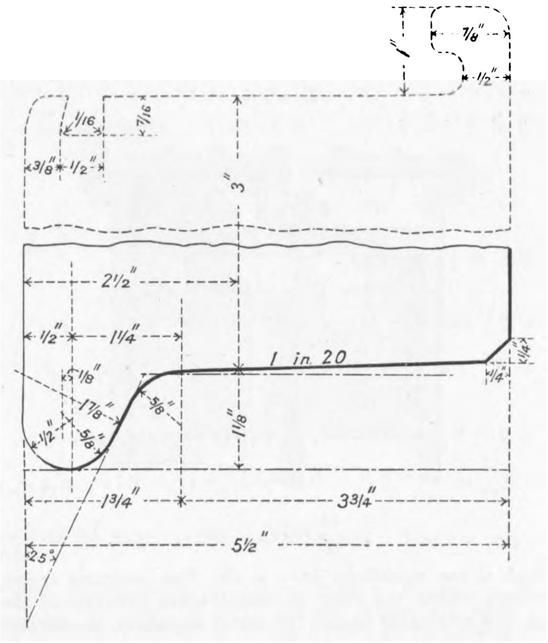


Fig. 7

Fig. 11 represents a section which has been termed "Boudin Bombé Fuyant." It resembles Fig. 10, but the lines E F and F G H are struck as shown from different centres. The dimensions are given on the section. This section is much favoured in the United States. It will be seen that the inclination of the line D E is about 70 deg., instead of 60 deg. as on the Prussian railways. For all these and many other flange profiles special advantages are claimed. M. Marié comes to the conclusion, after a careful investigation of both theory and practice, that about as good a section as can be got lies somewhat between Figs. 9 and 10. Take, for instance, Fig. 9, which gives the straight portion D E an angle of 80 deg. instead of 60 deg. In English tires this angle has been a mean between 60 deg. and 80 deg., and has given admirable results during the last twenty years.

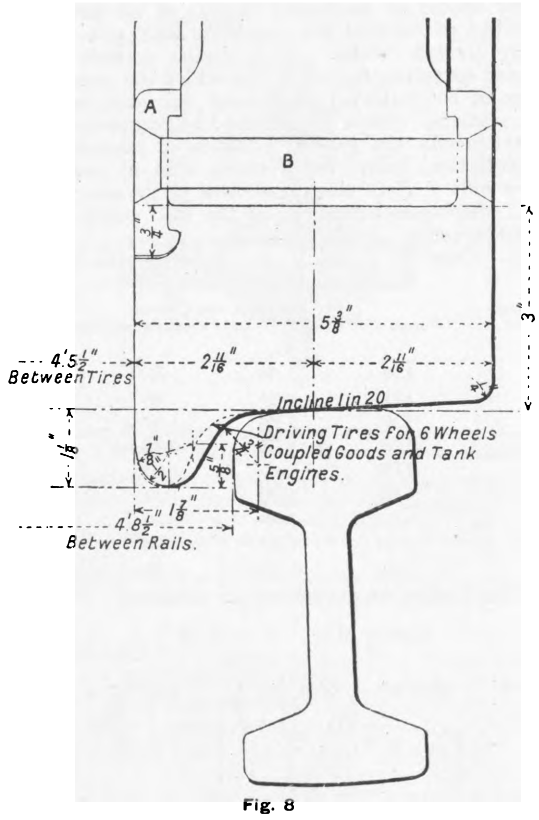
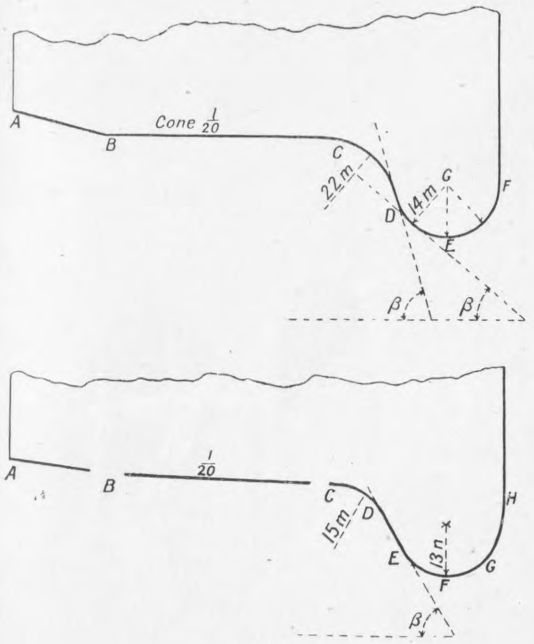


Fig. 8

It is not easy to see how any change can be effected in profile which is likely to reduce wear and tear; but there are certain objects which may be kept in view with advantage; the first is to augment the area of the contact surface between tire and rail. This at the best of times is very small. Careful measurements made by different observers give it as a maximum at about one-fourth of a square inch when the rail is fairly new. Even with badly worn rails and tires it cannot exceed half a square inch.

The loading being 8 or 9 tons, we have about 36 tons per square inch as a maximum, and about 16 tons as a minimum. It is evident that neither the rail nor the tire could have such stresses put upon it without being crushed, were it not that the portions in contact are supported all round by the rest of the metal. In the old days, when rails were of soft iron, the crushing was quite obvious early in the life of the rail. How the area of contact is to be increased it is not easy to say. If the top of the rail is much rounded, as in Fig. 1, which, we may add, is by no means the worst section in this respect that has been rolled, the contact must be very small. If we look at a new rail after it has been in use for a short time, we shall find on its upper surface a narrow, well defined bright ribbon, which marks the extent of contact laterally. No matter to what section a rail is rolled, it will wear down rather expeditiously to a section which will last some time, and it would seem to be good policy to give the rail this section from the first. That, no doubt, has been largely done in the Standards Committee's section. In like manner, it is found that tires wear down to a profile which seems to last, and this should be adopted as far as possible when turning them. But, after all, it must be confessed that the removal of material by wear is not always a certain indication of what the profile of either a rail or a tire ought to be. Still, the facts should be kept in mind and used with intelligence. In laying the rails it seems to be good policy to cant the chairs on the sleepers, so that the rails will incline inwards—as in Fig. 8—so as to take the cone of the tire squarely. This tends to relieve the stress on the keys, and to reduce the tendency, always existing, to burst the road.



Figs. 9 and 10

The next point for consideration is hardness. At first sight it would seem that rails and tires cannot be made too hard. The statement is only true within limitations. The greater proportion of wear of tires and rails is due to friction. If the wheels only rolled on the rails the wear would be very small. Now there are two causes of friction—that brought about by the difference in the distance passed over by the inner and the outer wheel when traversing curves, and that due to the slipping of driving wheels because of lack of adhesion. The first is common to all wheels, and can only be obviated by making one wheel of each pair run loose on the axle—a thing which will ultimately be done with carriages and wagons, we have no doubt, because difficulties which stood in the way years ago are now being removed by the coming of better materials and more accuracy of workmanship.

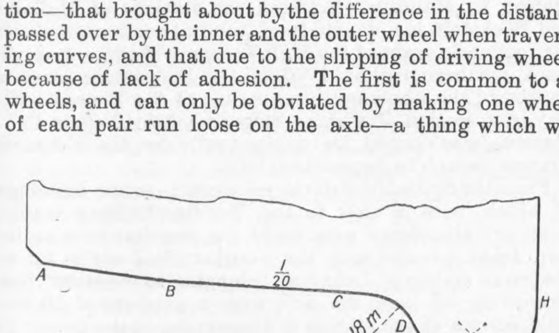


Fig. 11

The slipping due to lack of adhesion presents us with a very complex problem. It concerns driving wheels only; but they are, of course, the most potent cause of mischief. The coefficient of adhesion is taken in this country at one-sixth of the insistent weight; but it is an excessively variable quantity. With a perfectly dry, clean, cold rail it may reach one-fourth or a little more. A hot rail, as in summer, is a slippery rail. Then in winter we have slime, due to the mud splashed up from the ballast. That this splashing occurs is proved by the mud on an engine after a run on a wet day. Dead leaves have been known to stop a train in a cutting. Experiments have been made at various times to settle whether driving wheels always slip or not. The evidence goes to show that on clean dry rails, when the speed is not too high, no slipping occurs; but that circumstances may easily arise under which wheels, apparently holding well, are really slipping 10 per cent. or more. It must be borne in mind that under ordinary circumstances the driving wheels of a locomotive with two-thirds of the reciprocating masses compensated in the wheel rims will be lifted off the rail once in each revolution if the speed exceeds about 90 miles an hour. This is a strong point in favour of the four-cylinder engine, which gets on very well without any balance or compensating weights. The tendency of the normal two-cylinder locomotive is to jump along the rails at high speeds, and there is, therefore, lack of adhesion.

We now come to a factor about which very little is ever heard. We refer to the hardness of the rail and tire. It is but natural that the engineer controlling the permanent way should like to have his rails very hard indeed. The locomotive superintendent is of just the same mind concerning tires. For a long time past these last have been made about as hard as is compatible with turning them up in a lathe; but still harder steels are being introduced. Tires are now being made in Sheffield of 65-ton steel with an elongation of 12 per cent. These tires could not be turned at all but for the improved tool steels now available. Now, the harder the steel and the rail the less is the coefficient of adhesion. How much less is not known. It is highly desirable that experiments should be carried out to settle the relations between hardness and adhesion. The harder the rail and tire the greater will be the percentage of slip in the day's work of an engine; and there is reason to believe that the hard tire and rail may wear out faster than the softer metals, simply because the slipping is greater. We have never heard it disputed that one reason why the single engine was so successful in old times was the use of soft iron tires and rails. Indeed, we can call to mind one case in which steel tires were fitted to a single engine. After a trial of a few months they were removed, because the engine could no longer take its loads and keep time, and the rails, which were of iron, suffered. As we have said, the point deserves careful investigation.

Yet another cause of wear and tear is "hammer blow." In this country very little is heard about it; in the United States it has become a matter of extreme importance. The reason is simply that our rails being tougher than those of the United States, and, with a few exceptions, heavier, are not often broken. But it would be a mistake to assume that rails are never broken at all on British roads; the vigilance of platelayers prevents accidents. No attempt to reduce the wear and tear of permanent way can be satisfactory if it does not take account of "hammer blow" and its effects. Much may be done by spreading the compensating weight in the wheels as far as possible. The subject is far too large to be dealt with here any further, but we would refer our readers to Dr. Goss's researches, and the somewhat startling results which he got at the Engineering Laboratory of Purdue University. Our readers will find them fully set out in "Locomotive Performance," published in this country by Chapman and Hall, 1907. It must suffice to give here the last of five "conclusions" at which the author arrived:—"The contact of the moving wheel with the track is not continuous, even for that portion of the revolution where the pressure is greatest, but is a rapid series of impacts."

It will be remembered that Mr. Price Williams referred to the rapid wear of points and crossings, and of rails on curves. Whether it is or is not possible to reduce this by modifications in the proportions of wheel flanges it is difficult to say. It must not be overlooked that the differences in profile on different lines are so small that they can only be detected by careful measurement when the tires are new. Normal profiles are, in fact, survivals of the fittest. As for worn tires they are all alike soon in one respect, namely, that the character of the wear depends much on the general design of the engine. It would be worth while to extend much the practice of taking templates, and comparing the results of ten thousand miles running, say, of different types of engines on the same roads, as set forth in Mr. Hughes' paper on "Locomotives Designed and Built at Horwich," read during the Liverpool meeting of the Institution of Mechanical Engineers, and published in THE ENGINEER for August 6th last.

It would be a mistake to conclude that all wear and tear is concentrated in the tire and the rail table. The performance of an engine as a vehicle has to be kept in mind. An engine which rolls a good deal may try chairs, sleepers, and even ballast very much. Experiments made in France showed that the load on a leading wheel may vary between about 1 ton and 10 tons, the normal load being about 6 tons. An engine given to lurching, or "wandering," may try the lateral strength of a road severely. So long as the load for a driving axle does not exceed a steady 18 tons, the modern road will not take harm from mere deadweight. The difficulty with big engines is the bridges.

INSTITUTION OF MECHANICAL ENGINEERS.

No. II.*

WE continue our report of the discussion on Professor Dalby's paper on the transmission of heat, read at the meeting on Oct. 15th, and re-discussed on Oct. 29th.

Professor R. H. Smith spoke at some length. He, like several other speakers, remarked that too little attention had been paid to the question of improving the efficiency of steam boilers, and urged that the Institution should carry out further research, and that the research should be extended to investigations in connection with superheated steam. Then the speaker went on to refer to a curve which Dr. Nicolson had drawn upon the blackboard to represent the amount of heat developed with the rate of firing. The curve in question showed that the heat developed diminished as the rate of firing was increased, the curve being steep at first and then gradually turning over, similar to a curve showing the permeability of iron with different degrees of saturation. Professor Smith said that such a curve would only be obtained in cases where natural draught was employed, and that a very different result would be obtained if forced draught were used. He thought Professor Dalby's paper a most useful one. There were two points in connection with Professor Dalby's paper which were not clear. On page 23 there was an expression which was intended to give the coefficient of heat transmission for boilers, which was due to Professor Mollier. He would like to ask Professor Dalby what units had to be employed in connection with that expression. Again, on page 22 the author said that Professor L. P. Breckenridge made some experiments on a locomotive boiler with the object of finding the efficiency before and after cleaning, and came to the conclusion that the loss due to scale varies as 1.5 times the square root of the thickness of the scale. He would like to ask the author whether the word varied should not be equalled. The index at the end of the paper was a very useful one, and referred to a good many papers which he had not read. There were several valuable papers which were not included, and he would suggest that the list be still further extended. He thought also that the editors of the engineering Press might be asked to add to the list. No reference was made to the accurate measurements which had been carried out in some of the large electric generating stations. Many of the laws relating to the subject of heat transmission were based on experiments of very limited range, which made it dangerous to make use of them. Stefan's law of radiation was based on experiments carried out with thin strips of metal. He admired the work done by Mr. Jordan, but the greatest drop of temperature obtained in his experiments was 395 deg. Fah., and accuracy of a law could not be ensured with such a limited range of temperature. He also admired Dr. Nicolson's investigations, described in his paper read before the Junior Institution of Engineers, but the range of conditions over which the experiments were made was not sufficient to determine such an important law as Professor Nicolson had put forward. Among other things, the speaker referred to the methods of testing boiler performances. He said the most direct way to arrive at the efficiency of a boiler was from the weight of gas and the difference of temperature in the fire and flue. That was a direct method of arriving at the amount of heat which the boiler took up, but the difficulty attending such a test was to get an accurate measurement of the amount of gas.

Mr. H. C. A. Thieme said that as he had been working with Professor Dalby in connection with the paper, it was perhaps a little out of place for him to take part in the discussion, but he would like to draw attention to an experiment carried out by Professor Schuster, in the year 1903, to determine the effect of insulating a polished plate of a vessel on the water side. This experiment is described in one of the abstracts which Mr. Thieme has made, and can be seen in the library of the Institution. The experiment showed that with an insulating layer of scale on the water side the plate assumed a temperature of nearly half that of the fire. The conditions were similar to those which might be obtained in the fire-box of a locomotive, for the polished plate in the experiment correponded to the crown of the fire-box. The effect of the plate assuming such a temperature in the case of a locomotive boiler meant, of course, the collapse of the furnace crown, as all locomotive engineers were aware. Next, Mr. Thieme drew attention to the diagram given in the paper for indicating the loss of temperature head due to films of gas and water offering resistance to the transmission of heat. He said that the line *d e* in that diagram, which represented the temperature head required to cause the flow of heat through the plate itself, was not actually straight, as shown in the diagram, but was curved. Then the speaker turned his attention to the advantages to be derived from using damp coal, in the direction of preventing dissociation. High temperature in the furnace, he said, gave rise to dissociation, the presence of water vapour produced by the damp coal was prevented from having a beneficial effect on the performance of the boiler, but with slow combustion damp coal had a good effect. Mr. Thieme went on to refer to some experiments carried out by Professor Werner, who had used coal with various degrees of moisture and had obtained appreciable increase in the efficiency as compared with coal which contained practically no moisture. Turning to the question of the velocity of the gases, the speaker said that his firm, as practical engineers, had found that the question of the velocity of the gases was very important.

Mr. Percy Taylor thought that the paper showed what an enormous amount of work had already been done in the direction of research in connection with steam boilers. He said that if engineers, before commencing research work, would only take the trouble to look up what others had already done they would find, in many instances, that there was very little to investigate. It was, as Professor Dalby had shown, far less difficult for the heat to get out of the plate into the water than it was for the heat to pass from the fire into the plate. The film of gas on the fire side was by far the most important point to be considered. He did not think, however, that the gas film was so bad as Professor Dalby had made it appear in the diagram given in his paper. He did not think that it was right to be too hard on that gas film. In fact, he was of opinion that some engineers ought to be thankful for its existence, for in the early days, when grease and scale were allowed to accumulate on the boiler plates, it was highly probable that had it not been for that film some of the members would not have been present to take part in that discussion. It was worth while considering the heat balance of all boilers. The thermal efficiency of a good boiler could be fixed at 75 per cent., and allowing 8 per cent. for radiation, that left a balance of 17 per cent., which was nearly all accounted for. Under certain conditions it might be possible to reduce the

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* No. I' appeared November 5th.

THE TAUERN RAILWAY

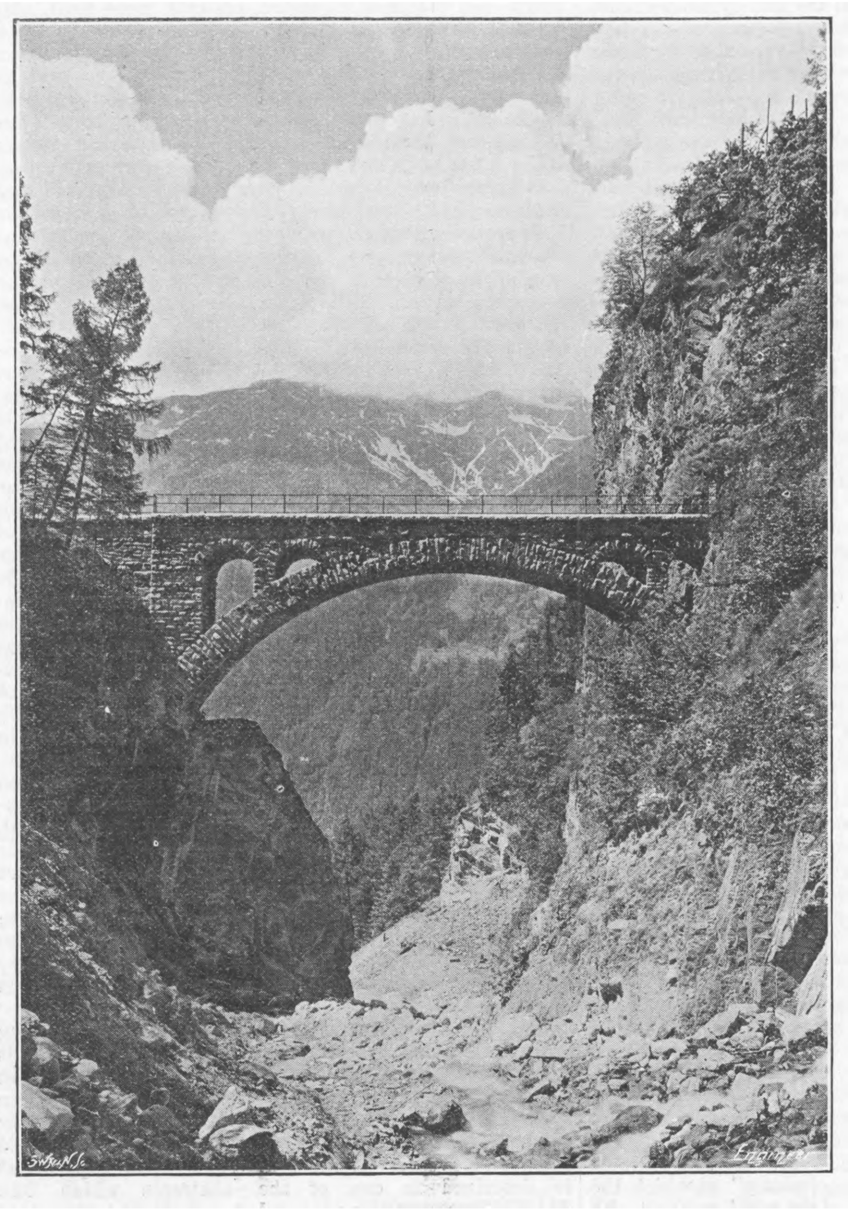

Fig. 1—GRATSCHACHER VIADUCT

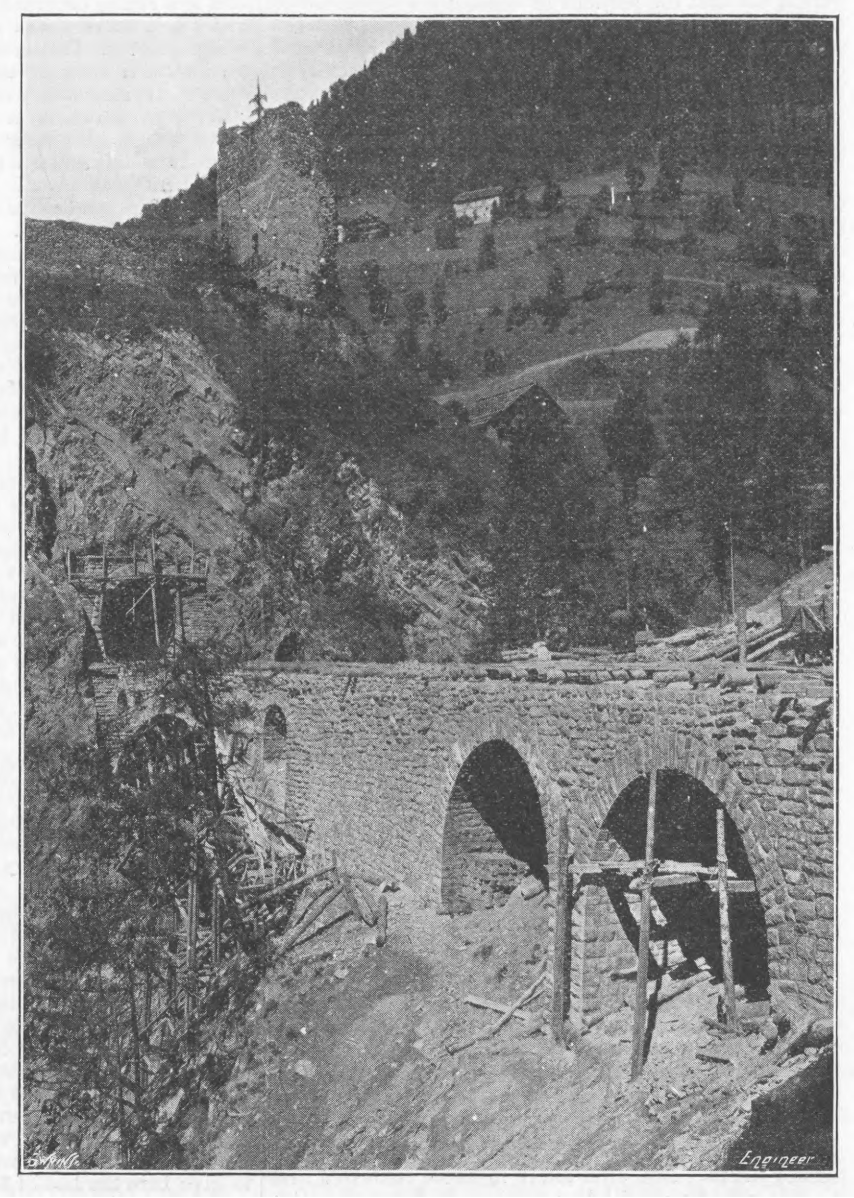

Fig. 2—OBER FALKENSTEIN

temperature at which the gases went up the chimney, but that meant the employment of a fan, and it was questionable whether there would be any saving. In conclusion, the speaker dealt with the question of the velocity of the gas, and said that when we considered, the small amount of heat which could at present be got through a square foot of heating surface, and the amount which it appeared possible to pass through, it seemed very desirable that further research work should be carried out.

Mr. C. H. Gadsby remarked that the index which was to be found at the end of the author's paper would be the means of putting engineers straight on to any particular item concerning heat transmission. Dr. Nicolson, Mr. Jordan, and others, he said, had recently devoted more attention to the fire side of the tubes than previous investigators. It was desirable to secure more complete combustion and to increase the velocity of flow of the gases, as Dr. Nicolson had shown in his paper before the Junior Institution of Engineers nine months ago. The speaker then went on to refer to the diagram in the paper indicating the loss of temperature head due to films of gas and water offering resistance to the transmission of heat. This diagram was given in our issue of October 22nd. In connection with this, Professor Dalby had said that there was probably a drop of temperature head represented by *c d* which was required to force the flow of heat across the surface where the gas film is in contact with the metal corresponding with the potential difference at a point in an electric circuit. The author had also said that there was a further fall of head *e f* at the surface of contact between the metal and the water film. Mr. Gadsby said that he would like to ask the author what experiment, if any, had been carried out to give rise to the assumption that these drops in temperature head existed. At the previous meeting the author had explained that if two rods of metal were procured, and one of these rods were cut, say, into four pieces, and then screwed together again, making the best possible joints, it would be found that if the solid rod were attached to the built-up rod and heat applied to the point where the two joined, the drop in temperature along the built-up rod would be considerably greater than that along the solid one, notwithstanding the fact that the joints made in the former were as good as it is possible to make them. The speaker thought that the greater drop of temperature along the built-up rod was merely due to bad contact, and that if the joints were soldered with silver solder there would be no greater drop in temperature head than that obtained on the solid rod. Lastly, Mr. Gadsby drew attention to the advantages which could apparently be obtained by increasing the velocity of the gases. If 30 lb. to 40 lb. of water could be evaporated per square foot of heating surface, it meant that considerable saving in space and weight of boilers would result, which would be of great advantage to central station and marine engineers.

Here the President remarked that the hour was too late for any other members to take part in the discussion, but he hoped that those who had come with the object of speaking, and who had not done so, would not fail to send in their remarks in writing. There were just three minutes left before the usual time of bringing the meeting to a close arrived, and in those three minutes he would ask Professor Dalby to say what he could in reply to the discussion.

In reply, Professor Dalby said that it was, of course, quite impossible for him to attempt to answer any of the questions which had been put with the small amount of time at his disposal. The discussion had been a very interesting one, and many of the points raised would require a good deal of thinking about. He had no doubt, however, that given the time to think, he would be able to refer the various speakers who had asked questions to abstracts of papers which would help to clear up their difficulties. With the time at his disposal he would just say a few words with reference to Mr. Mark Robinson's physical conception of what went on in the tubes of boilers. If it was considered what the size of a molecule of gas was as compared with the roughness of the metal, the projections on the plate due to roughness might be regarded as trees in a forest and the gas as a breeze of wind. It was well known that if only a moderate breeze were blowing, it would be possible to walk among the trees without feeling its effect; but the swifter the breeze became the more would its effect be felt at the ground level, and if a hurricane were blowing then anyone walking among the trees would be subjected to considerable discomfort. That, he thought, was a suitable analogy which might be employed to account for the increased evaporation per square foot of heating surface, with increased velocity of the gas. The greater the velocity of the gas the more it penetrated into the projections on the surface of the metal. It was to be remembered that when the size of a molecule was taken into account the surface of the metal was very rough indeed. He would reply in writing in due course.

THE TAUERN RAILWAY.

THE newly opened section of the Tauern Railway from Spittal-Millstättersee to Badgastein completes the Alpine railways, authorised by the Act of July 6th, 1901, to which belong the Tauern, Karawanken, and Wocheiner lines, and forms a second railway connection with Trieste. This railway secures a notable reduction of the journey from Central Europe to the Adriatic, and especially to Trieste.

The new line is remarkably rich in natural beauty. Starting from Spittal, situated at the conjunction of the Lieser and Drau rivers, the Tauern line makes its way through the Drau and Möll valleys to the foot of the snow-capped heights of the Tauern mountains, pierces this range by a tunnel 8½ kiloms. (a little over 5¼ miles) in length, and passes down the beautiful Gastein valley to the Schwarzach-St. Veit Station of the Salzburg-Wörgl Railway.

The length of the railway is 51 kiloms. (nearly 32 miles), and is a main line with gradients as steep as 28 per 1000, and curves with a radius as small as 250 m. (273.25 yards). It consists of a southern incline, a section on the summit, and a northern incline. The single track, southern incline, extends from the Spittal-Millstättersee Station to Mallnitz. Between the stations of Mallnitz and Böckstein is a double track summit section, on which the mountain train of the high Tauern will run. A single track, northern incline, Böckstein to Badgastein, forms a portion of the whole northern incline of the Tauern Railway, one section of which—Schwarzach-St. Veit to Badgastein—was opened for public traffic by the Emperor Francis Joseph in September, 1905.

From the Spittal-Millstättersee Station, to the buildings of which, with a view to the Tauern Railway traffic, extensive alterations were made, the new line runs on its own track parallel with the Southern Railway as far as the small station of Lehndorf, belonging to the latter line. Branching off here, the line, with a gradient of 10 per 1000, arrives at the station of Pussarnitz, on the border of the fruit-bearing Lurnfeld district. Directly after leaving this station the line climbs the mountain side to the left of the Möll Valley with a gradient which averages 25 per 1000 the whole way to Mallnitz Station. Embankment and cutting alternate as the line proceeds through forest and meadow land till the station of Mühldorf-Möllbrücke is reached. This station forms the starting point for the climb to Mühldorfer Hochalpensee, 2281 m. above the sea, and the Reiseck group of mountains, 2959 m. high, of whose snowy peaks only an occasional glimpse can be obtained. Shortly after leaving this station the line passes over the Tabor Valley by a steel girder bridge, with single arch of 20.9 m. span, across the Klinzer Valley by a masonry viaduct, with three arches of 8 m. span, then through two cuttings and past the lovely Waldschlösschen (little castle in the wood) lying to the right of the track. Immediately after this point, the line crosses the Mühldorfer River by a viaduct 105 m. in length with 6 arches and two steel bridges respectively 62 m. and 26 m. span. Steadily climbing, the line, immediately before reaching the Kolbnitz Station, curves round over the Rottauer masonry viaduct—Fig. 5, page 504—84 m. in length, its arches supported by high piers.

For the construction of the station at Kolbnitz, where the line had to be protected by a powerful embankment and retaining wall, it was necessary to excavate 150,000 cubic metres of earth and rock from the steep mountain side. From the station can be seen in the immediate neighbourhood Danielsberg, one of the interesting conical rocks surviving from the Glacial period. The villages of Upper and Lower Kolbnitz lie far below the station, the former at the foot of the mountain, the latter on the bank of the Möll River. Soon after leaving Kolbnitz Station, the line crosses the arched viaduct, 42m. long, which spans the Leithengraben Valley, and from this point as far as Rückenbach (or Rieckenbach) the railway is protected by numerous inner and outer retaining walls. The line next crosses the deep-lying valley by a great viaduct with a central steel bridge of 80 m. span, both ends of which are completed by stone arches—see Fig. 6, page 504. This is the Rieckental, a valley of wildly romantic beauty watered by a lake and waterfall and enclosed by the Reisseck mountains.

After crossing the Riecken River, the line winds in mighty curves along the so-called "saddle" of the wooded Danielsberg, a conical rock on which a temple of Hercules once stood. It then traverses a mountain ridge by the lower Litzelsdorfer Tunnel, 200 m. in length, crosses the Litzelsdorfer Valley by a viaduct, again penetrates the precipitous Talgehänge by the Upper Litzelsdorfer Tunnel, 84 m. long, and then mounts the increasingly steep heights by innumerable viaducts, of which the Mölltheuer, the Schlossgraben, and the Zweniggraben are the most notable, following each other in quick succession until the watering station of Penk is reached. The station lies 900 m. above sea level, and is called after the village of that name lying far below in the valley at a bend in the river Möll. Here a magnificent panorama of mountain scenery is afforded to the traveller, including the Salzkofel, 8100ft., and, on the opposite side, the giant mass of the Polinik, 9035ft.

In the next section of the railway, and as far as the station of Obervellach, the line had to be carried along the sides of almost sheer declivities, necessitating an almost unbroken series of tunnels and viaducts laid on sharp curves. Nine tunnels, with a total length of 3195.55 m. (about two miles), two galleries, and five large viaducts are included in this section. The difficulty of laying such a line was greatly increased by the labour involved in the transport to the spot of the required building material. All of this had to be conveyed from the country road through the Möll Valley to the line level, hundreds of feet higher. Not only was it necessary to strengthen roads and paths, but two cableways had to be fitted up for this work.

Directly after leaving the Penk Station the line passes through the Zwenberg Tunnel, 390 m. (426 yards) long, and crosses the Pfaffenberg-Zwenberg Valley, between gigantic walls of rock, by a viaduct overspanning at a height of 68 m. (223ft.) the gorge below, through which rushes the Wildbach torrent—see Fig. 7. The centre span of this viaduct is 190ft. wide, and the two side arches are 108ft. each. The three spans are carried on piers 170ft. (52 m.) in height, the foundations of which were sunk with great difficulty to a depth of 50ft. (15 m.) in the steep sloping ground. The separate sections of the bridge had to be conveyed from the depôt at Stampf on a special movable staging over *débris* and rock a distance of 437 yards (400 m.) to a place where they could be put together, and from which they were raised to the erecting scaffolding by means of a crane 111ft. (34 m.) in height.

After this point comes the Pfaffenberg Tunnel, 544 yards in length, and then the line takes an S-shaped double curve and proceeds to climb the steep sides of the Pfaffenberg with an average gradient of 24 in 1000. The Gratschacher Tunnel, which has a very sharp double curve—357 m.—is next traversed, and then follows the arched stone viaduct over the Gratschacher Valley —Fig. 1. Another tunnel, the Falkenstein, 67 m. in length, follows—see Fig. 2—and then is to be seen on the rugged mountain top the ruins of the castle of Ober-falkenstein. These had to be partially reconstructed with a view to the safety of the railway, but fortunately their beauty remains unimpaired.

With a heavy gradient, the line now passes in quick succession through the lower and upper Lindisch tunnels, 379 m. and 260 m. in length respectively, the two being only separated by an arched stone viaduct of 25 m. span over the Lindisch Valley. From the upper Lindisch Tunnel the line reaches the steep side of the Kofel Mountain. Here, at a great height above the Möll Valley, it is carried along in a deep rock cutting, protected by a wooden gallery against the danger of falling rock.

The line next enters the long lower Kapponig Tunnel, which is 789 metres long, and which is followed by a viaduct over the wild gorge of the Kapponig River. The principal span of this viaduct is 25 metres wide. A protecting gallery was also required here, through which the train passes to the long upper Kapponig Tunnel—205 metres long—and across the Laskitzer viaduct, which is constructed on a curve, and has seven arches, and so to the small station of Obervellach, situated 380 metres (1235ft.) above the attractive little town of the same name. The plateau on which this siding, also used as a watering station, was erected had to be wrested, as it were, from the mountain side by blasting the virgin rock, and is now protected by high retaining walls. From the station a magnificent view is afforded over the beautiful Möll Valley, shut in by snow-capped mountains—see Fig. 4.

The line proceeds at a continuous gradient of 25 in 1000 to the end of the Möll Valley, where it turns sharply northwards with a curve of 250 metres radius, and takes its way along the precipitous slopes of the Mallnitz. In quick succession the line then crosses on five great viaducts, the Haslacher, Küchelwald, Auer, Rauchen and Waldmann valleys. Numerous timber slides occur on the wooded slopes in the neighbourhood of the railway, and enable the peasants of the mountains to collect their harvest of hay and wood, the latter, unfortunately, not without detriment to the beauty of the hill sides. Far below in the gorge on the right bank of the Mallnitz, in the neighbourhood of Lassach, is an electrical works which, during the building of the Tauern Tunnel, supplied the power for the working of the boring machinery, the ventilation, lighting, and hauling plant.

Just before entering the long Dössen Tunnel, which is 880 m. long, the line crosses the narrowing gorge of the Dössen Valley by an arched viaduct—see Fig. 8—which spans the Wildbach River. On its northern side the Dössen Tunnel penetrates an old landslip, which, on account of its loamy nature and its numerous water carrying fissures, caused great difficulty in construction.

Out of the Dössen Tunnel the line curves into the station of Mallnitz, the highest on the Tauern Railway—see Fig. 3—which lies on the left bank of the Mallnitz River at a height of 1180 m. above sea level. Leaving the station the line passes the lovely Alpine village of Mallnitz, crosses the Seebach River obliquely by a steel bridge and shortly afterwards reaches the southern entrance of the Tauern Tunnel.

On the 23rd of January, 1909, after 7½ years of most arduous labour, the keystone of the Tauern Tunnel was placed in position. This marked the completion of one of the greatest pieces of constructional work of modern Alpine railways. The tunnel pierces the lofty Tauern range of the Central Alps below Gamskaarlspitze, 2828 m. high, and reaches at its greatest elevation a height of 1225 m. The length of the tunnel is 8550.5 m. (9346 yards) long, and is one of the longest tunnels of the Austrian Alps, being second only in the monarchy to the Arlberg Tunnel, the length of which is 10,247 m. At a little more than 3 kiloms. distance from the southern entrance the centre line of the tunnel reaches the border of the Crown lands of Salzburg and Kärnten, both of which are traversed by the tunnel. From the southern entrance the tunnel cuts through 574 m. of mica slate, then as far as 3250 m.—level measurement—it passes through porphyroid granitic gneiss, and afterwards to 5200 m. through fine-grained granitic gneiss. For the remaining 350 m. it traverses mountainous *débris* and great blocks of stone comprising the alluvial deposit of the Höhkar River.

Besides numerous smaller springs, there were opened up at 2262 m., 2460 m., and 2610 m. springs giving 60, 40, and 50 litres per second. The temperature of the rock on the north side steadily increased as the work proceeded, and in the middle of the tunnel reached a maximum of about 75 deg. Fah. On the south side, where the temperature was influenced by the cold springs, it remained pretty constant at between 40 and 57 deg. The temperature of the air in the working gallery of the roof rose, in spite of the artificial ventilation, as high as 91.5 deg. Fah.; it was, however, reduced by the water-spraying apparatus about 68 deg. Fah.

It was interesting, from the geologist's point of view, to meet with fulminating (detonating) rock, which would, with no previous warning and with a violent explosion, dislodge from the opened-up rock sheets of as much as 150 mm. in thickness.

In spite of the solidity of the rock, the building of the tunnel proved an exceptionally difficult task on account of the hardness and tenacity of the mineral formation, as well as on account of the unexpected quantity of water encountered, and also because of the above-mentioned explosive character of portions of the rock. On July 6th, 1901, the work of construction of the tunnel was begun by the piercing of the heading on the north side. In September of the same year, the Brothers Redlich and Berger took over the contract for the work of the piercing of the level, and the level on the south side was also begun. When in July, 1905, further sums of money were voted for the construction of the new Alpine railways and tenders were publicly invited, the above-named firm was entrusted with the carrying out of the whole of the work on the tunnel. The dividing wall between the north and south levels was pierced on July 12th, 1907, when it was found that the levels exactly corresponded in direction and height.

The clearing out of the rock was carried out on the Austrian tunnel system. To detach the rock explosive gelatine and dynamite were almost exclusively made use of, the blast holes for which were at first made by hand boring. Afterwards arrangements for mechanical boring were completed, and in addition to the hand boring, Brandt hydraulic drills and also the electric drilling machine of Siemens and Halske were employed.

The masonry work of the tunnel was carried out in stone set in Portland cement, and its chief use is only as lining for protection against loosening of the rock. In the fissured and water-bearing zone on the south side, as well as in the alluvial bed of the Hohkarbach River, where the tunnel lining had to sustain very great pressure, it was necessary to employ specially thick masonry work carried on vaulted arches, which in damp parts were covered with corrugated sheet iron to carry off the water and as protection against the washing out of the mortar. The water collected in the completed tunnel is drawn off to the portals by a masonry channel constructed below the ballast bed. For the building stone of the tunnel masonry work a hard granite gneiss, which was found on the north side in the slopes of the Böckstein Valley, and on the south side in the Seebach Valley, was employed.

The impurity of the atmosphere in the tunnel due to the presence of the labourers, the gas released in blasting, and the exhaust from the oil engines, together with the increased temperature of the air underground, necessitated a continuous renewal of the air. For this purpose high-pressure ventilators were installed on the north and south sides, and pumped in fresh cool air by pipes at the rate of 350 c.m. per minute, the impure air being removed at the mouth of the tunnel. Owing to a series of unforeseen circumstances, the work at the tunnel was repeatedly interrupted at longer or shorter intervals. After the commencement of the piercing of the north level, and at a distance of only 300 m. from the entrance, where the level passes through the alluvial bed of the Höhkar River, numerous subterranean springs were struck, which poured forth a continually increasing quantity of water into the workings. In order, in spite of this, to proceed with the excavation and lining of the tunnel, it was necessary to lay special drainage channels. When, however, in September, 1904, a flooding disaster occurred, in the district of the river Anlauf, and the river changed its course, which increased the water already in workings to 4000 litres per second, all work in the tunnel had to be stopped. Even after the flood had subsided, the water still entered the workings at the rate of 200 litres a second, and it was necessary, in order to resume work in the tunnel, to divert the river Höhkar above the workings by means of an artificial channel, and to conduct it back again into its natural bed below the workings.

On April 27th, 1907, an inrush of water at the rate of 60 litres per second occurred in the northern heading at a distance of 6 kiloms. from the portal, and work could only be resumed after a very considerable amount of reinforcement of the heading, and the lining of the walls with sheet iron as protection against the water. The continual inflow of water through the rock flooded the entire heading, so that the men working therein were always wading in the water. On July 13th, 1907, a considerable inrush of water and a spring was encountered in the south heading 3 kiloms. from the portal, which for the time completely laid under water

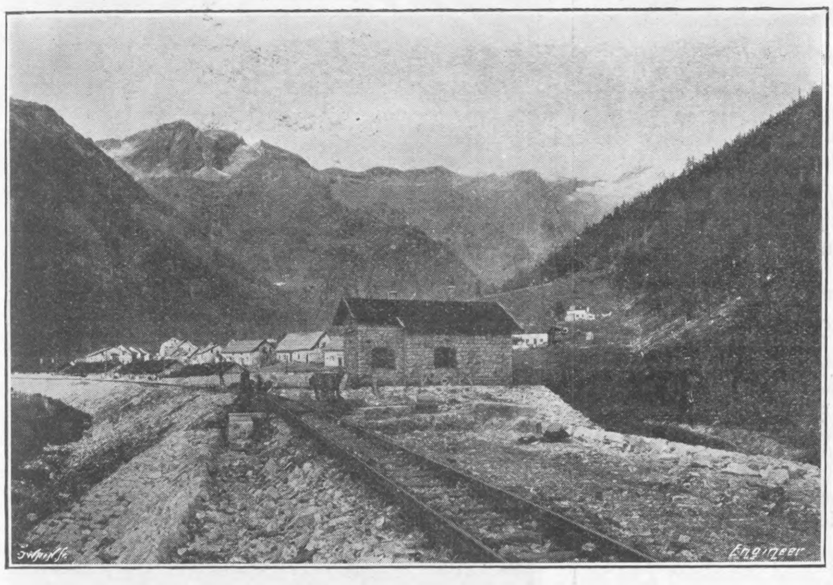

Fig. 3—MALLNITZ

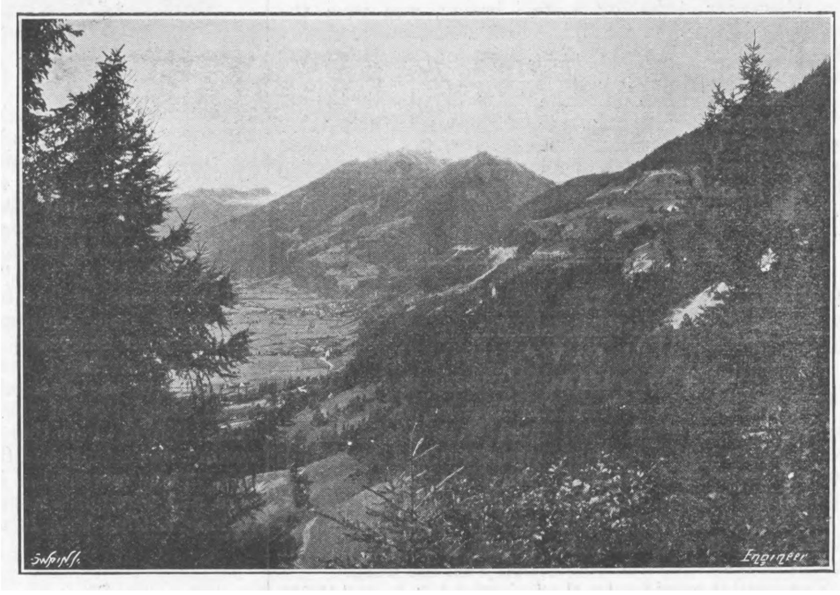

Fig. 4—THE MOELL VALLEY

the working, and similar measures to those employed in the northern heading had to be adopted.

With regard to the building materials used, we may say that the masonry work carried out in the tunnel absorbed 230,000 cubic metres of stone and 2350 wagon loads of cement. For the blasting of the rock 580,000 kilos. (1,278,320 lb.) of dynamite and 125,000 kilos. (275,500 lb.) of other explosives were employed. The material quarried in its loosened state amounted in round numbers to a million cubic metres.

From the Tauern Tunnel the railway enters the Anlauf Valley. Directly after leaving the tunnel the station of Böckstein is reached. The buildings comprised in this are most picturesque, with massive grey walls, green balconies, and gables, admirably in keeping with the surrounding landscape. From the Böckstein Station the track descends in steep gradients, crossing the roadway approach to the station and the river Anlauf by a great iron bridge of 43 m. span.

Beneath this bridge, on March 7th of the present year, an avalanche descended from the mountain summits between Henigleiten and Thomaskogel in the Haitzingeralm district, and caused the overflow of the river Anlauf, overwhelming thirty-eight labourers who were collected for breakfast in two small huts. Eleven of them were rescued at once, but only the dead bodies of the remaining twenty-seven were recovered after the removal of a mass of 15,000 c.m. of snow. The dam which is now seen at the foot of the opposite slope of the valley, and which extends from the Anlauf Valley to the Nassfelder Valley, was formed of half a million cubic metres of material obtained through the excavation of the northern half of the Tauern Tunnel.

Steadily descending, the line passes a large quarry, the hard granitic gneiss from which supplied the building stone for the masonry of the tunnel. The line then curves out of the Anlauf Valley into the upper Böcksteiner Valley, and reaches the station of Böckstein.

The line crosses the Stuhlalp viaduct with heavy gradients, high above which strong embankments have been erected to protect the line from avalanches. Shortly before reaching the station of Badgastein, the line sweeps in a great curve downwards, passes obliquely across the Upper Gastein Valley, crosses the marshy tract of the Gasteiner Ache by a steel bridge, and then the Ache itself by a trestle bridge of 24 m. span, finally arriving at the station of Badgastein, hitherto the terminus of the Tauern Railway.

The remaining portion of the line, 30 kiloms. in length, was opened for traffic, as already mentioned, in September, 1905. Leaving Badgastein the line passes through the lower Gastein and the Salzach valleys and effects a junction with the railway from Salzburg through Wörgl to Innsbruck at the station Schwarzach-St. Veit.

IRRIGATION WORKS OF THE UNITED STATES GOVERNMENT.

No. VI.*

THE UNCOMPAHGRE DISTRICT.

The Uncompahgre Irrigation District, in Colorado, presents features of very exceptional character and interest in the boldness of the scheme carried out, and the difficulties of construction entailed. An adventurous exploration survey along a mountain torrent, at the base of rocky walls 1500ft. to 3000ft. high, and in some places only 150ft. wide, at a considerable height above the bottom, had to be undertaken in connection with the work.

The district provides for the irrigation of about 140,000 acres of land, at an elevation of 5000ft. to 6400ft. above sea level, where the extremes of temperature are 20 deg. and 90 deg. Fah. The rainfall is 6in. to 11in. at some points, and 8in. to 20in. at others. The soil includes clay loam, adobe clay, gravel, and disintegrated red sandstone. The Uncompahgre River flows through a broad valley on the western slope of a range of the Rocky Mountains, with lands only awaiting a supply of water to become fertile. Of the 140,000 acres comprised within the present project, about 80,000 acres are general farming lands, and 60,000 acres are available for fruit farming. The fruit lands, when irrigated and properly cultivated, are very valuable, and some of them, when planted with apples and peaches, bring an annual revenue as high as £100 per acre. About 20,000 acres have been irrigated in an inadequate way for some years by private enterprise, but the natural volume of flow in the Uncompahgre River is sufficient only for the irrigation of a part of the great area of the valley, while the flow is so erratic that the river cannot be depended upon for an irrigation supply.

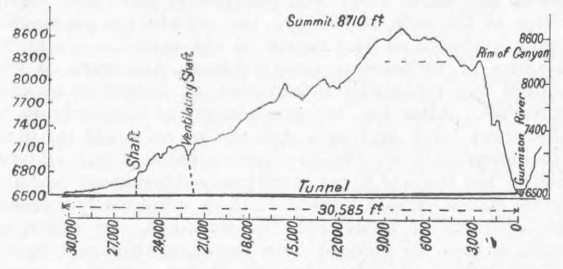

Fig. 41—LONGITUDINAL SECTION OF TUNNEL

Practically parallel with this river is the Gunnison River, about six miles distant, and separated from the Uncompahgre by a rugged mountain ridge rising to a height of 2200ft. above the Gunnison. This river has a large watershed extending to the summit of the Rocky Mountains, but it lies in a deep and narrow rock gorge or canyon, while its lower valley has no large area of irrigable land. The engineers decided, therefore, to obtain a supply of water from the Gunnison River for irrigating the Uncompahgre Valley, by means of a great tunnel through the dividing ridge. The tunnel is six miles long, 10ft. to 11ft. wide, and 12ft. high. It has a fall of 2.02ft. per 1000ft., and its flow capacity is 1300 cubic feet. per second. A longitudinal section is given in Fig. 41. The entrance portal is 6533ft. above sea level, while the summit on the line of the canal is 8710ft. above sea level. The dam will not be a very high one, as in forming a storage reservoir, but will be a comparatively low dam diverting the river flow into the tunnel.

The "Grand Canyon of the Gunnison," in which the diversion dam and tunnel entrance have been built, is noted for its wildness and its great depth, which ranges, as noted above, from 1500ft. to 3000ft. A large part of the canyon is inaccessible from above and impassable below on account of the fierce current of the river, which is broken by masses of rock, by the numerous sharp bends, and by vertical falls and rapids. Fig. 45 is a view in the canyon taken during a stage of comparatively low water. Some idea of its vastness may be gathered from the small figure of a man sitting on the big ledge of rock in the foreground. Fig. 46 gives a better idea of the wild and broken character of the canyon and of the difficulties encountered in the exploration. In flood stages the water will cover the rock to which the man is clinging. On the left is an old "pot-hole."

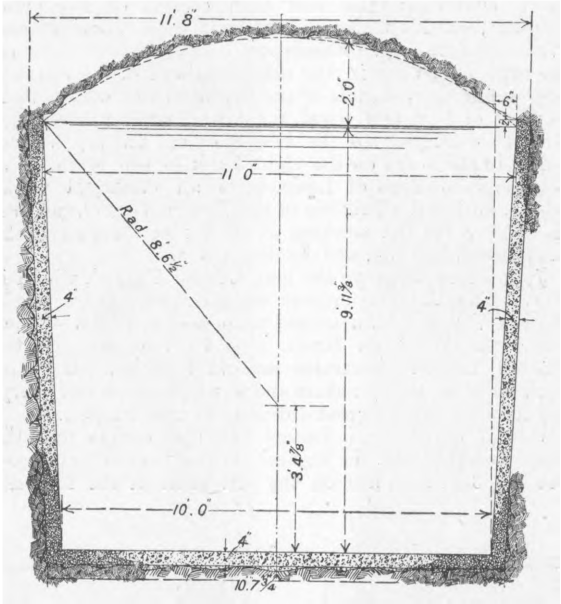

Fig 42—CROSS SECTION OF TUNNEL

The passage of this forbidding and dangerous canyon had never been accomplished, but it was absolutely necessary to carry the survey through the canyon in order to determine the elevation of the river, the character of the channel, and the best site for a dam. Some description of this work will be given later on; suffice it to say here that two engineers made the trip by wading, swimming, and floating on an air mattress for a raft. Their adventures included floating over a fall 30ft. high and through a natural tunnel. They were gone for so long a time that it was believed they had perished, sharing the fate of hunters and pioneers who had essayed the passage, but they emerged unharmed, and with their task successfully accomplished. On other parts of the surveys many of the engineers and topographers had to be lowered by ropes while making their studies and taking their observations.

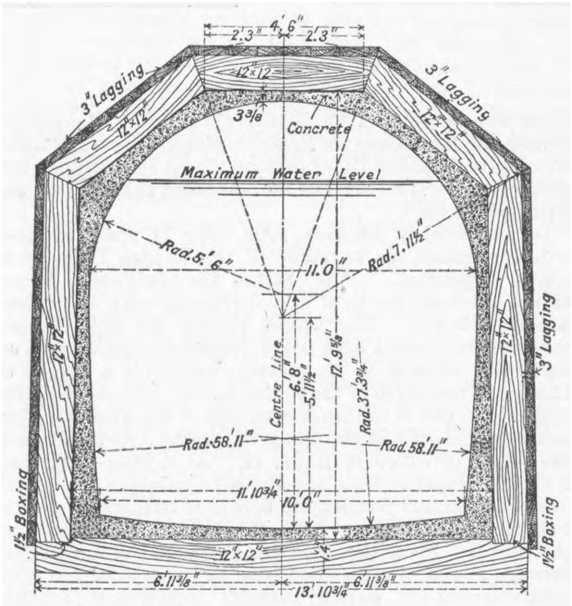

Fig. 43—CROSS SECTION OF TUNNEL

A road was built in the canyon to the site of the dam, partly in solid rock excavation and partly across a talus of massive boulders and broken rocks. This is sixteen miles long, and rises out of the end of the canyon by gradients of 1 in 4. Over this road the machinery was hauled piecemeal, and a construction camp and power plant established near the mouth of the canyon. The cost of transportation was enormous, all supplies and materials having to be hauled in wagons for great distances, and over the roughest kind of mountainous country. The tunnel was commenced by contractors, but their work was unsatisfactory, and they finally abandoned the job. New tenders were invited, but those received were so high that it was decided to carry on the work by the Government engineers and hired labour. The crude camps established at each end of the tunnel by the contractors, with no sanitary or other conveniences, and with wretched accommodation for the men, were replaced by small villages, properly laid out, and having water supply, sewers, electric light, a hospital, cottages, and a staff of sanitary inspectors and police. The working plants were also improved, and electric light and electric locomotives introduced in the headings. There were about 140 men at the camp on the eastern, or Gunnison, side, and 800 at the other camp.

The tunnel proved to be a most difficult and dangerous undertaking, but is now completed. The materials penetrated have included solid, shattered, and seamy rock, shale, clay, and beds of sand and gravel. Gas pockets were encountered, sometimes of dangerous extent. Springs of hot and cold water were numerous, necessitating a large pumping plant to deal with a flow of from 250,000 to 750,000 gallons per twenty-four hours. Several slides and falls occurred, and in many parts it was necessary to follow closely the excavation with a very heavy timber lining, leaving room for the permanent concrete lining.

The tunnel section in solid rock, with concrete side and floor lining, is shown in Fig. 42. It is 10ft. wide at the bottom, 11ft. wide at the springing line—which is the maximum water level—and 9ft. $11\frac{3}{8}$in. high to the springing line. The rock roof is dressed to a neat radius of 8ft. $6\frac{1}{2}$in., with a rise of 2ft. The concrete lining is 4in. thick, but where a concrete arch is required this is 6in. thick, with a radius of 7ft. $10\frac{1}{2}$in. on the intrados. Fig. 43 shows the section with timbering and concrete lining. This is of horseshoe section, with a semi-circular roof arch of 5ft. 6in. radius on the intrados. The timber sets are 3ft. apart between centres, and their sills, posts, and roof pieces are all 12in. by 12in. timbers. Outside the sets is 3in. plank lagging. Fig. 44 is an interior view of the timbered section before the concrete was put on. This shows the narrow-gauge double-line construction railway, the drain at the side, and the pipe line for compressed air.

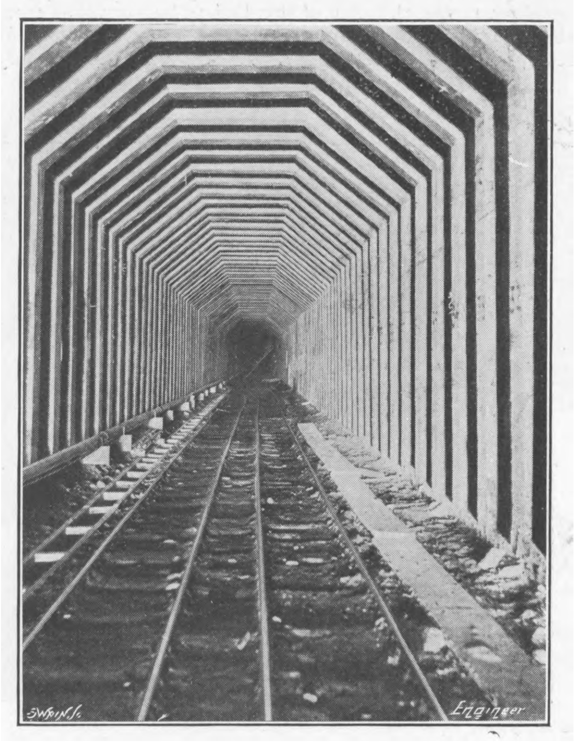

Fig. 44—INTERIOR OF TUNNEL

From the west or outlet portal of the tunnel a main canal extends across the valley to the Uncompahgre River, a distance of about twelve miles, with a fall of nearly 250ft. The broken character of the country and the difficult nature of the canal work may be judged from the following items of the principal structures, &c.:—Seven miles of canal in earth and soft material, four miles of concrete-lined canal, 2277ft. of tunnel, two inclined-plane drops of 46ft. and 28ft. vertical fall respectively, fourteen vertical drops of 10ft. each, eighteen masonry and pipe culverts, three bridges, and ten diversion pipes with gates, &c. It will be seen that in addition to the gradient, there are twelve vertical drops in the canal, with an aggregate fall of 214ft. About 20,000 horse-power will be developed by water wheels and turbines at these falls.

From the replenished river the water will be taken by two main canals, having concrete headworks with regulating gates. These will cross three streams—dry beds except just after rains—by inverted syphons. A tunnel, 1700ft. long, with a cross section of 8ft. by 10ft., will be built to avoid the necessity of building and maintaining $1\frac{1}{2}$ miles of canal along a steep side hill slope. These two canals will be thirty-five miles and thirty miles in length.

Reference has been made above to the adventurous trip of two engineers through the canyon of the Gunnison River, using an india-rubber air mattress as a raft to carry their heavier instruments, and to support themselves when necessary. Observations were made from ledges, boulders, and other points where a footing could be had. A description of the trip, written by one of these engineers, has appeared in *Van Norden's Magazine*, and is given herewith, but slightly condensed. Some idea of the difficulties may be gathered from the views in Figs. 45 and 46.

"With our record books and smaller instruments strapped to our bodies under our clothing, and the rest of the outfit attached to the rubber mat, we started down

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* No. V. appeared October 29th.

AMERICAN IRRIGATION WORKS—THE UNCOMPAHGRE PROJECT

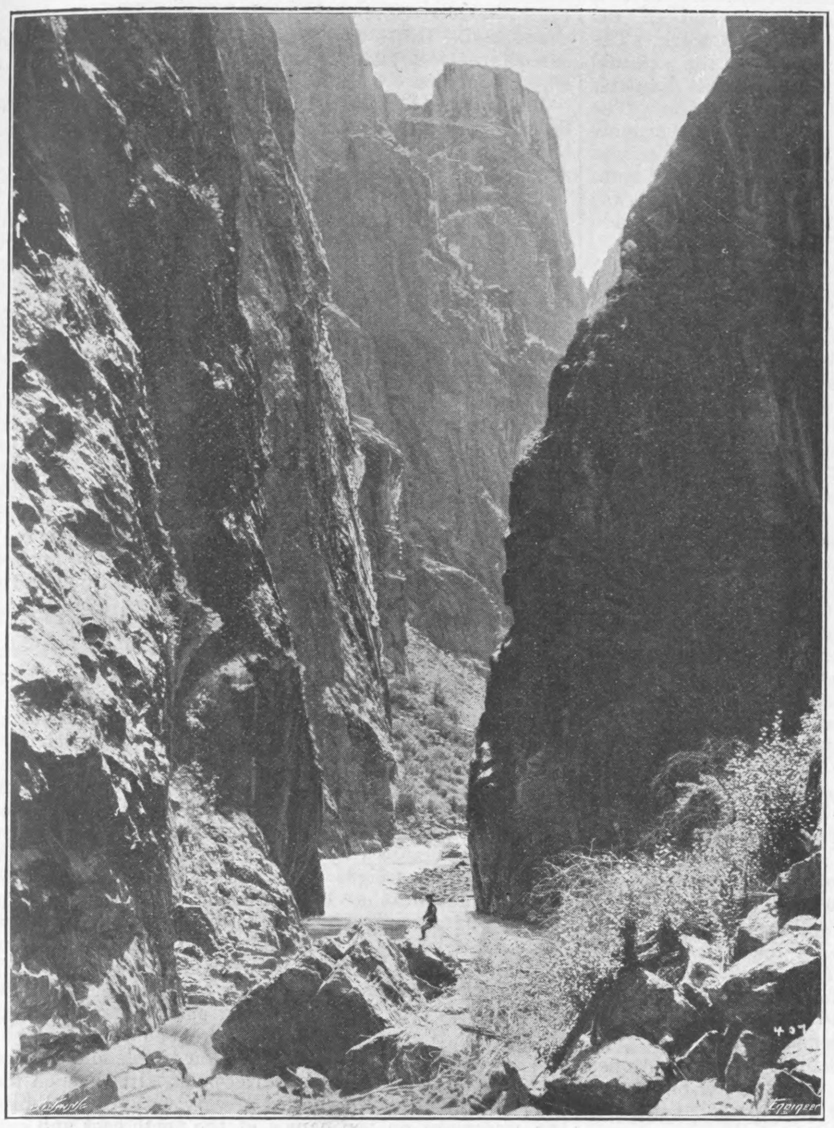

Fig. 45—THE GRAND CANYON, GUNNISON RIVER

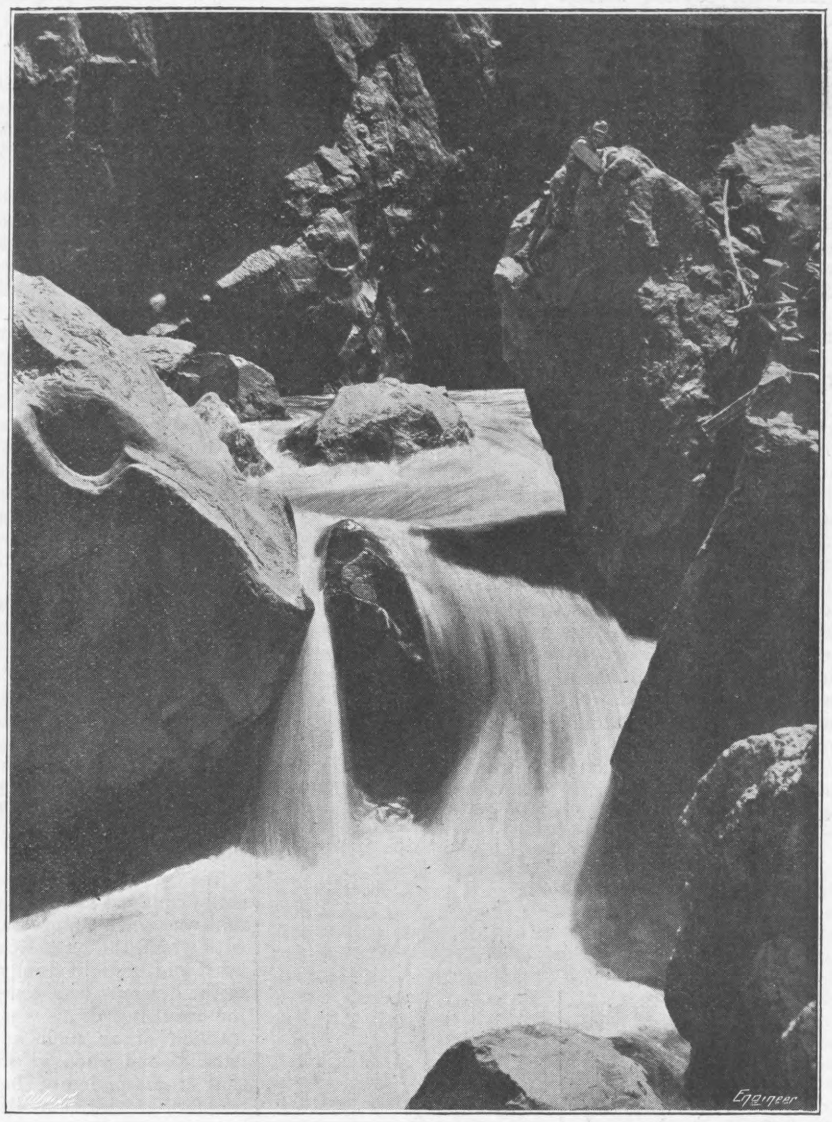

Fig. 46—EXPLORING THE BED OF THE GRAND CANYON

the gorge. The river, strewn with rocks, was a series of rapids, with an occasional bit of clear water. The walls were so steep that we could only climb along the face a few feet at a time, and had to wade, sometimes swim, through much of the gorge, towing the mat or letting it float before us, carried down by the current, while we tried to guide it between the rocks and keep it from being thrown ashore by the miniature whirlpools.

"We worked our way slowly along, up to the waist—sometimes shoulder high—in the ice-cold water, our faces continually drenched by the spray from rapids. In a number of places where the channel widened and deepened we would take turns swimming with the current and pushing the mat ahead, thus moving it in the proper direction. More than once this curious raft kept us afloat when so exhausted that we could not have crossed the pool without going under.

"Towards the end of each day we would look about for a place to stop. Sometimes our resting-place would be the top of a rock just above the seething waters, so small that we would have to moor the mat in the river. Here and there we found rock ledges just wide enough to stretch out upon, but, as I have said, the sides of the channel were so abrupt that most of our journey was made by wading and swimming rather than by climbing and walking on the sides.

"Our meals were eaten anywhere and at any time. When we had to rest for a spell we would get a bite of meat with a biscuit. Once in a while we came across a bit of dry wood left by the river when in flood. This meant a cup of coffee or tea and a little warmth; but we seldom had enough for a camp fire at night, when our wet clothes chilled us to the bone.

"As the Gunnison narrowed, the water poured over the boulder-strewn bed with such force that we could hardly stand. In one place, where we had to work our way over piles of rock fragments in the midst of the stream, and struggle to keep the raft from being battered to pieces amid the boiling rapids, we were actually five hours in going about 60ft., and down stream at that. It seems a miracle that we got through some of these mere rifts in the rock, through which the water poured like a mill-race, thrown high above our heads by striking the rocks and forming whirlpools and cross currents.

"We found a way to the rim by a narrow fissure where the canyon wall had given way, and by hoisting each other with ropes we got out safely. When we had to go down again to make more observations, we decided that we could only do it from the other side. This meant a march around the head of the canyon, in which we travelled 150 miles to reach the crevice. Then the ropes were again put in use, for in some places it was necessary to lower a man a sheer hundred feet before he had even a ledge on which to stand. With my partner I resumed the journey down the gorge.

"At one point the river passes over a waterfall. We knew nothing about it until we were a hundred feet or so from the brink. The depth shallowed here so that I could stand on the bottom in spite of the swift current. My partner did the same. He waded slowly ahead, feeling his way carefully, until he was within a few feet of the brink.

"'It's a fall,' he shouted, 'I'm going over here. We can't get back the way we came.' The mat went first, then we followed, trusting in Providence. I knew nothing for three or four minutes until I came back to my senses, to find that I was floating against a ledge of rocks and unconsciously had grabbed a narrow spur jutting out from it. Looking back I saw my partner partly seated on a stone shelf on which he had managed to pull himself. As near as I could estimate it, we had gone over a cataract fully thirty feet high, but as luck would have it, had fallen into the middle of the stream, where it was deepest, but on either side the dark points now and then sticking up out of the waves told us how we might have ended.

"For ten days and nights we were on the rim and in the Gunnison canyon, wading, climbing, swimming, not knowing what the next hour might bring to us. We had allowed about a week for the investigation and had enough food for that time, but when the week was up and most of the canned meat had disappeard, things looked serious.

"Soon we reached a place where the Gunnison disappeared in an underground passage. In front of us rose a dark mass of basalt rock which no man could climb. It was a case of following the river or remaining to die. The force of that current was such that it probably saved our lives, for it sucked us under the surface and prevented us from being dashed to death against the stone roof. I do not know how long we were whirled through it by the torrents, and when we emerged, though nearly exhausted, we had enough strength to reach the shore, where we rested. On the next day we reached a point where the gorge widened, and we noted a crevice in one of the great cliffs forming the sides.

As we had made all our surveys and examinations and believed we had located the right entrance for the tunnel, we decided to climb this crevice, and after hours of scrambling up shale and rock and the use of a rope we still had left, the top was reached, when our instruments showed that we had ascended no less than 1500ft. in a straight line. Yet the Devil's Slide, as the Indians call this place, is one of the lowest parts of the walls of the Gunnison canyon, as some of them reach a height of 3000ft. above the river."

THE MAKING OF TURBINE ROTOR DRUMS.

The increased use of steam turbines of large size has called into being a number of machines specially designed for their manufacture, and makers have been quick to adopt any new appliances which would tend to decrease the cost of production of the various parts. We have in the past made frequent reference to lathes and other tools which have been introduced to deal with this branch of engineering, and we have recently had an opportunity of observing in operation at the works of John Brown and Co., Limited, a series of patented processes by means of which the drums of steam turbines of large power are produced in a highly expeditious and efficient manner.

The whole procedure is, in conception, wonderfully simple. The earlier processes by which the large hollow blooms for final rolling are produced are modifications of well known processes, and it is not therefore necessary for us to describe them in detail. It is sufficient to say that the blooms are either produced by punching from solid ingots, and subsequently drawn to the requisite length and diameter—the large press shown in the supplement being used for this purpose—or are hydraulically forged, cut to length, and afterwards trepanned. In either case the blooms so produced reach the mill with a hole through the centre, large enough for the top roll to be threaded through, as described below, and of a cross section sufficient to roll out to the necessary diameter and thickness subsequently.

The bloom, when prepared by either of these processes is ready for rolling, which is carried out in an interesting mill now to be described. The rolls of this mill are driven from one end of the crank shaft of an engine, the other end of which can drive a large armour plate rolling mill. The engine develops as much as 12,000 horse-power. It is somewhat difficult to describe the hollow rolling mill without the aid of a drawing, which, unfortunately, we are unable to reproduce, but we will endeavour to make it as clear as possible. There are two main rolls, which are arranged horizontally one above the other, and which, normally, are parallel to one another. The bottom roll is driven direct from the crank shaft of the engine through a universal joint, so as to allow for motions of the shaft hereafter alluded to. The top roll is driven through gearing from the main shaft, and power is transmitted to it through a clutch, which can slip when the speeds of the two rolls become disproportionate owing to the reduction in the thickness of the metal in between them. The axis of the top roll always remains fixed, saving within small limits, which will be mentioned later on. The lower roll, however, can be adjusted in height so as first of all to give the necessary squeeze in rolling, and also so as to compensate for the reduced thickness of material as the rolling proceeds. The adjustment in the height of the lower roll is brought about by means of two vertical screws, of the same pitch, which carry the bearings at either end. On these screws work toothed pinions, the teeth of which gear with two racks placed horizontally one on each side of the screws, and actuated by two hydraulic cylinders. The pinions are held in position and cannot move in any way save to revolve, and the teeth are of the same pitch in each case, so that as they mesh with the same racks any motion of the latter is reproduced in identical upward or downward movements of the screws. Hence the roll is always horizontal, whether it is being moved upwards or downwards. The accompanying sketch, which is purely diagrammatic, will perhaps serve to make this explanation clearer. This shows a partly rolled drum or tube in position between the two main rolls, and it also shows the screw, the nut and the racks. Other pairs of rollers are also seen. These can be varied in position, so as to bear more or less strongly against the outside surface of the drum. By their means the shape of the drum is controlled, and if there is a tendency for it to depart from the cylindrical form it can be brought back again. These guide rollers are controlled hydraulically, and under ordinary circumstances only the lower pair—those shown touching the drum—are needed. In fact, we gathered that the upper rolls had not been brought into use hitherto, for they will only be employed when drums very much larger than those now in use are required, or when by some unforeseen circumstance the drum during rolling should become much deformed. Such an experience has not been hitherto encountered. All the hydraulic motions referred to are controlled from a raised platform where the operator has a full view of the work in hand and of those who are directing the proceedings.

The top main roll can be withdrawn endways with one of its bearings—that on the side away from the engine—by means of two horizontal hydraulic rams. When it is desired to roll a drum, a drawn tube is first of all heated to the requisite temperature in a furnace. The top roll is then withdrawn as just explained, and the tube is placed horizontally in the machine so that it rests on the two lower guide rollers, which can be adjusted so as to bring the bore of the tube concentric with the withdrawn top roll. The bore of the tube is slightly larger than the diameter of the roll, but the latter has an enlarged shoulder at the end where it enters the tube, this shoulder being provided, so that any scale which has formed may be forced out when the hydraulic rams push the upper roll through the tube and into its inner bearing. When this has been effected the lower roll is raised by means of the racks and screws as already explained, and rolling can commence.

We were fortunate enough to witness the rolling of a number of turbine drums of various sizes, the largest being 12ft. 2½in. diameter when finished, and weighing some 23½ or 24 tons. The actual rolling of this huge ring or tube of metal occupied only about 26 minutes. As will, no doubt, have been understood, the rolling is effected by getting a squeeze between the rolls by raising the lower of the two and then starting the engine. The effect of this is to revolve the tube and gradually to reduce its thickness while increasing its diameter. Of course, as the diameter increases the adjustment of the guide rollers, which are worked hydraulically, has to be altered. It is really astonishing how quickly the process is carried out. From time to time measurements are taken in order that it may be seen how the operation is going on, and whether the tube is maintaining a truly cylindrical form. To take these measurements accurately the machinery has to be stopped, though as a rough guide there are two dials, one of which shows the thickness of metal at one end of the drum and the other at the other.

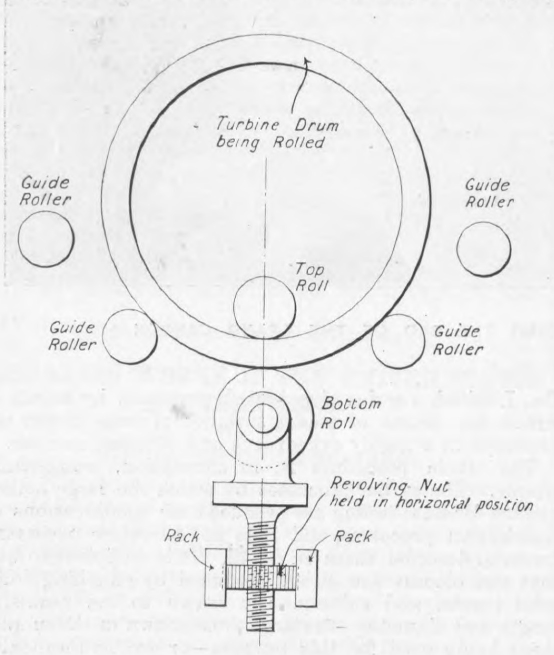

DIAGRAM OF HOLLOW ROLLING MILL

To correct anything which may be found to be wrong there are several adjustments which may be made. Supposing, for example, the diameter of the tube is slightly greater at one end than the other. The adjustment for correcting this is made by means of the top roll. Above the cap of the outer bearing of this—*i.e.*, the bearing away from the engine and next the hydraulic rams—there is a system of wedges. When these wedges are in a certain position the faces of the upper and lower rolls are parallel; when in another position one end of the top roll can be depressed, and when in still another position this same end can be raised. Consequently, since the bottom roll always remains horizontal, adjustments can be so made that any variation in diameter can be corrected. Then supposing there is a tendency to roll thicker in the middle than at the edges, the correction is made by setting the two rolls, which ordinarily are parallel, at a small angle one with the other in the horizontal plane. A tendency to assume an oval form is counteracted by means of the guide rollers. In fact, there is an adjustment for every possible malformation, but some of them are rarely if ever needed. If the drum travels either to one end or the other of the rolls instead of keeping in the middle, there are two hydraulically-worked pushers at either end which quickly bring it back into a central position. While the process of rolling is going on a stream of water is directed from a hose upon the inner and outer faces of the hot metal, and this has the effect of removing the scale, and so well does it do this that the resulting faces of the finished drum are smooth and shiny.

Referring to the largest drum which we saw rolled, we may say that the original dimensions of the tube before it was rolled were outside diameter 5ft. 9in. and internal diameter 3ft. 10⅝in., the metal being $11\frac{3}{16}$in. thick. The tube was 7ft. 8in. long. When completed, the external diameter was 12ft. 2½in. and the internal diameter 11ft. 5⅜in., the thickness of metal being $4\frac{9}{16}$in. The length of the drum was little in excess of the original length of 7ft. 8in. The original tube for this drum was produced by the second method referred to at the commencement of this article; that is to say, it was hydraulically forged and trepanned, and we may add that it was a very fine piece of work.

When we had the opportunity of witnessing this process in operation, we also gathered some information as to the progress which is being made in utilising the machinery for the production of other hollow cylindrical bodies, such as have been hitherto produced from rolled plates subsequently welded or butt strapped. We understand that rings made in this hollow rolling mill are specially applicable for use as locomotive boiler shells. In fact, in Germany the State railways have very largely specified solid rolled boiler shells, being influenced by the fact that they obtained from them greater uniformity as regards physical stresses; naturally, too, there is no leakage from longitudinal riveted joints. Such boilers would be, no doubt, valuable for use on up-country railways, such as those in India or South America, where repairs are not easily carried out, and we are informed that the experimental boilers made on this system, and used on some of the main line railways of Great Britain, have given entire satisfaction to the superintendents.

Whether or not there is a future for the process in connection with marine boiler shells is, of course, problematic, but it is interesting to know that, from an engineering point of view, there is no difficulty in producing, with the rolling mill which we have seen at work, and which is described in the foregoing, solid rolled boiler shells up to 15ft. or 16ft. in diameter and, say, 1¼in. thick.

We cannot close this article without referring to the skill displayed in the operations we saw carried out. The mill was under complete control, and the ease and rapidity with which the huge ring of red-hot metal was manipulated and brought finally and in a surprisingly short time to the desired form were remarkable. We may say that the resulting drum was accurate to within a very small fraction of an inch in all dimensions, and was quite parallel, and when we say this it may also be mentioned that at one period of the process the diameter of one end was 2in. greater than that of the other end, but this had been accurately corrected.

In our two page Supplement we give views of the horizontal drawing press, of the rolling mill, and of a finished drum 12ft. 2½in. in diameter and 7ft. 8in. long. We also give a view of this large drum, in the lathe during the process of machining.

Finally, we would tender our best thanks to John Brown and Co., Limited, and to all the members of the staff of this company with whom we came into contact, for their courtesy in permitting us to see this interesting plant in operation, and in affording us every facility for preparing the foregoing article.

THE ROYAL COMMISSION ON CANALS AND WATERWAYS.

No. XV.*

In our last article we referred to the recently issued report by Mr. Lindley on continental waterways, and summarised some of the details contained in it relating to the extent of the assistance given by the State in the development of inland navigation. In the present article we conclude our summary of the report.

The electric haulage on canals in France has hitherto been confined to a line of about thirty-six miles in length, of which the Canal d'Aire forms a part. The system is to be extended to other lines, bringing the total length up to fifty-five miles. The existing installation consists of four power stations of a combined capacity of 810 kilowatts and 8-ton tractors running on rails of metre gauge on one of the two paths. Two to four boats of the standard dimensions are drawn together at a speed varying from one and a-half to two miles per hour, or three to four empty boats at about four miles per hour. It is also proposed to adopt electric towage on the projected Canal du Nord. The capital outlay on electric traction is considerable, and makes its adoption only admissible on waterways where a heavy traffic has to be handled.

In Germany electric traction is confined at present to the Teltow Canal, on which a very complete system is installed, which we have described in previous articles. Boats are towed on this canal at speeds varying from 2.5 to 3.1 miles per hour, the average being 2.75 miles.

The report describes the experiments which have been undertaken in late years both in France and Germany with the object of determining the most favourable lines for boats, the best relation of the cross sectional area of the canal to the immersed cross section of the boat, and the clearance under the boat. The details of the experiments and their results are too extensive to quote, but they are of considerable interest, and show how thoroughly all matters connected with the improvement of inland navigation are treated in France and Germany. The most economical rates of speed have also been the subject of experiment, and in Germany the speed on rivers for steam-towed barges varies from 2½ to 3½ miles per hour up-stream, while down-stream the rate is often as high as 5 to 6 miles. On canals and canalised rivers steam towage is usual both up and down-stream, and the rate varies from 2½ to 3 miles per hour. As a rule, steam tugs are only used for the up-stream journey on free rivers, the current serving to carry boats down-stream, aided when conditions are favourable by the use of sails. Sunken chain towage has been used to a considerable extent in Germany, but the system is now being gradually abandoned. Horse towage is now used to a very limited extent, principally on the Finow Canal and for small boats on a few others.

The traction charges in Germany vary between wide limits; the limits appear to be about .03d. and .1d. per ton-mile. On the Teltow Canal .077d. per ton-mile is charged for electric traction, and on the Finow Canal .058d. per ton-mile for horse traction.

In France traction is, as a rule, free, and only in exceptional cases is it worked by the State. On rivers and on the canalised Seine and Oise steam tugs are employed. Horse traction is employed generally on canals and the remaining canalised rivers, except on certain short sections, where sunken chain or electric traction is employed. The rate of speed found most economical in France on free and canalised rivers by means of steam tugs is about 3⅛ miles per hour, and for horse traction on canals 1.67 miles per hour. The charges made on French canals for traction vary within wide limits, and many figures are given in the report. It is, therefore, difficult to arrive at an average rate per ton-mile. The cost of horse traction on the Canal de Bourgoyne, which is worked by contract, varies from .28d. to .54d. per ton-mile. On the other hand, the average charge on the North-Eastern canals for horse traction is apparently .06d. per ton-mile, light and accelerated services paying one-third more.

In Belgium, sails and tugs are used on the rivers and on the Rupel-Brussels Canal, and horse traction is dying out. On other canals horse traction is still usual.

Mr. Lindley furnishes elaborate tables containing comparisons of freights by water and rail in France, Belgium, and Germany, and in doing so he very justly calls attention to the absence of competition between railways and waterways in these countries and the State regulation of rates, which in many cases is exercised in favour of the water-borne traffic. In making any comparison between the cost to the freight owner of carriage by water and rail, the fact must not be overlooked that the State, and therefore, indirectly the freight owner and consumer, contributes largely to the construction of the waterways. In France and Belgium, as we explained in our preceding article, this contribution amounts to nearly ¼d. per ton-mile. That this State charge or subsidy is smaller in the case of Germany is due to the great advantage she has over the others in the possession of splendid natural waterways, and in other directions. In France the average freight charges naturally vary within wide limits, the minimum on the canals of the north-east and east being as low as .15d. per ton-mile for long-distance freights, while on the Rhone the rates vary from .4d. to nearly 1d. per ton-mile. The average results of his calculations are given by Mr. Lindley as .289d. per ton-mile for water-borne traffic, as against .565d. per ton-mile for rail traffic. The average haul is, however, 60 per cent. greater by water than by rail.

The important fact must be borne in mind that whereas the water freights are not subject to restrictions, the rail freights are fixed by law, and no reduction in railway freights may be made without the consent of a State-appointed committee. One of the points kept in view by this committee is the avoidance of undue competition between railways and waterways. The committee generally accepts a difference of 20 per cent. above the actual total freight on the waterway as the lowest admissible railway freight. "The acceptance of this 20 per cent. is based," says Mr. Lindley, "on the opinion that the waterways are considered not to be able to compete at equal freights with the railways, owing to the longer duration of transport. It is thus clear that in France the competition between the canals and the waterways is not free. The Government desires to retain the power of protecting the unorganised barge owners against ruin by any organisation of the railway monopoly."

In Belgium the average haul by rail is 57.5 miles, and by water 78.5 miles. The average freights per ton-mile are:—By rail, .84d.; and by water, .37d. As we have already stated, the State places the waterways at the disposal of the freight carrier, charging dues which suffice to cover only the greater part of the cost of maintenance and current improvements. The railways, as State owned, do not adopt any special measures of competition with the waterways. The railway authorities regulate their tariffs to suit the requirements of the railways, and do not attempt by special tariffs or exceptional treatment to attract the traffic from the State-owned waterways.

In considering the figures for the German waterways it is worth noting that 43 per cent. of the total water-borne traffic is on the Rhine, a stretch of 350 miles out of a total of 6200 miles of waterways. The transport of goods by water is in the hands of individual boat owners or companies. The following table gives the averages of the figures contained in Mr. Lindley's tables of German freight charges:—

Class of goods.	Railway.		Waterway or combined waterway and short rail freight.	
	Average haul, miles.	Freight per ton-mile.	Average haul, miles.	Freight per ton-mile.
		d.		d.
Coal...	214	·43	257	·187
Iron ore, &c.	262	·48	324	·208
Corn and rice	241	·805	285	·231
Sugar for export ...	149	·52	199	·27

The water freights given refer to the transport on waterways under the existing conditions free of dues on the rivers, and with dues on the canalised rivers and canals, which only cover about the cost of maintenance on these latter waterways, while the revenue from the railways not only covers maintenance, working expenses, and interest on capital, but leaves a surplus for the State. To cover the cost of the projected improvements in and extensions of the Prussian State waterways, it is proposed to levy dues to be charged on the cargo tonnage which on the canals will vary up to .386d. per ton-mile. On the rivers the new dues will vary from .008d. per ton-mile on the Rhine to .25d. per ton-mile on the Vistula. To show the influence the proposed dues will have on freight by water, Mr. Lindley gives tables which show that the water rates will be: for coal, 74 per cent.; for corn, 51 per cent.; for sugar for export, 63 per cent. of the freight by rail.

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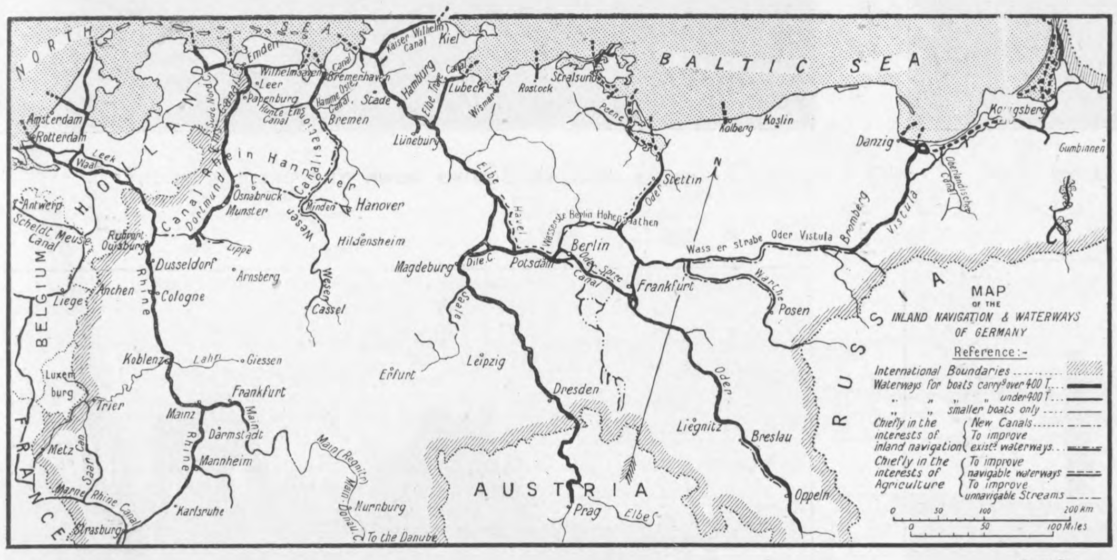
* No. XIV. appeared October 29th, 1909.

One of the most interesting sections of the report from the engineer's point of view is that which summarises the project sanctioned by the law passed by the Prussian Landtag in 1905, which involves an expenditure of nearly 17 millions sterling on new works in connection with inland waterways. This sum is equivalent to over 60 per cent. of the total expenditure hitherto on the waterways in Prussia. The principal features of this scheme of improvement and extension are indicated in the map of the German waterways given above.



"The Engineer" Swain Sc.

MAP SHOWING WATERWAYS IN GERMANY

The new works and the estimated cost are as follows:—

I. A waterway from the Rhine to the Weser, including the canalisation of the Lippe and secondary works consisting of:—		£
(a) A canal from the Rhine in the neighbourhood of Ruhrort to the Dortmund-Ems Canal (Rhine-Herne Canal), including the Lippe Branch Canal from Datteln to Hamm		3,725,000
(b) Various supplementary works on the Dortmund-Ems Canal on the reach from Dortmund to Bevergern		307,500
(c) 1. A canal from the Dortmund-Ems Canal to the Weser near Bueckeburg, with branch canals to Osnabruck and Minden, including impounding reservoirs in the upper valleys of the Weser basin and certain regulation works on the Weser below Hameln	£ 4,050,000	
2. A canal from Bueckeburg to Hanover, with a branch canal to Linden	1,975,000	
		6,025,000
(d) The canalisation of the Lippe, or the construction of diversion canals along the same, from Wesel to the Dortmund-Ems Canal at Datteln, and from Hamm to Lippstadt		2,230,000
(e) For the amelioration of agricultural lands in connection with the works mentioned under (a) to (d), and with the Dortmund-Ems Canal (with subsidies from the parties interested, fixed on the basis of existing principles)		250,000
Making the total for the canal from the Rhine to the Weser, including the supplementary works...		12,537,500
II. For the construction of a waterway of large cross-section from Berlin to Stettin (Berlin-Hohensaathen Canal)		2,150,000
III. For the improvement of the waterway between the Oder and Vistula, and of the Warthe from the confluence with the Netze to Posen		1,058,750
IV. For the canalisation of the Oder from the confluence with the Glatzer Neisse (Neissemundung) down to Breslau, and for trial regulation works on the reach from Breslau to Fürstenberg, as well as for one or more impounding reservoirs		982,500
Making a grand total of		16,728,750

The following are some of the principal engineering features of the proposed works, which have been designed with the benefit of experience gained more especially on the Dortmund-Ems Canal. The dimensions may be taken as representing the matured views of German canal engineers as to the best proportions for canals suitable for boats carrying 400 and 600 tons respectively, with the possibility of increment to 600 and 800 tons. It is intended to make the waterways west of Berlin and from Berlin to Stettin *viâ* Hohensaathen capable of taking 600-ton boats, with the possibility of increase to 800 tons, and the waterways east of Berlin for 400-ton boats with the possibility of raising the tonnage to 600.

The Rhine-Herne Canal for 600-ton boats is designed with a flat bottom and parabolic side slopes. It will be 11.5ft. deep, 49.5ft. wide at bottom, and 113ft. wide at water level. The relation (n) of area of cross section of canal to the area of immersed cross-section of the 600-ton boat at 5.75ft. draught is 6.55. The canal from Bevergern to Hanover will have the following dimensions:—

		Ft.
In cuttings ...	Depth	8.2
	Width at bottom	52.5
	Width at water-level	102.0
In embankments	Depth at middle	11.5
	Section of bottom	parabolic
	Width at water-level	102.0
The relation (n) is	... ...	4.4 and 5.2 respectively

Both sections of the canal, as well as the branch canals, are designed with the possibility of raising the water-level 1.65ft., in order at a future date to take boats of a larger tonnage. An interesting feature of the canal is that the total rise of 120ft. is on the line between the Rhine and Herne; the line of canal between the Dortmund-Ems Canal at Bevergern and Hanover, in consequence of the favourable conditions, can be constructed as one horizontal reach 107 miles in length without any locks. The Weser and the Leine have to be crossed by aqueducts, the descent to the river Weser being made by means of locks. The Berlin-Hohensaathen Canal has been designed with the following cross-section:—

Depth in the middle	8.4ft.
Depth at the sides	6.7ft.
Width at bottom	66ft.
Width at water-level	106ft.
The relation (n)	4.2

likewise with the possibility in the future of raising the water-level 1.65ft. The branch canals are designed of either double or single gauge, with passing bays to take the same boats. The locks on the Rhine-Herne Canal are twin locks, with chambers 31.5ft. wide and 220ft. to 312ft. long, the latter to take a boat with its tug; the new locks on the Dortmund-Ems Canal, with the exception of a special lock at Münster and the eleven locks on the canalised Lippe, are to be 31.5ft. wide and 312ft. long, the locks on the branch canals having the same width and 220ft. length. The locks on the Berlin-Hohensaathen Canal are designed 31.5ft. wide and 220ft. long, with the exception of the Lehnitz Lock, which is to be 280ft. long, in order to take four Finow boats. The width of the locks will allow a clearance of 5.25ft. over the beam of the boats, and the depth of 9.85ft. over the sill, a clearance of 4.1ft. under the boat. The lift of the principal locks on the main lines will vary from 17ft. to 23.5ft. The annual carrying capacity of the main lines is estimated as follows:—

	Tons.
Rhine-Herne Canal as proposed	8,000,000
With locks lengthened to 543ft....	10-12,000,000
With additional train locks	16,000,000
Bevergern-Hanover Canal—13 hours working...	10,000,000
24 ,, ...	16,000,000
Berlin-Hohensaathen Canal as proposed	5-6,000,000
With artificial water supply...	7-8,000,000
Canalised Oder	3,000,000

The carrying out of these works is made conditional on dues being levied by the State as mentioned above, and the guarantee on the part of the provinces and corporations of:—(1) The cost of administration, working and maintenance. (2) With certain alleviations, 3 per cent. interest on about one-third of the capital. (3) From the sixteenth year onwards ½ per cent. to the sinking fund; the State undertaking to find the monies for the interest and sinking fund for the remaining two-thirds of the capital.

THE EXPORT TRADE.

WHERE is there any improvement? one can imagine some business men asking just now. And well they might ask if the reference was to the home trade only. But the needs of the forty millions of population in the United Kingdom form but a small proportion of the aggregate requirements which British firms are called upon to satisfy, wherefore the state of the over-sea demand must always be one of the chief criterions as to the true condition of trade. And it is reassuring to know that when judged by this standard the general trade of the country is seen to be slowly improving. It cannot be denied that British exports of all kinds for the first ten months of this year, which amounted to £311,268,092, were a decline compared with the corresponding period of a year ago of £7,402,496; but this, which is only 2.32 per cent., may probably be largely accounted for by the lower level of prices in a number of commodities this year compared with last. But the exports for the single month of October amounted to £33,930,778, which was an augmentation of £923,192, or 2.79 per cent. And the imports show a forward movement for both periods compared with last year. The imports for the ten months amounted to £502,412,425, which was an increase of £15,902,148, or 3.26 per cent. Their value for the month was £52,651,756, which is an expansion as compared with the figures of a year ago of £1,905,477, or 3.75 per cent. Moreover, there was one working day less this October than last October, otherwise the month's expansion would doubtless have been larger, and the same circumstance may also be borne in mind when considering the above-noted slight export decline for the ten months.

Engineering productions as a whole have, it is true, been exported to a less value than was the case a year ago, both for the month and the ten months, the value of engines and machinery (taken together) having declined for October from £2,925,208 to £2,541,927, and for the ten months' period from £26,129,994 to £23,631,113. In several sections there have, however, been considerable increases. These include the following:—Miscellaneous prime movers, known as "other descriptions," for the month from £242,128 to £266,060, and for the ten months from £2,113,031 to £2,122,190 (in this department Europe and Australia show up very well, having both considerably increased their requirements); railway locomotives to South America for the ten months, from £594,320 to £789,693; road locomotives (including steam rollers) to all countries, from £36,091 to £37,011, and from £234,478 to £337,575; agricultural prime movers to South America, from £49,605 to £53,876, and from £153,514 to £166,128; India ditto, from £2613 to £3003, and from £23,436 to £31,556. Agricultural machinery for the ten months to all countries has improved in value from £1,115,538 to £1,183 596, Europe, South Africa, and Australia having been the chief cases of increase. The value of boilers exported in the ten months increased from £1,269,355 to £1,308,903, and of machine tools for the month from £42,132 to £82,018, and for the ten months from £324,731 to £648,851. The exports of mining machinery for the single month rose in value from £73 540 to £94,095, British South Africa going forward from £27,368 to £43,036. It is encouraging also to notice that these exports to the same market (South Africa) for the ten months grew in value from £257,724 to £345,766. Textile machinery to the United States increased for the month from £31,362 to £90,774, and for the long period from £333,912 to £542,569. Sewing-machine parts to all countries rose in value from £1,183,093 to £1,387,371. This was for the ten months, and there was also an increase for October. Electric engineering firms will be pleased to learn that the value of the shipments of electrical machinery of all kinds for the ten months' period has progressed from £1,148,681 last year to £1,184,658 this year. We have said enough to show that of many branches of British trade it may, in spite of "ups and downs," truly be remarked, "There's life in the old dog yet."

FLIGHT IN GERMANY.—Almost two years have passed since Herr Lanz, a member of the Berlin Aeronautical Club, offered a prize of 40,000 marks to the first German aviator who, with an aeroplane built entirely in Germany and of German material only, succeeded in flying several hundred metres in a straight line and who then, after wheeling to the right round a corner post, flew to another post one kilometre away from the first and wheeled to the left round this, and then flew back to the starting point. This amounts to describing an eight, one kilometre long, in the air, and was done by Herr Grade on Saturday, the 30th October, on the Johannisthal flying ground near Berlin. The conditions to be fulfilled in order to win the prize were rather easy, because in spite of the excellent pioneering work of Lilienthal and of the flourishing state of the German internal combustion engine industry, the art of aviation in Germany at the time when the prize was offered was in a very undeveloped stage. Herr Hans Grade, of Magdeburg, had tried very hard for several years to build a serviceable aeroplane. He commenced with a triplane, but gave this up in favour of a monoplane. After taking this step some considerable time elapsed before he succeeded in making his engine capable of sustaining him in the air long enough to enable him to win the Lanz prize.

NEW FIRE STATION AT CHARLTON.—The new Charlton station of the London Fire Brigade, which has been specially built as a motor station, without stables or other accommodation for horses, was officially opened recently. Accommodation is provided for twelve married men with their families, some being housed in the main building facing the road, and others having separate cottages in rear of the station. The engine-room has double self-opening doors on to the main road, and these are well set back so as to afford a clear drive out in either direction. Accommodation is provided for three motors, with an inspection pit under each machine. The motor equipment consists of three machines, all of identical size and power, and having all their parts interchangeable. Two carry the standard fire-escapes of the London Fire Brigade, and have also the standard first aid equipment, consisting of a copper cylinder containing water, and compressed air appliances for giving pressure. About 1000ft. of inlined canvas hose is carried on each machine, together with all the necessary appliances for hydrant work. The third machine is a "Hatfield" fire engine having a capacity of 500 gallons per minute, upon which accommodation is provided for 600ft. of inlined hose. All these machines are by Merryweather and Sons, and have been built to the special requirements of the Chief Officer of the London Fire Brigade.

REPAIR OF AUTOMOBILES BY BLACKSMITHS.—Technical courses for teaching country blacksmiths to repair automobiles started two years ago in Vienna under the supervision of the Automobile Technical Association have proved a wonderful success. In the beginning admission was restricted to country smiths, masters and men, in the country round Vienna, but since that time so many applications have been received from all parts of the monarchy that the courses are now open to the whole country. The provincial authorities, recognising the benefits to be derived from such education, have, in many instances, provided the funds for country smiths to come to Vienna and go through the course. This technical training institution has proved a double benefit. It has shown the country people that the motor car is not to be regarded as a hostile intruder, but rather as an instrument of progress, and it has also added largely to the earnings of the country smiths, who had suffered greatly from the modern developments of the last half century. And to the automobilists these courses have proved very valuable in providing them with efficient skilled help in case of accident in the most remote parts of the country. An up-to-date register of the names and addresses of all the country smiths who have qualified through these courses is supplied to motorists by the Austrian Automobile Club.

ROCK DREDGING IN BLYTH HARBOUR

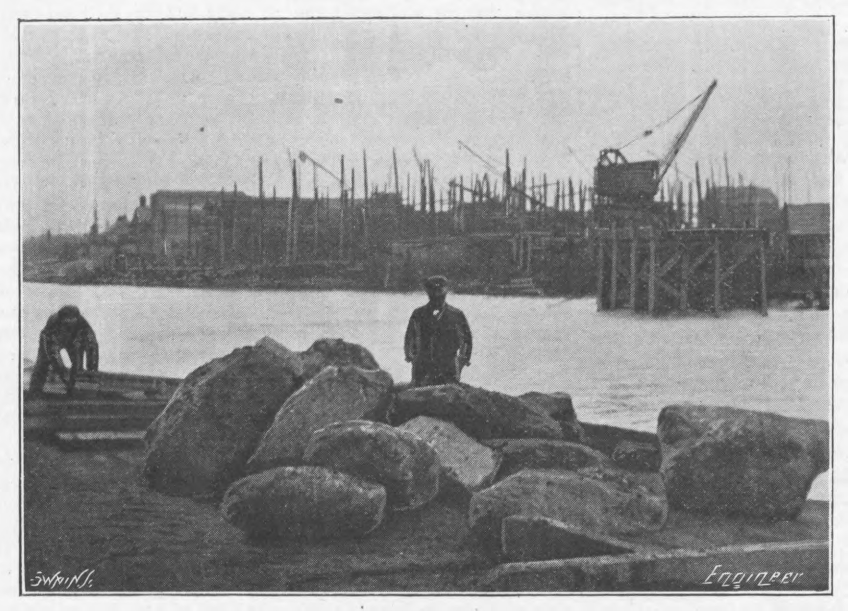


Fig. 1—BOULDERS DREDGED FROM THE HARBOUR

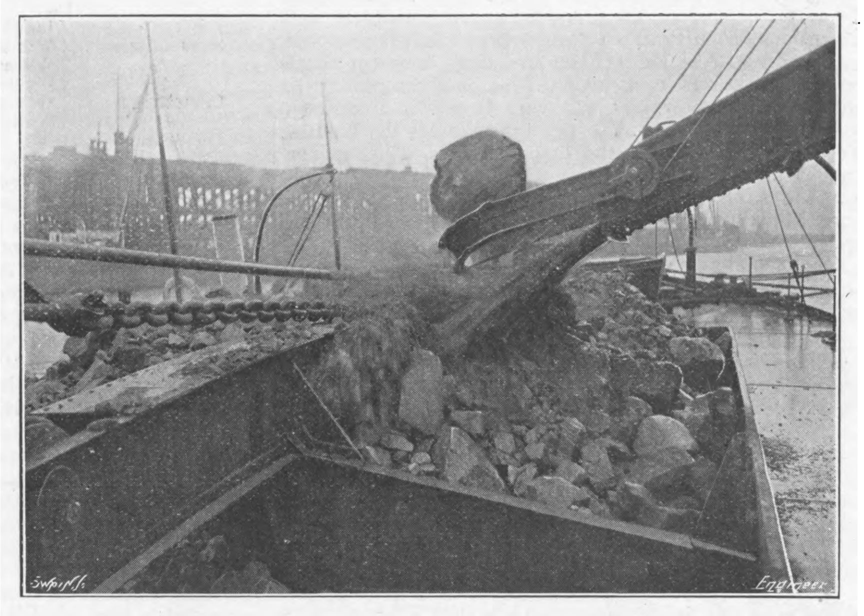


Fig. 2 - BOULDER COMING DOWN THE DREDGER SHOOT

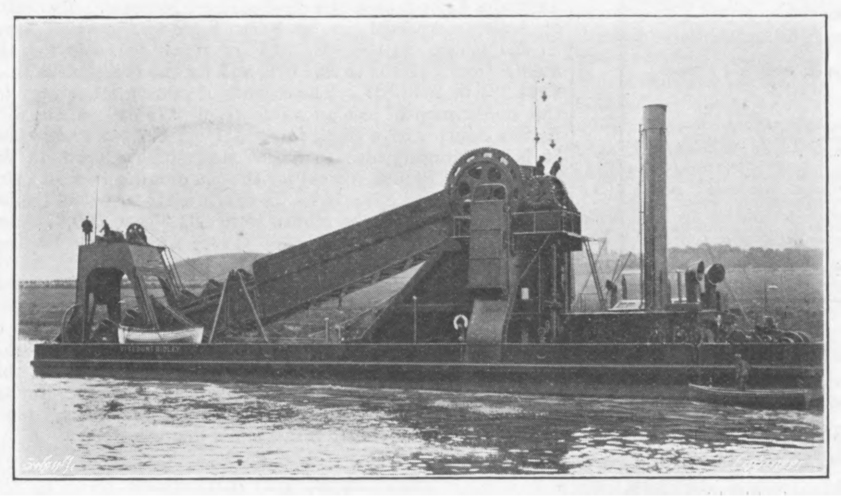


Fig. 3—THE DREDGER VISCOUNT RIDLEY

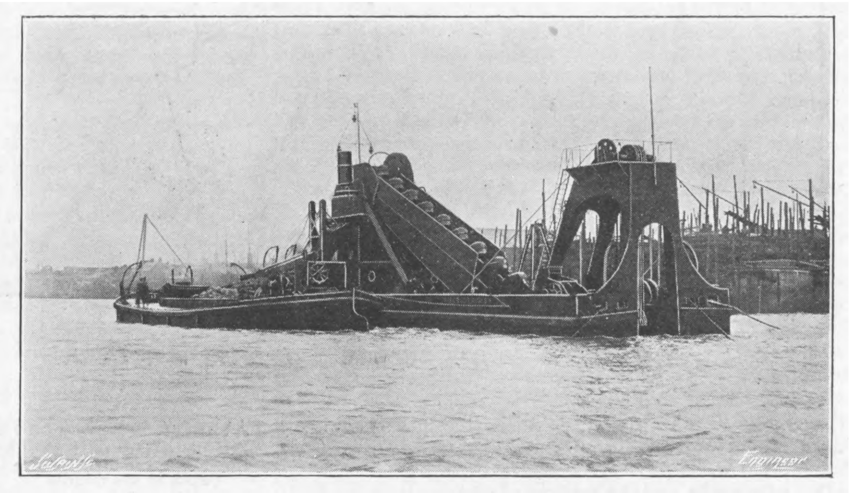


Fig. 4—DREDGER AND HOPPER IN BLYTH HARBOUR

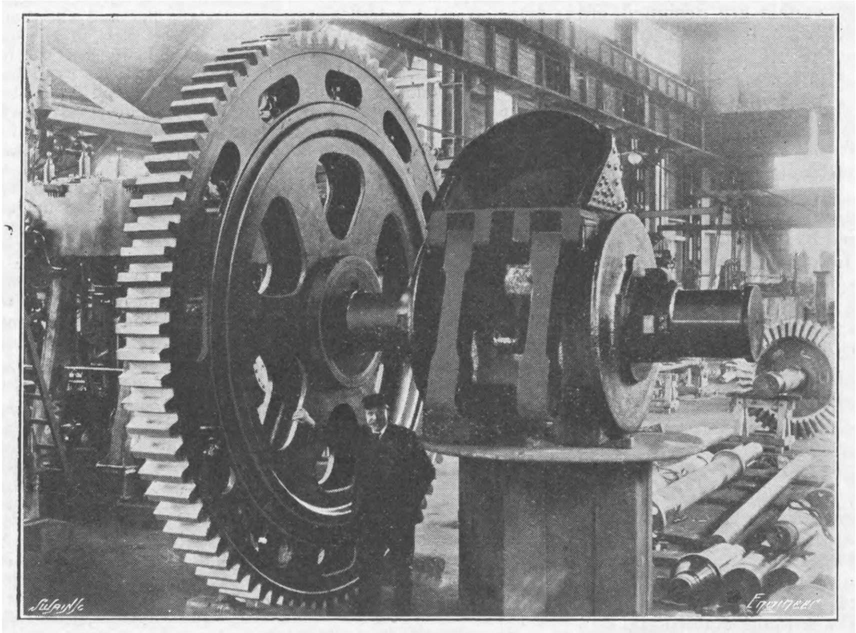


Fig. 5—TOP TUMBLER AND MAIN DRIVING SPUR WHEEL

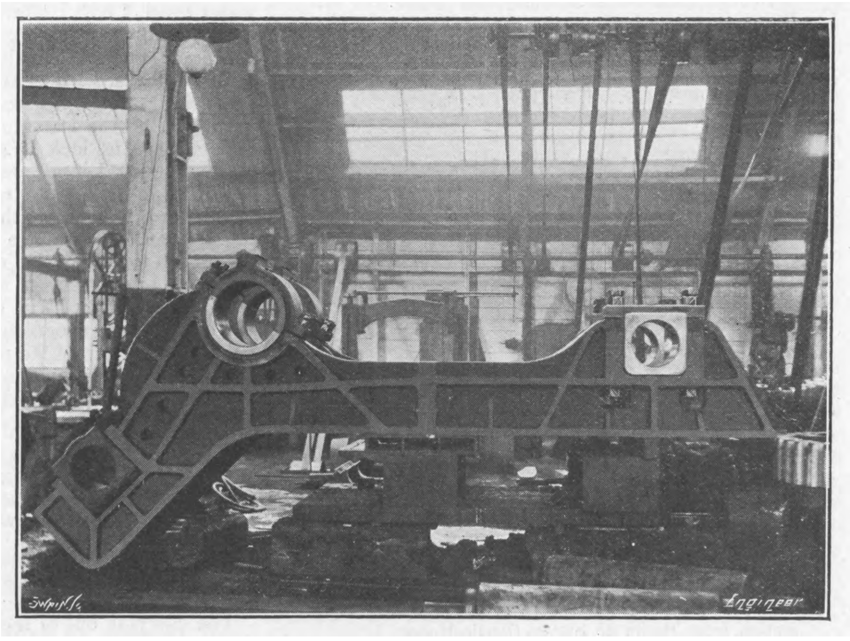


Fig. 6—MAIN GEAR TOP BRACKETS

A ROCK-LIFTING DREDGER.

IN the course of the detailed illustrated description of the Blyth Harbour improvement works published in THE ENGINEER of March 6th, 1908, mention was made of the fact that the deepening of the harbour and entrance channel at Blyth, so as to have 24ft. at low water or 39ft. at high water of spring tides, involves the removal of about 500,000 cubic yards of rock. For dredging this broken rock the Blyth Harbour Commissioners have recently introduced the powerful dredger Viscount Ridley, which has been built by Fleming and Ferguson, Limited, of the Phœnix Works, Paisley. This vessel has a length of 136ft., a breadth of 30ft., and a depth moulded of 11ft. 6in. She is specially constructed with heavy scantlings so as to withstand the abnormal strains of rock dredging, and is capable of lifting rock at depths varying down to 45ft. below water-line. The engines for driving the main gear are coupled direct to the gear shaft and are supplied with steam from one large cylindrical return-tube boiler. The shaft for driving the bucket chain is driven through cast steel spur and bevel gear, the teeth all being machine cut. These, together with the shaft, brackets, and framing, have a large margin of strength over the power developed by the engines, so that in the event of the buckets getting such a hold on the rock as to stop the gear, the risks of a breakdown are largely reduced.

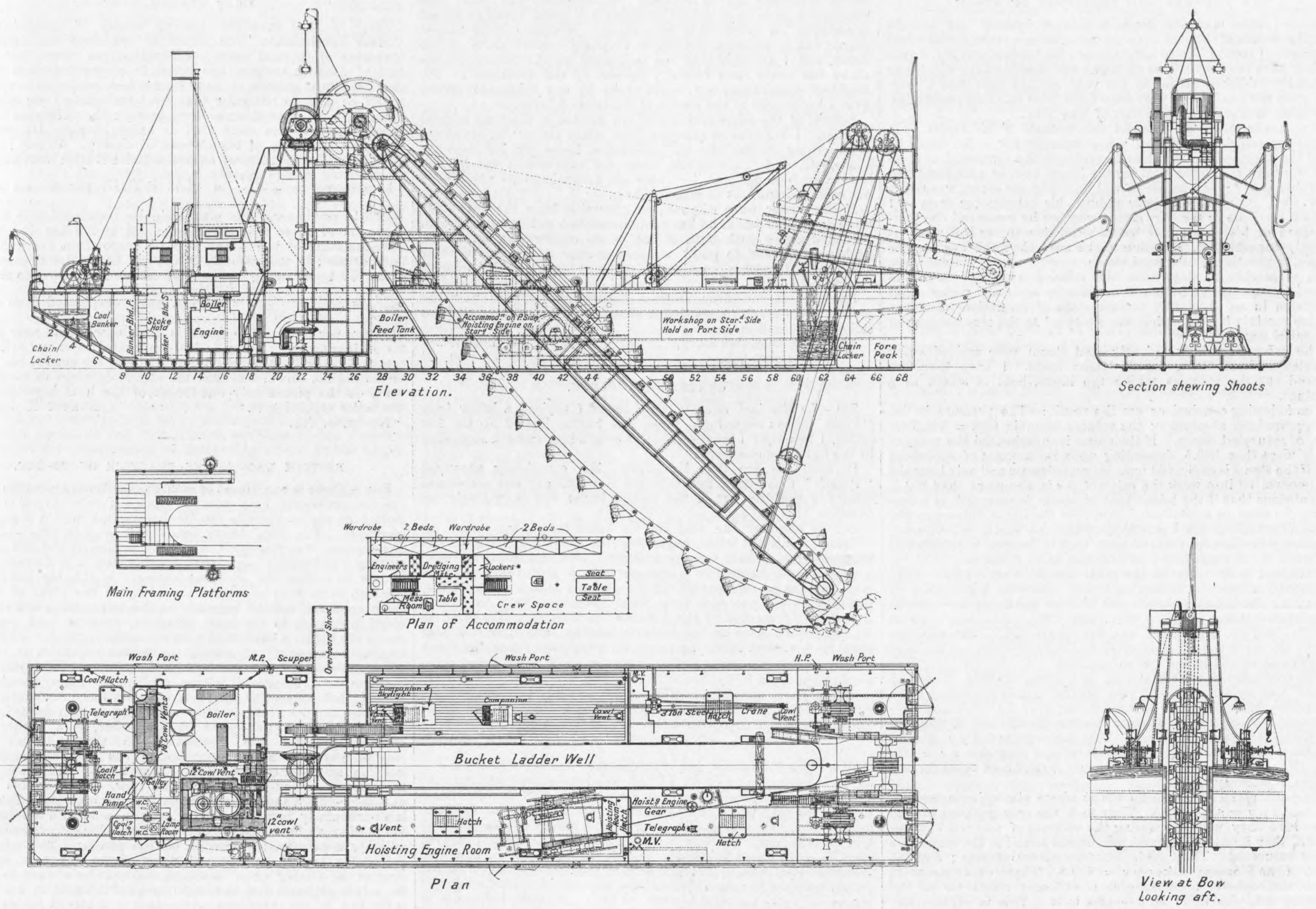
The bucket ladder is constructed of mild H section girders, 96ft. in length, between centres, and 6ft. deep at centre, and is strongly braced, whilst the chain of buckets are of special design, the bucket rims being reinforced by hard steel cutting lips. Both the hull and machinery of the vessel were constructed under Lloyd's special survey, and the boat is fitted with a complete installation of auxiliary machinery. To manœuvre the vessel three specially powerful dredger winches are fitted on deck. Independent steam engines are provided for hoisting and lowering the bucket ladder and shoots, and there is also an electric installation for lighting the vessel for night working.

The rock in Blyth Harbour consists of very hard sandstone intermixed with veins of metamorphic rock, and large numbers of boulders are also met with. Fig. 1 shows a number of these boulders taken out of the buckets in the space of three hours. As the removal of the boulders from the buckets entails a loss of time, it was decided to allow them to go down the shoots into the hopper barge alongside, and to prevent them from damaging the barges, strong channels are fixed to the points of the shoots in order to minimise the impact of the stones striking the hopper beams and chains of the barge. This arrangement has proved very successful, and stones varying from 20 to 30 cwt. in weight regularly pass down the shoots into the barges. Fig. 2 shows one of these boulders, which, owing to its shape, came down the shoots at a great velocity, and, striking the guard bar at the point of the shoot, travelled over the hopper on to the deck of the barge and then into the river. The guarantee undertaken by Fleming and Ferguson, Limited, was to raise 200 tons of rock per hour, and this was exceeded during the three days consecutive trials just completed. The maximum rate of dredging obtained was at the rate of 273 tons per hour.

We are enabled to give a series of engravings and some drawings of this interesting vessel. Fig. 3 shows her leaving the builders' yard. Fig. 4 gives a view of the dredger with one of the hoppers lying alongside in Blyth Harbour. Fig. 5 is reproduced from a photograph taken in the shops, and shows the top tumbler and shaft with a bucket and pair of links, and the main driving spur wheel; it gives an idea as to the proportions of the gear on this vessel. Fig. 6 shows the main gear top brackets in course of construction in the shops, and Fig. 7 gives detailed drawings. The vessel was built to the instruc-

THE HOPPER DREDGER VISCOUNT RIDLEY

FLEMING AND FERGUSON, LIMITED, PAISLEY, ENGINEERS



"The Engineer" Swain Sc.

Fig. 7

tions and requirements of Messrs. J. Watt Sandeman and Son, Newcastle-upon-Tyne, the engineers for the Blyth Harbour Commissioners, and the trials were carried out under their supervision and that of Mr. G. D. McGlashan, the resident engineer at Blyth.

THE NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.

THE twenty-sixth annual meeting of the North-East Coast Institution of Engineers and Shipbuilders was held in the lecture theatre of the Literary and Philosophical Society, Newcastle-on-Tyne, on the 29th ult., when the President, Mr. Summers Hunter, occupied the chair. The Council's report for session 1908-9 was approved on the suggestion of the President, seconded by Mr. W. H. Dugdale.

Mr. Summers Hunter, in his address, referred to the conference held in August last jointly with the Scottish Institution of Engineers and Shipbuilders. The four papers contributed would always be valuable as records of the progress of shipbuilding and engineering on the Clyde and the North-East Coast. By the kindness and generosity of the shipbuilding and engineering employers on the North-East Coast, their new rooms had been furnished free of cost to the Institution. The question of the incorporation of the Institution was, he said, being inquired into by the Council, and if, as seemed likely, it was found desirable, then alterations in the constitution and by-laws as affecting the various classes of membership would be revised and put upon a better basis. Referring to the paper read by Engineer-Commander Wisnom, at the Glasgow Conference, on the "Trials and Performances of the s.s. Otaki," Mr. Hunter stated that the calculations based upon investigations by the inventor and originator had been fully verified by actual results. The application of the turbine to lower speed or cargo vessels was now engaging serious attention. This problem was difficult, for they had to deal with full-lined vessels under varying conditions as to being light or loaded, and in one case they had direct-driven propellers almost continually immersed and in the other they were driven through the medium of some form of gearing and subject to the hard thrashing work of racing which takes place more or less even in moderate weather, depending upon the draught of the vessel.

After a hearty vote of thanks had, on the proposition of Col. Saxton White, seconded by Professor Weighton, been accorded to the Institution of Engineers and Shipbuilders in Scotland for their hospitality on the occasion of the Glasgow Conference, a paper on "Notes on Marine Boiler Design, Construction, and Economy" was submitted by Mr. D. Myles, vice-president of the Institution. In the course of this paper the author stated that, considering the improvements in boiler design during recent years, as a result of wider experience, what impressed him most was the great change of opinion and practice with regard to crowding a large amount of heating surface into the smallest possible boiler, thereby reducing the space for cleaning and examination, and otherwise making the boiler unsatisfactory. Boilers which a few years ago were considered large enough to contain about 2400 square feet of heating surface were now usually made 9in. or 12in. larger in diameter. This extra size was due to a number of causes, the principal of which was the desire to provide larger spaces between the combustion chambers, between nests of tubes, and between the steam space stays, thereby making the boiler much more accessible for cleaning, for as ship's engineers, together with boiler cleaners, were very human, the boiler which was not easily accessible was liable to go improperly cleaned.

Reference was then made to the improvements in steel works and boiler shop plant, and to the production and use of thicker and larger plates. Increased pressures, with the consequent modifications in the designs of boilers, and the use of corrugated furnaces of different types were also alluded to. With regard to the manufacture of marine boilers, the author remarked that the higher pressure had effectually put an end to the time when, as sometimes happened, a boiler was prepared for the official test by the introduction of a little sal-ammoniac in the neighbourhood of the seams of the plates, and boilers that could satisfactorily stand the working pressures general to-day had to be honestly fitted metal to metal, and the workmanship had to be beyond doubt. This severe demand on accuracy and workmanship would be admitted by those who remembered that not so many years ago it was no unusual thing for shipyard platers, riveters, and caulkers to be employed in the boiler shop.

Mention was then made of the improvements in the machines used in the manufacture of boilers, and of the increased use of electric or pneumatic drills in place of the hand brace. The practice adopted by some builders of boring out the flanged opening in the boiler front plate for the front end of the furnace appeared to the author to be a somewhat doubtful advantage. If the furnace was a good fit in the flange, a matter which did not present any great difficulty, there was nothing to be gained by machining the surface, but the removal of scale due to flanging and heating was necessary at all joints. The Classification Societies' rule that boilers must be tested to twice the working pressure was, he added, a relic of bygone days and ought to be deleted from the Societies' rules. He did not see any objection to continuing to make the boilers capable of standing this pressure, but considered the extra caulking necessary to prepare the boiler for this test as really detrimental to the boiler, and without any compensating benefit.

As regards water-tube boilers, Mr. Myles thought they were absolutely essential to some classes of work, but they brought with them defects to which the ordinary marine boiler was not subject, so that he considered that the latter type had still a long and useful career before it.

He had always considered caulking as a rather barbarous method of making boilers tight, and though recently introduced methods of welding were not at present thoroughly successful, he thought that something might eventually be done in this direction. Oil fuel then came in for notice, and the author gave it as his opinion that it was a mistake to arrange boilers for burning coal or oil alternatively.

After a reference to the increased technical knowledge and better training of our sea-going engineers, allusion was made to the improved appliances and better accommodation now provided for firemen, and to the recent move by the Board of Trade in directing attention to the ventilation of stokeholds. Defective ventilation in the stokehold had not infrequently been the real cause of unsatisfactory speed in the vessel, which, in the first place, was perhaps naturally attributed to a faulty propeller. This defect might also have a very important influence on economy of consumption, and was sometimes the real cause of serious and justifiable complaint from the shipowner on this account.

In the discussion following the reading of this paper, Mr. T. Westgarth said that he never used a patented furnace if he could avoid it. There was continual trouble with corrugated furnaces "pocketing" and having to be taken out. Of course, there were limits to the size of plain furnaces, but so long as a plain furnace without any supporting rings and within the thickness which the Societies allowed could be got he would never think of fitting anything else. Adverting to Mr. Myles' reference to sea-going engineers, Mr. Westgarth said those who, like himself, were manufacturers of boilers knew how much they were in the hands of sea-going engineers. He thought it would be an important matter for their Institution to agitate that the certificates of sea-going engineers should be dealt with in cases of proved negligence just as the captains' certificates are.

Mr. Alfred Harrison said that no less than one-third of the furnaces built during the past ten years at the Scotia Engine Works, Sunderland, for main boilers have been plain furnaces, and he had manufactured thirty-six main boilers there in one year. The limit of plate thickness allowed by the Board of Trade and other registries had in many cases prevented his getting a large and suitable diameter with plain furnaces, and because of that he had been compelled to fit corrugated furnaces. He felt sure that the principal cause of failure in corrugated furnaces was their thinness, the formulæ having been based on results of cold-water tests which were not borne out in practical working. He did not agree that the rule for testing by cold water to twice the working pressure should be abolished. If the workmanship was of high quality where plates are metal-to-metal before riveting, it would be found that 25 per cent. added pressure made no practical difference to the tightness of the boiler, whilst it had the distinct advantage of testing the material after all the work had been put upon it. It would appear that with steel plates where they simply cut off an infinitesimal portion of the plate for testing and based the whole of the conclusion upon it, they were very liable to find that some other local portion of the same plate was by no means equal to the tested part, and, further, there was that other inexplicable circumstance that the plate itself might have actually changed in the structure after being tested. In view of this, and of the absolute fact that this final water test was the one and only test that the material in the boiler actually received, a test only equal to about one-third the factor of safety of the boiler, he thought it prudent to retain their double working-pressure water test.

The further discussion of the paper was postponed until the next meeting of the Institution.

LETTERS TO THE EDITOR.

(We do not hold ourselves responsible for the opinions of our correspondents.)

THE VOLUMES AND PRESSURES OF STEAM.

SIR,—I have read Mr. Royds' article of October 15th and the leading article of October 22nd on the missing quantity with great interest. I should like to ask Professor Mallandain and Mr. Royds if they have read my letters on latent and sensible heat which you so kindly published earlier in the year, as they have such a bearing upon the conclusions they draw from their valuable researches. The most important letter is that of May 28th.

Mr. Royds states he checked the wetness of his steam by a throttling calorimeter, and it was practically dry. No doubt he used the accepted steam tables to work out the wetness, but if he will work out the wetness taking the latent heat as a constant and its value as 972 it is possible he will find that the steam was really very wet. Could Mr. Royds publish his calorimeter tests? I should also like to ask Mr Royds whether he measured the temperature of his steam just before admission to see if it was just slightly superheated, and thus make sure that the engine was receiving practically saturated steam.

In researches to determine the missing quantity the whole question turns upon whether the steam is saturated steam—that is, steam in an absolutely perfect state of formation when the engine receives it—and what are accepted as the true volumes of saturated steam.

The accepted volumes of saturated steam were arrived at by calculation from the accepted latent heats. I have therefore worked out the volumes taking the latent heat of steam as a constant.

The following conclusions are the result:—The pressure in lbs. per square inch absolute × the volume in cubic feet = 399.5 for 1 lb. of saturated steam. If the steam is superheated the value of $p\ v$ is more than 399.5, depending upon the amount of superheat and if the steam is expanded from saturated steam and only loses the heat converted into work the value of $p\ v$ is also more than 399.5. It is obvious that if the latent heat of steam is accepted as a constant, $p\ v$ must be a constant, except for the slight difference due to the expansion of the water from which the steam is produced, as exactly the same amount of heat, that is, energy, is required to convert 1 lb. of water into 1 lb. of steam at all pressures.

Southern, in his letter to the great James Watt which I have mentioned in previous letters, not only describes his method of measuring the latent heat, but also how he measured the volumes of saturated steam at 40in., 80in., and 120in. of mercury, or at 19 6 lb., 39.2 lb., and 58.8 lb. abs. per square inch. Will someone kindly tell me if the latest determination of the weight of mercury alters these values for lbs. per square inch?

The conclusion Southern arrived at, quoting his own words and italics, was as follows:—"These results appear to support the conclusion, that *the density of steam is nearly, if not accurately, proportional to its elasticity*; at least this may be affirmed of it within the limits of these experiments." This means he found $p\ v$ equals a constant. I have worked out his results, and he makes $p\ v = 389$, 380, 390. Possibly these may be higher if the latest value for the weight of mercury is taken.

Fairbairn and Tait's experiments at above atmospheric pressure also make $p\ v$ = a constant. They took the very greatest care to make sure they were measuring the volumes of saturated steam, in fact, they invented a special instrument to tell if the steam was really saturated. They made fourteen measurements; and the mean of the fourteen makes $p\ v = 400.3$. Their experiments at below atmospheric pressure give a different result for as the pressure falls the value of $p\ v$ also falls. This is explainable, however, if $p\ v = 400.3$ is accepted, as their vessel to hold the steam was too small to contain all the steam if all the water was evaporated. They also used a different apparatus at below atmospheric pressure. In the first of the articles on cylinder condensation, which appeared in THE ENGINEER on May 28th, 1908, in column 3, page 551, it is pointed out that Mr. Isherwood found with actual engines "the pressures are invariably as the spaces," and further on it is stated this is said to be thought a coincidence. To save space I cannot quote in full, but the whole of this magnificent statement should be read, as I am confident it is the key which unlocks the mystery of the missing quantity. If the latent heat of steam is accepted as a constant, and Southern, Fairbairn, and Tait are accepted, it is the truth that the pressure is proportional to the volume. I need hardly point out how much this affects the missing quantity. I have worked out the Willans trials on the basis that up to boiler cut-off $p\ v = 399.5$, and in some cases the missing quantity becomes a surplus quantity—for instance, Sir Alexander Kennedy's and Mr. Hartnell's trials. The chief object of this letter is to ask if anybody besides Southern, Fairbairn and Tait has measured the volumes of saturated steam, and if so, where can a description of his experiments be found.

I should also be grateful if anyone can tell me where the original calculations for the accepted volumes of saturated steam can be found. My firm conviction is, whoever calculated them accepted steam as a gas, and therefore corrected for both temperature and pressure. If steam is accepted as steam, the pressure alone should be corrected for, for if saturated steam is compressed and the steam remains always as saturated steam, there can be no change of of pressure unless there is automatically the correct change of temperature. With a gas, however, it is different. There can be a change of pressure without a change of temperature.

The questions I want to raise are:—(1) Is it not possible that in some cases a great deal of the missing quantity is due to the engine receiving wet steam which is not realised as the calorimeter tests are worked out on a wrong value for the latent heat? (2) Is not a great deal of the missing quantity due to experimenters accepting too large volumes for saturated steam at high pressures? (3) Is not a great deal of the believed re-evaporation during expansion due to experimenters accepting too small volumes of saturated steam at low pressures? (4) Is not the disappearance of the msising quantity when an engine receives superheated steam principally due to the accepted saturated steam volumes being actually superheated steam volumes instead of its being due to the superheat preventing initial condensation?

Blackheath, November 6th. FRANK B. ASPINALL.

ELECTRIC DRIVING OF TEXTILE FACTORIES.

SIR,—The report issued by the Bradford Engineering Society on the "Electrical Driving of Textile Factories" appears to have been accepted in some quarters as being an authoritative pronouncement based on exhaustive tests and backed up by the whole of the Committee. As this is certainly not the case I venture, as the reader of the paper, which was to some extent the cause of the formation of the Committee, but more particularly as a member of the Committee, to offer some explanation of the actual facts.

First, the Committee were not unanimous, and although I myself dissented from the form of the report, the Society have not thought fit to publish this fact.

Secondly, the report is not conclusive, nor are many of the so-styled "conclusions" based on any tests made by the Committee.

The report speaks of exhaustive tests, but it does not make it clear that the only comparative tests made were those of speed variation, and that of the two tests mentioned—at Dock Ing and Leigh Mills respectively—the latter, which is electrically driven, showed the smaller speed variation. The statement that, in the mechanically driven mill, "the amount of cyclical variation was not so great as had been anticipated" is an example of the misleading way in which the report is worded. It suggests that the Committee were unscientific enough to form a previous opinion on the matter, which was certainly not the case. The majority of the Committee had never seen the mill, and the anticipations referred to were of unknown amount, and existed in the mind of some unknown person. I submit that a vague statement of this kind should have no place in such a report.

No figures were presented to the Committee on the relative output of mechanically and electrically driven machines, but to say that "no evidence of increased output from electrically driven machines can be supplied" is incorrect, and that "the Committee have been unable to obtain any proof based on actual experience" is more—it is misleading. Evidence of increased output due to electrical driving is available from all parts of the world, and I am sure that the statement to the contrary made above has never been formally agreed by the members of the Bradford Committee, nor would it be by any unbiassed person with a knowledge of the results of electrical driving.

Several of the other conclusions are worded in the same curious manner. I will take as example those which state "Where power is generated on the site the mechanical losses are less than the electrical," and "mechanical losses are excessive if the friction load exceeds 30 per cent." These are generalisations which have not even a single test to support them.

If the writer were disposed to generalise from the very large number of tests which he has made in woollen mills he might with justice disagree with both of the above conclusions, but it is, perhaps, sufficient to point out that on such vital points as these the report furnishes conclusions without data—bricks without straw.

For the reasons given above I disassociated myself with the report, and I much regret that it should have been issued without fuller consideration.

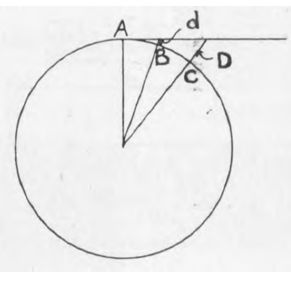
Thornhill, near Dewsbury, W. B. WOODHOUSE.
November 9th.

CENTRIFUGAL FORCE.

SIR,—In the last issue of your paper I noticed a letter from "Pater" about centrifugal force, and having looked up his first letter, I feel that I must accept his concluding remark somewhat in the light of a challenge.

It seems to me that Mr. Brown has completely answered "Pater's" first letter, but that the real difficulty was not stated clearly in the first but in the second letter, and is evidently the question of work done.

Let us consider the diagram for centrifugal force given by "Pater" in his last letter, neglecting the resistance of the air and supposing the circular velocity uniform. Now, the stone moves in a circular path instead of a straight one, so that the work done may be taken as represented by the distance D to a certain scale. In the same way the work done when the stone moves from A to B may be represented by the distance d. Now, if A B is equal to B C, the work done on the stone in moving from B to C is also equal to d, so that in the first case the work done when the stone moves from A to C is D, and in the second case $2d$. But as the path A B C is a circular path, it is evident that d is considerably less than $\frac{1}{2}$ D, so that D is much greater than $2d$. It follows, then, that the amount of work done per degree of circular path when the stone moves from A to B is much less than the work per degree when the stone moves from A to C. It is evident, then, that the smaller the number of degrees included in the diagram the less the amount of work per degree becomes and the nearer we approach the truth, so that, in the limit, the work done is zero.



"Pater" is quite right in maintaining that his diagram shows an amount of work done, but that is because of the necessity of drawing the diagram comparatively large for the sake of clearness. He will find that the fewer the number of degrees included in his diagram the less the amount of work per degree travelled, while the calculated amount of centrifugal force remains practically the same. How then do we get an acceleration towards the centre when no work is done? The fact is that the term "acceleration" in this case is a misapplication. In the limit, there is no real acceleration towards the centre, for in that case, if the stone were continually whirled round, it would finally arrive at the centre, instead of keeping a constant distance from it.

While the stone is in motion, as assumed above, the only forces acting upon it other than the force of gravity are:—(1) The radial force due to the inertia of the stone, which resists the change of direction; (2) the tension in the string. These forces are equal and opposite. When the string is cut both forces are destroyed, and the stone travels on in the direction in which it was moving.

November 8th. FILIUS.

THE DENNY EDGCOMBE TORSION METER.

SIR,—On reading your very interesting description of this apparatus it has struck me that it might be greatly simplified as regards the indicating gear, particularly when a record is not required, and allowing the whole to be completely boxed in—not only partly. Instead of the somewhat elaborate and delicate arc and pointer substitute the following.

Parallel with the shaft fix, on suitable supports, a straight scale bar divided into inch or millimetre divisions as desired, and carrying a vernier sliding thereon. The scale bar to be fitted with a small wheel at the left-hand end bearing on the base flanges. The whole to be capable of slight end movement, so as to enable the scale to follow slight end movement of the shaft as a whole. The scale also to be capable, after "setting," of end motion to the right, and to be held by a catch so as to throw the wheel out of gear when the apparatus is not in use. The vernier slide to have a similar wheel, or equivalent, bearing on the indicator collar. The apparatus to be "set" by:—(*a*) Set the vernier to read zero on scale. (*b*) The scale being in place, move the scale to the right by means of a screw acting on the base flange wheel until the wheel on the vernier slide touches the moving collar. (*c*) Then clamp the scale carrier.

Supposing the apparatus to be out of gear and a reading required. The catch holding the scale out of gear being released, a light spring pushes it into contact with the base flange. The observer then slides the vernier along until the wheel touches the collar. Whole divisions are then read off the scale and fractions from the vernier.

The advantage of the vernier is, of course, that with an open divided scale we can read as finely, or more, as we could if using a closely divided scale difficult to read in a poor light.

The apparatus may be completely boxed in, the scale and vernier above being exposed for use by lifting a hinged lid.

A recorder can be applied by a light arm projecting from the vernier slide and carrying a pencil or equivalent bearing on the paper drum.

It is obvious that the exact instant that the small wheel on the vernier touches the collar may be indicated, if special accuracy is required by making the wheel and collar parts of an electric bell or galvanometer circuit. Also, that for scientific purposes, when extreme accuracy is required, a micrometer eye-piece may be substituted for the vernier.

Angmering, November 6th. GEO. T. PARDOE.

HEAT TRANSMISSION.

SIR,—In your excellent leading article of yesterday upon "Heat Transmission" you object to engineers considering the "number of thermal units" transmitted per minute per square foot of heating surface, and state, in contradistinction to this, that "he must provide so many square feet per horse-power." It would be well to recognise that heat transmitted per minute is essentially the same thing as horse-power; the difference between them is only of the same kind as exists between 1ft. and 12in. Each is a time rate of transference of energy. Taking 778 foot-pounds as the mechanical equivalent of 1 British heat unit, then

$$1 \text{ horse-power} = \frac{33.000}{778} = 42.42 \text{ B.Th.U. per minute} = 2545$$

Br.Th.U. per hour. This may again be translated into terms of "pounds of water evaporated from and at 212 deg. Fah." The determination of the latent heat of evaporation has undergone fluctuations; it was recently 965.7, but the latest re-calculation gives 970.4. Dividing by each of these, 1 horse-power = either

$$\frac{2545}{965.7} = 2.636 \text{ or } \frac{2545}{970.4} = 2.624 \text{ lb. water evaporated from and at}$$

212 deg. per hour. The mean is 2.63 lb., which is near enough for ordinary work. Every 2.63 lb. evaporated from and at 212 deg. means 1 boiler heat horse-power. If 10 lb. are needed per I.H.P. of the engine, this means that the engine develops in mechanical work on the piston only one-fourth of the heat horse-power of the boiler supplying it. ROBERT H. SMITH.

November 6th.

BRITISH LOCOMOTIVE PRACTICE OF TO-DAY.

SIR,—There is one aspect of modern locomotive practice which has not previously been touched upon. I refer to valve gears. Both here and in America the Stephenson link motion is generally employed. For very heavy loads and high speeds—taken in conjunction—the drawback with this motion is the difficulty of getting a sufficiently large port opening and a sufficiently rapid release to enable the steaming capacity of the big boilers now common to be fully utilised. According to the point of cut-off, the Stephenson motion imposes, on the one hand, a limit to the speed in relation to the load, owing to excessive back pressure; or, on the other, a limit to the load in relation to the speed, due to either excessive compression or to the reduction in tractive power consequent on too small a port opening. The compromise between the two limits, it is true, enables fairly heavy loads to be hauled, but unless the speed is comparatively moderate, these loads are not so great as they might be, having regard to the quantity of steam generated by the boiler, if a higher mean effective pressure was maintained in the cylinders. The reasons why the Stephenson motion has been so popular are well understood, but the fact remains that there are, from the steam distribution point of view, better valve gears available—the Walschaerts' and the Joy, for instance. The latter is a particularly good gear, giving, as compared with the Stephenson motion, an improved port opening, a prolonged expansion, and a higher mean effective pressure on the pistons. The only thing is that the wear of the pins and slides of the Joy gear, and the wear of the driving-wheel bearings, must not be allowed to go too far. It is probable that the employment of this gear by Mr. Whale is the key to the excellent performances achieved by his 4-4-0 engines of the "Precursor" class—such as taking 460 tons from Crewe to Euston at an average speed of 54.2 miles an hour and 360 tons at an actual average of practically 58 from Euston to Stafford—seeing that Mr. Whale adopted a steam pressure of only 175 lb. per square inch, and a boiler having a mean diameter of 5ft. 0¾in.

The new American valve gear, the Pilliod-Baker, is claimed to give a distribution better than that of the Stephenson motion, but it lacks the simplicity of the radial gear designed by the late Mr. David Joy.

Does any one know of a case in which a two-cylinder simple engine, fitted with the Stephenson link motion, has taken a load of 550 or 600 tons net at an average speed of not less than 60 miles an hour for a minimum distance of, say, 100 miles?

F. W. BREWER.

London, November 2nd.

DEVELOPMENT OF THE GAS ENGINE.

SIR,—In answer to the letter by a "British Manufacturer" published in your last number, I beg leave to state that limitation of the number of revolutions is by no means a result of any characteristics of the high-power gas engine. I have already pointed this out by a practical example in my letter published two weeks ago.

The factors which, in practice, limit the number of revolutions of any piston engine are the result of the design and size of the valves, and of the most efficient proportion which we have to take between the area of cylinder and the stroke. These factors make up the volumetric efficiency of the engine, which plays an important part in the design of all large piston engines, whereas it does not count for so much in small engines.

If any doubt remains on this point, I would ask your correspondent to draw a comparison between high-power steam engines and high-power gas engines of the same size; he will then find the same number of revolutions in each, though the reciprocating weights of the gas engine are, owing to the higher maximum pressure, greater than those of the steam engine.

I would further like to draw your correspondent's attention to the high-power gas engine of about 700-800 horse-power, designed about eight years ago as single-acting engines. He will find that these single-acting engines run with a lower number of revolutions than is usual with the double-acting engines.

As to the other matter queried by your correspondent, I would ask him to what account he would put the trouble and cost of making a single-acting piston of any considerable size, tight running, if not to that of the first costs of the engine.

As to the melting-pot in which the high-power gas engine is still lying, it seems to me that the said melting-pot is a remarkably useful one, considering it has already turned out 1,000,000 horse-power engines, which are a boon to their owners which has no parallel in industry since James Watt's invention. In my opinion on this matter I find myself in agreement with the views expressed in the publications of authorities such as the late Mr. B. H. Thwaite, as Mr. H. A. Humphrey, Mr Dugald Clerk, and others.

Erith, Kent, November 8th. DAVID NEUSTADTER.

PHYSICAL SOCIETY'S EXHIBITION.—The date of the annual exhibition held by the Physical Society of London, which was fixed some time ago for the 10th inst., has been altered to Tuesday, December 14th, so that the exhibition may be open in the afternoon as well as in the evening.

THE ILLUMINATING ENGINEERING SOCIETY.—The opening meeting of this Society will take place on Thursday, November 18th, at 8 p.m., in the hall of the Royal Society of Arts, 18, John-street, Adelphi, London, W., when a brief report of the progress of the Society will be presented by the hon. secretary, and the opening address will be delivered by Prof. Silvanus P. Thompson, D.Sc., F.R.S., the first president of the Society.

RAILWAY MATTERS.

The *Sole* (Milan) of 29th October notifies that the Syndic of Vieste (Foggia) has submitted to the Ministry of Public Works a project for the construction of a railway in Garganica. The line will leave the station of Lucera (State Railways), and, passing along the lake of Varano, will terminate at Manfredonia.

H.M. Consul at Bucharest reports that the President of the Tulcea Chamber of Commerce has addressed to the Roumanian Ministry of Public Works a petition requesting that the proposed railway from Tulcea, through Babadag, to Constantza, a distance of 120 kiloms. (about 75 miles), should be constructed as soon as possible.

The Natal Government is now moving in the matter of providing that Colony with further railways and an extension of harbour facilities, and £370,000 has been allocated for these and other public works. The Cape Government has lately brought in a Bill to authorise the purchase of Hoetjes Bay foreshore, for the purpose of constructing harbour works there.

According to a consular report dealing with the trade of Madagascar, the railway has reached Soanivana, 165 miles, whence motor cars and other vehicles take the passengers to Antananarivo, only 2¾ miles distant. The time taken from Tamatave to Tananarive is now two days, and when the rail reaches Tamatave from Brickaville the journey will be completed in one day.

The *Gaceta de Madrid* of October 21st notifies that Don Timoteo Goiri y Loyola has applied to the Dirección General de Obras Públicas for a concession for the construction and working of a horse tramway from Bilbao railway station to Las Arenas, and that a period of one month from the date of the *Gaceta* is allowed for the presentation of competing offers at the abovementioned Dirección.

The *Bollettino Finanze, Ferrovie* (Rome) of 21st October notifies that an application has been submitted to the Italian Ministry of Public Works for powers to construct and work a steam tramway from Bassano to Montagnano, *viâ* Vicenza, with a branch from the Barbarano Bridge to Barbarano. The application includes a request for an annual State subsidy of 1500 lire (£60) per kilometre for a period of fifty years.

The directors of the London and South-Western Railway Company have, it is stated, departed from their original intention of building a new dry dock on the Woolston shore of the Itchen, and have decided instead to enlarge the present Trafalgar Dock at Southampton. When completed the Trafalgar Dock will be 890ft. long and 100ft. wide at the entrance, and will carry 34ft. of water. It will comfortably accommodate the Atlantic liners of the largest type.

In his report to the Board of Trade on the railway accident at Friezland, on the London and North-Western Railway, on August 10th, when a passenger train left the rails, and the driver and fireman were killed and the guard and thirteen passengers injured, Lieut.-Colonel von Donop says the most probable cause of the accident is that rail-climbing took place, and the leading pair of wheels of the engine were derailed. He attributed this derailment to the fact that the engine was not of suitable construction for running round a curve at a high speed—probably between 60 and 70 miles an hour. The engine used was originally designed for heavy passenger trains on suburban lines.

The draft of the proposed agreement between the Hull and Barnsley and North-Eastern Railway Companies was recently published in Hull. It is proposed that the agreement shall take effect from January 1st, 1910, and shall remain in force for a period of at least fifty years, terminating at any time after December 31st, 1959, on either side giving not less than five years' notice. Under the agreement junctions are to be constructed, maintained and worked at or near Hull at joint cost, in proportions to be agreed or settled by arbitration, including a junction giving access from the Hull and Barnsley Railway to Paragon Station, the parties to concur in applying for any necessary powers for construction of such junctions.

Great interest attaches to the arrangements which have now been completed for the continuation of the Bagdad Railway. The present terminus is at Bulgurlu, and the line is now to be extended thence to Helif, the junction station for the town of Mardin, in the province of Diarbekr. The plans likewise comprise the making of a short branch line from Tel-Harbesh, the junction station for Aleppo. This branch line would connect the main Bagdad Railway with Aleppo, and thus bring Constantinople into connection with the Hadjaz Railway, whereby direct communication would be established between the capital and the holy places of Islam. The part of the railway between Bulgurlu and Helif traverses the Taurus Mountains, and the construction will be difficult and costly.

Railway electrification in Chicago has been under discussion for a number of years, and about a year ago the Illinois Central Railway took the first active steps, publicly at least, to study the problem. It is interesting to note what the railway company has learned as the result of its investigations, and its conclusions can be gleaned in a measure from the annual report of Mr. J. T. Harahan, president of the line. He points out that there are no great freight terminals operated by electricity, and that it is still questionable if the electrification of such is practicable. The terminals of the company include 310 miles of track, and President Harahan states that with the best information obtainable it appears that the electrification would cost more than £3,600,000, a great sum to spend upon a project which he says "would be a doubtful success in operation." The question has been brought up in Chicago solely in an effort to reduce the smoke nuisance, and the company hopes to accomplish this to an extent by other means.

It is many years, states the *Railway Club Journal*, since the elevated railway in New York, and some other lines in America, were fitted so that the centre rails of a three-track road could be used either for up or down trains, according to the pressure of traffic; but so far the principle has never been adopted in this country. The adaptation of the South London line of the London, Brighton and South Coast Railway on this principle for some distance out of London Bridge station is therefore a matter calling for special notice. The tracks in question are those which are used for traffic *viâ* Peckham Rye, though in addition many trains, and particularly empties, use these tracks and, after passing South Bermondsey station, travel by the spur line to regain the main line *viâ* New Cross. The alternative third track extends from outside London Bridge Station to South Bermondsey Station and along the spur line to the junction with the main line, so that onwards to Peckham Rye the old arrangement of one down and two up lines is retained. On the rearranged portions of the centre line, the old "up fast" is worked either as "up fast" or "down fast," according to the period of the day. The signalling is specially arranged so that one set of signals, so far as they relate to the centre line, are locked at danger when the other set is in use, and therefore all possibility of collision is avoided. Moreover, the crossover connections have also been rearranged to suit the new method of working. Special permission for working in this manner had to be obtained from the Board of Trade, and no doubt other similar adaptations may be expected in due course.

NOTES AND MEMORANDA.

Petroleum as a disinfectant, for checking the spread of plague, is advocated by some medical officers in India. It is pointed out that during the pestilence that swept Europe long ago the oil regions of Baku were untouched, although in the surrounding country 50 per cent. of the population perished. Lerche, who visited Baku in 1735, wrote:—"It is quite likely that the fact that the Black Death did not touch Baku was due to petroleum."

The author of an article in the Frankfürt *Vulkan* deals with the industrial prospects opened up by the possibility of producing pig iron electrically in considerable quantities, as demonstrated by recent successes in Sweden, where, it is stated, various works are putting the Grönwall-Lindblad-Stalham process to practical use. According to the authority named, the cost of producing pig iron by electricity is 16 per cent. less than that entailed by ordinary smelting methods.

Subterranean streams of water have been detected by sound, according to a recent United States consular report, by a French instrument known as the "acoustele," with which the Belgian Society of Geology, Palæontology, and Hydrology is said to have made extensive experiments. The device has proved most successful, the report states, in certain kinds of chalky formations in which the subsurface waters flow with sufficient velocity to create a rumbling or gurgling sound by their fall, and where the surrounding geological formation is of a resonant character capable of transmitting the sound to the surface.

According to a recent report in *l'Engrais*, a discovery has been made of an important nitrate bed in California, and a company has been formed to exploit it. The quality of the nitrate is said to be fully as good as the Chilian product, and considerable importance is attached to the discovery, in view of the fact that water is readily obtainable near the fields, and steamers of moderate tonnage can sail to within a very short distance of them. The Panama Canal will be open in a few years' time; this is a decided advantage. The present yearly production of the Chilian fields is about 1,650,000 tons, and the new beds are estimated to contain 20,000,000 tons.

The vacuum vessel introduced by Dewar has proved of such value as a means of improving the thermal insulation of bodies that it is no surprise to find it introduced into calorimetry. At the suggestion of Prof. Nernst, of the University of Berlin, Dr. H. Schottky has carried out a series of measurements with a modified form of Favre and Silbermann calorimeter, in which the mercury was replaced by pentane, and the bulb of the calorimeter surrounded by a vacuum vessel. The instrument looks like a Bunsen ice calorimeter using pentane instead of ice, and having a vacuum vessel around its bulb. It has proved a great improvement on its predecessors, and is considered by Dr. Schottky to be extremely accurate. A full description appeared in the *Physikalische Zeitschrift* for September 15th.

Concrete poles hexagonal in shape and hollow through the centre are used by the Oklahoma Gas and Electric Company. A 35ft. pole measures 7in. across corners at the top and 16in. across at the butt. They are moulded in forms up made of 5ft. sections, so that it is possible to cast a pole of practically any length. Steel rods are placed symmetrically about the central axis and at the top and bottom project through holes in steel plates. The rods are bent over at each end and securely fastened. The core, which is wrapped with one thickness of building paper, is suspended within the form by wires at intervals along its length. The concrete used consists of a mixture of one part cement, two parts sand and three parts chats or zinc tailings, which can be obtained in large quantities from the zinc mines of south-western Missouri.

The rapid progress of aviation has caused attention to be drawn from a new direction to the dangers of atmospheric electricity. In an article in the *Elektrotechnische Zeitschrift* Mr. L. Zehnder discusses the danger to balloons and aeroplanes of electrical disturbances, and the methods of avoiding disastrous effects He points out that the electrical conditions of the air are subject to great variations during thunderstorms and that the atmospheric charges may change suddenly in sign. In clear weather an ordinary balloon without metal parts is not exposed to any danger so long as it floats in the air; but in the modern dirigibles much of the framework consists of conducting materials, which add to the danger. Also a balloon may be charged with electricity and a spark produced when contact with the ground is made, setting fire to the gas.

A disposal service for the handling of material excavated at building foundations, building rubbish, ashes from power plants, &c., is being operated by the Chicago Subway Company, which owns a system of some 40 miles of small, deep level tunnels under the city of Chicago. Spurs are run to deep basements or to shafts where the materials are loaded into cars which are hauled by electric locomotives to a disposal station on the west bank of the Chicago River near Madison-street. Here there is a shaft, over which are the runways for two electric trolley hoists, each operated by a man riding on the machine. When a car is set at the bottom of the shaft, the body is hoisted up and run out over a dump scow moored alongside the station. The car body is lowered and the bottom released, discharging the contents into the scow. The empty body is then run back and lowered upon the car frame at the bottom of the shaft.

During the nine months ending September 30th Great Britain exported iron and steel and manufactures thereof to the value of nearly twenty-eight millions; other metals, six and a-quarter millions; cutlery, hardware, &c., nearly four millions; machinery, twenty-one millions; and ships, over four and three-quarter millions. Our exports of iron and steel and manufactures thereof for September amounted to £3,106,535; of other metals to £757,498; of cutlery, hardware, &c., to £468,061; of machinery to £2,324,643; and of ships to £764,025. The total British exports for September amounted to £32,801,024. The total value of exports from the United Kingdom during the nine months ending September 30th was £277,337,314. Among the items in which there was an increase in comparison with the corresponding month of last year the most important were iron and steel and manufactures thereof, cutlery, hardware, &c., and electrical goods. The advances were £242,507, £23,834, and £6416 respectively.

In their latest published patent Messrs. Orville and Wilbur Wright disclose a method of automatically controlling and maintaining the balance of the machine longitudinally, laterally, and vertically. The method consists in employing a movable horizontally mounted plane adapted to be actuated by air currents. This plane is mounted on parallel levers just in front of the main planes and between the main planes and the elevator plane. The automatically operating plane is rigidly connected to a link pivotally jointed to the front ends of the projecting levers. The rear end of one of the levers is provided with a weight to balance the movable plane. Air currents met with that tend to upset the balance of the machine automatically deflect this plane. By means of the plane a valve is operated between a differential cylinder containing a differential piston and a reservoir in which air is stored under pressure. The movement of the differential piston in its cylinder by means of the air pressure is employed to control the elevator plane, the warping planes, and the rudder, so as to counteract any tendency of the wind to disturb the balance of the machine as soon as it occurs. Means are provided to enable the pilot to control and vary the automatically operating mechanism during flight.

MISCELLANEA.

According to *African Engineering*, a representative of the Italian Government is visiting the Benadir coast with the object of determining the most suitable spot for the construction of a harbour to serve as the base of the proposed railway through the interior.

A new explosive, of British invention, which is said to possess possibilities of revolutionising the blasting work in connection with the construction of the Panama Canal, has been tested on the Isthmus of Panama recently, and as a result the Canal Commission has ordered 20 tons of it for trial.

Exhaustive trials of automatic rifles are, we understand, being made at the School of Musketry under the direction of Colonel W. N. Congreve, V.C., and a weapon with which a hundred aimed shots a minute can be fired has been secured. The end of the barrel is supported on a tripod to give steadiness.

The Committee of the Aero Club, in fulfilment of the rules imposed by the International Aeronautical Federation, have suspended MM. Delagrange, Sommer, Le Blon, and Melon from taking part in any contests held under the Federation rules until January 1st, 1910, on account of their having taken part in the recent Doncaster meeting.

The *Diario Official* of 1st October publishes a decree opening at the Ministry of Communications and Works a credit of 1,000,000 milreis (about £62,500), to be utilised for the purpose of counteracting the serious and injurious effects of drought in the Northern States of Brazil. This will involve schemes for the construction of dams and irrigation works.

The Transvaal gold output for October was 581,132 oz. from the Witwatersrand district, of a value of £2,468,493, and 21,284 oz. from the outside districts of a value of £90,409, making a total of 602,416 oz. of fine gold, the value being £2,558,902. This is a decrease of 39,969 oz. in weight and £16,858 in value as compared with the month of September, 1909.

It is stated that a naval base of considerable strategic importance is to be created near Scapa Flow, a natural harbour in the Orkney Islands. The site chosen will command the Pentland Firth, and a fleet stationed there could prevent a hostile fleet from forcing its way into the Atlantic Ocean from the North Sea. Scapa Flow lies to the south of the Island of Pomona.

The unarmoured cruiser Bellona returned to Plymouth on Wednesday evening after a 38 hours' four-fifths power trial, which she reported to have proved satisfactory. The new battleship Vanguard was delivered at Portsmouth on Wednesday, and will next week undergo gunnery trials. She will be ready for commission within two years of the first keel-plate being laid.

The South Wales Coal Conciliation Board met at Cardiff on Wednesday to consider the workmen's application for an increase of 2½ per cent. in wages, which, if granted, would have brought the wages up to 50 per cent. above the standard of 1879. Finally, the workmen's representatives informed the owners that, in face of the facts before them, they would withdraw their application.

Arbroath is in possession of a massive water tower, formerly used for the storage of the Nolt Loan underground water supply. Since the introduction of the Noran water by gravitation the tower, which cost over £10,000, is now practically useless, and the Arbroath School Board have appointed an expert to report as to the advisability of negotiating with the Town Council for the purchase of the tower, with a view to adapting it for the purposes of a gymnasium.

A short time ago it was announced that the Astronomer Royal had objected to the construction of electric tramways from Woolwich to Eltham on either the conduit or overhead system owing to danger of electrical interference with the Observatory instruments. The Highways Committee of the London County Council have now reported upon the matter, and recommend that certain tramways in the neighbourhood of the Observatory be constructed upon the overhead system, using two trolley wires for each track.

H.M. Consul at Stockholm reports that, according to the *Stockholms Dagblad* of 21st October, the chief of the Beton Construction Office has proposed, for the new bridge over Tranebergssund, a construction of a totally new type. The bridge suggested is a pontoon bridge, but differs from the usual type, in that the pontoons are quite submerged, and are anchored to weights resting on the bottom of the sea. The bridge, which is constructed with lattice work, consists of long links 35 metres in length, each of which rests on two pontoons. The excess of sustaining power of the pontoons is so great that tramways passing over the bridge do not cause any depression whatever of the pontoons. The whole bridge remains thus perfectly still, independent of the water-level.

A Blue-book recently issued gives elaborate reports on the hydrographical investigations carried out in the North Sea and adjacent waters. It has been ascertained that over a considerable part of the North Sea the tidal action is powerful enough to effect a thorough mixing of the waters from surface to bottom, this being more particularly the case in the southern regions where the depths are but slight. Over the northern part of the North Sea, however, the conditions are entirely different, and only in the colder months, when the action of convection currents is most powerful, does any uniformity whatever exist in the surface to bottom distribution. Over the North Sea area, the temperature in summer decreases from the shore outwards to the open sea, while in winter the reverse conditions hold good.

Speaking before the Royal Society in London last Tuesday night on the subject of magnetic storms, Mr. E. W. Maunder, superintendent of the Solar Department of the Royal Observatory, Greenwich, said that magnetic disturbances were in some way connected with the rotation of the sun upon its axis. It was clear that, besides sending us light and heat, the sun sent some kind of influence which came only from certain portions of the surface and came along closely restricted lines. They found there was a tendency for magnetic disturbances to take place when a sun spot had got to a definite portion on the sun's disc. If they took it that the influence that came from the sun and struck the earth came from the centre of the sun spot, they would be able to calculate how long it had taken place, and, assuming that, they found it would take about twenty-six hours to come from the sun, a distance of 93,000,000 miles, to the earth.

An address read recently before the American Mining Congress admits that mine inspection in the United States has been generally neglected except where obvious dangers have forced Legislatures to devote attention to proper regulations. The tendency is always strong to avoid governmental interference with private enterprise, and the peculiar form of Government in the States has rendered such action more difficult. Mine regulation in other countries is established by the Central Government, but the Congress of the United States has no power to enact regulations which shall apply to the separate States. Under such conditions it is more difficult to arouse public sentiment favouring measures which limit the freedom of individuals. The growth of the mining industry, however, by increasing the number of labourers employed in such operations, has aroused interest in the matter latterly to a degree formerly unknown. The result has been the passage of Acts by the several States, the chief characteristic of which has been their inadequacy and their dissimilarity.

THE TAUERN RAILWAY

(For description see page 494)

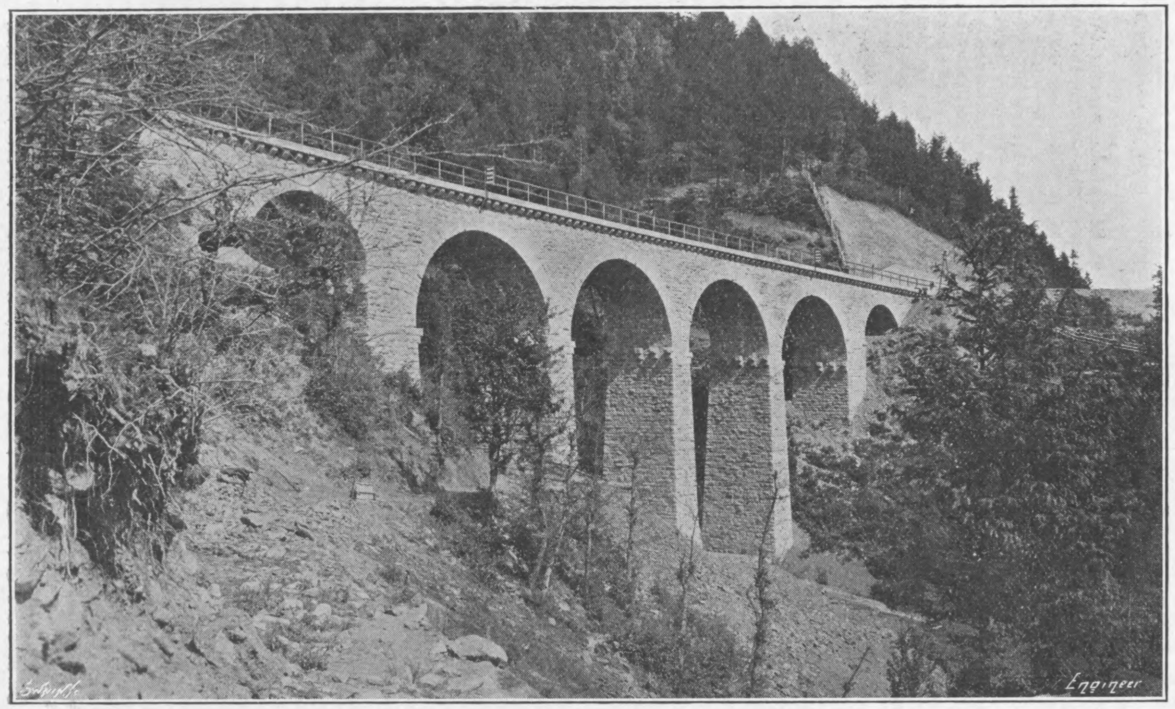


Fig. 5—ROTTAUER VIADUCT

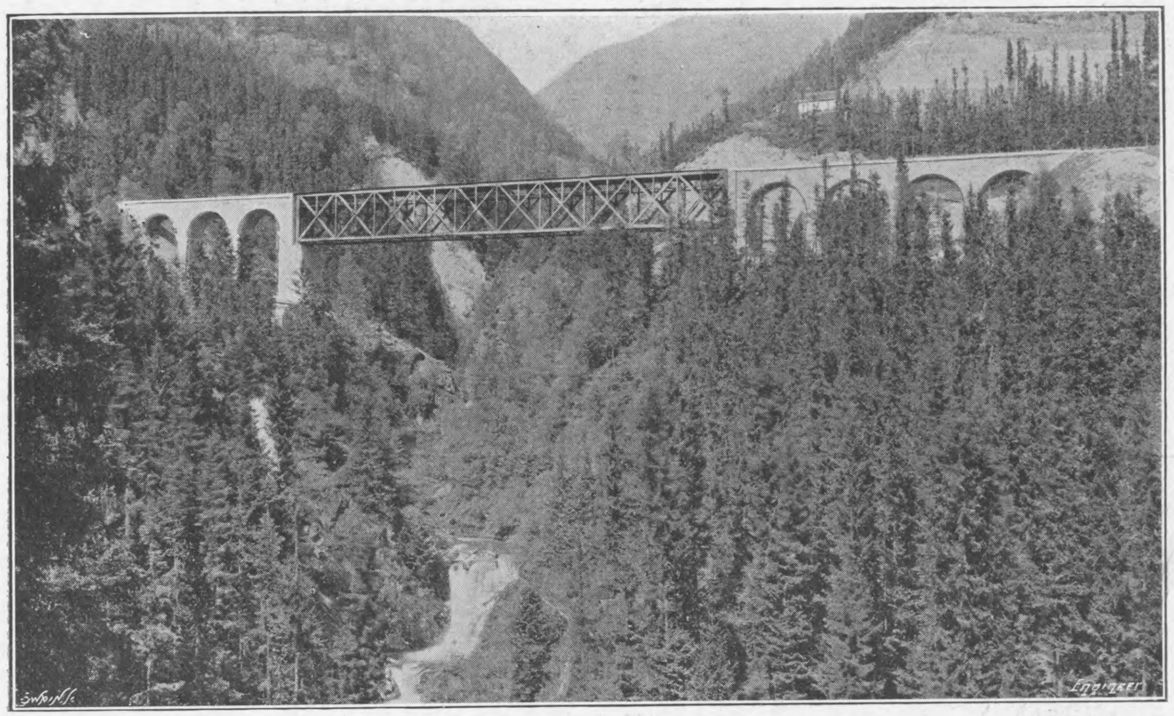


Fig. 6—RIEKENBACH VIADUCT

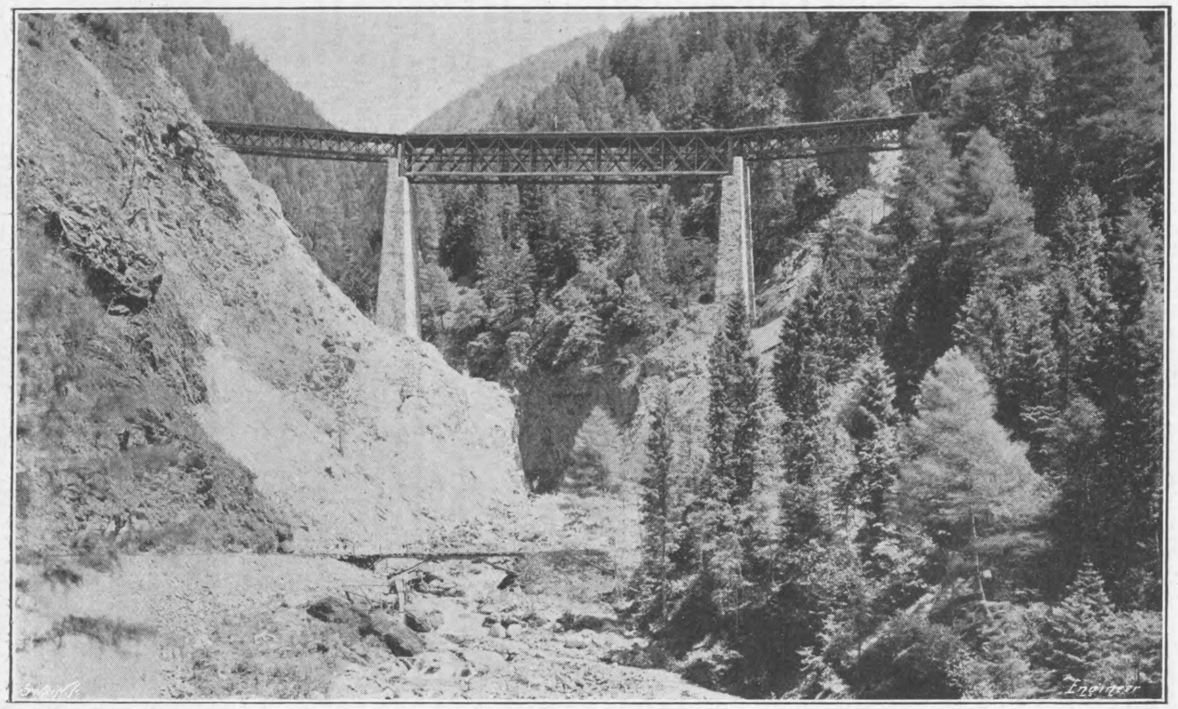


Fig. 7—ZWENBERG PFAFFENBERG VIADUCT

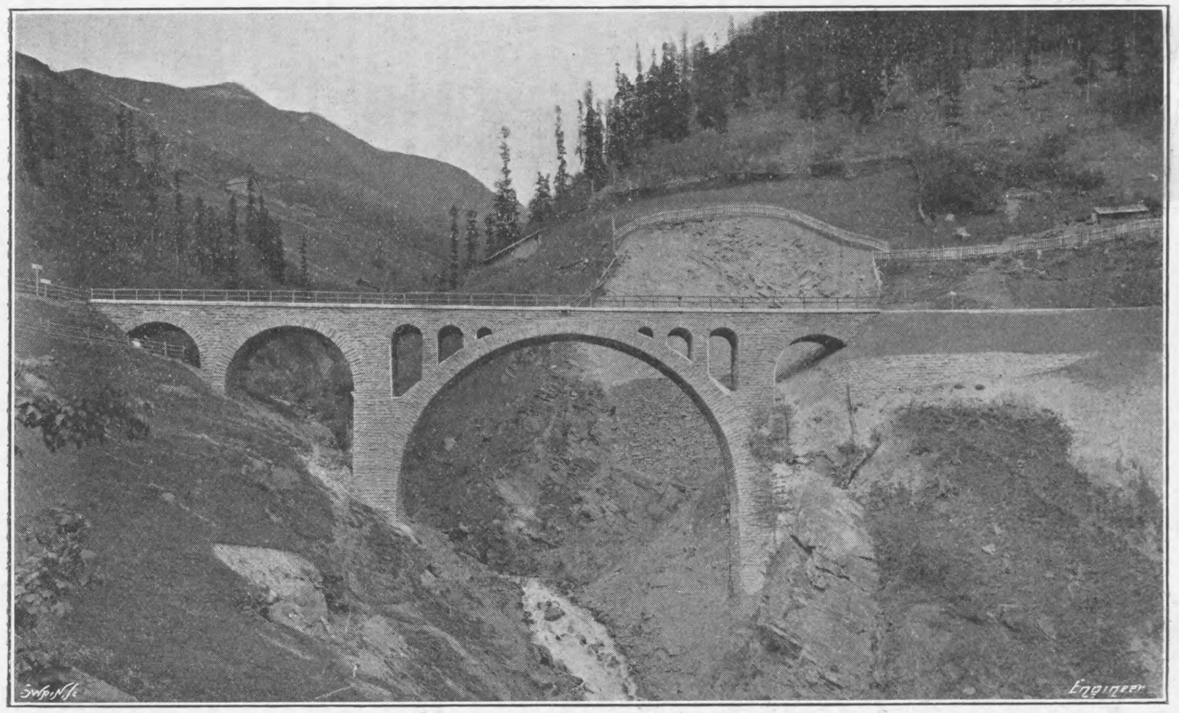


Fig. 8—DOSSEN VIADUCT

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Letters relating to Advertisements and the Publishing Department of the Paper are to be addressed to the Publisher, Mr. Sydney White; all other Letters to be addressed to the Editor of The Engineer.

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PUBLISHER'S NOTICES.

*** *With this week's number is issued, as a Supplement, a Two-page Engraving of a Hollow Rolling Mill for Steam Turbine Drums at the Works of John Brown and Co., Limited, Sheffield. Every copy as issued by the Publisher includes a copy of this Supplement, and subscribers are requested to notify the fact should they not receive it.*

H.M.S. BELLEROPHON.

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TO CORRESPONDENTS.

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☛ *We cannot undertake to return drawings or manuscripts; we must, therefore, request correspondents to keep copies.*

REPLIES.

J. K. (Plumstead).—It should be possible to make a screw of such short length with no appreciable inaccuracy of pitch, which is, we presume, what you want. Good mathematical or astronomical instrument makers would prepare one for you. The method usually employed is to lap the screw in a cast iron nut almost as long as the screw itself. A 1in. *commercial* bolt, 10 threads per inch, should not differ in pitch more than 1½ thousandths per inch length.

MEETINGS NEXT WEEK.

Institute of Marine Engineers.—Monday, November 15th, at 8 p.m., at 58, Romford-road, Stratford, E. Paper, "Marine Engines and Superheated Steam," by Mr. A. F. White.

The Institution of Electrical Engineers: Glasgow Section.—Tuesday, November 16th, at 8 p.m., at 207, Bath-street, Glasgow. Ordinary meeting. Mr. E. George Tidd will deliver his Inaugural Address.

Royal Society of Arts.—Wednesday, November 17th, at 8 p.m., at John-street, Adelphi, London, W.C. Ordinary meeting. Inaugural Address, "An Imperial Navy," by Sir William H White, K.C.B., LL.D., F.R.S., Vice-President and Chairman of the Council.

The Institution of Mechanical Engineers.—Friday, November 19th, at 8 p.m., in the Institution House, Storey's Gate, St. James's Park, Westminster, S.W. Paper, "An Internal-combustion Pump, and other Applications of a New Principle," by Mr. Herbert A. Humphrey.

The Institution of Electrical Engineers: Leeds Local Section.—Wednesday, November 17th, at 7.15 p.m., at the Department of Applied Science, The University, St. George's-square, Sheffield. General meeting. Paper, "Some Experiments on Single and Stranded Fuses," by Mr. W. T. Maccall.

Junior Institution of Engineers.—Tuesday, November 16th, at 8 p.m., at the Royal United Service Institution, Whitehall. Presidential Address on "The Propelling Machinery of Warships," by Engineer Vice-Admiral Henry J. Oram, C.B., Engineer-in-Chief of the Fleet. Saturday, November 20th, at 3 p.m. Visit, Foundation Work of the New County Hall of the London County Council, Belvedere-road, Lambeth, S.E.

The Institution of Civil Engineers.—Tuesday, November 16th, at 8 p.m., at Great George-street, Westminster, S.W. Ordinary meeting. Discussion on papers: "The Single-phase Electrification of the Heysham, Morecambe and Lancaster Branch of the Midland Railway," by J. Dalziel and J. Sayers. "The Equipment and Working Results of the Mersey Railway under Steam and under Electric Traction," by Joshua Shaw. "The Effect of Electrical Operation on the Permanent Way Maintenance of Railways, as illustrated on the Tynemouth Branches of the North-Eastern Railway," by Charles Augustus Harrison.

THE ENGINEER.

NOVEMBER 12, 1909.

The Borough Engineer as Arbitrator.

At a time when the question of professional status in relation to engineers is very much in evidence, it is not inexpedient to consider the nature of certain duties falling to the lot of many engineers which require the exercise of high probity and honour. We allude, of course, to the duties of an engineer in relation to a contract for works. So long as he is merely called in as an independent arbitrator his position is in no way peculiar. Any fair-minded man who has no interest of either party to serve can act as an arbitrator; but the difficulty of his position is enormously increased if, at the very outset, he is necessarily more or less biassed in favour of one side. Is not this the position which the engineer has to occupy in relation to numerous contracts? Upon the many points which arise in connection with the works his decision is to be final. Take any ordinary form of contract, the use of which is insisted upon by a local authority.

The engineer who is to supervise its execution is appointed by the local authority. Indeed, he is often in their permanent employment. It is for him to decide whether the contractor may sub-let any portion of the work and whether plant or apparatus used by the contractor is of approved type. He has also to decide as to extras and variations. It is his duty to test the materials and workmanship of the plant, and if he thinks fit he may reject it. All the works are to be carried out to his satisfaction, and as regards payment, this is to be made from time to time as the work proceeds on the written certificate of the engineer. Many contracts of this kind contain a general clause which provides that "the works generally and every part thereof shall be executed and completed to the satisfaction of the engineer, and in all cases of difference of opinion as to the manner in which the same is executed or as to quality of the materials, or as to the true intent and meaning of this specification or the said drawings, or as to any matter of charge or account or otherwise as between the corporation and the contractor either during the progress or after the completion of the work, the decision of the engineer shall be final and binding on both parties." One has but to read this clause to realise the position of trust which the engineer occupies. The contractor is delivered up into his hands, and unless actual fraud on his part can be proved, is bound by his every decision. Some contracts, of course, contain an arbitration clause which affords some measure of protection to the contractor. Thus the "Model General Conditions for Electricity Works," which are approved by the Institution of Electrical Engineers, provide that "if at any time any question, dispute, or difference shall arise between the purchasers or their engineer and the contractor . . . such dispute shall be referred to the arbitration of a person to be mutually agreed upon, or, failing agreement, to some person appointed by the President for the time being of the Institution of Electrical Engineers." By such a provision, of course, the contractor is fully protected; but it is notorious that many local authorities will consent to no such clause. They prefer to leave the arbitrament of all disputes entirely to their own engineer or surveyor, as the case may be. And although an examination of some of the cases on the subject reveals the fact that there is some tendency on the part of the Court to modify the rigour of the law on the subject, the earlier decisions have held the contractor tied and bound. He may often be tempted to ask: "Why should I be bound by the decision of the engineer to the corporation—or other local authority—who is practically judge in his own cause?" The answer is that by signing the contract which contains a clause giving the engineer these extraordinary powers the contractor has estopped himself from taking any such objection.

That in most cases he is not unfairly served by the engineer cannot be denied, for the consulting engineer has a high sense of honour in these matters, but in some instances the position is highly anomalous. In a recent case, for example, the Court of Appeal has considerably modified the rigour of the clause. We refer to the case of Blackwell and Co., Limited, *v.* Mayor, &c., of Derby, which was heard in the Court of Appeal on July 29th, 1909. It has not been reported in any of the official reports, and the following extract has been made from a transcript of the shorthand notes. The action was brought by the plaintiffs to recover a sum of £1500, which had been deducted from the price of laying down certain tramways under a contract. The deduction was made by the engineer of the corporation, who was engineer under the contract. The plaintiffs alleged that the delay that occurred was occasioned entirely by the conduct of the corporation, through their engineer, in not allowing the plaintiffs proper facilities for proceeding with the work. They alleged, in effect that, the engineer did not distinguish between the duties of an impartial engineer under the contract and what he would like to do as borough surveyor—which position he also held. In these circumstances, as the conduct of the engineer himself was really in question, they sought to bring an action rather than invite the arbitration of the engineer himself. The corporation, however, promptly took out a summons to have the matter proceed to arbitration, and the matter was finally discussed in the Court of Appeal. The arbitration clause, which was very wide in form, provided that disputes of all kinds should be settled by the engineer: but in the event, it was held that as the conduct of the engineer was the real subject matter of the dispute, it ought not to go to arbitration. Lord Justice Moulton said:—"Each case must be decided on the facts, and, in my opinion, where the nature of the dispute arising from facts which were subsequent to the contract is such that we are of opinion that the tribunal is not likely to be able to deal with the dispute, it is open to us, and it would usually be the duty of the Court to refuse to enforce the arbitration clause. It has been suggested that this would make us tear up all arbitration clauses, but in my experience, a Court is quite capable of judging what is the substance of the dispute, and it will not be so easily misled by mere allegations. But in the present case I am satisfied that the dispute is in substance as to whether the engineer has not, from the first, acted unreasonably towards a contractor, viewed from the point of view of the contract. Corporations are, in my opinion, often too fond of putting officers of theirs in the position of engineers under a contract, and they forget that, as they are performing other duties to the corporation, there may arise a conflict between their duties in these offices and their duties as engineers under the contract. This may give rise to unfair treatment to the contractor by reason of the zeal with which the officers perform their other duties. Of course, if you have exalted an officer of that kind as the arbitrator under the contract, you cannot say merely, because he is an officer, that therefore he is an unfit judge. But if facts subsequent to the signing of the contract have given rise to a substantial dispute, in which there are allegations of continued unreasonableness on his part, and that is the real dispute between the parties, I think we should not be acting in the spirit of the law if we shut the doors of the Court to such a dispute and forced it to be referred to arbitration." Lord Justice Buckley, in the course of a similar judgment, pointed out that the allegation of the contractors—whether true or false—was that the engineer had hindered the performance of the work and had been otherwise unreasonable. He then said: "The worst possible referee on the question of unreasonable conduct is the person who is accused of being unreasonable. . . . It is not human nature to suppose that he can properly determine that he himself is an unreasonable person."

We have quoted somewhat lengthy extracts from the judgments in this case, and it is easy to see that the case is of considerable importance. As we have seen, the question whether this particular engineer had or had not been unreasonable was not decided by the Court; the sole point was whether the case should go to arbitration or not. If the principles enunciated are adopted, we may expect the emancipation of many a contractor from the chains by which he is enfettered. What are the objections to an arbitration between contractor and local authority? The proceedings are conducted in secret. The public and the ratepayers know nothing of what goes on. On the plea that "it is the ratepayers who will suffer" the local authority fight to the bitter end, and spend a mint of money in so doing. Last, but not least, there has up till now been the bias of the tribunal. We hope that the case of Blackwell *v.* Mayor, &c., of Derby, may lead the great corporations and local authorities of the country to adopt a more reasonable attitude towards the contractor.

Modern Marine Boilers.

THE survival of the fittest is abundantly manifested by the Scotch boiler, which after passing through many vicissitudes, is still the most popular with the shipowner. Its simplicity of construction, eminent suitability to the conditions of marine life, and more than fair efficiency have kept it alive notwithstanding multitudinous adverse criticisms and well-meant attempts to supersede it. It was never in worse case than when, some twenty years ago, attempts were made to work it with forced draught in the British Navy. That it has given place to a large extent to Babcock and Yarrow boilers in warships is in nowise remarkable, because conditions of working and upkeep prevail in the Navy which are very different from those obtaining in the mercantile marine. But it must not be forgotten that its success alike in our greatest Atlantic liners and our smallest ocean tramps is mainly due to causes which are not closely concerned with the general design of the boiler.

It is clear that the workmanship and material of a boiler have next to nothing to do with its evaporative efficiency. So long as the boiler does not leak, a square foot of heating surface is just as good, other things being equal, in a weak, badly made boiler as it would be in a boiler of the best possible construction. This means, in other words, that the Scotch or return flue marine boiler found its way to the hearts of the shipowners while pressures were very low, plates thin and small, and workmanship poor when judged by modern standards. As time went on safety valve loads augmented, and it was argued that only the water-tube or locomotive boiler could stand the stresses. But shell plates were rolled at moderate prices, daily larger and thicker, and this more rapidly than pressures rose. Then it was said that although shells might comply with the conditions, furnace tubes could not. The answer to that was the corrugated flue. In one word, the steel manufacturers were able to supply plates, and the boilermaker to use them, in a way which met any possible demand for high pressure. The notable fact is that the design of the boiler lent itself easily to the utilisation of thick plates, just as well as it did to the utilisation of thin plates. We are prone to forget, now-a-days, the importance of the part played by good workmanship and good material, in perpetuating types which must have become obsolete without them. Every advance that has taken place in the economical production of power at sea has been in the first place due to an increase of pressure. While the pressure remained at 30 lb., nothing whatever was gained by compounding. The introduction of a second cylinder had no effect, unless to augment the weight of steam required per horse-power per hour. In like manner, triple-expansion with 75 lb. or 80 lb. steam meant waste. The presumed effect of reduction of range of temperature in each cylinder had no existence. The pressure jumped to 130 lb. and 150 lb., and lastly to 160 lb. Now we have quadruple expansion; but to make it pay the pressure is 200 lb. to 220 lb., and these last enormous pressures are carried with perfect safety in gigantic boilers, still of the Scotch type. The thing would be wholly impossible were it not for the improvements which have been made in rolling mills, and in the machinery of our boiler yards. Twenty-five years ago no one would have dreamed of designing a Scotch boiler 15ft. in diameter, with shell plates 2in. thick. Modern plant has rendered the manufacture of such boilers a matter of certainty, and that on a perfectly satisfactory commercial basis. We are very liable, when criticising our predecessors, to forget that much that was known to them to be desirable was also known to be impossible.

Nor is the end even yet in sight. Lloyd's and the Board of Trade used to stipulate that no steel over 38 tons or under 26 tons should be used in a boiler. These rates were modified, and now Lloyd's no longer stipulate for anything save that their engineer surveyors shall be satisfied. It is by no means impossible that 60-ton steel may be used at no distant period. It is now, we may say, simply a question of price. But inasmuch as the weight of a boiler made of high steel would be little more than 60 per cent. of that of a boiler made of low steel, there is, it will be seen, a considerable margin available. As far as mere saving in weight is concerned, however, it is doubtful if the owner of large ships would attach any particular importance to it.

It is clear that the closing of $1\frac{3}{4}$in. rivets is quite beyond the power of manual labour. It follows that but for the riveting machine we should have no thick boiler shells. At every turn, indeed, we have the interdependence of the arts brought before us. The facts are put very much in evidence by a few passages contained in an excellent practical paper on "Marine Boiler Design, Construction, and Economy," read before the North-East Coast Institution of Engineers and Shipbuilders, on the 29th ult., by Mr. D. Myles. After referring to the time when ship riveters and caulkers were employed in making boilers when they were not wanted on the slips—a practice now quite out of date—he went on:—"Along with the improvement in workmanship, there have been vast improvements made in machines used in the manufacture of boilers. The holes for stay tubes, which a few years ago were tapped by hand, are now almost universally accurately tapped by machine, and this applies also to stay holes between combustion chambers, boiler backs, &c., and a hole tapped by machine is more likely to be true and fair than one tapped by a man pulling at the end of a long single-ended lever, as was frequently the case in former years, and if the hole is truer the screwed stay will necessarily be a better fit." One result of all this is that the only limit to the size of a boiler is economy in working. Double-ended boilers, carrying 190 lb., and weighing over 100 tons, are in use, and giving much satisfaction. The weak point about these heavy boilers is the caulking. No method of welding is trustworthy; but it would not seem to be impossible to devise some method of electrical or blow-pipe welding by which the edge of one plate might be fused autogeneously, if we may use the word, on to the surface of the other, riveting having, of course, first been done in the usual way.

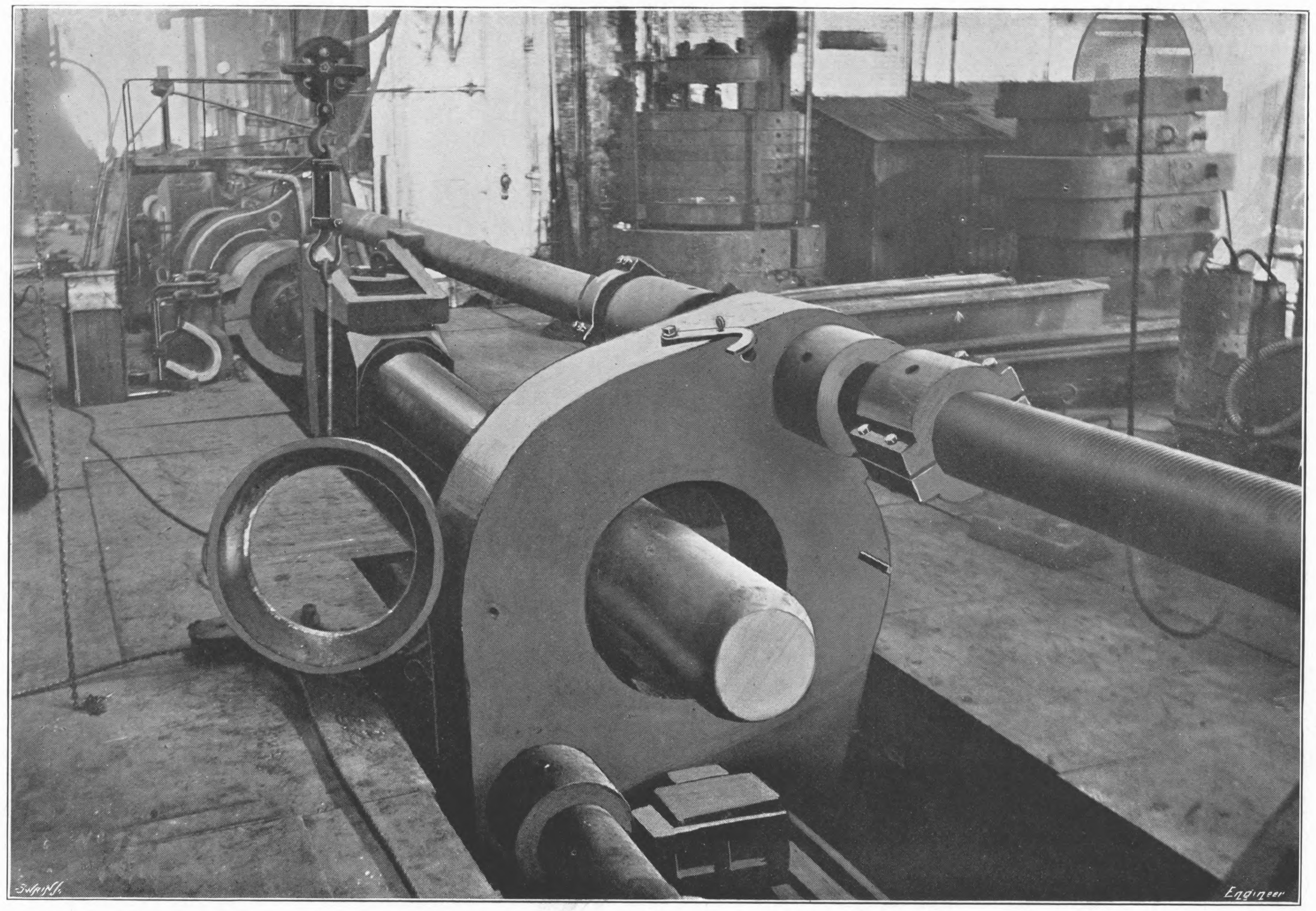
One fact we commend to the attention of those who believe that reduction in the size of a boiler is a highly desirable prize. Mr. Myles points out that the whole modern tendency is to make boilers larger instead of smaller. Thus combustion chambers are made much deeper than they were, with great benefit; and more room is left between the shell and the tubes. Nothing has struck him more forcibly "than the great change of opinion and practice with regard to crowding a large amount of heating surface into the smallest possible boiler, thereby reducing the space for cleaning and examination and otherwise making the boiler unsatisfactory. Boilers, which a few years ago were considered large enough to contain about 2400 square feet of heating surface, are now usually made 9in. or 12in. larger in diameter. This extra size is due to a large number of causes, the principal of which are the larger spaces between combustion chambers, between nests of tubes, and between steam space stays, thereby making the boiler much more accessible for cleaning; and as ships' engineers, together with boiler cleaners, are very human, the boiler that is not easily accessible is very liable to go improperly cleaned, and the opposite, of course, also holds good, that a boiler easily accessible is much more likely to be thoroughly cleaned, and in boiler treatment cleanliness is of the very highest importance if long life and satisfactory results are to be obtained." It is frequently forgotten by professional boiler designers, and always forgotten by amateur designers, that much more has to be kept in view than the combustion of coal and the making of steam. Apparently small matters may make a great difference. No mistake is more common or more harmful than the crowding of too many tubes into a shell. Boilers have this in common with animals, that they must have room to breathe.

London Traffic.

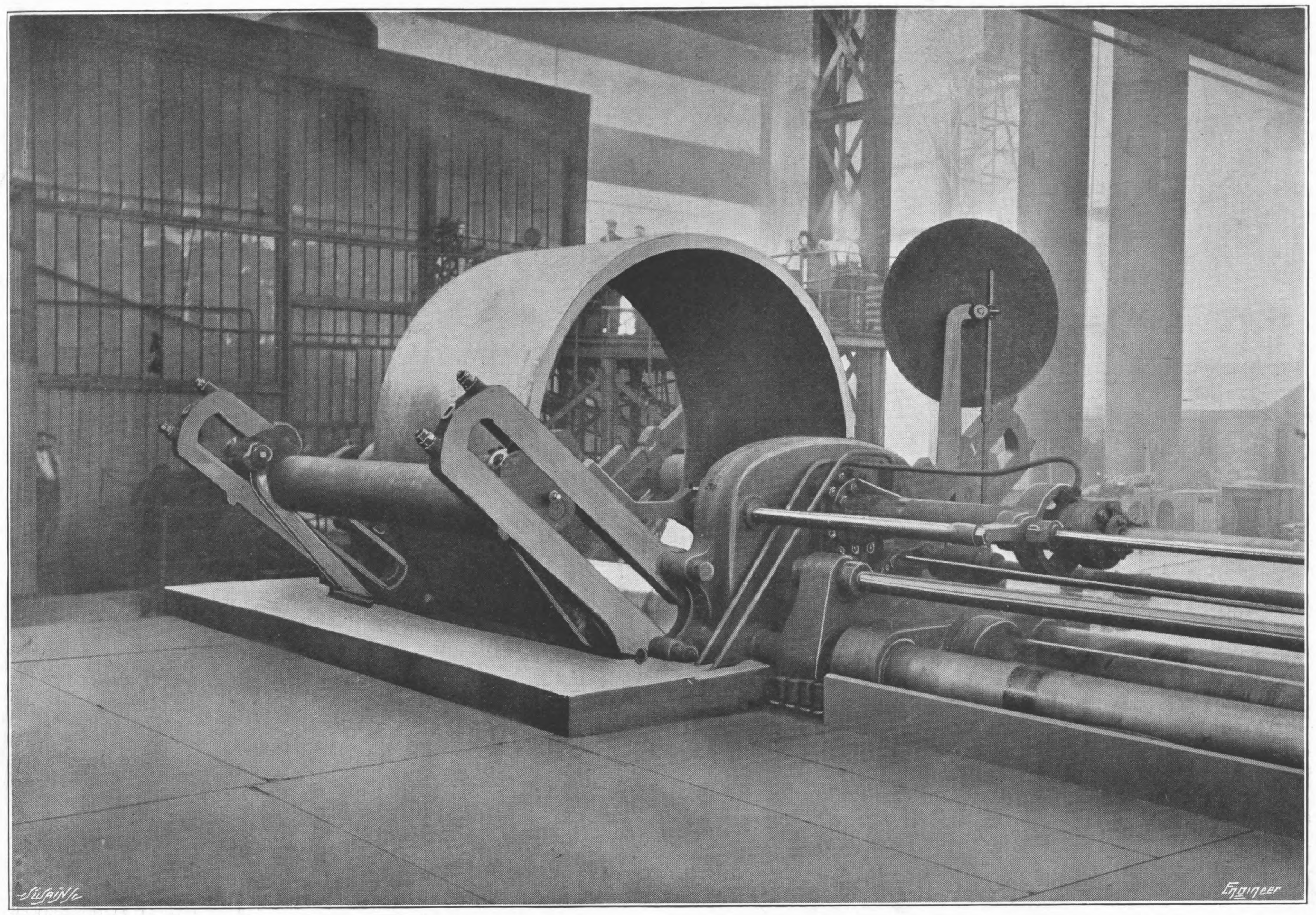
THE conditions of London traffic have undergone a marvellous change during the past few years, and the situation is now represented by the problem as to which system or systems of handling the passenger traffic will ultimately prove to be victorious. On the one hand we have the underground railways, of comparatively ancient origin as times go now-a-days, and the deep-level tube railways, all of which are operated by electric traction; and on the other we have on the street level electric tramways and omnibuses, both of the mechanically propelled and horse-hauled type. It is scarcely necessary to point out that the present position is largely dominated by the electric tramways on the street surface, on which over two thousand cars are now in use or available for service in different parts of the metropolis. So carefully, indeed, are the traffic requirements watched and cultivated by the staff of the London County Council, that numerous cars are placed upon the streets in the early morning and early evening in order to collect every possible passenger, and to combat every existing rival or any new one which may be so bold as to attempt to obtain a share. But these particular cars are withdrawn during the comparatively slack hours in the middle of the day, and judging from the present practice, it would seem that the greater the demand manifested the larger will be the number of cars placed at the disposal of the public. What prospects, in these circumstances, have rival means of transport of maintaining the competition in the face of the low fares and long distances over which passengers are carried by the tramways at the present time? The steam railways in the metropolis have been hopelessly beaten; the Metropolitan and District Railways have as yet scarcely benefited from the adoption of electric traction; the underground tube railways, excepting the Central London Railway, are making but little progress; whilst the omnibus undertakings continue their downward career, in consequence of the rivalry of the tramways and the underground lines where their routes are in the same direction. In fact, the tramways, wherever they are constructed, continue the work of diverting the major portion of the traffic from other methods of transport.

It may safely be assumed that however unfavourable or comparatively unfavourable the conditions may be for the underground railways in general at the present time, these railways will eventually stand to benefit from the circumstance that, as London passenger traffic is constantly increasing, they will naturally be required to perform their part in dealing with the expansion. This assumption is all the more reasonable from the fact that it would not be financially advantageous, even if it were possible, to construct tramways everywhere; and if no limit can be placed upon the actual number of cars plying for traffic in the streets, there is a limit beyond which it would not be remunerative to augment them, for the larger the number of cars on a given route the less will be the average speed, owing to the stoppages for the exit or admission of passengers. If, then, this limit should be exceeded, it is highly probable there would be a diversion of traffic from the tramways to the railways and the motor omnibuses; but, in the event of its not being surpassed, the railways and motor omnibuses will have to await the gradual growth of traffic in general before they may hope to attain a state of prosperity, or of greater prosperity, as the case may be. If the steam railways serving the London area are left out of consideration for the time being, it is found that the omnibus undertakings, one of which has rendered excellent services for over fifty years, have suffered the most from the advent and encroachments of the electric tramways, and also from severe rivalry among themselves. Company after company has disappeared, entire services on

HOLLOW ROLLING MILL FOR STEAM TURBINE DRUMS AT THE WORKS OF JOHN BROWN AND CO., LIMITED, SHEFFIELD


Swain sc.
Engineer

THE HYDRAULIC DRAWING PRESS


Swain sc.
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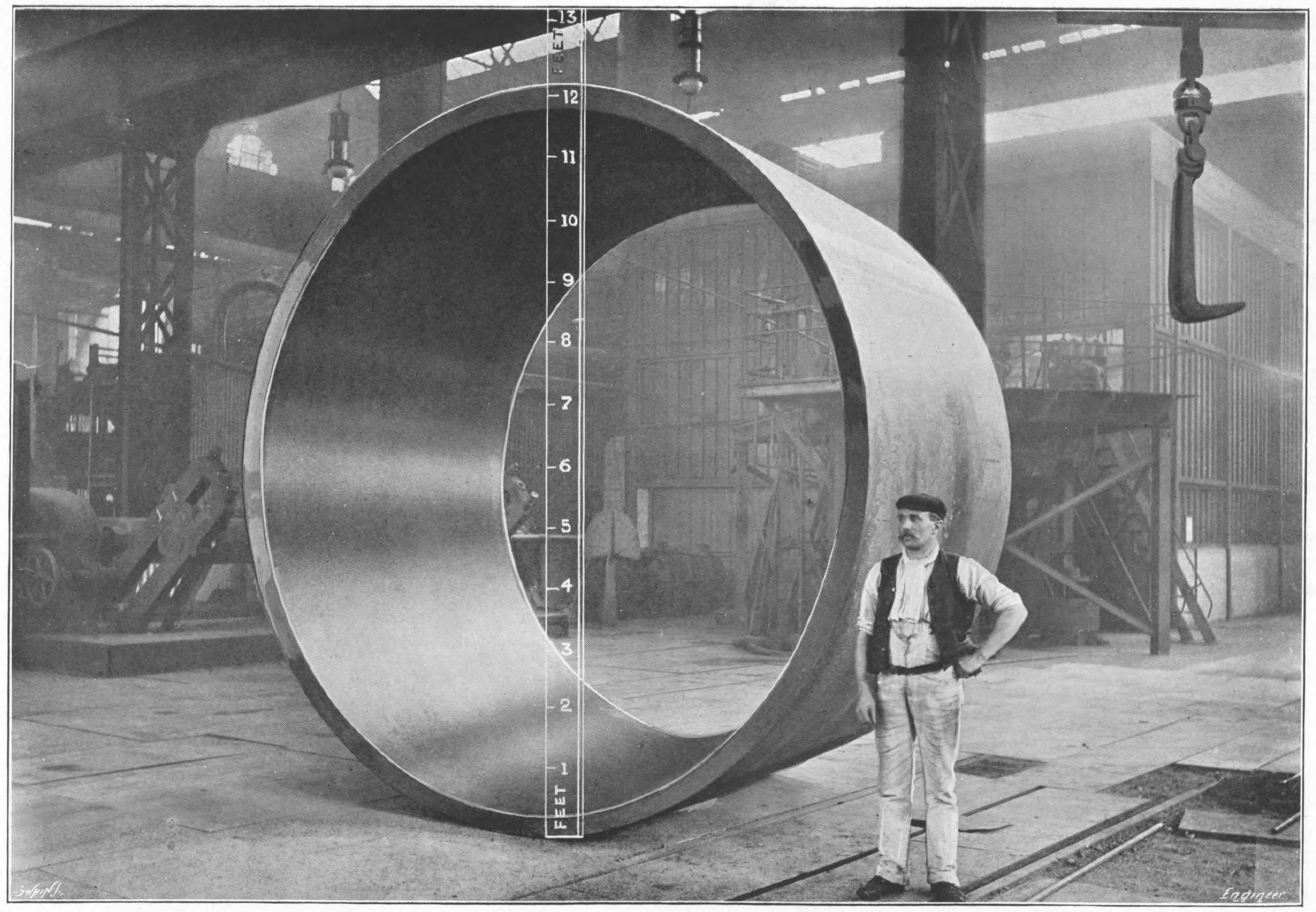
THE HOLLOW ROLLING MILL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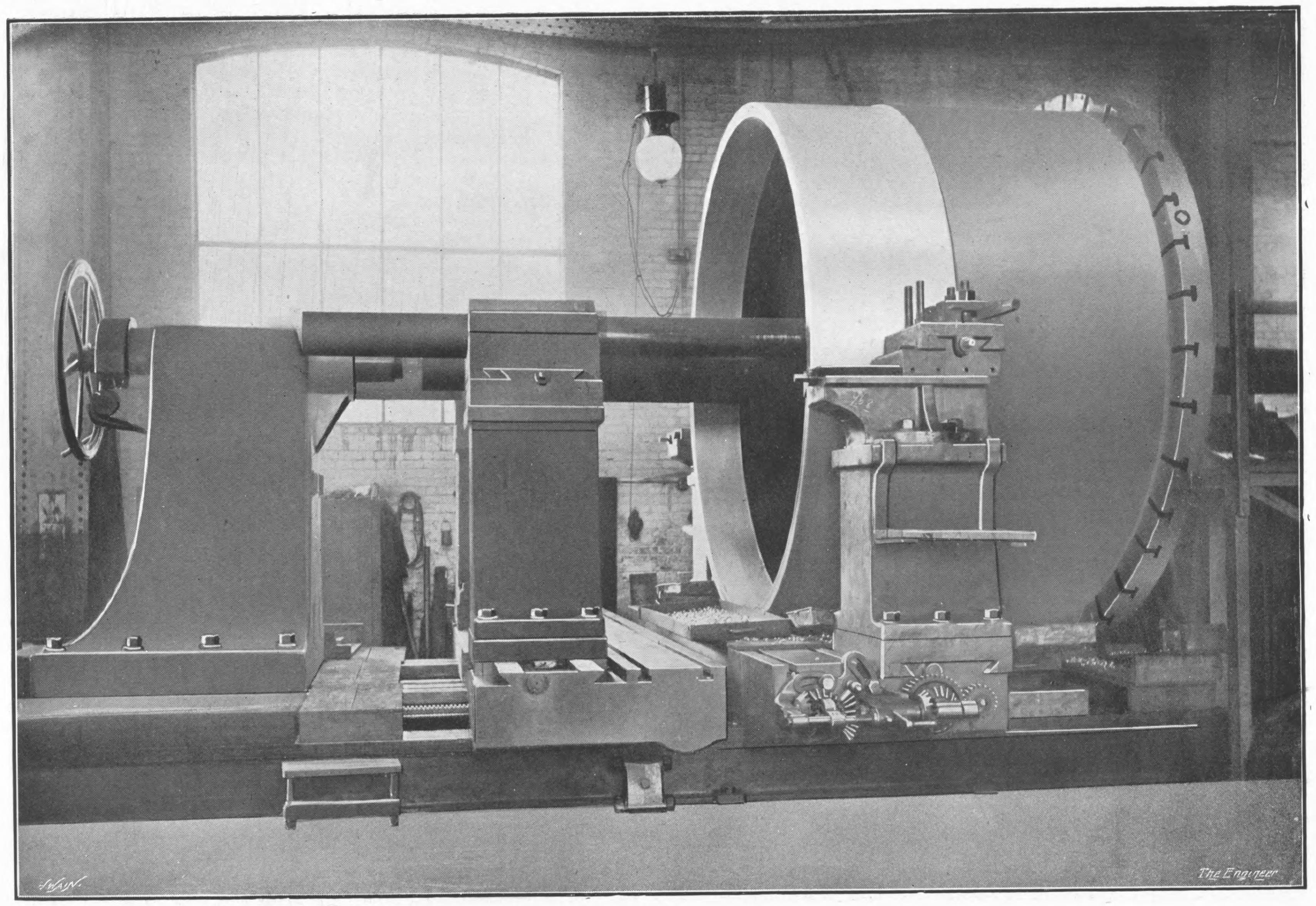
Swain sc.
Engineer

12-FOOT DRUM AFTER ROLLING


Swain sc.
The Engineer

DRUM IN A LATHE

various routes have been withdrawn, the daily receipts on many horse omnibuses are scarcely more than sufficient to pay the wages of the drivers and conductors, and it is probable that out of the three remaining omnibus undertakings not a single one is now earning any genuine profits. The amalgamations which have taken place have not brought about the advantages which were expected, the adoption of motor omnibuses has not proved to be the salvation set forth in company prospectuses, and it will only be a question of time when a fresh reorganisation will be necessary if the omnibus undertakings are to be placed on a sound commercial basis.

The annual reports of the Commissioner of Police of the Metropolis throw an instructive light on the course of events in connection with the progress or retrogression of the vehicular traffic coming within the province of the police authorities. The day of the horse omnibus, if it has not quite passed, is passing, although there may still be routes served by a number of these vehicles for some years to come. Every year since 1901 the number of horse omnibuses licensed has decreased, and the 3667 vehicles of this kind available in 1902 declined to 2150 in 1908. On the other hand, the number of motor omnibuses licensed has advanced from 29 in 1902 to 1205 in 1907, but in 1908 there was a reduction to 1133. Many hundreds of the original vehicles, which were mostly of foreign manufacture in so far as the chassis were concerned, have been scrapped or otherwise disposed of, whilst others, which were very numerous, were never permitted to be placed in service, owing to defects or non-compliances with the requirements of the police. If it is assumed that the useful life of a motor omnibus is represented by the number of years during which it is licensed, the reports of the Commissioner of Police are beginning to afford some information on this point that is not imparted either by the makers or the owners. Apparently all the vehicles which were in use down to the end of 1905 have wholly disappeared, as the total number licensed in 1908 was less by five than the combined total of new omnibuses which were authorised to ply for traffic in the years 1906, 1907 and 1903; and at least 500 omnibuses could scarcely have lasted a period of two years, in 1906 and 1907. In fact, all the vehicles at present in service represent construction during the past three years, and when the report for 1909 becomes available, it will be possible to obtain further information as to the useful life of the omnibuses. In the meantime there can be no question that the present vehicles are improvements upon their predecessors, and with further progress they will probably become remunerative means of transport. The motor omnibus undoubtedly meets the requirements of the public, and unless the omnibus companies are to vanish altogether, they will have to develop this system, as it affords the only hope of coping with the competition of electric tramways where rivalry has any prospect of success.

The Mines Eight Hours Act.

The short discussion in the House of Lords on Tuesday upon the Mines Eight Hours Act was timely. Lord Newton, in pressing the Government for authoritative information regarding the decrease of output consequent upon the new measure, said he had ascertained upon his own account that in some parts of the country the curtailment of production was serious. He estimated that in Lancashire the reduction of output averaged about 10 per cent., and that the same figure applied to some portions of the Midlands and South Wales. Earl Beauchamp, replying on behalf of the Government, admitted that the Mines Inspectors "reported that there had been more or less generally in England and Wales some decrease in the output," and added that "the decrease appeared in some cases to amount to as much as 10 per cent. or more." Of course, it will be some considerable time yet before either the industries of the country or the householders will feel the full effects of the Eight Hours Act. We must wait until the Act becomes operative in Durham and Northumberland, and until there is a real revival in trade and a vigorous demand for coal. We must wait also until the miners have enforced their demand for such a readjustment of their payments as will give them wages for the lessened output at least equal to those they enjoyed before production was cut down. Then we shall know where we are. Meanwhile, however, it is abundantly clear that this new law will be reflected in a rise in the price of coal by no means trifling. Not only will there be a rise in price on account of scarcity, and on account of increased standing charges and costs per ton at the mines, but there will be an additional rise through the increased wages per ton. Already the miners are pressing for wage increases to make good their losses on account of the new law; they are also asking for various bonuses, and that fines for breaking rules be abolished. Only this week, for example, the South Wales Miners' Federation is applying for a 2½ per cent. increase of wages.

So far as output is concerned, it may be mentioned that at the four leading Bristol Channel coal ports the tonnage shipped, foreign, coastwise, and on bunker account, during the quarter ending September, compared with the corresponding quarter of last year, declined from 8,312,406 tons to 7,801,477 tons—a drop of more than 6 per cent. And this is drawing the comparison with a bad quarter. Compared with the third quarter of 1907, the decline is much larger. We venture to say that if at the present time trade had been good instead of bad—if the iron and textile industries had been in full swing—the rise in the price of coal would have given the nation a shock. Reports from South Wales show that at many collieries output has declined by more than 10 per cent. and cost of production has increased by from 6d. to 1s. 6d. per ton. Even collieries which spent enormous sums of money upon new appliances in anticipation of the law find their outputs considerably diminished, not to mention the addition to capital and standing charges. While this is so—while the nation's industries are being saddled with dearer coal—the Miners' Union is pressing for higher wages and a still more stringent law. Not only this, but some of the miners' leaders are going about telling the men that if only they will have the courage to strike to enforce their demands "the State will come to their assistance."

Despite the prevailing trade depression, the Welsh coal contracts for 1910, so far effected, are at rates varying from 1s. 6d. to 2s. 3d. per ton above the 1909 prices, and the 1909 rates were fixed higher than they would have been if there had been no Eight Hours Act in sight when the contracts were entered into during the closing months of 1908. Thus, the rise in the new quotations is not the full measure of the immediate effect of the new law.

Reports from the Midland counties, like those from Lancashire and Wales, show a marked diminution of output, and an equally marked increase of cost per ton; but here also it is admitted that the full effects will not be felt until the New Year. From inquiries made at several mines in Warwickshire, we learn that the loss in output averages 10 per cent., and that the managers anticipate a larger difference in the winter months. The increased cost of production, we learn, is not less than 6d. per ton in Warwickshire, and owing to decreased earnings there is much discontent among the colliers, so that an agitation for a rise in wages is imminent. In Staffordshire a number of mines report decreases of output ranging from 7½ to 12 per cent., and a rise in cost of production of between 4d. and 5d. per ton. The reduced earnings of the men are provoking a spirit of unrest which can have but one ending—an all-round increase of wages per ton. In some of the old pits in the Midlands the reduction reaches 15 per cent., while at comparatively new pits the decline ranges from 5 to 8 per cent. At one quite typical colliery in Nottinghamshire the loss in output equals 11 per cent., and the rise in cost of production is 9d. per ton. In Yorkshire only a few pits record any serious decline—apart from the recent boys' strikes—under existing conditions, but if trade revives and demand expands the loss will there, as elsewhere, be very material, now that overtime is practically prohibited. Even in Yorkshire there is much grumbling among the men on the score of stoppage of overtime and extra earnings, and the movement for higher wages will be heartily supported.

Thus it will be seen that not only is this mischievous and absolutely uncalled for Eight Hours Act lessening the supply and enhancing the price of coal, but it threatens to involve the whole country in an industrial conflict of unparalleled magnitude. A strike over its inception in Wales was only narrowly averted, and is still feared, the men being discontented beause under the new law they are prohibited from making up a lost Monday by extra time during the rest of the week. It provoked, if it did not create, the threat of a strike over the wages of the Scottish miners. And it is possible, if not probable, that it will lead to a great national strike over the readjustment of wages rendered imperative by the reduced earnings and general discontent of the colliers in various parts of the country. Apart from the general question of wages throughout the country, there is trouble looming on the horizon in the North. In Durham and Northumberland this new Act, which becomes operative in those counties at the beginning of the New Year, will completely upset existing arrangements. Protracted negotiations between the coalowners and the miners' union, conducted with a view to smoothing out differences in advance, have yielded no satisfactory results yet. Indeed, the negotiations have reached a very acute stage at the moment of writing. A crisis is rapidly developing; but, strike or no strike, the inevitable result of this new law will be dearer coal, and all that that means in hampered industry and restricted employment; while if, as seems likely, a great strike occurs and the nation's commerce is paralysed, the public will hold the Parliament which passed this measure responsible.

TECHNICAL SCHOOLS AT HOME AND ABROAD.

(*From a Correspondent.*)

It is difficult to take up a newspaper containing an article on foreign competition without finding some remark on the superiority of continental technical education, and the resultant progress that is taking place. There is a great deal of misconception on this subject, and many authorities who are loud in their praises of continental schools know little or nothing of the schools at home; it will therefore be of interest to touch on one or two points in connection with this subject.

One frequently hears statements to the effect that the technical schools like those at Charlottenburg and Hanover turn out thousands of highly trained engineers, architects, and chemists every year. The facilities for study at some of the big German high schools are unrivalled, but it by no means follows that the average student turned out is greatly superior to those in this country.

In Germany, as in most parts of the Continent, the university or technical school is looked upon quite as much as a social as an educational institution, and for the first few terms study has to give place to Corps functions, beer drinking, and duelling. The courses are not fixed to the same extent as they are here, and as long as the fees are paid no notice is paid of the attendance or absence, and a student can remain as long as he likes.

In most of the large German high schools the number of diplomas and degrees taken is surprisingly small, in proportion to the number of students, and usually a large proportion of the leading students are foreigners. In Great Britain a student has to take a three or four years' course, lectures must be attended, and laboratory work and exercises carried out. In the event of the written examination and general work being found unsatisfactory, the student is liable to be sent down or dismissed from the school. The diploma is a guarantee that lectures have been attended, and that a certain minimum of marks have been obtained in examinations and general work. The average student is, therefore, distinctly better than those on the Continent, where the number of students is no criterion of the number of good men turned out.

In one way, continental schools are distinctly ahead of those here; every encouragement is given to professors to engage in consulting work, and keep in touch with the latest technical progress. Manufacturers seem willing to co-operate and supply copies of their detailed designs to an extent quite unknown here, most manufacturers thinking that the progress of the country is more important than the keeping of petty secrecies. Very frequently these drawings are reproduced and sold to students at cost price; it would, for instance, be very difficult in this country to supply a series of drawings of electrical machinery like those printed for the Carlsruhe High School. This co-operation has its influence on literature, and modern German engineering books are noted for their admirable illustrations and practical detail.

In the United States at the present day there is a great tendency towards the stereotyping of technical work, especially in the mechanical branches, due very largely to the influence of the big trusts, which force the highest grades of work into the hands of the comparatively few. This, together with a natural eagerness to get to business, leads to the taking up of practical questions, without sufficient groundwork or sufficient care in the intermediate stages. The result is that in practice there is too much reliance upon manufacturers' catalogues, elaborate tables, and empirical formulæ without thorough understanding of the principles and circumstances on which they are based. This feeling is reflected in American technical literature, which very frequently consists of pictures, tables, and padding, without sufficient reasoning, and it may be said that, contrary to the generally accepted ideas, in many branches America lags behind and does not lead. There is sufficient technical competition and enthusiasm on the Continent to prevent the great industrial Cartels from having a similar deadening influence.

In most continental schools diploma students have to make out complete technical estimates for electrical and mechanical installations, the commercial question being kept well to the fore, and in some schools, in order to encourage the student to think and not merely to copy, no two students have the same type of machine to design at the same time. At home many of the technical schools are admirably equipped and well run, but one of the weakest points is that the professors and assistants are frequently too academical, and without sufficient practical experience. Professors frequently start as leading students, renowned for their exhaustive calculations and illustrated note-books, and, after taking an extra year's course, which may be taken up with more or less futile research work, a position is found as assistant demonstrator at some other school, and after passing through the positions of demonstrator and lecturer a professorship is obtained, the selection frequently being left to a non-technical committee. Matters are, however, getting distinctly better in this respect, though still in many cases the practical professor, with experience in design and construction, is conspicuous by his absence. Many of the smaller schools make a greater point of practical experience, but the absurdly low salaries usually offered are hardly attractive to good men.

The highly coloured drawings and water polished fittings shown to admiring parents at some technical schools show too plainly that many teachers are out of touch with modern ideas. In many places arrangements have now been made to sandwich in practical work in a factory between terms at a technical school; that being so, the amount of so-called workshop practice taught at many institutions could be reduced with advantage, and replaced by elementary instruction in contract work, estimates, costing, and the engineering and other markets at home and abroad, the commercial management being the weakest point of many engineering concerns in comparison with those abroad. It seems quite possible that a summer vacation course on commercial engineering, held at an attractive centre like Oxford or Cambridge, might prove very useful.

In design work rough particulars should be given of the market value of the machines drawn out, and also some particulars of the methods of construction; some of the instruction given in German schools is remarkably good in this respect. At home mathematics is too frequently taught to engineering students by mathematical professors without any engineering experience, and lectures are frequently given in higher mathematics without any practical examples to make the matter interesting; in the same way chemistry is rarely taught by those with experience of the practical side.

German technical schools are exerting a remarkable influence on the trade, not merely of Europe, but of the whole world, and the same thing is happening with regard to Canada, Mexico, and South America in connection with the schools of the United States. Several thousand foreign students attend German technical schools every year, and most of these enter business life with a certain bias in favour of German methods and products. It is frequently a difficult matter for an English contractor to obtain consideration from a foreign purchaser who understands German methods and has been told as a student that technical work in England is out of date. German taxpayers frequently complain of the cost of educating so many foreigners, and a movement has taken place to charge extra fees, but the return in trade each year is certainly many times the extra amount spent on account of the foreign students.

Arrangements are made among the leading continental schools so that a student can move about during the last few terms of his training, and, starting at Charlottenburg, can stay a term at Darmstadt, Nancy, or perhaps Vienna. Unfortunately, this does not seem to apply to schools at home; as a result, on the Continent many leading technical men know very little of the progress that has taken place here, and continental journals and books, while describing American designs and processes, rarely deal with British matters.

In this respect it is interesting to note that on Monday last an appeal was made in the daily press for subscriptions towards a fund for the International Exchange of Students. This scheme is supported by a number of well known men interested in technical education, and is for the purpose of granting travelling scholarships and encouraging students from the United Kingdom, Canada, and the United States, to see a little of the world and broaden their minds before starting practical work. This is really an extension of the Studienreise system, which has been a feature on the Continent for many years.

This scheme is likely to be of great value with regard to Canada, as many Canadians are accustomed to look to New York for technical assistance, especially with regard to engineering matters, and, for want of knowledge, consider any work of British origin to be out of date. It is significant of the indifference towards technical education of many well-to-do people at home that the committee state in their appeal that they apprehend no difficulty in raising the necessary funds for the Canadian and American branches.

If English engineers and manufacturers are to regain the position they once held in the world's markets, the technical schools must be kept more in touch with practical progress, and every encouragement given by advertisements or the granting of scholarships to students from neutral European countries, the Colonies, and the Far East, to come to England to study and obtain some insight into our manufactures and engineering methods.

VERTICAL RETORTS IN GAS MAKING.—On October 30th the general meeting of the Manchester District Institution of Gas Engineers was held at St. Helens, Mr. J. W. Morrison, the president, in the chair. Over 120 of the leading gas engineers of Lancashire and Yorkshire were present, this record attendance being caused by the great interest taken in the question of carbonisation. At St. Helens Gasworks the members saw the new system at work. A complete setting of vertical retorts has been installed, which enables the gas to be tested independently of the other gas-making plant on the works. There is a battery of eight retorts, which are automatically fed from coal bunkers at the top. These bunkers can hold twenty-four hours' supply of coal, and are fitted with specially designed coal valves, which are periodically opened when supplying the coal to the coal hoppers in direct connection with the mouthpieces of the retorts. After the carbonisation of the coal the coke is mechanically discharged, and as the coal follows the coal in its descent, the capacity of the retort is in consequence regulated. Advantages claimed for the system are the greatly increased make of gas on the same ground space, reduced wear and tear, and reduction of labour. Mr. Morrison presided at the subsequent business meeting, at which there was a discussion on the paper read at the last meeting on the slot meter system. Mr. Samuel Glover, gas engineer to the St. Helens Corporation Gas Committee, one of the patentees of the new system, read a paper on the vertical retorts at St. Helens, and quoted the results of a series of tests. A discussion followed.

A NEW LUBRICATOR FOR LOCOMOTIVES.

MECHANICAL lubricators are by no means new, but a type which differs from the usual designs employed on locomotives has been brought to our notice by the firm of C. C. Wakefield and Co., of 27, Cannon-street, E.C. In this lubricator the intermittent delivery of the oil has been replaced by an undeviating constancy of feed which the firm maintains is highly essential with the high steam pressures, increased piston speeds, and particularly with the highly superheated steam now employed in reciprocating engines. A special feature in connection with the pumps of these lubricators is that differential hollow plungers are so employed that the oil is forced forward on both strokes. Thus there is no idle period, and consequently a spasmodic feed is avoided. This does not mean that double the quantity of oil is used, but that the delivery is equally divided between the two strokes.

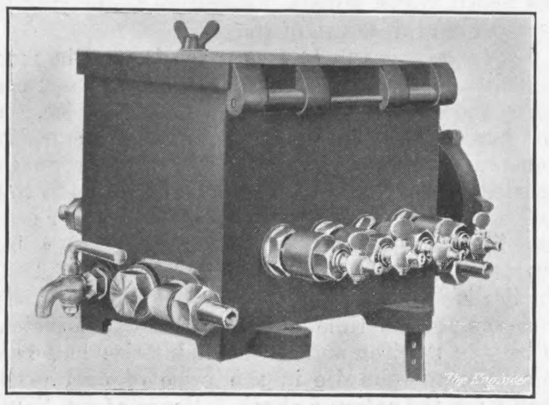


Fig. 1—FOUR-FEED LUBRICATOR

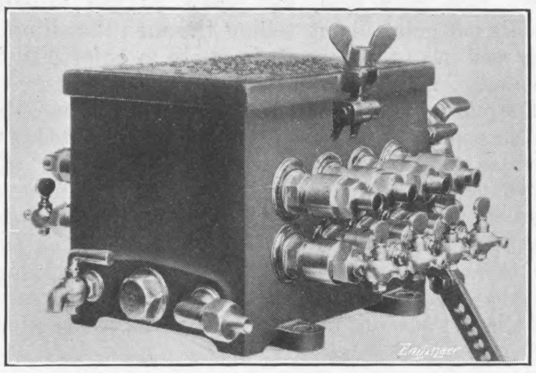


Fig. 2—EIGHT-FEED LUBRICATOR

From the drawing it will be seen that a reciprocating motion is given to the plungers inside the oil reservoir by means of the rocking shaft J, which may derive its movement from the valve or other rods. When the plungers are moving from right to left the oil is drawn past the suction valves C and through the large hollow plungers E into the large pump barrels E^1. On the return stroke the oil is forced back through the hollow plunger E, past the intermediate valve D, and through the small hollow plungers F into the small pump barrels and oil outlets F^1. As the small pump barrels will only contain half the quantity of oil held by the large barrels, it follows that after the small barrels are full the surplus oil is forced into the steam chest and cylinders, and the oil remaining in the small barrels is forced away on the opposite stroke, that is when the large plungers are on their suction stroke. In this manner a constant and unvarying flow of oil is maintained, keeping the valves and pistons well lubricated. The makers particularly draw attention to the fact that the oil is not flushed into the steam chest on one stroke only, with consequent waste, but is fed steadily and surely the whole time.

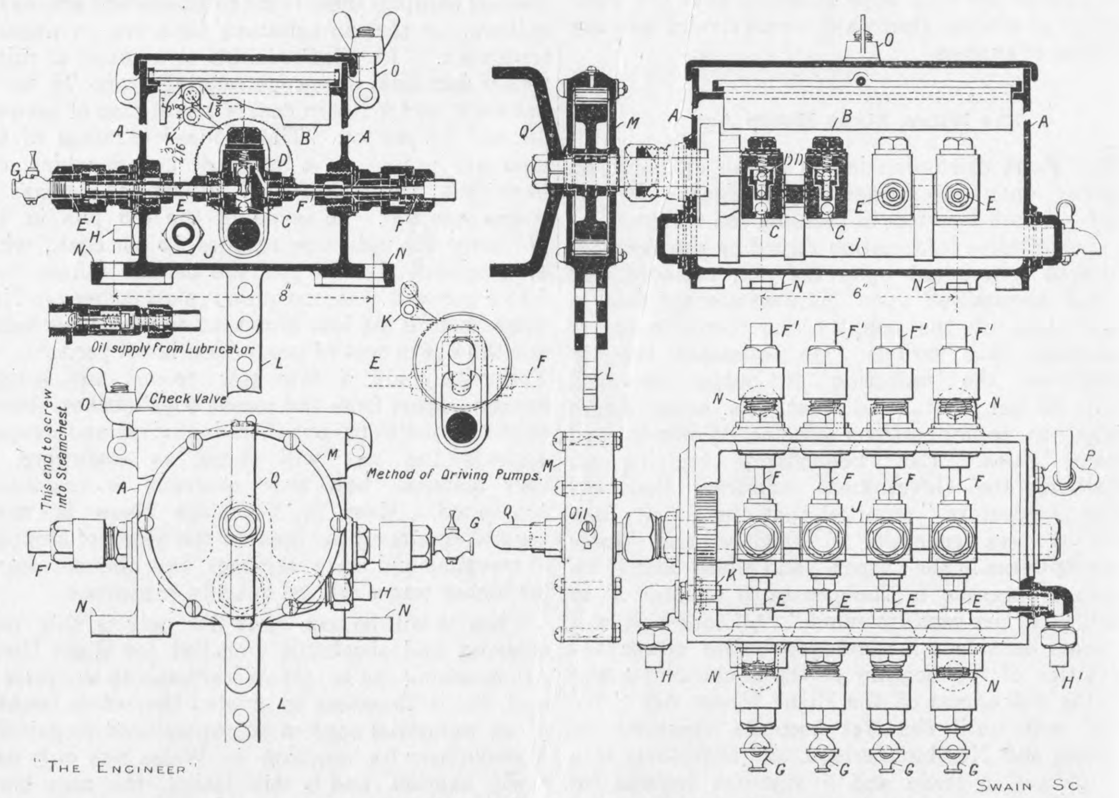


Fig. 3—SECTIONS OF FOUR-FEED LUBRICATOR

The makers state that in the central ram lubricator, where a single ram is used to drive the oil to the various parts requiring lubricating, several faults are to be found. For example, when the packing gives out all the feeds are stopped, there is an uncertainty concerning the amount of oil passing through the feeds, and there is also the inconvenience of winding up the ram. Considerable economy of oil is claimed to result from the use of this new lubricator owing to the steady and continuous feed as compared with the usual system, where the oil is fed intermittently, resulting in alternately flooding and "starving" the rubbing surfaces. When first starting these lubricators the large plungers E are moved to the ends of the barrels, and the air cocks G are opened to relieve the pressure. The cocks G are then closed and the pump worked by hand in order to fill the pipes.

It will be observed that all the moving parts, including the ratchet, are in oil. The functions of the other parts of these lubricators to which we have not referred are fairly evident from an inspection of the drawing, A being the oil reservoir, B a wire gauze strainer, H the steam inlet to the oil warming pipe, H^1 the steam outlet from the warming pipe, K the ratchet pawl to prevent backward movement of the driving wheel, L the driving arm, M the roller clutch gear case, N fixing lugs, O butterfly nuts for securing the lid of the reservoir, P a drain cock, and Q the flushing handle. The drawing and the illustration, Fig. 1, show a four-feed lubricator, but it is obvious that any ordinary number of feeds can be provided. The lubricator shown in Fig. 2, for example, has eight feeds, four being situated on one side of the oil reservoir and four on the opposite side, but the side from which the feed pipes protude is a matter which can be settled by the user, as the firm manufactures these lubricators with any ordinary number of feeds on one side of the oil box, as well as placing them on both sides, as shown in Fig. 2. The foregoing description refers to the firm's No. 1 size of mechanical lubricator.

DOCKYARD NOTES.

IF the correspondent of the *Glasgow Herald* is correct in his description of the new design of battleships and cruisers Orion and Lion classes, our doubts as to the use of 13½in. guns are confirmed. It appears that the 12in. gun is still to be used, but that all the barbettes will be placed on the centre line of the ship, the second pair of guns, presumably both from the bow and stern, firing over the bow and stern pair—as, for example, in the Minas Geraes and several other vessels. Thus there will always be four guns available for fore and aft fire as at present, but by placing the middle barbette on the centre line all ten guns will be available on either broadside. It is reported that the vessel is to be 600ft. long, and if that is so we shall scarcely feel surprised if another pair of guns also on the centre line is introduced. That would cause no great difficulty, and would be a far wiser course than the adoption of a new piece. We agree, however, with the correspondent of the *Glasgow Herald* that such a great jump in length from the 510ft. between perpendiculars of the Neptune is improbable, and it is more likely that the Orion will be nearer 550ft. than 600ft. long. In that case there would barely be room enough for another barbette. The new arrangement has been compared to that of the Delaware, but it is to be hoped that a more convenient arrangement than that of the two after barbettes on that ship may be found. These guns, it may be recalled, are on the same level, whilst the third barbette is placed just forward of them, and fires over both. It will be seen that the use of the middle pair of guns out of the three is greatly curtailed. The new British ship, however, is 30ft. or 40ft. longer than the Delaware, and there will be no necessity to crowd the barbettes together.

The new cruisers of the Lion type will, if reports are correct, be very remarkable vessels indeed. They will be 700ft. long by 86ft. 6in. beam, and they will be propelled at 28 knots by 70,000 horse-power turbines. The displacement will be over 26,300 tons, and they will carry eight 12in. guns. Again note that there is no suggestion of a larger piece. It is highly probable that the inner pair of turrets will fire fore and aft over the end pairs, as a good bow and stern fire may be deemed especially useful to a cruiser.

THE trials of the new battleship St. Vincent are expected to take place in December. Those of the Collingwood are likely to be run somewhere about the same time. The third ship of this class, the Vanguard, built by Vickers, Sons and Maxim, has already carried out her trials, and although the last to be laid down, will probably be the first to be put in commission. These three ships have 9¾in. belts instead of 11in., as they are all fitted with a new Vickers armour, which is considerably superior to K.C.

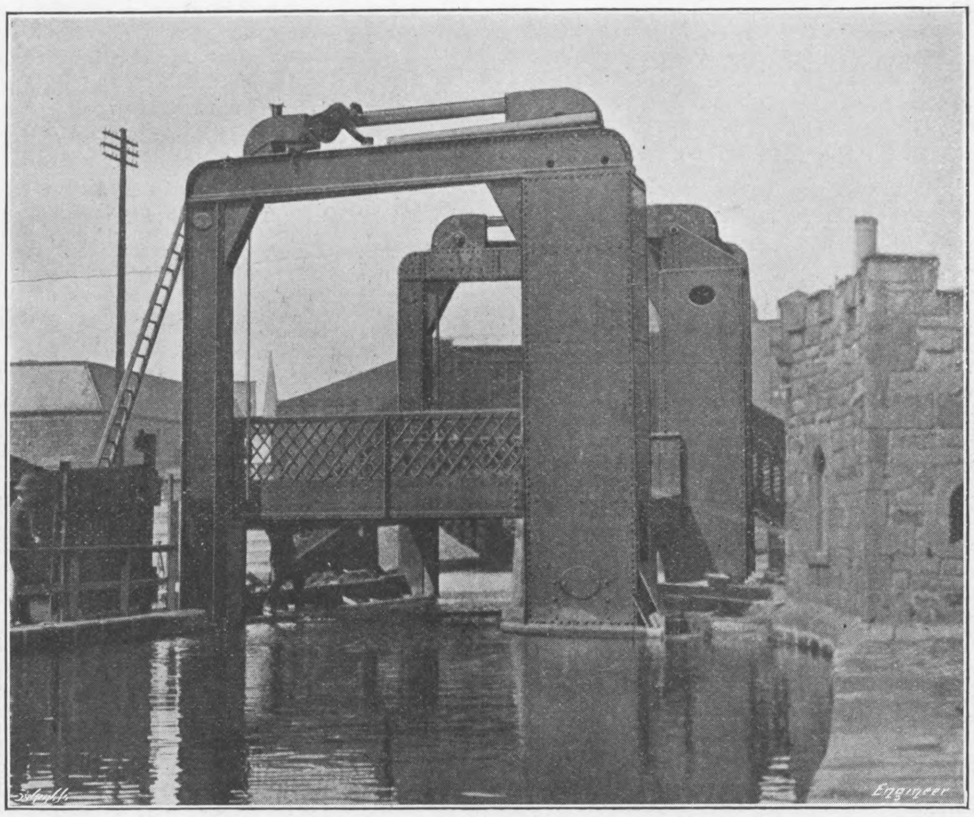
VARIOUS wild rumours concerning the Neptune are in circulation. So far as we can ascertain, she will, to all intents and purposes, be nothing but a slightly enlarged copy of the St. Vincent, with one important exception. Instead of the solid bulkheads characteristic of the Dreadnought type, the Neptune will, it is said, be fitted with special water-tight doors of a new design.

THE Indefatigable will carry the same big gun armament as the Indomitable, but the 'midship guns will be much further apart than in the type ship. Instead of the middle turrets being bunched abaft the second funnel, one turret will be abaft the first funnel and one abaft the second. The object of this arrangement is to secure a wider angle of fire, but whether in practice it will prove to be much greater remains to be seen.

THE new French smokeless powder, of which so much has been heard, does not possess any of the special advantages believed to belong to it in the matter of ballistic property. Its main advantages are that it is not in the least affected by temperature or damp, and is extremely stable in all conditions. Whether experiments have been pursued sufficiently far to satisfy the French Admiralty that refrigerating plant for the magazines is unnecessary we cannot say, but it is probable that the line of greatest safety will be followed for some time.

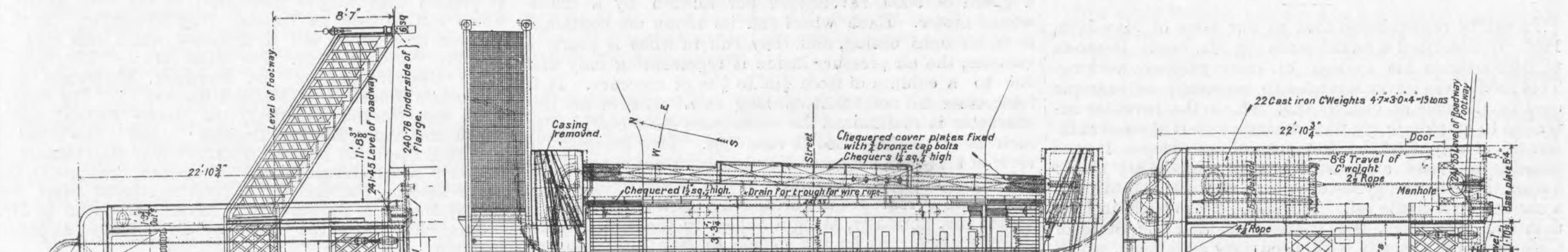
ELECTRIC LIFTING BRIDGE AT EDINBURGH

SIR W. G. ARMSTRONG, WHITWORTH AND CO., LIMITED, NEWCASTLE-ON-TYNE, ENGINEERS



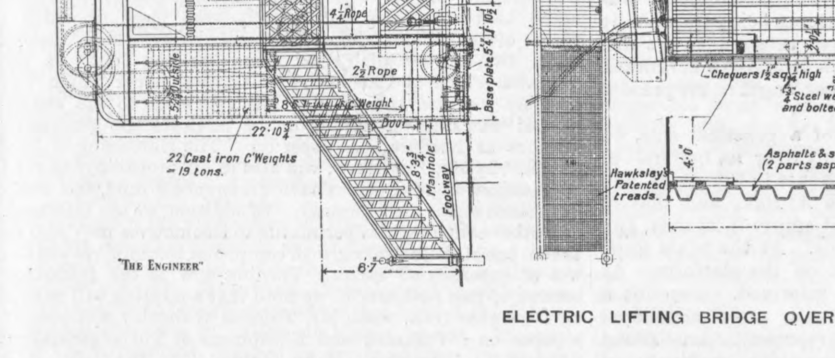
AN ELECTRICALLY WORKED LIFTING BRIDGE.

AN interesting example of an electrically worked lifting bridge has recently been constructed over the Union Canal at Fountainbridge, Edinburgh, and is illustrated in the accompanying engravings. The bridge carries a roadway 25ft. in width across a water passage of 13ft. 6in., and is provided with a 3ft. 6in. footpath on each side, so that the total width of the bridge between hand rails is 32ft. The bridge is built of steel side girders, and has a floor consisting of heavy steel trough plating, filled in with a mixture of asphalt and sawdust, and covered by 2½in. oak planking, extending the full width of the road. The two footways are raised slightly above the level of the roadway, and side girders of open steelwork, surmounted by teak hand rails, are provided outside each footway. The bridge is designed for a moving load of 32 tons on two axles at 8ft. centres, and may be lifted through a height of 8ft. 6in., which will leave a head room of about 8ft. 9in. above water level for barges using the canal. The bridge platform moves vertically in guides consisting of four steel pillars, one at each corner, and connected on either side of the platform by cross girders. A steel elevated foot-bridge is provided on one side of the road bridge for use of foot-passengers when the platform is lifted for canal traffic. Four wire ropes of 4½in. circumference are connected, one at each corner, to the moving platform by shackles and adjusting screws. Passing vertically upwards, they are led over sheaves mounted on the two cross girders already referred to. Two balance weights, each weighing about 19 tons and consisting of cast iron plates, are suspended inside the two larger uprights from each pair of these corner ropes. From the lower surface of each of these weights a steel wire rope of 2½in. circumference is led over suitably placed guide pulleys to the cast iron drum of the electrical winding machinery. This latter consists of a 12 brake horse-power electric motor, driving through worm and spur gearing on to the winding drum, and is housed on a platform fixed to two of the uprights and extending across the waterway at the same level as the foot-bridge. This arrangement necessitates one of the 2½in. ropes attached to the balance weight being led across the width of the road, and for this purpose a channel, closed by chequered plates, is cut at the edge of the bank, along which channel the rope is led. About half-way across the roadway this rope is provided with an adjusting screw and shackles. It will thus be seen that to lift the bridge the motor hauls down the balance weights; for lowering purposes the platform has been given a preponderance in weight over that of the balancing masses, and, with the exception of magnetic brakes, no machinery is called into play when lowering. The whole of the bridge, together with the operating machinery, was supplied and erected by Sir W. G. Armstrong, Whitworth and Company, Limited, of Newcastle-on-Tyne, to the designs and requirements of Mr. James Bell, of Edinburgh, the Engineer-in-Chief of the North British Railway Company.


8'·7"
Level of Footway
11'·8⅜"
241·45 Level of roadway
240·76 Underside of flange.
22'·10¾"
Door
8'·6½" Clear
Removable casing
2'·0"
between pillars
Sliding windows
Between guide bars 14'·3" Centres
4½" Rope
2½" Rope
Roadway level
Footway level
Water level 240·22
Bottom of pillars ¾" above water level
13'·6" Passage
Union
Weight
Manhole
Footway
Base plate 5'·4"
22 Cast iron C'Weights = 19 tons.
6'·7"
Casing removed.
N
E
S
W
Street
Chequered 1½" sq. ¼" high.
Drain for trough for wire rope
Chequered cover plates fixed with ¼ bronze tap bolts
Chequers 1½" sq. ¼" high
13'·6" Passage
Bridge 18'·8" over kerbs
Access 18'·9½" between kerbs
Controller
Canal
To Port Hopetoun
241·45
Chequers 1½" sq. ¼" high
Steel wearing bar grooved and bolted to cast iron kerb.
Cross Section.
Asphalte & sawdust composition 100 lbs per cubic foot (2 parts asphalte & 1 part dried fine sawdust)
2½" Oak planking
Hawksley's Patented treads.
Troughing ⅜" thick 55 lbs per sq. ft.
32'·0" inside of plates
22 Cast iron C'Weights 4'·7"×3'·0"×4"=19 tons
8'·6" Travel of C'weight
2½" Rope
Level of Roadway
Footway
Removable casings
8'·6" Lift
Casing for sheaves & ropes not shown in this view.
241·45 Level of Roadway
Footway

"THE ENGINEER" SWAIN SC.

ELECTRIC LIFTING BRIDGE OVER THE UNION CANAL AT FOUNTAINBRIDGE

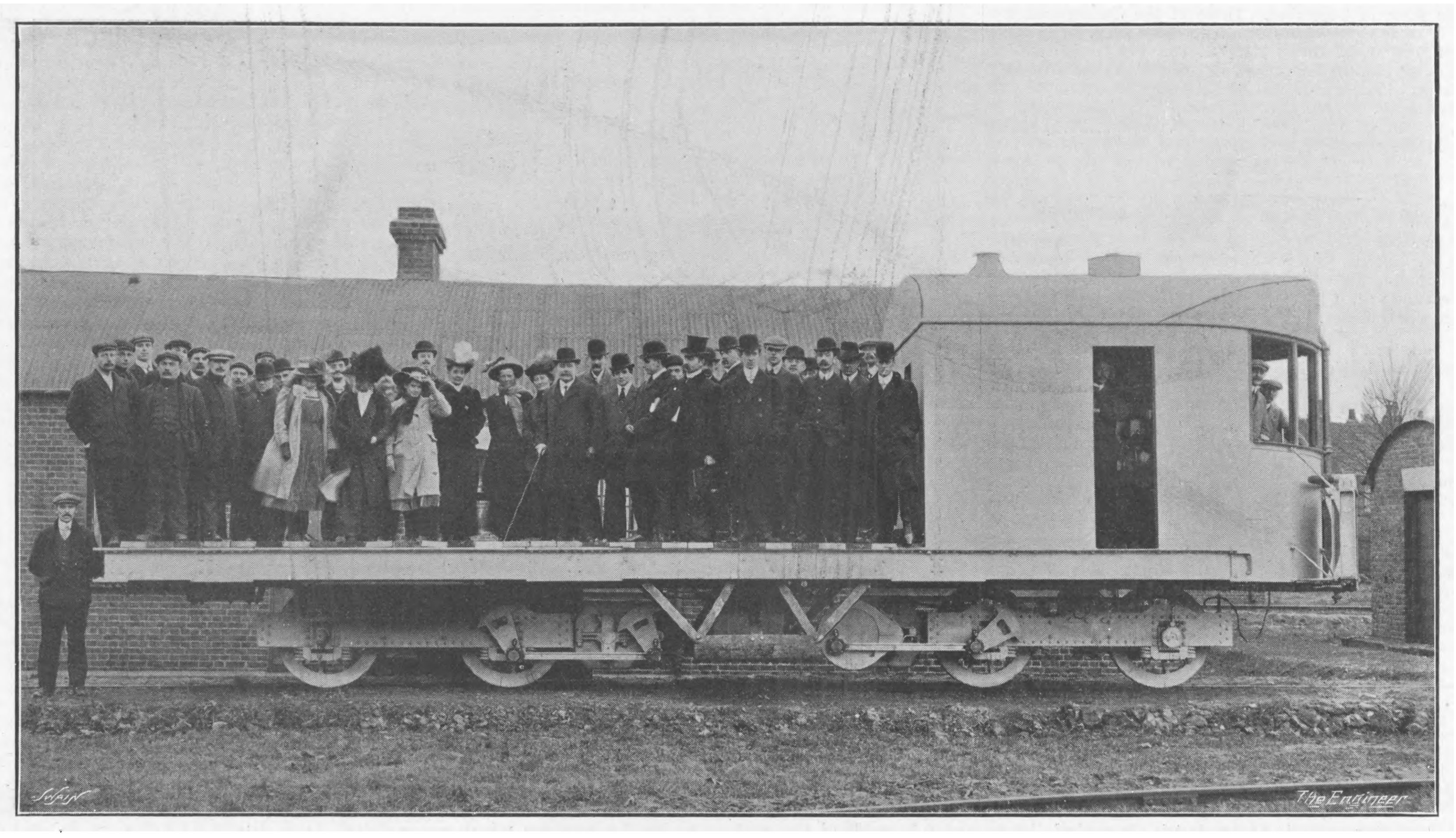

Casing shewn in section
Casing shewn in section
32'·2⅝" Between pillars
32'·1½" Between guide bars.
8'6" Lift
Roadway level 241·45 rising to 241·55
Footway level
241·55
241·45
Water level 240·22

CROSS SECTION OF BRIDGE

ACCORDING to the *Engineering News*, a substitute for cotton waste for car journal-box packing has been invented by Mr. Samuel A. Flower, of Bayonne, N.J. The material is made from the fibre of the cocoanut husk. It is submitted to a chemical treatment, and the hard, woody portions are removed. It is claimed that in its capillary absorption and elasticity it is a superior material to the ordinary cotton waste. Tests on railway cars which have made the round trip across the Continent are said to have shown better results in boxes packed with the new waste than those packed with cotton. Mr. Flower has also invented a cheap waste for wiping machinery, which is said to cost half as much as the cotton waste now used for that purpose.

FOUR-WHEEL SELF-PROPELLING MONORAIL CAR

MR. LOUIS BRENNAN, GILLINGHAM, ENGINEER



THE BRENNAN MONORAIL SYSTEM.

It will be remembered that in our issue of May 10th, 1907, we described a model made by Mr. Louis Brennan to demonstrate his system of mono-railway working. This model was never intended to represent an example on a small scale of exactly that which the inventor intended to employ in his final designs, but it showed sufficiently clearly that by the use of gyroscopes it was possible to make an unstable body temporarily stable during the time the gyroscopes were at work, and to make a car run on a single rail. His success was such, in fact, that the War-office, the India-office, and the State of Cashmir came forward with pecuniary assistance, which has enabled him to carry his invention to such a point that he has now applied it to a vehicle capable of dealing with loads up to 15 tons, and designed to work in actual service.

On Wednesday last we had an opportunity of inspecting this vehicle in operation at the Brennan Torpedo Works at Gillingham, near Chatham. Here a circular single railway, 220 yards round and a straight line some 440 yards in length, have been laid, in addition to sidings. The rails employed, we may say in passing, were of the Vignoles section, $5\frac{3}{4}$in. high, and weighed 70 lb. to the yard run. The head of the rail is rounded to a radius of 5in. The line is laid on sleepers 3ft. 6in. long, placed at about 3ft. centres on soft made ground, the rails being held down by spikes driven into the sleepers.

The car, which we are enabled to illustrate by means of a reproduction of a photograph taken at the time of the trials which we witnessed, is, in design, not unlike a road motor lorry. The photograph, we may mention, was taken with the gyroscopes working and the car standing upright on its line. The persons on the platform were all standing near one edge of the platform. The car is carried on four wheels, mounted two and two in two independent trolleys. When on the straight all the four wheels are in one straight line; but, since the centre pins of the trolleys are connected to the body of the vehicle by means of ball bearings, there is considerable flexibility in rounding curves—indeed, reverse curves of 35ft. radius are readily negotiated, as we had several opportunities of observing. The four wheels are each 3ft. in diameter, and one wheel of each trolley is driven by an enclosed tramway type electric motor, through reduction gearing and two coupling rods, one on each side of the trolley frame.

The car itself consists of a long platform 10ft. wide, carried on rolled joists, and at one end of it is mounted the cab which contains the propelling and controlling mechanism. The former consists of two petrol engines, practically, if not identically, of the same type as those used in motor cars. One of these engines is rated at 80 horse-power, and the other at 20 horse-power, though both may develop more than these figures when called upon to do so. Each engine drives directly an electric generator, which supplies current for a number of purposes:—First for driving the trolley motors, and hence for propelling the car; secondly, for revolving the wheels of the gyroscopes, of which there are two; thirdly, for compressing air for the brakes, and for another purpose which will be alluded to later on, and fourthly, for working a small motor which drives an oil pump.

The gist of the whole system lies, of course, in the gyroscopes. It is the office of these to correct any tendency of the vehicle to depart from a position of stable equilibrium. The two gyroscopes are mounted side by side, but some few feet apart in the cab. The wheels each weigh $\frac{3}{4}$ of a ton, and they each are driven at a speed of 3000 revolutions per minute by a shunt-wound motor. Each wheel and its motor are contained in an air-tight casing, and they run in what is nearly a vacuum, the air pressure inside it representing only that due to a column of from $\frac{1}{2}$in. to $\frac{5}{8}$in. of mercury. It is interesting to note that as long as a vacuum of this character is maintained the motor runs quite cool, but as soon as air is admitted it runs hot. Mr. Brennan, in view of this fact, suggests that much, at any rate, of the heating in electrical machinery is due to air friction.

The two gyroscopes are arranged with their axes horizontal and, normally, at right angles to the rail. When there is a tendency for the vehicle to lean either to one side or the other, this is corrected automatically by mechanism actuated by pneumatic power, which alters the planes of rotation of the gyroscopes, these being deflected either to the left or to the right in the vertical plane, as the case may be. We were enabled to make a number of trips on the platform of the car, and can say that it went round and round the circular track, up and down the straight line, and negotiated some very heavy curves with ease. The mechanism was evidently most sensitive, the gyroscopes being continually on the move. In the article above referred to we discussed the principle underlying Mr. Brennan's invention, and we need not refer to it at greater length in the present instance.

As evidence that the vehicle is of a practical size, we may say that it measures 40ft. long over its buffers—or will do so when these are fitted—that it is 10ft. wide and 13ft. high. The total wheel base is 20ft., and that of each trolley is 5ft. 4in. Its weight empty is 22 tons, and it can carry from 10 tons to 15 tons. At the trials some forty people were easily conveyed on the platform. As at present built it could, we are informed, surmount a short incline of 1 in 13, and with some additional motive power which would represent an added weight of 4 tons it could negotiate gradients of 1 in $6\frac{1}{2}$. The two engines can be used separately or together, so that the power that can be applied can be varied from 20 to 100 horse-power. During the trials only the smaller engine could be worked, as the generator of the larger engine had had to be returned to the makers for some alterations; but the smaller power was quite sufficient to demonstrate the working of the vehicle, though, of course, no great speed could be obtained. The actual speed developed was about seven miles per hour; but with the two motors together we understand that a speed of some 35 miles per hour can be attained on the level. It should be stated that this particular vehicle has been built with the idea of showing that a car capable of carrying heavy weights at moderate speeds could be built; but Mr. Brennan explains that what he believes will be the chief development of his system will be the high-speed passenger train. He quite looks forward to constructing coaches 25ft. wide, and perhaps 150ft. long, which will be propelled at velocities twice that now possible as a safe working maximum on ordinary railways.

FORTHCOMING MEETINGS.

No. I.

THE various Engineering Societies have now commenced their winter meetings, and a number of papers have already been read. From the programmes which we have before us the season promises to be one of considerable activity, and the papers cover a very wide range of subjects. As regards the Institution of Civil Engineers, we are unable to do more at present than to give particulars of the next meeting, which will be held on Tuesday, 16th November. On this occasion three papers will be discussed which were read on Tuesday, November 9th. The titles are:—"The Single-phase Electrification of the Heysham, Morecambe and Lancashire Branch of the Midland Railway;" "The Equipment and Working Results of the Mersey Railway under Steam and under Electric Traction;" and "The Effect of Electrical Operation on the Permanent Way Maintenance of Railways, as Illustrated on the Tynemouth Branches of the North-Eastern Railway." The first-mentioned paper was read by Messrs. J. Dalziel and J. Sayers, the second by Mr. Joshua Shaw, and the third by Dr. Charles Augustus Harrison.

The programme of the Institution of Mechanical Engineers cannot be given in full with any degree of certainty, for, in common with the programmes of the other large Institutions, it is subject to alteration. It can be stated definitely, however, that at the next meeting, which is to be held on November 19th, a paper will be read on the new internal combustion pump invented by Mr. H. A. Humphrey, which was described in our issue of October 22nd, 1909. It is probable, we understand, that a meeting will shortly take place at which a report of the Alloys Committee will be presented, dealing with the work which has been carried out at the National Physical Laboratory. Another paper which may possibly be read this session has reference to the utilisation of water power at one of the large electric generating stations at Niagara. A paper on "The Hardening of Tool Steels," by Mr. Brayshaw, will also in all probability be read this session; and two papers having reference to mild steel under combined stress are promised. In addition, we are informed, two other contributions pertaining to locomotives may also be taken, one of these dealing with compound locomotives and the use of superheated steam. Turning now to the graduates' section of this Institution, we note that a meeting will be held on December 13th, when Mr. Thomas Walmsley will present a paper on "Planning and Equipment of Turbo-generating Stations." "Artesian Water Supply" is the title of a paper to be read by Mr. A. D. Salway on January 10th. The annual graduates' dinner will take place on February 11th. A special lecture on "Petrol Motors" will be delivered on February 14th by Mr. F. Leigh Martineau. Mr. C. V. V. Hutchingson is to read a paper on March 14th entitled "Locomotive Valve Motions." The interesting subject of "Mechanical Flight" will be dealt with in a paper by Mr. A. B. F. Cheeseman, to be read on April 11th, and on May 9th a paper will be presented by Mr. W. E. Moss, the title of which is apparently not yet settled.

The programme of the Institution of Electrical Engineers cannot be given at present, and it is improbable that definite information will be forthcoming, but we hope in a subsequent issue to be in a position to give our readers some idea of the nature of the papers which are to be read in London during the present session. In the meantime it may be of interest to say something of the papers which are to be read before the Manchester section of this Institution. "Telephones" and "The Recent Developments in High-tension Transmission on Overhead Lines" are the titles of two papers which will be read during the present month. The former, which is by Mr. L. E. Wilson, will be presented on the 16th, and the latter, whose authors are Professor E. W. Marchant and A. E. Wilson, on the 30th. One paper, which has been written by Messrs. L. J. Lepine and A. R. Stilling, will be presented on December 14th. The title is "Notes on Methods and Practice in the German Electrical Industry." On January 11th Professor A. Schwartz will read a paper on "The Testing of Rubber for Electrical Work," and on the 25th of the same month Mr. W. P. Durtnall will deal with his favourite subject, "The Generation and Electrical

Transmission of Power for Marine Propulsion.'' Two papers are on the programme for February; one is on "Three-wire Balancers,'' which has been written by Mr. A. G. Cooper, and is to be presented on the 8th of that month, whilst the other, whose authors are Messrs. B. and E. Thomas, is entitled "Some Modern Developments in Automatic Switchgear.'' The annual dinner takes place on February 25th. One of the most interesting papers to be read in Manchester, from the dynamo designer's point of view, is by Mr. Miles Walker, who, on March 8th, will present a paper on "The Short-circuiting of Large Electric Generators and the Resulting Forces on Armature Windings.'' The annual general meeting takes place on March 22nd, when Messrs. Pollard, Digby, and D. B. Mellis will read a paper on "Some Properties of Switch and Transformer Oils.'' The list of papers given, relating to the Manchester section of the Institution of Electrical Engineers, will all be read during this winter's session, but the dates must be taken as provisional only, and are subject to alteration, of which due notice will be given.

The Junior Institution of Engineers, which holds its meetings at the Royal United Service Institution, Whitehall, has arranged a very good programme. On November 16th Engineer Vice-Admiral Henry J. Oram, C.B., will deliver his presidential address, which is to be on "Recent Warship Machinery.'' Mr. Harry Horsburgh will read a paper on "The Design and Maintenance of a Cement Works'' at a meeting to be held on Wednesday, December 15th. At the following meeting, on Thursday, January 13th, a paper will be read by Mr. R. H. Hammersley Heenan, entitled "The Creation and Growth of a Successful Commercial Harbour.'' On Friday, February 11th, a meeting will take place with the Architectural Association Debating Society at 18, Tufton-street, Westminster, when a paper on "Architectural and Engineering Considerations in Town Planning'' will be read by Mr. Frank R. Durham. The Institution's anniversary dinner will be held at the Hotel Cecil on Saturday, February 12th. "The Transmission of Power by Belts'' is the title of a paper which will be read by Mr. Reginald F. Krall on Monday, March 14th. "High-speed Steam Turbine Rotor Design and Construction'' is the title chosen for a paper to be read by Mr. J. M. Newton on Tuesday, April 12th; and at a meeting to be held on May 11th Mr. Lauret M. Jockel will read a paper on "The Running of an Electricity Works.''

A good programme has reached us from the Liverpool Engineering Society. On November 17th Mr. W. A. Oglethorpe will read a paper entitled "Modern Dredging Appliances,'' and on December 1st Mr. C. J. Blackman will present a paper on "The Working of Parsons' Steam Turbines on Fast Channel Steamers.'' The "Theory of Suspension Bridges'' is the subject of a paper to be read on December 15th by Mr. L. H. Chase. On January 12th Mr. J. H. Collie will present a contribution on "The Power Equipment of a Modern Shipyard.'' The annual dinner will take place on January 20th. "Aeronautical Engineering'' is the subject chosen by Dr. Hele Shaw for a paper to be read on January 26th. The two papers to be presented in the month of February are entitled "The Engineering Aspects of Town Development'' and "Quarry Engineering.'' The former is by Mr. John A. Brodie and the latter by Mr. A. H. Wheeler. The first paper to be read in March is by Mr. Holbrook Gaskell, and is on "Recording Steam Meters.'' The second paper for that month is by Mr. Humphrey N. Giles, and its title is "An Additional Supply to the Waters of Lake Vyrnwy; the Diversion of the River Marchant.'' The last two papers are on "The Structural Arrangements and Strengths of Certain Types of Ships'' and "Photographic Surveying.'' The former is by Mr. John McGovern and the latter by Professor S. W. Perrott. The annual general meeting will take place on April 27th.

SHIPBUILDING NOTES.

THE opening meeting of the 26th session of the North-East Coast Institution of Shipbuilders and Engineers was held on Friday, the 29th ult., at Newcastle-on-Tyne. Mr. Summers Hunter, who has been re-elected president for this year, made some interesting references to the question most prominent at the present time in engineering and shipbuilding circles—the combination of reciprocating and turbine engines. He suggested some difficulties in applying this system to vessels of moderate speeds, full form, and subject to considerable variation in loading. The difficulties attendant upon the application of this system to low speed vessels are indeed formidable, and the results of the experiments now being carried out on the Vespasian will be awaited with great interest. Meanwhile, there are still those who are unconvinced as to the ultimate advantage to be derived from an installation, even in vessels of higher speeds. In some cases the substantial increase of first cost may prove prohibitive. Assuming the question to have been duly considered, it is significant that some recent vessels of high speed, notably the Cunard liner being built at Wallsend, have ordinary reciprocating engines.

AFTER vessels constructed for carrying oil in bulk, we should say that those to be engaged in carrying frozen meat rank next in popularity. We referred some time ago to the new Corry vessel built at Belfast, and mentioned some of the conditions governing the design of these steamers. We now observe that the first of the vessels, being built for H. and W. Nelson, Limited, Liverpool, was launched from Messrs. Russell and Co.'s. yard at Port Glasgow, on October 28th. The same firm is building two steamers for this company, and one is also being built at Liverpool. As before stated this type of steamer seems to be increasingly in demand. One is being built for the Shaw, Savill and Albion Company, and negotiations have recently been in progress for the construction of quite a large number, but so far the actual contracts have not been placed.

THERE is still a satisfactory improvement in the amount of new work contracted for on the North-east Coast. Amongst recent orders placed, the most considerable are three vessels to be built for Messrs. F. C. Strick and Co., London, secured by Wm. Gray and Co., and a welcome increase to Hartlepool's provision for the winter. At the time of writing nothing is known in respect of the allocation of new floating docks for the Admiralty, and definite news is expected in Newcastle with a not unnatural interest.

THE annual report of Lloyd's Register for 1908-9 has just been issued, and is characterised by a personal note that is comparatively new to it. We refer to the recent changes in the staff of the Registry, to the death of the chairman, Mr. Jas. Dixon, and of Dr. F. Elgar, and the appointment of the new chairman, Mr. T. L. Devitt. Reference is made to the serious depression in shipbuilding which has existed for so long. This depression is very accurately reflected in the amount of tonnage classed by the society, which is considerably below the average of recent years. At the end of June of this year, however, there were 10,424 merchant vessels classed in the society's register, with a total gross tonnage of 20½ million tons.

AMONGST the matters of technical interest referred to in the report may be mentioned the revision of the society's rules, which were very fully dealt with in the columns of this journal on June 25th last. In this connection special acknowledgment is made of the services of Mr. Henry Witby, the chairman of the shipbuilding and engineering representatives of the Technical Committee. In the list of large steamers constructed we notice one that represents not only the strides Japan has made in practical shipbuilding, but exhibits also her potentiality for the future in that respect. That vessel is the Chiyo Maru, 13,426 tons, built in Japan for the Toyo Kisen Kaisha. In the period of which the report treats it is stated that seven steamers, each over 8000 tons gross, and of which the Chiyo Maru is the largest, have been built in Japan, and in each case, except that of the above-named vessel, the machinery also had been made in that country. In view of the emergence of Japan as a possible shipbuilding rival to this country, we may find some comfort in this fact, that her shipbuilding practice and her official rules for the determination of scantlings are almost exact copies of our own. Our remarks on vessels for carrying refrigerated cargoes are emphasised by a reference made to the continued increase taking place in the numbers of such vessels. At the present time, the report states, the total capacity of these steamers is 12¾ million carcases of mutton.

SOME time ago we referred to some discussion that had taken place on the stability of ships, induced no doubt by recent losses. The contributors were shipmasters who had had practical experience of the running of ships under various conditions, and we emphasised then the importance of a thorough knowledge of the subject and, in particular, of how instability manifested itself at sea. We still find a neglect of these somewhat essential points. In a recent contribution on this subject to a contemporary, we find the "Initial Stability'' of a vessel defined as being the stability in the light condition. It is also assumed that excessive rolling is indicative of a want of stability. As a matter of fact, in the light condition, most cargo ships are very stable, and in some cases this excess of stability is an actual structural danger to the vessel in respect of the violent motions which are induced.

THE members of the Institute of Marine Engineers held their annual dinner on Wednesday, the 3rd inst., at the Holborn Restaurant. Mr. James Denny was in the chair, owing to the death of the Institute's President, Mr. James Dixon. The proceedings comprised a presentation to the Hon. Secretary, Mr. Adamson, in recognition of his 21 years' services. Amongst the list of speakers, Mr. Alfred Booth, the newly-appointed chairman of the Cunard Company, was prominent. Mr. Booth made some judicious remarks on the teaching of technical and mechanical science, and shipbuilders especially should welcome the conclusion of his witty argument on shipowning—"That there must always be a superfluity of shipowners and therefore of ships.''

THE TEXTILE INSTITUTE.

IT is a little remarkable, having in mind the extent and importance of the textile industry, that up to the present time there has been no institution which is at all comparable to an organisation such as the Iron and Steel Institute and similar bodies in connection with other industries. A movement with which Mr. J. H. Lester and Mr. George Moores have been associated has now taken definite shape, the adhesion of the leading men in the industry having been secured, so that the project may now be considered as having been established.

The objects of the proposed Institute, which, like the Iron and Steel Institute, will be international in character, are many in number, and in contradistinction to existing institutions, which have been formed in the case of other industries, the Textile Institute will devote attention to commercial as well as mechanical and technical interests. At the same time there is no doubt that the scientific side will be a very important one, judging by the names of those who appear in an advanced list of supporters of the Institute, and the desire is naturally to bring theory and practice into closer relation. The Institute will arrange for the holding of meetings, the reading of papers, will establish an official journal, and will constitute itself an authority for the determination and recognition of technical and trade standards, usages, terms, and definitions. It is also proposed that the Institute shall obtain statistical and other information regarding the production and use of raw and manufactured textile material. Research work will also be an important part of the work of the new body, and reference may be made to subjects suggested for investigation, which include fibres, filaments, and other natural or artificial products, the constitution, properties and uses of dyes, sizes and other substances used in textile processes, and methods of testing by chemical analysis or by mechanical means. It is suggested that a useful field before the Institute will be covered by the appointment of special paid commissioners to investigate and report upon problems or processes in connection with the industry. It is proposed that the membership shall include patrons, honorary members, life members and associate members. The first list of those supporting the Institute includes Sir Thomas Glen-Coates, Sir Alfred Jones, Sir Henry F. Hibbert, Sir Phillip Magnus, M.P., Sir William Mather, Sir William Priestley, M.P., Sir Mark Oldroyd, Mr. Cedric Lee, Mr. Harold Lee, Mr. Francis Ashworth, Chairman of the Manchester Chamber of Commerce, Mr. E. Tootal Broadhurst, and the heads of the textile departments of the Textile Colleges and Institutes at Bradford, Huddersfield, Leeds, Belfast, Salford, Municipal Schools of Technology, Manchester, Bolton, Glasgow, Galashiels, and Dundee. It is intended formally to inaugurate the Institute by a conference which will probably be held in Manchester in January next. Mr. Geo. Moores, of 12, Exchange-street, Manchester, is acting as honorary secretary.

MOTOR CAR EXHIBITION AT OLYMPIA.

THE eighth International Exhibition of Motor Cars which opened to-day at Olympia under the auspices of the Society of Motor Manufacturers and Traders bids fair to exceed in importance any of its predecessors. During the past year structural alterations have been made in the building known as Olympia, the large annexe having been thrown into the main hall, with the result that a much more effective display of the vehicles is possible. Over 300 firms are represented in the hall, and there are probably about 600 cars on view, in addition to engines, ignition apparatus, lamps, tires, clothing, &c. The success of these annual shows is the more significant in view of the fact that no exhibition of this sort is this year being held on the Continent, and it would appear that London will be looked upon as the motor mart of Europe at any rate. When it is considered that the first show of motor cars in this country was held only as recently as 1902, the tremendous strides which the industry has made is realised. At that show there were less than 100 exhibitors, and foreign-made cars preponderated.

At the present show British exhibitors are in a large majority. Although the trend of motor car construction presents no startling departure this year, except in the one direction of the elimination of the tappet valve engine, many new objects of interest are on view among the accessories and tires. In wheel construction a decided tendency prevails to discard wooden wheels and take up wire wheels, which when properly designed can be made quite as rigid as the former, while very much lighter, thus enabling motorists to carry among their equipment a complete spare wheel in place of spare tires and rims. Many makers are, indeed, now adopting the wire wheel as their standard. We shall have something to say next week on the principal features of the show, which remains open until Saturday, November 20th.

THE BIRTHDAY HONOURS.

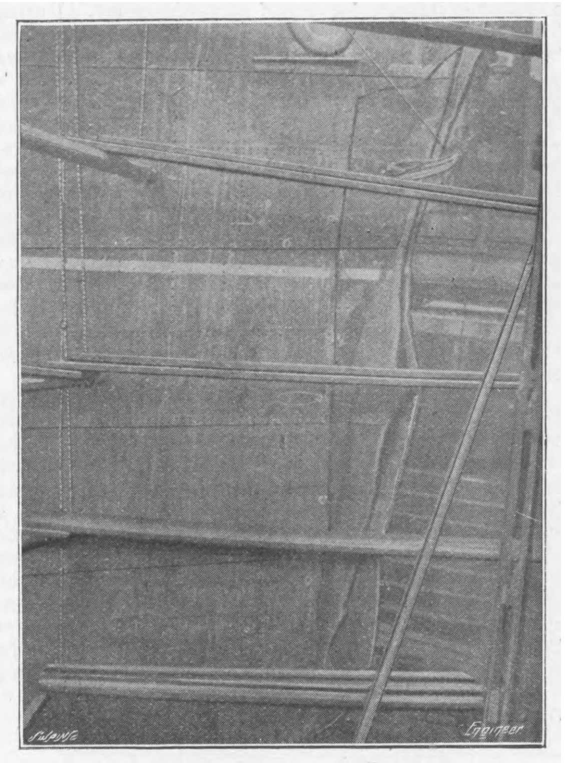
THE list of birthday honours does not contain many names of engineers, or of those connected in some way or other with the engineering profession. We notice, however, that Mr. W. J. Crossley, head of the well-known firm of gas engine manufacturers, has been made a baronet, while Mr. Arthur Trevor Dawson, a director and superintendent of ordnance in the firm of Vickers, Sons and Maxim, Limited, and Mr. C. Friswell, motor car manufacturer, have been knighted. Among chemists, Sir Henry E. Roscoe has been distinguished by being created Privy Councillor, and Professor William A. Tilden has been given a knighthood. In a supplementary list it was also announced that a barony had been conferred on Admiral of the Fleet Sir John A. Fisher, G.C.B., O.M., First Sea Lord of Admiralty.

THE INSTITUTE OF MARINE ENGINEERS.—The nineteenth annual dinner of this Institute was held on November 3rd in the King's Hall of the Holborn Restaurant, London. Mr. Jas. Denny, who, on the death of Mr. Dickson, the president of the Institution for this year, had carried on the presidential duties from his previous year of office, occupied the chair at the dinner. The evening was marked by a presentation to Mr. Jas. Adamson, the honorary secretary of the Institution. In handing over the gift, which consisted of a cheque to Mr. Adamson and a writing bureau to Mrs. Adamson, the president remarked that the Committee appointed in connection with the presentation had managed to collect a sum of over £530, and that the generous response to their appeal had testified to the members' hearty appreciation of Mr. Adamson's services. The Institute had now reached its 21st year, and during that time Mr. Adamson had done much to widen the sphere of influence of its work. He had also, the chairman remarked, been the leading spirit in the body of thirteen gentlemen who had laid the foundations of their Society twenty-one years ago. Dealing with the growth of the membership since then, Mr. Denny said that they now numbered 1161, and that the Society was increasing phenomenally. After Mr. Adamson had replied, Mr. Summers Hunter, Pres. N.E. Coast Inst. of Engineers and Shipbuilders, proposed the toast of the Institute of Marine Engineers to which Mr. J. T. Milton, Chairman of Council, responded. The other speakers included Dr. T. J. Macnamara, Parliamentary Secretary to the Admiralty, who dealt with "The Shipping and Commerce of the Empire,'' and Mr. Alfred A. Booth, chairman of the Cunard Steamship Company, who responded to Dr. Macnamara's toast.

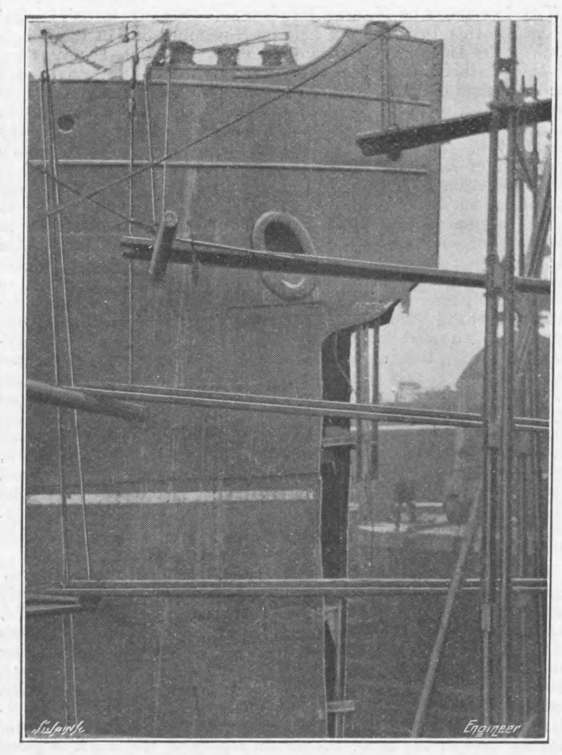
NEW FIRE-ALARMS.—A project for a new fire-alarm system embodying some new and highly interesting features, has recently been under the consideration of the Kiel Fire Department. Inspired by the fact that practically all persons in large towns know how to use a telephone, the Kiel authorities are making trials with a system in which each street fire-alarm box from which the alarms are given is fitted with a loud-speaking telephone. The arrangement is such that when a person breaks the glass of the fire-alarm box an annunciator is actuated at the fire-station or office. Having broken the glass, the person reporting the fire now gains access to a key, with which he can open the box, so as to enable him to speak into the telephonic transmitter contained therein, and thus give the number of the fire-alarm box used and describe the scene of the fire. By having the scene of the fire reported telephonically, the clockworks generally contained in the alarm-boxes are rendered unnecessary. The special new feature in the system consists in there being a loud-speaking telephone in the fire-alarm box which loudly reproduces the words spoken by the man at the fire-office, thus enabling him to ask any question that it may be necessary to address to the person giving the alarm. The condition of the lines is continuously checked at the fire-station by a current flowing permanently through each line; but although each line is also used for the transmission of the loud-speaking currents it is composed of two metallic conductors only, which have, up to the present, been generally considered insufficient for loud-speaking purposes; not less than three being invariably employed. Another difficulty which the telephone engineers concerned have apparently overcome is that of obtaining satisfactory results with loud-speaking telephones over long lines. The lengths of the lines to be used in the above-mentioned fire-alarm system average about 10 kiloms., and will be enclosed in cables. The total cost of the system will perhaps amount to £15,000.

CUTTING OFF A STEAMER'S STEM.

ALTHOUGH demonstrations of cutting metal by means of oxygen have been given in Glasgow by the Scotch and Irish Oxygen Company, Limited, of Polmadie, the first demonstration of carrying out practical work by this method in the Glasgow district has recently been given, and was attended with marked success. The British Oxygen Company, Limited, has taken over, and is now developing the business formerly in the hands of the company first named. The success of the British company in work of this kind has been repeatedly shown of late in London and other districts where it has branches of its business—Birmingham, Manchester, Newcastle. The work just accomplished in Glasgow was nothing less than the removal of the bow of the steamer Tenasserim, of the fleet of Indian traders owned and managed by Messrs. P. Henderson and Co., Glasgow. This vessel was damaged last month in collision with the Cardiff steamer Segentian in the Mersey, and was put into the hands of Messrs. D. and W. Henderson, of Partick, for repair. The vessel, after being docked in one of the Clyde Trust graving docks at Govan, was found to have sustained such serious damage that a large number of plates connected to the stem would have to be removed and the whole stem rebuilt. Many of the plates, however, were so badly buckled that great difficulty was experienced in driving out the rivets. Messrs. Henderson finally resolved to have the stem and the attached shell-plating bodily cut away by the oxy-acetylene process of metal-cutting. The British Oxygen Company was entrusted with the work. After the erection of proper staging, &c., one operator was put on to the job, and he completed the work in about a day and a half's time.



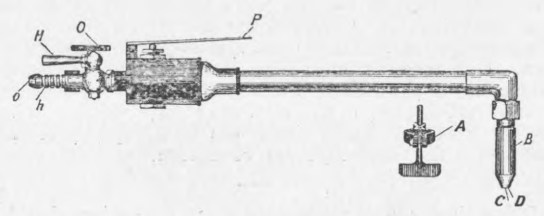
THE DAMAGED BOW OF THE S.S. TENASSERIM



THE BOW WITH DAMAGED PART REMOVED

We are enabled to give two engravings reproduced from photographs of the stem of the Tenasserim in dock. One shows the cutting effected from near the top of the stem down to the forefoot, and just prior to the removal of the severed portion by the crane, and the other after this removal had taken place. The total length of cutting was about 90ft. Single plates were ½in. thick, and, of course, double thickness was encountered where they overlapped at the landings. The stem bar was broken through at the top, where the cutting commenced, but was intact at the bottom, and the total thickness to be cut through there, including the plates on each side of the stem, was 5½in. The workman entrusted with the job by the Oxygen Company completed the task, as has been said, in about a day and a-half; but had the weather conditions not been so unfavourable, and had he been more accustomed to working on scaffolding, the task could have been accomplished well within one day.

The hand-cutter used on the work is illustrated herewith. It is of the blow-pipe pattern introduced originally in 1904 by the Société Anonyme l'Oxhydrique International, of Belgium, in which the extra supply of oxygen—following upon the mixture of oxygen and acetylene, which heats to incandescence the metal being acted upon—effecting actual severance, is supplied through the one nozzle. Another form of cutting instrument, as is well known, has separate nozzles; one projecting the flame of mixed gases, and the other placed immediately behind the flame, projecting the extra and independent oxygen which effects the actual cutting. The heating arrangement in the cutter we illustrate is on the injector principle, the oxygen alone being supplied under pressure; the fuel-gas is drawn into the cylindrical mixing chamber seen to the left of illustration, and it passes along with the oxygen along the tube and out through the nozzle. The two gases enter the apparatus side by side at the inlets to the left of the chamber, and are separately adjusted by means of the two cocks or valves shown. The two mixed gases discharge through an annular opening in the end of the nozzle. The oxygen which is used for cutting issues through a separate passage in the centre of the nozzle, and is controlled by the thumb-lever valve shown on the top of the chamber portion of the apparatus. The adjustable sliding guide shown at the side of the nozzle may be attached thereto to maintain a uniform distance between the cutter and the work, and also to ensure steadiness when the cutter is in operation, but this adjunct was not required in the case of the work on the Tenasserim's stem. In the engraving of the cutting tool *o* and *h* are the attachments for the supply of oxygen and acetylene; O and H valves by which these gases may be separately controlled; D annular passage through which the mixed gases are discharged; P the thumb lever for regulating the jet of oxygen for cutting; C the passage through which the jet of oxygen for cutting is discharged; and A an adjustable sliding guide, which can be attached to the cutter-head at B, in order to maintain a uniform distance between the cutter and the work, and to ensure steadiness when the cutter is in operation.



OXY-ACETYLENE BLOW-PIPE CUTTER

Oxygen and dissolved acetylene compressed in cylinders were employed, the cylinders lying at the bottom of the graving dock, the supply of gases being carried to the cutter by suitable lengths of tubing. In the carrying out of the work, the Oxygen Company's operator was under the instructions of Messrs. D. and W. Henderson and Co., and it is conceded by them that had the work been carried through by the ordinary method of hand-cutting it would have taken ten men about two days to finish it.

LLOYD'S REGISTER OF SHIPPING.

THE Annual Report of Lloyd's Register of Shipping for the year 1908 9 has just reached us. At the close of the year ended June 30th, 1909, 10,424 merchant vessels, registering over 20½ million tons gross, held classes assigned by the Committee of Lloyd's Register. The details are set out in the following table:—

Material of construction.	Description.	British.		Foreign.		Total.	
		No.	Tonnage.	No.	Tonnage	No.	Tonnage.
Iron and steel	Steam..	6095	12,280,467	2899	6,390,392	8994	18,670,859
	Sail ..	511	836,109	710	1,031,616	1221	1,867,725
Wood and composite	Steam & sail	197	27,056	12	3,936	209	30,992
	Total..	6803	13,143,632	3621	7,425,944	10424	20,569,576

The serious depression which has existed for so long a time in the shipbuilding industry is, it is pointed out, again reflected in the amount of tonnage classed by the society during the year, which is considerably below the very high average attained in recent years. This decrease is not a matter for surprise in view of the fact that the total tonnage under construction in the United Kingdom at the end of June last was less than 53 per cent. of the amount being built three years before.

Classes were assigned by the Committee to 550 new vessels. Their registered gross tonnage amounted to 854,984 tons. Of these vessels, 481, of 845,719 tons, were steamers, and 69, of 9265 tons, were sailing ships. These vessels were all constructed, in accordance with approved plans, under the special supervision of the surveyors to Lloyd's Register. Of the total, 470,137 tons, or 55 per cent., were built for the United Kingdom, and 384,847 tons, or 45 per cent., for the British Colonies and foreign countries.

The following table sets forth the new tonnage classed by the society during the last ten years:—

	Steam.	Sail.	Total.
1899-1900	1,236 831	18,908	1,255,739
1900-1	1,328.395	25,916	1,355,311
1901-2	1,381,750	43,666	1,425,416
1902-3	1,182,265	68,155	1,250,420
1903-4	1,051,960	27,085	1,079,045
1904-5	1 189.769	11,058	1,200,827
1905-6	1,408,579	4,066	1,412,645
1906-7	1,470,312	14,410	1,484,722
1907-8	1,147,547	4,244	1,151,791
1908-9	845,719	9,265	854,984

The most important fact which calls for mention in the work of the society during the past year is the completion of the task of revising the society's rules* for the construction of steel ships, which occupied the attention of the Committee for several months. The Committee believe that the work has been successfully accomplished, and that the revised rules, which they are gratified to know have already been accorded a very favourable reception, will be found to meet the shipowners' demand for vessels of great cargo capacity, economical both as regards weight and cost, while still maintaining the high standard of efficiency which it has always been the society's object to uphold.

During the year under discussion forty-four steamers of upwards of 5000 tons each have received the 100 A1 Class, and the following vessels, each of which exceeds 10,000 tons, have been assigned this classification since the issue of the last annual report, viz.:—

Name of vessel.	Tons.	Owners.
Chiyo Maru	13,426	Toyo Kisen Kaisha
Osterley	12,129	Orient Steam Nav. Co., Ltd.
§ Otranto	12,124	
† Otway	12,077	
‖ Orsova	12,036	
* Morea	10,890	Peninsular and Oriental S.N. Co.
Malwa	10,887	
Manitua	10,895	

It may be mentioned that during the period under review seven steamers, each over 8000 tons gross, of which the turbine s.s. Chiyo Maru is the largest, have been built in Japan to Class 100 A1, and in each case, except that of the above-named vessel, the machinery also has been made in that country.

At the present time, in addition to a fifth liner for the Orient Company, similar to the four previously mentioned, the new Cunard steamship which is to take the place of the Slavonia is being built to the society's highest class, as are also two new Union-Castle liners, each of 13,000 tons. Reference is also made to some other interesting vessels which have recently received, or are being built to, the 100 A1 class, such as the two twin-screw steamers for the Canadian Government; the s.s. Earl Grey, to be used as an ice-breaker and specially fitted up for the passenger and mail service between the mainland and Prince Edward Island, and the s.s. Simcoe, for Lake service and constructed with special appliances for lifting light buoys; the s.s. Monitoria, built at Sunderland, representing a novel design of construction in the form of two corrugations worked in the shell plating of the sides, which it is claimed will have the effect of diminishing the resistance of the vessel ** Up to the present, thirteen vessels of the Isherwood type,†† with a total tonnage of 60,000 tons, have been, or are intended to be, classed in the Register Book. Thirty vessels designed for the carriage of oil in bulk have been classed 100 A1 since June, 1908, with a total tonnage of 121,478 tons.

In the course of the year the plans of 530 vessels intended to be built of steel, fifty-two of wood and one composite—making a total of 583 vessels—were submitted for the Committee's consideration, with a view to the approval of the vessels for classification by the society, while during the year 477,513 tons of ship and boiler steel were tested by the society's surveyors at home and abroad. During the past year several important changes have occurred in the *personnel* of the society's surveying staff. Prominent among these is the retirement of Mr. Harry J. Cornish from the position of chief ship surveyor, to which he was appointed in 1900, in succession to the late Mr. Benjamin Martell, whose assistant he had been for the previous thirty years. As we have already announced, the Committee have appointed Mr. S. J. P. Thearle to succeed Mr. Cornish as chief ship surveyor.

The total length of chain cable tested during the year at the public proving-houses in the United Kingdom, all of which are under the superintendence of the society, was 303,759 fathoms. The number of anchors tested was 6896.

The number of vessels to which freeboards were assigned by the society under the Merchant Shipping Act, 1894, up to the 30th June, 1909, was 14,864. The number to which freeboards were assigned during 1908-9 was 397, representing an approximate gross tonnage of 877,360 tons. These figures refer to original assignments, and are quite independent of a large number of re-assignments under the amended tables. Of these latter cases, 4687 were dealt with up to the end of June.

In view of the increasing extent to which wireless telegraphy and submarine signalling are being used in passenger steamers, the Committee have caused special notations to be made in the present edition of the society's Register Book in the cases of vessels installed with apparatus for the above purposes, and have also included in the book separate lists of vessels so fitted. There are recorded in the Register Book at the present time 404 vessels fitted with wireless telegraphy and 362 vessels fitted with submarine signalling apparatus.

Reference was made in last year's report to the preliminary action which had been taken, as a result of the generosity of Mr. A. F. Yarrow, in the direction of the establishment at Bushy of an experimental tank in connection with the National Physical Laboratory, in support of which object the Committee of this society have had much pleasure in promising to guarantee a sum of £1000, spread over a period of ten years, towards the maintenance fund which is being raised. The society's chief surveyors have been elected members of the Advisory Committee which has been formed in connection with this scheme.

The society suffered a severe loss by the death, in July, of the chairman, Mr. James Dixon, after a long and trying illness. Mr. Thomas L. Devitt, who has for many years been a member of the Committee, and for the last few years joint chairman of the Sub-committees of Classification, has, as we have already announced, been elected chairman of the society in succession to Mr. Dixon. Reference is also made to the death, in January last, of Dr. Francis Elgar.

ECONOMISERS in tower plant operation, states the *Engineering Record*, which can be secured by proper instruction and encouragement to firemen and attendants, are shown by figures recently compiled by the American Navy Department, which has recently instituted competitive rewards for low fuel and oil consumption records while vessels are under way. These figures, on the present showing, indicate a saving of almost £200,000 per year in fuel and oil.

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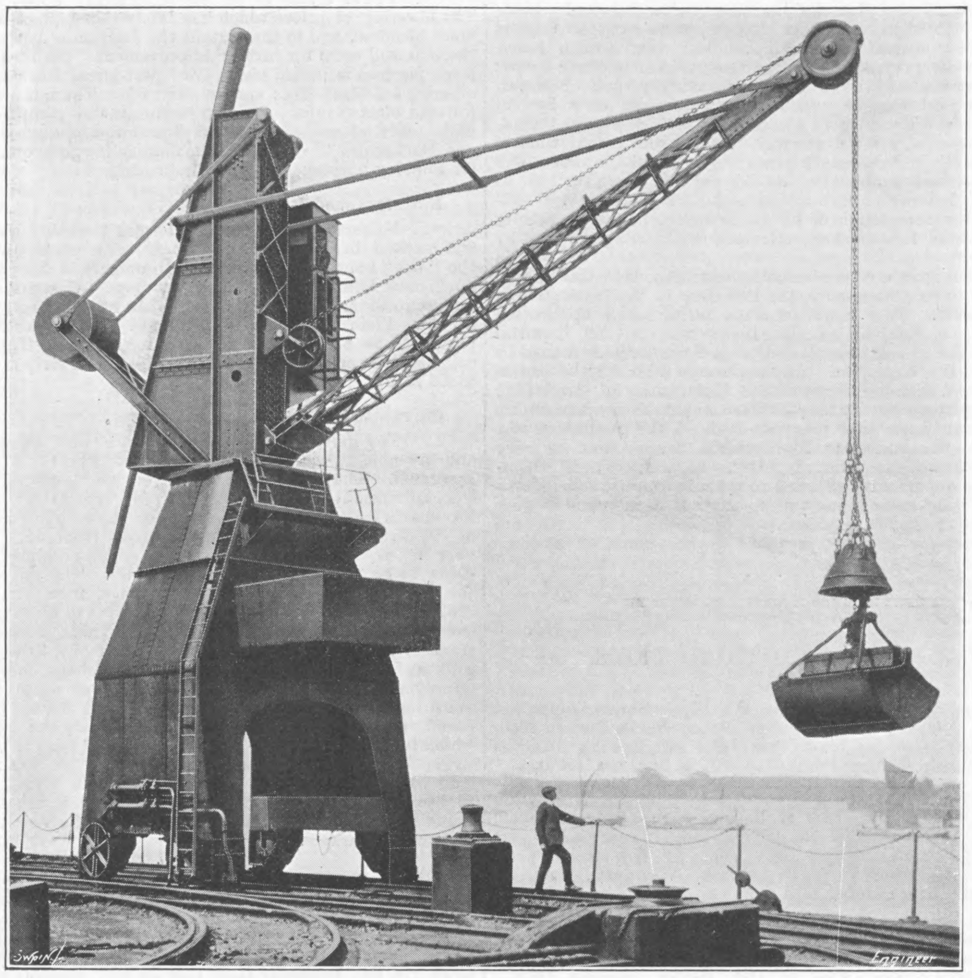
* See THE ENGINEER, 25th June, 1909.

* See THE ENGINEER, 21st August and 13th November 1908.
† ,, ,, 27th November, 1908.
§ ,, ,, 9th July, 1909.
‖ ,, ,, 28th May, 1909.
** ,, ,, 6th June, 1909.
†† ,, ,, 17th April and 14th August, 1908.

A NEW HYDRAULIC CRANE

C. AND A. MUSKER, LIMITED, LIVERPOOL, ENGINEERS



A MOVABLE HYDRAULIC CRANE.

THERE has recently been put into service the movable hydraulic portal crane illustrated in the accompanying engraving. This crane was constructed by C. and A. Musker, Limited, of Liverpool, and is in use at Woolwich for rapidly discharging Government colliers, the grab employed for this purpose being suspended by a single chain.

The pedestal, on which is mounted the crane and driver's box, is built up from steel plates and angles, and is fitted with four cast steel travelling wheels arranged to run on rails of 12ft. 3in. gauge. Two of these wheels, situated at opposite corners of the pedestal, are fitted with a geared drive for travelling purposes. A clear opening 10ft. wide and 10ft. 6in. high is left in the base of the pedestal, thus permitting the passage of trucks, &c. To the top of the pedestal is fitted a strong casting turned to receive a live roller ring and bored to fit a cast iron pivot which is fixed to the foot of the crane post. The pivot bearing is provided with a gun-metal bush, and at its lower end with phosphor bronze and hardened steel discs arranged alternately. The crane post and jib are constructed from steel plates and angles, the latter and the load being partly balanced by the disc weights shown in the engraving. For hoisting purposes a cylinder with ram and multiplying gear is fitted between the uprights of the crane post, while for slewing the crane two cylinders provided with 2 to 1 multiplying gear are carried on the pedestal at the base of the post, and these work through a pitch chain in connection with a cast steel slewing drum fixed to the post, the arrangements being such as to permit of a rotation of $1\frac{1}{3}$ turns in either direction. For derricking or luffing a direct-acting cylinder is installed, and the ram of this is fixed to a crosshead working in guides, forged steel tie rods connecting the jib to this crosshead. Hand power is employed for travelling purposes. To ensure overhauling when the jib is at its position of minimum radius a constant-pressure draw-back is fitted, and this further assists in lowering the jib quickly.

All the rams employed are of gun-metal, while the hoisting valves are of the balanced mitre type, and those for slewing and luffing of the slide valve type. Under test conditions it was found to be easily possible for the following sequence of events to be accomplished forty times per hour:—(1) Grab, weighing two tons, lowered from maximum height to pick up a full charge of coal at the lower limit and raised with load to full height; (2) jib, with grab, &c., luffed from 34ft. to 27ft. radius; (3) jib rotated through 225 deg., coal discharged into a hopper, and the jib returned to its original position. To test the strength and stability of the crane a dead load of 6 tons was suspended from the hoisting chain, and with this load the crane was rotated through one revolution in either direction. The crane in normal circumstances has a hoisting capacity of 4 tons, and can raise its load through a distance of 82ft. The jib can serve as a maximum a radius of 34ft., its minimum being 20ft. When at its maximum radius the pulley at the end of the jib is 40ft. above the ground.

THE compressive strength of concrete when reinforced with separate transverse ties or iron wire arranged in lattice form, and when mixed with scraps of iron wire, has been investigated by Mr. W. P. Nekrassow, of St. Petersburg. He reported to the Copenhagen Congress of the International Association for Testing Materials that when the wires of the lattice are from 4 mm. to 3 mm. or less in diameter, the increased resistance to crushing is in every case as great as that of hoops. The same is true with scraps of iron wire when they are 0.5 mm. to 0.25 mm. in diameter.

THE INSTITUTION OF CIVIL ENGINEERS.

ADDRESS OF MR. JAMES CHARLES INGLIS, PRESIDENT.*

(*Concluded from page* 473.)

Having thus reviewed briefly the matters which have largely engaged attention during the past presidential year, it may not be inopportune to reflect on the position which the engineer occupies in relation to the economic and political life of the general community. You will all agree with the proposition that, without the engineer a great mass of labour would be impotent for any useful effect, and it may be said with truth that the labour interest more directly concerns the engineering profession than any other.

Labour is the beginning and end of engineering, and any interference with the application of labour to engineering undertakings at once affects the profession, and periods of stagnation are liable to result therefrom. I fear such a period is now being experienced, and we must all earnestly desire that it may be a rapidly passing one, as representing a time of hardship to many members of our profession and one of great anxiety for the future.

Nature's laws, we realise, are definite in the physical world; and, so far as they are known, there is every reason to believe that they are equally exact in the economic or political world. But the treatment which many of our labour problems are now receiving at the hands of so-called "leaders" cannot be reconciled with any "nature treatment."

If the treatment of labour interests is not in accord with Nature's laws, the result will ultimately be the same as that which befalls the structure whose foundation the engineer has omitted to place on a firm basis. Such a structure will most assuredly, and in an infinitely less time than it has taken to erect it, resolve itself into a host of useless units—bricks, for instance—each unit after the crash being rendered more or less unsuited for further use. So in our economic system we have our—bricks—units of unemployed, after being subjected to unnatural, unsound treatment, all more or less deteriorated and unfitted for use, and many damaged beyond the possibility of further usefulness.

I fear some of you will be thinking "What has all this to do with engineering?" But, as I have pointed out, labour interests and engineering interests are to a very large extent identical, and there is at the present time a tendency to legislate in a fashion which, I submit, if pursued, will result in an unsoundly built labour structure tending to crumble into a *débris* of unemployed; and unemployed labour means unemployed engineers.

Trade unionism is a result of a high state of industrial development, which no one regards as other than natural and proper so long as its actions are conformable to law, just as, in the case of civil engineers, we endeavour to guard and promote our collective interests. But when the leaders of trade unions prevail on Parliament to give unchallenged authority to purely restrictive trade union ideals—and that to such an extent that the collective employment of labour becomes unremunerative either from want of control or of discipline, or by reason of shortness of output or inferior quality of work—then the restriction of the activities of our profession must appear.

Too many steps have even now been taken along this wrong road, and restrictive trades union legislation has already proceeded so far as to make apparent the great industrial evils which are its natural outcome. As engineers who know and appreciate the value of labour, and who also know the workers, it is our duty to confront this problem—to endeavour to adjust conditions which are unreasonable—to give willingly rates of pay in proportion to output or results—and so to demonstrate that the solution of this vital problem lies not in restrictions, either in rates of wages or of output, nor yet in unnatural and arbitrary regulation of labour, but in the direction of co-operation and of payment by results.

The present tendencies, if continued, will result in one sure ending, viz., the transference of orders from the workshops of Great Britain to those of other countries where mutual and equitable relations between capital and labour prevail. Legislation which protects labour interests to the point of partiality, and which does not at the same time pay due regard to the interests of those who have to initiate enterprise and dispose of the products of labour, is proceeding in an illogical and impossible course which can have but one ending. Our peculiarly close relations with labour interests is my sole apology for troubling you with a series of elementary considerations which, if they do nothing else, will, I hope, help to make plain to each one here that we all, employer and employed, depend on one another; and that any hindrances, artificially or legislatively opposed to the free use of labour, must react not only on the prosperity of the country, but thereby very directly on the prosperity of the individual civil engineer and of his profession.

Some of you may say, "This is politics, which should be unknown in engineering"; but I would point out that when the economic conditions of our profession are at issue it is necessary that we engineers should not shrink from looking the facts in the face.

An instance, among others, may be recalled when, in June, tenders were asked from English and German makers for certain steel goods. The specifications and conditions were precisely the same, but the price quoted by the English firms was just 45 per cent. greater than the German. I may further say that the effect on one company alone of the tenders invited in this instance was to involve a difference of £37,000. Under the competitive conditions of to-day users cannot afford to deal other than in the lowest market, and the result is simply that work is deflected from British manufacturers and British workmen.

Uncertain as the outlook is at present, from the more or less continuous conflict between capital and labour, it may be affirmed with truth that students of these difficult labour problems are gradually coming to the conclusion that some form of co-operation or unity of interest between the two is desirable. As this becomes more widely accepted, and especially if at the same time it is recognised that arrangements tending in the co-operative direction will be sympathetically looked upon by the men interested, then a better era for labour will appear, and with it a more active time for members of this Institution.

The present period of unrest, want of confidence, and uncertainty is, I doubt not, already only too easily traceable in the ledgers of many members of this Institution. Unfortunately, we have a significant indication from our own records that the conditions of engineering employment have become steadily and seriously less favourable during the past few years, particularly among the junior members of the Institution. The secretary tells me he finds from his records that ten years ago the applications from young engineers for assistance in obtaining employment were practically equal to the number of inquiries for staff received from employers. In the past two years the number of those seeking appointments has been nine times greater than the number of vacancies, whilst during the period of ten years our membership has only increased 23 per cent.

How is this situation to be met? How are we from a professional point of view to help to restore confidence and to encourage that reasonable flow of capital which is essential if scope is to be found for our activities, and which, if obstructed and discouraged, will most assuredly arrest not only commercial progress and enterprise, but the continued advance of civilisation in Great Britain. There is no royal road, no patent panacea; the only course is one which must be characterised by a capacity for adaptation to changed conditions and a readiness to adopt such methods as those changed conditions may render necessary.

One of the first matters which must claim our professional attention is the increased necessity for designs, which are not merely examples of engineering ingenuity, but which combine efficiency with economy. I am very far from saying that either of these two latter considerations have not had due weight in the past; but I do say without fear of contradiction that both of them, and perhaps more particularly the latter, viz., economy, must have greater weight in the future. This, of course, means that the engineer who is to contend successfully with the new conditions must be one who, by his personal knowledge of the principles of his profession in every detail, is able to evolve the most efficient methods at the least possible cost. It does not require great ability to handle a situation in which resources are boundless. True ability is that which can get the greatest result out of the least means, and without the detailed knowledge of principles to which I have alluded this is impossible.

The successful engineer of the future, then, must possess in an increasing degree a thorough knowledge of the principles o design, of the materials to be used, and their behaviour when in use—keeping in view the facility and cost of repairs—and of the actual working conditions affecting the life of the structure or plant or machine designed. In other and perhaps plainer words, the necessity is for civil engineers to become more practical, if I may make bold to say so in this Institution.

By the word "practical" I mean that the engineer should not only know how to design his works, but be familiar with the conditions under which they are to be used. The practical engineer of the early part of the nineteenth century built up his theory from his personal experience, and applied his self-taught theories according to his judgment. The practical engineer of the twentieth century is he who, knowing the theoretical principles of his profession, employs as data the facts gathered from his experience, and whose generalisations from such experience merely consolidate, if I may put it so, his knowledge of principles.

The Council of this Institution, with ideas such as the foregoing, have been endeavouring to impress on members and students alike the supreme importance of practice in the education of a civil engineer, and have been pleased to note a general acquiescence in this view.

I observe that the President of the British Association, Sir J. J. Thomson, in his address at Winnipeg, on the 25th August last, dealt at considerable length with the necessity of cultivating the practical or concrete side in the scientist. He said:—"I have alluded to the fact that pure mathematicians have been indebted to the study of concrete problems for the origination of some of their most valuable conceptions; but, though no doubt pure mathematicians are in many ways very exceptional folk, yet in this respect they are very human. Most of us need to tackle some definite difficulty before our minds develop whatever powers they may possess. I think the moral to be drawn from it is that we should aim at making the education in our schools as little bookish and as practical and concrete as possible. With practical things the difficulties have to be surmounted. This constant need for thought and action gives to original research, in any branch of experimental science, great educational value even for those who will not become professional men of science."

The President of the British Association is a Professor at Cambridge University and one of the leading scientists of the day, so that his opinion on the relations between theory and practice and the effect of each on the other is of the greatest interest, particularly to civil engineers, whose occupation is to apply the principles which scientists evolve to the everyday wants of mankind. It is satisfactory to know that the aim of your Council in regard to practical training, experience, and culture is to work on precisely the same lines as the President of the British Association, who represents the scientific side of the question, and who, from that point of view, finds that the theoretical can be best developed by application to the concrete and practical.

In my address of last session I pointed out the ever-present feature of "transport" as the basis of our profession; how it provides, directly and indirectly, the chief demand for large engineering works and machines. The same influence—transport—operates in another direction, *i.e.*, to equalise the cost of production, and thus to counteract the influence of class legislation and unscientific political economy. The philosophical aspect of this operation can furnish, I fear, but poor comfort to those who depend on the use and construction of engineering works for their livelihood. It, however, points to the desirability of the Institution of Civil Engineers keeping in view the imperial and world-wide character of its functions and interests. It also presses home the necessity of continuing to aim at its governing body, the Council, being as representative as may be consistent with executive efficiency.

Much has yet to be achieved in the way of economy in rural and municipal administration by raising the standard of general education and of the engineering knowledge of those appointed to control the carrying out of public works. There lingers in many influential quarters the idea that the construction and maintenance of roads, the provision of water supplies and sewage schemes, &c., can be placed in the hands of uneducated, untrained, and unskilled men. Stories of the absolute ignorance of engineering principles, of the hopeless muddle, and worse, in carrying out small works are common. The controlling authorities have apparently not yet recognised that the health, comfort, and economical working of any district depend more on the efficient execution of the engineering works than on the reports of the medical officer. It is as necessary that the public works officer should be fully qualified as it is in the case of the medical officer, and most large communities are alive to this fact, but I submit it is not so in many of the smaller class of district authorities.

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* Delivered November 2nd, 1909.

The proposition made by the Government as to grants towards the efficient making, improvement, and maintenance of public roads points to an opportunity of building up a system of skilled control with suitable sub-officers for the smallest units. Whilst deprecating bureaucratic interference in administrative details, it appears to me essential that public officials whose duties are of a technical character should possess definite qualifications which the public can recognise and accept. Let us hope that the Local Government Board may soon be moved to put a stop to wasteful administration, by recognising, in a practical manner, that the services of a qualified engineer are as important to the public health as are those of a qualified medical officer, and are essential to the proper expenditure of money allocated to public works.

In looking back upon the results of our labours of the last session, I should like to thank my colleagues, the members of your Council, the secretary, Dr. Tudsbery, and the staff, for the wholehearted way in which they have devoted so much of their experience and thoughtful consideration to the many matters which have from time to time come up for discussion and decision, and for the ready help that I have always found forthcoming when any knotty questions have had to be gone into.

Lastly, I must express my debt of gratitude to the whole body of members of this Institution for the cordial support they have given me during the past year, and for the acceptance of the views which I had the honour to introduce to them a year ago. It is, we must all realise, due to the manner in which the members of the Institution have always been prepared to co-operate for the common good that the strength of its present position is due; and I have the greatest confidence that, in the future, not less than in the past, the members will be ever ready to sink personal predilections and interests in favour of any policy that is admittedly advantageous to the common interests of the Institution.

THE SOCIETY OF ENGINEERS.

On Friday, November 5th, a paper entitled "Some Observations on the Chemistry and Bacteriology of Sewage Purification," by David Sommerville, was read before this Society.

The intention of this paper is to refer engineers to some fundamental principles connected with the purification of sewage. It is shown that bacterial action is effected through enzymes. The cell consists of colloids and crystalloids in common solution in water, and all cellular reactions are reactions in solution, and based on laws governing their velocities and the conditions of equilibrium. The living cell is an energy transformer, and in all its activities conforms to the requirements of the doctrines of the conservation of matter and of energy. Enzymes are catalysts, and under their influence it can be shown that for a single substance α undergoing conversion into two substances β and γ, the common type of action of enzymes,

$$\frac{dx}{dt} = k_1\left(\alpha - x\right) - k_2\left(\beta + x\right)\left(\gamma + x\right)$$

where α is the molecular concentration of the single substance, β and γ molecular concentrations of the two into which it is converted, and x the change in concentration in time t. Enzymes, unlike inorganic catalysts, are rendered inactive by rise of temperature. Enzymes are colloids, and as such subject to the laws governing the phenomena known as "adsorption." Enzymes are capable of reversible action, and consequently effect syntheses as well as dissociations.

Sewage is composed of a watery mixture of proteins, carbohydrates, fats, and various inorganic matters. The organic matters exist in solution and in particulate form. Colloidal solutions are constantly encountered. Sewage is charged with bacteria and enzymes, and when of domestic type contains, in addition to air, water and soil organisms, dominant types indigenous to the human intestine. Sewage carries the organisms and enzymes of its own putrefaction. The chemical reactions of the putrefactive stage are closely analogous to those which effect the digestion of foodstuffs in animals. Protein dissociation occurs in two stages—primary, albumoses, peptones, and peptides; and secondary, amino-acids. Reference is made to the constitutional structure of a few of the more commonly occurring amino-acids. The hydrolysis of carbohydrates and fats is simple when compared with that of proteins.

Most species of bacteria in sewage and soil are capable of forming ammonia from organic matter. Free nitrogen is liberated by some sewage bacteria and atmospheric nitrogen fixed by others. Certain bacteria reduce nitrates to nitrites and ammonia; others reduce nitrates and nitrites to NO and N_2O. Where unlimited oxygen is supplied nitrifaction predominates, but where oxygen is limited denitrification appears. In certain cases it may be advantageous to transform as much as possible of the nitrates and ammonia into free nitrogen. The presence of humus in soil adds to its nitrifying power, and beds performing nitrification poorly may have their activity increased by the addition of humus from other beds working normally. The bulk of the matters left on the filters remains unchanged for a considerable time. The sick sewage bed is like the sick man who overeats. The aerobic method of treating sewage has the best of it all the way round. Bacterial activity is by no means the only activity engaged in the purification of sewage. It is only an assumption that when a sewage is nitrified pathogenic bacteria have been destroyed.

ROYAL RESERVE ENGINEERS.

Applications are now received half-yearly by the Institution of Civil Engineers from the Army Council for the submission of the names of gentlemen recommended by the President to be granted commissions in the Royal Reserve Engineers. The members constituting each class so formed usually number fifteen, and the classes assemble in February and July of each year. Applicants for appointments to commissions as Second Lieutenants "on probation" in the Royal Reserve Engineers must be between the ages of 18 and 25. Unless under exceptional circumstances, candidates are required to have passed the Associate Membership Examination of the Institution, or to have taken a degree in engineering at a recognised University.

The course of training involves a probationary period of one year, comprising a course at the School of Military Engineering, viz.: – Military training, 80 days; fortifications, 105 days; survey, 30 days; construction, 30 days; and for the remainder of the year, attachment to regular units of the Royal Engineers. An officer, who has been confirmed in his appointment, is liable to undergo annual training for a period of fifteen days, and to be called up for Army service at home or abroad at a time of national emergency. The minimum period of liability contemplated in the Army Order is three years from the completion of the probationary training, the conditions of retirement subsequently being set forth in detail in the Army Orders above referred to.

Promotions are made up to the rank of Captain. A Second Lieutenant is promoted to be Lieutenant after five, and a Lieutenant is promoted to be Captain after ten years' service. Officers resigning their commissions with not less than fifteen years' service may be permitted to wear the uniform of their corps; and, if Captains, may be granted the honorary rank of Major. During the probationary period the emoluments of a Second Lieutenant comprise an outfit allowance of £40, and pay, including allowances, of 10s. 7d. per day. During the actual time of annual training in subsequent years the pay and allowance of a Second Lieutenant amount to 14s. 7d. per day; and, further, he will receive in arrear at the conclusion of each year's service, subsequent to the completion of his probationary period, a gratuity of £20, provided that he has performed the training required by regulations.

Applications from civil engineers for commissions in this Special Reserve are to be addressed to the President of the Institution of Civil Engineers. They must be made on forms of application which may be obtained at the Institution, but all inquiries relating to the appointments and to the regulations are to be addressed to the War-office. Any applicants who may be cadets of the Officers' Training Corps of the Universities of Cambridge and London should signify the fact when making their applications.

The Council hope that many students of the Institution who have passed the Associate Membership Examination or have obtained degrees exempting from it, will seek to avail themselves of the opportunity afforded to them to acquire some knowledge of military engineering and to support the Council in their endeavour to further the utilisation of the special qualifications of civil engineers for military purposes in the event of national emergency.

LAUNCHES AND TRIAL TRIPS.

Steel hopper barge; built by the Blyth Shipbuilding and Dry Docks Company; to the order of the North-Eastern Railway Company; the machinery has been supplied by Tangyes Limited; launch, October 7th.

Westgarth, steel screw cargo steamer; built by Sir Raylton Dixon and Co.; to the order of R. and J. Rea, of Liverpool; dimensions, 252ft. by 36ft. 3in. by 20ft. 9in.; to carry 2320 tons; engines, triple-expansion, 18in., 30in., 50in. by 36in. stroke; pressure 180 lb.; constructed by Richardson, Westgarth and Co., Limited; trial trip, October 16th.

Winneba, steel screw steamer; built by Irvine's Shipbuilding and Dry Docks Company; to the order of Elder, Dempster and Co.; dimensions, 355ft. by 46ft. by 25ft. 3in.; engines, triple-expansion, 25in., 49in., 67in. by 45in. stroke; pressure 180 lb.; trial trip, October 18th.

Gerania, steel screw steamer; built by the Northumberland Shipbuilding Company, Limited; to the order of Mr. D. Tripcovich, of Trieste; dimensions, 402ft. by 52ft. 6in. by 29ft. 8in.; to carry 8100 tons; engines, triple-expansion, 26in., 42in., 72in. by 48in. stroke; pressure 180 lb.; constructed by the North-Eastern Marine Engineering Company; trial trip, October 20th.

Ashtree, steel screw steamer; built by Craig, Taylor and Co.; to the order of Howard, Jones and King, of Cardiff; dimensions, 255ft. 9in. by 36ft. 9in. by 18ft.; engines, triple-expansion, 19in., 31in., 51in. by 36in. stroke; pressure 180 lb.; constructed by the North-Eastern Marine Engineering Company; trial trip, October 23rd.

City of Colombo, steel screw steamer; built by Swan, Hunter and Wigham Richardson, Limited; to the order of the Ellerman Lines, Limited; dimensions, 424ft. 10in. by 54ft. by 33ft. 7in.; to carry 9650 tons; engines, triple-expansion, 25½in., 43½in. 75in. by 51in. stroke; constructed by the Wallsend Slipway and Engineering Company, Limited; launch, October 30th.

Highland Laddie, steel screw steamer; built by Cammell, Laird and Co.; to the order of H. and W. Nelson, Limited; dimensions, 405ft. by 56ft. by 37ft. 6in.; engines, triple-expansion, 31in., 51in., by 86in.; launch, October 30th.

Parisiana, steel screw steamer; built by the Northumberland Shipbuilding Company, Limited; to the order of Furness, Withy and Co., Limited; dimensions, 422ft. by 52ft. beam; to carry 8700 tons; engines, triple-expansion, 28in., 46in., 77in. by 54in. stroke, pressure 200 lb.; constructed by Palmer's Shipbuilding and Iron Company; trial trip, November 4th.

South Africa, steel screw steamer; built by the Clyde Shipbuilding and Engineering Company, Limited; to the order of Birt, Potter and Hughes, Limited; dimensions, 295ft. by 42ft. by 20ft.; engines constructed by the builders; launch, recently.

Steersman, steel screw steamer; built by Wood, Skinner and Co.; to the order of C. Rowbottom and Sons, of London; engines, triple-expansion, 15½in., 25in., 41in. by 27in. stroke; constructed by the North-Eastern Marine Engineering Company, Limited; trial trip, recently.

Queen Liner, steel screw steamer; built by the Northumberland Shipbuilding Company; to the order of Thos. Dunlop and Sons, of Glasgow; dimensions, 395ft. by 49ft. 9in. by 29½ft.; engines, triple-expansion, 24½in., 40in., 68in. by 48in. stroke, pressure 180 lb.; constructed by the North-Eastern Marine Engineering Company, Limited; launch, recently.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

The Lancashire Dynamo and Motor Company, Limited, has opened a permanent office at 109, Peterkin Buildings, Toronto.

The Warner Engineering Company, Limited, has recently opened offices at 425, Maipu, Buenos Ayres, and at No. 2, Rector-street, New York, U.S.A. Mr. Albert Burnstine has been appointed general agent for the company in the Argentine, Uruguay and Paraquay, with offices in Buenos Ayres.

Contracts.—Among the orders recently booked by Andrew Barclay, Sons and Co., Limited, of Kilmarnock. are those for two locomotives for a company in India; three light class locomotives for Japan; one 14in. crane locomotive, to lift 5 tons, for South Wales; one 17in. crane locomotive, to lift 8 tons, and one 9in. narrow-gauge locomotive, both for British Colonies.—The entire sanitary installation of the new Automobile Club building, which is in course of erection on the site of the old War-office, Pall Mall, under the direction of Messrs. Mewes and Davis and Keen Purchase, architects, is to be carried out by Doulton and Co., Limited, sanitary engineers, Lambeth, London.

THE IRON, COAL, AND GENERAL TRADES OF BIRMINGHAM, WOLVERHAMPTON, AND OTHER DISTRICTS.

(*From our own Correspondent.*)

Pig Iron Steadier.

There seems to be less uncertainty about crude iron. The lowering of prices which has lately taken place has induced more business, and to that extent the position is better, although there is still room for further improvement. Staffordshire cinder forge pig iron is quoted 46s. to 47s.; part-mine, 50s. 6d. to 51s. 6d.; all-mine hot blast, 85s.; and foundry, 90s. There is a fair demand for cold blast at 115s. Pig iron producers are complaining of the high price of cokes. Northampton forge is quoted 48s. to 49s. and Derbyshire 49s. to 50s. The inquiry for good quality pig iron for foundry purposes is slightly improving.

Manufactured Iron.

Makers of best quality iron are tolerably well engaged, and marked bars are still quoted £8, with plates and sheets by the "list" houses in proportion. In unmarked bars there is not much new business being done just now. Common bars are in fair request and are quoted £6, with nut and bolt sorts about £5 15s. Plain sheets are in moderate call for working up purposes; £7 2s. 6d. to £7 5s. is asked for doubles. There is a fair colonial demand for hoop iron at £6 15s. Gas strip is quiet at £6 to £6 7s. 6d.

Galvanised Sheets: Large Exports.

The galvanised sheet houses are well placed for work and are able to maintain quotations at £11 to £11 5s. f.o.b. Liverpool. They have been doing very well lately on foreign and colonial account. The Board of Trade returns for October and for the first ten months of the year show that for the month of October the quantity shipped rose from 35,976 tons last year to 47,707 tons this year, the corresponding advance in value being from £502,220 to £582,114. The improvement for the ten months' period was, in quantity, from 318,263 tons to 393,886 tons, and, in value, from £4,440,302 to £5,281,790. That over five and a-quarter millions' worth of trade should have been transacted so far this year is eloquent testimony to the great and growing importance of the galvanised sheet industry. The improvement in value over last year was as much as £841,488. With regard to the quantities shipped during the ten months compared with a year ago, the following are among the improvements which have taken place:—India, from 76,273 tons to 77,515 tons; Argentine Republic, from 52,272 tons to 76,570 tons; Australia, from 51,374 tons to 68,282 tons; British South Africa, from 12,294 tons to 15,480 tons. Increases also took place in the demand from Canada, Chili, New Zealand, Uruguay, Straits Settlements, and some other markets.

Steel.

In the steel trade there is rather more movement than recently, and prices are well maintained. Makers quote angles £5 17s. 6d. to £6, girder plates £6 to £6 2s. 6d., boiler plates £7 5s., joists £5 15s. to £6, mild steel engineering bars £6 7s. 6d. to £6 17s. 6d., Bessemer sheet bars £4 15s., Siemens £4 17s. 6d.

The Coventry to Arley Railway Project.

A number of district residents are again interesting themselves in the old question of making a line from Coventry to Arley, and have intimated to the Coventry City Council that it is their intention to promote a Bill in the next session of Parliament with that object in view. It is proposed to serve a portion of the Warwickshire coalfield and also to link up the Midland and London and North-Western systems. The projected route is said to be much the same as that suggested in the previous schemes of 1903 and 1907. The length of the line would be about 7½ miles, and the route would be by way of Coundon, Corley, and Fillongley.

The Late Mr. F. S. Bolton.

Much regret is felt in the Midlands at the death at his residence, Ashfield, Edgbaston, at the age of eighty-one, of Mr. Francis Seddon Bolton, founder of the firm of Thomas Bolton and Sons, Limited, copper smelters and wire drawers, Broad-street, Birmingham, with branches at Oakamoor, Staffordshire; St. Helens, and Widnes. The firm supplied the copper wire for the first Atlantic cable, and the preparation of copper wire for electric cable making has been one of their chief departments for some time past. In 1902 the business was converted into a limited company, with Sir George Robertson as chairman.

NOTES FROM LANCASHIRE.

(*From our own Correspondent.*)

Manchester, Thursday.

Pig Iron Stagnant.

The position of pig iron has distinctly receded, even from the low position it reached last week. True, the attendance on the Manchester Iron Exchange on Tuesday was good, even almost above the average, but there was one complaint on the part of sellers, and that was the absence of orders. In all cases prices were distinctly in buyers' favour. Quantities were small, and only calculated to meet pressing requirements. Although the representative of one important Scottish firm was on the "boards," and quoted a certain figure, merchants were able to offer at 6d. to 1s. per ton less money, while, with firm orders, even less would have been accepted. Middlesbrough brands were not much in evidence on this market, although business is possible to a small extent. Other English sorts showed little change, and there was a shade better feeling in hematite, although offers of second-hand lots were made at low figures. Forge iron was about 6d. lower on the week.

Finished Iron and Steel.

The market was quite featureless in this department, with practically no change to report.

Copper.

Higher prices were quoted for sheets and English tough ingots, but there was no change in tubes. No doubt much of this was due to the appreciation in the price of the raw metal, but consumers held that it was not justified by spot demand. Probably it was due to outside influences of a speculative character.

Lead and Tin.

Lead: Sheets were very quiet, inquiry being slow. There was no particular change to report. Tin: Tough ingot ruled firmer, at a shade above late rates.

Quotations.

Lincolnshire, No. 3 foundry, 56s.; Staffordshire, 54s.; Derbyshire, 55s.; Middlesbrough, open brands, 59s. 10d. to 60s. 1d. Scotch: Gartsherrie, 61s. 6d.; Glengarnock, 61s. 3d. Eglinton, 59s. 9d., delivered Manchester. West Coast hematite, 62s. to 62s. 6d.; East Coast ditto, 60s., both f.o.t. Delivered Heysham: Gartsherrie, 59s. 6d.; Glengarnock, 59s. 3d.; Eglinton, 57s. 9d. Delivered Preston: Gartsherrie, 60s. 6d.; Glengarnock, 60s. 3d.; Eglinton, 58s. 9d. Finished iron: Bars, £6 10s.; hoops, £7 12s. 6d.; sheets, £7 15s. to £8. Steel: Bars, £6 2s. 6d. to £6 5s.; Lancashire hoops, £7 5s.; Staffordshire ditto, £6 17s. 6d.

to £7; sheets, £7 17s. 6d. to £8; boiler-plates, £7 5s. to £7 7s. 6d.; plates for tank, girder, and bridge work, £6 5s. to £6 7s. 6d.; English billets, £4 12s. 6d. to £4 15s.; foreign ditto, £4 10s. to £4 15s.; cold drawn steel, £9 10s. to £9 15s. Copper: Sheets, £72; tough ingot, £62; best selected, £62 per ton. Copper tubes, 8½d.; brass tubes, 6d.; condenser, 7d.; rolled brass, 6¼d.; brass wire, 6½d.; brass turning rods, 6½d.; yellow metal, 5d. to 6d. per lb. Sheet lead, £17 per ton. English tin ingots, £136 10s. per ton.

The Lancashire Coal Trade.

The feature of the week has been a meeting of the Lancashire coalowners, which was held in Manchester on Tuesday, to consider the position. It was thought that house coal would stand an advance, but after prolonged discussion it was decided to leave the question to the Executive to deal with, and should they consider any further step desirable, they are at liberty to call another meeting in the near future. On the Coal Exchange the feeling was that an advance would be against the interests of the Lancashire coal trade. In some cases it was felt that slack and some other sorts of steam coal might stand 6d. per ton more, but it is evident that the condition of the cotton trade at present would not justify it. There was a fairly good feeling reported in the shipping department. There was no change reported in official quotations.

BARROW-IN-FURNESS, Thursday.

Hematites,

The orders placed during the week in the hematite iron trade have been few, but in the aggregate they represent practically the make of the district, although there has been an increase in warrant stocks to the extent of 495 tons. Warrant stocks now bulk at 16,836 tons. Makers' stocks are low and are not increasing. There is no reason to believe that further depression will assert itself in the trade, as indications are that the present position will be maintained, if it is not improved upon, during the remainder of the year. There are 26 furnaces in blast, and each of these produce over 1000 tons of iron per week, a good proportion of which is utilised by local steelmakers. Very little business is doing on colonial or continental account, but there is a fairly good home demand, and this is not confined to ordinary iron, but also to special iron, for which the demand seems to be growing. Makers are quoting 62s. for mixed Bessemer numbers net f.o.b., and warrant iron sellers are at 60s. 6d. net cash, 61s. 10d. three months. Special hematites are selling at 64s. and 65s. per ton, according to specification. Sales of ferro-manganese are fairly maintained, and another large cargo of manganiferous ore has been imported to Barrow of late. Spiegeleisen is also in good demand. Charcoal iron sells in small parcels at about £7 5s. per ton. There is still a good demand for scrap iron, and a few cargoes have lately been shipped to South Wales, where it is used in the production of Siemens steel and in ordinary heavy and light castings. There is more business doing in native iron ore, as the consumption has increased at local furnaces, but there is also a steady importation of foreign ores from Spain and Algeria. Native sorts are selling at 12s., 14s. 6d., and 18s. net at mines for ordinary, medium, and best classes.

Steel.

The outlook in the Bessemer department is not rosy, and there is some difficulty experienced in maintaining anything like continuous activity. Prices are at about £5 5s. per ton net f.o.b. The merchant mills have been busy of late, especially on fish plates. There is no prospect of the restarting of the plate mills at Barrow, which have stood idle for so long, but if there is any marked improvement in the shipbuilding trade this is a branch of industry which will probably find employment. At present £6 per ton is the price of ordinary plates net cash. The shipbuilding trade is not well employed.

Shipping and Coal.

The shipments of iron and steel from West Coast ports last week amounted to 17,558 tons—iron 5794 tons and steel 11,764 tons—as against 13.721 tons in the corresponding period of last year, an increase of 3837 tons. For the year to date the shipments aggregate at 532,109 tons, against 422,779 tons, an increase of 109,330 tons. There is a better business doing in the coal and coke trades. Blast furnace coke is at 22s. 6d. per ton delivered at furnaces in this district. Freights are low.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

House Coal Firm.

THOUGH no official advance has yet been made by coalowners, there is no difficulty whatever in getting the 1s. per ton increase in price usually obtained at this season. The inquiry from London and the Eastern Counties markets has not been equal to what is usually experienced towards winter, but local sales are better, and supplies are going out more freely. Quotations:—Best Barnsley, 12s. 6d. to 14s. per ton; secondary descriptions, 10s. 6d. to 11s. 6d. per ton. The superior grades continue in chief request, though there is a fair trade otherwise being done.

Steam Coal.

Business continues fairly active in steam coal, but prices are not very firm. We do not hear of any contracts being as yet fixed for next year. It is expected that higher rates will rule in the arrangements for forward deliveries. The official return of coal forwarded to Hull during last month shows a total of 599,072 tons, which compares with 502,176 tons for October of 1908, and 650,208 tons for October of 1907. For the ten completed months of the years named the totals come out thus:—1909, 5,047,216 tons; 1908, 5,002,752 tons; 1907, 5,480,880 tons.

Small Coal and Coke.

At the moment small coal is in better request than perhaps any other class of coal in consequence of the active demand of the patent apparatus for consuming it for boiler and other purposes. A normal trade is being done in the Lancashire and Yorkshire textile districts, the qualities forwarded there readily realising from 4s. 6d. to 5s. 6d. per ton. Coke quotations are maintained at 12s. 6d. per ton for best washed and 11s. to 11s. 6d. per ton for unwashed. An advance of 6d. per ton is required for forward deliveries for best washed coke.

Iron Prices.

Hematites are still firm, though very little business is being done. A hopeful feeling is maintained respecting revival in trade and American demands. West Coast hematites, 68s. to 70s. per ton; East Coast, 65s. to 67s. per ton, both net, delivered in Sheffield and Rotherham. The Lincolnshire Ironmasters' Association, at their meeting last Friday, made no change in quotations, which remain as follows:—No. 3 foundry, 52s. 6d. per ton; No. 4 foundry, 51s. 6d. per ton; No. 4 forge, 51s. 6d. per ton; No. 5 forge, mottled and white, 51s. 6d. per ton; basic, 52s. 6d. per ton—all net delivered in Sheffield and Rotherham. Orders are accepted on these terms for delivery this year, but for delivery during the first six months of next year a premium of 1s. 6d. to 2s. per ton is required. Derbyshire irons are also unchanged, No. 3 foundry making 52s. per ton, and No. 4 forge 50s. 6d. per ton—both net delivered in Sheffield and Rotherham. Deliveries in pig iron generally are about equal to what has been experienced during the last two months, the principal call being for basic iron.

Bars, Hoops, and Sheets.

No improvement has to be noted in the bar iron and kindred trades, quotations standing as before, viz., bars, £6 10s. per ton; hoops, £7 10s. per ton; sheets, £8 10s. per ton.

The Heavy Industries—Swedish Bar.

Conditions do not differ from those reported last week in the marine, military, and railway material departments. The large establishments, though fairly employed, could do with much more work in all these branches of manufacture. The call for the high grades of steel, more especially for the United States market, is fairly well maintained; but, generally, the situation in the steel trade, in the heavier branches, leaves much to be desired. At the present time considerable anxiety exists in Sheffield as to the supply of Swedish iron. The strike has been considered to be substantially over in so far as the greater proportion of men who were out on strike have returned to work, but, unfortunately, the operatives immediately connected with the production of material have not seen well to resume their employment so unanimously. The present condition of affairs affects Sheffield trade to the extent that the Swedish bar, which enters so largely into the better classes of steel, is becoming difficult to obtain.

Cutlery Exports.

The foreign trade in cutlery shows an increase during October, the value of exports last month being £64,567, as compared with £54,308 for October of last year. A sharp decline is recorded in the United States business, which fell to £4173 last month from a total of £6531 for October of 1908. Gratifying features are the increases in Australia, Canada, British East Indies, and South Africa. Australia takes first place with £14,138, which compares with a value of £11,255 for October of last year; Canada comes next with a value of £7576, against £4504; British East Indies, £6579, against £5642; British South Africa, £5533, against £4016. For the ten completed months of the year the exports amounted to £526 601, against £514,582 for the corresponding period of 1908, and £644,551 in 1907.

Sheffield Chamber of Commerce.

Mr. Joseph Dixon and Mr. T. W. Ward attended the meetings of the Congress of Chambers of Commerce of the Empire at Sydney on behalf of the Sheffield Chamber. At a meeting of the Council of the Sheffield Chamber, held on Monday, a letter was read from these two gentlemen dealing with the work done by the Congress. Messrs. Dixon and Ward wrote that the Sheffield resolution advocating a return of duty on British commercial travellers' samples, provided that the traveller was not in Australia for as long as twelve months, had been carried. It was stated that British commercial travellers in Australia might avoid the difficulty of getting back the Customs duty which they had paid on entry if, instead of paying that duty, they were to pay a sum by way of deposit. While there would be little difficulty in getting back the deposit, the reverse was the case when the actual duty was paid. The Sheffield Chamber has protested to the Colonial-office against several of the provisions of the Transvaal Estate Duty Act, 1909. A letter was read from the Colonial-office stating that they were in communication with the Board of Trade on the subject.

NORTH OF ENGLAND.

(*From our own Correspondent.*)

Cleveland Pig Iron.

THE pig iron trade of this district is passing through a period of quietness, so far as the distribution of orders is concerned, and prices have dropped a little. The tone of the market is not cheerful, and traders are not very ready to commit themselves to business for next year's execution, while they have not much to buy for the current year's delivery, having fairly well covered. At the same time producers are not keen sellers for next year; indeed, there seems to be a general tendency to wait as regards forward business. The more favourable Board of Trade returns for October have done nothing to strengthen the market, but this is probably due to the disappointment concerning the business with America. It is not developing to anything like the extent that was expected, and as the anticipation of heavy deliveries of Cleveland pig iron to the United States similar to those of 1907 was the main cause of the recent upward movement in prices and the sanguine tone of the market, the failure of the demand to materialise has somewhat "thrown cold water" on the market, and quotations have been creeping slowly downwards. In the early part of the week it was reported from the States that No. 2 Northern iron had been advanced 25 cents. This is the quality with which Cleveland foundry iron chiefly competes in America, but the intelligence failed to have a good effect on the Middlesbrough market, for the influence of the news was counteracted by the statement that the production of pig iron in the States had now got up to the requirements, and for the present there is not much need to import pig iron. For October the output of the American blast furnaces reached 2,600,000 tons, which is equal to over 31 millions per annum, and in some parts these stocks are accumulating. Thus the news from the other side is not so encouraging as it has been, and, moreover, there are not many inquiries coming forward, while the placing of orders is again at a standstill. Cleveland pig iron warrants are rather largely held by American speculators, and some of these have been selling out, a course which is not altogether a good feature, because if America buys Cleveland iron with anything like freedom next year the prices must go up. The Cleveland iron market has lately been detrimentally influenced by the home political situation, and traders are inclined to wait until the early general election which is talked about is over. The quotations for Cleveland pig iron are easier than they were last week. Cleveland warrants have been down as low as 50s. 10d. cash buyers, that being the poorest figure which has been reported since the middle of September, and it was nearly 2s. per ton below the best autumn quotations, that being reported about the end of September. For No. 3 Cleveland G.M.B. pig iron for prompt delivery 51s. has been the general quotation, with 52s. to 52s. 3d. for delivery over the first quarter of next year, but consumers are timid about buying for 1910, and the forward prices are almost nominal. No. 1 is at 53s. 6d., No. 4 foundry at 49s. 6d., No. 4 forge at 49s., mottled at 48s. 6d., and white at 48s., all for prompt delivery, with the same premium for forward delivery as is reported for No. 3.

Hematite Pig Iron.

New business comes very slowly to hand in the East Coast hematite pig iron trade, but producers are as strong as ever with respect to prices, because they have plenty of orders booked for the next two or three months' execution. They are not very ready to quote for spring delivery, because they cannot fix upon the prices, seeing that they cannot get those who supply them with materials to decide upon what they will ask. Where prices are named for next year's deliveries of ore and coke they are much above anything that consumers are prepared to give. For mixed numbers East Coast hematite pig iron, early delivery, 60s. is the general quotation, though it is reported that second hands are still to be met with who will take a little less for small lots. For first quarter next year 62s. 6d. per ton is the regular price. It is difficult to buy Rubio ore for delivery next year, and the mine owners in Spain do not appear to have made up their minds what they shall ask. The demand from all pig iron manufacturing districts for Spanish hematite iron ore is great and is increasing, so that the suppliers of it are the masters of the situation. Even American ironmakers have begun to buy heavily from the Peninsula, south as well as north. The nominal price of Rubio ore for early delivery is 17s. 6d. per ton c.i.f. Tees. Much more has been asked for forward. Coke is becoming dearer, as the supply now is hardly equal to requirements, and prospects of a larger demand are good. Furnace coke is firm at 17s. 3d. per ton delivered early at Middlesbrough.

Stock of Cleveland Pig Iron.

Messrs. Connal and Co. report that the stock of Cleveland pig iron in their public store on 10th inst. was 345,384 tons, an increase for the month of 9899 tons. The stock consisted of 317,689 tons of No. 3; 24,835 tons of other iron deliverable as standard; and 2860 tons of other iron not deliverable as standard. Nearly 200,000 tons has been added to the store this year.

Shipments of Pig Iron.

The activity in shipments which was noticeable last month has, unfortunately, not been maintained this month, at which there is naturally some disappointment. The quantity exported this month to Wednesday was 26,395 tons, as compared with 33,081 tons last month; 41,487 tons in November last year; and 47,018 tons in November, 1907, all to 10th.

Manufactured Iron and Steel.

The business reported in manufactured iron and steel is slower than it has been for some time, but, nevertheless, prospects are good in most branches, and no changes in quotations are to be reported. The works are less irregularly employed than they have been hitherto this year, and shipments have seldom been larger than are now being made.

Shipbuilding.

The shipbuilding industry in this district continues steadily to improve, and builders are succeeding in securing rather better prices for new tonnage than was possible in the first half of the year. The Tyne-Tees Steam Shipping Company is about to place an order for a passenger steamer for its London service, and tenders are also being asked for a Canadian Lake steamer 250ft. long. The Dundee, Perth and London Shipping Company is in the market for a passenger and cargo steamer. The number of idle steamers has not yet increased as expected; in fact, the number still laid up in the Tyne is about fifty. Smith's Dock Company is transferring the plant of its shipyard at South Shields to its new yard at Southbank near Middlesbrough; it has orders on its books for half-a-dozen trawlers and coasting steamers. On the site of its Shields yard it will construct a new graving dock 600ft. long, 65ft. wide, and 20ft. depth of sill at low water, and capable of accommodating the largest vessels trading with the North-East Coast.

Coal and Coke.

After a somewhat bad time in the steam coal trade business has this week shown a slight improvement, buying being somewhat brisker, and the collieries are working more regularly. There has lately been a large amount of idle time, and the price of best steam coal fell as low as 10s. per ton f.o.b., but this week 10s. 3d. is mostly quoted, with 8s. 9d. to 9s. for seconds. Steam smalls have been somewhat scarce owing to the reduced production of large, and the prices have risen—they vary now between 5s. and 6s. 6d., according to quality. Gas coals are in very fair request at 10s. 9d. per ton f.o.b. Coking coal and bunkers are in better supply than demand, and can be got at 9s. to 9s. 6d. per ton f.o.b. Tyne Dock, while 10s. to 10s. 6d. are quoted for 1910 delivery, which buyers are loth to pay. The coke trade is showing much more favourably than the coal trade, and consumers complain of the comparatively high prices that are asked—17s. 3d. per ton for furnace coke, delivered Middlesbrough.

NOTES FROM SCOTLAND.

(*From our own Correspondent.*)

General State of Trade.

A QUIETER feeling prevails in not a few departments of trade. Uncertainty as to monetary and political conditions is believed to be hampering enterprise, but there are not wanting indications that business is surely, although slowly, assuming a more satisfactory position. While the speculative markets have sustained a check for the moment, there is considerable advantage to manufacturers in the arrest of the appreciation of raw material. It was found impossible to obtain a corresponding rise in the prices of manufactured articles, and the halt that is now being experienced in the upward movement of pig iron especially may not, it is felt, be without its advantages.

The Pig Iron Market.

There has been comparatively little doing in the pig iron warrant market this week. A fair business has occasionally taken place at the forenoon meeting of the iron ring, but in the afternoons there has on some days been nothing whatever done. Speculators in warrants have had a disappointment in the course of the market, which has been receiving comparatively little support by operators for a rise; whilst, on the other hand, the decline in prices has so far not been very serious. Business has been done in Cleveland warrants since last report from 51s. 2½d. to 50s. 10d. cash, 51s. 5½d. to 51s. 3d. one month, and 52s. 3½d. to 52s. three months. There has been much less done for future delivery, and the cash business is of moderate proportions.

Scotch Makers' Iron.

The demand for special brands of makers' iron is fairly well maintained, but business generally has taken a quieter turn, and prices are in some cases quoted a little below the official figures, in order to influence orders. At Glasgow harbour, Monkland is quoted f.a.s., No. 1, 58s.; No. 3, 56s.; Carnbroe, No. 1, 60s. 6d.; No. 3, 57s. 6d.; Clyde, No. 1, 62s. 6d.; No. 3, 57s. 6d.; Gartsherrie and Calder, Nos. 1, 63s.; Nos. 3, 58s.; Summerlee and Langloan, Nos. 1, 65s.; Nos. 3, 60s.; Coltness, No. 1, 90s.; No. 3, 59s. 6d.; Eglinton, at Ardrossan or Troon, No. 1, 58s.; No. 3, 56s.; Glengarnock, at Ardrossan, No. 1, 65s.; No. 3, 59s.; Dalmellington, at Ayr, No. 1, 62s.; No. 3, 57s.; Shotts, at Leith, No. 1, 63s.; No. 3, 58s.; Carron, at Grangemouth, No. 1, 65s.; No. 3, 59s. per ton. An additional furnace has been placed on the manufacture of hematite pig iron. There are now 43 making hematite, 35 ordinary, and 5 basic iron, the 83 furnaces thus in operation in Scotland comparing with 82 last week, and 77 at this time last year.

The Hematite Trade.

In the course of the last six days thirteen cargoes of hematite ore reached the Clyde, nearly all of it from abroad. The imports for the ten months ending with October amount to 913,600 tons, against 825,580 tons in the same period of 1908, showing an increase this year of 88,020 tons. The output of hematite pig iron in Scotland has been increased by about 350 tons per week, and now amounts approximately to 15,000 tons weekly, which is nearly 1000 tons per week more than at this time last year. The current consumption of hematite is not believed to be quite up to the output, and yet it cannot be much short of it. In any case, the impression is that there can be little risk in adding somewhat to stock at present prices. Merchants quote Scotch hematite pig iron 63s. 6d. per ton for delivery at the West of Scotland steel works. A lot of Cumberland hematite warrants has been sold in our market at 60s. 6d. cash, usual Cumberland terms.

Pig Iron Shipments.

The shipments of pig iron from Scottish ports in the past week amounted to 6833 tons, compared with 8380 in the corresponding week of 1908. To Canada 1605 tons were dispatched, United States 1306, South America 500, Holland, 400, France 350, India 177, Germany 135, Australia 73, other countries 319, the coastwise shipments being 1968 tons, compared with 3382 in the same week of last year. The arrivals at Grangemouth of pig iron from Cleveland and district were comparatively small, 6570 tons, or 7902 less than in the corresponding week.

Finished Iron and Steel.

There is little or no improvement to note in the finished iron trade. Orders come to hand slowly, and not in sufficient quantity to keep the works in anything like full operation. The outlook in the steel trade appears to be somewhat more promising. Shipbuilders are taking rather better supplies of material, and several of the steel works are reported to be pretty busy with this class of work. A fair call exists for various kinds of structural material for abroad, and inquiries are being made with the apparent object of securing delivery over a part of next year. About this business merchants and makers are necessarily cautious, but there is a prospect of a fair trade resulting with Canada and some of the Colonies. Makers of sugar-crushing plant and pipe founders speak a little more cheerfully as to the future.

The Coal Trade.

The increasing demand for house coal, owing to colder weather and the advance of the season, has tended to give a firmer tone to the coal markets. Both for home use and export the demand for household qualities has quickened considerably. House coal of the better sorts has been commanding a little more money for home use, but otherwise it cannot be said that there is so far any improvement in prices.

WALES AND ADJOINING COUNTIES.

(*From our own Correspondent.*)

Last Week's Coal Trade.

THE slight improvement which occurred last week by the receipt of delayed tonnage somewhat saved the situation, and enabled coalowners to clear off large quantities of coal, and also stopped the quiet movement in prices downward. A few pence per ton was the average reduction, and this was chiefly given by owners who wanted to clear their wagons. On several days there were large cargoes sent from Cardiff—on the 4th, 5000 tons to Port Said, 5000 to Rio, 5000 to Montevideo, 4200 to Varna. Newport, too, which has not been exempt from slackness in the coal trade, sent during the week nearly 110,000 shipment foreign and about 18,000 tons coastwise, while Swansea despatched 69,490 tons, and Port Talbot 39,789 tons foreign and 4187 tons coastwise. Swansea claims that its coal output was fully 20 per cent. better than at any similar period during the last three months.

Latest Cardiff Coal Prices.

It would seem impossible for the Welsh coal trade to escape some disturbing influence. The latest has been the statement which at present is talked about on 'Change, that the Admiralty, which takes about 1¼ million tons of Welsh coal, is making arrangements for a supply of Northern coal for the Navy. Two vessels, carrying 5500 tons, have been, it is said, ordered to the Tyne to load coal for the depôts. The point under discussion is whether the order is not a part of the Bearing tactics to lower Cardiff prices. Best Cardiff prices are 16s. 6d., as compared with Newcastle, which are 10s. The latest news is that no other steps have been taken by the Admiralty, but customers appear to be holding off to see if a drop will take place, and among the old buyers are the Compagne Générale Transatlantique, who are said, on 'Change, to be bent on "taking the chance of the market" rather than committing themselves to present prices. The latest quotations are as follows:—Cardiff: Best steam coal, 16s. 6d. to 16s. 9d.; seconds, 15s. 6d. to 16s. 3d.; ordinaries, 14s. 6d. to 15s. 3d.; best drys, 16s. to 16s. 6d.; ordinary drys, 14s. to 14s. 3d.; best washed nuts, 14s. to 14s. 6d.; seconds, 13s. to 13s. 6d.; best washed peas, 12s. 6d. to 13s.; seconds, 11s. to 12s.; very best smalls, 8s. 9d. to 9s. 3d.; best ordinaries, 8s. to 8s. 3d.; cargo smalls, 6s. 9d. to 7s. 6d.; inferior kinds, 6s. to 6s. 6d.; very best Monmouthshire black vein, 15s. 3d. to 15s. 6d.; ordinary Western Valleys, 14s. 6d. to 14s. 9d.; best Eastern Valleys, 13s. 6d. to 13s. 9d.; seconds, 12s. 6d. to 13s. Bituminous coal: Very best households, 17s. to 18s.; best ordinaries, 15s. to 16s.; No. 3 Rhondda, 17s. 3d. to 17s. 6d.; brush, 13s. 6d. to 13s. 9d.; smalls, 10s. to 10s. 6d.; No. 2 Rhondda, 12s. 3d. to 12s. 9d.; through, 9s. 6d. to 10s.; smalls, 7s. to 7s. 6d. Patent fuel, 15s. to 15s. 6d. Pitwood, 20s. to 21s. Coke: Special foundry, 24s. to 27s. 6d.; foundry, 19s. to 20s.; furnace, 17s. 3d. to 18s. Large cargoes going to Port Said, Havre, and Savona. Mid-week 62,000 tons were cleared in one day to various foreign ports.

Newport Coal.

Though the coal of the district retains some degree of firmness, there is not much briskness to be noted. For forward delivery coalowners adhere to quotations, and tonnage has come in and cleared off stocks to a large extent. Pitwood is decidedly advancing. Latest:—Very best Newport black vein, 15s. to 15s. 3d.; Western Valleys, 14s. 3d. to 14s. 6d.; Eastern Valleys, 13s. 3d. to 13s. 6d.; other kinds, 12s. 6d. to 13s.; best smalls, 7s. to 7s. 3d.; seconds, 6s. 3d. to 6s. 9d.; inferiors, 5s. 9d. to 6s. 3d. Bituminous coal: Best house, 15s. to 15s. 6d.; seconds, 14s. to 14s. 6d. Patent fuel, 15s. to 15s. 3d. Coke: Foundry, 18s. to 19s.; furnace, 17s. to 17s. 6d. Pitwood, ex ship, 19s. 6d. to 20s. 6d.

Swansea Coal—Anthracite, Steam, and Bituminous.

There has not been much alteration since last week. Tonnage has relieved to some extent, but supplies are plentiful and in excess of demand, which lacks vigour. Swansea large is reduced and red vein not quite so firm. Prompt buyers are able to get concessions. Some kinds of machine coals are stiffening; beans are very firm; rubbly culm hardening; duff continues weak. Steam coal and bituminous no change. Latest prices:—Anthracite best malting large hand-picked, 24s. to 25s. net; second malting, 21s. 6d. to 22s. 6d. net; big vein, 18s. to 20s., less 2½; red vein, 12s. 6d. to 13s. 6d., less 2½; machine-made cobbles, 23s. 6d. to 24s. 6d. net; Paris nuts, 26s. to 27s. net; same French nuts and German nuts; beans, 17s. 6d. to 18s. 6d. net; machine-made large peas, 11s. to 12s. 6d. net; fine peas, 10s. 6d. to 11s. net; rubbly culm, 5s. 3d. to 5s. 6d., less 2½; duff, 2s. 6d. to 3s. net. Steam coals: Best large, 17s. to 18s.; seconds, 14s. 6d. to 15s.; bunkers, 9s. 6d. to 10s. 6d.; small, 7s. 6d. to 10s. 6d., all less 2½. Bituminous coal: No. 3 Rhondda, 18s. to 18s. 6d.; through, 14s. 9d. to 15s. 6d.; small, 10s. 6d. to 11s. Patent fuel, 13s. 6d. to 14s., all less 2½. Coal quotations all f.o.b., net cash, 30 days.

German Coke to Cardiff.

A cargo of German coke was imported last week to Cardiff *viâ* Barry.

Iron and Steel.

There was more work done at Dowlais last week, chiefly in the Bessemer department, and the men were tolerably well employed up to Friday evening. This was very acceptable to the men, who have often had only three, or at the best, four days' work a week. The standing order which has been some time in hand was heavy rails for the India State Railways. There is also an order in hand for steel sleepers, which Dowlais was one of the first leading works to arrange for. At the Little Mill the principal output was composed of light tram rails, fish-plates, and bars and billets. At the close of last week, 1250 tons steel came to Mordey Jones, Newport, from Antwerp. One of the largest importers of ore was Blaenavon, which received nearly 5000 tons from Bilbao. Latest iron and steel prices: Newport, heavy rails, £5 5s. to £5 7s. 6d. Swansea Metal Exchange: Steel bars, Siemens, £4 15s.; Bessemer, £4 12s. 6d.; Pig iron, hematite, mixed numbers, 60s. 4½d. cash and month; Middlesbrough, 50s. 11d. cash, and 51s. 4d. month. Scotch, 56s. 10½d. cash and month. Welsh hematite, 66s. to 67s. 6d. d.d; East Coast, 64s. to 65s. Other Swansea quotations: Copper, £53 17s. 6d. cash, and £60 2s. 6d. three months. Block tin, £138 15s. cash; £141 three months. Lead, English, £13 8s. 9d.; Spanish, £12 18s. 9d. Spelter, £23 3s. 9d.; silver, 23⅞d. per oz.

Tin-plate.

There has been no falling off in the tin-plate trade, and it is to be noted in all directions that manufacturers are alive to the policy of making extensions to meet the increasing demands. This is observable from Swansea to Llanelly, and a praiseworthy emulation is maintained to preserve the character as well as the quantity of the make. The extensions to the annealing house at the Duffryn works are completed. The shipments of tin-plates last week were very large, 160,109 boxes; receipts from works, 103,457 boxes; stocks now consist of only 83,820 boxes. Latest:—Ordinary plates, I.C. × 14 × 112 sheets: Bessemer, 12s. 4½d. to 12s. 6d.; Siemens same. C.A. roofing sheets, £8 10s. to £8 15s. per ton; big sheets for galvanising, £8 10s. per ton; finished black plates, £9 10s. to £9 15s.; galvanised sheets, 24 g., £11 per ton.

French Railways.

It is stated on 'Change, Cardiff, this week that these railways are negotiating for 102,000 tons large coal and 351,740 tons small; deliveries at Nantes and other ports; tenders to be in by November 15th.

Swansea Imports.

The character and quantity of imports, as showing the varied trade of the port, was well exhibited last week. In pig iron 2357 tons were received; 3179 tons scrap steel, &c.; 1750 tons iron ore; 578 tons copper ore; 3065 tons copper regulus; 85 tons copper bottoms; 2016 tons calamine; 1000 tons blende ore; 393 tons steel billets. Pitwood and pit props, 11,161 tons; 1450 tons timber; 583 tons grain; 248 tons flour; 200 tons phosphates; 336 tons sundries; and tin-plates and general goods 8810 tons.

Port Talbot.

The improvement at this port continues, and shows a marked increase. Last week the shipping showed a total of 54,024 tons—an increase of 16,728 tons on exports, and 4714 tons on imports, or a total increase of 21,422 tons over the preceding week. The chief item of export was 39,789 tons of coal to foreign ports.

New House Seam Struck.

The New North Rhondda Glyncorrwg struck a few days ago, after twelve months' operation, a fine seam, 9ft. 2in., and sent out several trucks of fine samples.

Colliers' Wages.

This week the question of the application by colliers for an advance will come forward. The belief in Cardiff is that the application will be resisted, and that in such case the question will be again brought forward before Lord St. Alwyn. The wages now stand at 47½ per cent. above the standard of 1879. As pointed out, this is the first case to be dealt with since the passing of the Eight Hours Act, and is looked forward to with grave interest.

NOTES FROM GERMANY, FRANCE, BELGIUM, &c

(*From our own Correspondent.*)

Rheinland-Westphalia.

THE general tendency in the iron and steel industry is distinctly upwards, and if a slackening off was again felt in some branches, this does not influence the condition of prices, firmness prevailing all round. On foreign account a fairly good trade was done during the week. Several railway companies have placed orders up to 1912. Export bounties will remain the same as before in the first quarter of 1910, and no alteration is to take place in the prices for semi-finished steel.

From the Silesian Iron Market.

Favourable accounts are given of the business in iron and steel, demand being regular and slightly improving, both on home and on foreign account.

List Quotations.

Official accounts from the Düsseldorf 'Change on October 17th state current rates to be as under:—Raw spathose ore, M. 10.90; roasted ditto, M. 15.50; Nassau red iron ore, 50 per cent. contents, M. 11.50, all per ton net at mines; spiegeleisen, 10 to 12 per cent. grade, M. 60 to M. 63; Rhenish-Westphalian and Siegerland forge pig, M. 55; iron for steelmaking, M. 56 to M. 58; German Bessemer, M. 58 to M. 60; basic, free place of consumption, M. 48 to M. 50; Luxemburg forge pig, M. 44 to M. 46; Luxemburg foundry pig, No. 3, M. 47 to M. 49; German foundry pig, No. 1, M. 56 to M. 58; No. 3, M. 55 to M. 57; German hematite, M. 57 to M. 59; good merchant bars in basic, M. 98 to M. 104; the same in iron, M. 122.50 to M. 125; common plates in basic, M. 106 to M. 112; steel plates for boilermaking purposes, M. 116 to M. 122; hoops, M. 122.50 to M. 125; sheets, M. 120 to M. 125; drawn wire in iron and steel, M. 126 to M. 127, all per ton free at works.

Coal and Coke.

In the Silesian district demand, though lively, has been lower than output, the latter having been very extensive. Coalowners expect their stocks to be partly cleared during the winter. Coke is wanting in animation. The German output of pit coal in September of this year was 12,739,966 t., against 12,780,870 t. in the same month of last year; in brown coal 5,816,755 t., as compared with 5,724,074 t.; in coke 1,783,947 t., as compared with 1,739,548 t. in September, 1908. From January to end of September output was as follows:—Pit coal, 100,635,897 t., against 111,391,925 t.; brown coal, 49,704,071 t., as compared with 48,892,403 t.; coke, 15,775,206 t., as compared with 15,836,933 t. in the corresponding period of the year before. Import in pit coal during the same period was 1,181,398 t., as compared with 1,209,917 t. in the previous year. Imports from Great Britain alone were 1,008,374 t., against 1,066,982 t. in 1908. From January to September 8,690,855 t., against 8,774,420 t., were imported. Export in September was 1,982,179 t., as compared with 2,208,534 t. in 1908. During the first nine months 16,767,860 t. were exported, as compared with 15,501,967 t. in 1908.

The Austro-Hungarian Iron Market.

Business moves on slowly, and there is nothing new to relate. A quiet demand comes in for most articles in iron and steel; now and then more life appears to be stirring in some branches, but this is only an improvement of a passing nature, and the general condition of the iron industry is quiet, with prices tending to firmness. On the Austro-Hungarian coal market demand is about equal to production, and the coke factories are well occupied.

Healthy Business in Belgium.

The confident tone that is noticeable in the iron and steel trade enables producers to hold firmly to their prices. Orders for 1910 can only be accepted at raised quotations. In bars contracts have increased in the course of the present week, and this is regarded as a symptom of improvement in trade; for export £4 16s. f.o.b. Antwerp has been realised, iron bars fetching 1s. less. This improvement is partly attributed to the reduction of 6s. 6d. in the sea freight to India. The plate business shows an improving tendency in consequence of the fair accounts received from the German iron market. A good deal of attention has been given to the scrap iron business of late, which is playing a far more important part in Belgium than in Germany. In a request submitted to the Railway Minister by the Union of Ironmasters in the Charleroi district, where fourteen blast furnaces are worked, it was stated that Belgium does not produce sufficient scrap iron to cover the inland demand, and so supplies have to come in from abroad. The Union of Ironmasters now desire inland consumers only to be admitted to the tenderings for scrap iron henceforth, and that import tariffs for scrap iron be reduced and export tariffs be raised. Deliveries in house coal have been lively during the week, and rates are firm. Briquettes show a weak tendency, and prospects in this department are dull.

AUSTRALIAN NOTES.

(*From our own Correspondent.*)

THE position of Assistant Commissioner for Railways in New South Wales, rendered vacant by the death of Mr. David Kirkcaldie, has been filled by the appointment of Mr. John Harper, the chief traffic manager. The choice of the new Assistant Commissioner has given universal satisfaction both with the general public and the railway staff.

During the past month much interest has been evinced in Sydney as the seat of the seventh Congress of the Chambers of Commerce of the Empire. Delegates were present from Great Britain and all parts of the British Dominions, including Canada, South Africa, and India. The chair was occupied by Sir Albert Spicer, Bart., President of the London Chamber of Commerce.

A recent inquiry made into the running of the Addington (N.Z.) Railway workshops has brought forth some very caustic remarks on the Government's inaction after a board has been making deliberate inquiries, and no result is achieved.

It has been stated by the Federal Treasurer that the new Australian Commonwealth coinage will be ready for distribution about the month of November. Under the new coinage the half-crown will disappear.

Engineer-Commander Clarkson has been appointed as superintendent to control the arrangements for the purchase of machinery for the small arms factory about to be erected at Lithgow, N.S.W. The Minister for Defence proposes to spend from £40,000 to £50,000 on machinery for this object.

The Commonwealth revenue in the year just closed showed a reduction of £665,338, the decreases being wholly in Customs and Excise. Below are shown the differences in each State:—

	1907-8.	1903-9.	
	£	£	£
New South Wales	5,815,830	5,625,393	190,437 dec.
Victoria	4,062,815	3,748,654	314,161 dec.
Queensland	1,966,761	1,989,507	22,746 inc.
South Australia	1,355,523	1,305,898	49,625 dec.
West Australia	1,270,675	1,165,682	104,993 dec.
Tasmania	544,194	515,326	28,868 dec.
	15,015,798	14,350,460	655,338 dec.

AMERICAN NOTES

(*From our own Correspondent.*)

NEW YORK, November 3rd.

THE steel industry is in a most thriving condition by reason of the pressure from buyers for supplies of crude and finished material. The latest large order on Saturday was for 30,000 tons of Bessemer, for which 19 dols. was paid by the Youngstown Sheet and Tube Company. Bessemer will touch 20 dols. A Philadelphia concern purchased 3000 tons at the former figure. The Valley furnaces are refusing to make quotations for further deliveries next year. The larger consumers are pretty well supplied for three or four months, and are unable to close at present for what they may want for next spring or next summer. The bar mills are also refusing to quote for deliveries after February 1st. Open-hearth billets have gone up to 28 dols. and forging billets to 30 dols. The total number of freight cars contracted for during the past two weeks reaches the ordinary total of 18,000, which makes a grand total for the past ten months of this year of 128,000 cars. This enormous total is still to be further increased probably by orders from the New York Central and the Pennsylvania for 27,800 cars to be delivered next year. When these inquiries were received a few days ago the car builders made a hasty canvass of the plate mills in order to ascertain whether the enormous requirements from these orders could be assuredly filled. The steel plate makers assured the car builders that by speeding up they could take care of them. Nearly all steel plants are increasing their capacity. Those concerns making semi-steel are particularly industrious. Open-hearth capacity is being expanded in the Pittsburgh district. The extraordinary demand has led to an advance to 1.60 on plates and shapes. The United States Steel Corporation is expected to make an announcement of this price in two weeks to cover next year's business. The manufacturers of structural steel, of which that corporation is the greatest, clearly recognise that the present productive capacity is absolutely insufficient to meet the demands which are now looming up and which will call for delivery throughout the coming year. A large structural plant is to be immediately erected at Gary, Indiana, which will be completed in time to turn out structural steel for next year. A great deal of new work involving bridge construction is coming up. In fact, every branch of the iron and steel industry is feeling a pressure upon its capacity, and it is intended to make additions in many localities to increase capacity. There is a strong disposition to prevent the establishment of premium quotations. Builders, however, must have material for prompt delivery, and they will bid high enough to get it. The United States Steel Corporation during October booked orders for 80,000 tons of steel. All the independent concerns are offered more business than they can comfortably accommodate. The demand for copper continues light, and there is nothing deserving of comment. Exports during the week ending October 28th were 4368 tons, and for the month to that date 21,615 tons. Imports of copper since October 1st 8295 tons, of matte 2350 tons, and of ore 1110. Lead is quiet and without a change. The tin market remains quiet, arrivals during October being 4180 tons with 2115 tons afloat. The tin-plate mills are running to nearly full capacity, and the demand for that source is large and steady.

BRITISH PATENT SPECIFICATIONS.

When an invention is communicated from abroad the name and address of the Communicator is printed in italics.

When the abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent-office Sale Branch, 25, Southampton-buildings, Chancery-lane, London, W.C., at 8d. each.

The first date given is the date of application; the second date at the end of the abridgment is the date of the advertisement of the acceptance of the complete specification.

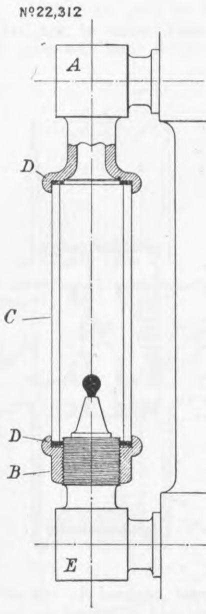
Any person may on any of the grounds mentioned in the Acts, within two months of the date given at the end of the abridgment, give notice at the Patent-office of opposition to the grant of a Patent.

STEAM ENGINES.

22,312. October 21st, 1909.—IMPROVEMENTS IN THE METHOD OF MOUNTING SIGHT TUBES, APPLICABLE FOR WATER LEVEL GAUGES AND SIGHT FEED LUBRICATORS, John Henry Wood, "Ivanhoe," Forest-road, Loughborough.

This invention relates to an improved method of fixing glass sight tubes, applicable for liquid level gauges and sight feed lubricators, whereby a simple, convenient, and neat construction is attained. The invention also consists in fixing the sight glass by means of a single nut screwed upon the bottom fitting of the glass, and bearing upon the end of the glass. A is the top fitting, and E is the bottom fitting which carry the glass tube. C is the sight glass. D are packing washers of any pliable material as leather, rubber, or the like. B is the nut which secures the glass C in position, and which is threaded on to the bottom fitting. It will be clearly seen from the drawing that if the securing nut B be unscrewed down the bottom fitting, the glass C may be lowered sufficiently to withdraw it out of the recess in the top fitting A, and taken away from its position by means of a side slanting movement. The operation of fitting a new sight glass would, of course, be the reverse of the above.—*October 20th*, 1909.

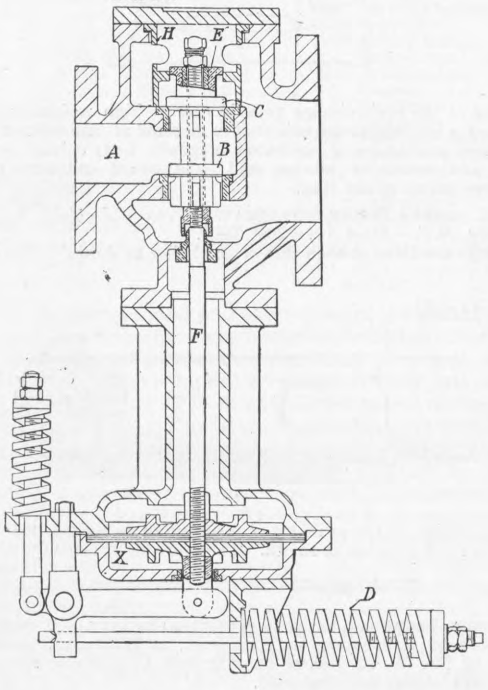
Nº22,312



5533. November 4th, 1908.—IMPROVEMENTS IN AND RELATING TO REDUCING VALVES, John Graham, Archibald Graham, jun., both of 15, Armadale-street, Dennistoun, Glasgow, and David Auld Graham, of Duntrune, Crosshill Drive, Rutherglen, Lanark.

This is a modification of a previous invention, No. 9613, May 4th, 1908. High-pressure steam enters by branch A and acts against a valve lid B and area of under side of valve C (which are nearly equal to each other), consequently when valve is shut practically no upward force is tending to open the valve. As soon as valve is opened by the action of spring D at the bottom of valve these areas are at once changed, and if no balancing piston E were fitted there would at once be a considerable force (according to the inlet pressure) tending to open the valve, and in this way cause the pressure on reduced side to vary considerably. To avoid these variations in pressure on the low-pressure side, in carrying this invention into effect, and in order that the valve-rod F may easily move the double-beat valve B C of the reducing valve described in the prior specification the valve is balanced by a piston or valve E working in a seat or short cylinder above it, formed in the cage H, and of nearly the same diameter as the bore of the seat of the bottom lid C. When the lids are resting on their respective seats, and fluid pressure is acting between them, there is very little tendency for the valve to lift, and, should the valve be lifted, the fluid pressure acts on both sides of the top lid B, balancing it. The pressure also acts on the bottom side of the balancing piston E, which in turn balances the bottom valve C; thus the whole valve is caused to be in equilibrium, and is easily actuated by the valve-rod F, controlled by a diaphragm.—*October 20th*, 1909.

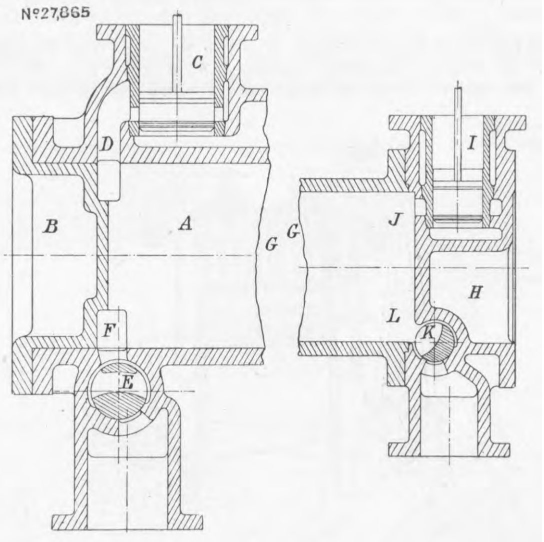
Nº5533 09.



27,865. December 22nd, 1908.—IMPROVEMENTS RELATING TO VALVES FOR STEAM ENGINES, Pollit and Wigzell, Limited, of Bank Foundry, Sowerby Bridge, Yorks.

This invention has reference to certain valves for horizontal or vertical steam engines, known as drop piston steam admission valves, combined with the Corliss exhaust valves and consists, in horizontal engines, in placing the piston drop valves vertically at the top of the cylinder at each end of the cylinder body and at right angles with the piston; the exhaust valves of the Corliss type being placed at the bottom of the cylinder at each end of the cylinder body. Or, the drop piston steam admission valves may be placed in the top of the cylinder covers and the exhaust valves of the Corliss type in the bottom of the cylinder covers. In vertical engines, the drop piston steam admission valves and the exhaust valves of the Corliss type would be placed in the same relative positions with the centre lines of the drop piston valves and the pistons parallel with each other. The left-hand engraving shows the end of a horizontal cylinder engine in section, lettered A. B is the cylinder cover having the drop piston steam admission valve C at the top of the cylinder body at right angles with the centre line of cylinder, and having the steam admission ports D. The Corliss exhaust valves E are placed at the bottom of the cylinder body with the exhaust port at F. The right-hand engraving shows the end of a horizontal cylinder in section, lettered G, with the cover H and the drop piston steam admission valve placed at I in the said cylinder cover H at right angles with the centre line of the cylinder and having the steam admission ports at J. The Corliss exhaust valves K are here placed in the bottom of the cylinder cover having the exhaust ports shown L.—*October 20th*, 1909.

Nº27,865

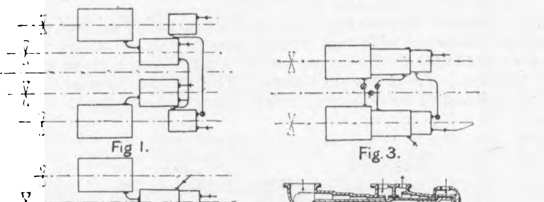


TURBINE MACHINERY.

19,106. August 19th, 1908.—MARINE TURBINE INSTALLATION, *Aktiengesellschaft, Brown, Boveri and Co., Baden, Switzerland.*

It is necessary in connection with marine turbine installations having reaction turbines for low speeds, and consequently low number of revolutions, to provide special additional or auxiliary stages—cruising turbines—so as to obtain the greatest possible economical utilisation of steam. Hitherto these cruising turbines have always been arranged in special casings. According to this invention, however, additional or secondary stages are combined with the main turbines in one casing, so that besides effecting saving in room and weight, owing to the absence of bearings, stuffing boxes, and various pipes and conduits, a considerable simplification of the installation is also attained. In order to be able to arrange turbine parts which are not consecutive as regards the sectional area for the passage of the steam in one and the same casing, special packings are provided between the different turbine parts. The invention is shown by way of example in the accompanying diagrams. Fig. 1 shows diagrammatically a known arrangement for four shafts. Fig. 2 shows the same arrangement modified in accordance with this invention. Fig. 3 shows an arrangement constructed in accordance with this invention to be used for a ship having only two shafts. Fig. 4 shows a packing between two turbine parts combined in one casing of the type mentioned above.—*October 20th*, 1909.

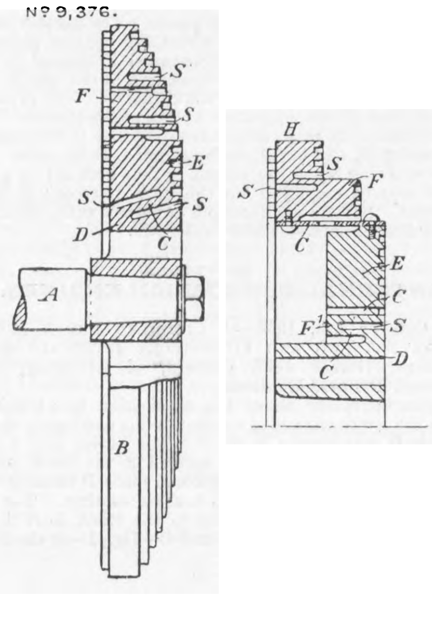
Nº 19106.



9376. April 20th, 1909.—IMPROVEMENTS IN AND RELATING TO RADIAL AND LIKE TURBINES, *Aktiebolaget Ljungströms Angturbin, of Fabriksgrand 3, Stockholm, Sweden.*

In the engravings A designates the shaft, B the turbine disc, and D, E, F and H the annular parts into which the same is divided. C designates the axial connections between the different rings. In the constructional form shown on the left these connections are formed between annular grooves S extending into the disc B from opposite sides and lying one close to the other; the connections will thus get the shape of rings being concentrically arranged and united at the one end with an outer ring, for example, the ring E at the other end with an inner ring, for example, the ring D. In the constructional form shown on the right, between the rings E and F an axial connection C is arranged consisting of a flexible ring which, by means of screws or the like, is attached with the one edge to the ring E and with the other edge to the ring F. Between the rings D and E the connection C consists of two projections of annular shape projecting from the rings, the ends of which are welded together at F¹. Another modification is also dealt with.—*October 20th*, 1909.

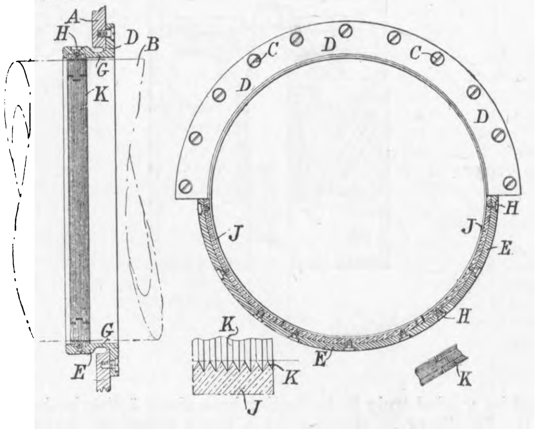
Nº 9,376.



14,606. October 14th, 1909.—IMPROVEMENTS IN IMPULSE TURBINES, John Brown and Co., Limited, of Atlas Works, Sheffield, Yorkshire, and of Clydebank, Dumbarton.

The central aperture in the stationary diaphragm A—only a small part of which is shown—is considerably larger than the diameter of the rotating shaft B. To one side of this diaphragm is secured an annular flange D, by screws C or other means, on what may be termed a casing or holder E, also of larger internal diameter than the external diameter of the shaft B. This holder E is preferably either cast iron or steel, so that it will expand and contract in the same ratio as the shaft B, and thus the clearance between the adjacent surfaces of both will tend to remain the same under all circumstances. The cross sectional area of the holder E is reduced at the part marked G to facilitate expansion when the holder is heated by the surrounding steam, and this reduction in area also gives sufficient flexibility to the holder, so that in case of sudden shock, such as might result from the shaft B whipping, the holder will be able to spring with the shaft. In a groove in the internal circumference of the holder E there is secured by screws H a ring, preferably of brass or other suitable comparatively soft metal, or metallic composition. This ring J is built up of segments the ends of which are checked into each other with sufficient clearance, or otherwise jointed together, so as to permit of circumferential expansion of the ring as a whole, and as only one of the screws H holding each segment is a fit in the aperture in the holder through which the screw passes, the apertures for the other screws being enlarged, the expansion of the ring is not prevented by these holding screws. The inner surface of the ring J is serrated by fine circumferential grooves K, and each segment of the ring is so secured, as described, in the holder E that when the latter is placed around the shaft B there is the desired minimum running clearance between the serrations and the shaft to prevent steam leakage.—*October 20th*, 1909.

Nº14,606

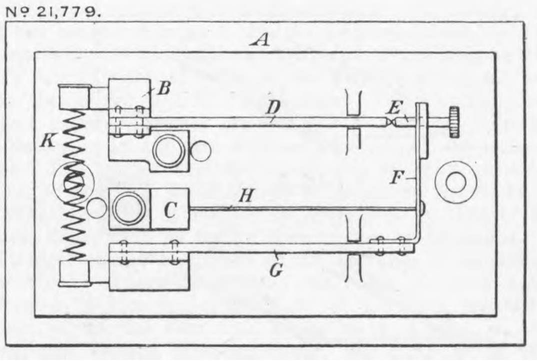


SWITCH GEAR.

21,779. October 16th, 1908.—IMPROVEMENTS IN APPARATUS FOR LIMITING THE SUPPLY OF ELECTRICAL ENERGY, George Wilkinson, of Beech Mount, Harrogate, York.

This invention relates to apparatus designed to limit to any predetermined maximum the amount of current supplied to any consumer or consuming device. For example, if a consumer applies for a definite number of lamps at a contract price per lamp, the apparatus is set to supply the equivalent current required by such lamps, but if this current is at any time exceeded, say, by switching on additional lamps, this improved apparatus immediately

Nº 21,779.



breaks the circuit and continues to connect and disconnect the supply at short intervals, until the amount of current is reduced to the agreed maximum or less, when the supply again becomes continuous. The letter A indicates an insulating slab or stand, B and C terminals to which the current-carrying wires are led, D and E the make-and-break contact pieces. The contact piece D is a bar secured to the terminal B, whilst the contact piece E is a screw adjustable in a piece of spring metal F, carried on the end of a bar G. The thermal wire H is secured at one end to the terminal C, and at the other end to the spring F. The expansion of the wire H thus causes separation of the contact pieces D and E. A high resistance K may connect the terminal C by way of the wire H, spring F, and bar G, to the terminal B, in order to avoid excessive sparking when the circuit is thus broken; or a suitable condenser may be employed for the same purpose; or both may be employed. Several modifications are dealt with, and there are four other illustrations.—*October 20th*, 1909.

INTERNAL-COMBUSTION ENGINES.

21,297. October 8th, 1908.—A Combined Piston and Inlet Valve for Two and Four-stroke Internal-combustion Engines, Horace John Howard, of "Briarley," Cherry Orchard, Staines, Middlesex.

The upper engraving shows the application to a trunk piston, whilst in the lower engraving a piston-rod is employed, the piston being made in two parts—A and B. The barrel part A carrying the piston rings has an aperture formed in the usual solid end; this aperture is closed by a separate end piece B forming a valve, with one end of the barrel portion A as its seating. The valve B conveys the power of the explosion to the crank shaft through a piston-rod D—Fig. 2—connecting-rod C—Fig. 1—or the like, and must be guided truly to its seating by a nicely fitting bushed web as H—Fig. 2—or in the case of a trunk piston by making the barrel A a sliding fit over the outside of B, the top of which is perforated on its narrowed sides as at I—Fig. 1—to allow the gas to pass to the combustion chamber from below. The seating at E must be perfectly gas-tight, as it has to withstand the full force of the explosion, which forces A tight on to B; normally A and B are kept together by a spring F which, being on the delivery side of the piston, is never subjected to sufficient heat to destroy its temper. In two-stroke engines having cylinder and pump in line, also those using crank-chamber delivery, the valve may be opened mechanically by checking the barrel portion A with a soft washer, as at G—Fig. 1—slightly before the end of the outstroke, or it can be opened automatically by the compressed charge beneath it, when the explosive pressure above is reduced by terminal ports or an exhaust valve.—*October 20th*, 1909.

Nº 21,297.

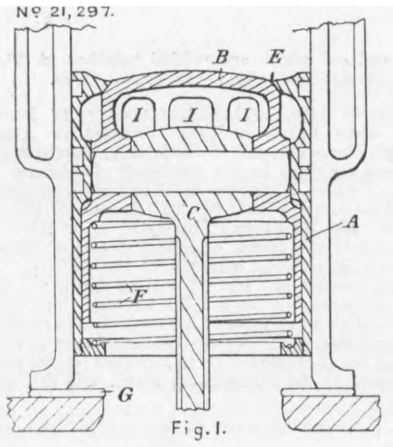


Fig. 1.

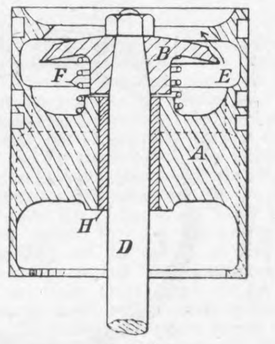


Fig. 2.

TRANSFORMERS.

16,985. July 21st, 1909.—Improvements in Insulating Former Wound Coils, *Siemens and Halske Aktiengesellschaft, of Askanischer Platz 3, Berlin, Germany.*

The present invention refers to a method of insulating the separate layers of self-contained former wound coils which are used for transformers, induction coils, electromagnets, or the like. The invention with modifications thereof is illustrated in the accompanying engravings, in which by way of example in Fig. 1 a paper strip is shown of which the rim is formed by bending the paper twice over. Fig. 2 shows the same arrangement, in which a double layer of paper is used. Fig. 3 shows a strip of single paper, where a narrow strip of cardboard is inserted in the rim, which is similarly formed to that in Fig. 1. Fig. 4 represents a section of a high-tension coil of a transformer, the separate layers of which are insulated from each other by a similar strip to that shown in Fig. 1. It will be clear from these figures that by doubly or repeatedly folding over the edges of the paper insulation, the windings are prevented from slipping sideways, and that the various layers can be made of the same width. Since the bent-over rims are lower in depth than the wire windings, air or oil, which is mostly used in the case of transformers, can reach the wire winding itself without difficulty. As it is further possible to select the paper insulation of the exact thickness required for the difference of potential between the layers, the section of the completed coil will be smaller than that of coils hitherto wound by other methods, and in like manner the cooling capacity is increased.—*October 20th*, 1909.

Nº16,985

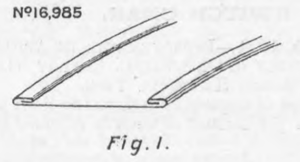


Fig. 1.

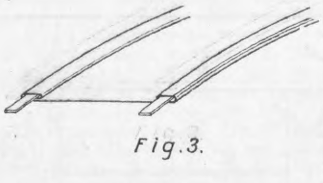


Fig. 3.

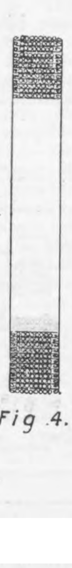


Fig 4.

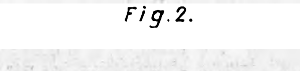


Fig. 2.

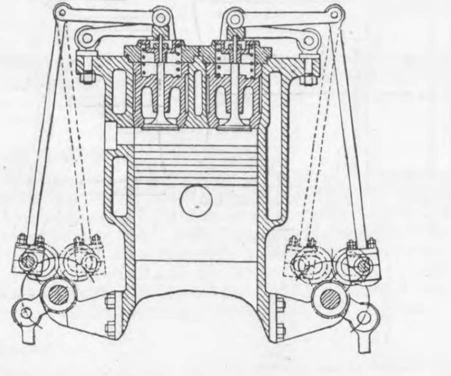
SELECTED AMERICAN PATENTS.

(*From the United States Patent-office Official Gazette.*)

935,500. Reversible Valve-gear for Elastic-fluid Engines, *R. Hennig, Hamburg, Germany.—Filed April 27th*, 1908.

Two sets of valves are used—one of which can be held fixed while the other is at work, roller levers being used to work one valve during the idle stroke of the other gear. There are six very long claims.

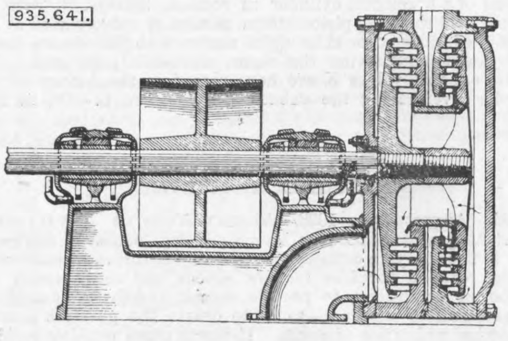
935,500.



935,641. Rotary Engine, *J. Clark, Medina, N.Y.—Filed October 13th*, 1908.

This patent is for the combination in an elastic fluid turbine of a casing, two sets of relatively movable buckets mounted therein, means for directing the steam in one direction parallel to the axis of rotation to act on one of the sets of buckets, and means for directing the exhaust steam from the first set of buckets in the opposite direction parallel to the axis of rotation to act on the second set of buckets. There are twenty claims.

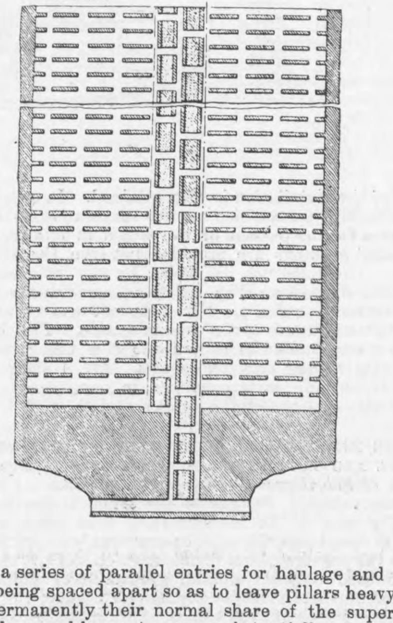
935,641.



935,762. Method of Mining Coal, *D. P. Loomis, New Philadelphia, Ohio, assignor of one-half to J. A. Beidler, Cleveland, Ohio.—Filed September 26th*, 1908.

This patent is interesting, because it is probably all but unique. Patents connected with coal mining are, of course, numerous, but they do not refer to the laying out of a mine or the plans of roads and airways. There are six claims. The second runs as follows:—The method of mining coal, which consists in driving in the vein to be mined a series of parallel entries for haulage and airways, said entries being spaced apart so as to leave pillars heavy enough to sustain permanently their normal share of the superimposed strata, and then working out rooms substantially at right angles to said entries, the pillars between such rooms being weakened throughout their entire length so as to cause the rooms, after being thus worked out and abandoned, to cave in, leaving a line of cleavage parallel with and contiguous to the line of said ways, whereby said first-named pillars are relieved of any abnormal burden, substantially as described.

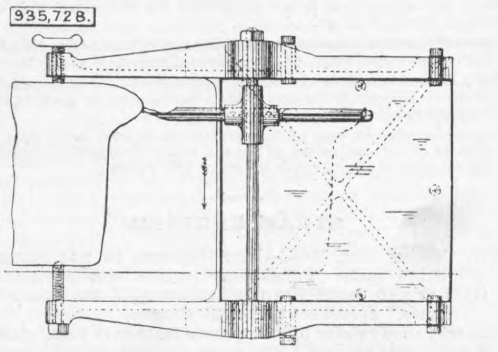
935,762.



935,728. Wheel Tire Contour Recorder, *W. C. Arp and F F. Hildreth, Terre Haute, Ind.—Filed May 17th*, 1909.

The diagram makes the nature of this invention clear without much description. The instrument consists of a tablet on which a card can be clamped, and a sliding tracing rod, one end of which is kept in contact with the tire, while the other, fitted with a pencil, traces the profiile of the tire. There are two claims.

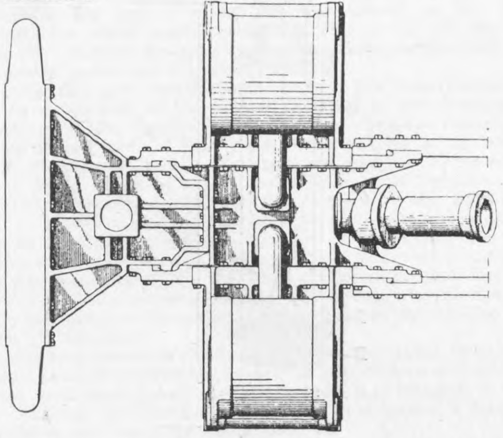
935,728.



936,198. Locomotive, *S. M. Vauclain, Philadelphia, Pa., assignor to Baldwin Locomotive Works, Philadelphia, Pa., a Corporation of Pennsylvania.—Filed July 15th*, 1909.

This patent is for a modification of the bar frame. An intermediate frame, less in width than the main frame, and having rearwardly extending arms secured to the side members of the main frame, is introduced, said intermediate frame having forward arms. A headstock frame is mounted between the forward arms and secured thereto. A cylinder is carried on each side of the intermediate frame beyond the end of the main frame. There are nine claims.

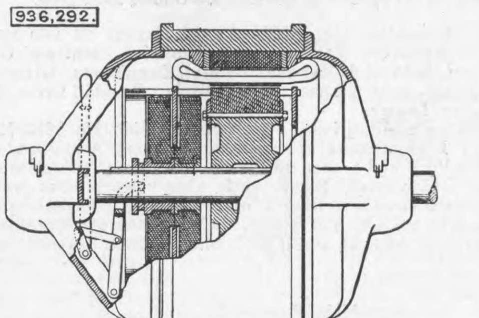
936,198.



936,292. Induction Motor, *Sven R. Bergman, Lynn, Mass., assignor to General Electric Company, a Corporation of New York.—Filed March 22nd*, 1909.

There are six claims. The fourth runs as follows:—An induction motor having a stationary primary winding, a secondary rotor winding of the squirrel-cage type having a high resistance end ring and a low resistance end ring in parallel at one end of the secondary conductors, a laminated magnetic body carried by the rotor, and means for moving said body toward and away from said low resistance end ring.

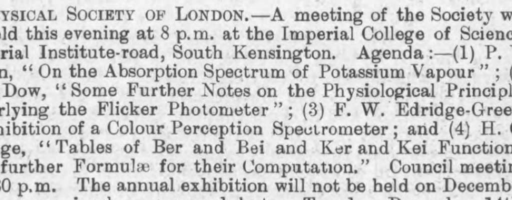
936,292.



936,412. Steam Boiler Superheater, *Francis J. Cole, Schenectady, N.Y.—Filed April 20th*, 1909.

Casings are fitted at each side of the boiler as shown. Through these a portion of the products of combustion is passed over the surface of steam tubes as shown. There are eight claims.

936,412.



Glasgow Technical College Scientific Society.—A meeting will be held to-morrow, the 13th inst., at 7.30 p.m., when a paper by Mr. W. A. Dexter on "Modern Condensing Installations" will be read and discussed.

Physical Society of London.—A meeting of the Society will be held this evening at 8 p.m. at the Imperial College of Science, Imperial Institute-road, South Kensington. Agenda:—(1) P. V. Bevan, "On the Absorption Spectrum of Potassium Vapour"; (2) J. S. Dow, "Some Further Notes on the Physiological Principles underlying the Flicker Photometer"; (3) F. W. Edridge-Green, "Exhibition of a Colour Perception Spectrometer; and (4) H. G. Savidge, "Tables of Ber and Bei and Ker and Kei Functions, with further Formulæ for their Computation." Council meeting at 7.30 p.m. The annual exhibition will not be held on December 10th, as previously announced, but on Tuesday, December 14th from 3 to 6 p.m. and from 7 to 10 p.m.

GERMAN SHIPYARDS.

No. IV.*

JOH. C. TECKLENBORG A.G., of Bremerhaven.—No. I.

In 1841 Franz Tecklenborg, an influential shipowner of Bremen, founded a shipyard on the Geeste, with the object, in the first instance, of building and maintaining the vessels required for his own business. As orders from other owners were at that time comparatively rare, the main feature of the business was repairing. The increase in size of vessels rendered the operation of careening them more and more difficult, so that the construction of a dock was found to be necessary. The conditions of the water in the Geeste forbidding the use of a floating dock, a stonework graving dock on the further shore of the river was decided upon and built in 1856. This dock, subsequently enlarged to four times its original size, is still at work—see Fig. 8, page 530. It can take in vessels up to 330ft. in length.

When in 1881 the yard took up iron shipbuilding, the working operations were all transferred to the other side of the Geeste near Geestemünde, where, on account of the excellence of its work, the yard soon obtained a gratifying degree of success. The development of the iron shipbuilding industry and the increasing dimensions of the vessels built, towards the end of the century, rendered large purchases of land and extensions of the yard necessary. In 1897 the firm was accordingly transformed into a joint-stock company, under the name of Joh. C. Tecklenborg A.G., with a capital of about £70,000 and a site of about 12½ acres. The further development of the yard into one of the most important shipbuilding undertakings in the country, necessitated fresh purchases of ground, so that the site now comprises about 58 acres. The buildings now cover about 45,400 square yards, and the building slips 30,000 square yards. The yard is on a peninsula in the Geeste, with a water frontage of 1640 yards, 330 of which form a well equipped quay. The share capital is about £200,000, to which must be added loans amounting to about £130,000.

The older plant, comprising the wet dock with the machinery for working it, and the old joiners' shop, pattern store, and brass foundry, are on a strip of ground separated from the present yard by the dock establishment of S. Seebeck—see Fig. 1. A second group of old buildings and workshops is situated on the eastern and south-eastern parts of the yard, close to the main entrance. Next to these come the building slips and the fitting-out basin. Beyond the slips lie the new platers' sheds, the power-house, and a group comprising the boiler shop and forge. On the outfitting quay are fitted the general store, the new joiners' shop, the saw-mill, the fitting-out workshops, the galvanising shop, and the tinsmiths' and coppersmiths' shops.

In the northern part of the yard are the new pattern-making shop, store, and foundry, the new offices being situated in the southern section. All the workshops and buildings are roomy, well lighted, and substantially constructed of iron and steel throughout, so that extensions may easily be made.

Part of the material, and in particular the timber for the saw-mill, is brought into the yard by water; the main supply, however, comes by the branch line from the State railway. This line enters the yard from the north, and skirting the platers' sheds leads through between the engine shops and the boiler shop to the fitting-out dock. Other branches from this line lead to various parts of the yard their course being readily followed from Fig 1. From the yard lines, which have the standard gauge throughout, branches lead into all the workshops, the total length of track being nearly 10,000 yards.

The new platers' sheds consist of seven bays, each about 66ft. in breadth and 164ft. in length, with a transverse bay, 82ft. in breadth by 262ft. 6in. in length—see Fig. 2. The transverse bay contains the plate-laying ground, and has the moulding loft above it. Bay No. 1 contains the shipyard office and the smiths' shop, all the fires of which are provided with smoke-exhausting apparatus on the Assmann principle.

Bays 3 and 4 contain the double furnace and the frame-bending blocks with a frame-bending machine by Davis and Primrose. The frame furnace, which is 82ft. long, is shown in Fig. 6. It was constructed by the Stettiner Chamottefabrik, and is heated, on the reverberatory principle, by gas. In bays 2, 5, 6, and 7 are placed the various machine tools, the arrangement and make of which may be seen from the shed plan and the accompanying list. Worthy of special mention is the hydraulic keelplate-bending machine and the joggling and flanging machine, both by Hugh Smith and Co., of Glasgow—see Fig. 7, page 523.

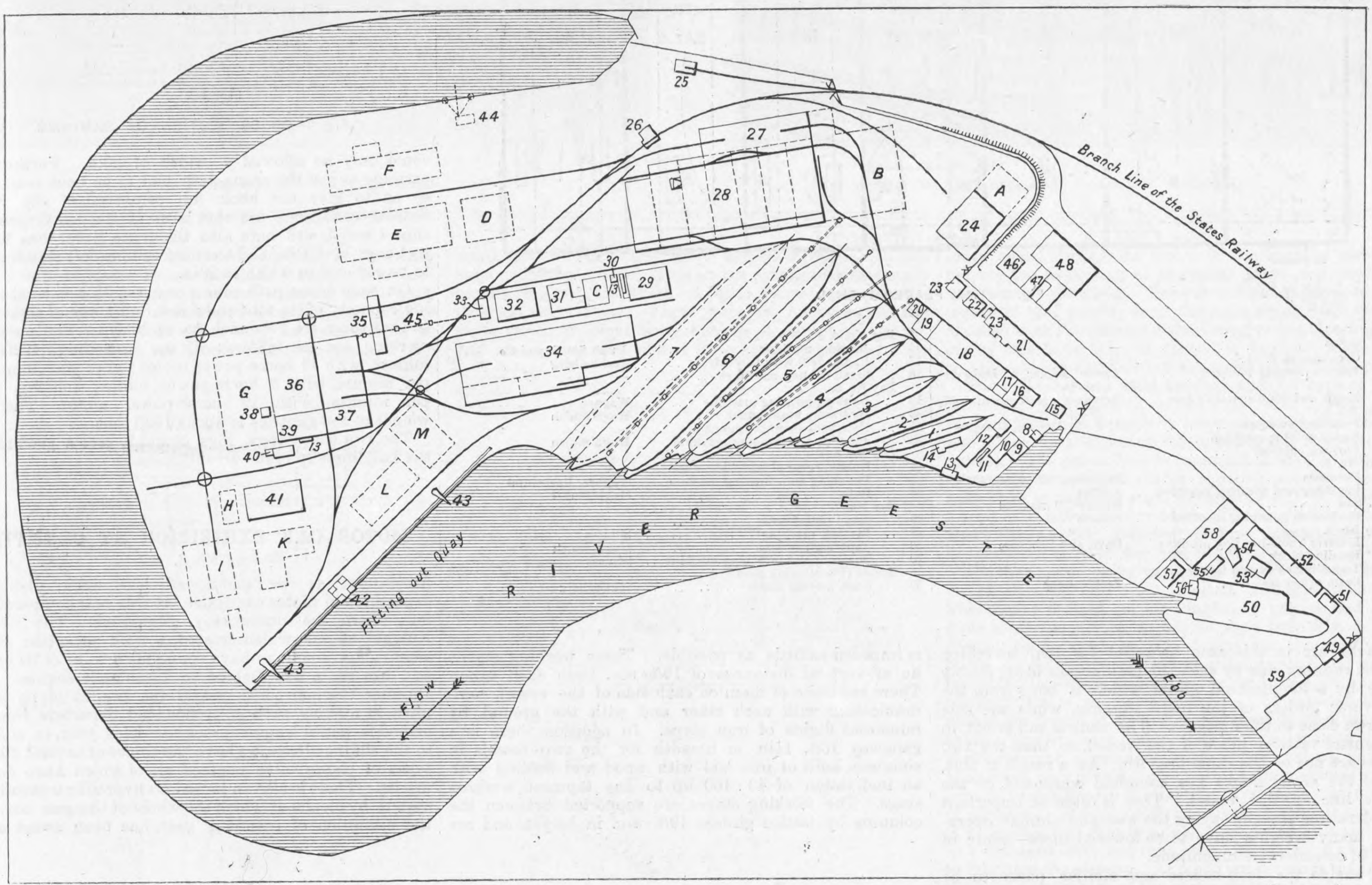
The plate-laying ground is commanded throughout its length and breadth by a 5-ton travelling crane, 82ft. in length, supplied by the Märkischer Maschinenfabrik Ludvig Stuckenholz A. G., while the machine-tool sheds are each provided with two travelling cranes, each having two motor crabs with the plate transporting arrangement shown in Fig. 3. It will be seen from the plan that several of the tools are hydraulically operated, but in the case of the heavier machines individual electric driving is used, while the smaller tools are driven electrically in groups.

The finished parts are placed on bogies which run on the line passing through the ends of the longitudinal bays and are either brought directly to the building slips or to the riveting places beside the platers' sheds. Here stands a riveting crane with four arms from each of which a hydraulic riveting machine can be suspended.

The yard has four older building slips—Nos. 1 to 4—for vessels of sizes ranging from about 280ft. by 36ft. to 460ft. by 53ft., each of which is served by two or three derrick cranes, and two new slips—Nos. 5 and 6—for vessels of 590ft. by 72ft. and 755ft. by 88ft. 6in. respectively. In addition, the construction of a slip for vessels of 820ft. by 92ft. is in contemplation.

The restricted breadth of the Geeste made it impossible to arrange the slips at right angles to the bank, and they are accordingly placed diagonally to it, being spread out in radial fashion. In this way it becomes possible to launch the largest of vessels, the bend of the river being made the most of, as may be seen from the general plan of the yard. Attention may here be drawn to the circumstance that at the launches in the Tecklenborg Yard the ordinary German method of checking the vessel's way by means of long wedge-shaped pitch pine wood baulks arranged to be drawn through oaken beddings clamped with iron is not resorted to. Instead of this large sledges loaded with iron plates are attached to the vessel by chains, and are drawn along by her, a system which has worked in the most satisfactory manner for the largest vessels built by the firm.

In the years 1906 to 1907 the new building slips 5 and 6 were provided with cranes constructed by the Nürnberg-Augsburger Maschinenfabrik A.G. These are of the overhead type, a design first employed for this purpose by the G. Seebeck A.G., and afterwards in 1900 in a much improved form by the Vulkan, of Stettin, and the Germania, of Kiel. As applied to the building slip these overhead cranes are found to possess the following advantages, in addition to those attending their ordinary use. The cranes themselves can be of light construction, so that the total weight to be moved in the longitudinal direction is not out of proportion to that of the loads dealt with as in the case of the tower cranes and outrigger cranes employed in the German yards already described. There is, further, no fear of work being stopped by stormy weather, as is the case elsewhere. Then, again, the command of the field of work is, with overhead cranes, more complete, the more so in that several can be made to work side by side at any point without interfering with the work at other points; and finally, the framework supporting the cranes on each side of the slip can be used for the support of the staging planks and working platforms. The drawback to



"THE ENGINEER" SWAIN SC.

1.	Slip for vessels of 280ft. × 36ft
2.	,, ,, 330ft. × 40ft.
3.	,, ,, 360ft. × 46ft.
4.	,, ,, 460ft. × 52ft. 6in.
5.	,, ,, 590ft. × 72ft.
6.	,, ,, 740ft. × 82ft.
7.	,, ,, 740ft. × 82ft. (projected)
8.	Hospital
9.	Timber store
10.	,, ,,
11.	Drying stove
12.	Joiners' shop
13.	Lavatories
14.	Fire-engine house
15.	Gate-house
16.	Old office buildings
17.	Rope store
18.	Platers' sheds
19.	Boiler-house
20.	Engine-house
21.	Canteen
22.	Washhouse
23.	Gate-house
24.	New office building
25.	Locomotive sheds
26.	Weighbridge
27.	Plate-laying space with moulding loft above
28.	Platers' sheds
29.	General store
30.	Accumulator
31.	Boiler and pump-house
32.	Power-house
33.	Cooling tower
34.	Engine shops
35.	Loading crane
36.	Boiler shop
37.	Forge
33.	Plate furnace
39.	Washing-room
40.	Boiler-house
41.	Tinsmiths' and boilersmiths' shops
42.	150-ton quay crane
43.	Movable quay crane
44.	80-ton quay crane
46.	Foremen's dwelling-houses
47.	Lodging-house
48.	Storing sheds
49.	Dwelling-houses and offices
50.	Dock basin
51.	Gate-house
52.	Store
53.	Foundry
54.	Mould store
55.	Boiler-house
56.	Dock pumps
57.	Smithy
58.	Old pattern shop
59.	Store sheds
A.	Extension of the offices
B.	,, ,, platers' sheds
C.	,, ,, boiler and pump house
D.	Patternmakers' shop and store
E.	Foundry
F.	Canteen
G.	Extension of the boiler shop
H.	Galvanising shop
J.	Saw mill
K.	Outfitting shops
L.	Joiners' shop
M.	General store

Fig. 1—THE SHIPYARD OF THE JOH. C. TECKLENBORG A.G., AT BREMEN

the arrangement is, of course, its considerable first cost.

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* No. III. appeared November 5th.

The fundamental principles of construction which in 1900 were applied by the contractors to the gantries of the Vulkan of Stettin proved their excellence thoroughly, and were adhered to in the construction of the Tecklenborg building slip arrangements. Some minor differences are, however, involved in the design, a general idea of which will be gathered from Figs. 4, 5, and 9.

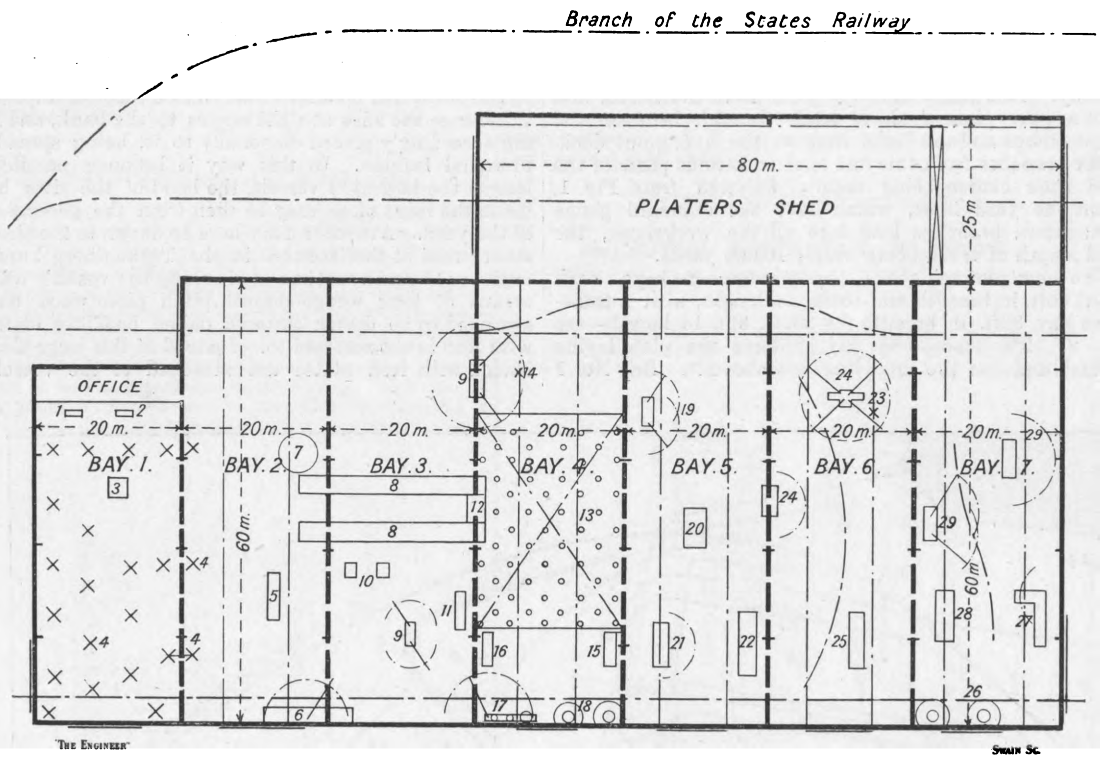

Fig. 2—THE PLATER'S SHED

	Bay No. 1.	
1	Office	—
2	Grindstones	—
3	Electric forging hammer	Aessen Müller of Ludwigshaven
4	Single and double smith's fires	Rerzener Maschinenfabrik, Hannover
	Bay No. 2.	
5	Punching machine	A. P. W. McQuie, Glasgow
6	Radial drilling machine	—
7	Furnace chimney	—
	Bay No. 3.	
8	Furnaces	Strettiner Chamottefabrik
9	Punching and shearing machine	Schiess
10	Saw	Wagner, Dortmund
11	Horizontal punching machine	Schiess
	Bay No. 4.	
12	Electric frame-bending machine	Davis and Primrose
13	Bending block	—
14	Travelling block and tackle	—
15	Beam squeezers	Tecklenborg
	Bay No. 4.	
16	Bending machine	Hugh Smith and Co.
17	Radial drill with three drills	Tecklenborg
18	Small drilling machines	—
	Bay No. 5.	
19	Double punching machine	Wagner
20	Hydraulic beam buffer	Hugh Smith
21	Hydraulic manhole punch	—
22	Joggling and flanging machine	Hugh Smith
	Bay No. 6.	
23	Hoisting gear of travelling crane	—
24	Punching and shearing machine	Wagner, Dortmund
25	Rolls	Hugh Smith
	Bay No. 7.	
26	Small radial drills	—
27	Planing machine	Schiess
28	Tapering machine	Hugh Smith
29	Shearing and punching machine	Schiess
	Annex (Plate-laying shed).	
30	5-ton moving crane	Stukenhotz

Tracks are in this case arranged for two travelling cranes, running side by side, the middle rails being jointly borne by a longitudinal girder which is hung from the transverse girders of the main framing, while the side rails run close to the uprights. The central rail is not in the central vertical plane of the vessel, so that the two cranes are not of the same breadth. As a result of this, one of the crane hooks has complete command of the centre line of the vessel. This is often an important consideration, since in laying the keel and similar operations many weights have to be lowered there—some of them of considerable magnitude.

To enable the deck-houses and similar parts to be erected at the slip, the height of the framing has to be considerable; in addition, the inclination given to the vessel for the launch has to be taken into account, and the crane-paths laid at such a height that the crane and its load can reach over the highest point of the vessel. In view of this the top of the crane track is kept 102ft. above the floor of the slip. For the crane itself a height of 6ft. 6in. above the rail had to be provided, so that the clear height from the ground to the lower part of the transverse girder is 108ft. 6in. To this has to be added the height of 3ft. 3in. of the transverse girder itself.

The crane-path of building slip No. 5 is about 607ft. long, but that of slip No. 6 is 755ft. long, and is therefore suitable for the longest liner yet built. The distances apart in the longitudinal direction of the stanchions and transverse girders is here about 102ft., while in the Vulkan yard at Stettin it is only 33ft., to enable the structure to carry a roof, if such an addition should some day be found desirable.

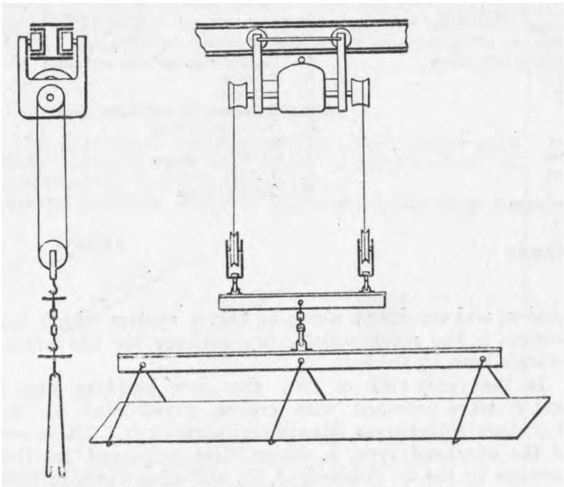

Fig. 3—PLATE CARRYING TACKLE

The feet of the gantry columns are arranged in portal form to enable narrow-gauge wagons to pass through them. Like the other members of the framing, these columns are made with wide-meshed latticing, so that traffic on the working stages running through the columns is impeded as little as possible. These working stages lie at vertical distances of 19ft. 8in. from each other. There are three of them on each side of the vessel, communicating with each other and with the ground by numerous flights of iron steps. In addition, there is a gangway 13ft. 1½in. in breadth for the two vessels in common, built of iron laid with wood and leading with an inclination of 40 : 100 up to the topmost working stage. The working stages are supported between the columns by lattice girders 19ft. 8in. in height, and are laid with planks. The vertical struts of these girders are each formed of two angles and serve to support the flying stages, which are easily rigged up and taken away again as required.

Since the various slips lie at acute angles one with another, the construction of the framework was attended with considerable difficulty. When the vessel on slip No. 5 is launched it has to pass under the crane path at the side of slip No. 6. Thus below the crossing point of the two outer crane paths no columns could be placed for the support of the lateral girders, as these would bar the way for the launch of the vessel. From this point onwards, then, the girders had to project over the last support. Similarly, the last transverse girder, from which the central girder is suspended, had to be carried over from the last column of slip No. 6 to the overhanging side girder. The overhang of the girder amounts to 121ft. Its height from the ground is increased at the centre by 4in., and the calculated deflection at its outer end is 7in., a figure which has been found to agree fairly well with the results of practical trials. As a result of this allowance, the girder is nearly horizontal when loaded.

The omission of the last column, and the overhang arrangement of the girder, did not alone suffice to let the vessel leave slip No. 5. The last column but one, although with the addition of the extra load entailed by the overhang of the girder it had to bear a weight of 200 tons, could only be allowed a width of 20in. Further, the extreme end of the crane-path had to be bent somewhat, so as to give the hook full command of slip No. 5. Similar conditions are met with at the convergence of slips 4 and 5, and here also the crane girder has to project over by 102ft., and the last column left standing has to be reduced in width to 20in.

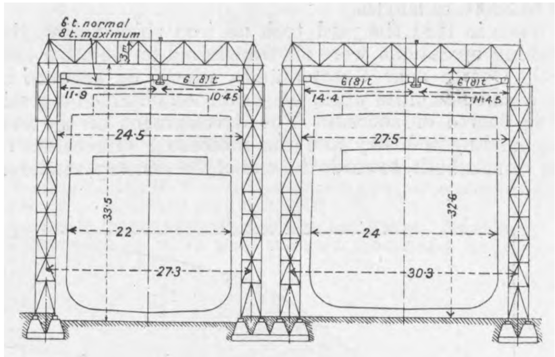

Fig. 4—CROSS SECTION OF GANTRIES

On each crane-path runs a crane with a normal carrying capacity of six tons and a maximum one of eight tons, so that there are two such to each slip. The speeds of working are as follows:—Crane travelling, 492ft. per minute, with 19 horse-power motor; crab travelling, 98ft. per minute, with 2 horse-power motor; hoisting, 39½ft. per minute, with 19 horse-power motor. The total weight of the gantries is about 1300 tons.

The two engravings, Figs. 5 and 9, give a good idea of the building-slip crane arrangement.

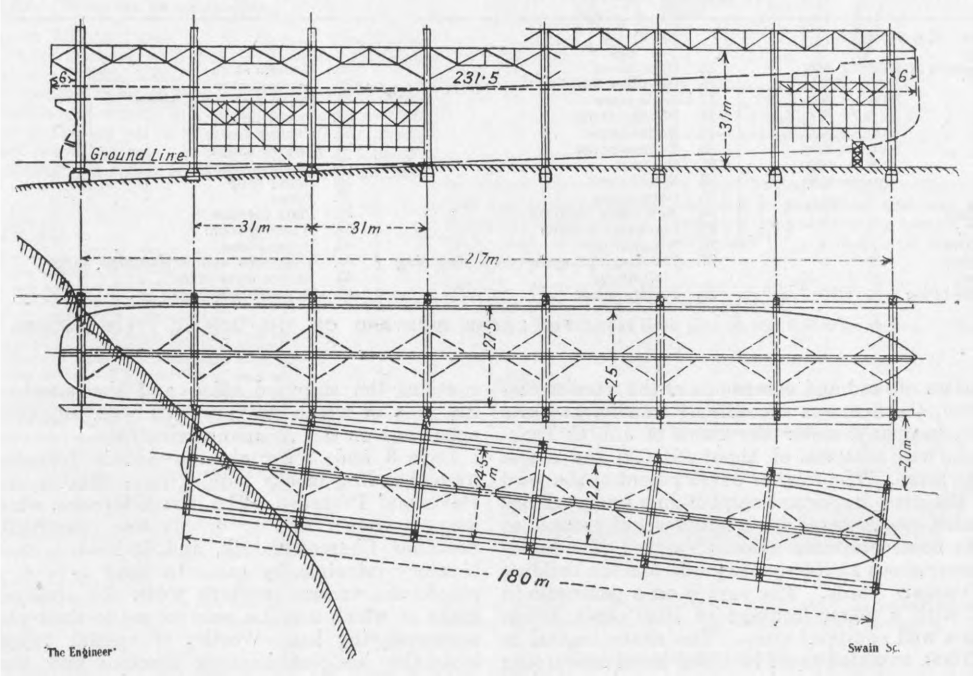

Fig. 5—PLAN OF GANTRIES

MOTOR CAR EXHIBITION AT OLYMPIA.

No. I.

Although, as we mentioned last week, distinctive departures in motor car design are this year comparatively few, there are noteworthy exceptions. The "Silent Knight" engine, which created a mild sensation at last year's show, seems to have confounded some of its critics, and has set a new fashion in automobile engines. The Daimler Company has reaped the benefit of its enterprise in making such a pronounced departure from the orthodox petrol engine practice. This year, in addition to the sliding sleeve, we have the choice of several distinct types of piston valve engines, all of which have certain merits. There is also an ingenious hydraulic transmission system by means of which the whole of the gear box, with the exception of reversing gear, has been swept away. Steam-propelled cars are confined to the stands of three well-known firms, while electric vehicles are scarcely represented at all.

With regard to the general design of petrol vehicles, there is an obvious increase in the number of car builders who are taking up the worm drive, which has hitherto been chiefly used in the Lanchester and Dennis cars. Although a well-designed and efficiently lubricated worm gear provides a drive which is both efficient and silent

SHIPYARD OF THE JOH. C. TECKLENBORG A.G., AT BREMEN

(For description see page 519)

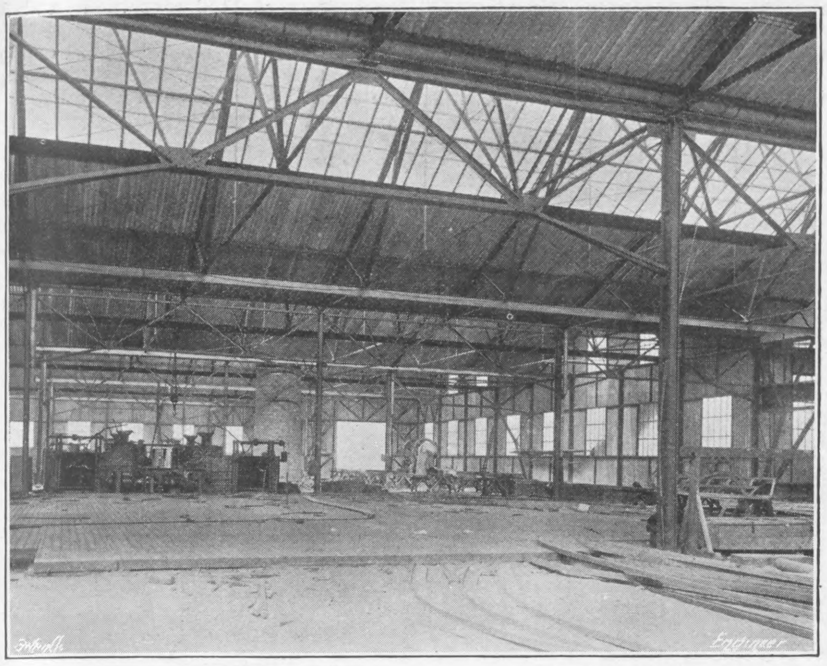

Fig. 6—THE PLATERS' SHED

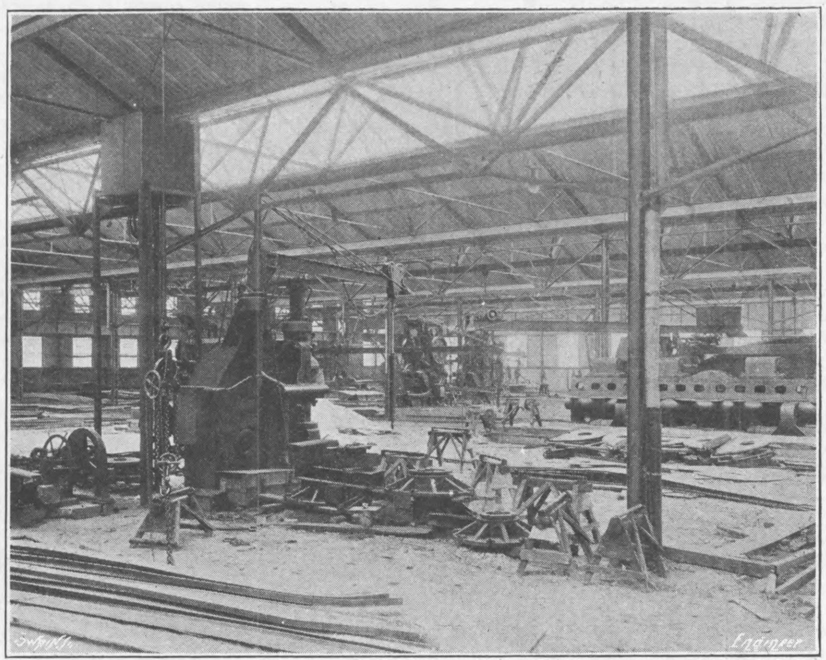

Fig 7—JOGGLING AND FLANGING MACHINE

there may be other reasons for the increasing popularity of this form of transmission, which is certainly as expensive, if not more costly, to produce than the bevel gear. There are rumours of threatened litigation on behalf of owners of master patents which may have something to do with the change of front. Hitherto one of the chief obstacles which the builders of the worm-driven motor car have had to overcome has been the cutting of a worm to the correct form to allow the wheel to drive the worm, as is necessary in running down hill with the clutch out. This has, however, been overcome, and there is no reason why the worm should not continue to grow in popularity. In the matter of engine design there is a decided lengthening of the strokes this year, and the adoption of light steel pistons in the place of those of cast iron enables the piston speed to be correspondingly increased. Many of the next season's engines will have their valves, stems, springs and tappets boxed in, which is a good feature, as it serves both to quieten the working of the engine and to exclude dust. Forced lubrication by means of geared pumps is very general, the oil being sent through the crank shaft to the big ends and sometimes to the gudgeon pins. For ignition purposes the accumulator has fallen further into the rear, and the magneto is now considered quite a necessary feature of a modern car. The dual system embracing both the above is in all cases worthy of adoption. In clutch design there is no material change to record, but the pitch chain is falling further into the background for transmission purposes. With regard to the suspension of the chassis, the most popular system of springs seems to be the semi-elliptic on the front axle and three-quarter elliptic on the driving axle. In the case of the new Deasy motor car, however, the Lanchester system of rear springing has been adopted in conjunction with a three-quarter elliptical spring on the front axle.

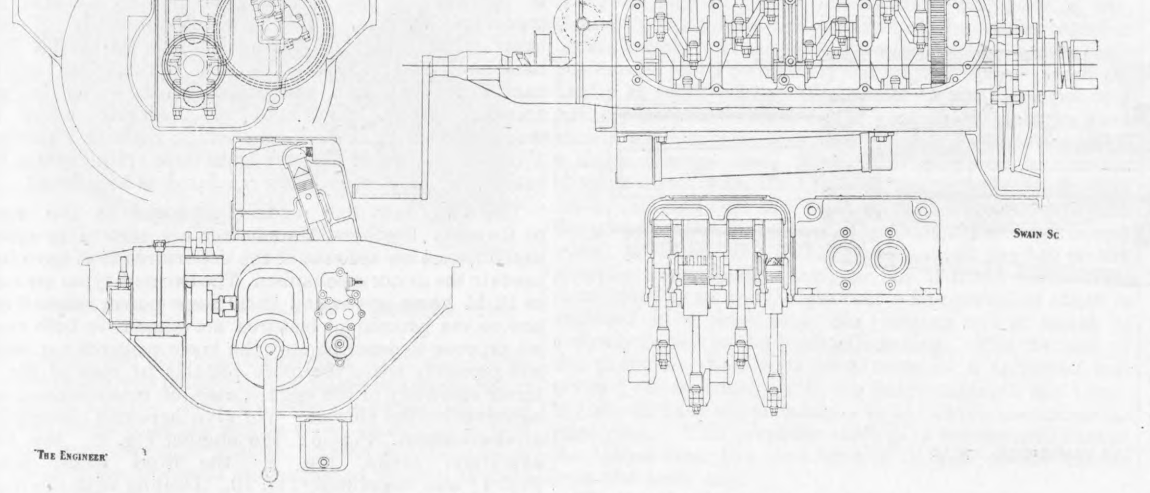

Fig. 1—HEWITT'S PISTON VALVE PETROL ENGINE

The Hewitt piston valve engine illustrated in Fig. 1 will appeal to marine engineers. It has four cylinders, and it works on the four-stroke cycle, having exhaust and inlet piston valves, which reciprocate in water-cooled sleeves, being operated from a half-speed auxiliary crank shaft. The valve liners are open on top to the combustion space, and at about the middle of their length have a ring of ports which lead into a surrounding water-jacketed valve chest. These ports are uncovered by the valve piston at about three-fourths of its upward travel, and are opened and closed in exact proportions to the suction and scavenging action of the main piston. It will be understood that the inlet ports are never exposed to the heat of combustion. The exhaust ports are water-cooled ingeniously in order to prevent heating and burning of the edges. A feature to which the makers attach much importance is the arrangement of the valve piston rings, which are concealed during the time of highest compression and firing. At the time of firing the exhaust piston valve shown in section in the figure is already travelling outwards, and continues to do so at its maximum speed during the whole of the working stroke, so helping the expansion of the spent gases, and producing quietness of operation. The valve crank shaft is driven by means of spur gearing from the main crank shaft, and it is claimed that the exhaust valves receive impulse from the gases, and thus help to drive the engine. The valves travel at about one-third of the speed of the main piston.

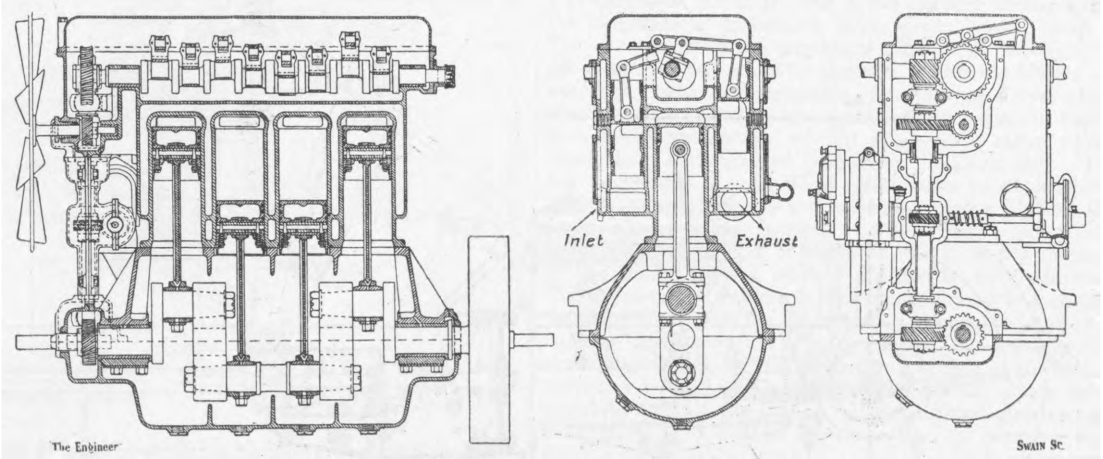

Fig. 2—BINGHAM'S PISTON VALVE ENGINE

The cylinders are solid-headed, with no caps or water joints, and the valve liners are fitted with ground coned joints. The inlet branch is incorporated in the casting, and the carburetter fits on the opposite side to the exhaust outlets. The crank case is constructed with a large side inspection door, which enables the main and valve pistons, with their connecting-rods, to be removed. A system of forced lubrication is provided. The engine is made by Davy Engineering, Limited, Hulme, Manchester, under licence from Hewitt Engines, Limited.

Another piston valve engine is shown by the firm of G. H. Bentall and Co., Limited, Heybridge, Maldon. This engine is built on C. Bingham's patent, and forms quite a new departure, as will be seen from Fig. 2. The distinctive features of this engine are the methods of operating the piston valves by a rotating shaft and rocking levers on top of the engine casing, and the slow speed of reciprocation of the valve pistons. The valve shaft only makes one fourth of the number of revolutions of the crank shaft. The inventor claims that the combination of this slow valvular movement with piston valves and the absence of spur gearing, give to this engine extreme quietness of running, with the minimum of wear and absence of vibration. The whole of the valve-operating mechanism is accessible and runs in a bath of oil, which is maintained at a constant level and runs over into the valve chambers to lubricate the pistons. Another noteworthy, though not entirely new feature of the motor, is the skew gear-driven vertical shaft shown, which drives the magneto, pump, fan, excentric valve shaft and make-and-break mechanism for accumulator ignition when fitted. It will also be observed that the induction and exhaust ports are part of the cylinder casting.

A third novel design of piston valve engine is shown by the Cooper Steam Digger Company, Limited, King's Lynn. This is a four-cylinder vertical motor working on the two-stroke cycle, and its operations resemble very closely those of a locomotive steam engine. The form of construction necessitates the employment of piston-rods crossheads and guides and piston valves, but there is an absence of separate cylinders for air pumps, pressure in the crank chamber, special carburetters, &c. The crank side of each piston and cylinder is employed to provide a charge of mixture for the upper side of the piston at each revolution, and thus, as there is an actual impulse at every revolution, the thrust is always in one direction, while the employment of four cylinders gives a nearly constant torque on the crank shaft. The broad principle on which the Cooper engine operates is as follows:—On the "up" stroke of the piston B—Fig. 3—carburetted mixture is drawn direct from the carburetter into a chamber formed by the under side of the piston B. On the explosion taking place the piston is forced down and drives the mixture from this chamber into a smaller compression chamber G surrounding the valve F, which is in the form of a small piston working in a cylinder. Here the mixture, owing to the difference in area of the two chambers, is compressed to a pressure of 6–7 lb. per square inch. At the proper moment when the exploded charge is escaping through the exhaust port the inlet valve piston E descends, and allows the mixture under pressure to enter the combustion chamber through a series of ports or grids in the walls of the inlet valve cylinder. On its return stroke the inlet piston closes these ports, and the main piston rising at the same time, the mixture in the combustion chamber is compressed and fired, thus completing the cycle. In order to prevent the mixture drawn from the carburetter into the reservoir chamber under the piston from being forced back by the downward travel of the piston into the carburetter again, and to allow it to reach the compression chamber, the connecting passage between the three points, carburetter, compression chamber and reservoir, is formed by a small cylinder in which a piston driven from the valve crank shaft forms what is practically a "two-way cock," opening a passage first between the carburetter and the reservoir and then between the reservoir and the compression chamber.

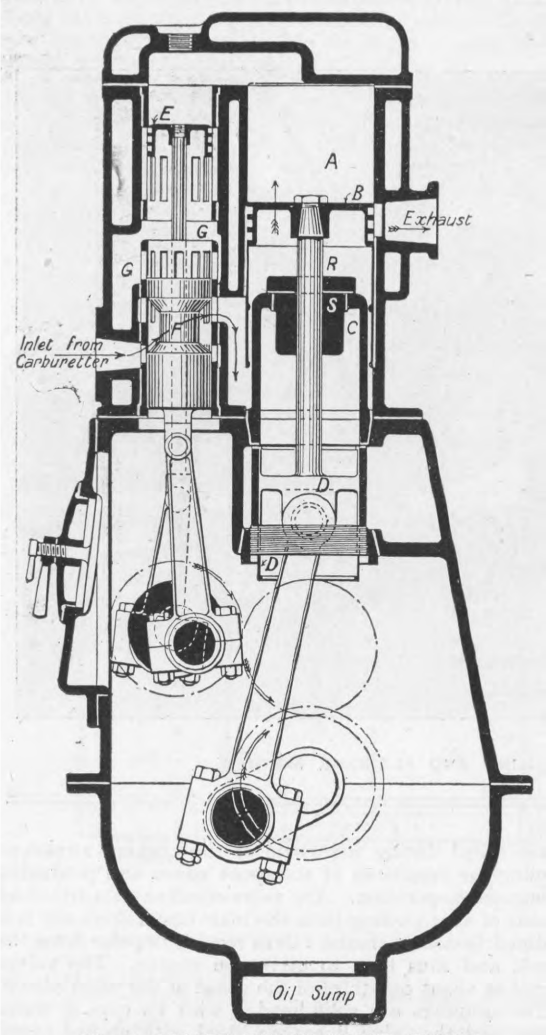

Fig. 3—COOPER PISTON VALVE ENGINE

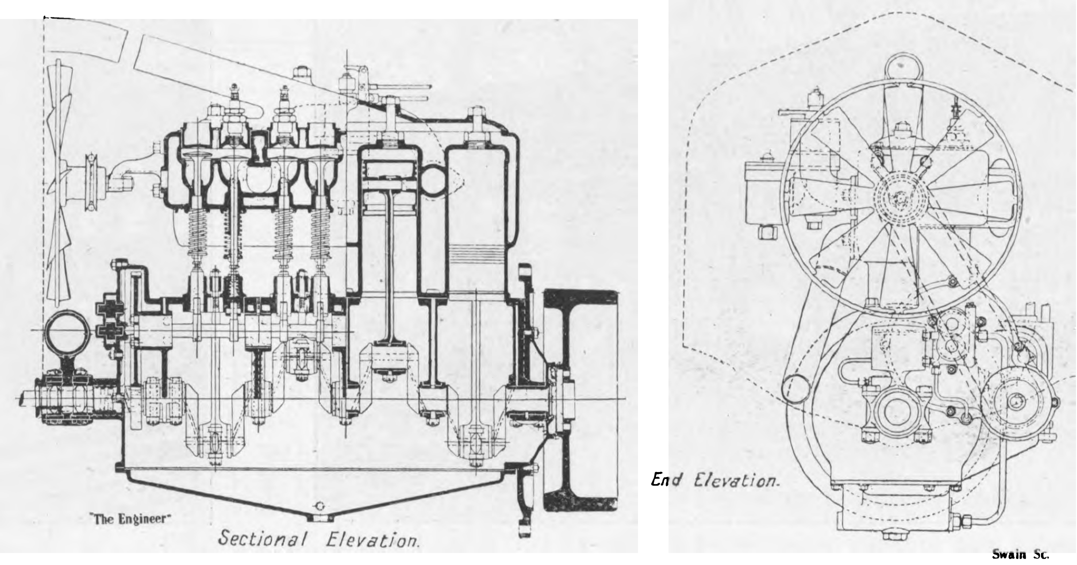

Fig 6—CROSSLEY ENGINE

In the sectional illustration of the Cooper engine—Fig. 3—the piston B is shown on the upward stroke, compressing the charge which has been delivered into the cylinder A, and at the same time drawing in on the underside a new charge of mixture from the carburetter through the passage round the mixture valve F, the passage to the compression chamber being closed. The engine shown is rated at 22 horse-power. It has four cylinders 3¾in. bore by 4½in. stroke. It gives 10 horse-power at 400 revolutions, 20 horse-power at 750 revolutions, 30 horse-power at 1150 revolutions, and 35 horse-power at 1400 revolutions.

The Cooper car shown at Olympia has two other features worthy of special mention. One is the provision of two distinct series of gear ratios, and the other is a system of springs which is adjustable according to the weight carried. With regard to the former the desired object is attained by providing the main bevel wheel on the live axle with two rings of gears, which can be actuated by two pinions of different sizes, and either of which can be put in connection with the propeller shaft by a hand lever. This does not, of course, replace the ordinary change speed gear-box, but is in addition thereto. The arrangement is seen in Fig. 4. The propeller shaft A carries a sliding clutch, which is actuated by the hand lever. On the end of the shaft to which the clutch D is secured is a bevel pinion C with eleven teeth, E is a bevel pinion with fourteen teeth solid, with the extension sleeve and clutch F, the shaft of C being free to revolve in the sleeve of E. When the clutch B on the propeller is in engagement with the clutch D and pinion C the lower gear ratio is in use, whereas if B is in engagement with F the higher gear is in operation. The springing is effected by side and transverse springs, which act independently of each other. The transverse spring is made adjustable by a hand nut and screw. The side springs are of the cantilever type, and are proportioned so as to give smooth motion with light or moderate loads, the transverse spring in such case taking little or no weight. With an increase of load the transverse spring comes into action, the proportion being regulated as mentioned.

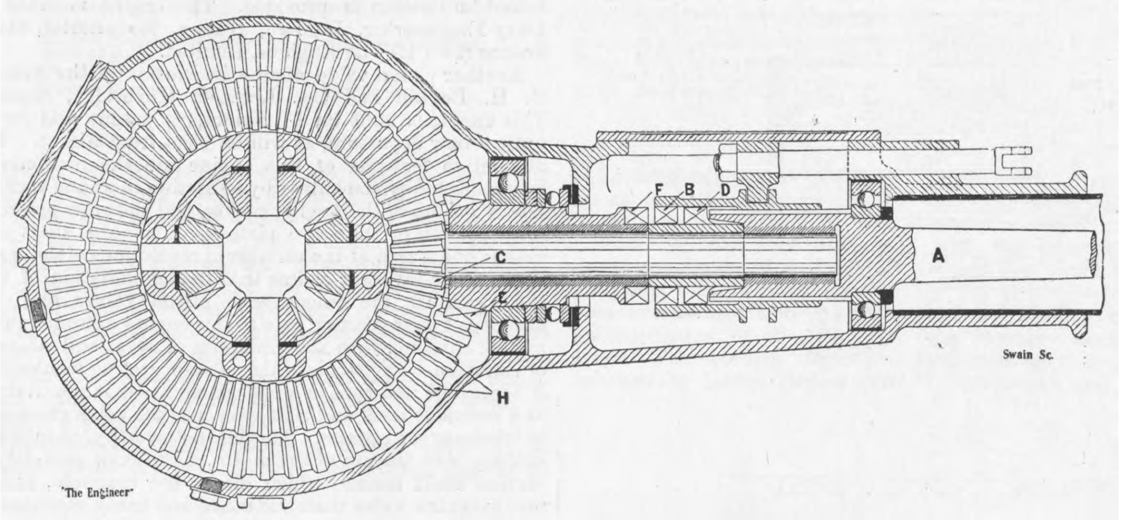

Fig. 4—COOPER DOUBLE TRANSMISSION GEAR

The two new car models produced at the works of Crossley Brothers, Manchester, are certain to attract much notice on account of the departures that have been made in the motor mechanism. The two new types are rated at 12 14 horse-power and 18-20 horse-power respectively, and as the prominent features are similar in both cases, we propose to describe only the lower powered car, which will probably prove the more popular in view of the extreme elasticity of the engine, ease of management, and lightness of the chassis. We give herewith illustrations of the chassis, Fig. 5; the engine, Fig. 6; the back axle and brake, Fig. 8; the front wheel brake, Fig. 9; and the clutch, Fig. 10. Dealing with the frame first, it will be seen that this is of pressed steel of amply strong sections, inswept at the front and upswept at the back. Tubular cross members are provided to carry the

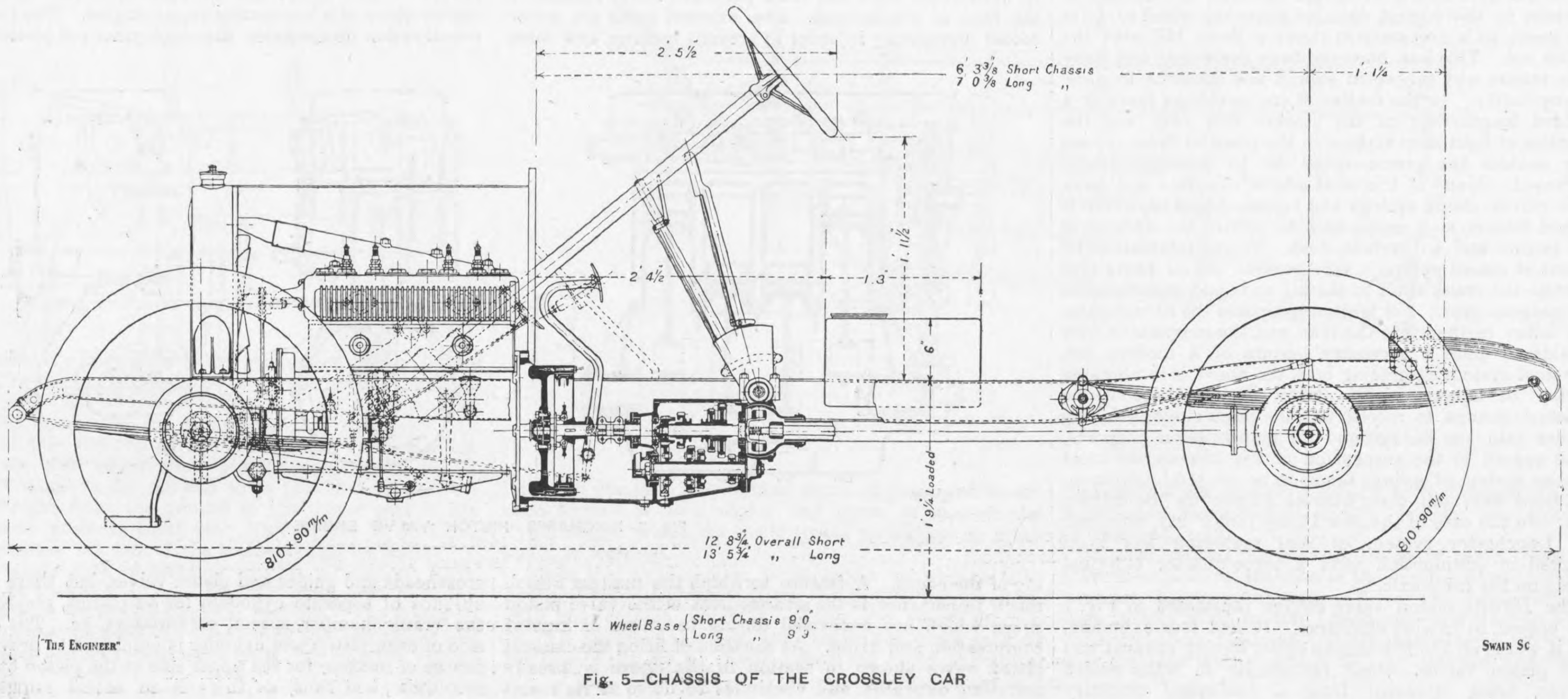

Fig. 5—CHASSIS OF THE CROSSLEY CAR

engine and gear box on the three-point suspension system. That is to say, the unit comprising the engine, fly-wheel, cradle pit, and gear box is carried on a single trunnion at the front and on a double suspension bracket at the back, being trussed by two short steel rods to the side members of the chassis. The long springs are semi-elliptical in front and three-quarter elliptical at the back, all the shackle bolts being lubricated by grease cups. The whole of the frame is made to jigs. The remarkably large insweep at the front enables a very wide steering lock to be provided. In fact, the car can be turned in a 25ft. circle.

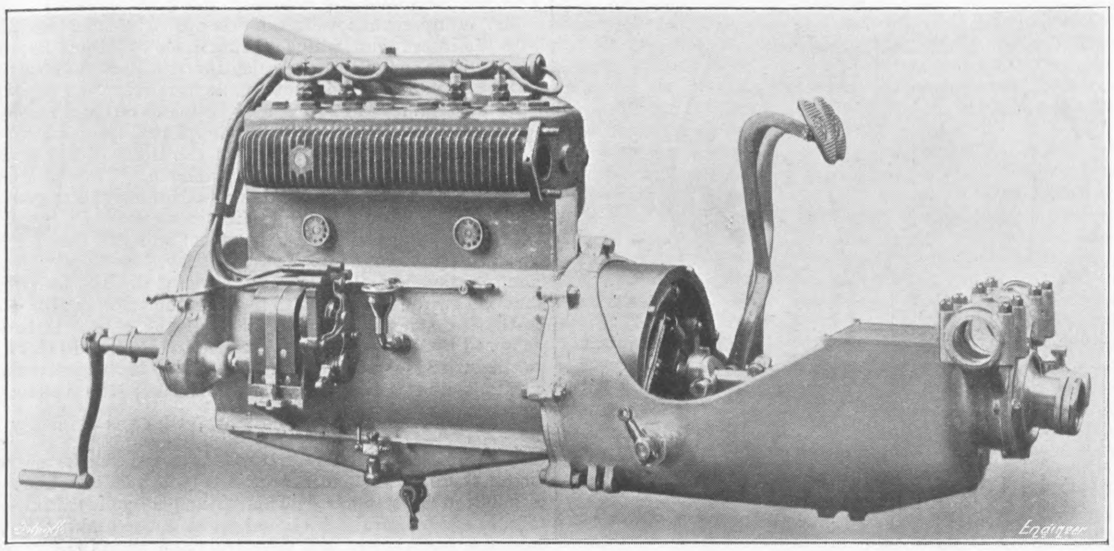

Fig. 7—ENGINE AND GEAR BOX OF CROSSLEY CAR

The engine is a praiseworthy example of clever design and high-class workmanship. The cylinders are cast *en bloc*, and have a bore of 3⅛in. and stroke of 4¾in. Ample water space has been allowed, and the cooling is on the thermo-syphon system. In order to reduce the weight of the reciprocating parts to a minimum the pistons are of pressed steel and the connecting-rods light stampings. These are beautifully balanced, each piston and rod together weighing only 41 oz. Here we have one of the secrets of the silent running of the engine at all speeds up to well over 2000 revolutions per minute. These speeds coupled with the long stroke enable the engine to develop at least 25 horse-power on the R.A.C. formula. The pistons are long, with three rings above the gudgeon pin and one below. The crank shaft is of a very high grade steel and has five bearings. The main bearings are supported independently of the bottom half of the crank casing, which is removable, and so designed that the shaft, complete with connecting-rods and pistons, can be removed without disturbing the cylinders. The removable bottom cover forms an oil sump for the lubricating oil, which is circulated under pressure to the bearings by means of a rotary pump cunningly placed in an accessible position in front of the crank case. The timing wheels are lubricated by a jet of oil which is caused to impinge at the actual point of contact of the teeth. The pressure of the lubricating system can be read at all times on a dial fixed to the dashboard. The valves are of large size. They are all on one side, and are enclosed by an air-tight aluminium plate easily attached and detached. The employment of a high grade aluminium alloy, it may be mentioned, forms one of the conspicuous features of the engine and mechanism. The valve tappets are of unusual design, each tappet containing a dashpot containing oil, and a spring to obviate noise. In the matter of ignition there is little room for failure. The cars are fitted with Bosch high-tension magneto ignition, and the Bosch dual system of accumulator ignition for starting.

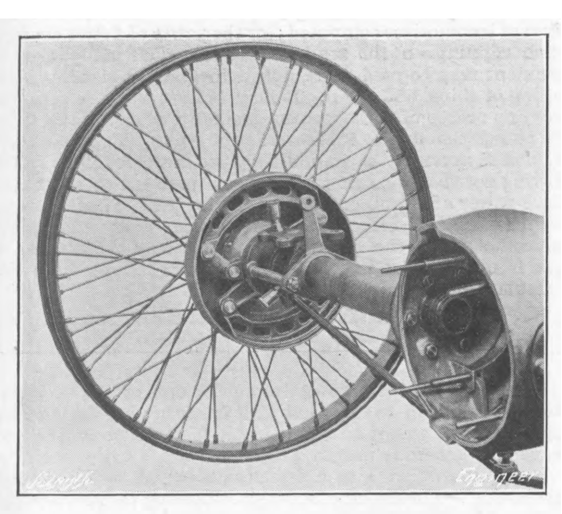

Fig. 8—BACK AXLE AND BRAKE OF CROSSLEY CAR

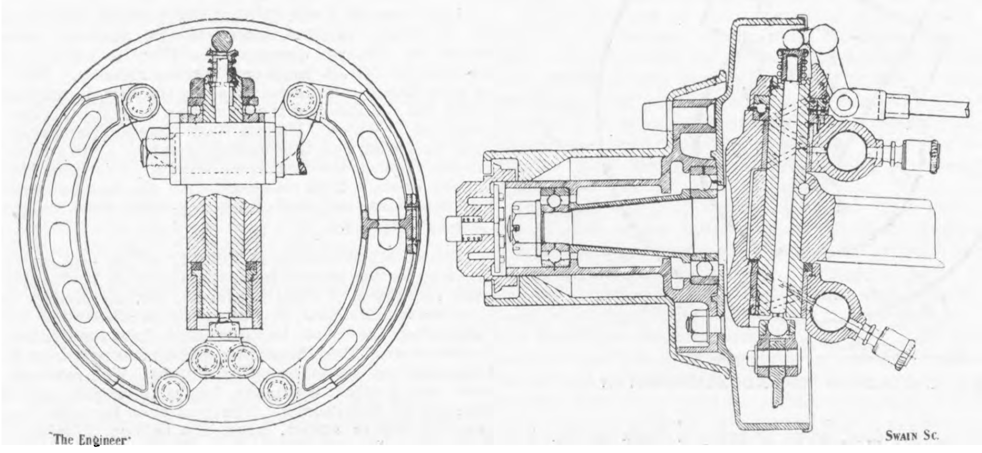

Fig. 10—CROSSLEY'S FRONT WHEEL BRAKE

The carburetter is carried directly on the induction pipe, and is of the variable jet pattern. It is simple in construction, easy to inspect, and gives a correct proportion of air and gas at varying speeds of the engine. The throttle valve is embodied in the carburetter. The clutch shown in Fig. 9 is of the internal expanding metal-to-metal shoe type. It is light, runs on ball bearings, and can be adjusted for wear in a simple manner. Another advantage is that it can be dismounted without dismantling the engine or gear box.

The gear box has been reduced to the smallest limits, and is of aluminium, combined with a cradle pit, in which the light fly-wheel runs. The cradle pit and gear box casting are in one, and this casting registers with, and is securely bolted to, the engine crank case casting, consequently the engine and gear box can be erected together on the bench. At the same time the engine and the gear-box can be lifted completely out of the chassis independently of each other. The shafts in the gear box run entirely on ball bearings, and provide for four forward speeds and a reverse operated through a pivoted gate by a single-change speed lever. The drive on the fourth speed is direct from the engine to the propeller shaft. The drive from the gear box is through a universal joint to the propeller shaft, and thence through a bevel and crown wheel to differential and live axle. At the top of the propeller shaft, behind the gear box, is fitted a universal joint running in an oil-tight box. The propeller shaft is enclosed in a steel tube, the bottom end of which is securely bolted to the back axle casing. The top end of the propeller shaft tube terminates in a spherical ball pivoted concentrically with the universal joint, and forming the oil bath above referred to in which the universal joint runs. This propeller shaft tube consequently takes the thrust from the road wheels as well as the torque from the back axle.

The back axle is arranged so that the whole of the differential and propeller shaft can be removed without disturbing the axle. The two side shafts are splayed and enclosed in taper steel tubes bolted to the central casing. The differential is of the bevel type, and the whole of the gears in the back axle run in oil, ball bearings being used throughout. Another unusual feature of the Crossley cars is the absence of brakes on the transmission system. They have instead brakes on the front wheels, designed and made under Allen-Liversidge licence, on the Renouf system, operated by a foot pedal, and brakes on the back wheels worked by hand by means of a side lever. These are shown in Figs. 8 and 10. On the front wheels a brake drum is mounted on the hub. The steering pivot is made hollow, and within it is a plunger, held in position by a spiral spring. Upon this cap the end of a bell-crank lever presses, being actuated by the brake pedal through rods. The depression of the plunger by the bell-crank lever takes effect upon the brake shoes by expanding toggles, with the result that the brake shoes are thrust outwards against the inner periphery of the brake drum upon the pivots. The brake shoes are of pressed steel with cast iron liners. The rear wheel brakes are also of the internal expanding type, the opposite ends of the shoes being each pivoted to an arm on the spring bracket. A rocking collar on the axle casing has two projecting arms—Fig. 8—connected by links to the free ends of the shoes. The collar is caused to move round the tube by the side lever and suitable connections.

The high quality of the materials employed throughout has enabled the designer to reduce the weight of the parts to a minimum, and the makers are to be congratulated on the production of a car which bids fair to achieve a reputation equal to that of the Crossley gas engines. The Crossley firm is also showing the Cowey system of suspension, in which pneumatic buffers take the place of springs. There are four air cylinders in which are pistons, and the latter are connected to the axles by pivoted rods; and by an ingenious arrangement the pistons are made to adapt themselves to the vertical movements of the axles.

Other unorthodox types of engine which have already been dealt with in these pages, namely, the valveless engine designed by Mr. Lucas, the Dolphin two-stroke engine, illustrated in connection with our show article last year, and the Daimler Company's sliding sleeve engine, seem to have given general satisfaction to their producers. In the valveless engine, which is now built by David Brown and Sons, of Huddersfield for the Valveless Car Company, Hanover-square, W., it has only been found desirable to modify the arrangement of the ports. In the Dolphin engine the single notable alteration is the addition of a water jacket to the pocket at the top of the combustion chamber. while we understand that the system of lubrication of the Knight-Daimler engine has undergone some slight modification. The Daimler Company has also adopted a new system of spring suspension, in which two spiral springs of different strengths are interposed between the rear end of the back semi-elliptical springs and the dumb irons—an arrangement which is said to give easy riding over rough roads.

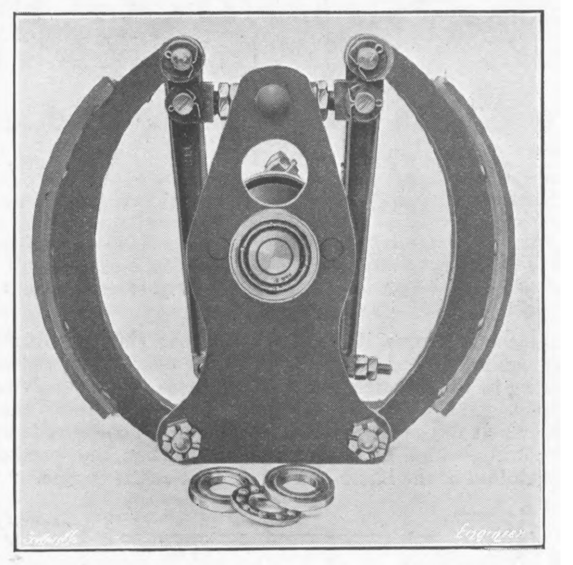

Fig. 9—CROSSLEY'S CLUTCH

A hydraulic system of transmission for motor cars is shown by the Motor Mercantile Association, Duke-street, Grosvenor-square, London. The hydraulic apparatus is shown diagrammatically in Fig. 11. Keyed on the projection B^1 of the engine shaft B is a box made in three parts numbered 1, 2, and 3. This box carries the four pairs of blades or impellers A, which can revolve in the bosses E of the carrier. The lower end of each blade is provided with a plate G in which is cut a radial slot. In the latter a pin engages, which is fixed in the endwise sliding box 4, the longitudinal movement being given by the shaft 5. The shaft receives the necessary movement through the pin 6 and the outer sliding sleeve 7. Now the blades are nominally held in the position of maximum drive, which obtains when the angle formed by any two adjacent blades is in the neighbourhood of 180 deg.—or in other words, when their surfaces are practically in alignment. The full movement of each blade corresponds to an angle of 90 deg., after which the two adjacent blades assume the more or less parallel position. In this position practically no liquid in the casing is displaced, owing to the thinness of the blades, and a neutral position is thus provided. The speed of the vehicle is thus controlled up to a certain point by the hydraulic apparatus. When the engine is running the blades impinge upon the liquid with which the drum is full, and the momentum of this liquid is then absorbed by the drum, the pressure on the drum being equal to that on the blades. For the direct drive a cast iron rim 8 is bolted to the drum, and is provided with three grooves at its internal periphery. Two shoes resting on a carrier 9 attached to the projection of the engine shaft can expand and contract by means of two right and left-hand screws symmetrically placed in relation to the axis of the drum. Fixed on each screw spindle is a short lever 10, which, by means of the adjustable rod 2 and sleeve 7, operates the shoes. The movement of the sleeve 7 is controlled by the pedal, the force exerted by the spring tending to bring the blades in line with the longitudinal axis of the vehicle and to lock the device just mentioned. A downward movement of the pedal first releases the lock, then the blades are moved to suitable angles, indicated on the segment 14. It should be mentioned that the drum C, which replaces the usual gear box, is provided with radial ribs, in order more readily to absorb the whole of the kinetic energy stored up in the liquid. To obtain a reverse motion an epicyclic gear is placed behind the hydraulic drum. The introducers of this system claim that, besides obtaining an appreciable increase in torque, it adds greatly to the elasticity of the transmission, and that the fly-wheel effect is increased owing to the kinetic energy of the mass of the revolving liquid. The efficiency of the transmission requires that the whole of the momentum of the liquid be absorbed by the drum, which can only be obtained when the speed of revolution of the latter is one-half that of the engine.

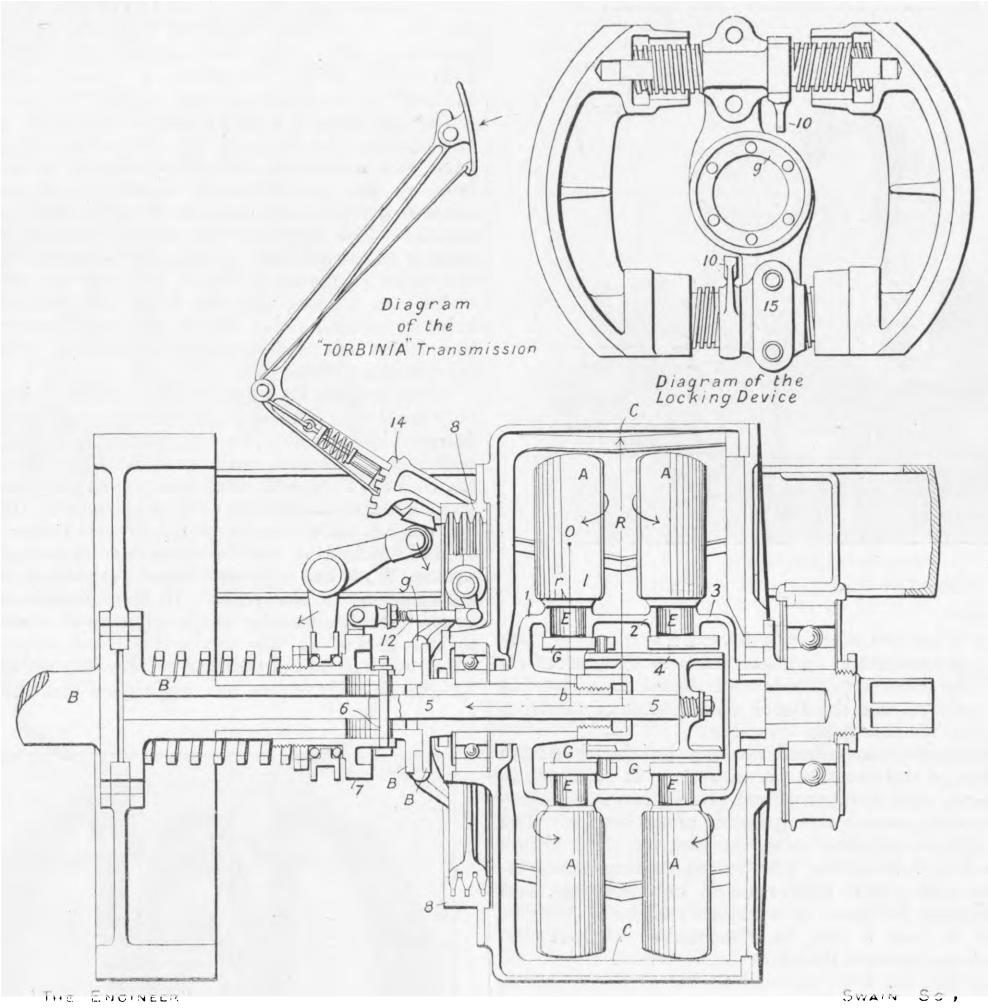
Diagram of the "TORBINIA" Transmission
Diagram of the Locking Device
10
g'
10
15
14
8
C
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A
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4
7
B
B
G
G
A
A
8
C
THE ENGINEER
SWAIN SC.

Fig. 11—HYDRAULIC TRANSMISSION GEAR

A NEW ACCELEROMETER.

THE invention of an accelerometer has occupied the minds of many ingenious people, but, apart from those who have really studied the question, it is doubtful if many either understand the nature of the problem or the value of an instrument when it is made. Let us then, by way of introduction to a description of the latest instrument, consider very briefly both points.

All accelerometers depend upon the fact that the inertia of a body causes it to resist change of velocity. A pendulum, for example, hung in a railway train in the plane of motion will, if guarded from external disturbances, hang vertically as long as the train is at rest or is moving at a constant velocity. If, however, the velocity increases, the pendulum bob will lag behind until a new steady velocity is reached, and if the speed decreases the pendulum will advance until new conditions of stability are attained. The pendulum is the simplest type of accelerometer, and in various modified forms or equivalents is the basis of all instruments of the kind. In a simple shape, however, the pendulum is not a practicable instrument, and when it is brought down to a useful form it develops new sources of error. Principal amongst these is the fact that, though it is desired to make observation with regard to movement in one direction only, incidental movement in other directions—say the rolling of a coach or ship, for example—affects the reading. Suppose, for example, that the instrument takes the form of an unbalanced metal disc supported on a vertical spindle and restrained by a hair spring. A pointer attached to such a disc would indicate acceleration quite truly as long as the spindles were perfectly vertical, but any inclination of the spindle would introduce a new couple acting on the disc and tending to rotate it. Thus the readings would be false save under exceptionally perfect conditions. In the accelerometer invented by Mr. H. E. Wimperis this difficulty is got over in a very ingenious and simple way, with the result that the instrument is not disturbed by such movements. A general view of this accelerometer, which measures 4in. across the face, is given in Fig. 1, whilst Fig. 2 shows the essential parts in diagrammatical form. Here C is the outer brass case; L are the legs on which the instrument stands, one of them being a levelling leg; D is a copper disc pivoted on a vertical axis and capable of rotation; M is a magnet for "damping" magnetically the motion of the disc; H is a small hole in the copper disc—the presence of which has the effect of throwing the centre of gravity of the disc slightly out of the axis; G are two gear wheels of equal diameter, one being fastened to the axis bearing the disc, and the other on a separate axis, and carrying the long pointer N. A coil spring—not shown in the diagram, but resembling the mainspring of a watch—is also fitted to the disc, so as to bring it back to the zero when deflected.

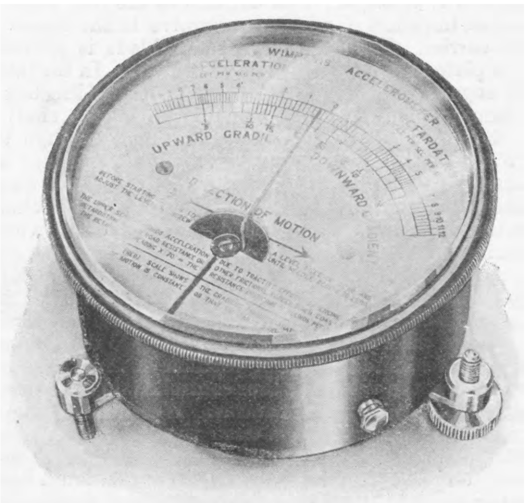


Fig. 1—WIMPERIS' ACCELEROMETER

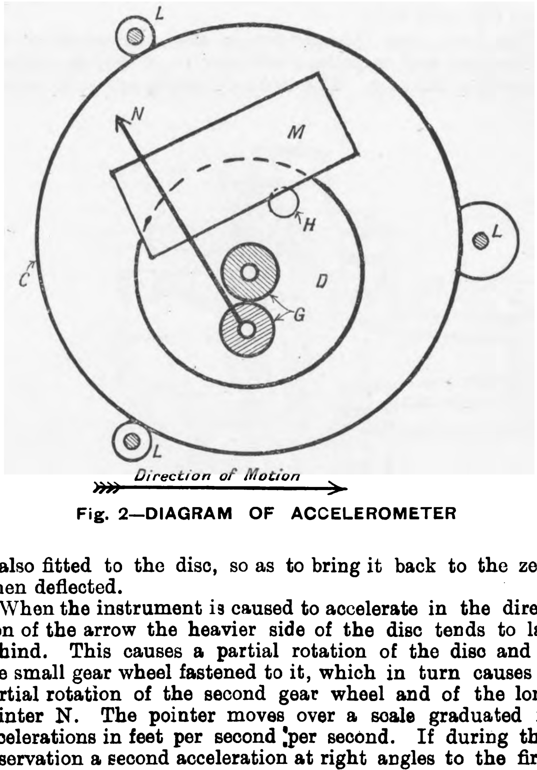


Fig. 2—DIAGRAM OF ACCELEROMETER

When the instrument is caused to accelerate in the direction of the arrow the heavier side of the disc tends to lag behind. This causes a partial rotation of the disc and of the small gear wheel fastened to it, which in turn causes a partial rotation of the second gear wheel and of the long pointer N. The pointer moves over a scale graduated in accelerations in feet per second per second. If during this observation a second acceleration at right angles to the first were introduced—also in the plane of the paper—an effect which would be caused by the vehicle swinging round a corner, or getting on to a track that sloped sideways—like the camber of a road—then a force would be introduced which would, as we have said, tend still further to rotate the disc, and so render its reading a false one. This ill effect is neutralised by the action of the second gear wheel and needle, which are so proportioned as to form a dynamic balance with the copper disc; that is to say, the product of mass by distance between the centre of gravity and the axis is in each case the same. The readings are, therefore, absolutely correct, even when the vehicle or ship is affected by gradients or accelerations at right angles to the direction of motion. This fact, that the instrument records accelerations in one only of the three directions in space, is one that distinguishes it from the other attempts that have been made in the past to deal with this problem.

Mr. Wimperis has written a descriptive circular to send out with the instrument, which is being made by Elliott Brothers, and as it is practically a scientific explanation of certain features we do not hesitate to quote from it. "An important feature of the instrument is that it singles out and reads the acceleration produced by the driving force operating on the vehicle. It is thus independent of the effect of any gravitational forces which may affect the vehicle. Thus, if a tramcar is fitted with electric motors powerful enough to give the car when on a level track a starting acceleration of, say, 2.2ft. per second per second, the instrument will still read 2.2 even if the start be made up a slope of, say, 1 in 30 or down it. The instrument will still read 2.2 even if the hill be so steep that the current is unable to increase the velocity of the car. In that case the accelerative effect of the engine is exactly balanced by the opposite retardation due to the hill slope and as the latter is equal to $g. \sin \phi$ (where g is the gravitational constant and ϕ the angle of the slope), the instrument reading is a measure of the slope, which is evidently $\frac{2.2}{32}$ or 1 in 15. The dial is graduated in red figures so as to enable these gradient measurements to be made without any calculation whatsoever. This principle applies also to the retardation due to the frictional forces of the brakes; in each case the instrument acts selectively and shows the negative acceleration due to those forces alone, and does not also add or subtract whatever gravitational forces may be induced by the measurements being made up or down hill."

It will be seen, then, that this accelerometer is really a practical convenient instrument that can be used without any extraordinary precautions. Of the various uses to which it may be put we shall mention a few. The most obvious, of course, are the acceleration and retardation of trains, trams, boats, &c. These are obtained by direct reading. Then we may find the retardation due to frictional resistance of a train or other vehicle when coasting, and we can tell from the result whether the vehicle is in good condition. The instrument may be used on motor cars for this purpose. Or, again, the efficiency of brakes may be measured and the tractive effort of locomotives computed; or the power of petrol engines when running on the road may be taken. Finally, the instrument may be used to read the inclination of a hill, the rolling of ships, and so on. It may be interesting to consider how one or two of these measurements are made. Take, first, the retardation due to friction when coasting. To obtain this, all that is necessary is to multiply the scale reading by 70. Having got that we can make a measurement of the brake horse-power of petrol engines of motor cars when running on the road. Since we know the road resistances overcome up to the clutch, and the speed of the car can be read from the speed indicator, the B.H.P. follows from the formula:—

$$\text{B.H.P.} = \frac{\text{Road resistance in pounds per ton} \times \text{weight of car in tons} \times \text{M.P.H.}}{375}$$

We have not space to go into other uses of the accelerometer, but it will be seen that Mr. Wimperis has designed an ingenious instrument in a practicable form which is likely to prove very generally useful.

In conclusion, we give a few results which will be found interesting:—On the tube railways of London the acceleration produced by the motors on starting is found to range from a maximum of 1.6 on the City and South London Railway to 2.4 on the Hampstead Tube (in feet per second per second in each case). The braking retardation in these two cases reaches a maximum of 3.5 and 4.5 respectively. Light motor cars on the road start to accelerate at as high a figure as 7.0, or even 8.0; but the acceleration falls very rapidly as the car gets under way. The coasting retardation of motor cars is very commonly 1.0 (at speeds not exceeding 20 m p.h.), corresponding to a retarding resistance due to friction of the road, &c., of 70 lb. per ton.

PURCHASE OF FOUR CUNARDERS BY SHEFFIELD FIRM.—Messrs. T. W. Ward, Limited, Albion Works, Sheffield, have purchased from the Cunard Company the Etruria, which in its day was among the fastest boats crossing the Atlantic. The "record" of 5 days 20 h. 5 mins. established by the Etruria remained unbeaten until the Lucania and the Campania were built. The Etruria is a vessel of 8000 tons. Messrs. Ward have also purchased the Aleppo, the Saragossa, and the Cherbourg, which up to a recent date were in the Cunard Mediterranean service. The three last vessels are, approximately, 2000 tons each. All the four Cunarders—Etruria, Aleppo, Saragossa, and Cherbourg—have been bought for breaking-up purposes.

ROYAL METEOROLOGICAL SOCIETY.—The first meeting of this Society for the present session was held on Wednesday evening at the Institution of Civil Engineers, Mr. H. Mellish, president, in the chair. Mr. C. J. P. Cave gave an account of his methods of observing the pilot balloons used for investigating the upper atmosphere. Two theodolites and a measured base line are used, and observations taken every minute. The readings are worked out and plotted when the height, direction, and speed of the balloon are determined. The best time for observing balloons is shortly before sunset, when the balloon, illuminated by direct sunlight, will shine like a star. Mr. Cave has seen a balloon burst at a distance of forty miles under these conditions. The rate of ascent of balloons is found to vary considerably near the ground, but higher up it remains fairly uniform. Mr. W. Marriott read a paper on "Registering Balloon Ascents at Gloucester, June 23rd and 24th, 1909." The records obtained showed that the temperature decreased uniformly up to five and six miles; above this it increased, and then kept nearly stationary up to about twelve miles. A paper on "Winter Temperatures on Mountain Heights," by Mr. W. P. Brown, was read. The author dealt with the readings of a minimum thermometer which he placed in 1867 on the summit of a mountain near Snowdon, 3262ft. above sea-level. Mr. E. Gold read a paper on "The Semi-diurnal Variation of Rainfall," in which he suggested that the upward motion of the semi-diurnal variation of pressure is the probable cause of the semi-diurnal variation of rainfall.

THE EXHAUST STEAM TURBINE.

ON Saturday last an interesting paper on "The Exhaust Steam Turbine" was read before the Manchester Association of Engineers by Mr. J. N. Bailey. The author said that there was no special feature about an exhaust turbine, with the exception that instead of having to provide blades to deal with the expansion of the steam from boiler pressure down to that of the condenser, only about half the number were necessary, as the pressure drop was less, and the heat drop only one half. Proceeding to deal with the properties of steam, the author referred to the Mollier diagram, in which B.Th.U.'s in a pound of steam are plotted against entropy. By means of this diagram it was possible, he explained, to obtain at a glance the chief properties of steam at any pressure without having to calculate them from steam tables, and since the specific heats of superheated steam had now been determined and added to the diagram, its usefulness had made it almost indispensable to the steam engine and turbine designer. The author placed before his audience the diagram, Fig. 1, and accompanying table, showing the relation between the steam consumption of engines, percentage decrease in steam consumption with a turbine, and the efficiency of the combined plant :—

Table from which Curves in Fig. 1 *are derived.*

1000 I.H.P. triple-expansion engine and exhaust turbine.
Pressure range from 175 lb. to 15 lb. for engine from 15 lb. to 1 lb. for turbine (absolute).

A	B	C	D	E	F	H	J	K	L	M
13	67·0	80·0	17·8	10·0	1721	10·35	20·0	75·0	721	72·1
14	62·3	75·3	18·8	9·0	1770	10·64	24·0	73·7	770	77·0
15	58·2	71·2	20·0	8·4	1822	11·0	25·6	71·4	822	82·2
16	54·6	67·6	21·0	7·5	1874	11·2	30·0	70·0	874	87·4
17	51·4	64·4	22·1	7·0	1923	11·5	32·3	68·3	923	92·3
18	48·5	61·5	23·1	6·5	1971	11·73	34·7	66·8	971	97·1
19	46·0	59·0	25·0	6·1	2055	12·18	36·0	64·5	1055	105·5
20	43·7	56·7	25·0	5·7	2100	12·4	38·0	63·3	1100	110·0

A—Steam consumption of engine per I.H.P.
B—Efficiency of engine, condensing.
C—Efficiency of engine, non-condensing (assumed).
D—Steam consumption, non-condensing.
E—Per cent. moisture.
F—Total I.H.P. output of engine and turbine.
H—Steam consumption of engine and turbine.
J—Per cent. reduction in steam consumption.
K—Efficiency of engine and turbine.
L—Equivalent I.H.P. from turbine $= \frac{\text{K.W.} \times 1.34}{.92 \times .9}$ and $\frac{\text{I.H.P.}}{\text{B.H.P.}} = .9$.
M—Per cent. increase in output due to turbine.

Theoretical steam consumption of engine working condensing, 8.72 lb. per I.H.P. hour; theoretical steam consumption of engine and turbine, 7.85 lb. per I.H.P. hour; theoretical steam consumption of engine working non-condensing 14.2 lb. per I.H.P. hour.

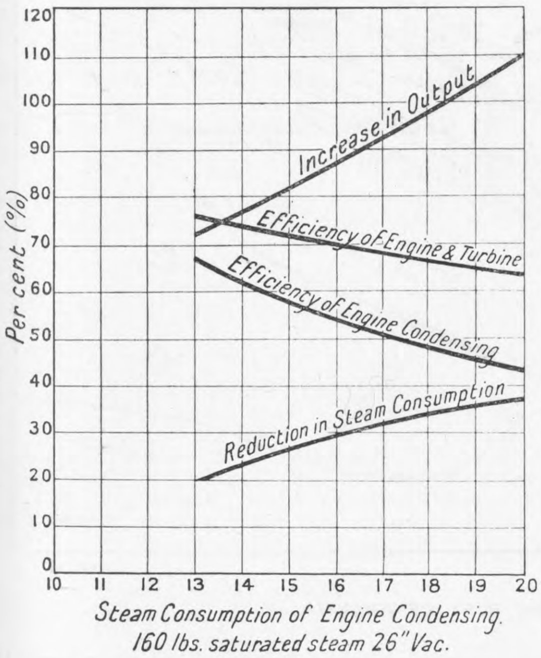


Fig. 1

If the work required from the turbine is less or more than can be obtained from the exhaust steam the case could be met by :—

1. For a smaller amount—(*a*) Using a turbine designed to work on a lower steam-pressure drop ; (*b*) using the same pressure drop, but transmitting back to the engine shaft the surplus energy through a balancing motor.

2. For a larger amount—(*a*) Using a low-pressure turbine and admitting high-pressure steam through a reducing valve ; (*b*) using a mixed-pressure turbine ; (*c*) increasing the back pressure on the engine and increasing the cut-off.

In 1 (*a*) the blading would be suitably designed for the smaller heat drop. This required no further comment.

In 1 (*b*) the arrangement consists of a reciprocating engine, a steam turbo-generator, and a motor which could also be alternatively a generator, depending upon whether electric current was supplied to it, in which case it tended to drive the engine; or, if the engine drove it, then it would deliver current to an external circuit. This generator was coupled up electrically in parallel with the turbo-generator. If the amount of exhaust steam from the engine was more than sufficient to drive the turbine on its external load, the surplus steam would cause the turbo-generator to take the whole external load, and the excess current would be delivered to the motor generator, which would tend to drive the engine at slightly over normal speed. The effect would be the partial closing of the throttle valve by the governor, and less steam would be admitted to the engine. The exhaust would necessarily be less also, and this in turn would prevent the turbo-generator from driving the motor generator to so great an extent, and so a balance was set up which enabled the load of either engine or turbine to vary within limits, and yet enable all the exhaust steam to be efficiently used. This arrangement was, he said, specially adapted to textile mill drives, where the fluctuation of load was comparatively small, the maximum amount being usually the lighting load.

In the case of 2 *a* a low-pressure turbine was frequently adopted, because it was so much simpler than a mixed-pressure turbine, and also because the quantity of live steam to be admitted was comparatively small. A mixed-pressure turbine must of necessity be somewhat less economical than a pure low-pressure turbine, as the high-pressure element must be rotated idly in steam at about atmospheric pressure, while the low pressure steam was sufficient to carry the load. The resulting skin friction losses must be borne by the low-pressure steam at reduced economy.

In 2 (*b*) there was the mixed-pressure turbine, which was merely a non-condensing and pure exhaust turbine combined in one casing. A special arrangement of valves was necessary, as it was essential that the exhaust steam should be used always when available, and when not available the high-pressure steam must be automatically and instantaneously admitted as the low-pressure steam admission valve was simultaneously closed. Immediately the low-pressure supply was again available the reverse operation took place. The mixed-pressure turbine made a particularly flexibile unit, as generally it was capable of carrying :—(1) Any load up to heavy overloads on high-pressure steam; (2) full load on low-pressure steam ; (3) any load up to heavy overloads on mixed high and low-pressure steam. With the exception that this was a slightly more complicated turbine, both as regarded blading and valve gear and that the steam consumption was slightly worse than a pure exhaust turbine, there was little doubt but that it approached very nearly the ideal design for industrial works.

In 2 (*c*) we were, he added, enabled to obtain a greater output while maintaining the high efficiency, by merely increasing the back pressure on the engine and increasing the cut-off so that the engine could still do its load. The increased quantity of steam then available would obviously enable the turbine to carry a greater load than if the back pressure were the same as that of atmosphere or less.

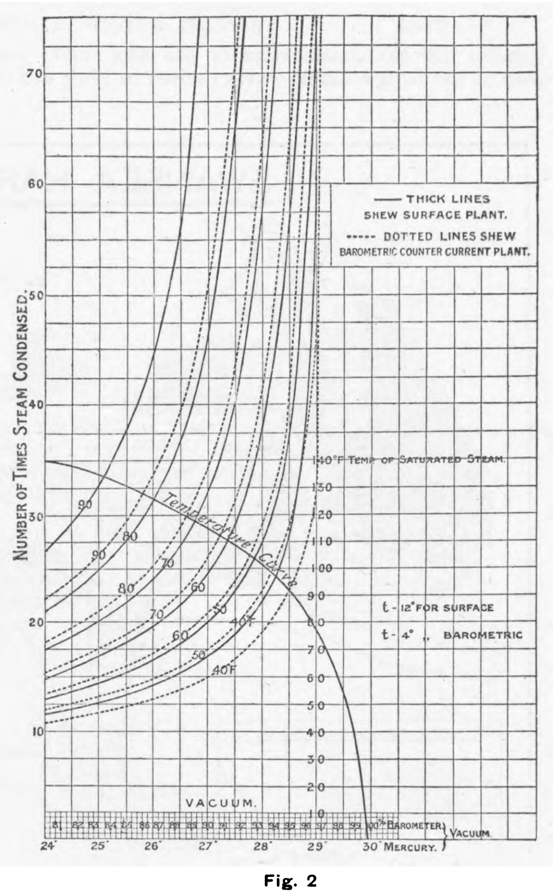


Fig. 2

While the size of the generating unit must be primarily fixed by the demand made upon it, there would be many cases where the size would be insignificant, if indeed practicable, owing to the very intermittent nature of the supply of exhaust steam, were it not for the heat accumulator. This piece of apparatus acted exactly in the nature of a fly-wheel, absorbing steam during the periods when the supply was greater than the demand, and giving up steam when it was less.

In broad terms it might be stated that there were few cases indeed where exhaust steam would be available that it would not pay handsomely to put in exhaust steam plant. There was one condition, however, which should be pointed out in which a retrograde step might easily be taken, *i.e.*, to use exhaust steam in a turbine in preference to a feed-water heater. The author said that he had come across a case where exhaust steam was diverted from a feed heater and passed through an exhaust turbine, and no feed heating took place previous to the water entering the boilers. Apart from the harm done to the boilers in such a case, the major part of the latent heat in the steam which was efficiently used in the feed heater was thrown away into the condenser into which the turbine exhausted. While some 90 per cent. of the heat in the steam could be used in the feed heater, only about 8½ per cent. could be used in the turbine. As it was only possible, however, to use about 12 per cent. of one's exhaust steam for feed-water heating, there was still a large amount available for the turbine. If an economiser was used in addition only about 6 per cent. should be used in the feed heater. This amount would allow the water to enter the economiser without condensation of the moisture in the hot gases taking place on the economiser tubes and their rapid corrosion and clogging of their scrapers.

The author then dealt with the subject of vacuum, and said that a good vacuum was of first consideration in the installation of an exhaust-steam turbo plant, since the pressure range, or, more correctly speaking, the available heat range, was so greatly affected thereby. The vacuum which can be obtained depended upon :—(1) The temperature and quantity of the circulating or injection water; (2) the capacity of the air pump ; (3) the capacity of the condenser ; (4) the type of condenser ; (5) the tightness of the vacuum system ; (6) the closeness of the condenser to the turbine, as the vacuum at the turbine alone counted.

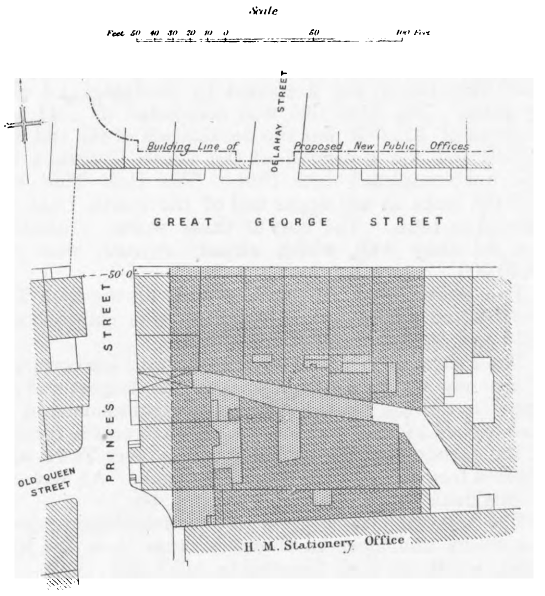
As the temperature of the condensed steam—in a surface condenser—or the temperature of the mixture of injection water and condensed steam—in a jet condenser—must be at least as low as the boiling point of water at the particular vacuum obtained, the temperature of the cooling water played a most important part in the vacuum obtainable. Fig. 2 showed, it was explained, the boiling point, and also the ratio between weights of cooling water and steam condensed at various vacua for both surface and good jet or barometric condensing plants. The curves were drawn on the assumption that the temperature difference between the cooling water outlet and the temperature corresponding to the vacuum was 12 deg. Fah. with a surface plant and a temperature difference of 4 deg. Fah. for the multiple jet or counter-current barometric type. The above figures for temperature difference—viz., 12 deg. for surface and 4 deg. for multiple jet plants—were commercially obtained, but the former figure could be considerably reduced with clean tubes and an air-tight system.

It would be seen, he continued, that, though a high vacuum was most desirable, since it so considerably improved the steam consumption and output of the turbine, there were limitations which were very quickly reached. A condensing plant and vacuum must be chosen which would give maximum economy consistent with outlay on the plant. In aiming at a high vacuum we could easily expend in capital outlay more than could be saved in steam consumption. On the other hand, we could as easily cut down these figures to a point where we did not get a sufficient return from our exhaust steam. Just the right vacuum to adopt required the most careful consideration if we were to get the best results.

The author next described the Leblanc condenser, and concluded his paper by giving the leading particulars of a few typical exhaust steam installations, which included the plant in a flax mill in Belfast ; Samuelson's Ironworks, Middlesbrough ; Canadian and American plants, and the exhaust turbine plant on the Otaki.

THE INSTITUTION OF CIVIL ENGINEERS—NEW BUILDING.

THE Council of the Institution of Civil Engineers have now concluded the arrangements with H.M. Office of Works for the acquisition of the site for the new building on terms which they hope will enable building operations to be proceeded with in the spring of 1910. The freehold area acquired by the Institution, inclusive of No. 6, Great George-street, which was purchased from H.M. Commissioners of Woods and Forests, is shown tinted on the accompanying plan. The Council have invited competitive designs for the new premises from six architects, and hope that matters may be so far advanced as to enable the selection of a design and the appointment of an architect to be made early next year. It is intended to take steps with a view to building operations being begun as soon as possession of the site is obtained ; and it is hoped that the Institution may be established in its new house in 1912.



SITE OF THE NEW CIVIL ENGINEERS' BUILDING

H.M.S. INVINCIBLE.

H.M.S. INVINCIBLE, after many delays due to defects in the electric turret gear, is to be ready for sea in a few weeks, or practically nine months after first commissioning, during which time the main armament has never been fit for service.

This vessel has been the subject of many parliamentary questions, which have been unsatisfactory both from the point of view of the questions (which have been drafted to infer blame attributable to the contractors), and the answers, which have endeavoured to disguise the experimental nature of the electrical turret gear.

Though the difficulties have now been thought to be overcome, it is practically certain that the experiment of electrically-worked turrets is a comparative failure, the increased speed of working as against hydraulic gear which was anticipated not having been realised.

It seems fairly certain that we shall not yet see a system superior to the hydraulic for actuating our heavy guns on board ship.

THE KING'S DOCK, SWANSEA.

No. I.

On Tuesday next, the 23rd inst., the new King's Dock at Swansea will be opened after having been in course of construction for over five years. The ceremony of cutting the first sod in connection with the work was performed by his Majesty the King in July, 1904, since when the works have been carried on at a rapid rate and an area of some 500 acres lying to the east of the old harbour mouth have been completely transformed and converted into a vast system of docks, quays, and railway sidings. Practically the whole of this area has been reclaimed from the foreshore by means of the construction of a sea embankment two miles in length. Before proceeding to describe the new works, it will be of interest briefly to recall the earlier history of the port of Swansea.

Swansea is situated at the mouth of the river Tawe, on the north shore of the Bristol Channel, 38 miles from its entrance. Placed as it is in the bight of a wide bay, it is admirably sheltered from the heaviest winds, the Mumbles promontory affording protection on the westward side. The heaviest seas experienced at Swansea are those from the south-west round to south-east. The roadstead between Swansea and Mumbles is one of the best in the Bristol Channel. The tidal rise at Swansea is 28ft. at springs and 20½ft. at neaps. The recession of the tide at springs leaves bare a wide area of sand flats, and in places the foreshore exposed at low water of springs is over a mile in width. Although the port of Swansea is placed on the banks of the river Tawe, it may for all practical purposes be regarded entirely as an artificial port, the discharge of the river being trifling as compared with the volume of tidal water ebbing and flowing between the pier heads.

The history of the Swansea port works may be said to have commenced about the year 1792, when an Act for improving the harbour was obtained. Previous to that year the port facilities consisted of a few insignificant wharves near the mouth of the Tawe, the entrance to the river being open to the sea.

Under the Act of 1792 piers were constructed at the mouth of the harbour, which were completed in 1800, from the designs of Captain Huddart, F.R.S. These piers continued to form the harbour entrance for nearly seventy years, and a portion of the old West Pier still exists at the root of the present west jetty.

About 1826 and 1827 a small harbour was built on the foreshore on the east side of the river within the piers and in connection with the Tennant Canal. Although Port Tennant, as it was called, has long since disappeared, the Tennant Canal still exists, and a connection between it and the new King's Dock has been constructed at considerable cost and some inconvenience to other work.

Between the years 1826 and 1840 the Swansea Harbour Trustees discussed many schemes for improving and extending the harbour accommodation, but it was not until 1840 that a channel, still known as the New Cut, was formed to provide a diversion of the river Tawe. The old river bed which now forms the North Dock and Half Tide Basin was deepened by dredging and closed by gates. The New Cut was completed in 1844 at an expense of £23,000, but the dockisation of the Old Town Reach and the provision of the South Entrance Lock was not completed until 1851. The Half Tide Basin and the locks at the upper end of the North Dock were opened in 1861. The cost of these works, exclusive of the old quay wall, which already existed, was under £100,000.

The South Dock on the west side of the river Tawe, constructed partly on the foreshore, was commenced in 1851 and opened in 1859.

The Prince of Wales Dock, which, until the completion of the new King's Dock, has been the largest and most important of the Swansea docks, was commenced in 1879 and opened in 1882. It was constructed on the foreshore of the harbour on the east side of the river Tawe, and is entered from the channel through a lock. An extension of this dock was opened to traffic in 1898.

The following table gives the principal dimensions of the docks and locks at Swansea other than the King's Dock, which we shall describe in full detail:—

Name of dock or basin.	Area (acres).	Depth on sill at H.W.O.S.T.	Dimensions of lock.		Width of tidal entrance.	Length of quayage.	Date of opening.
			Length.	Width.			
		ft.	ft.	ft.	ft.	ft.	
North Dock	10	23	160	56	—	5520	1852
Beaufort Dock ...	1	—	—	—	—		
Half-tide Basin (1)...	2½	32	—	—	60		
Half-tide Basin (2)...	1½	—	—	—	—		
South Dock	13	24½	3[illegible]0	60	—	4800	1859
South Dock Basin ...	4½	34	370	60	70		
Prince of Wales Dock	27½	32	500	60	—	7800	1882
Prince of Wales Dock (Tidal Basin) ...	3	35	—	—	—		

It is of interest to recall the fact that Swansea was one of the earliest ports, if not the earliest, to adopt hydraulic power for working dock machinery on any considerable scale. In the year 1853 the late Mr. Abernethy, who was then the Trustees' engineer, was in communication with Sir William Armstrong on the subject, and in 1856 hydraulic power was applied to work the old lock gates and machinery. Hydraulic appliances were afterwards used in connection with all the new dock gates and lock machinery. Hydraulic coaling hoists, made by Sir William Armstrong, as well as hydraulic cranes, were first installed at Swansea about the year 1857.

The staple trade of the port of Swansea is coal, and the continued growth of the tonnage entering the port during the last fifteen years, and the increasing length and beam of ships trading to South Wales, rendered it imperative that some considerable addition to the existing dock accommodation should be provided. The Swansea Harbour Trustees therefore obtained parliamentary powers in 1901 to construct a new dock on the foreshore of the bay to the south-east of the Prince of Wales Dock entrance. The existence of a large and practically undeveloped coalfield—a great portion of which yields anthracite—in the country at the back of Swansea, to which the port is the natural outlet, is a circumstance of immense advantage to the town, and the Harbour Trustees, acting on the advice of their engineers—Mr. P. W. Meik and Mr. A. O. Schenk, MM. Inst. C.E.—decided that the new dock should be sufficiently large to meet all the requirements of the port for many years to come, and should also be designed to accommodate the largest class of vessels that are likely to be built.

The principal trade of the new dock will be coal, and the arrangements of the berths, sidings, and approaches to the quays have been specially designed with this class of traffic in view.

The following tables show the increase in the trade of the port since the year 1862:—

Trade of Port of Swansea, 1862-1908.

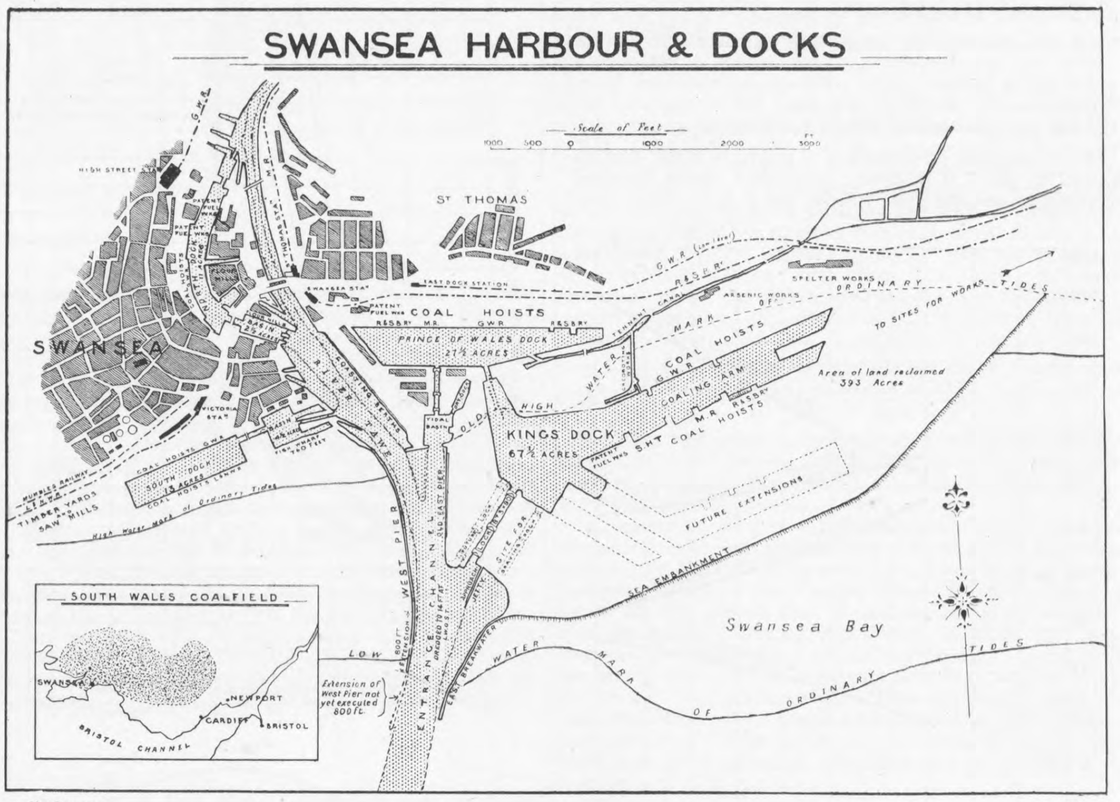
Year.	Imports. Tons.	Exports. Tons.	Total. Tons.
1862	369,700	914,000	1,283,700
1868	438,600	1,006,000	1,444,600
1878	450,180	1,051,860	1,502,040
1888	653,634	1,953,724	2,607,358
1898	817,881	2,749,351	3,567,232
1908	942,155	4,897,376	5,839,531

Swansea—Total Imports and Exports Combined.

	1898. Tons.	1907. Tons.	1908. Tons.
Coal, patent fuel, and pitch ...	2,480,177	4,385,679	4,449,628
Metals and their ores (not iron)...	233,611	207,260	201,468
Iron, steel, iron ore, and tinplates	470,937	579,134	598,797
Other imports and exports... ...	382,507	553,026	589,688
Total	3,567,232	5,725,099	5,839,531

Tenders for the construction of the new dock—now known as the King's Dock—were invited in 1904, and in June of that year a contract was entered into with Messrs. Topham, Jones, and Railton, Limited, of Westminster. As stated above, the ceremony of commencing the works was performed by his Majesty the King, in July, 1904, since when the contractors have pushed forward the work with such expedition that the dock is to be opened to traffic eight months before the expiry of the contract time.

The plan of the work has undergone considerable modification since 1901, when Parliamentary sanction was obtained. The general plan of the harbour works, Fig. 1, shows the King's Dock and its surroundings, together with the older docks and harbour works.



"The Engineer" Swain Sc

Fig. 1—GENERAL PLAN OF THE PORT OF SWANSEA

We shall now describe in succession the principal features of the new works.

The Dock.—The King's Dock possesses a water area of 68 acres, in addition to the area of the deep water extension, which when it is completed will add another 40 acres to the total. The combined area of all the old docks at Swansea is about 60 acres, so that the addition of the King's Dock more than doubles the accommodation of the port, apart from other considerations. The dock is irregular in shape, and the entrance lock is so placed as to facilitate swinging. The largest vessel the lock can take will be able to swing in the dock near the lock without interfering with any ships berthed alongside the quays. The width of the dock at this point is 1240ft. The extreme length of the dock is 4600ft., the width in the upper portion or coaling arm, which is 4000ft. long, averaging 560ft. The total length of quays reserved for general trade is 10,350ft., and for coaling purposes 2800ft., making a total of 13,150ft. In addition there are pitched slopes forming the dock sides for a length of about 400ft., which can, when required, be converted into wharves. The level of the impounded water is that of H.W.O.S.T., or 35ft. above the dock bottom and 6ft. below coping level. The level of the water will be maintained by means of pumping when the increase in the number of lockings between spring tides has the effect of materially lowering the water level in the dock. Pumping plant for this purpose has not yet been installed, but a small supply of water is available from the Tennant Canal. Provision will also be made for increasing the depth of water in the dock by 2ft. if required, thus bringing the depth up to 37ft. At the north-west corner of the dock is a funnel-shaped extension, terminating in a communication passage between the new dock and the Prince of Wales Dock. This passage is 70ft. wide at coping level, and has a depth of 28ft. below H.W.O.S.T. A connection is also provided with the Tennant canal by means of a short branch canal and a barge lock on the north side of the coaling arm.

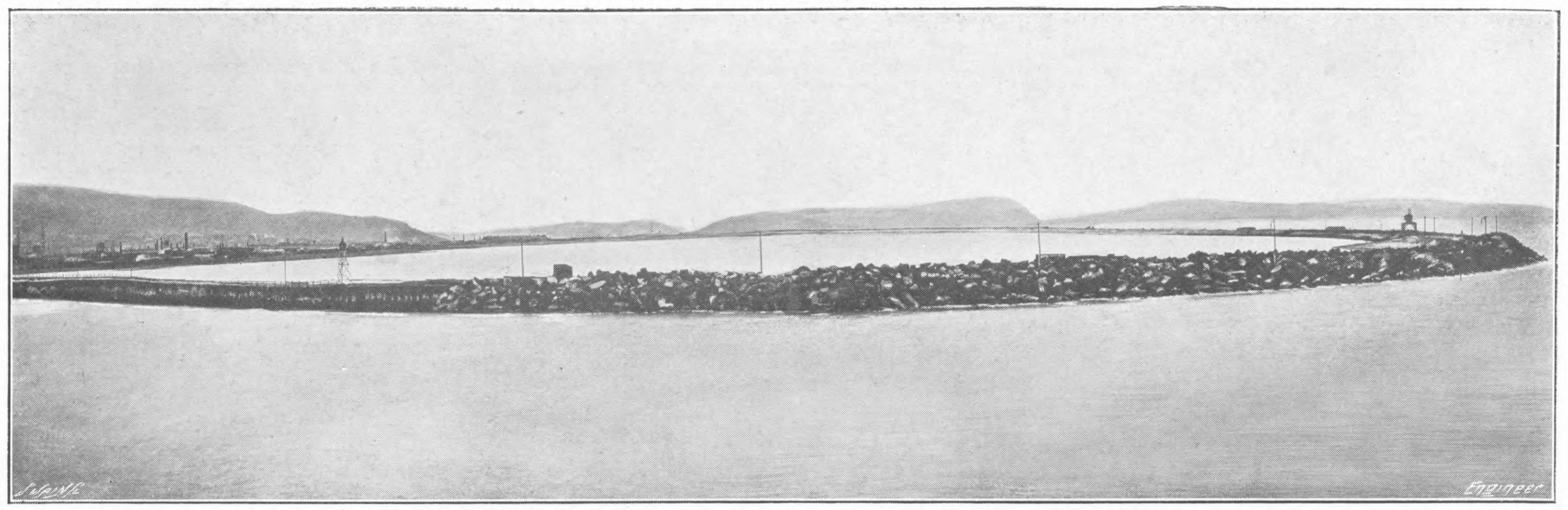
The most striking feature of the planning of the dock is the exceptionally large proportion of quay frontage to water area. This has been obtained without unduly restricting the water area required to enable vessels to manœuvre or to lie at moorings on the dock awaiting a berth. The peculiar arrangement of projecting jetties in the coaling arm is designed with the view to economy of berthing space. The bays between the jetties, which vary in length from 280ft. to 493ft. on the south side, will be occupied by vessels of moderate length. These will be loaded by means of the movable coal hoists, which will traverse as required to take up positions opposite the ship's hatchways. Other vessels, the length of which may exceed the limits permissible in the bay berths, will lie alongside the jetties overlapping the ships moored in the bays alongside the wharves. The ships at the jetties will be loaded by means of the fixed hoists, and warped in or out as necessary to bring the hatchways under the tips. This device practically doubles the wharf accommodation, and is, we believe, a novel arrangement in dock construction. The obvious criticism is the possibility of difficulties in mooring a large vessel broadside on to the end of a narrow jetty when a strong gale is blowing; the engineers have, however, provided heavy moorings at intervals along the middle of the dock.

The mooring anchors consist of large concrete blocks sunk below the surface of the dock bottom. The mooring chains are shackled to mooring bars embedded in the concrete.

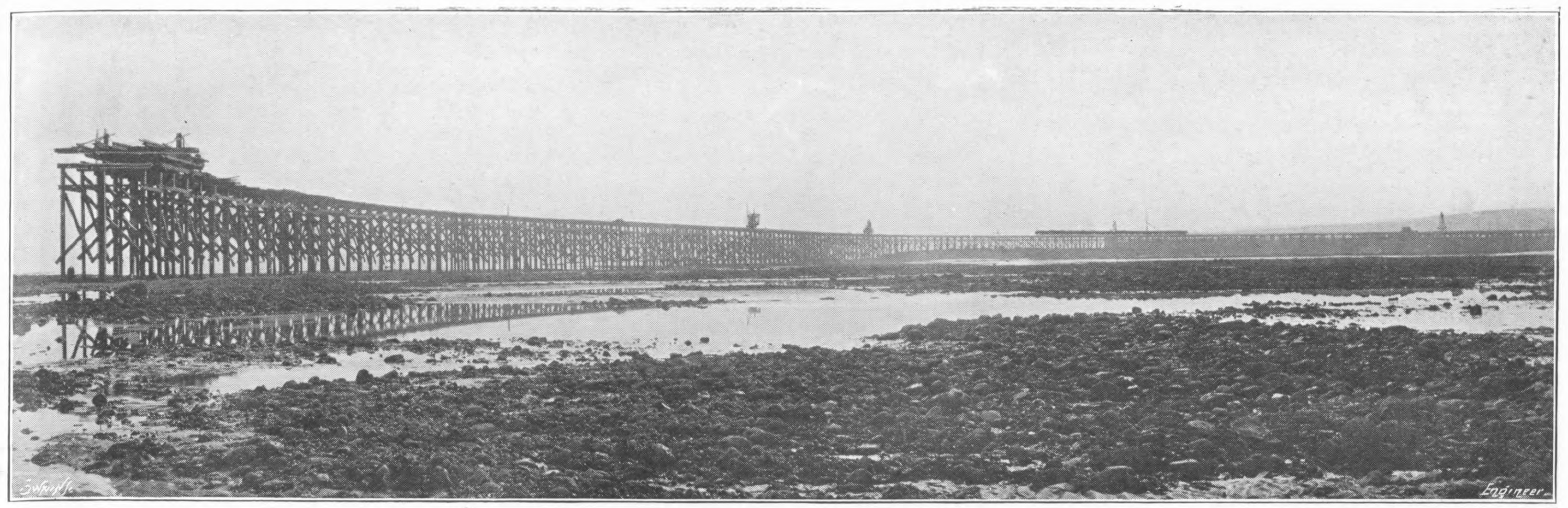
The sea embankment.—The first work undertaken by the contractors in 1904 was the reclamation of 400 acres of foreshore by means of a sea embankment. Within the area so enclosed the King's Dock itself was constructed later on. The sea embankment is nearly two miles in length—Fig. 2. It consists of a stone rubble bank, protected on the sea face by large stone pitching, no stone in the pitched face being less than two tons in weight, the general average being about four tons. The stones were carefully set by two Titan cranes travelling along the top of the embankment. One of the engravings in our Supplement is reproduced from a photograph showing one of the stone-setting cranes. The cranes were of 6 and 8 tons capacity, and each had a working radius of 70ft. The rock pitching, as well as the rubble hearting, is Pennant stone from the Cwm Crumlyn quarries, Llansamlet, about four miles from the dock works. These quarries are the property of the contractors, Messrs. Topham, Jones and Railton, Limited, and are capable of turning out 12,000 tons of stone per week. A private line of railway was constructed by the contractors from the quarries to the site of the works. The batter of the sea face of the embankment is 2 horizontal to 1 vertical, and that of the inner face 3 to 1.

The foreshore at the site of the embankment is for the most part soft sand and beach, at a level of 3ft. to

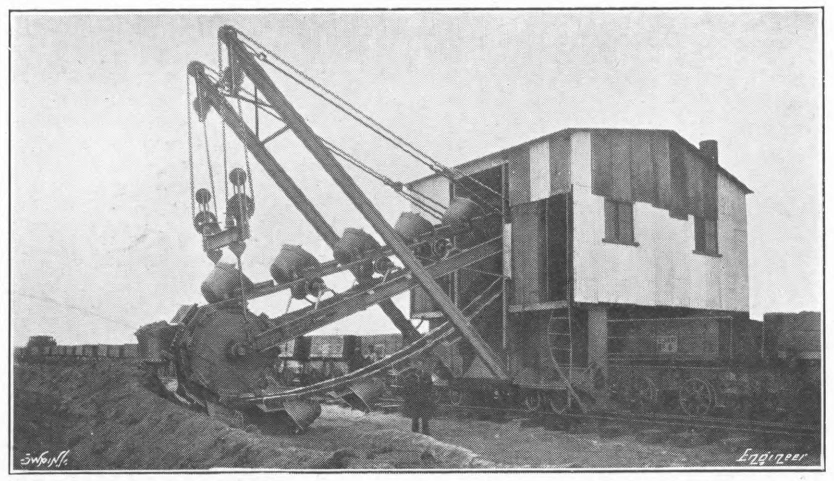
THE KING'S DOCK, SWANSEA



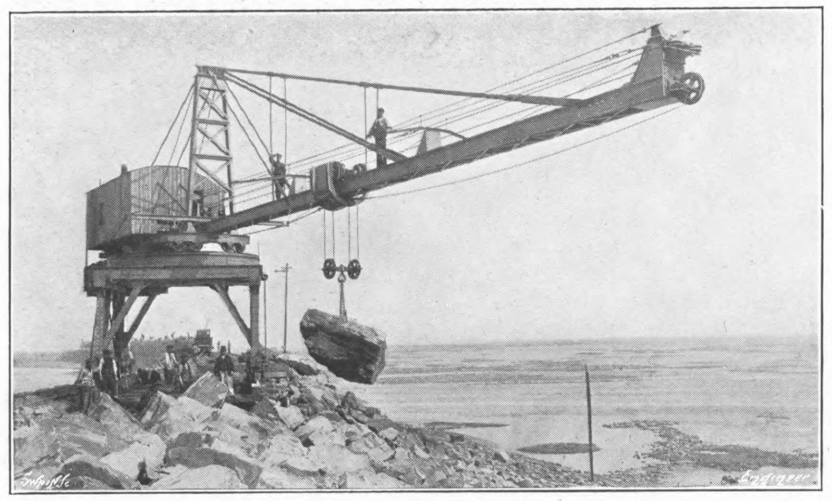
THE SEA EMBANKMENT FROM THE SOUTH-WEST IN APRIL, 1906



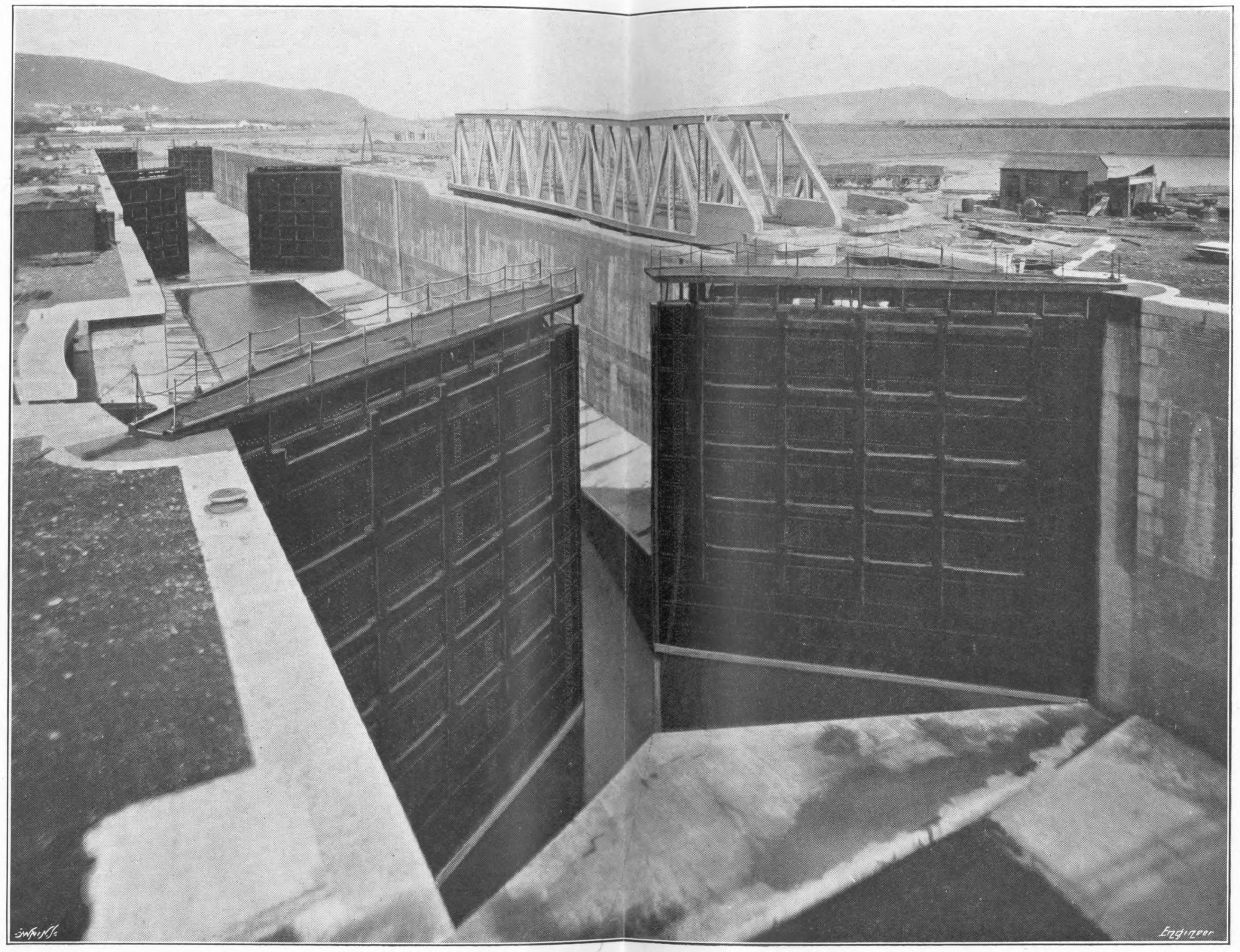
TIMBER GANTRY USED IN CONSTRUCTION OF SEA EMBANKMENT



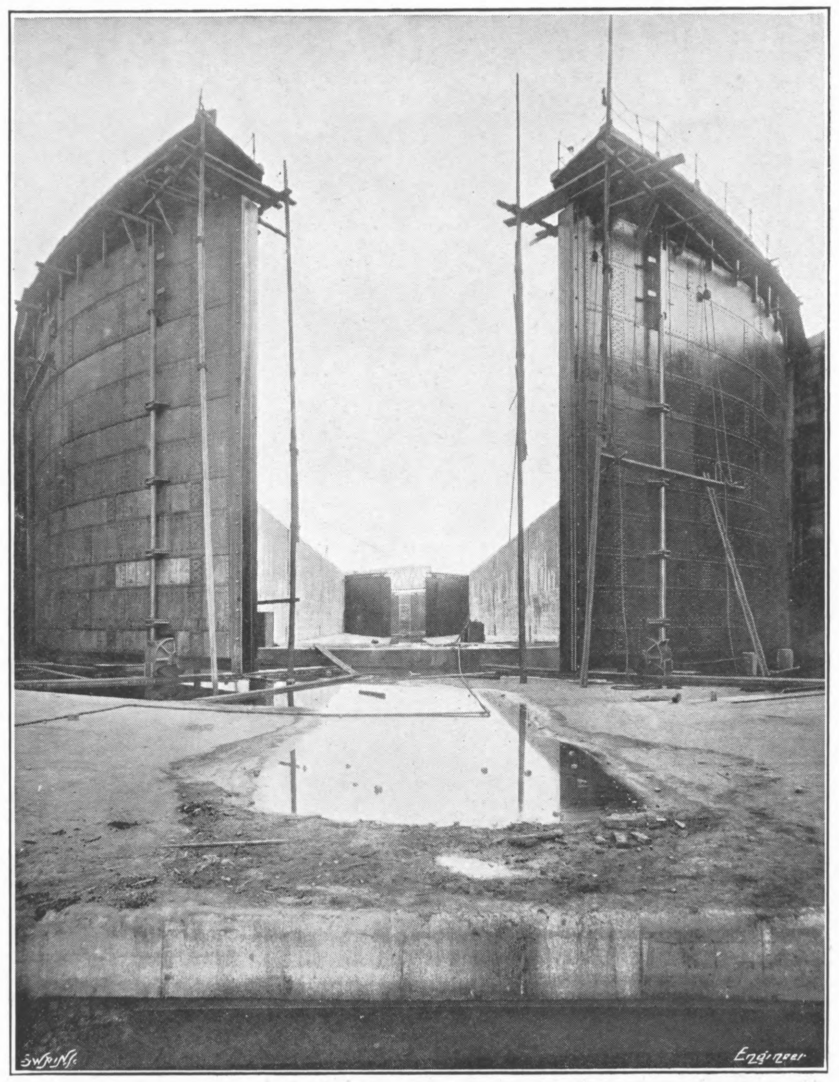
GERMAN NAVVY EXCAVATING SAND DUNES



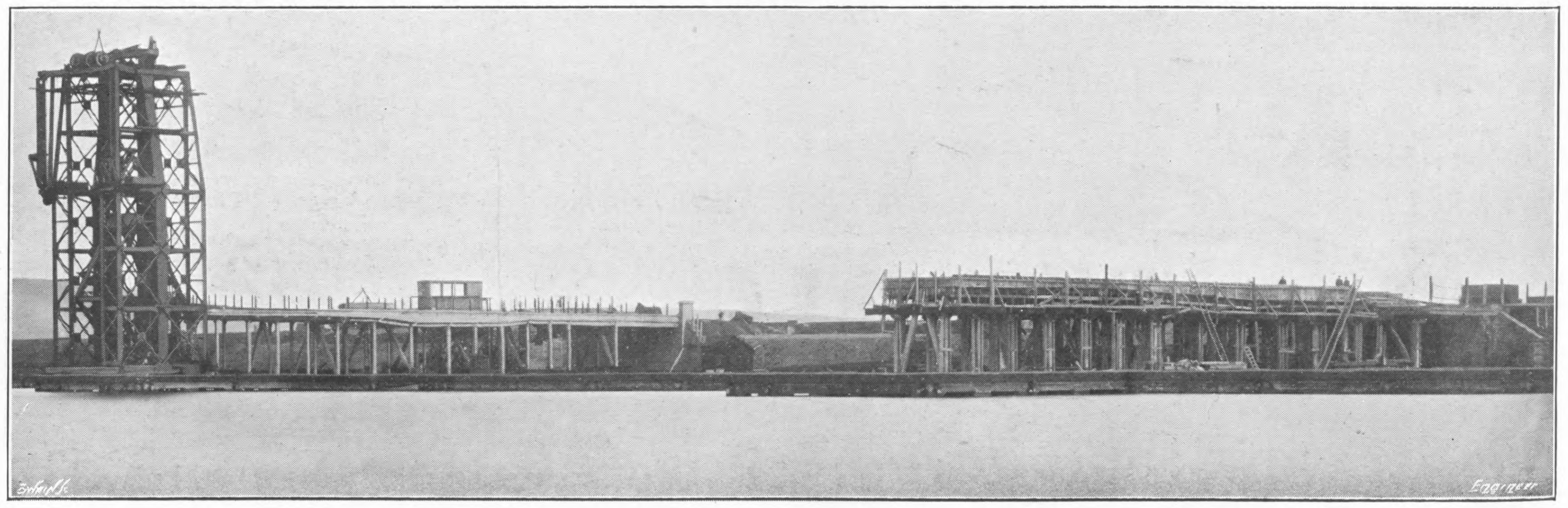
TITAN CRANE PITCHING SEA EMBANKMENT



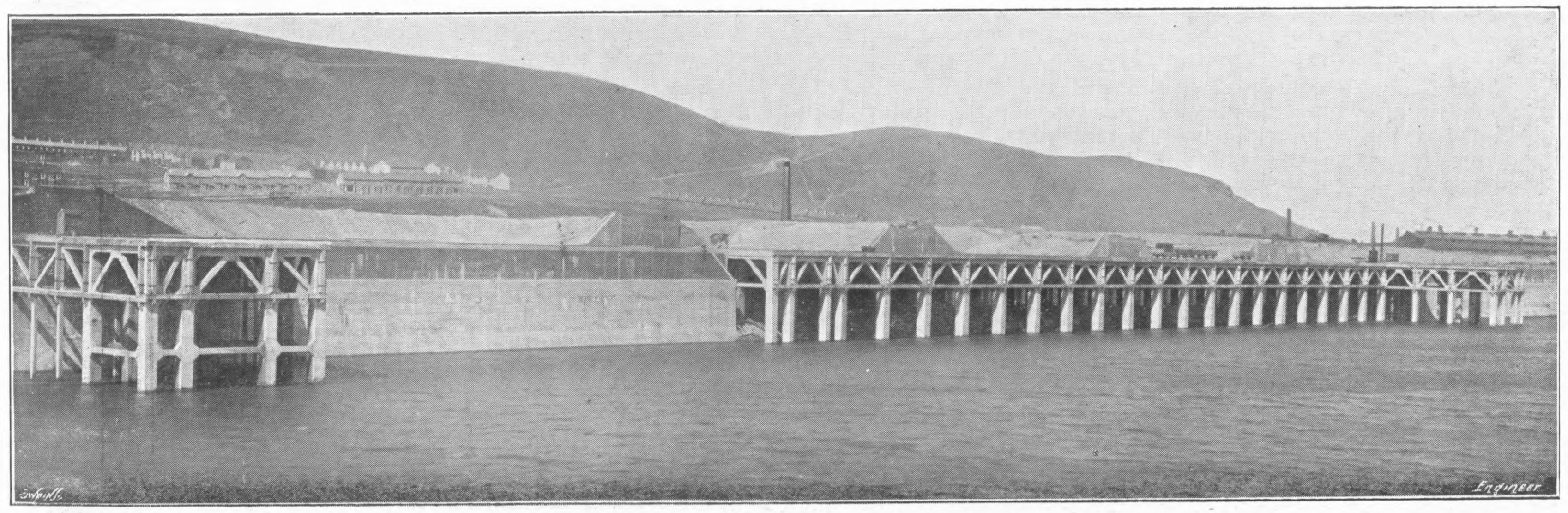
LOCK FROM THE OUTER END



INNER GATES FROM KING'S DOCK



FERRO-CONCRETE COALING QUAY FOR MIDLAND RAILWAY



FERRO-CONCRETE COALING QUAY FOR GREAT WESTERN RAILWAY

4ft. above low water of spring tides. The depth of water in front of the embankment at high water of spring tides is therefore about 20ft. The toe of the seaward slope of the bank is formed by large stones not less than three tons in weight laid in a trench in the sand 6ft. deep—Fig. 2. This trench was excavated by means of grabs. The inner face of the rubble bank is at a slope of $1\frac{1}{4}$ horizontal to 1 vertical, and is of unpicked rubble. The stone embankment is itself backed by sand filling 150ft. wide at the top, carried up to a level of 6ft. over H.W.O.S.T. It was originally intended to pump this sand from the foreshore outside the embankment on to the area within the embankment, but the contractors ultimately decided to obtain the material from the sand hills to the east of the new works, where it was excavated by a steam navvy of the land dredger type—see Supplement. This form of excavator is admirably adapted for the purpose, and maintained an average of 25,000 to 30,000 cubic yards of sand excavated per week, working night and day. A line of railway over four miles long was constructed by the contractors between the sand dunes and the site of the works. The object of the sand backing was to make the embankment practically water-tight. To prevent the sand being wasted by the wind the top surface and the inside slope, which is about 3 to 1, were overlaid with stone rubble. The stone embankment is surmounted by a concrete parapet and apron, the surface of the latter being at a level of 10ft. above H.W.O.S.T. The parapet wall is 7ft. high, and shelters the reclaimed area from sea wash and spray. The concrete in the parapet wall apron is 6 to 1.

No effort was spared to expedite the completion of the embankment, which has proved successful in every way. The stone bank itself was finished in April, 1906, but it was not until three months later that the sand backing was completed and the impounded water sluiced out to enable a start to be made on the construction of the dock walls. A photograph of the sea embankment from the south-west, taken immediately after it was closed, is reproduced in the Supplement. The sea embankment was carried across the site of the new entrance channel in front of the lock to form a temporary dam, within which a portion of the entrance works was carried out in the dry. This part of the embankment was removed when the headworks of the lock were sufficiently advanced to enable its protection to be dispensed with.

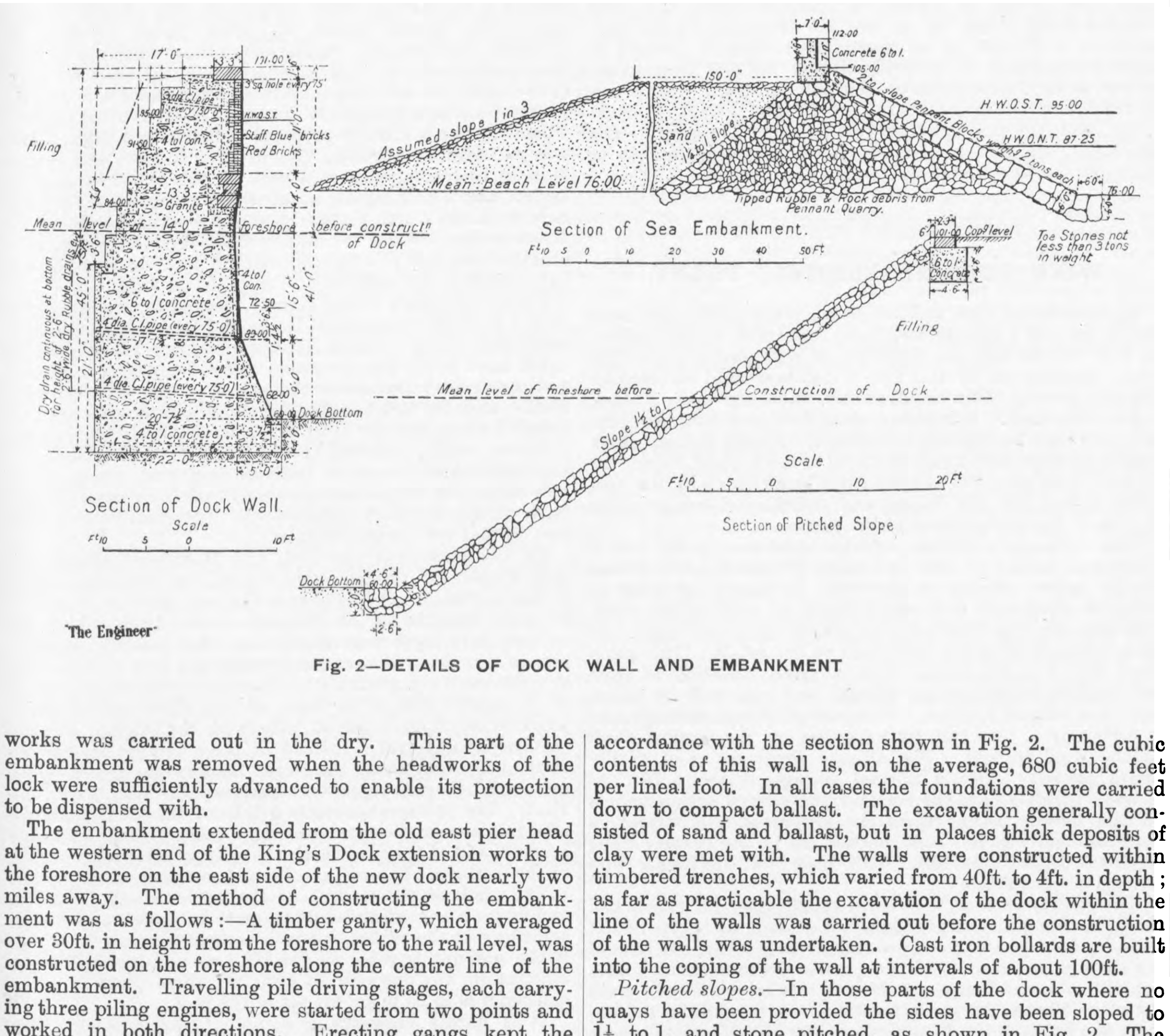


Fig. 2—DETAILS OF DOCK WALL AND EMBANKMENT

The embankment extended from the old east pier head at the western end of the King's Dock extension works to the foreshore on the east side of the new dock nearly two miles away. The method of constructing the embankment was as follows:—A timber gantry, which averaged over 30ft. in height from the foreshore to the rail level, was constructed on the foreshore along the centre line of the embankment. Travelling pile driving stages, each carrying three piling engines, were started from two points and worked in both directions. Erecting gangs kept the construction of the gantries well in advance of the rubble mound. Train loads of stone rubble were brought on to the gantries and tipped until the latter structures became buried in the stone *débris*. The piles and other timber, with the exception of the upper portions of the gantry, were left buried in the rubble mound as the work proceeded. A view showing the timber gantry is reproduced in the Supplement.

A portion of the embankment, commencing at the eastern end of the work, was constructed without the use of a gantry, the materials being tipped end on as the bank advanced. The importance of completing the sea embankment at the earliest possible date led to the adoption of the gantry method of construction for the greater part of the work.

The cranes for dealing with the larger blocks of stone used on the sea face of the embankment travelled upon the gantry road, and afterwards, as the work neared completion, on the top of the embankment itself. A total of about 528,000 cubic yards of stone has been used in the construction of the embankment, in addition to 1,213,000 cubic yards of sand from the dunes.

The dock walls.—A cross section of the concrete dock wall is shown in Fig. 2. The dock walls, as well as those of the lock, are constructed throughout of 6 to 1 cement concrete, faced with 4 to 1 concrete up to a level of 16ft. 6in. below the coping. At this level granite oversailing courses project 6in. beyond the lower part of the wall, and from the top of the oversailing course up to the granite coping the wall is vertical and faced with Staffordshire blue bricks. The face of the wall below the oversailing course batters 1 in 24 to 32ft. below the coping; below that level the batter is increased to 1 in 2·75 down to the dock bottom. About 20 per cent. of large stone plums or displacers have been used in the 6 to 1 hearting concrete. The aggregate used was broken stone from the Llansamlet quarries and coarse sand. The foundations vary in depth, the minimum level being 4ft. below the normal dock bottom, or 45ft. from the coping. In places the foundations were carried as low as 28ft. 6in. below dock bottom, making the maximum height of the wall 69ft. 6in. The base width of the wall is 22ft., which is reduced by steps to 7ft. under the coping. The Staffordshire brick facework is in alternate course of $4\frac{1}{2}$in. and 9in. thick; the face bricks are backed by hard red bricks, which are bonded into the concrete backing as shown in the section. The granite copings are fine dressed with rounded nose, and measure 3ft. 3in. by 1ft. 6in.; all coping stones are joggled at the end joints. Throughout the work granite has been used only for the oversailing courses and in positions when hard wear is likely to take place, such as steps and copings, and at coigns at the corners of quays and passages. The coigns at the step landings and other positions where hard wear is not anticipated are of granolithic concrete.

For the purpose of draining the ground at the back of the walls during construction two 4in. cast iron pipes are built into the wall in the positions shown on the section at every 75ft. length. These drain pipes were sealed on the completion of the work. Vertical dry rubble stone drains are laid behind the walls at the back of the drain pipes, and a continuous dry drain is placed at the level of the lowest cast iron drain pipe. 3in. drains are also provided under the coping at intervals of 75ft., and in every 150ft. length of wall there is another 3in. drain discharging at a level of 12in. above high water of spring tides.

In the main King's Dock, the coaling arm and the passage to the deep-water extension there is a total length of 1140ft. of quay wall constructed, generally in accordance with the section shown in Fig. 2. The cubic contents of this wall is, on the average, 680 cubic feet per lineal foot. In all cases the foundations were carried down to compact ballast. The excavation generally consisted of sand and ballast, but in places thick deposits of clay were met with. The walls were constructed within timbered trenches, which varied from 40ft. to 4ft. in depth; as far as practicable the excavation of the dock within the line of the walls was carried out before the construction of the walls was undertaken. Cast iron bollards are built into the coping of the wall at intervals of about 100ft.

Pitched slopes.—In those parts of the dock where no quays have been provided the sides have been sloped to $1\frac{1}{2}$ to 1, and stone pitched, as shown in Fig. 2. The stone pitched slope is capped by a granite coping set on a concrete foundation. A length of only 400ft. of this form of bank has been constructed in the dock. The slopes under the reinforced concrete wharves on the north and south sides of the coaling arm are in most cases 2 to 1, and are not pitched. These slopes, however, are not carried to a higher level than 16ft. below coping, the ground above this level being held up by reinforced concrete curtain or retaining walls, 18ft. in height from the foundation to the dock level.

The engravings in our two-page Supplement include views of the coaling arm and of the lock, as well as those views to which we have called attention above.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

AT the opening meeting of the Institution of Electrical Engineers, held at Westminster on Thursday, November 11th, the new president, Dr. Gisbert Kapp, delivered his presidential address. Unlike most addresses of this kind, Dr. Kapp deals with no particular subject, but briefly reviews the present state of electrical engineering and draws attention to some of the novel features in the design of electrical apparatus, and to a few among the many applications of electricity to industrial processes. In dealing with generators mention is made of the fact that the modern tendency is to erect very large units. The General Electric Company of New York, it is stated, has built several turbo-alternators of 14,000 kilowatts capacity at 9000 volts, and the British Westinghouse Company considers it quite feasible to construct sets of 15,000 kilowatts working at a pressure of 13,000 volts, or, if necessary, 15,000 volts. Mention is made of the power-house of the Norwegian Nitrogen Company at Svälgfos, near Notodden, which has been fitted up with four water-turbine sets of 10,500 kilovolt-ampères, capable of developing 7000 kilowatts, with a power factor of .67, the speed being 250 revolutions per minute, the terminal pressure 10,000 volts, and the periodicity 50 cycles. The total losses at full load amount to 320 kilowatts, corresponding to a generation of heat of 270,000 calories per hour for each machine. That special ventilating arrangements are necessary is obvious. Air ducts are carried under the floor to each machine, but no provision is made to carry the heated air away, the air being simply discharged into the engine-room. Dr. Kapp states that there is no difficulty in arranging for a discharge into the open through ducts under the floor, and this would certainly conduce to the comfort of the engine-room staff. After considering the modern methods of ventilating large machines, Dr. Kapp goes on to deal with a plant in Germany where the circulating pumps are driven by means of a steam turbine instead of by an electric motor, as is customary. The question of the utilisation of exhaust steam in exhaust turbines is also dealt with.

A point which requires careful attention in the design of generators, it is stated, is the permissible drop. For safety a large drop is desirable, whilst for regulation, both the inductance and the demagnetising force of the armature should be kept as small as is commercially possible. Thus the best design is, as usual, a compromise. Here mention is made of the ingenious method devised by Mr. Miles Walker and adopted by the British Westinghouse Company, in which the exciting coils are housed as usual in longitudinal slots in the rotor, but instead of arranging these coils symmetrically to the polar axis, Mr. Walker places the centre of the coils nearer the leading edge of the pole, so that the teeth in that part of the rotor are more strongly magnetised than those in the polar axis, whilst the magnetisation is weaker still in the teeth in the lagging polar edge. If the machine works at a power factor not much less than unity, the armature currents weaken the induction over the leading and strengthen it over the lagging polar edges. Since the latter are not highly magnetised to begin with, this strengthening action can take place fully, whilst the weakening action on the leading edge has much less effect on account of the initial saturation. Thus on the whole there may be no change or even a slight rise of total flux with an increasing load, so that the armature back magnetisation is compensated. This compensation fails, however, if owing to a short-circuit there is a great increase in armature current, for then the current lags so much that the pole as a whole is demagnetised, and the machine is no worse than one of the usual type designed for a small short-circuit current. Since several non-synchronous machines have recently been put into operation in various parts, it is by no means surprising to find that Dr. Kapp makes reference to them. A special low periodicity turbo-alternator, designed by Mr. E. Ziehl, is also described.

Coming to transformers, Dr. Kapp says, thanks to the researches of Sir Robert Hadfield, which have resulted in the production of the excellent material known as alloyed iron, the science of transformer making has developed in a remarkable degree. Speaking of large units, Dr. Kapp says the General Electric Company of America has built for the Great Western Power Company on the Feather River several 10,000-kilowatt three-phase transformers working at 60 cycles and giving a pressure of 100,000 volts. The reduction in weight of transformers, due to the use of alloyed iron, large units, and vigorous cooling, Dr. Kapp considers is very remarkable. As an example, he takes a modern three-phase transformer by Brown, Boveri and Co. for 4600 kilowatts at 27,000 volts, 50 cycles. It is oil-cooled with water coils in the case. The active material, by which is meant the iron carcase and copper coils, but exclusive of case or fittings, weighs only 31·24 kilos. per kilowatt, and the efficiency is 98·6 per cent. at full non-inductive load. In an Oerlikon 3500-kilowatt transformer the active iron only weighs 7 tons, being at the rate of 2 kilos. per kilowatt. Its efficiency is also nearly 99 per cent. This transformer is the more remarkable as no oil is used. It is a so-called dry transformer with forced draught, yet the voltage on the high-pressure side is 27,000.

Turning to electric motors, Dr. Kapp says that inventors are busy in devising means for reducing the speed of alternating current motors, and he draws attention to the principle of cascade working which has recently been developed by Mr. Hunt, of the Sandycroft Foundry. Mr. Hunt has, by an ingenious method of grouping the coils, succeeded in adapting the cascade principle to one motor only. He is thus able to run an 8-pole motor at the speed of a 12-pole motor, whilst getting a better power factor than is possible with the orthodox way of using two motors in tandem. Among other new motors reference is made to the single-phase machine devised by Mr. Deri and practically developed by Brown, Boveri and Co., which was described in our issue of October 23rd, 1908.

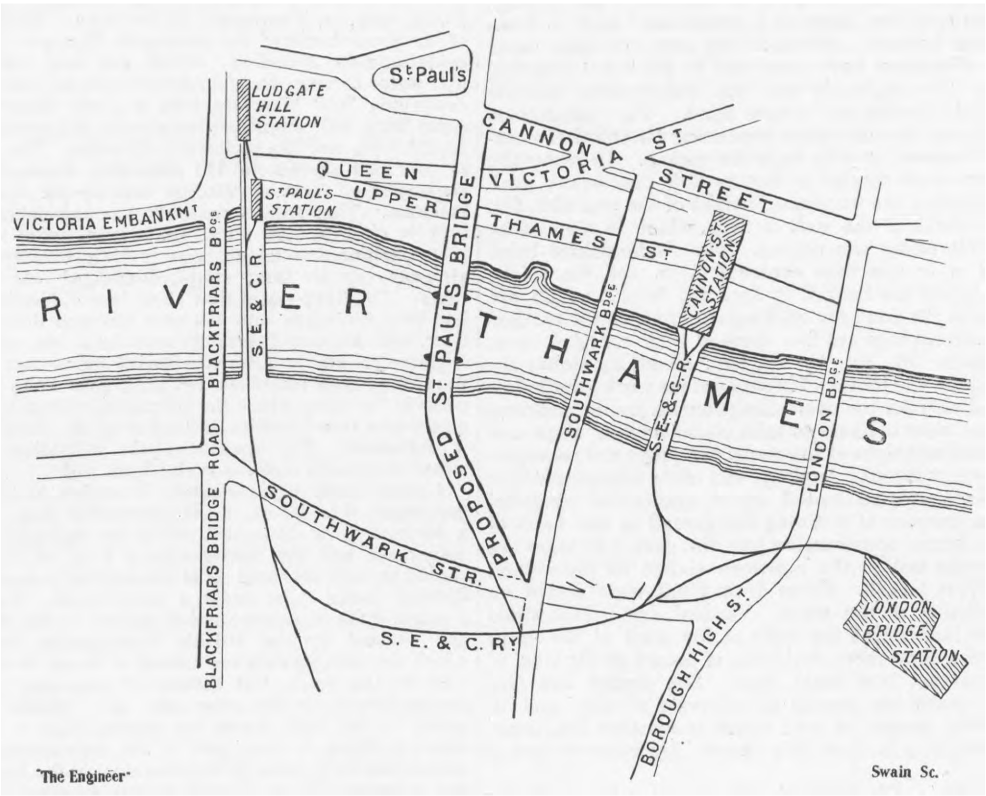
In dealing with the electric transmission of power, Dr. Kapp states that the voltage is limited not so much by the dielectric strength of the insulators as by dispersion of electricity through the air, and the consequent loss of power. In this connection attention is drawn to the experimental work recently carried out by Mr. Ralph D. Mershon to determine the maximum voltage which may be used under given conditions on an overhead three-phase line. Mr. Mershon gives the following formula as a near approximation to the experimental results. The limit of pressure beyond which dispersion causes sensible loss of power is in virtual kilovolts:—

$$\mathrm{K\,V} = \left(\frac{1}{1 + K_4 p^1}\right) K_1 \left(1 + \frac{K_2}{K_3 + r}\right) r \log\left(\frac{s}{r}\right),$$

where K_1, K_2, K_3, K_4 are constants, p^1 is a quantity which Mr. Mershon calls the "vapour product," r is the radius of the wire, and s the distance between two wires at which the pressure K V exists. It will be noticed that the temperature does not directly enter into Mershon's formula, though it is implicitly contained in the value p^1, whereas Ryan's old formula contained the temperature itself. By taking Mr. Mershon's curves, and assuming proportionality between the barometric pressure and critical voltage, as in Ryan's formula, Dr. Kapp has found the following somewhat simpler expression represents fairly well the critical potential difference in virtual kilovolts:—

$$\mathrm{K\,V} = \frac{0.115\, b}{.5 + r}\left(\frac{1}{1 + 0.013\, v}\right) r \log \frac{s}{r}$$

SITE OF THE PROPOSED NEW BRIDGE OVER THE THAMES



"The Engineer" Swain Sc.

Here b is the barometric pressure in mm. of mercury, r the radius of the wire in cm., s the distance between the two wires in cm., and v is Mershon's vapour product, namely, the pressure of saturated steam in mm. of mercury at the given temperature multiplied by the relative humidity, or the ratio $\frac{\text{actual moisture}}{\text{possible moisture}}$

Dr. Kapp has communicated this formula to Mr. Mershon, and has asked his opinion with regard to it. In reply, Mr. Mershon states that he finds that Dr. Kapp's formula does not give quite as close results as his own; but he thinks, perhaps, the results it does give are as close as the measurements would justify, and as it is somewhat simpler than his own, it is, perhaps, preferable for practical use.

Some exceptionally interesting information is given concerning the protection of power lines against pressure surges due to atmospheric and other causes, and also to a new invention, the object of which is the prevention of the infiltration of high-pressure current into low-pressure lines. That such a device is urgently needed is shown by the lamentable accident which happened last August in Olgiate, when several persons were killed by contact with normally low-pressure lighting circuits. Dr. Kapp also deals with electric railways, winding engines and rolling mills, electric steel furnaces, fixation of atmospheric nitrogen, and electricity in agriculture.

NEW BRIDGE OVER THE THAMES.

NOT without meeting with a considerable amount of opposition, the Corporation of the City of London on Monday last decided to construct a fine new bridge between Blackfriars and Southwark Bridges and to reconstruct the latter bridge, at a total cost for the two works of £1,907,983. Of this sum £1,646,983 will be expended on the new bridge and £261,000 devoted to the alterations to Southwark Bridge. The idea of connecting the opposite banks of the Thames at or about this point has been under consideration for some considerable time, and various schemes for bringing it about have been proposed. The cross-river traffic in and near the City is rapidly increasing. Before the construction of the Tower Bridge as many as 23,000 vehicles passed over London Bridge in twenty-four hours. This number has slightly decreased, only 20,000 vehicles now passing over this bridge in the same period; but, on the other hand, as many as between 14,000 and 15,000 make use of the Tower Bridge each day, so that the combined totals reach a number of between 34,000 and 35,000, an increase of very nearly 50 per cent. on the first-named figure. Southwark Bridge has always been inconvenient. It is narrow, in the first place; but more important, perhaps, even than this is the fact that it is laid on a heavy gradient in both directions, this rendering it most unsuitable for heavy traffic. It has, in consequence, been comparatively little used. In a widened and more level form it would doubtless be of very considerable importance and utility, and this was the point of view taken by those who most strenuously opposed the complete scheme. It was argued that by all means Southwark Bridge ought to be made wider and flatter, but that before the much greater expense of a new bridge was incurred a reasonable time should be allowed to elapse in order that it might be seen what effect the alterations, combined with the relief which has been experienced in connection with the recently carried out widenings of London and Blackfriars Bridges, would have. These counsels were, however, not permitted to prevail, though it must be admitted that, on the face of them, at all events, there is a good deal in their favour. The majority have decided that as the extra bridge would undoubtedly have to be constructed at some time or other, it would be as well to build it now as at a later date. It was pointed out that a great deal of the City's business was going to the West End simply because there were better facilities for traffic there than in the City, and that this must be put a stop to at all costs. The new bridge, it may be added, is to have its northern approach practically in St. Paul's-churchyard, with a viaduct passing over Queen Victoria-street. This was another point to which objection was taken, on the ground that it would obstruct the view of this thoroughfare. Further arguments against the scheme were that greater congestion than ever would be caused in Cannon-street, and that Thames-street would in no way be relieved. In the end, however, a division on an amendment brought forward to agree to the report of the Bridge House Estates Committee, except as to the erection of the new bridge, "which this Court does not consider needful at present," was lost by 34 votes, and the combined scheme is to go forward. The accompanying sketch plan shows the proposed line to be taken by the new bridge and its main approaches.

WIND TURBINE ELECTRIC PLANT.

AN interesting wind turbine electric plant has recently been put to work at a private house at Bromyard, Herefordshire, by J. G. Childs and Co., Limited, of Willesden-green. The plant includes one of this firm's standard wind turbines for electric driving, 24ft. in diameter, mounted upon a steel tower 75ft. high. It is placed about 435 yards away from the house (where the battery is situated), on some ground which stands perhaps 90ft. above the level of the ground round the house. The generator is placed in a small house at the foot of the tower, and the battery and switchboard are arranged in one of the outbuildings of the house.

The current is conveyed from the generator at the foot of the tower to the battery by means of bare solid overhead copper cables, carried on porcelain insulators mounted on poles, in connection with which lightning arresters are fixed. The poles and the cross arms are placed about 30ft. apart, and were obtained from the plantation on the estate. The generator is of a special design, with a speed variation of from 400 to 1600 revolutions per minute, and runs with its armature in a vertical position. It is carried on ball bearings, and is driven by a 5in. belt from a pulley on the vertical shaft of the wind turbine. The electric generator is of 4 kilowatts capacity, with a normal voltage of about 70. As it was wished to have the whole of the control arrangements in the battery room, where the switchboard is placed, a separate field wire has been carried up to the battery along with the other conductors. This, also, is a bare copper wire carried on insulators.

The battery consists of 28 cells, supplied by Pritchetts and Gold, having a discharge capacity of 46 ampères for ten hours. It is divided into two equal groups, either of which can be used for the lighting circuit, which is run at 25 volts, using Osram metallic filament lamps. Arrangements have also been made for using 50 volts for power, as the plant, in addition to running the lights in the house—about 100 in all—also drives a 50-volt motor for running a chaff cutter, circular saw, and root pulping machine. This motor is placed in a shed about 80 yards from the house, and is connected to the battery by means of an armoured lead-covered cable laid in the ground. The chaff cutting required for the homestead is easily dealt with by this machine, and a considerable amount of firewood, &c., is also sawn. The motor is belted direct to the various machines, and of course only runs one at a time.

The plant has now been running for over a month, and we gather that it behaves well. It is entirely automatic, being fitted with the firm's patented tail gear, for giving accurate adjustment to the wind. This arrangement consists of three tails, two of which stand out at about 20 deg. with the wheel. Two of these are connected together, so that when the wheel is required to stop these have only to be pulled down into a horizontal position and the wheel immediately comes up into the wind and stops running. In the same way the tails are so balanced that when the wind reaches a predetermined velocity, the tails tend to take the horizontal position, and so bring the wheel more or less out of the wind as the strength of the wind varies. In the recent gales which swept over the Midland Counties this plant had a very good test of its stability, and though a very large tree was blown down close to it, the wind turbine suffered, we are informed, not the slightest harm. The makers state that in practice it is found that the supply from the wind turbine is so reliable that it is almost the same as a supply laid on from the public mains, as the attention required by the plant is so small. All the main bearings carrying load are ball bearings, and the gear is enclosed in a cast iron oil bath, and it is claimed that even if the plant were left for twelve months no harm would result from want of lubrication.

As the wind turbine is placed on ground somewhat higher than that on which the house stands, and is out of sight behind a wood, there is often a good wind blowing at the turbine when none is felt down at the house. The plant is guaranteed to produce 3000 units a year, but in practice it produces at a much faster rate than this. In twelve hours a few days ago it produced 14 units, with wind averaging 15 miles an hour. The makers consider, however, that the average wind in this situation would be about 9 miles an hour, and that the output of the plant in a year will probably be about 5000 units.

We may add that we fully described this method of obtaining electric power from the action of the wind in our issue of March 26th last.

THE NORTH-EASTERN AND HULL AND BARNSLEY RAILWAYS AGREEMENT.

IN the letter from the railway companies to the Hull Corporation which accompanied a copy of this agreement, it is admitted that the reason why some steps should be taken to reduce competition between the two companies is that the Immingham Docks will shortly be opened. These, it is feared, will prove a powerful competitor, more particularly in connection with the heavy over-sea trade of the Humber, the greater portion of which is now enjoyed by the Hull and Barnsley Company, owing to the superior accommodation at the Alexandra Docks.

The submission of the proposals to the Corporation reminds one of the early history of the Hull and Barnsley. Many will still remember the vicissitudes through which the Bill for its incorporation passed. It was fought vigorously by the North-Eastern Railway, whose monopoly was being invaded, was financially backed by the Hull Corporation, which, as a consequence, nominate two of the directors, and its sanction aroused popular enthusiasm, not only in Hull, but South Yorkshire, which enthusiasm showed itself in a practical way in investments by people of all ranks in the concern.

For long the company struggled against adversity. Many proposals were made as to its absorption by other companies—the Midland and Lancashire and Yorkshire in particular — but all were afraid of the North-Eastern opposition, which would at once have diverted its valuable unconsigned traffic to other lines. But recent extensions to large collieries in the South Yorkshire coalfields and the superior accommodation of the Alexandra Docks brought it through. A crisis arose in 1898 when the North-Eastern proposed to build a new dock. This was successfully opposed, and in 1899 a joint dock—to be built by both companies at a cost of £2,000,000—was sanctioned, and is now rapidly approaching completion. To this new dock the North-Eastern Railway was unable to secure direct access owing to innumerable level crossings, so it obtained sanction to run over the Hull and Barnsley line on payment of a toll calculated as equal to six miles.

The Immingham Docks, already referred to, are being built by the Humber Commercial Docks and Railways Company—really the Great Central Railway—and are situated on the south bank of the Humber, about six miles west of Grimsby and about ten miles nearer the mouth of the Humber than Hull. Another factor calling for closer relations between the North-Eastern and the Hull and Barnsley is the competition of Goole, which, although twenty miles further inland, is a Lancashire and Yorkshire Railway port, and, consequently, now supported by the London and North-Western and Midland, neither of which companies is interested in any other port in that part of the kingdom.

By the agreement the Hull and Barnsley Company will gain access for its passenger trains into the commodious Paragon Station of the North-Eastern Railway, described in THE ENGINEER of February 14th, 1908—which will be infinitely more convenient than the present passenger terminus in Cannon-street, and enable the Hull and Barnsley to cultivate a suburban traffic. Junctions will have to be laid in to enable this to be done, and for these parliamentary sanction must be obtained, otherwise the scheme does not require any approval. Instead of the six miles toll for coal to the new Joint Dock, the North-Eastern has agreed to pay one-sixth of a penny per ton on all coal conveyed by rail into Hull. The new arrangements will be of benefit to traders as affording access to either company's docks without additional expense, and of benefit to both the railway companies because of the facilities of access to collieries now only served by one.

The whole of the receipts of the traffic to and from Hull and district and of the docks are to be pooled and divided according to the receipts of each company during 1908; but if the amount payable to the Hull and Barnsley does not amount in any one year to £400,000, three-quarters of the deficiency is to be made up out of the pool.

It is hardly necessary to point out that this agreement gives to the North-Eastern Railway a practical monopoly between the Humber and the Tweed, and is another stage in the "districting" of the whole of the kingdom.

THE AMERICAN SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS.—The seventeenth general meeting of the Society of Naval Architects and Marine Engineers has been held in New York this month. The following is a list of papers down to be read:—(1) "Evolution of Screw Propulsion in the United States," by Charles H. Cramp, vice-president; (2) "The Effect of Parallel Middle Body upon Resistance," by Naval Constructor D. W. Taylor, U.S.N., vice-president; (3) "The Influence of the Position of the Midship Section on the Resistance of Some Types of Vessels," by Professor H. C. Sadler, member of Council; (4) "Some Ship-shaped Stream Forms," by Assistant Naval Constructor Wm. McEntee, U.S.N., member; (5) "Applications of Electricity to the Propulsion of Naval Vessels," by W. L. R. Emmet; (6) "The Producer Gas Boat Marenging," by H. L. Aldrich, member of Council; (7) "Building and Equipping Non-magnetic Auxiliary Yacht Carnegie with Producer Gas Propelling Equipment," by Wallace Downey, associate member; (8) "The Design of Submarines," by Marley F. Hay, member; (9) "The Foreign Trade Merchant Marine of the United States: Can it be revived?" by George W. Dickie, member of Council; (10) "Material Handling Arrangements for Vessels on the Great Lakes," by Alexander E. Brown, member; (11) "Structural Rules for Ships," by James Donald, member; (12) "Rivets in Tension," by Robert Curr, member; (13) "The Strength of Water-tight Bulkheads," by Professor William Hovgaard, member; (14) "Cruising Motor Boats," by E. T. Keyser.

RAILWAY MATTERS.

The *Natal Government Gazette* of 12th October publishes the text of a Government Bill, which it is intended to introduce into the Natal Parliament this session, providing for the raising of a loan of £370,000 for the construction and equipment of railways, and for the construction of harbour works at Durban, and of telegraph and other public works of a permanent nature.

The Board of Trade have recently confirmed the undermentioned Order, made by the Light Railway Commissioners:—Southend-on-Sea Light Railways (Revival and Extension of Time) Order, 1909, reviving the powers granted by the Southend-on-Sea and District Light Railways (Extensions) Order, 1904, and extending the periods limited by that Order for the compulsory purchase of lands and for the completion of certain of the railways and works thereby authorised and for other purposes.

The *Diario Oficial* of 19th October contains a contract between the Mexican Legislature and the Compañia Ferrocarriles Nacionales de Mexico, under the terms of which the latter is authorised to construct and work, for a period of 99 years, a railway in the State of Durango. The line will run from Durango to a point called Llano Grande. The whole line must be completed within 3½ years. For a period of four years the company may import, duty free, materials necessary for the construction of the railway.

The *Journal de St. Pétersbourg* of 24th October reports that the surveying operations for the new line from Llobine to Kieff are completed, but that it is not yet known when constructional work will begin. This is the last section of the St. Petersburg to Kieff Railway. The *Journal* of 29th October states that a company is in process of formation for the construction of a railway in the Southern Caucasus. The first portion to be constructed is the line from Djoulfa to Adji-Koboul by way of the Arako Valley. Its length will be 343 versts (227 miles).

Arrangements had been made for the repair of the overhead equipment on the Devonport and District Tramways between Milehouse and Tor-lane damaged in the gale last May. Since the announcement was made that the company had paid to the corporation the rent of the leased lines, and withdrawn its appeal against the decision of the magistrates, imposing fines for discontinuance of the service on the leased lines, there have been repeated rumours that the company contemplates resuming the service on these lines; but, so far as can be ascertained, no arrangements have yet been made to provide such service.

According to a Colonial-office report on Hongkong the Chinese section of the Kowloon-Canton Railway made considerable progress during 1908 under the direction of Mr. Grovo, who has stated that there is every prospect of opening a length from Canton of 30 miles by April, 1910, and anticipates that he will be able to run through trains for traffic with the British section on or before July 1st, 1911. Negotiations carried on at Pekin for a construction loan for the northern portion of the Canton-Hankow line had not resulted in any loan agreement by the end of the year. The southern section from Canton northwards made some progress under a Chinese chief engineer and with Chinese capital. By the end of the year about 40 miles were open to traffic.

The London County Council Highways Committee has passed a resolution in favour of the construction of an electric tramway from Woolwich to Eltham. This line, over two miles in length, will be constructed on the overhead system at a cost of £76,480. In order to overcome the objection raised by the Greenwich Observatory authorities, it is proposed to use two overhead wires instead of one only for each track, thus completely insulating all conductors. To construct the line on the conduit system would, it is estimated, cost £101,120, and the delay in proceeding with the work has been due to the difficulty in adopting a cheaper system of traction in view of the probability of there being a loss on working for some years to come. It is proposed to run through cars between Eltham and Abbey Wood. The Borough Council has carried out street improvements in anticipation of tramways being laid.

The *Canada Gazette* of the 16th October contains a notice to the effect that application will be made to the Parliament of Canada, next session, for an Act incorporating a company, under the name of "The Nelson River Railway Company," with power, among other things (1) to construct and work a line of railway from a point on Lake Winnipeg, between the Nelson and Saskatchewan rivers, to the Hudson Bay Railway; (2) to construct, acquire, charter and operate vessels from Winnipeg and other places on the Red River and the Saskatchewan River to Lake Winnipeg to connect with the said railway; (3) to construct and operate tramways at points on the Nelson River and on the Saskatchewan River where necessary to transport freight and passengers around any rapids upon these rivers; (4) to operate steamers, &c., from a point on the railway, to be constructed by the company, to places on the Nelson River, and also between places on the Nelson River; (5) to operate lines of steamships between the mouth of the Nelson River and any other places; (6) to acquire, utilise and develop water-powers on the Saskatchewan and Nelson rivers, &c.

The County Council Improvements Committee decided to draw attention, as a matter of urgency, to the proposals for widening the main thoroughfare from Dockhead to Greenwich. The scheme has been proposed in connection with the reconstruction for electric traction of the existing tramways from Tooley-street to Deptford, and their extension over Deptford Creek Bridge to join the electric tramways in Greenwich. The gross cost of the improvement was estimated at £151,000, and the net cost at £148,500. The Committee recommend the construction of a new street between Dockhead and Jamaica-road. In connection with the reconstruction of the Highgate-hill tramways, it is proposed, owing to the steep gradient of the route, to fit with a special kind of brake the electric cars to be used on these lines, and to lay the slot rail with a projection of one-eighth inch above the adjacent paving in order to provide for the efficient working of the brakes. With the view of testing the working of the special brake in question, it has been decided to arrange for a short length of track at the cenrtal car repair depôt in Woolwich-road to be laid with the slot rail raised above the surface of the track. The cost of the work is estimated at £50.

Bridge reconstruction on the Northern Pacific Railway, states an American contemporary, is being carried on in a systematic manner with the purpose of having all openings spanned by permanent structures. The total length of timber structures replaced by steel bridges, embankments, or in other permanent form from July 1st, 1885—when the work was commenced—to June 30th, 1909, has been 112.75 miles. During the year ending June 30th, 1909, there were 90 bridges replaced and 16 abandoned; of 46 bridges, 29 (5479ft.) were replaced by embankments, and 17 (3268ft.) by truss, plate, girder, and I-beam spans. The annual report, from which the above figures are taken, states that there are now under construction on operated lines 2302ft. of steel girders on concrete piers, 835ft. of steel trestles, and 1616ft. of reinforced concrete trestles. It is expected that by the end of 1911 all timber structures on the main line between St. Paul and Livingston, Mont. (1007 miles), will have been replaced with steel or concrete. A plant has been established at Glendive, Mont., for making concrete piles and slab girders with which the present pile bridges—which it is not necessary to replace with steel girders—can be replaced in concrete with ballasted decks. This latter type of construction is very similar to that of the concrete trestles of the Chicago, Burlington, and Quincy Railway.

NOTES AND MEMORANDA.

The plasticity of clays may be determined quickly and easily, according to a United States Geological Survey bulletin article by Mr. H. E. Ashley, by observing their absorption of certain dyes; malachite green giving very satisfactory results. Mr. Ashley tested most of the well-known commercial clays with a standard green solution and found that the absorption of the colouring of the dye corresponds very closely with their actual known plasticities.

An inquiry has been made into Indian soils, with regard to their capacity for taking up nitrogen, by nitrifying organisms and the purification of sewage and sullage. It is stated that the soil almost everywhere in India is peculiarly well adapted for the purification of sullage, and that the land treatment of sullage is simpler, cheaper, and more efficient than treatment by filter or sprinkler beds. Compared with effluents from artificial filters, land treatment can in India produce a far better effluent, both chemically and bacteriologically. With the great necessity for a liquid fertilising medium, it seems likely that caste prejudice will not long withstand the manifest advantages of applying fertilisers in some form.

A new method of removing water from oils intended to be used for insulation purposes in transformers is reported from France. The dehydrising agent used is sodium. This metal is added in small quantities to the oil, when hydrogen is formed, the soda falling to the bottom. About three-quarters of an ounce of sodium is added to 20 gallons of oil, more being added gradually until no more gas is disengaged. The oil should be shaken up at intervals for a period of three or four days, and it is found that the longer the oil is allowed to mature over the deposit of soda the stronger will be its insulating powers. Oil, it is said, can be treated in the transformers themselves, the sodium being melted and moulded into sticks, which are attached to wires and plunged into the liquid. Dehydrisation in bulk, however, is naturally preferable.

The production of steel ingots in France in the first half of 1909 amounted to 1,506,329 metric tons, as compared with 1,364,979 tons in the corresponding period of 1908. The Meurthe-et-Moselle District leads with 688,236 tons, followed by the North with 372,169 tons. The Center produced 107,935 tons and the Loire 81,077 tons. Only 46,143 tons was acid Bessemer steel. The product of basic Bessemer was 909,995 tons; of open hearth steel, 541,508 tons; of crucible steel, 7973 tons, and of electric steel, 620 tons. The production of finished iron and steel was 1,006,436 tons, which included 182 755 tons of rails, 177,471 tons of plates, 69,669 tons of beams, 140,880 tons of shapes, 251,256 tons of various merchant products, 15.090 tons of tires, 55.820 tons of "machine," 28 887 tons of wire, 17,755 tons of tubes and pipes, 19,184 tons of tin-plate, 21,222 tons of forgings and 16,449 tons of steel castings.

The view generally held that in the liquefaction of gases in the Linde or Hampson apparatus the cooling is due to the Joule-Kelvin effect, has been attacked by Pictet in a series of articles which have appeared in the technical Press during the last half-dozen years. He has put forward an expression for the cooling which makes it depend on the work the gas does in overcoming the pressure in front of the expansion valve, and implies that it increases with increase of initial temperature and is almost independent of the fall of pressure. Messrs. W. P. Bradley and C. F. Hale, of the Wesleyan University of Connecticut, have made an extensive series of experiments on the cooling of the air in a liquefying apparatus in widely differing circumstances of pressure and temperature, and have found that the facts are qualitatively in agreement with the original theory, although there are quantitative differences to be explained, while they are diametrically opposed to the Pictet theory. The memoir is contained in the September number of the *Physical Review*.

A writer on motor engineering in a contemporary states that great difference of design still exists in relation to the method of supporting the engine from the chassis. This is explained by the fact that no one knows or can calculate precisely what twists and stresses may be taken by the main girders and transmitted to the engine base when the car is on the road. One designer's work in this respect is not directly comparable with another's, because it is affected by the method of suspension and springing and the weight distribution. One school stiffens the main chassis, narrows it, and brings the engine bearers directly and rigidly on it. The other school employs an underframe of small girder work suspended below the chassis, and places the engine, and sometimes also the gear-box, in this sub-frame. The advantages of each system are obvious, and it is a question of experience whether the simplicity of the former can be combined with sufficient strength, and whether the elasticity and strength of the latter can be obtained with sufficient lightness and without extra expense.

The soil of Indo-China contains many sorts of minerals, and a good deal of activity has been manifested, especially in Tonkin, in prospecting and reserving areas. The results, however, have hitherto been comparatively disappointing, and, owing to difficulty of access, poorness of deposit, lack of capital by the promoters, or other causes, the rule has been for these enterprises to end in nothing. An exception must be made in regard to the deposits of coal in Eastern Tonkin; the coal mines of Hongay on the coast, north of Haiphong, have been worked for some years with considerable success. The coal is anthracitic, and, besides being consumed in factories, &c., and sold to Chinese, is mixed with about 20 per cent. of Japanese coal and 10 per cent. of British coal-tar, and manufactured into briquettes, which are used by the steamers of the Messageries Maritimes and by the local railways. A special briquette is manufactured for the use of the navy. Other deposits of similar coal are worked at Dong-Trieu, Kebao, and elsewhere in Tonkin. The production of zinc also is increasing, the principal mine being in the Thai-Nguyen province of Tonkin. Zinc now takes a regular place in the list of exports. Alluvial tin is being worked in Tin-Thuc, near Cao-bang, and is said to give good promise of future development. Wolfram ore comes from the same district.

A novel method of killing moths and other insects which are harmful to grape vines has been adopted near Rheims. Posts supporting five-candle-power electric lamps were placed in the vineyards, from each of which a dish containing water with a top layer of petroleum was suspended. During the first night these traps were placed in three parallel rows at distances of about 200ft. from each other, the distance between each lamp being about 75ft. On the first clear evening late in July the current was turned on about 8 o'clock, and the lamps remained burning until an hour or so after midnight. Soon after the lamps were lighted the insects swarmed towards them, and were rapidly killed either by the fumes of the petroleum or by the petroleum itself. The same operation was resumed the next clear night, but the lamps of the two outside rows were placed about 25ft. closer to those of the centre row, and this was repeated in each of five subsequent clear nights, so as finally to bring the three rows within about 50ft. of each other. During the succeeding six or seven clear nights the movement was reversed in the same manner, so as to return the lamps to their position of the first night. As to the position of the lamps, numerous experiments were made during these trials, and it was proved that the greatest number of insects were killed when the petroleum dish was elevated only a few inches above the ground. These experiments were witnessed by representatives from a number of leading champagne makers, and this method was recommended to all wine growers who can avail themselves of the services of electricity.

MISCELLANEA.

The use of electric power for driving textile machinery in the New England States is steadily increasing. There are now some forty steam turbine generating plants in this important manufacturing district.

The *Bulletin Commercial* (Brussels), quoting from the Dutch *Telegraaf* of 29th October, states that the Communal Council of Rotterdam has decided on the construction of a large bridge at Delfshaven, with a view to the improvement of communications between Rotterdam and Schiedam.

The Port of London Authority have decided to provide entirely new electrically driven pumping plant for the purpose of raising the level of the water in the Royal Victoria and Albert Docks to the extent of 2ft. 6in., giving in the Victoria Dock a minimum depth of 28ft., in the Albert Dock 29ft. 6in., and in the Albert Dock basin 34ft. 6in. The passage between the Albert Dock and the basin is about to be deepened 4ft., so as to allow of the entry of larger vessels.

One of the leading German medical papers declares that the rays from mercury vapour lamps are injurious to the eyesight. Five cases are reported where either conjunctivitis or paralysis of the retina was caused by the use of mercury vapour lamps for therapeutic purposes or as illuminants in factories. This extremely powerful lamp, with its chemically active coloured rays, is comparatively new, and as yet scarcely understood. It is probable enough that the lamps should be so placed as to avoid the direct rays falling on the eyes. It is a point requiring further investigation.

It is announced that the launch of the third improved German Dreadnought, the Ersatz Beowulf, under the name of Thuringen, at the Weser Yard at Bremen, on the 27th inst., will be followed by the launch of the cruiser G, of the Invincible type, at the Blohm and Voss Yard at Hamburg, in December. Thus all the warships laid down in 1908 will have taken the water by the end of the year. The cruiser Blucher, representing the connecting link between the old cruisers and the new Invincible type, reached a speed of 25.25 knots on her trials off Danzig, which is above the contract speed.

Excellent progress is being made with the work of arming the battleship Collingwood at Devonport. The three centre line barbettes have received their equipment, the foremost shield and mountings having been lifted on board on Friday last, thus bringing the equipment weight of the 12in. armament in position to over 1000 tons. The mounting of the centre secondary armament of twelve 4in. guns has proceeded concurrently with that of the main armament, and this part of the equipment is generally complete. The other eight 4in. guns of the anti-torpedo armament will be mounted in pairs on four of the barbettes. The work of shipment has been greatly facilitated by the use of the new electrically worked 160-ton crane.

The work of repairing the damage caused to torpedo boat No. 105 by colliding with the battleship Hannibal in Torbay recently is well in hand at the Devonport Dockyard, and there is good reason to expect that its execution will still further enhance the reputation which the Western yard enjoys for expeditious repair work. Although only four days have elapsed since the vessel was moved into dock, the damaged bow section has been detached, and preparations are well advanced for replacing it with a new section. An examination of the damaged plates indicates that had the blow been end on instead of a glancing one, it would have very seriously impaired the safety of the vessel. No. 105 was for several years attached to the guardship at Bombay as a unit of the defence flotilla.

An order—No. 1155—under Section 79 of the Factory and Workshop Act, 1901, has been issued from the Home-office, containing regulations for the grinding of metals and racing of grindstones. The order deals with the duties of occupiers and employés as to the provision and use of the required appliances and with regard to other precautions, also specifying cases exempt from these regulations Regulations 2 and 3 come into force on December 1st, 1909, and Regulation 1 on June 1st, 1910. A further order—No. 1180—revokes the order of December 20th, 1882, whereby the special exception under Section 54 of the Factory and Workshop Act, 1878, as to overtime employment of women, young persons, and children on an incomplete process was extended to certain classes of non-textile factories and workshops.

The American Consul at Berlin reports that subsidies are granted to owners of industrial automobile vans, provided the vans and motors are constructed according to the specifications of the German War Department and the owners enter into a contract with the military authorities to place the trucks at the Government's disposal whenever the army is mobilised, and to keep the trucks always in such a condition during a period of five years that they can be utilised for military purposes. The cars are tested by military experts to ascertain if they fulfil the requirements of the specifications, and are subject to inspection by army officials at any time. Sale of subsidised trucks during the five-year period can only be made in Germany, and then only on the condition that the buyer binds himself to carry out the terms of the unexpired contract. Sales of the subsidised trucks to residents of foreign countries are not permissible.

The Committee appointed to inquire into the best means of extending the harbour facilities at Melbourne is understood to favour the construction of a new railway pier, 1750ft. long, 220ft. wide, and providing 30ft. of water at low tide. The plans include four berths, each 600ft. long. The pier will have railway tracks, a cross-over traverser, and other conveniences, so that the work of loading and discharging trucks can be carried on at each berth without interfering with the work at other berths. An elevated platform, 90ft. wide, will run along the centre of the pier, with an overhead shed of one or two storeys, 60ft. wide. This platform will extend to the full length of the pier on each side of the shed for a width of 15ft. Special trains will run upon the pier, and will discharge their passengers on these platforms. Overhead movable footbridges will be provided, one for each berth, so that passengers will go direct from the platform to the ships' decks without having to cross the railway tracks. The cost of this proposal would be £252,000. Provision has been made on the plans for the installation of electric cranes, but these are not included in the above estimate.

In an address, Mr. S. J. Watson recently called the attention of the Manchester section of the Institution of Electrical Engineers to the large aggregate amount of unemployed plant installed in central stations. No less than 37 per cent. of the plant is "spare," the difference between total capacity and maximum demand being 293,000 kilowatts, valued at £6,000,000. Undoubtedly the method of the future is to link up our town generating stations, and so avoid the necessity for multiplying spare plant. Mr. Watson takes a district surrounding Manchester as an example, and shows how by merely joining mains an additional load of 25,000 kilowatts could be undertaken without purchasing any new generating plant. Even the manufacturing department of the industry is not benefited by the present system, because capital charges on spare plant must contribute towards the difficulty of quoting sufficiently low charges to increase the power supply business more rapidly, and it is a well-known fact that the sale of machinery and apparatus for using electricity is a more extensive and more profitable trade than the sale of central station plant.

SHIPYARD OF THE JOH. C. TECKLENBORG A.G., AT BREMEN

(For description see page 519)

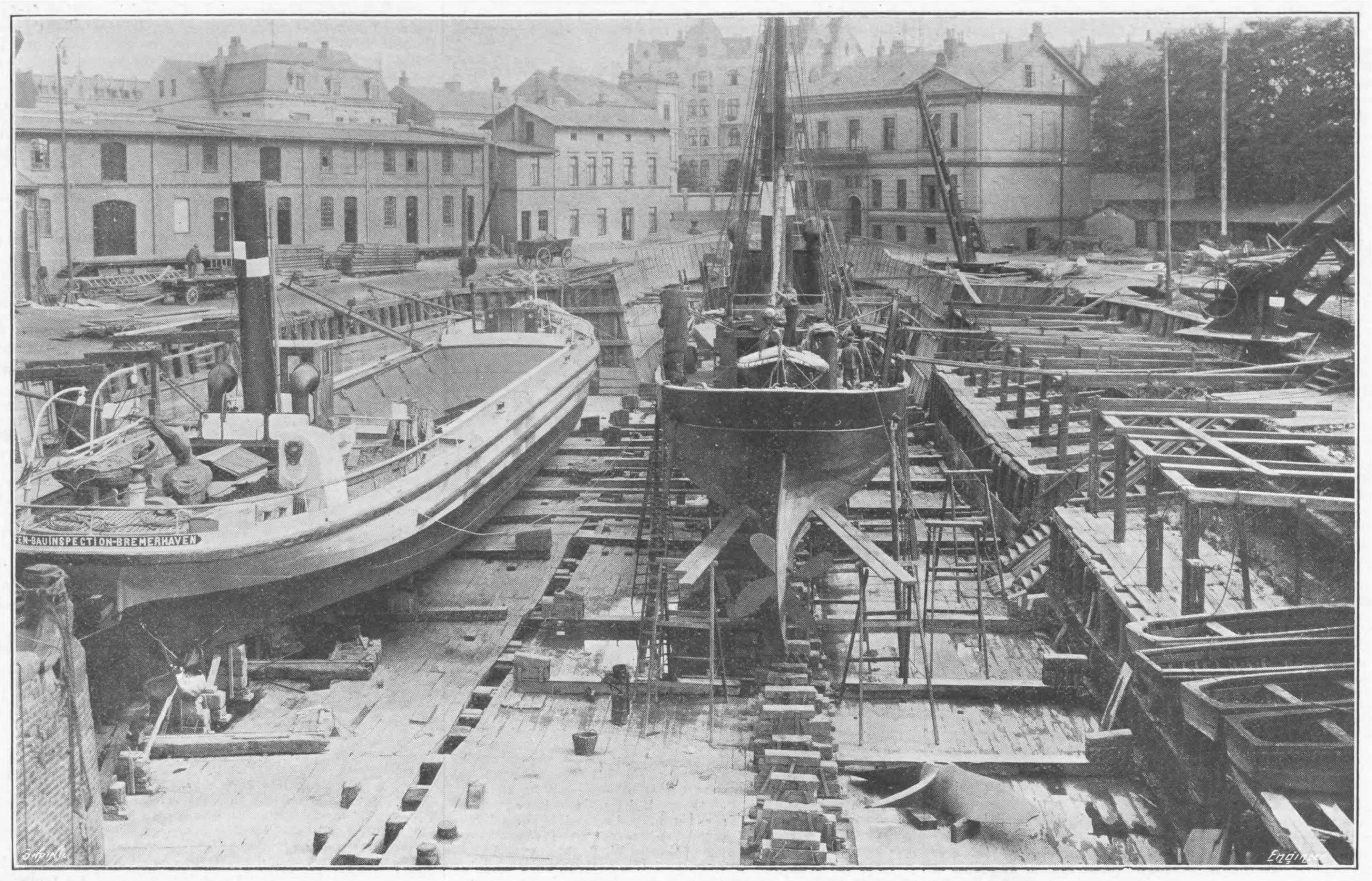

EN-BAUINSPECTION-BREMERHAVEN
Swain Sc.
Engineer

Fig. 8—THE OLD DOCK

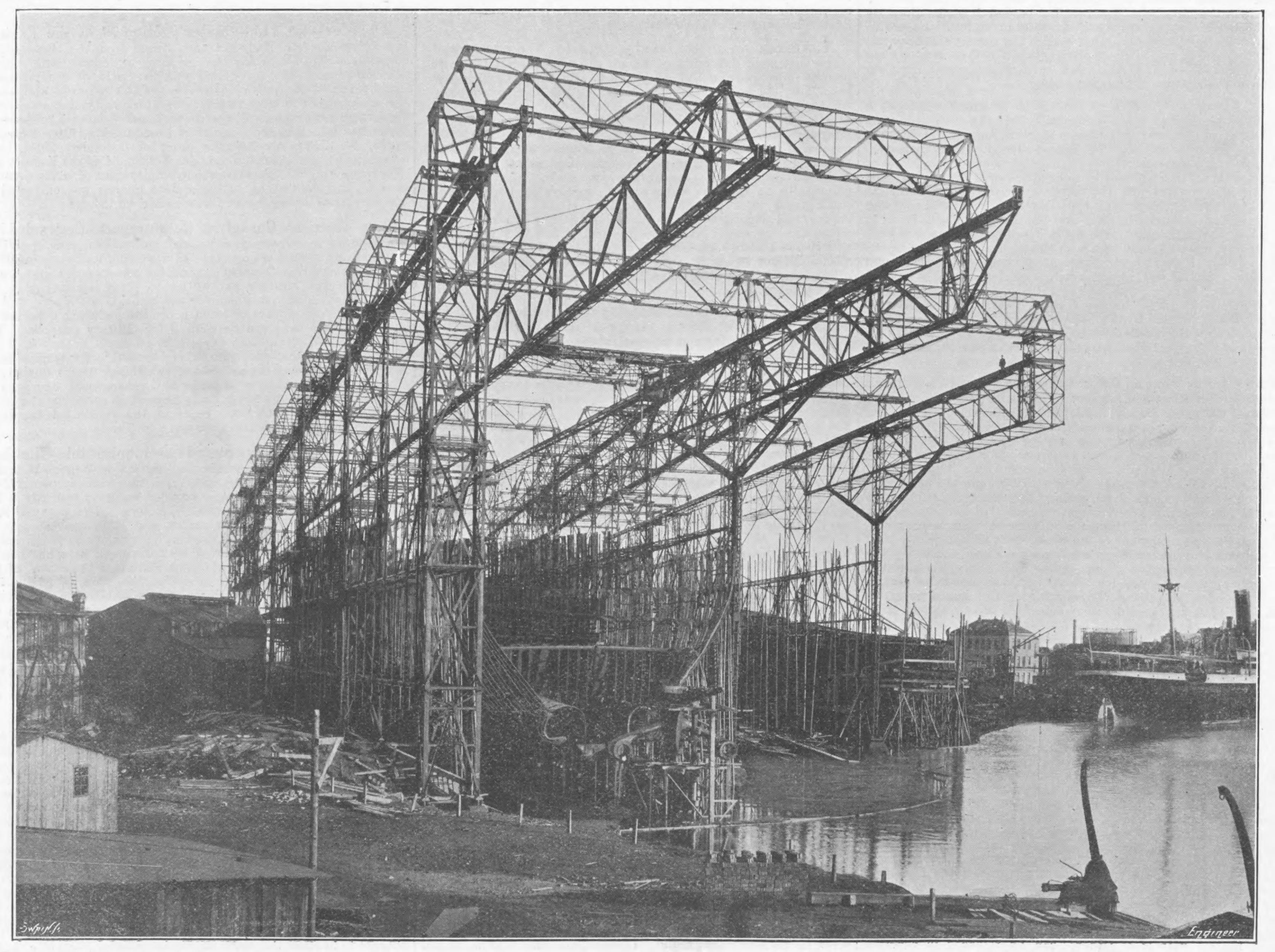

Swain Sc.
Engineer

Fig. 9—THE SHIPBUILDING GANTRIES

AGENTS ABROAD for the Sale of "THE ENGINEER."

AUSTRIA.—F. A. BROCKHAUS, *Seilergasse* 4, *Vienna.*
CHINA.—KELLY AND WALSH, LIMITED, *Shanghai and Hong Kong.*
EGYPT.—F. DIEMER, FINCK & BEYLAENDER, *Shepheard's-buildings, Cairo.*
FRANCE.—BOYVEAU & CHEVILLET, *Rue de la Banque, Paris.*
CHAPELOT & CIE., *Rue Dauphine*, 30, *Paris.*
GERMANY.—ASHER AND CO., 5, *Unter den Linden, Berlin.*
F. A. BROCKHAUS, *Leipzic;* A. TWEITMEYER, *Leipzic.*
INDIA.—A. J. COMBRIDGE AND CO., *Railway Bookstalls, Bombay.*
ITALY.—LOESCHER AND CO., 307, *Corso, Rome;* FRATELLI TREVES, *Corso Umberto*, 1, 174, *Rome;* FRATELLI BOCCA, *Turin;* ULRICO HOEPLI, *Milan.*
JAPAN.—KELLY AND WALSH, LIMITED, *Yokohama.*
Z. P. MARUYA AND CO., *Tokyo and Yokohama.*
RUSSIA.—C. RICKER, 4, *Nevsky Prospect, St. Petersburg.*
UNITED STATES OF AMERICA.—INTERNATIONAL NEWS CO., 83 *and* 85, *Duane-street, New York;* SUBSCRIPTION NEWS CO., *Chicago.*
S. AFRICA.—WM. DAWSON & SONS, LIMITED, 7, *Sea-st.* (*Box* 489), *Capetown.*
CENTRAL NEWS AGENCY, LIMITED, *Johannesburg, Capetown, Durban, &c., and at all their Bookstalls.*
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PUBLISHER'S NOTICES.

*** *With this week's number is issued, as a Supplement, a Two-page Engraving of the King's Dock, Swansea. Every copy as issued by the Publisher includes a copy of this Supplement, and subscribers are requested to notify the fact should they not receive it.*

FAMOUS RAILWAY WORKS.

*** *Coloured Engravings, on art paper, of the Britannia Bridge and Kilsby Tunnel Works on the London and North-Western Railway, suitable for framing, can be had in sets of four at 1s. 3d. per set, post free.*

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TO CORRESPONDENTS.

☞ *In order to avoid trouble and confusion we find it necessary to inform correspondents that letters of inquiry addressed to the public, and intended for insertion in this column, must in all cases be accompanied by a large envelope legibly directed by the writer to himself, and stamped, in order that answers received by us may be forwarded to their destination. No notice can be taken of communications which do not comply with these instructions.*

☞ ***We cannot undertake to return drawings or manuscripts; we must, therefore, request correspondents to keep copies.***

REPLIES.

M. G. S. (Hartlepool).—Dr. Mollier's tables and diagrams for saturated steam have not yet been published in English.

S. S. (Brentwood).—The only way to obtain such appointments is to apply for them. There is no competitive examination.

F. P.—The engine is being built by the North British Locomotive Company at Glasgow, and was described in our issue of November 5th, page 485.

L. N. H.—Possibly the best book is Parr's "Machine Tools and Workshop Practice." It is published by Longmans. The only works we issue ourselves are the series of Machine Tool Supplements, which cover the whole subject.

G. R.—The coefficient of fineness of a vessel is the relation which the underwater part bears to a rectangular block which would just contain it. Suppose, for example, that a vessel was carved out of a square section log of timber, and that in making it four-tenths of the wood were cut away, the coefficient of fineness of the vessel would be 0.6. For such elementary question about naval architecture we cannot refer you to a better book than Walton's "Know your own Ship."

MEETINGS NEXT WEEK.

INSTITUTE OF MARINE ENGINEERS.—Monday, November 22nd, at 8 p.m., at 58, Romford-road, Stratford, E. Lecture, "Notes on Boiler Covering," by Professor A. T. S. Frohmenger.

ROYAL SOCIETY OF ARTS.—Wednesday, November 24th, at 8 p.m., at John-street, Adelphi, London, W.C. Ordinary meeting. Paper, "Photo-Telegraphy," by T. Thorne Baker, F.R.P.S. (with Practical Demonstrations).

THE INSTITUTION OF ELECTRICAL ENGINEERS.—Thursday, November 25th, at 8 p.m., at the Institution of Civil Engineers, Great George-street, Westminster, S.W. Ordinary general meeting. Paper, "The Present Aspects of Electric Lighting," by H. W. Handcock and A. H Dykes.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND.—Tuesday, November 23rd, at 8 p.m., in the Lecture Hall of the Institution, 39, Elmbank-crescent, Glasgow. General meeting. Discussion on Mr. C. A. Ablett's paper, "Electrically-driven Reversing Rolling Mills." Paper, "Concrete Pile Foundations, with Particular Reference to the 'Simplex' Method of Constructing Same," by Mr. Alexander Melville.

PHYSICAL SOCIETY OF LONDON.—Friday, November 26th, at 5 p.m., at the Imperial College of Science, Imperial Institute-road, South Kensington. Papers: "The Effective Resistance and Inductance of a Helical Coil," by J. W. Nicholson, M.A., D.Sc. "Ductile Materials under Combined Stress," by W. A. Scoble, B.Sc. "The Recoil of Radium C from Radium B," by W. Makower, D.Sc., and Sidney Russ, D.Sc. "The Sun's Motion with Respect to the Æther," C. V. Burton, D.Sc.

THE INSTITUTION OF CIVIL ENGINEERS.—Tuesday, November 23rd, at 8 p.m., at Great George-street, Westminster, S.W. Ordinary meeting. Discussion on papers: "The Single-phase Electrification of the Heysham, Morecambe, and Lancaster Branch of the Midland Railway," by J. Dalziel and J. Sayers. "The Equipment and Working Results of the Mersey Railway under Steam and under Electric Traction," by Joshua Shaw, M. Inst. C.E. "The Effect of Electrical Operation on the Permanent Way Maintenance of Railways, as Illustrated on the Tynemouth Branches of the North-Eastern Railway," by Charles Augustus Harrison, D.Sc., M. Inst. C.E.

THE ENGINEER.

NOVEMBER 19, 1909.

ENGINEERING PROGRESS OF SOUTH AND CENTRAL AMERICA.

We have pleasure in announcing that an important series of articles from the pen of our Special Commissioner, Mr. Percy F. Martin, F.R.G.S., will begin in "The Engineer" next week. Mr. Martin, well known as an authoritative and critical writer upon the Latin-American Republics, is now in South America, will send us from time to time articles dealing with "Modern Engineering in the Spanish-American Republics," including descriptions of all important works in construction and contemplated, such as railways, docks, harbours, and will also discuss openings for trade and commerce. These articles will be fully illustrated with photographs, line-drawings, maps, etc., and when completed should form a valuable index to the engineering progress of the different countries visited, which will include Argentina, Brazil, Chile, Peru, Bolivia, Ecuador, Venezuela, Uruguay, Paraguay, Panama, Colombia, Honduras, Salvador, Gautemala, Costa Rica, Nicaragua, and probably Mexico. Should any of our readers desire to acquire any information with regard to trade opportunities of any particular Republic, letters of inquiry may be addressed to our Special Commissioner, care of "The Engineer," and they will be forwarded as opportunity offers.

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An Imperial Navy.

IT is not often that the Society of Arts listens to an address fraught with such great issues as that which Sir William White delivered on Wednesday evening. It was entitled "An Imperial Navy," and was a review of the work of the recent Conference on Imperial Defence, illuminated by observations based on the author's personal experiences during a recent visit to Canada. Everywhere that Sir William went, in small towns as well as great, and as much from French-Canadians as from those whose ties with the Mother Country are closer, he found the same recognition of the principle that it was the duty of the Colonies to assist in the maintenance of an Imperial Navy. "It has been recognised generally by Canadians," he told his audience, "that in future, the Navy must be regarded as the common possession of all parts of the Empire; that the immense outlay now required for the construction and maintenance of a supreme war fleet ought no longer to be borne by the Mother Country alone, but should be shared by the great self-governing Colonies." But Canada, like Australia and New Zealand, has not stopped at the expression of pious principles; she has actually, as the Blue Book issued on Wednesday tells us, formulated a scheme for the construction of a small war fleet of cruisers and destroyers, which shall be owned, manned and controlled by the Dominion, and shall be ordinarily stationed in Canadian waters on one side or other of the great continent, but which shall, nevertheless, fit into the general scheme of Imperial defence. Unfortunately, there is little homogeneity of opinion as to the best way of helping the Navy, and whilst one party favours the scheme outlined, another would prefer to see a substantial contribution made to the Estimates, whilst a third, taking a purely business view, fails to see that Canada has any need of naval assistance at all, and looks to the assistance of the United States in case of trouble. It may be presumed that the last party is composed largely of immigrant Americans, and we prefer to believe with Sir William "that strong national feeling in the Dominion revolts from any policy involving dependence upon the United States, and recognises the certainty that such dependence must necessarily be paid for dearly."

The particular direction which the co-operation of our Colonies may take in support of an Imperial Navy is, of course, a matter which must be very largely decided by the internal politics of the Colonies themselves, and is hardly a subject which comes within the scope of a technical journal. We may, however, express our general agreement with Sir William White's opinion that whatever the Colonies may decide to do, and particularly if they should ultimately build up for themselves, as Canada and Australia propose, navies of their own, there must be no question about concerted action when occasion arises. The Navy must be one, one great Imperial fleet, not a congeries of allied fleets, each member of which would have more or less independence of the others. "An Imperial Navy," said Sir William White, "must be one and indivisible, otherwise it cannot fulfil the duties imposed upon it. Its distribution and training in peace and its operations in war must be controlled by one central authority. Dominions beyond the seas may construct, maintain, own and control their fleets in peace time without serious loss of efficiency to the Navy as a whole; provided that types of ships and training of officers and men form parts of a common and complete scheme of naval defence. In time of war the available force of the Empire must act as a whole; its sections must be in constant, close, and cordial co-operation." It does not require the example of Yalu to enforce an argument which every one knows by a thousand instances to be fundamentally true. Allied fleets, like allied armies, have ever been weaker than a single homogeneous whole ruled by one desire and commanded by one authority. But to carry out this principle of oneness it is not sufficient that the fleets of Australia, Canada, and in due course, no doubt, of Africa, should faithfully serve as units of the Imperial Navy. To provide for their being of the greatest value in that capacity it is, in Sir William's opinion, essential that "the character and constitution of the fleet required at various times to maintain supremacy at sea and to ensure free communication between various portions of the British Empire, must be based upon a definite and well-considered scheme of naval defence—a plan of campaign. Each section of that fleet must have its duties and field of operations assigned thereto; its constitution must be regulated by the task imposed upon it. A central authority must frame the plan of defence, and be responsible for introducing necessary modifications as circumstances change. On that central authority all contributories to the Imperial Navy should find representation." Sir William White admits that such a General Naval Staff as is here foreshadowed would find the task before it far from easy. It would have to decide between the best class of ships to suit what would often be—if not conflicting—at least different interests. Canada's first object, for example, would clearly be to protect her own commerce, and she would, in Sir William's opinion, wisely require a fleet of commerce-protecting cruisers of a type the construction of which has for some years been dropped, but to which we are, with a "saner policy," now returning. Such matters could, however, be settled without any serious difficulty, seeing that, after all is said and done, the object of the Navy would be to preserve the integrity of the Empire as a whole, and to encourage and protect the trade between the different countries of which it is composed. Imbued with that single idea, difficulties would disappear. Canada, Australia, India, and America would recognise that the protection of the Mother Country was essential to their welfare, whilst Great Britain, on the other hand, would not delay in her recognition of the fact that the health of the trade of those dependencies was reflected in her own prosperity.

The idea of an Imperial Navy, which Sir William White laid before his hearers with all the rhetorical skill of which he is an acknowledged master, is the only solution of a problem which becomes more and more difficult as year succeeds year, and the outlay on the Navy increases by million upon million. The Colonies must take their share in the support of the Navy of the Empire to a far greater extent than the insignificant one and a-half per cent. that they have hitherto contributed. They recognise that fact now, and are hastening to acknowledge their obligations either by contributions to the Estimates, or by the purchase of ships that will relieve the Royal Navy. Only within the last two days we have learned from the official report of the Conference on Imperial Defence that the Australian Commonwealth will provide no less than thirteen ships of various kinds, New Zealand will give a battleship-cruiser with a substantial subvention, and Canada will construct a few cruisers and destroyers. "However much," said Sir William, and we quote it in conclusion, as it is the last word that can be said on this matter, "however much present conditions may be regretted, there is and can be no hesitation or doubt as to the course to be followed in regard to the British Navy. It must be kept supreme. The outlay necessary to attain that end is increasing by 'leaps and bounds'; the co-operation of the self-governing Colonies at this juncture, and the prospect of their continued and increasing help in the future, are facts of high import, and cannot fail to exercise widespread influence at home and abroad."

Propelling Machinery for Warships.

THE inaugural address which was delivered on Tuesday evening to the Junior Institution of Engineers by Engineer Vice-Admiral H. J. Oram, Engineer-in-Chief of the Fleet, on taking the presidential chair, is full of promise of future utility. The most substantial mistake made by those who invent and improve machinery of all kinds lies in producing that which is not really wanted, or cannot be used in the way intended. The mistake is normally the result of ignorance; not indeed of the principles of mechanics, but of the conditions on which any and every invention depends for its fitness. The modern machinery used in propelling vessels is all the result of hard work. Inventions are borne along the steadily flowing stream of time, continuously, without ceasing. Some come into harbour; the greater number sink. Admiral Oram recounted the recent history of the marine engine; and he supplied information which ought to do much to keep inventors from going astray, and wasting their time, their energies, and their money on devices which are futile. If he had done nothing more than explain with full knowledge of his subject, that the conditions prevailing in a ship of war are so different from those existing in a merchant ship, that what may be excellent in one is inadmissible in another he would have done most excellent service. He has, however, done very much more than this, for he has dealt with almost every department of marine mechanical engineering, and supplied information which has in many cases been regarded as confidential for reasons which no one understands outside the Admiralty.

He began by comparing the reciprocating engines of the cruisers Shannon, Minotaur and Defence, of 27,000 indicated horse-power, and of the battleship Lord Nelson and Agamemnon of 16,750 indicated horse-power, with the yet more recent turbine engines of the Indomitable 41,000 shaft horse-power. The former are, of course, the last word in that type of naval engine, running as they do at speeds of 120 to 145 revolutions per minute, and a piston speed of 1000ft. These things have been rendered possible by the use of forced lubrication. In destroyers the whole of the working parts are enclosed in an oil-tight casing. In the larger ships with reciprocating engines, pumps separate from the main engines are fitted for circulating the oil, the delivery pipes being provided in duplicate. The oil supply to them is first led to the main bearings and thence through the shafting to the others, and in these ships it was not considered necessary to apply forced lubrication to the crosshead pins or link gear. With a view to separating any water which might mix with the lubricating oil, owing to drainage from slide and piston-rod glands, an oil settling tank is fitted in each engine-room. It is all very pretty and simple—when we know how to do it. But this knowledge was not picked up in a moment. It is not, perhaps, too much to say that it is to forced lubrication the continued existence of the reciprocating engine in the Navy is largely due.

The experiences obtained in ships of war by no means coincide, however, with those had in the mercantile marine. Admiral Oram gives 13·48 lb. as the weight of steam used per shaft horse-power per hour in the Dreadnought, which is about 15 per cent. better than the results obtained with the reciprocating engines of the period. In later vessels the consumption has been reduced to a little over 12 lb. This does not appear to be the result obtained in our great liners. At all events, the reciprocating engine still remains in favour, and nothing is ever heard of the superior economy of the turbine—note, too, the return of the Cunard Company to the piston type in its latest ship—which could hardly be the case if the experience already obtained pointed to any substantial saving in fuel. It is possible, however, that the naval reciprocating engine is not as economical as its fellow in the Merchant Navy. The whole tendency is to simplify turbine propelling machinery. The addition of separate turbines for cruising purposes has been found to be a mistake. With superheating, the experience obtained seems to be altogether unfavourable in the turbine, because of expansion and contraction. As for piston engines, even with superheats as low as 60 deg. Fah. the high-pressure cylinder liners began to cut, and trials have been made by mixing superheated and ordinary steam. Admiral Oram did not mention the fact that this system was patented by Wetherhed some fifty years ago, and tried with very fair success. Superheaters cannot be used at all if salt water gets into the boilers, because the tubes suffer from rapid corrosion. But they last well with surface condensers if the make-up feed is fresh.

While referring to the difficulty of getting a high combined efficiency from the turbine and the propeller, he made no allusion to the recent schemes for the introduction of gearing or pumps between the turbine and propeller shafts. He concentrated his attention on the proposal that the turbine should drive a dynamo, and the dynamo should drive a motor on the propeller shaft. As the question stands now, he condemns the scheme very carefully, for reasons which do not seem to have suggested themselves to inventors. For example, it would be very difficult for a ship fitted with this class of machinery to keep station in manœuvres, because so far the various firms professing to make it can give only three electrical speeds, full, half, and quarter, a sub-division not nearly fine enough. Again, no saving in space would be effected, and there would be an absolute loss of 12 per cent. efficiency at least. It has not yet been shown that the increased efficiency due to larger diameter and slower speed of the screw would equal this, much less exceed it. Admiral Oram makes the remarkable statement that in particular cases, such as those supplied by large cruisers of the Invincible class, the fast running screws of the turbine have been as efficient as the slower running screws of the piston engine. Possibly this is, after all, not saying much for the latter. He gives a final blow to the scheme by saying that it is by no means clear that room could be found under the counters of war ships for screws larger than those now fitted. Mercantile practice is not much use as a guide it would seem.

He dismisses, as being for the time outside of practical politics, the use of oil or producer gas engines. A favourable estimate gives the output of gas engines and producers as one ton per 11.6 brake horse-power. But the turbine machinery and boiler of the Indomitable developed 13.8 shaft horse-power, and of the Bellerophon 13 shaft horse-power per ton. Against this is, of course, to be set an important reduction in the quantity of fuel to be carried. Admitting, however, that all other obstacles were overcome, the difficulty remains that no satisfactory gas producer has yet been devised for working with anything but anthracite, and this can only be obtained at a very few ports outside this country. Therefore, before any progress can be made with gas engines in the Navy a satisfactory bituminous coal producer must be available. Furthermore, a return to crank engines will certainly not commend itself to those who are familiar with the turbine. Dealing lastly with oil fuel, Admiral Oram told his hearers that so long as spraying with air or steam was retained no satisfactory results had been obtained. Spraying was now effected by a pressure pump, and the results were quite contenting. But he added that while the total supply of mineral oil is only 3 or 4 per cent. that of coal the use of oil as a fuel must remain strictly exceptional.

We congratulate Admiral Oram on his address. He certainly gave his audience a great deal to think about. If the thinking is done on right lines and without prejudice it must do the thinkers good. There is a great deal of ability wasted by the younger members of our profession because they have nothing to guide them along the proper path. Admiral Oram has said enough to stimulate his hearers to study the present position of propelling machinery in the British Navy—a very large subject—and in some measure, at all events, to keep them from travelling on wrong roads in the pursuit of improvements.

Ideal Locomotives.

WE think that the discussion concerning locomotive engines which has proceeded for several months in our pages may now close. We suspect, indeed, that our correspondents will feel grateful rather than angry. For some while past they have been repeating themselves; and the endeavour to adduce a new argument must have become irksome. Obviously those who have taken principal parts have held the faith that there must be an ideal locomotive; but there has been no unanimity as to what the characteristics of the ideal locomotive shall be. The discussion has been curiously narrow in its scope. As we have recently pointed out, it has dealt more with cylinder proportions than with anything else. Compounding and non-compounding are inextricably mixed up with the capacity of cylinders. Next to nothing has been said about boilers, or grates, or front ends. Nothing at all worth saying about balancing or the performance of a locomotive as a vehicle. The beginning and end of the controversy has been fuel economy, which is only, as we have often urged, a second-rate factor in determining the merits and demerits of any type of locomotive.

The present controversy is no way different from all other controversies; so far as we can see no conversions have taken place. Each man still holds that he is right. Furthermore, there has been very little direct practical evidence brought forward by any of the controversialists to prove his case, and many of the arguments used have only a limited application, while others ignore considerable factors, or are ignorant of their existence. No one has stopped to think of the element of first cost, or maintenance, or lubrication, or demurrage, or the effect of an engine on the road. We might name a dozen things well worth intelligent discussion about which nothing at all has been said. If these matters were taken into consideration we should be further than ever from arriving at an ideal locomotive.

The locomotive is the most remarkable machine ever constructed to develop power. No other motor works under the same varying conditions. At one moment we find it developing maximum horse-power while making, perhaps, ninety or one hundred revolutions per minute. Soon afterwards it is again giving out maximum power, while its cranks are turning round 300 or 350 times in a minute. It is a slow-speed engine. It is a high-speed engine. It is an all and every speed engine; and it is expected to be economical, no matter what the average cylinder pressures may be. The resistance which it has to overcome varies from minute to minute. It must behave well as a vehicle. It must be beyond all other machines trustworthy. With heavy, fast, long-run trains it has to work within an inch of its life for hours together. There is nothing like it in the world. The motor car has no such difficulties to contend against. If it has to climb a hill the gear is changed. There is no change gear for the railway engine. The torpedo destroyer's engines are to a certain extent like the locomotive; but the occasions when full power is wanted and put forth are quite rare. With the locomotive maximum power is the rule, not the exception.

It ought to be obvious that to get an ideal engine under such conditions is from one point of view hopeless; from another we have it already. Every locomotive is an ideal machine. All depends on the concept formed, on the standard of excellence to which the ideal engine must conform. As we have already said, each man will shape his own ideal, or will reject the notion as impracticable. So far no one has attempted to do more than say that some given type will be better than other types; but the so-called proof is seldom convincing, or, if convincing, satisfying. Take, for example, compounding. It would be quite out of place to say anything here about the merits or demerits of the system from a theoretical point of view. It is certain, however, that the principle has been very fully and carefully tried for a great many years on many of our great railways under the most varying conditions, and on none of them has it retained its position. It is merely wild hitting in the dark to say that its unpopularity is due to prejudice. The truth is that the only possible advantage the compound has over the non-compound is fuel economy; but as we have often explained, the saving must be a very large one if it is great enough to counteract contingent disadvantages. So far as we are aware, no one attempts to say that under favourable conditions the compound will not save coal. But the facts go to show either that these conditions are not present on British railways to any notable extent; or else that the expenses of maintenance and so forth are so great that compounding is not worth having. It is improbable that any of our correspondents has had recent running shed experience, or has received drivers' and examiners' weekly and daily reports. These things do not reach the public, but they represent very special and valuable information, enabling locomotive superintendents to decide on the perpetuation or rejection of any particular system of construction or method of working. We do not, of course, wish it to be supposed that we think that finality has been reached, and that no further developments or improvements are possible. Far from that, we believe that they will be made; but it is not necessary that they shall be confined to augmenting economy in fuel. But even in that progress will take place. Superheating has for sometime past been tried on a scale and with a completeness never before attempted in this country. Of the economy secured there is no question. Nothing but the lapse of time can tell us whether the price paid for the saving is or is not too great. Meanwhile we would ask our correspondents to possess their souls in patience. New experience will be acquired. New developments will take place, and they will, haply, find new things to say, and we shall find space in which they may say them at another time in the not distant future.

Warship Armament.

WITH a new type 13.5 gun on trial in the British Navy, and a 14in. gun in the United States also under test, it is impossible not to feel that we may be on the eve of another revolution in naval construction. Probably, however, every nation will hold back the actual mounting of heavier guns as long as possible, on the grounds that the adoption of bigger pieces would render obsolescent many existing ships which are now quite up to date. On a previous occasion some years ago, when there was a similar leaning towards a bigger gun, the introduction of more powerful guns on medium calibre checked any great progress in that direction. No war occurred to test whether a few enormously powerful guns were better than a larger number of more moderate pieces. For instance, it was never known whether the Benbow, with her two 16in. guns, was or was not a better ship than the Camperdown with four 13.5in. pieces. As the majority of the Admiral class received the Camperdown armament, and it was subsequently repeated in the Royal Sovereigns, the assumption is that the naval authorities of those days were satisfied that two enormously powerful guns were not equal to four guns of somewhat lesser power. The experiments of more than two enormously heavy guns was only tried in the Italian navy in the Lepanto and Ruggiero di Lauria classes. There is considerable doubt as to whether any of these ships ever used all four big guns at once, or what would have happened to them if they had done so!

To-day, however, ships are larger, and constructive methods have improved. The modern idea of a Dreadnought with 13.5in. guns is simply a Dreadnought that carries that calibre instead of the normal 12in., and as yet no idea seems to obtain of substituting a few heavy guns for a larger number of lighter ones. In connection with the armament of modern warships comes the problem of three-gun turrets, which appear in Japanese, German, French, and Italian designs. Whether in all these cases it will be proceeded with is another matter, but it is an indication of the problem that the immense length of modern artillery is producing. How to get the guns in is already an acute problem, for there must obviously be some limitation to the possible dimensions of warships. Their size cannot but be governed by the dimensions of docks; and even more by the depth of water in harbours and in channels. In Germany, where the draught problem is most acute, a solution has been sought in an enormous increase of beam. But here, again, limitations must be imposed by the width of the available dry docks. In the United States the Panama Canal is a governing factor, and one very promising design appears to have been abandoned owing to the fact that it would have been unable to negotiate the canal. It is said to be a fact that if the Dreadnought went up to Chatham Dockyard she might have to wait for some weeks before she could get down again.

These are problems that must profoundly affect naval armaments, and since that solution of the problem which consists in making the ship bigger cannot be very much longer continued, the coming controversy in the immediate future is not unlikely to be a revival of the old puzzle: Are a few very powerful guns superior or inferior to a larger number of lesser power? To this question there is not a single shred of historical data to assist an answer.

LITERATURE.

The Gas, Oil and Petrol Engine. By Dugald Clerk, F.R.S., M. Inst. C.E. Vol. I. 9 × 6. 380 pages. Longmans and Co.

No one who is at all acquainted with the immense progress made in late years with all that appertains to the internal combustion engine will be surprised to hear that it has been found necessary to re-issue Mr. Dugald Clerk's well-known book in a form more than double its original size. The last edition of the book was printed in 1896, and in the thirteen years that have elapsed the science of thermodynamics, as affecting the internal combustion engine, has been greatly changed. The present volume is devoted to thermodynamics, and some three-fourths of it is new. A companion volume on the engine in practice is to follow, and it will probably be found that that side of the subject has required to be rewritten to an equal extent. The modern petrol engine has almost entirely been created since 1896, and its handy and portable size has led to its characteristics being studied to a greater degree than those of any other types of engine; so there is correspondingly more to write about it.

This first volume is divided into ten chapters and five appendices. The introductory chapter is an historical sketch of the gas, petrol and oil engine to 1908, a subject for the discussion of which Mr. Clerk, by reason of his legal experience, is peculiarly fitted. Its substance is chiefly that of the corresponding chapter in the earlier edition, but brought up to date. The author is able to give some very interesting statistics of progress made in the manufacture of gas engines, particularly those of large size. He quotes Mr. Adams' estimate that 350,000 horse-power is now at work or under construction in the United States. As regards Europe, he gives Mr. Mathot's figures, which are so striking as to warrant reproduction. The estimate of large gas engines "recently" built in Europe is:—"Messrs. Crossley Bros. 57 motors, with an aggregate of 23,660 horse-power; Messrs. Ehrhardt and Sehmer 59 motors, total 69,790 horse-power; Otto Gasmotoren Fabrik 82, total 47,400 horse-power; Gebrüder Körting 198, total 165,760 horse-power; Société Alsacienne 55, total 23,410 horse-power; Société John Cockerill 148, total 102,925 horse-power; Société Suisse 67, total 8620 horse-power; Vereinigten Maschinenfabrik Augsburg and Nürnberg 215, total 256, 240 horse-power. The mean power of the gas engines made by Messrs. Ehrhardt and Sehmer and the Augsburg and Nürnberg companies is in each case 1200 horse-power. It is stated that in one factory there are gas engines representing a total output of 35,000 horse-power. These European large gas engines thus give nearly 575,000 horse-power between them."

The next three chapters describe the method of operation of the internal combustion engine, its general classification and the thermodynamic principles concerned, assuming the working medium to be "air." This part of the book is not new, and we need not refer to it further, beyond saying that it is a useful, though somewhat lengthy, discussion of the various conceivable cycles of operation.

Chapters IV. and V. contain important new matter. The author discusses the effect of temperature and pressure upon specific heat. Regnault's, Joly's, Holborn, and Austin's, Mallard and Le Chatelier's and Langen's results are carefully discussed, and the complicating effect of dissociation considered. The rapid increase of specific heat with temperature, in the working medium of the gas engine, is, of course, now admitted. It is interesting to notice how very slowly—judging from Joly's figures for carbon dioxide—the specific heat changes with pressure; even at 320 lb. per square inch, the specific heat was found to be only some three per cent. greater than at 100 lb. per square inch. Having cleared the ground of these preliminary matters, Mr. Clerk proceeds to his main theme, the analysis of explosion curves, and to this devotes nearly one hundred pages of the book, besides a large part of the appendices.

Chapter VI. is given up to the experimental investigations of explosion and cooling in a closed vessel, and the following chapter to a discussion of the data deducible. The very earliest experiments having permanent value were made by the author in 1884. This early experience, together with the close attention he has given to the subject in the twenty-five years that have followed, entitles him to speak with greater authority on these matters than any other man living. But so large is the subject and so many difficulties does it present that even a preparation such as Mr. Dugald Clerk's is none too much to ensure an effective grasp being obtained. Even to Mr. Clerk himself we feel that some of these difficulties have proved unsurmountable—largely, no doubt, because of the uncertainty of our knowledge of many important physical data.

Among other matters the author discusses the anomaly in Grover's experiments that so much lower pressures were found than had been obtained by other observers. This he attributes to incomplete combustion, which we seem to recognise as a favourite explanation of Mr. Clerk's. He does not accept the experimenter's own suggestion that this result was due to the influence of a water film, although support is afforded to this hypothesis by the fact that oil engine builders are now using water injection for the purpose of reducing pre-ignition. Mr. Clerk's explanation, ingenious as it is, does not render Grover's view any less tenable.

The eighth chapter on "explosion and cooling in a cylinder behind a moving piston," brings theory into very close relationship with actual practical work. The extra complication due to the moving piston is, from the theoretical point of view extremely—almost bafflingly—great. The exposed surface is continually altering its area, its temperature is continually being "wiped down" by the piston, the shape of the space in which the hot gases are confined is continually changing. Worse still, the piston is at a very different temperature to the walls, and at different moments is at differing distances from the centre of the volume of the gas. Mr. Clerk needed therefore not a little courage to compile even twenty-two pages on so thorny a subject. Experiments are few and uncertain, so that there is difficulty, even with the assistance of the very elaborate work of Messrs. Bairstow and Alexander—highly creditable as the latter is to the Royal College of Science—in accepting some of Mr. Clerk's conclusions. This difficulty is noticeable even in the author's description of his own experiments on successive compressions and expansions in a gas engine cylinder, where in order to obtain his well-known specific heat figures, he had to make an assumption as to the cooling loss, the validity of which the B.A. Gaseous Explosions Committee found it necessary to criticise. The Committee gave reasons for thinking that Mr. Clerk's figures were all of them too high. We notice that although this report appears as an appendix to the book, the author has not revised his figures, and it would possibly have been better, had arrangements so permitted, to have delayed publication until this could have been done. An unexpected feature of these particular experiments is that the specific heat values show but little increase at the higher temperatures, which seems an unlikely occurrence, since any dissociation of the carbon-dioxide that there may be would tend to increase materially the apparent specific heats at the higher temperatures. All these matters are now under investigation, and one cannot but feel the difficulties in which an author is placed who endeavours to deal with the subject at the present time.

In the last chapter we come to considerations of the efficiency of actual engines. We find an increase in brake thermal efficiency from 14 per cent. in 1882 to 32 per cent. in 1908; this is rapid progress, and we do not think the figures can go much higher unless some means of compounding is found. In this chapter Mr. Clerk also describes the gas engine tests carried out by the Institution of Civil Engineers' Committee, the optical indicator devised by Professor Hopkinson, and the measurements of the mechanical efficiency made therewith on a petrol motor. An account is also given of Professor Burstall's 1908 report to the Institution of Mechanical Engineers on some experiments made with a Premier gas engine working with Mond gas at various compression ratios. The volume concludes with five appendices, on the "Determination of Charge Weight in Internal Combustion Engines," on the "Calculation of Adiabatic Lines with Varying Specific Heat of Working Fluid"—an approximate method—on the "Calculation of Efficiency with Varying Specific Heat of Working Fluid"—an approximate graphical method,—the first report of the B.A. Committee on "Gaseous Explosions," and lastly, a table of the "Adiabatic and Isothermal Compression of Dry Air."

Except for small details, the worst criticism to be made of the book is that it attempts too much. On the other hand, there are many reasons to be grateful to Mr. Dugald Clerk for bringing into a single volume an account of the experiments of so many of the workers in this field. Although, for the reasons mentioned, it would be rash to consider what is written in this volume as the last word on the subject, it is interesting to read Mr. Clerk's conclusion at the end of Chapter VII., that—"So far as economy is concerned, heat loss may be rendered negligible without having recourse to incandescent walls or non-conducting linings, which for a long time have formed the favourite device of the inventor who imagines that the greater part of the heat loss of an engine is through the enclosing walls. It is also evident from the curves that the rate of reduction of heat loss diminishes with increased density, so that little increased heat saving would follow greatly increased density," and that "it is evident that loss by cooling may be reduced indefinitely by increasing the dimensions of the engine, so that when volumes of flame, such as 64 cubic feet, are used in an engine, which is the order of dimensions of many large engines now, heat loss may be rendered practically negligible even with a non-compression engine."

In case the book may go to yet another edition at an early date, we draw Mr. Clerk's attention to the table of efficiencies on page 92, which is repeated in exactly the same form seven pages later on, and in each case with three out of the eight figures incorrect.

We are grateful to Mr. Dugald Clerk for the first instalment of this new edition, but we shall look forward with particular interest to the next edition, in which the author will, perhaps, be in a position to give us the result of his analysis of the important experimental work now in hand, which it is possible will by then have been brought to a conclusion. The following interesting prophecy made by the author at the close of his sketch of the past history of the internal-combustion engine is worth quoting in conclusion:—"These motors have almost fulfilled the expectations of those engineers who—like the author—have devoted a large part of their lives to their study and advancement. They are looking forward now to the completion of the work begun so many years ago, and expect at no distant date to find the internal-combustion motor competing with the steam engine, even in its latest form—the steam turbine—at sea as vigorously as it does at present on land."

SHORT NOTICES.

The Polar Planimeter. By F. J. Gray. London: St. Bride's Press, Limited. Price 1s. net.—The variety of uses to which a planimeter may be put are probably recognised by few engineers other than ship's draughtsmen. There are applications of this beautiful instrument which would, we believe, be found to simplify many otherwise tedious calculations of a graphical nature; but there is, unfortunately, a prevalent idea that its use requires high mathematical ability and considerable skill in manipulation. Even of those who make frequent use of the planimeter, few seem to understand its principle. To all classes we would recommend the present little volume, as it contains everything that is necessary for an understanding of the instrument. There are many accounts of the working of the planimeter to be found in various places, but nearly all these involve the higher mathematics. In this work the explanation is given in simple terms, and does not call for more knowledge on the part of the reader than is ordinarily possessed by many people to whom its advantages are at present unknown, and whose work would be considerably simplified and expedited by its use. The author bases his explanation on a conception of the wheel of the instrument as travelling along a path made up of a succession of concentric circular arcs in the form of steps. Such a geometrical solution has, we know, been given before; but the present book makes it available to many who would otherwise not have heard of it.

Elementary Electrical Calculations. By T. O'C. Sloane, Ph.D. London: Crosby Lockwood and Son. Price 9s. net.—The study of electrical engineering is essentially mathematical, and no student can be well advised who takes up the theory of the subject without having previously mastered at least the more elementary portions of the different branches of mathematics. In the present work the author has attempted to cover a wide field, embracing all the more fundamental calculations of an elementary course of study in this particular subject. Some idea of the work and of the class of student for whom it is suited will be gathered from the author's statement in his preface. According to this there are very few calculations in the book calling for the use of algebra higher than that involved in using the various applications of Ohm's law. This is true of the earlier parts of the book, but towards the end determinants and theories involving a knowledge of the calculus are introduced, so that the author apparently presupposes a simultaneous study of pure mathematics on the part of his readers. To a student without mathematical knowledge, or to one who has already acquired a fair amount, the book will, we think, be not altogether indispensable; to those who commence their acquaintance with the two subjects at the same time it should prove of some value.

BOOKS RECEIVED.

Machine-shop Drawings. By Fred. H. Colvin. London: Hill Publishing Company, Limited, 6, Bouverie-street, E.C. Price 4s. 6d. net.

The Ore Deposits of South Africa. Part II. By J. P. Johnson. London: Crosby Lockwood and Son, 7, Stationers' Hall-court, E.C. Price 5s. net.

Laboratory Notes on Iron and Steel Analyses. By Walter Macfarlane, London: Longmans, Green and Co., 39, Paternoster-row, E.C. Price 7s. 6d. net.

The Apprentice's Course of Experimental Physics and Mechanics. By J. L. Maxim, B Sc. (Vict.), F.G.S. (Lond.). London: Longmans, Green and Co., 39, Paternoster-row, E.C. Price 1s. 6d.

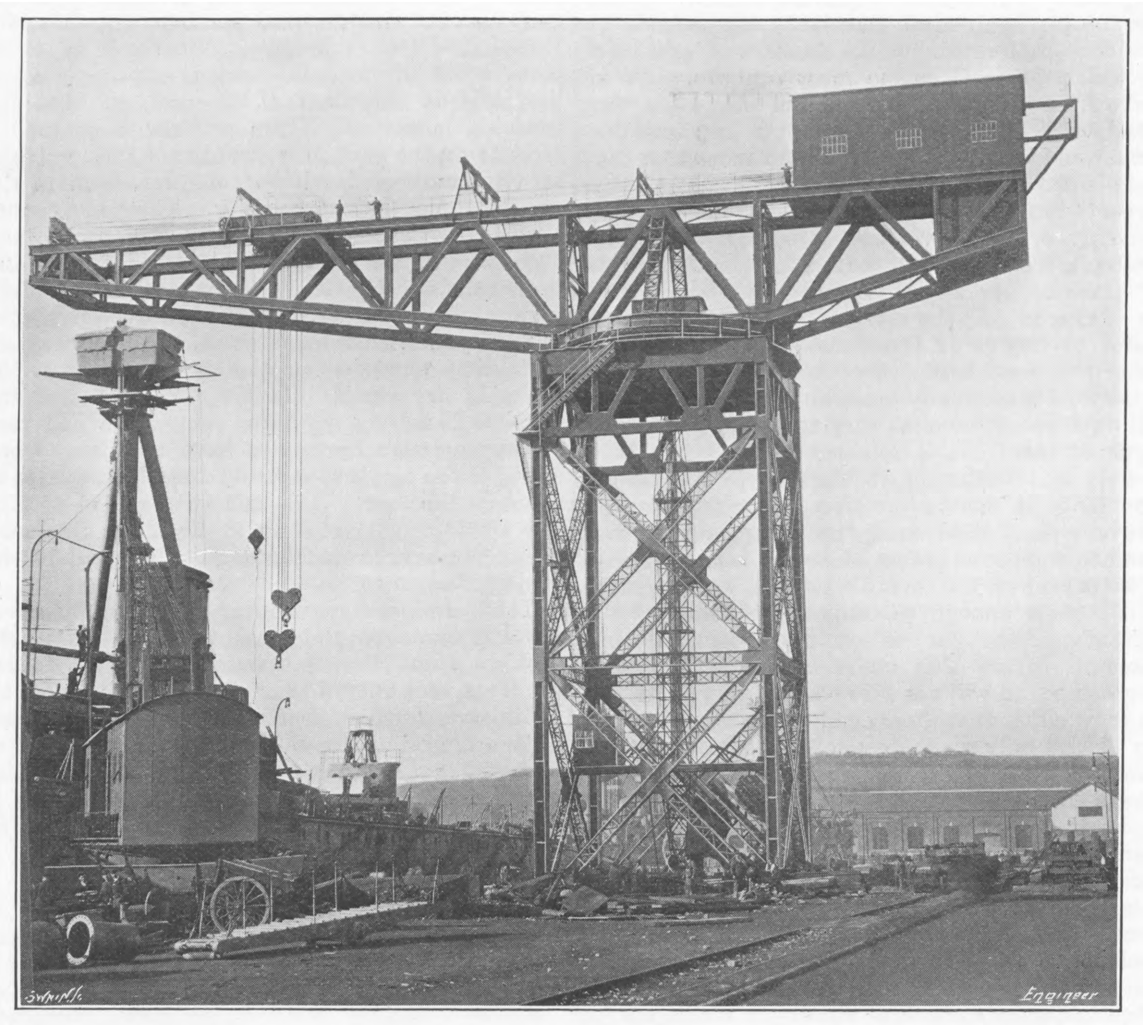
Oscillations de Lacet des Véhicules de Chemins de Fer. By Georges Marié. (Extrait des Annales des Mines.) Paris (VIe.): H. Dunod and E. Pinat, 49, Quai des Grands-Augustins. Price 3f.

Etude Complémentaire sur la Stabilité du Matériel des Chemins de Fer. Théorie des Déraillements; Profils des Bandages. By George Marié. (Extrait des Memoires de la Société des Ingénieurs Civils de France.) Bulletin de Mai, 1909. Paris (VIe.): H. Dunod and E. Pinat, 49, Quai des Grands-Augustins. Price 2f.

THE Government chincona factory in Bengal last year utilised 938,800 lb. of bark. The quantity of quinine manufactured was 36,919 lb., and of cinchona febrifuge 7281 lb. A start was made to turn out quinine in tablet form. The receipts of the factory fell short of the expenditure by Rs. 31,000.

REVOLVING CANTILEVER CRANE

COWANS, SHELDON AND CO., LIMITED, CARLISLE, ENGINEERS



160-TON ELECTRIC REVOLVING CANTILEVER CRANE.

AN excellent example of modern cranework has recently been supplied to the Admiralty at the Keyham extension of H.M. Dockyard, Devonport, by Cowans, Sheldon and Co., Limited, of Carlisle. The crane, which was completely designed by the manufacturers, is nominally of 160 tons lifting capacity, but has been tested in accordance with the usual Admiralty requirements with a load of 240 tons. From the illustrations it will be seen that the crane is of the revolving cantilever type. The crane is constructed to lift a working load of 160 tons at 25ft. radius, 80 tons at 105ft. radius, and 50 tons at 128ft. radius. The various motions are being worked at the following speeds, which are somewhat in advance of the specified requirements:—

Main lift,	160 tons (two blocks)	at 6ft.	per minute.
,,	80 tons (one block)	at 6ft.	,,
,,	loads up to 15 tons	at 30ft.	,,
Light lift,	30 tons	at 20ft.	,,
,,	loads up to 7½ tons	at 75ft.	,,
Traversing,	160 tons	at 30ft.	,,
,,	80 tons	at 60ft.	,,
Revolving,	160 tons, 1 revolution in 8		minutes.
,,	80 tons, 1 revolution in 6		,,
,,	no load, 1 revolution in 6		,

The main lifting gear consists of two independent purchases of 80 tons capacity each, this arrangement being provided in accordance with Admiralty requirements, to enable long guns and shafts to be angled when being passed through hatchways, &c. Each main block is carried on eight parts of 4¾in. circumference steel wire rope, which is sufficiently long to enable the blocks to be lowered 50ft. below the quay level. Each rope is coiled in one layer on a turned and grooved cast iron barrel, 6ft. 6in. diameter by 10ft. long. The ropes were supplied by T. and W. Smith, Limited, of Newcastle-on-Tyne. They were of the firm's extra special flexible plough steel quality, and comprised the following lengths and sizes:—2034ft. and 2053ft. of 4¾in. circumference; 1218ft. of 4¼in. circumference; 162ft. and 277ft. of 3in. circumference. The main barrels are driven from the motor through three reductions of steel machine-cut gearing. The speed-changing gear is enclosed in a complete cast iron oil bath. An automatic solenoid brake is fitted on an extension of the armature shafts, and arranged to come into action immediately the current is cut off from any cause. In addition to the solenoid brake, a large automatic mechanical brake of the Weston screw type is fitted on the intermediate shaft. These brakes are constructed entirely of steel and gun-metal, and are enclosed in a complete cast iron oil bath. The light lift gear is of similar construction to the above, but is arranged to lift the load on four parts of 4¼in. circumference steel wire rope, two parts being coiled on the barrel in right and left-hand coils. The motor, speed changing gear, and brakes are arranged to be interchangeable with those for the main lift. The traversing gear consists of two barrels, driven by a motor through steel machine-cut gearing, and is provided with an automatic solenoid brake on the intermediate shaft. Two ropes are taken from each barrel, one being carried to the trolley direct and the other round the pulleys at the end of the cantilever and back to the trolley. The whole of the above machinery is carried on one self-contained steel framing, which is rigidly bolted to the cantilever. An overhead traveller is provided over the gear, and arranged to lift one main barrel complete with its spur-wheel and shaft, which represent a load of 12 tons, and to lower it to the ground level. The lifting gear on this traveller is worked electrically, and the traversing and travelling motions by hand power. The whole of the machinery is enclosed in a strong steel house, which is 46ft. long by 24ft. wide by 23ft. high, covered on the sides and ends by flat steel plates, and on the roof by corrugated sheeting. The back end of the house is arranged to enable the overhead crane to be travelled out when required.

The trolley frame is constructed entirely of steel plates and sections, and is mounted on four pairs of cast steel rail wheels. The various rope pulleys are of cast iron, well ribbed, and bushed with brass. Heavy straining screws are fitted at each end of the trolley for adjusting the traversing ropes.

The two cantilever girders are about 220ft. long by 28ft. deep at the centre, and are fixed parallel to one another at 20ft. centres. The bracing is arranged on the Warren principle, with intermediate struts to reduce the bending in the upper flanges. Each top flange is provided with a double rail track, placed at 2ft. 6in. centres. The top and bottom booms are braced together horizontally from the centre to the back end, and the extreme forward ends are strongly united by a heavy bridge girder. Buttress struts are fixed at the centre, and also a diaphragm bracing over the roller path to prevent any lateral movement. A large plate and angle ballast box has been built in between the girders at the back end, and filled with 160 tons of stone ballast. Rope rollers are provided along the girders to carry the slack ropes, and the necessary stairways, platforms, and handrails are fitted.

The roller paths are 46ft. diameter, and each consists of single web circular girders, 2ft. 6in. deep. The girders are stiffened round the circumference, and the top girder is further strengthened by heavy cross girders. Each girder is fitted with a broad forged steel pathway, machined on the wearing surfaces to the correct angle. The superstructure revolves on 72 solid forged steel rollers, each alternate one being connected to the centre casting by steel radial rods. The centre pin is of forged steel, 18in. diameter, and is carried in substantial castings attached to the upper circular girder and the centre pin girder on the tower. The revolving motion is transmitted to the rack through worm, spur, and bevel gearing. The worm gear consists of a steel treble threaded worm, connected to the motor armature shaft, and working into a phosphor bronze wheel, the whole being enclosed in an oil bath. A slipping device is fitted to the intermediate spur gear to relieve either the gear or structure from undue shocks. The rack pinion is of forged steel, and the rack of cast steel, made in segments and bolted to the lower circular girder by turned steel bolts. The whole of the gear has machine cut teeth, except the rack. The revolving machinery is provided in duplicate to enable the crane to be revolved without delay in case of a breakdown. The motors and worm gear are enclosed in a steel house, which is fitted with tackle for dismantling and repairs.

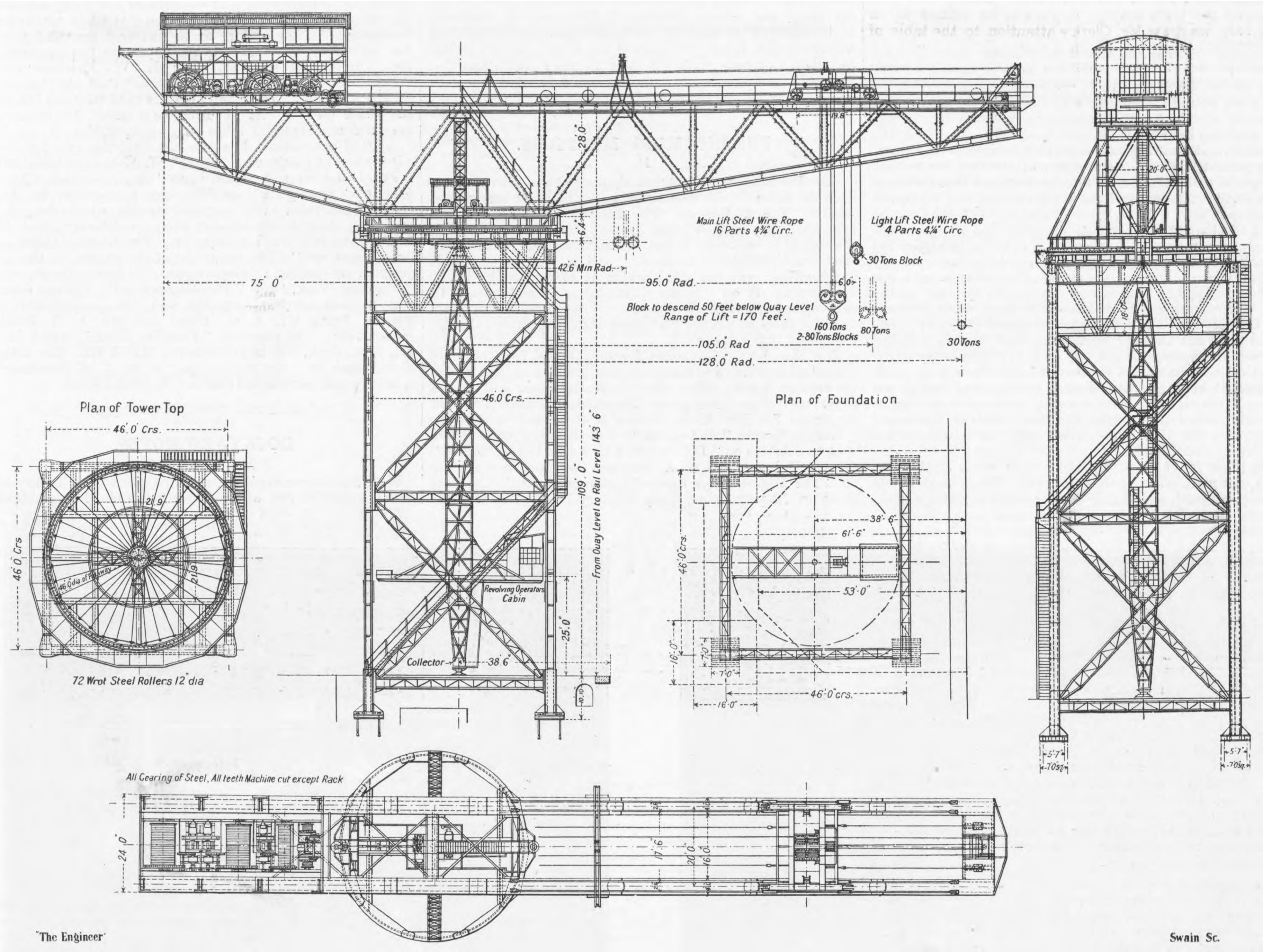
The tower is 109ft. high above quay level, and 46ft. square to the centres of the main columns. The latter, which are 2ft. 6in. square, are fitted with grillage sole-plates, and are embedded in the solid concrete for about 11ft. The tops of the columns are connected by heavy braced girders 18ft. deep, which in turn carry the various cross girders provided to support the lower roller path. Lattice diagonal and cross ties are connected to each of the columns to brace the tower and to withstand the wind forces. Broad steel stairways are carried round the tower up to the top platform.

A feature of the crane is the arrangement and position of the operator's cabin, which has been fixed about 25ft. above the quay level, in order to bring the driver as close to the work as possible. The cabin is carried on a lattice steel frame, which is turned by the crane as it revolves. In addition to the controllers, switchboard, &c., a telephone of the Graham navyphone type is fitted in the cabin to enable the operator to communicate with anyone in the machinery

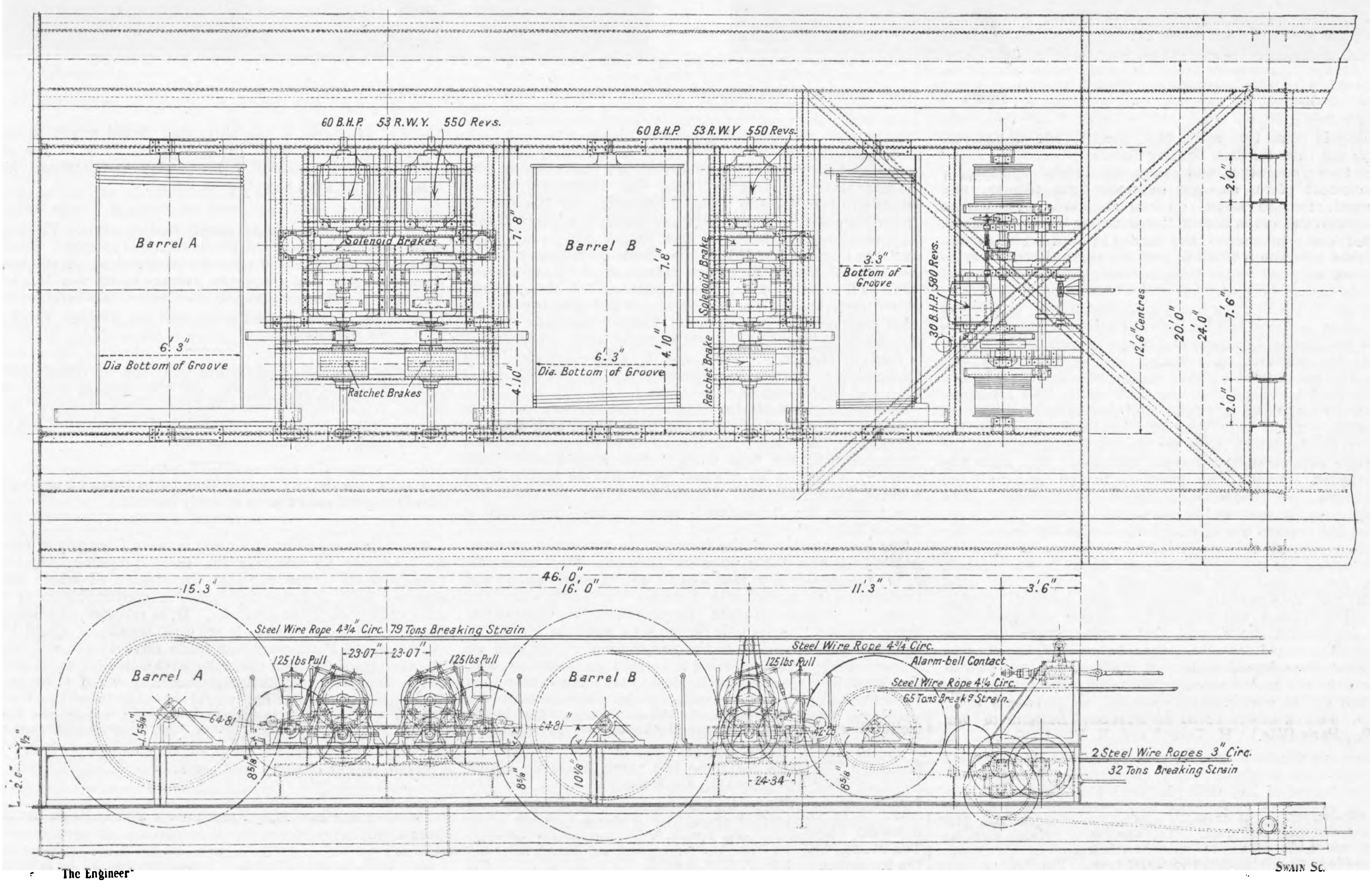
160-TON REVOLVING CANTILEVER CRANE

COWANS, SHELDON AND CO., LIMITED, CARLISLE, ENGINEERS

(*For description see page* 534)


Plan of Tower Top
46.0 Crs.
46.0 Crs
21.9
21.9
46.0 dia. of Pathway
72 Wrot Steel Rollers 12" dia
75' 0"
28.0
6.4
42.6 Min Rad.
95.0" Rad.
46.0 Crs.
109' 0"
From Quay Level to Rail Level 143' 6"
Revolving Operators Cabin
25.0"
Collector
38.6
10.10
Main Lift Steel Wire Rope
16 Parts 4¾" Circ.
Light Lift Steel Wire Rope
4 Parts 4¼" Circ
30 Tons Block
19.8
6.0
Block to descend 50 Feet below Quay Level
Range of Lift = 170 Feet.
160 Tons
2-80 Tons Blocks
80 Tons
30 Tons
105.0" Rad
128.0" Rad.
Plan of Foundation
38'-6"
61'-6"
53'-0"
46'0"crs.
16'-0"
7'0"
7'0"
46'-0"crs.
16'-0"
20'-0
18'-0
5'-7
7'0sq.
5'-7
7'0sq.
All Gearing of Steel, All teeth Machine cut except Rack
24.0
17.6
20.0
16.0
"The Engineer"
Swain Sc.

GENERAL DETAILS OF THE CRANE


60 B.H.P. 53 R.W.Y. 550 Revs.
60 B.H.P. 53 R.W.Y 550 Revs.
Barrel A
Solenoid Brakes
6' 3"
Dia Bottom of Groove
Ratchet Brakes
7' 8"
4' 10"
Barrel B
7' 8"
4' 10"
6' 3"
Dia. Bottom of Groove
Solenoid Brake
Ratchet Brake
3' 3"
Bottom of Groove
30 B.H.P. 580 Revs.
12' 6" Centres
20' 0"
24' 0"
2' 0"
7' 6"
2' 0"
46' 0"
15' 3"
16' 0"
11' 3"
3' 6"
Steel Wire Rope 4¾" Circ. 79 Tons Breaking Strain
125 lbs Pull
23·07"
23·07"
125 lbs Pull
Barrel A
64·81
1 5/8"
8 5/8"
Barrel B
64·81"
8 5/8"
10 1/8
Steel Wire Rope 4¾" Circ.
125 lbs Pull
Alarm-bell Contact
Steel Wire Rope 4¼ Circ.
65 Tons Break'g Strain.
42·25
24·34"
8 5/8"
2 Steel Wire Ropes 3" Circ.
32 Tons Breaking Strain
2' 6"
½
"The Engineer"
Swain Sc.

DETAILS OF THE HOISTING MECHANISM

house. There is also an alarm bell and indicator to warn the operator when either of the two purchases is being overloaded from any cause. A dial radius indicator, worked from the traversing gear, is provided in front of the driving position to enable the operator to see the permissible loads and radii.

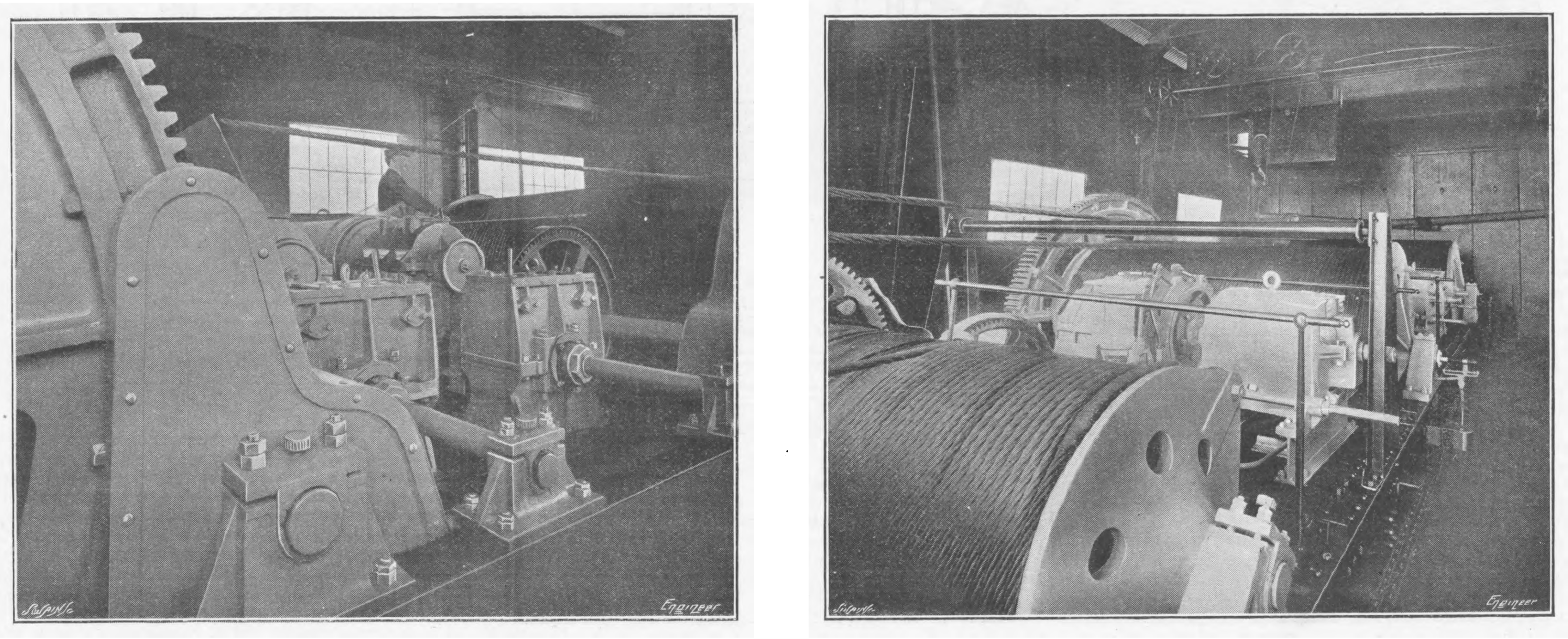
The following motors have been fitted on the crane to work the various motions, viz. :—

Main lifting ..	2 motors, each	60	B.H.P. at	550	revs. per min.
Auxiliary lifting	1 motor	60	,, ,,	550	,, ,,
Traversing ..	1 ,,	30	,, ,,	580	,, ,,
Revolving ..	2 motors, each	60	,, ,,	550	,, ,,
Overhead crane	1 motor	10	,, ,,	630	,, ,,

The motors are of the totally enclosed series-wound multipolar type, wound for working with direct current at 440 volts. The rating provides for a temperature rise not exceeding 70 deg. Fah. after one hour's run on full load. The auxiliary lift, traversing, and revolving motors are each provided with a tramway type controller. The two main lift motors are worked off a special three-drum controller, so arranged that the right or left hand drums control the corresponding sets of gear in the ordinary way. When it is required to work the two sets of gear together the two motors are controlled off the centre drum. An adjustable field rheostat is provided to ensure the two motors running at the same speed, independently of any unequal loads. During the trials this arrangement was tested by lifting 120 tons on one block, and no load on the other, and we are informed that under these extreme conditions the speed of both sets of gear remained the same. The makers point out that the great advantage of this arrangement will be apparent to any one used to lifting heavy loads, as no time need be wasted in ensuring that there is an equal load on both hooks. If it is desired to lift a load level it can be done by means of the field rheostat, or the load can first be adjusted to any desired angle, and then lifted at this angle through the full lift. The switchboard has an enamelled slate base containing the following mountings, all of which are enclosed in sheet steel cases:—One main double-pole switch, one main double-pole quick-break circuit breaker, one double-pole switch and circuit breaker for each motor circuit, double-pole fuses for each motor circuit, one double-pole switch and fuses for each lighting circuit.

The tower, cantilever, and cabins are lighted by means of incandescent lamps enclosed in water-tight fittings, and arranged, two in series, on iron standards. The cables throughout the crane are of "Association" quality, taped, braided, and compounded, and carried in solid drawn galvanised steel conduits. The whole of the above electrical equipment was supplied by the British Westinghouse Electric and Manufacturing Company, Limited, Manchester, with the exception of the lighting and wiring, which was carried out by Cowans, Sheldon and Co.'s own electrical engineers. The crane was erected by means of a 15-ton steam derrick crane, which was mounted on a timber staging 100ft. high, this being in turn carried on steel trucks which travelled on a double track laid parallel to the dock wall. The crane was practically completed last June, and put through a series of preliminary trials with gradually increasing loads by the makers, during which time the deflections throughout the structure were carefully taken and checked. The crane was then tested officially with loads up to 240 tons. All the tests were, we understand, carried satisfactorily. The deflection at the front end of the cantilever when lifting 160 tons at 95ft. radius was 4¾in. and 7¾in. with 240 tons. The structure showed no sign of lateral deflection or vibration under any of the conditions through which it was worked. Each set of gear was tested with a load of 120 tons, which was satisfactorily sustained and lowered by both the solenoid and the mechanical brakes independently. The mechanical brake was first disconnected, and the test load lowered on the solenoid brake by hand, and afterwards the solenoid brake was disconnected and the load lowered by the motor through the mechanical brake. The specified speeds were slightly exceeded, as previously mentioned, in all cases without the motors consuming more than their rated current.

Owing to the weather exposure to which such cranes are subjected, and to the difficulty of preventing corrosion, no plate or section of less than ⅜in. thick has been used on any part of the crane except the house sheeting and certain chequered floor plates. When designing the crane, Cowans, Sheldon and Co., Limited, also made a strong point in avoiding all enclosed or inaccessible pieces of girder work, a rule which was extended even to the circular girders, which for this reason were made of the single-web type. Great care was taken to ensure the stability of the crane being correct, and the whole of the work was carefully weighed during erection to check the calculated weights. The centres of gravity with no load and with the full load fall about equidistant on either side of the centre pin, and with the 240-ton load the centre of gravity was about 4ft. inside the pathway. The whole of the foundations for the crane were prepared by the dockyard authorities, and are of a very substantial description. Owing to pressure of work in hand at the time the crane was ordered, Cowans, Sheldon and Co., Limited, after preparing the whole of the detail drawings for the tower and cantilever, sub-let this part of the work to Arrol's Bridge and Roof Company, Limited (now A. and J. Main and Co., Limited).



VIEWS OF THE HOISTING MECHANISM OF THE 160-TON CANTILEVER CRANE

FORTHCOMING MEETINGS.

II.

THE Institution of Electrical Engineers has provisionally fixed the dates for the reading of three papers for the current session. The first is on "The Present Aspects of Electric Lighting," the authors being Messrs. Handcock and Dykes; the second is entitled "Notes on Methods and Practice in the German Electrical Industry," and is by Messrs. Lepine and Stelling; and the third, which is to be read by Dr. J. A. Fleming, is on "Some Quantitative Measurements in connection with Radio-telegraphy." The dates provisionally fixed for these papers are November 25th, December 9th, and December 16th respectively.

The Manchester Students' Section of the Institution of Electrical Engineers will hold its first meeting on the 23rd of the present month, when Mr. V. W. Newman will read a paper on "The Testing of Electrical Machinery." On December 7th Mr. A. L. Hawes is to present a paper on "Electric Cranes," and on the 21st of the same month there is to be a debate on "D.C. *versus* A.C. for Railway Traction." Messrs. P. Kemp and W. A. Stephens have promised a paper on "The High-tension Spark Discharge in Air," the date given on the programme being January 18th. "Face Plate Type Starters and Control Apparatus" is the title of a paper to be presented by Mr. J. G. Travis on February 1st. On the 15th of the same month there is to be a joint meeting with the Manchester and District Junior Gas Association, when a debate will take place on "Gas *v.* Electricity for Heating and Power Purposes." At the following meeting, which will take place on March 1st, Mr. J. J. Law Brooks will read a paper on "The Commercial Side of the Electrical Industry." On the 15th of the same month Messrs. J. P. Gardiner and R. L. Bell are to present a contribution on "A Modern Telephone Exchange." The second supper and smoking concert takes place on April 5th. On the 19th of the same month the annual general meeting will be held, when a paper is to be read by Messrs. F. Shaw and J. Davis, entitled "The Application of the Cradle Dynamometer to the Testing of Electrical Machinery."

The Institute of Marine Engineers has already had quite a number of meetings since the first, which took place on September 27th. Mr. J. M. Newall is to present a paper on December 6th, the title being "The Engine-room Telegraph." A lecture on "Fuel Test" will be delivered on Monday, December 13th. On January 10th a discussion will take place on Mr. Ruck-Keen's paper on the "Treatment of Marine Boilers."

The next meeting of the Incorporated Institution of Automobile Engineers takes place on December 8th, when Mr. F. W. Lanchester is to read a paper on "Tractive Effort and Acceleration of Automobile Vehicles on Land, Air and Water." "Some Modern Developments of Commercial Motor Vehicles" is the title chosen for a paper by Mr. T. B. Brown, which, according to the programme, will be read on January 12th. At a meeting to be held on February 9th, Mr. Mervyn O'Gorman will deal with the subject of "Coachbuilding." Other papers on the programme of this Institution are "Valves and Valve Gearing for Petrol Motors," by A. Craig; "Chains for Power Transmission," by A. S. Hill; and "Forced Lubrication," by R. K. Morcom. The dates for these last three papers are March 9th, April 13th, and May 11th respectively.

The Association of Birmingham Students of the Institution of Civil Engineers holds its first meeting on November 25th, when Mr. A. D. Greatorex will deliver his presidential address. Mr. E. L. R. Muir is to read a paper on December 2nd, the title being "Notes on the Design of Railway Underbridges." On the 16th of the same month the subject of bridges will again be dealt with by Mr. V. M. Barrington Ward, the title of this gentleman's contribution being "Notes on the Reconstruction of Bridge at Lea Marston." The annual dinner will take place on January 27th. "Flying Machines: Their Stability and Directional Control," is the title of a paper promised by Mr. H. F. Lloyd for February 3rd. For the 17th of the same month Mr. A. C. Anderson's name appears on the programme, his subject being "Centrifugal Pumps for Waterworks." Two lectures are to be delivered in March, both of which are on "Canals for Inland Navigation." The first is to be delivered on the 3rd and the second on the 17th. Other papers on the programme are "Reinforced Concrete," by L. W. Kershaw; and "Refuse Destructors: Their Construction Past and Present," by J. P. Rudder. The former is to be read on April 7th and the latter on the 21st of the same month. The students' annual general meeting takes place on April 28th.

A good programme has reached us from the Leicester Association of Engineers. Mr. F. W. Hobson will deal with "The Loughborough Waterworks" on November 27th; a paper on "Steam Turbines" has been promised by Mr. F. A. Noel for December 11th; a special evening is to be devoted to workshop subjects on January 8th; on January 22nd Mr. A. G. Hales is to read a paper on "The Electric Motor and its Applications." The remainder of the papers on the programme are entitled: "Carburetters," "Service Reservoirs," "Foundry Work," and "The Microscope." The two former will be read on February 5th and 19th respectively, the authors being Mr. A. G. Hales and Mr. A. G. Ionides respectively. The paper on "Foundry Work," which is by Mr. E. J. Cook, will be presented on March 5th. The author of the paper on "The Microscope" is Mr. J. H. Hawthorn; it will be read on March 19th.

DOCKYARD NOTES.

A CURIOUS rumour is about to the effect that Turkey has made a bid for one of the three Brazilian Dreadnoughts. There is, of course, a possibility that Brazil might be ready to part with one of these three ships, but it is, at the same time, rather improbable. Tremendous preparations have been made for their reception in Brazil.

THE Bellona has done extremely well on trials. The maximum speed of the one-fifth power trial was 15 knots. During the second thirty hours' trial she steamed at 14,400 horse-power for eight hours, and the average speed was 25 knots. During the remaining twenty-two hours the turbines were worked at 11,000 horse-power, and an average speed of 23.9 knots was attained.

On the eight-hours' full-power trial the maximum horse-power developed was 20,000, and the average speed 25.9 knots. Steaming with wind and tide over a measured mile, a speed of 28.2 knots was obtained, and against wind and tide of 26.8 knots, giving an average of 27.8 knots.

A RUMOUR that extra men were to be taken on at Devonport Dockyard seems to be entirely incorrect.

TREMENDOUS efforts are being made in Germany to secure the contract for building the three projected Argentine Dreadnoughts. The political importance of where these ships are built is rather overlooked in contemplation of the commercial side of the situation. If, as reported, the German Government has offered a 15 per cent. rebate, it would look as though the Fatherland was quite alive to the situation. The Government would naturally have a lien on these ships, and in the event of hostilities occurring when these ships were nearing completion, would be able to utilise them. This is just another instance of what an invaluable asset private yards are to the State; and the folly of that indirect campaign against private yards which is carried on to-day by a certain section of party politicians.

THE German battleship Nassau made 20.7 knots on her full speed trial.

THE German battleship Ersatz Beowulf, built at Bremen, will be launched on November 27th, and named Thuringen. According to the models that are about in Germany, the ship will carry four three-gun turrets in the centre line; but it is extremely difficult now-a-days to ascertain what new German ships are going to be like, and it is quite possible that the Thuringen will turn out to be something very like the Dreadnought, and the triple turret ships will be the new Hildebrandt class.

THE United States battleship North Dakota is reported to have reached the maximum speed of 22.25 knots and to have made a mean speed of 21.8. During the trials a boiler tube burst and injured four men.

THE Town Class cruiser Liverpool has been launched.

IT is stated by the Japan *Times* that the whole of the ships now being built in Japan are being modified to bring them up to date with modern ideas. The Aki and Satsuma are, it is stated, being converted into Dreadnought type ships. Presumably this means that they will be given ten 12in. guns instead of the four 12in. and twelve 10in. previously decided upon. Similarly, the Japanese are credited with contemplating the conversion of the Ibuki and Kurama into Invincibles. We are inclined to imagine that this information should be taken with a grain of salt. The technical difficulties in the way—unless the ships are practically pulled to pieces and rebuilt—would seem to be very great indeed, if not insuperable.

LETTERS TO THE EDITOR.

(*We do not hold ourselves responsible for the opinions oj our correspondents.*)

CENTRIFUGAL FORCE.

SIR,—With reference to "Pater's" letter in your issue of the 22nd ult., perhaps I can help to clear up the difficulty. Discussing the question of a stone whirled round by a string, he thinks, I take it, that there is some force acting on the stone in the direction of its motion, and that this is balanced by the pull of the string.

Now, in the first place, there is no other force acting upon the stone but that of the tension of the string; this is evident when we consider that there is nothing except the string which could put a force upon it. Secondly, the velocity of the stone is being continually changed in direction, and we cannot therefore say that it is in a state of static equilibrium. Hence no balance of forces is to be expected.

The best way of looking at it is this:—The stone, if freed from all constraint, as, say, by the breaking of the string, will continue to travel along the tangent with the same velocity that it had before the breakage; but in the actual case the constraint of the string compels it continually to change the direction of its motion. It can be readily shown by a graphic method that this comes to the same thing as continually imparting to the stone an additional velocity along the line joining it to the centre.

By Newton's second law this can only be produced by a proportionate force acting in the direction of the imparted velocity, and it is this force which is supplied by the pull of the string. It will be observed that the new velocity continually imparted to the stone does not alter the absolute magnitude of its velocity but only the direction.

Swindon, November 10th. L. H. G. DINES.

SIR,—In reply to your correspondent "Pater," he does not appear to me to state his problem very clearly. A stone whirling round in a circle at the end of a string would not be in equilibrium at all points. I think the revolving simple pendulum would explain all he wants. In this pendulum a weight hangs by a rod or string to a vertical spindle as in the centrifugal governor of a steam throttle valve.

When the spindle rotates with accelerating velocity the weight rises until the velocity becomes uniform, then the three forces in equilibrium are the tension on the string or rod and its two components, centrifugal force and weight, acting horizontally and vertically respectively.

In the example quoted by "Pater" the stone of 5 lb. has a velocity of 2000ft. per minute = 33.3ft. per second, and its centrifugal force $= \frac{5}{g} \times \frac{v^2}{r} = 109$ lb.

As $\frac{v^2}{r}$ is constant there is no acceleration. $\frac{v^2}{r}$ may be called deviation of velocity of stone, but not acceleration, which only takes place when v is increasing from 0, or from a lower to a higher velocity. It would then be expressed by $\frac{v_2^2}{r} - \frac{v_1^2}{r} = a$. Where v_2 is higher and v_1 lower velocity and a = acceleration.

When $\frac{v^2}{r}$ is constant, the centrifugal force is merely a deviating or deflecting force acting radially to the circular path of the stone, and is similar to the deviating force in the fixed ring of blades in a steam turbine.

The steam is deviated through as large an angle as in the moving blades, but as the force is at right angles to the curved face of the blades the steam is neither accelerated nor retarded, and the blades being fixed there is no work done. A. R.

November 15th.

SIR,—The letter of "Filius" in your last impression simply repeats what may be found in most text-books, as, for example, "Ganot's Physics." If it answered my student's question I need not have troubled your correspondents.

There is no getting away from the fact that, according to the definitions accepted, a force acting along a tangent is balanced along a radius at right angles to that tangent by another force. Nothing else can be read into the definitions, and the definition has been deduced from two facts. The first is that there is a pull in the direction of the radius, and the second is that if released the stone will move along the tangent. Now, I find it impossible to form a concept of forces at right angles balancing each other. The cutting up of spaces in the way done by "Filius" only gets over one difficulty by introducing another. If the pull is due to the movement of the stone, then the reduction of movement must reduce the pull, and in the end there would be no movement and no pull. If, on the other hand, the motion of the stone is the cause of the pull, then we must calculate the work done on either of two different assumptions, both of which have been used. They are in no sense or way inventions of mine.

First, let us assume that the stone is revolving round a horizontal axis, and is at the top of the circle. The work done on it will consist in "accelerating" it from the position at the top of the circle to a position at the bottom of it—that is to say, it will traverse a distance equal to the diameter of the circle during the time spent in making half a revolution.

Secondly, let the circumference of the circle be, say, 20ft., and a revolution be made in one second. If, now, the string were cut, the stone would fly tangentially to a distance of 20ft. in one second. The work done then consists in "accelerating" the stone through a distance of 20ft. in one second; that is to say, in deflecting it over a distance of 20ft. in one second.

It is obvious, however, that no work is done. That is proved by direct experiment, and the question is this: Why is no work done? This develops into another aspect of the problem.

When a projectile is fired from a gun, say, point blank, gravity at once comes into play, and causes the projectile to deviate downwards. No one disputes that gravity does work in deflecting the projectile. What is the difference between it and the string holding the stone from departing at a tangent?

It is true that the projectile describes a parabola—omitting air resistance—but if we use "Filius's" reasoning, and take any very small portion of the path, we may regard it as a portion of a circular curve; and so the reasoning which he used in his letter last week will apply to the case of the projectile. If not, why not?

I cannot for the life of me see how the cutting up of the time of action or space of action of a force can so alter its direction that it can be made to balance another force at right angles to it.

The truth seems to me to be that our definition should be that we have two static forces which are equal but not opposite, and yet they balance each other. A difficult concept to frame. To get over the difficulty, may we assume that only one force exists at a time, namely, a radial force. There is no tangential force whatever. The moment we cut the string the radial force disappears and the tangential force springs into existence. This theory involves no confusion of thought, and constitutes a very simple concept. PATER.

November 15th.

SIR,—May I offer the following suggestions on the problem troubling "Pater" in your issue of November 5th and *ante*.

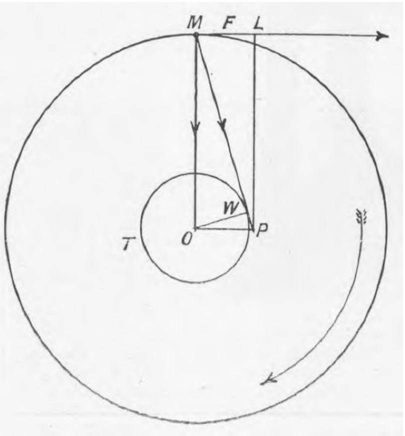
Referring to the figure, let F equal tangential force necessary to impel the stone at a uniform acceleration around the centre O against a certain resistance. Let this resistance be f(V) per unit mass. To constrain the stone to travel the path of a circle around the said centre we introduce the string.

The forces it is necessary to apply at any given moment are:—

Centripetal force along M O... ... ... $m\ V^2/R$

Tangential force F... ... ... $m f(V) + m\,.\,dV/dt$

represented by M O, M L respectively.



Ascertaining the values of these for any given case, we can draw our parallelogram of forces and obtain the resultant M P.

This represents the magnitude and direction at the moment of the force required to accelerate the stone in its circular path.

Draw O W perpendicular to M P.

I think it will be clearly seen that if the string be held at the point W whilst swinging the stone by hand, then that point must describe the circle W T whilst exerting a force M P in order to impel the stone at the given acceleration.

Then the work done per revolution = M P × 2π O W.

I hope this is what "Pater" requires.

November 17th. L. R.

BRITISH LOCOMOTIVE PRACTICE OF TO-DAY.

SIR,—Mr. Dauncey points out that better work could have been done by the London and North-Western Railway compound 4-4-0 engine if the low-pressure cylinders had been larger than 20½in. He states the reason being that the mean effective pressure on the pistons would be proportionately increased. Evidently he is under the impression that as better work would follow the use of larger cylinders, the mean effective pressure on the pistons must necessarily have been increased. As a matter of fact, the mean effective pressure would be actually reduced, the better work being brought about by the steam acting over an augmented piston area, thus getting more work out of the steam before final exhaust took place, emphasising the great advantage to be derived from compounding an engine. To bring about an increase in the mean effective pressure on the pistons of a compound, and so as still further to enhance the power of the engine, it becomes necessary to reduce the cylinder ratio by increasing the area of the high-pressure cylinders. To get the maximum of work from the boiler of the London and North-Western Railway engine it would therefore have been necessary to increase the diameter of the high-pressure cylinders up to that of a simple engine. As these would practically be as large as the low-pressure cylinders, would it not be more practical to dispense with the high-pressure cylinders and pass the steam direct through the low-pressure ones? It occurs to me that this is what practically takes place when converting compounds back to simple.

I certainly agree with the Irishman that one type of British locomotive is quite as good as another. Curiously enough, in this connection some twelve years ago I had the privilege of looking over the drawings of a compound locomotive engine designed by an eminent British locomotive engineer. If this engine had been built, it would in my opinion have been considerably more powerful than the best engine at work at the present day either on a British or continental railway, and would probably have obviated the necessity for Mr. Dauncey starting this discussion. I base my conclusion on the fact that the engine had 24in. low-pressure cylinders and high-pressure cylinders with a reduced cylinder ratio to that of present practice.

Mr. Dauncey is correct in assuming that the compound engine with large high-pressure cylinders was a three-cylinder engine. The low-pressure cylinder was 31½in. in diameter, or the equivalent of a two-cylinder 22¼in. The desire was to fit on a cylinder 34in. or the equivalent to two 24in., but gauge limit prohibited this. The great success of this engine lay in the fact that there was a marked improvement in the steaming of the boiler from the use of two high-pressure cylinders, as compared with the one high-pressure one. Moreover, not only was the engine able to haul the maximum load to the limit of its adhesive weight up heavy grades, but also to haul the same load at a fairly high speed on the level. In fact, the engine was worked in every respect similar to a simple engine, except that the lever could be placed at 25 per cent. of the stroke of the high-pressure piston immediately the train was put in motion, and was kept there even when climbing the heaviest grade.

Although a compound locomotive with 30in. low-pressure cylinders may never materialise on British railways, there appears no valid reason why the compound system should not do so, especially when it affords a means of designing a compound engine which can deal with loads impracticable for a simple engine to keep time with.

I will now make a comparison between British locomotive practice and the system I advocate, which should make clear the great advantage in favour of the latter.

Let us take the London and North-Western Railway compound referred to and a compound having two 20in. high-pressure and two 24in. low-pressure cylinders, and let the following tests be carried out:—(*a*) A test to be made with the boiler steam used in the high-pressure cylinders only in each case. (*b*) A test to be made passing the steam through the low-pressure cylinders only with each engine. (*c*) Tests to be made with the steam passing through high and then low-pressure cylinders, boiler steam never to reach the low-pressure cylinder direct. It occurs to me that it requires but little elementary knowledge of the principles of locomotive working to decide which type of engine would give the best results.

In conclusion, to amplify the great increase in power available with the locomotive on British railways even with its restricted gauge, it may be of interest to point out that it is quite practicable to make use of four 22in. low-pressure cylinders, and to place four 15in. high-pressure cylinders tandem to these. Such an engine would be the equivalent to a four-cylinder compound having two 21¼in. high-pressure and two 31½in. low-pressure cylinders, or the equivalent of a two-cylinder compound having one 30in. high-pressure and one 44in. low-pressure cylinders.

Let Mr. Dauncey compare this veritable powerful locomotive with the London and North-Western compound referred to, and if he takes into consideration the fact that boilers are actually in use on some railways which can steam cylinders of such large dimensions, he may agree with me that the time has arrived when a compound locomotive can be built which will prove to be the last word in this discussion. JOHN RIEKIE.

Argaith, Dumbreck, November 14th.

SIR,—I have followed with great interest the various letters in connection with the above lately appearing in your columns.

I am rather surprised by Mr. Dauncey stating, in your issue of 5th inst., that with equal initial steam pressures the mean effective pressure is increased by a greater ratio of expansion, seeing that it is certainly decreased, as has been proved both theoretically and in practice. Surely he has made a clerical error. As regards his remarks about "elementary knowledge of engineering," I fear that the want of that, among a large section of engineers, is the reason that what should be quite a simple design is often a most complex one. This is very apparent in some recent locomotive work.

I think there is no doubt about the greater efficiency of expanding in two or more cylinders in place of one, it having been amply proved in marine work, but the extent is not so impressive in the case of locomotives as in more powerful marine engines, which have also an efficiency due to their size. The advantage of compounding may in a locomotive easily be lessened by a slight mistake in the designing, such as giving too much compression to the low-pressure cylinder. I shall probably be told that the work done in compressing the air is given out during the return stroke, but I question that, judging from experiments I have made with pistons in connection with leakage.

Personally I approve of Mr. Riekie's method of designing a compound locomotive so as to deal with the boiler steam and not to suit the adhesion, enabling the locomotive to be run to the adhesion limit under all conditions of working, through the medium of "cut-off" and "throttle." To ensure its practical success I consider that vacuum valves should be fitted to low-pressure cylinders. I have no doubt that a four-cylinder compound locomotive can be built to suit British railways, and to show a very appreciable saving in the year's running over the simple.

Glasgow, November 13th. MARINE ENGINEER.

[This discussion must now cease.—ED. THE E.]

THE VOLUMES AND PRESSURES OF STEAM.

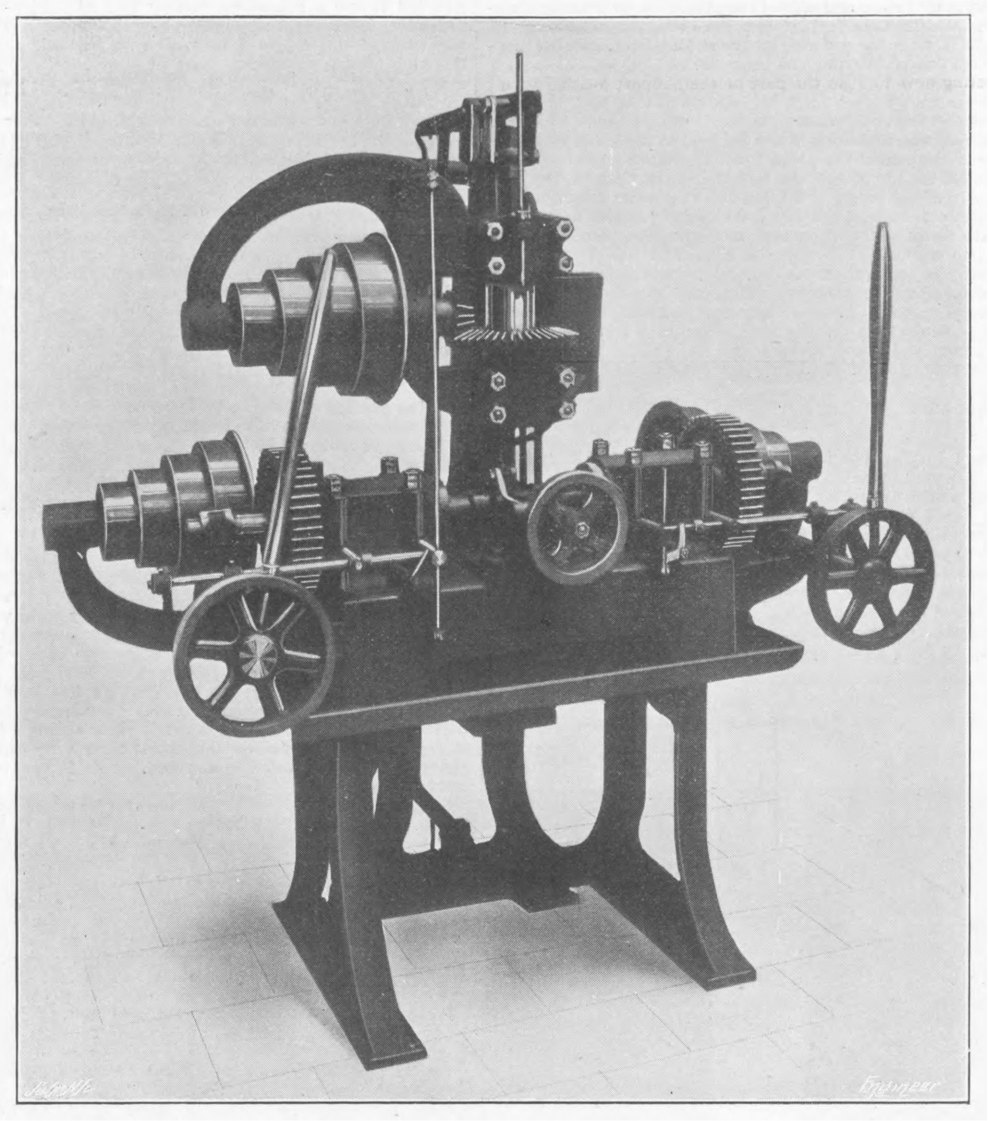
SIR,—Your correspondent, Mr. F. B. Aspinall, asks me to publish some of the calorimeter results obtained during some steam engine tests, but I do not think any useful purpose would be served by such publication. Mr. Aspinall's arguments seem to be based on his conclusion that the latent heat of steam is constant at all temperatures. Without expressing any opinion as to the accuracy of the ordinary steam tables, as based on Regnault's experiments, it is common knowledge that the published results of other vapours besides water steam show a decrease of latent heat as the temperature of saturation is increased—that is, the nearer the critical temperature and pressure is approached. Mr. Aspinall has only to refer to the accepted values of the latent heat for all known vapours to realise that the probabilities are that the latent heat of steam decreases with increase of the saturation temperature. R. ROYDS.

The Glasgow and West of Scotland Technical College,
Glasgow, November 15th.

LIVERPOOL ENGINEERING SOCIETY.—In his presidential address to the members of the above Institution at a meeting held recently, Mr. William Brodie gave some instructive information concerning the world's ports and oversea trade. He said that some of the necessary factors in the constitution of a seaport were beyond the control of the port authorities; others were capable of improvement, and of these several fell within the scope of engineers' work. They were the safety and convenience of sea access, which depended to a great extent on the width, depth, and direction of the channels, their navigability under all conditions of tide, and freedom from fog and ice obstructions; the existence of a sufficient hinterland, agricultural mining, or manufacturing—alone or combined—furnishing goods for export, and requiring for the use of its population the goods it did not itself produce, so ensuring imports; inland communication as full and free as possible by efficient navigable waterways and (or) railways. In addition to these requirements, partly depending on matters geographical, physical, and political, there were others also of great importance, one of them dependent on the foregoing to a great extent, viz., low port charges, another being efficient administration. Some of these attributes were essential. No port possessed them all in the fullest degree desirable, and the combination of them in the several great ports varied very considerably. Inferiority in one respect might be balanced by superiority in another, so that the elements of success continued to exist. Thus, the port which had a long, tortuous, and difficult access from the sea by river, might have the compensation of very full and free inland communication formed by that river itself and its connections, and so with other matters. Mr. Brodie then described the chief characteristics of the leading continental ports, and with regard to America he said that New York was the foremost amongst the great ports of the world in the matter of the depth obtaining at all states of the tide. There was now in the Ambrose Channel across the outer bay a good wide navigable cut, having a depth of 40ft. at low water, and at a shoal place citywards the present depth was 35ft. for a good width, and the projected depth also 40ft. The accommodation in the port was mostly in the form of piers of moderate length, jutting out at right angles to the shore line. The foundations were generally bad, and called for a type of construction of quay walls on lines similar to those adopted under like conditions in Europe. The address concluded with a reference to the port of Liverpool and the work of the Mersey Docks and Harbour Board in connection with dredging, and the construction of the revetment of the bank at the Crosby Channel.

MULTIPLE SCREWING AND TAPPING MACHINE

CARTER AND WRIGHT, HALIFAX, ENGINEERS



MULTIPLE SCREWING AND TAPPING MACHINE.

A MACHINE for screwing nipples or tapping tees and elbows at one operation has been introduced by Messrs. Carter and Wright, of Halifax. The machine consists of a body of box section which carries two horizontal spindles and forms the base for a frame which carries a vertical spindle and a gripping vice. The two horizontal spindles are driven from a four-speed cone and spur gear, the latter being mounted on the barrel or sleeve, which rotates in adjustable bearings on the body. The sleeves are bored to suit the diameter of the spindles, the latter having key-grooves cut in them, and are rotated by feathers in the sleeve, so that there may be no wear on the periphery of the spindle beyond that due to the sliding motion caused by moving the spindles backwards and forwards. Each spindle is bored to receive a die holder, and at the outer end is mounted a ball washer to take the end thrust. A grooved bush with two slide blocks mounted on each spindle engages with a vertical lever for bringing the dies or taps up to the nipple or tee to be screwed or tapped. The dies, which are mounted in holders on the spindle, are solid, and the nipples to be screwed are held in a vice. An adjustable gauge is attached to the vice, so that the nipples can be set in position. Connected with and operated by the lever which brings the spindle with the dies or taps to the work is a stop or releasing rod, which can be set to screw or tap the required distance. This rod actuates a trip connected to the overhead motion, which has reversing pulleys for each spindle, and the belt can be instantaneously thrown on to the reversing pulley for the return of the taps or dies. The main body of the machine is mounted on a tray provided with a tank to catch the lubricant, which is pumped back into a tank on the upper part of the machine and conveyed to the work to be operated upon by tube.

The machine illustrated is designed for screwing or tapping from ⅛in. to 1in. fittings. When it is required for screwing or tapping nipples or two-way couplings only, the vertical frame may be dispensed with. The general design will readily be seen on an examination of the engraving. The makers claim not only that this machine is useful and expeditious in screwing nipples, but that it can be advantageously used for making double-ended screwed studs. For larger sizes than 1in. nipples, adjustable dies are used with an automatic release motion to the dies in place of a reversing motion.

NEW DEVICE FOR ASCERTAINING THE HARDNESS OF METALS.

IN measuring the hardness of metals the Brinell ball test is frequently used. This test consists in pressing against the surface of the object to be tested a very hard steel ball—usually about 10 mm. in diameter—and then measuring the diameter of the impression, an operation which is best done with a microscope. If the pressure used, expressed in kilogrammes, is now divided by the spherical surface of the impression, expressed in square millimetres, the result obtained will constitute a measurement for the hardness of the material, and is usually referred to as the hardness numeral. This method has many advantages, but also possesses the disadvantage that different hardness numerals will be obtained for the same metal if different pressures or a different diameter of ball is used. It is therefore always necessary to state, when giving the hardness numeral, what pressure and what diameter of ball have been used.

To avoid this inconvenience, a proposal was made by Dr. Paul Ludwik, of Vienna, to use, instead of a ball, a hard steel cone, with a top angle of 90 deg., the point of which should be pressed into the testing material. Owing to the fact that conical impressions, whether they are small or great, are always similar in shape, the same hardness numeral—cone-test hardness—will, in accordance with Kick's Law, always be obtained with the same material, independently of the testing pressure used. The method has, moreover, from a purely practical point of view another considerable advantage. By means of a suitable arrangement, the diameter of the impression may, it is claimed, be easily and accurately read off while the test specimen still remains in the machine, and consequently avoids the use of a microscope.

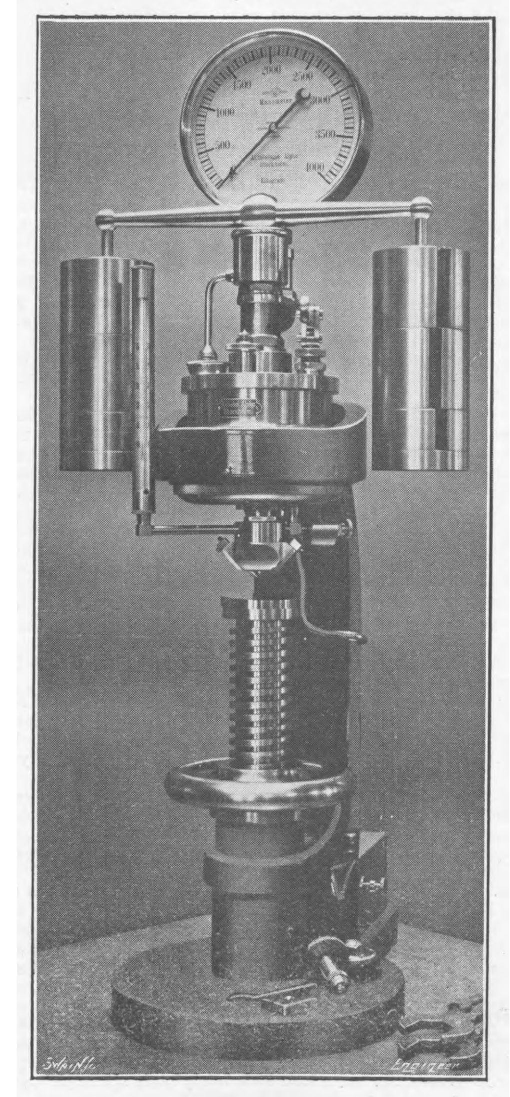


Fig. 1—HARDNESS TESTING MACHINE

Such a device, constructed and manufactured by the Aktiebolaget Alpha, Stockholm, Sweden, which is represented in this country by J. W. Jackman and Co., Limited, Caxton House, London, S.W., was exhibited at the last Material Testing Congress at Copenhagen, where it gained much approbation from, among others, Dr. Ludwik, the inventor of the cone-test method. The apparatus is intended to be attached to the well-known ball-testing machine made by the same firm, but it can also be fitted to other testing machines. Its construction is shown in Figs. 1 and 2. When the point of the hardened steel cone is forced into the metal to be tested, two movable steel points are pressed upwards along the sides of the cone. These in turn push upwards two carefully fitted steel pistons, thus pressing a quantity of mercury corresponding to the movement of the steel points into a glass tube, where the diameter of the impression made on the test specimen may be read off with ease against a scale empirically graduated. The corresponding hardness numeral will be found in a table. With this method not only may the hardness of metals be ascertained, but it is said their homogeneity or any increase in their hardness towards the centre may be determined. This latter quality is tested by finding out the hardness numeral at one point with, for instance, 1000, 2000 and 3000 kilos. If the same hardness numerals are obtained the material is homogeneous, but if the hardness numerals increase with the increased pressure the material is harder inwards and conversely. For ascertaining the hardness of hardened steel the method is not so suitable as the ball-testing method, because the point of the cone may then possibly get deformed. In the case of unhardened steel the durability of the cone has proved quite satisfactory.

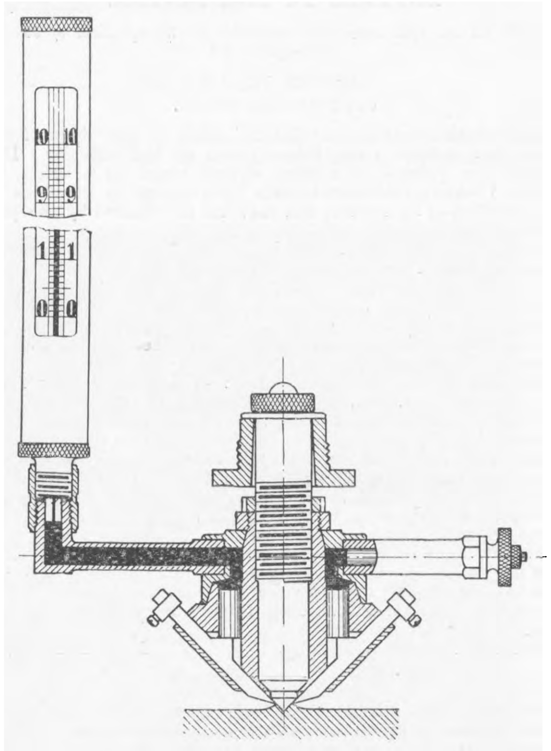


Fig. 2—IMPRESSION RECORDING APPARATUS

THE INSTITUTION OF MECHANICAL ENGINEERS: GRADUATES' ASSOCIATION.—The second general meetiug was held at the Institution, Storey's-gate, Westminster, S.W., on Monday, November 8th, 1909, at 8 p.m., Mr. Henry Fowler in the chair. The minutes of the first general meeting were read, approved, and signed by the chairman. A paper, entitled "The Commercial Testing of Railway Materials," was presented and read by Mr. T. H. Sanders. Mr. Duncan opened the discussion in which the following graduates took part:—Messrs. Fanghanel, Aykroyd, York, Bremner, Sibeth, Maitland, Briggs, Gamble, Allen S. A. Smith, Petrie, Symons, and Mr. Ady. The chairman also contributed to the discussion.

GLASGOW UNIVERSITY ENGINEERING SOCIETY.—There was a meeting of this society on Thursday, November 4th, when a paper on "Three-phase Motors with Speed Control" was read by Mr. Parker Haigh. The paper dealt with the cascade and pole-changing types of windings, and showed the advantages to be gained by the adoption of the latter when a reduced speed of motor is required for even short periods. A motor capable of developing 100 horse-power as an ordinary single-speed motor gives 85 horse-power when used as a two-speed motor with the same upper speed, and this is accomplished with an efficiency of over 90 per cent., as against about 45 per cent. for the single-speed motor, slowed down to half-speed by the ordinary method of using resistances. Various railway equipments by Continental firms, and also colliery installations by English and Scotch firms, were described, and it appears that home firms are well to the front with this class of motor. There was also a meeting of the society on Thursday, November 11th, when Messrs. R. Stokes and J. Cunningham delivered a lecture on "Experiences with Oechelhaeuser Gas Engines in Great Britain." In the course of a most comprehensive paper, Mr. Stokes described the first engines on the Oechelhaeuser principle, and showed how the early difficulties in the design had been successfully overcome. The details of the engines were thoroughly gone into, and the many improvements that had been effected described. In the latest design of engine, floor space has been greatly economised, and the reciprocating parts of the engine lightened, thus permitting higher speed, while the loss in efficiency due to work done on pumps has been reduced to 7 per cent. Reliability has greatly improved, and the loss of working hours is now not more than 2 per cent. The comparative cost of gas-power plant as against steam-power plant was shown, and it was seen that gas possessed great advantages, especially as regards cheapness of production. In conclusion, the lecturer described projected developments in the near future, showing designs for both tandem and vertical engines of this type. A discussion followed the paper, and Mr. Cunningham subsequently spoke in reply to the points raised.

PROPELLING MACHINERY FOR WARSHIPS.*

By Engineer Vice-Admiral H. J. ORAM, C.B.
(Engineer-in-Chief of the Fleet).

Before deciding on a suitable subject for the address which I am privileged to give to-night, it was suggested to me that some general remarks on points of current interest in connection with propelling machinery, from the naval point of view, would be acceptable, and this view I have adopted, although I shall not deal with any matters relating to machinery of our newest ships.

The same general principles of mechanical science apply in a very large measure to all designs of marine propelling machinery, but while first cost, cost of maintenance and repairs, durability, and economical performance at a given speed are the paramount factors in determining the arrangement and dimensions of the merchant-ship machinery, and have also to be fully considered in the design of a warship's engines and boilers, other considerations have a very important share in the settlement of the latter.

Among these may be mentioned the greater limitations of weight and space, owing to the many demands for both in the design of the warship as a whole, the necessity of keeping the machinery and boilers under armour protection, the considerable water-tight sub-division of the machinery spaces, and military requirements, as regards the suitability of the boilers for quick steam raising and the adaptability of both engines and boilers for large and frequent variations of speed. These considerations have so much influence on the design as to give characteristic and peculiar features to warship machinery which are not necessary in other cases where the determining conditions are more commercial.

It is for reasons such as those referred to that water-tube boilers are now practically universally adopted in warships, and that the old horizontal reciprocating engines were used in these ships so long after they had been abandoned in other vessels. Such reasons also explain why vertical engines of warships must be of the comparatively short stroke and quick running types, and indicate why the change from the reciprocating engine to the steam turbine was necessary, as soon as the latter could be installed on the same weight and was proved to be as reliable and economical.

It will be interesting to glance briefly at a comparatively recent stage of progress by making a few remarks respecting reciprocating engines, which up to a few years ago were universal for marine purposes. The last few ships in the Navy to be supplied with this type were the cruisers Shannon, Minotaur, and Defence, of 27,000 indicated horse-power, and the battleships Lord Nelson and Agamemnon, of 16,750 indicated horse-power. These engines were the outcome of years of experience, both in the Navy and mercantile marine, and are giving great satisfaction.

When these ships were constructed the speed of reciprocating engines had increased, so that 120 to 145 revolutions per minute, with a piston speed of 1000ft. per minute, represented the practice for installations in large ships, while in the small vessels, such as destroyers, it was 400 revolutions per minute with a piston speed of about 1200ft. per minute. If the turbine had not been introduced, revolutions would probably have steadily increased up to the limit fixed by inertia pressures, particularly since forced lubrication, which was supplied to the later reciprocating-engined ships previously referred to, enabled some other difficulties connected with fast running to be successfully overcome.

Previous to its adoption in large ships, forced lubrication had been applied to the main engines of several torpedo-boat destroyers with great success, and although some extra weight was involved by these designs, this was compensated for by less liability to accident and saving in friction of engine bearings. As a testimony to its success for such purposes, it may be stated that on examining the main engines of one of the first destroyers fitted with this system, after they had been running 20,000 miles, it was found that the original tool marks in the white metal bearings were still visible, and no measurable wear had taken place. This experience with the smaller ships led to the introduction of forced lubrication for the crank pins, excentrics, and main bearings of the engines of the larger ships previously named. It was found in practice to be a great improvement, and eliminated entirely the risk of accident due to hot bearings caused by ineffective oil supply, which was the principal trouble of the marine engineer at that time.

The method adopted in the destroyers was to enclose the whole of the working parts, including the crosshead bearings of the connecting-rods, in an oil-tight casing, packed glands being provided in the casing for the piston and slide-rods to work through. Observation windows and electric lights were fitted. The oil was supplied by pumps worked by excentrics on the crank shaft, and taking their supply through strainers, and delivering into the hollow crank shaft and weigh shaft, pressure gauges being fitted on the delivery pipes. Holes were drilled approximately radially at each main bearing, excentric, and crank pin and through connecting-rods, &c., to supply the oil to the various surfaces.

In the larger ships with reciprocating engines, pumps separate from the main engines were fitted for circulating the oil; the delivery pipes being provided in duplicate. The oil supply to them was first led to the main bearings and thence through the shafting to the others, and in these ships it was not considered necessary to apply the forced lubrication to the crosshead pins or link gear. With a view to separating any water which might mix with the lubricating oil, owing to drainage from slide and piston-rod glands, an oil settling tank was fitted in each engine-room. Although the adoption of forced lubrication on such an extensive scale as for reciprocating engines is not required in the case of turbine machinery, yet in this case as well, the principal bearings, viz., the turbine spindle and propeller shaft bearings are provided with this system.

Forced lubrication had previously been so successful in overcoming bearing troubles in electric light engines that it has now been applied to the great majority of auxiliary engines with satisfactory results as regards behaviour of bearing surfaces, and many of these engines are consequently now run at a high speed of revolution. One difficulty arose in the application of forced lubrication to reciprocating engines, viz., the constant splashing of the oil on the piston-rods, and the entry of this oil on the rods into the cylinder on the in-stroke caused a considerable amount of oil to pass with the exhaust steam to the condensers, and from these to the feed-water and finally to the boilers.

Oil in boilers is a fruitful cause of overheating and other similar troubles, and it was necessary to deal with this phase of the question, so that modifications of design and superior glands have been fitted in many cases, and this, with improvements to grease filters, has so minimised this difficulty that, with proper attention to the fittings provided, it becomes unimportant. The adoption of turbines has been a great improvement in this respect, as the quantity of oil passing to the condensers with the steam from them is practically nil, and the grease filters in these cases have only to deal with the grease from the auxiliary engines.

The reciprocating engine in its latest form in the Navy, fitted with forced lubrication and with its moving parts designed so as to practically balance the inertia forces, embodying improvements that had been evolved during many years, had reached a high degree of mechanical excellence, and omitting imperfections inherent to the type, the only important obvious feature in which it was wanting as regards fittings was the ability to use superheated steam, and secure the fuel economy which is well known to result therefrom.

In view of the renewed attention now being given to the subject of superheating for marine work, its extensive use on shore, and the possibility of its re-adoption to a limited extent, all the available records as to superheating in naval ships have been looked up to see exactly what happened when they were used and the circumstances attending their abandonment; a task not easy, seeing that records fifty years ago were not so well kept as they are to-day. I shall not burden the Institution with details of these records, but have stated their general nature later.

The circumstances attending their introduction were as follows:—In 1858 an Admiralty Committee, consisting of an admiral and two engineers, one of whom was James Nasmyth, was appointed to inquire into "The Design and State of Marine Engines in the Navy," quoting the exact terms of their reference. It is interesting now to read the part of their report dealing with superheating and the Admiralty comment on it, as showing the judgment of those associated with the Admiralty at that time on this question, after consideration of the result of experiments made from 1830 to 1858.

The eventual result of this report was that from 1863 to 1870 Admiralty boilers were always specified to have superheaters, but they had thus only a brief career, and were abandoned for new ships at the latter date, and did not reappear in the Navy till the one recent case which will be referred to later.

The following summarises the experience with them and the causes of their abandonment. The earliest difficulties with superheated steam were increased wear and tear of the valves, pistons, and cylinders of the engines, due to the charring of the lubricant and the burning of the soft packings, and this caused excessive leakage of steam, especially in the trunk engines. To minimise these troubles, the amount of superheat was first reduced, and subsequently it was proposed to divide the steam into two streams, one only of which was to be superheated, and by their subsequent mixture to control the steam temperature, the necessary adjusting valves being provided.

The superheaters themselves became defective internally from corrosion, and in many cases they suffered from leaky tube ends, due to overheating. Further, as salt water was used for boiler make-up feed, when the boilers primed the steam carried over salt to the superheaters, which caused the corrosion in the latter to be very active, and actual burning out of the tubes resulted, due to the resistance of the resulting hard scale. Copper was sometimes found deposited on the slide and cylinder working surfaces, and this was attributed to the salt in the water being decomposed, and some chemical action in connection with the copper steam pipes. The rust from corrosion was carried over into the slide casings and cylinders, and this, with the dry steam and its adverse action on the lubricants, caused considerable wear on those surfaces and on the piston rings, which was aggravated in the majority of cases, owing to the engines being of the horizontal type.

In many of the earlier boilers the heating surface was frequently not efficient, and this caused the uptake temperatures to be excessive and contributed to the rapid decay of the superheaters. The economical use of superheaters from the fuel point of view was most apparent in those boilers which were short of steam space and were liable to prime; the superheaters then acted more as dryers of steam; that is, they really formed an addition to the boiler steam space and heating surface by causing further evaporation of the priming water in the steam to take place while passing through the superheaters. It may be noted in passing that wet steam has a higher specific heat and is a better conductor than dry steam.

It was generally accepted that under favourable conditions a coal economy of from 20 to 25 per cent. was obtained from superheaters in H.M. ships at that time, but improvements in the construction of boilers leading to the use of steam of higher pressures, and the introduction of multiple-expansion engines with the consequent greater economy without the same mechanical difficulties, were additional reasons causing them to fall into disuse.

It was only in 1904 that superheaters were again ordered in H.M. Service, and on a small scale. Six Babcock and Wilcox water-tube boilers of the total of twenty-one in H.M.S. Britannia, a battleship of 18,000 indicated horse-power, were fitted with them in order to obtain experience as to the efficiency of superheating and the durability of the superheaters themselves under the greatly altered condition of boiler construction and treatment as compared with the conditions obtaining when the superheaters were abandoned. The construction of boilers had considerably improved since the early days, and higher steam pressures and greater rates of expansion of the steam were employed. Boilers are now worked with practically fresh water, the cylinders and slide valves were vertical instead of horizontal, the workmanship and details of these parts had improved, metallic packings were used for piston and slide-rod glands instead of the more perishable earlier packings, and the steam pipes are, and mountings can be, of steel. All these details of design are conducive to the better practical application of superheating than was the case forty or fifty years ago.

Although the Britannia's engines embodied the improvements in design just mentioned, it was thought desirable to proceed cautiously with the fitting of superheaters, owing to possible increased wear of rubbing surfaces of the engines, and for this reason only a portion of the boilers were so fitted. It was not thought that the early troubles with the superheaters themselves would be repeated, although it was not certain that all difficulties with them would be eliminated.

The actual alterations made in these six boilers during the design stage, as compared with the remainder, was that one-eighth of the tube surface was removed and the same amount of superheater surface added, the gases passing over the superheater surface after they had traversed the first third of the heating surface. The general results were as follows:—Two thirty hours' trials at one-fifth full power were run, six superheater boilers being used in one case, and six ordinary boilers in the other, the steam used per indicated horse-power per hour for all purposes was 18.19 lb. with superheaters, and 21.02 lb. without superheaters, showing an economy of 13½ per cent. in water consumption due to superheating. The actual amount of superheat obtained was 93 deg. Fah. at the boilers, with a gauge pressure of 200 lb., which fell to 84 deg. Fah. in the high-pressure receiver, with a gauge pressure of 86 lb. per square inch.

The high-pressure cylinder liners are of forged steel, the piston rings being two narrow phosphor bronze restrained rings, and after the trial with superheated steam, these cylinder liners showed signs of "dragging."

Further trials were then made with superheat of 30 deg. Fah. and 61 deg. Fah. After the trial with 61 deg. Fah. superheat there was an increase in the "dragging" action noticed previously, the surfaces were very "brassy," and flecks of metal from the piston rings were embedded in the cylinder walls, while with the 30 deg. Fah. superheat the condition of cylinder liners improved.

The results of these trials led to the conclusion that, as then fitted, it was not advisable to work the engines with steam superheated beyond 30 deg. Fah., and to admit of their always being so worked, a connecting pipe was added so that a mixture of superheated and ordinary steam could be used as desired. In this condition, however, the steam can hardly be much more than dried, and no marked economy could be expected on service.

Internal lubrication was not used on any of these trials in accordance with the established practice of the Admiralty, but if it had been used it would probably largely have reduced the action described, but with the present means of feed-water filtration the admission of such lubricant is objectionable.

There is no doubt that had the reciprocating engine remained the standard for marine purposes in the Navy, this matter would have been pursued further, and the difficulties would have been dealt with and no doubt overcome in future ships by improved fittings and materials.

It is more important to us as regards the future to notice the behaviour of the superheaters themselves after about 3½ years' work, with the view of determining whether the troubles of years ago are likely to be repeated, and there does not appear to be any such likelihood with the degree of superheating attempted, which was not great. The ship has been at work since 1906, and the superheater boilers have been used equally with the remaining ones, and no defects have been reported due to the superheaters. Periodical reports of examination of the condition of the superheater tubes have been made, and a few are removed and cut up for examination at intervals. The most recent report states that the interior of the superheater tubes was coated with a rusty deposit, and active pitting is taking place which is general. In the worst cases, however, the pitting does not extend beyond ·04in., the original thickness of the tubes being ·144in., and the tubes are good for several years' further service.

The deposit inside the tubes consisted of a mixture of ferrous and ferric oxides, with quite small amounts of chlorine, carbonic anhydride and lime. The latter constituents form an indication of the moisture carried to the superheater with the steam. They amounted on the average to: Carbonic anhydride, ·32; chlorine, ·1; and lime, ·52 per cent. respectively.

When we came to consider the use of superheated steam in turbine machinery, a different set of conditions and requirements were met with, and although no difficulty was to be anticipated as regards wear of parts due to dryness of steam, the alteration of relative position of parts, consequent on differences of expansion due to variations of temperatures, is materially increased by superheating. This increased difference of expansion between the various parts of the turbine casing and drum from the cold condition to that when at work due to temperature renders larger clearances of parts necessary; and there are further objections due to the effect of possible variations of superheat. The use of superheated steam, therefore, in turbines, containing close-fitting parts, did not seem to warrant the extra risks involved by it, so that the fitting of superheaters received a check. Besides this, the results being obtained in the Parsons turbines with ordinary saturated steam were extremely good.

At present, too, as compared with the early days of low-pressure steam, the difficulties of obtaining adequate superheating are greater. Compared with the practice of forty years ago the temperature of the steam itself has been considerably raised by successive increases of pressure, while at the same time, by improvement in boiler efficiency, there has been a continued reduction of the temperature of the gases discharged from the boiler. The difference between these two temperatures which is now available for superheating is considerably less than it used to be. There was no difficulty in the old days in obtaining, within reasonable limits, as much superheat as was desired from the gases, finally leaving the boiler without any modifications to the latter, which would make it less efficient, and the heat abstracted was so much clear gain. At present, however, this is not possible, the gases are so reduced in temperature by their passage over the normal heating surface that unless special arrangements are made the excess over the steam temperature is too small to be of much use for superheating.

With the ordinary type of Yarrow or Babcock and Wilcox boiler used in the British Navy, there is therefore difficulty in obtaining any considerable superheat by simply placing the superheater among the gases which have just left the boiler. Superheating with the present-day boilers therefore requires some alteration in boiler proportions or arrangement, in order to obtain such a difference between the temperature of saturated steam and that of the funnel gases in contact with the superheater as will secure sufficient superheating. This modification somewhat reduces their efficiency as boilers and the resulting gain, due to the use of superheat, is the difference between these two items, which have each to be examined so as to be certain that there is sufficient gain on balance. An alternative for large ships has been suggested in the fitting of separately oil-fired superheaters, which would remove the objection noted previously to modifications in design of boilers, the extra space and weight of the separately fired superheaters being compensated for by reductions in the number of ordinary boilers.

At the other end of the temperature scale very important considerations occur as regards the temperature and vacuum when the steam leaves the turbine, for it is well known how eminently suitable the marine steam turbine is for the economical utilisation of very low pressures. It has a great superiority over the reciprocating engine in this respect, and the reasons for this may be usefully referred to. The amount of work obtained from a given quantity of steam depends principally on its final volume after expansion while doing work, and this final volume depends on its velocity and the sectional area available for the flow of steam. In the reciprocating engine, its velocity when doing work cannot exceed that of the piston, which is limited by practical considerations quite independent of those of steam efficiency, and its sectional area, *i.e.*, the area of low-pressure cylinder cannot be increased much, for in this case we should have enormous and impracticable cylinders and large losses due to friction, condensation, and in other directions. In the turbine there is no similar limit to the steam velocity, and the steam can be expanded to within about 1in. of the condenser vacuum, so that as the steam annulus at the low-pressure end is large, and the velocity of the steam high, an enormous increase in volume is obtained during expansion while in contact with the turbine blades.

In naval reciprocating engines, it is well known that owing to considerations of weight and space a large expansion was not given at full power—in other words, economy at full power had to be sacrificed to other requirements in the warship compromise. Taking a number of representative reciprocating engines for our more recent warships with a fairly high steam pressure, viz., about 220 lb. per square inch by gauge in high-pressure receiver, the average pressure at the completion of the expansion at full power is 12½ lb. absolute, with a back pressure, whilst the cylinder is open to the exhaust of 6.7 lb. absolute, the average vacuum being 26in., or, say, an absolute pressure of 2 lb. per square inch.

Further, whilst the average back pressure in the low-pressure cylinder was about 6.7 lb. absolute, or 16½in. vacuum, the expansion only extends whilst driving the piston to about 12½ lb. absolute or 5in. vacuum, so that a considerable percentage of the energy in the steam which could be obtained by gradual expansion from 12½ lb. to 6.7 lb. while doing work, is also lost.

In the turbine, however, instead of these comparatively high pressures at the termination of expansion, we have the fact that the steam does useful expansive work to about 27in. vacuum at the turbine end, with a vacuum of 28in. in the condenser, the necessary volume being obtained as indicated previously. At the other end of the scale the average steam pressure at the turbines has only been about 140 lb. in recent examples.

Assuming adiabatic expansion, the following table shows the energy available in thermal units per 1 lb. of steam when expanding between various pressures, and the comparatively large amounts obtained for small drops of pressure at low pressure:—

Expanding	from	235 lb. absolute to 16½in.	vacuum	249 thermal units.
,,	,,	16½in. to 20in.	,,	16.2 ,,
,,	,,	20in. to 22in.	,,	11.8 ,,
,,	,,	22in. to 24in.	,,	15.1 ,,
,,	,,	24in. to 26in.	,,	21.4 ,,
,,	,,	26in. to 28in.	,,	31.9 ,,

It will be seen that the B.T.U.'s given up by the steam expanding adiabatically from a vacuum of 16½in. to one of 28in. is 38.7 per cent. of the B.T.U.'s available from an adiabatic expansion from 235 lb. absolute to 16½in. vacuum, showing the great gain by the economical expansion to low pressures and explaining the superior economy of the turbine.

A low vacuum, therefore, being of the highest importance as regards economical efficiency, much attention has been directed in recent years to various means of improving the vacuum, and with success. We have the well-known "augmentor" condenser, and a great deal has also been done by improvements in condenser and air pump design. These improvements consist principally in so arranging the shape of condenser and the spacing of tubes as to make the area for flow of vapour proportional to its volume increasing the velocity of the circulating water, and modifications in other directions. This has enabled contractors to guarantee a vacuum approaching closely the maximum possible with a much less condenser cooling surface per horse-power than was usual some years ago.

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* President's Inaugural Address at the Junior Institution of Engineers, Tuesday, November 16th.

Apart from the considerations of the general design of condensers, the provision of a tight condenser is not an easy problem in marine engineering. Although the specification for the materials of condenser tubes and tests are most stringent, yet in new ships trouble is sometimes experienced soon after ships have commissioned. It is, however, satisfactory to note that the care which is now exercised has resulted in a considerable diminution of defective condensers.

Inquiry was made some time ago as to the mercantile marine experience with condensers. One reply was so favourable, stating that no trouble had ever been experienced, that it was thought desirable to further investigate the procedure adopted. Examination, however, showed that with the tank boilers fitted in these vessels, it was never attempted to keep the boiler water fresh, but it was always maintained at a density considerably more than fresh water. Under these conditions it was not remarkable that what we should regard as condenser troubles with water-tube boilers where fresh water is essential, were not so regarded in that case where the entry of some salt water was considered immaterial.

With the large eduction pipes fitted to turbine installations, one would have expected that the necessity for readily testing the condenser would have led to designs with condensing water outside the tubes. In reciprocating engines so fitted, to test the condenser it is only necessary to remove the covers, close the discharge valve, and work the centrifugal pump. If the condensing water is so arranged for turbine installations, it is found that to obtain an area through the inside of the tubes at least equal to the area of the eduction pipe is generally impossible without tube plates of abnormal number or dimensions. For this reason the water in all cases is arranged to pass through the tubes.

Although the reciprocating engine in the Navy in its final state of development was of considerable excellence, it had to make way for the marine steam turbine, which is due to the genius, enterprise, and patient research of one of our past-presidents. All recent warships in the Navy are fitted with turbine engines, and as illustrating the magnitude of the change recently made, it may be mentioned that there are now either actually constructed or on order practically 2,000,000 S.H.P. of Parsons' turbines for the British Navy alone, and I am sure we should all wish to congratulate Mr. Parsons thereon. Now that everything is progressing smoothly as regards turbine machinery, and as ship after ship carry out successful trials without incident or failure, we are apt to forget the years of strenuous work and the magnitude of the difficulties faced and surmounted by him in the earlier stages.

The great success and freedom from accident which has attended this great revolution in propelling machinery, and the application of new principles on such an extensive scale, is remarkable, and it is due to Mr. Parsons to acknowledge the skill in design which has enabled these good results to be achieved and the estimates of performance of marine turbines to be amply borne out by actual results.

Besides the gain in economy at full power resulting in a diminution in numbers of boilers, and the comparative freedom of the turbine from running defects, the clean and dry engine-room platforms, absence of noise and bustle, &c., are features which are noticeable by everyone familiar with corresponding conditions of reciprocating engines.

An extraordinary alteration in the usual conditions of design has followed from the substitution of turbines for reciprocating engines. In the latter engines the number of revolutions per minute is determined by the engine arrangements only, and is settled from experience with previous examples, having regard to their size and the allowable piston speed, and the considerations of inertia referred to previously. Increase of revolutions and piston speed had to be made cautiously as experience justified. The revolutions having thus been decided on, the speed of ship gave the pitch, allowing for a slip determined from experience, and hence followed the suitable diameter of propeller.

Revolutions of turbines, however, are settled on radically different lines, as, if we first decided on the revolutions we would like to adopt, and proceeded as before, we should generally arrive at a propeller which is quite unsuitable. Considering the turbines alone, there is practically no limit to the number of revolutions which could be adopted even with large powers, and we have to proceed to the propeller, to determine the revolutions of shaft which are permissible. The area and diameter of the propeller have therefore to be decided from the estimated thrust, and knowing from experience the practical limit to the thrust per square inch of projected propeller area—about 12 lb.—the area is fixed, and the diameter is thus obtained. The narrow limits admissible as regards ratio of pitch to diameter for an efficient screw then gives the pitch, from which, and the speed of ship, the maximum revolutions are determined. These revolutions are made as high as the before-mentioned practical limitations will allow.

The steam engine indicator also, invaluable for reciprocating engines, is one of little or no service with turbines. Its place as regards the estimation of power has been taken by the torsion meter, and it is astonishing with what rapidity this new instrument has been developed to meet the requirements of steam turbines.

Leaving now these differences between the old reciprocating engines and turbine engines, we pass on to a few remarks respecting the relative economy of the two types.

Trials of the turbine cruiser Amethyst furnished a good comparison between reciprocating machinery and turbines in the small cruiser class, but the first turbine machinery fitted in the Navy of large size was in the Dreadnought, and it is well known how rapidly this machinery and ship were constructed and what excellent results were obtained.

When it was decided in the Dreadnought to supersede the ordinary reciprocating engine by the Parsons marine steam turbine, careful analyses of the results obtained in previous vessels indicated that an increased economy would be realised over the average type of reciprocating engine of that period, to an extent which would enable the S.H.P. of the turbine to be the same as the indicated horse-power of the reciprocating engine, while using about 15 per cent. less steam.

The machinery of the Dreadnought was designed on these lines, *i.e.*, a reduction of about 15 per cent. was made in the usual boiler proportions, and the trial results confirmed the action taken, the consumption of steam at full power for turbines only being 13.48 lb. per S.H.P. per hour, as carefully ascertained from large measuring tanks. The initial pressure at the turbines was 164 lb. per square inch by gauge.

The turbines of subsequent ships have been gradually improved with experience, and although the general construction remains the same, clearances and other adjustments required are by experience better known, and improved fittings and measuring appliances enable the dummy clearances on which steam leakage very much depends to be reduced, so that subsequent results have been even more satisfactory than those of the Dreadnought. The average steam consumption of the three battleships succeeding this ship was 13·01 lb. per S.H.P. per hour for turbines only, with an average gauge pressure of 147 lb. per square inch on the high-pressure turbine.

The turbine engines of the Indomitable Class of 41,000 S H.P. were much greater in size and of slower revolutions than those of the battleships, and the effect of this on the efficiency of the turbines could not be quite foreseen, so rather a conservative estimate was made of the probable steam economy, and though the boilers were made a little smaller proportionately (about 4 per cent.) than in the Dreadnought, trials of these ships showed that the steam consumption of the turbines was lower than expected. The results were superior to anything that could have been predicted with confidence at the time, as the average consumption of steam at full power for turbines only was 12·03 lb. per S.H.P., with the average gauge pressure 123 lb. per square inch at the high-pressure turbine.

All our original turbine ships were fitted with cruising turbines in addition to those for use at the higher powers. The Dreadnought, for example, has four turbines on each side of the ship, counting as one turbine the low-pressure and low-pressure astern, which are in one casing. Experience, however, has shown us that there are certain inconveniences attending the use of cruising turbines. They are economical, but being very often not in use they are apt to be neglected, and not to receive the attention they require, and the few accidents that have occurred with turbines have practically all occurred in the cruising turbines.

The question arose as to whether the increased economy due to their use is worth the extra complication, cost and liability to injury, and the conclusion is arrived at, at least in the case of single cruising turbines, that the balance of advantage and disadvantage is adverse to them, and they have not been fitted in recent warships. This view is the more readily taken as the alternative recommended by Mr. Parsons appears to give us most of what we require without multiplication of turbines. This alternative is to considerably increase the expansion allowed in the main turbines at high powers, provision being made to obtain the maximum power by means by by-pass arrangements. This insures greater economy at low powers than was hitherto obtainable with the main turbines, and by this system we gain simplicity and also a reasonable economy at such low powers.

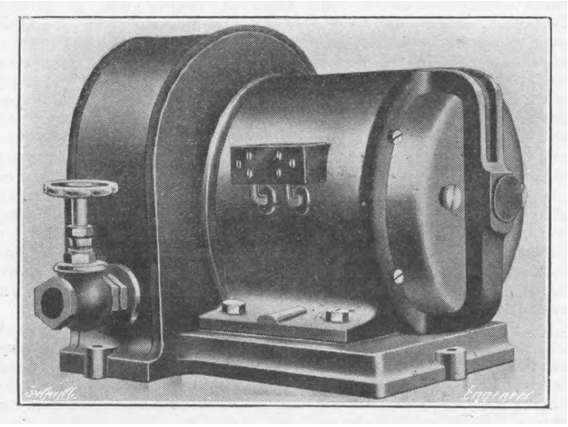
In certain classes of ships, however, where the radius of action at low powers is exceedingly important owing to their limited coal or oil storage, as in torpedo boat destroyers, two cruising turbines in series are fitted. In a typical example of this sort there are five turbines fitted on three shafts, again counting the low-pressure and low-pressure astern turbine as one. In this case, the gain by the use of the cruising turbines in series is much greater, and is considered to make up for the extra cost, weight and complication involved, and they are being retained.

(*To be continued*).

A NEW HYDRO-ELECTRIC GENERATOR.

WHERE a good pressure of water is available the use of water motors for driving small dynamos often becomes advantageous, particularly in places where there is no supply of gas, or where the use of oil, either for direct illumination in lamps or in oil engines for the generation of electric current is undesirable. A water-driven generating set has recently been put upon the market by the Union Electric Company, of Park-street, Southwark, S.E., which may be employed under such circumstances, and which has been specially designed for use in coal and other mines, as well as for the electric lighting of small factories, houses, &c. The set is shown in the accompanying illustration, from which a good idea of the compactness and general adaptability of the machine can be gathered. The turbine is designed to operate with any head of water exceeding 120ft.

In placing this little machine on the market, the makers draw attention to the fact that mines may often require lighting in places where the tubs are uncoupled, or at awkward corners, and that such places are frequently without the ordinary electric supply; whereas, in almost every colliery water is available, so that a generating set, such as we are describing, can be connected by a pipe to the nearest rising main in any of the roads.



SMALL HYDRO-ELECTRIC GENERATOR

The output of the dynamo is 200 watts at a pressure of 25 volts, and this can be developed with a pressure of 60 lb. Thus when the water motor has been coupled up a fair supply of electric current for lighting purposes is available. Before the advent of metallic filament lamps a dynamo with an output of 200 watts was only capable of lighting lamps with an illuminating value of about 50 candle-power, but with the newer type of lamp in which one watt represents approximately one candle-power, some 200 candle-power are available with this apparatus. In addition to mining and general lighting service, the set can also obviously be used for charging secondary batteries for ignition and other purposes.

The dynamo, which is of the two-pole type, is shunt-wound, and, as will be gathered from the illustration, it is totally enclosed. To reduce friction to a minimum, Hoffman ball bearings with automatic lubrication are fitted and oilways protected with removable plugs are provided throughout. The generator is intended to be used without switches and fuses, thus increasing its value in gaseous mines. The current is collected from the commutator by means of carbon brushes, and these can be inspected and removed with very little trouble. The water motor is of the impulse-wheel type, and is enclosed in a strong cast iron case, which latter is provided with an inspection cover. The bed-plate on which the dynamo is mounted is cast with the turbine casing, and the dynamo being placed very near the turbine casing, makes the set compact and rigid. The impulse wheel is made of cast iron, and is fitted with double impulse buckets. It is keyed direct on to the armature spindle, and there is, therefore, no coupling between the two machines. The combined wheel and armature are balanced, after being assembled. A 1in. screw-down stop valve is fitted to the nozzle, which latter is of hard brass. The nozzle, we are informed, can easily be exchanged to suit various pressures of water supply. The makers state that in the design of this set every care and attention has been exercised to produce a machine which is capable of operating continuously under load for six months at a stretch, this being a necessary feature for mining work. Special cable in flexible armouring is supplied with the machine when desired, and this cable is provided with screwed water-tight joints and water-tight sockets, so that lamps may be inserted in these sockets at various distances according to requirements.

HULL COAL TRAFFIC.

THE return of the Hull Incorporated Chamber of Commerce and Shipping for October shows that the month has been a very busy one. The total weight of coal taken to the port was 599,072 tons, as compared with 502,176 tons for October of 1908; for the ten completed months 5,047,216 tons, as compared with 5,002,752 tons for the corresponding period of last year. The trade for the month is only second to the October record created in 1907, when the total reached 650,208 tons; for the ten months, too, the weight is only second to that of 1907.

The exports during last month reached a total of 288,362 tons, which compare with 227,794 tons in October of last year; for the ten months 2 683,882 tons, against 2,426,001 tons for the same ten months of 1908. North Russia was the principal foreign customer, taking 86,528 tons last month, against 60,338 tons for October of last year. During the ten months North Russia received 658.115 tons, against 603,756 tons for the corresponding period of 1908. Germany was second on the month with 53,828 tons, against 41,196 tons; for the ten months 430,960 tons, against 392,600 tons; Holland was third with 49,541 tons, against 24 782 tons; for the ten months 434,160 tons, against 310,429 tons; Sweden was fourth with 37,764 tons, against 30,345 tons; for the ten months 309,185 tons, against 337,508 tons. Other increasing markets on the month were Denmark, 6304 tons, as compared with 4557 tons; Norway, 4520 tons, as compared with 2596 tons; South America, 6449 tons, as compared with 3961 tons; East Indies, 3023 tons, as compared with 2880 tons; South Russia, 599 tons, as compared with 312 tons. Taking the ten completed months of the year, Denmark received 99,919 tons, against 99,249 tons for the corresponding period of last year; Norway, 35,663 tons, against 30,206 tons; South America, 152,915 tons, against 122,268 tons; East Indies, 14,636 tons, against 11,787 tons; South Russia, 2001 tons, against 2594 tons.

The decreasing foreign markets on the month were Austria, 6538 tons, against 6585 tons, but for the ten months an increase is shown to 152,915 tons, against 122,268 tons; Belgium, 7813 tons against 10,144 tons; for the ten months 69,997 tons, against 81,720 tons; Egypt, 8754 tons, against 9994 tons; for the ten months an increase to 135,860 tons from 95,430 tons; France 8107 tons, against 18,564 tons; for the ten months 117,838 tons, against 184,903 tons; Italy, 7265 tons, against 7997 tons; for the ten months an increase to 77,588 tons from 70,148 tons; Jersey and Guernsey, 814 tons, against 1683 tons; for the ten months 12,848 tons, against 12,847 tons. No business was done in coal from Hull last month with the United States, Gibraltar, Portugal, Roumania, Spain, Turkey, and West Indies. Africa took 515 tons last month, against nil for October of 1908; for the ten months 5479 tons, against 1011 tons; the United States, for the ten months 4824 tons, against 6005 tons; Portugal and Roumania, for the ten months 7249 and 4405 tons respectively, against nil for the ten months of 1908; Spain, for the ten months 4230 tons, against 6790 tons; Turkey, for the ten months 24,385 tons, against 24,111 tons; West Indies, 1366 tons, against 4003 tons.

Coastwise exports from Hull during October amounted to 64,985 tons, against 67,773 tons for October of last year. Of last month's total, London took 43,897 tons, as compared with 58,547 tons of the total for 1908. The total exported coastwise for the ten completed months is 683,944 tons, of which London has received 465,441 tons; Southampton, 72,384 tons; Plymouth, 34,843 tons; Rochester, 12,915 tons; and Newhaven, 12.177 tons. The principal contributing collieries to the great Yorkshire port last month were, as usual, Denaby and Cadeby Main, which forwarded 67,456 tons, against 56,928 tons; for the ten months 804,232 tons, against 465,528 tons. Manvers Main Colliery second with 28,024 tons, against 25,216 tons; for the ten months 256,224 tons, against 240,520 tons.

WESTMINSTER TECHNICAL INSTITUTE.—A special course of six lectures on steel construction work, with reference chiefly to frames, roofs, &c., in general building work, and the amendment of the London Building Acts relating thereto, is being given weekly at this Institution by Mr. F. Hudleston, M. Inst. C.E. The first lecture was given on Friday, 12th November, at 7.30 p.m.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.—The second general meeting of the session will be held in the Lecture Hall of the Sunderland Literary Society, Fawcett-street, Sunderland, this evening at 7.30 p.m. The discussion on Mr. D. Myles's paper on "Notes on Marine Boiler Design, Construction, and Economy" will be resumed, and a paper on "Some Notes on the Erection of the Baikal Railway Ferry Steamers," by Mr. Isaac O. Handy, will be read and discussed.

DRIVING BAND.—We have received from Mr. C. McD. Cheeld, of Thorpe-le-Soken, Essex, a sample of his Torque driving band with patent fastenings. The band is made of a three-ply hemp rope, and is ¼in. diameter. The fastenings are small stamped steel hooks with bulb ends. The strands of the band are laid open a short way and the bulb placed in position, a soft iron ring being then closed round the strands with a pair of pliers. The joint is very easily and quickly made and holds excellently. A feature of the band is that it can be lengthened or shortened quite readily by untwisting or twisting it so that a suitable driving tension is easily obtained. But since it is far more elastic than a gut or leather band, there is not the same need for precision in length, a difference of ½in. or so, which would be fatal in a gut band, making no appreciable difference. We have given the band a good test on a foot lathe and found it perfectly satisfactory. Whether it is as durable as gut or leather we cannot yet say, but as it is very cheap and easily fitted, less durability would not be of great consequence. It may be safely recommended for the amateur workshop. We understand that the Torque band is made in various sizes.

A NEW FUEL.—The firm of Charco, Limited, of Winchester House, 50, Old Broad-street, E.C., is introducing a process for the production of a new fuel known as "Charco." This fuel is produced by subjecting coke as it comes direct from the gas retorts or coke ovens to this firm's patented process. By simple manual labour, without additional plant—or in the case of larger installations, by simple appliances for handling the fuel—the coke is said to be transformed into a valuable fuel, closely akin to charcoal. We are informed that at a works in Derbyshire the process has been in operation since December, 1908. In place of coke which formerly sold at 7s. and 9s. per ton, "Charco" is said to be now selling at 17s. 6d. per ton, without any diminution of the quality of the gas produced. The ordinary production of tar ammoniacal liquor, &c., is said not to be affected in any way by this process. Many important claims are made for this new fuel, among which are:—It is absolutely smokeless, and it readily ignites, and lasts for hours without attention. The ash is said to remain in the grate instead of being diffused as dust in the atmosphere. It is claimed to produce intense heat, and on burning the combustion is said to be more complete than is the case with ordinary fuels, and consequently a less quantity is required.

THE IRON, COAL, AND GENERAL TRADES OF BIRMINGHAM, WOLVERHAMPTON, AND OTHER DISTRICTS.

(*From our own Correspondent.*)

Pig Iron.

THE consumption of foundry sorts of pig iron is a little larger than previously, but still leaves much to be desired. The same may be said of forge sorts. Cold-air pig iron is still quoted 115s., hot-blast foundry 90s., and forge 85s. Cinder forge is in fairly good output, and is still quoted 46s. to 47s., with part-mines 50s. 6d. to 51s. 6d. Northamptons are quoted 48s. to 49s., and Derbyshires 49s. to 50s.

Manufactured Iron.

There does not appear to be any improvement in manufactured iron. Hardly any works are on full time, and new business is very scarce. These remarks apply particularly to common bars and plain sheets. The former are quoted £6, and the latter, for doubles, £7 2s. 6d. to £7 5s. With regard to galvanised sheets, these continue to form an exception to the prevailing quietude—and a very welcome exception too. The foreign demand continues satisfactory, and the home demand for galvanised hollowware making fairly so. The marked bar firms are moderately well placed for work, and still quote £8. Rivet iron is £6 15s. to £7, whilst gas strip is £6 5s. to £6 7s. 6d.

Steel.

Steel girder plates are in rather quiet demand at £6 to £6 2s. 6d. Some of the Midland steel makers sent in tenders in connection with structural material needed for the new works which the Midland Railway Carriage and Wagon Company is proposing to build at Washwood Heath. These tenders were not, however, successful, the contract—which is said to be worth some £30,000—having, it is understood, gone to the North of England. Angles are in fair demand, and are quoted £5 17s. 6d. to £6. For mild steel engineering bars £6 7s. 6d. to £6 17s. 6d. is asked, according to quality and conditions of order. Semi-finished steel is in fairly good call. Bessemer sheet bars are quoted £4 15s. and Siemens £4 17s. 6d.

The Grinding of Metals.

At a meeting of the Council of the Birmingham Chamber of Commerce on Monday, the Secretary of the Chamber, Mr. G. H. Wright, brought forward a report with reference to the Home Secretary's new regulations as to the grinding of metals, and the racing of grindstones. The report pointed out that the Home-office had hitherto pinned its faith on the one system of exhaust draught, but that under the new regulations there was to be a free choice of efficient alternatives In securing this point alone, the opposition to the draft regulations had been more than justified. Another important concession was obtained by the Birmingham Chamber—on whose behalf alone the point was pressed—namely, with reference to grindstone racing. In the draft regulations the following alternatives were allowed:—(1) A cover and an exhaust draught; (2) a method of wet racing by means of a stream of water directed upon the point of contact with the tool and stone; (3) racing in the open air; (4) racing in a room exclusively devoted to that purpose. But as a result of the opposition, this regulation had been so modified as to permit the continuance of the present methods, provided all other work was suspended during the racing, and not resumed until the room had been cleansed from dust.

NOTES FROM LANCASHIRE.

(*From our own Correspondent.*)

MANCHESTER, Thursday.

Curious Position of Pig Iron.

THE condition of the pig iron trade in this centre presents a state of things which has not been known for many years past. On Tuesday on the Iron Exchange reports were most pessimistic. It would appear that as a result of speculative buying some months ago merchants and others have not been able to take delivery as per contracts, with the result that a great deal of iron has been put on the market for sale at the best prices obtainable. This, too, entirely independent of makers' official rates. In some cases the difference between buyers and sellers has been as much as 2s. 6d. and 3s. per ton, but even at the lowest level buyers do not respond readily. They prefer to wait in the hope that still better prices than these will prevail to their advantage. It is only fair to say that a number of both makers and merchants refuse to regard the position as anything but an abnormal one, and that when the re-sale lots are placed quotations will resume their former position. It will be readily understood, therefore, that the quotations for pig iron given below are only approximate in character, and apply to legitimate transactions in the ordinary way of business. Forge iron, although quiet, is steady.

Finished Iron and Steel.

Matters remain about the same as last week. Business slow.

Copper.

Manufactured keeps advancing in sympathy with the raw metal. Tubes are ¼d. per lb. higher. It must not be thought, however, that the demand on spot warrants this advance. Merchants complain strongly of want of orders, but it is evident that speculative influences are at work to keep up prices.

Lead and Tin.

Lead: Sheets steady at late rates. Tin: English ingots about 20s. per ton higher.

Quotations.

Pig iron, 56s.; Staffordshire, 53s. 6d.; Derbyshire, 55s.; Middlesbrough, open brands, 59s. 10d. Scotch: Gartsherrie, 61s.; Glengarnock, 60s. to 60s. 6d.; Eglinton, 59s., delivered Manchester. West Coast hematite, 61s. to 61s. 6d.; East Coast ditto, 60s., both f.o.t. Scotch: Delivered Heysham: Gartsherrie, 59s.; Glengarnock, 58s. to 58s. 6d.; Eglinton, 57s. Delivered Preston: Gartsherrie, 60s.; Glengarnock, 59s. to 59s. 6d.; Eglinton, 58s. Finished iron: Bars, £6 10s.; hoops, £7 12s. 6d.; sheets, £7 15s. to £8. Steel: Bars, £6 2s. 6d. to £6 5s.; Lancashire hoops, £7 5s.; Staffordshire ditto, £6 17s. 6d. to £7; sheets, £7 17s. 6d. to £8; boiler-plates, £7 5s. to £7 7s. 6d.; plates for tank, girder, and bridge work, £6 5s. to £6 7s. 6d.; English billets, £4 12s. 6d. to £4 15s.; foreign ditto, £4 10s. to £4 15s.; cold drawn steel, £9 10s. to £9 15s. Copper: Sheets, £72; tough ingot, £62; best selected, £62 per ton. Copper tubes, 8¾d.; brass tubes, 7⅛d.; condenser, 8⅛d.; rolled brass, 6½d.; brass wire, 6¾d.; brass turning rods, 6¾d.; yellow metal, 6d. to 6⅓d. per lb. Sheet lead, £17 per ton. Tin ingots, English, £137 per ton.

The Lancashire Coal Trade.

There was a fair attendance on the Coal Exchange on Tuesday, but trade, on the whole, was slow. Certainly domestic fuel was in better demand, owing to the cold spell, but slack and steam coal were only in moderate request. There is a large supply coming from West Yorkshire and Derbyshire, and competition evidently prevents the Lancashire coalowners from putting up prices. Shipping demand quiet but steady. Speaking generally, we do not see that the demand justifies any advance in prices for the present.

BARROW-IN-FURNESS, Thursday.

Hematites.

There is not much business being done in the hematite iron trade, but still some 30,000 tons a week are being delivered by smelters to consumers. There are twenty-eight furnaces in blast, and another furnace at the Distington Ironworks will be lighted next week. But in the meantime stocks are slightly on the increase. They now stand in warrant stores at 16,836 tons. This, of course, is not a big figure, as it only represents practically half a week's production, but smelters are not averse at the moment to the increase of stocks, as they have the knowledge they will be required later on. The trade with local steelmakers is not so large as it was some time ago, nor is there much business doing with the Colonies or the Continent. There is a satisfactory trade in special hematite iron, which is being more largely used for purposes where the highest grades of metal are required, and this is being sold at about 64s. or 65s. per ton, according to specification, while ordinary mixed numbers are at 62s. net f.o.b., and warrant iron is at 60s. 9d. net cash sellers. A steady trade in ferro manganese and spiegeleisen is reported, although the consumption of the latter locally has fallen off somewhat of late. Scrap iron is in good demand. Some business is being done in charcoal iron, and preparations are in progress for keeping the only charcoal furnace in this country situated in this district in full operation for some time to come, as a large stock of charcoal has been accumulated at the works. The trade in iron ore locally is better than it was some time ago, but there is a fairly large importation of foreign ores, which, of course, compete against the local product. The latter is now quoted at 12s., 14s. 6d., and 18s. per ton net at mines.

Steel.

The works of the Barrow Steel Company are in operation again in the Bessemer department, and although the demand for railway material is not so good as it has been, there is reason to believe the mills will be kept busy until the end of the year. The Moss Bay Works are, however, at a standstill for a few weeks during repairs, and when they are restarted the works of the same company at Derwent will be closed down for certain repairs. Prices are steady at about £5 5s. for heavy rail sections. Merchant steel is in fair request. The demand for ship plates is quiet, and there is nothing doing at the local mills.

Shipbuilding and Engineering.

It is rumoured that one of the new super-Dreadnoughts is likely to be fixed with Vickers, Sons and Maxim, who are now conducting the trials of H.M.S. Vanguard, whose keel was only laid in April of last year. Engineers are better employed, and have now on hand the propelling machinery of the third battleship required by the Brazilian Government now building at Elswick.

Shipping and Coal.

The shipments of iron and steel from West Coast ports last week amounted to 7087 tons - iron 3235 tons and steel 3852 tons—as against 14,850 tons in the corresponding period of last year, a decrease of 7763 tons. For the year to date the shipments aggregate at 539,196 tons, against 437,629 tons, an increase of 101,567 tons. Coal and coke are in fair request and prices steady.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

House Coal Firmer.

THE demand for house coal is getting firmer, owing to the spell of wintry weather and the advancing season. No official notification of increased rates has been made by the collieries, but the usual season advance is being asked and obtained for all new orders. The lessened demand for steam coal is for the present placing more "seconds" house fuel on the market, which qualities are suitable for many domestic purposes, and this prevents further increase in prices being pressed. A fair demand is reported for London and the Eastern Counties, and the local markets are also pretty busy. Best Barnsley is making from 12s. 6d. to 14s. per ton; secondary descriptions, 10s. 6d. to 11s. 6d. per ton.

Steam Coal—Australian Inquiries.

With the exception of the nearer Baltic ports, such as Reval and Riga, the Baltic navigation may be regarded as practically closed. This, for the present, has the effect of throwing more coal on the market, and bringing about somewhat easier prices for prompt delivery. During the shipping season the rates, it will be remembered, were anything between 9s. and 10s. per ton; the current rates now are from 8s. to 8s. 6d. for prompt delivery. Of course, although the Baltic ports are mainly closed, there is still a good export going on, and in the crisis impending in Australia some inquiries have been received even for export to the Antipodes. Sending coal to Australia is not a new thing from this district, as one or more collieries forwarded large cargoes on a previous occasion of a strike there some years back.

Railway Coal Contracts.

Several of the railway coal contracts expire about this season of the year, and in view of the better prices obtained recently for shipping, and the prospect of higher rates next year, coalowners are not disposed to make contracts at last year's prices, some of these having been exceptionally low in the light of rates since obtained. As yet, we are unable to learn that any contracts have been made for next year, but in some instances a considerable quantity of arrears have to be made up, and neither buyers nor sellers have need to press the matter.

The Eight Hours Act and the Output.

As the state of industry in the country is at present, the operation of the Eight Hours Act has not affected the output so much as it did a few weeks past when the shipping season exercised pressure, but in the event of a revival of trade coming upon us, at the time of the shipping season in particular, it is questionable whether sufficient coal could be got by the present number of miners to supply the wants of trade demands. At the outset of the Act, it will be remembered, the working hours of the miners were reduced a matter of 30 per cent., with a corresponding diminution of output. This reduction, however, by the adoption of double shifts where the number of men has allowed has been somewhat modified to the figures we have formerly given—from 12 to 15 per cent.

Small Coal and Coke—Advance in Coke.

An active demand for small coal is still maintained. The call for the Lancashire and Yorkshire textile districts keeps up in spite of the short time which, it is stated, is to be continued in the cotton mills. The qualities for these purposes fetch from 4s. 6d. to 5s. 6d. per ton. Coke is also in good request, best washed making from 12s. 6d. to 13s. per ton, and unwashed 11s. 6d. to 12s. per ton. The latter figures for unwashed show an advance of 6d. per ton, following the previous advance of 6d. per ton on washed.

The Iron Market.

Quietude prevails all round in the pig iron market. Very little business doing in hematites beyond what is needed for immediate requirements. Neither is the foreign demand at present very active, for there is a considerable quantity of hematite iron yet to deliver on foreign account. We hear a pretty general feeling expressed that no material change is probable this year. The official quotations—all net, and delivered in Sheffied and Rotherham—are as follows:—West Coast hematites, 68s. to 70s. per ton; East Coast, 65s. to 67s. per ton; Lincolnshire, No. 3 foundry, 52s. 6d. per ton; No. 4 foundry, 51s. 6d. per ton; No. 4 forge, 51s. 6d. per ton; No. 5 forge, mottled and white, 51s. 6d. per ton; basic, 52s. 6d. per ton. These are the quotations on which orders are taken for delivery to the end of this year, but for delivery during the first six months of next year there is required a premium of 1s. 6d. to 2s. per ton on these figures. Derbyshire, No. 3 foundry, 52s. per ton; No. 4 forge, 50s. 6d. per ton.

Bars, Hoops, and Sheets.

The bar iron trade continues very flat, with no immediate prospect of improvement. Bars, £6 10s. per ton; hoops, £7 10s. per ton; sheets, £8 10s. per ton.

The Heavy Trades: Swedish Iron.

The heavy industries at the East End of Sheffield continue fairly well employed. Nothing has yet been heard of the expected new orders for armour plates, which will be very welcome when they arrive, as the present orders are rapidly approaching completion. We hear of nothing definite with regard to other matters affecting the naval and military departments. No further orders of any importance have recently been received for marine specialities, and the railway material trade still continues dull, both for home and foreign markets. The reports as to the steel trades are somewhat varying, as several houses are differently placed from others in the matter of new work. It seems, however, that the improved demand for tool steel from the United States keeps well up, and other features recently noted remain pretty much as they were. In regard to Swedish iron, which is so largely used in the local manufacture of the higher qualities of steel, increased prices, due to the uncertainty in delivery, are being asked and obtained.

NORTH OF ENGLAND.

(*From our own Correspondent.*)

Cleveland Pig Iron.

WHILE there is still a lull in the Cleveland pig iron market, business is beginning to revive a little, and consumers are not quite so averse to buying as they were last week. The slackening of the orders has brought out a fact which is rather important, and it is that the position of the Cleveland ironmasters is more encouraging than was expected, and that second hands do not see their way to undersell producers. Prices have been upheld in a remarkable manner, for though very few purchases have been made during the last three or four weeks, the changes in quotations have been small; indeed, for a fortnight quotations were quite stationary, a circumstance which has not been reported previously for many months. Poor shipments and a heavily increasing stock of Cleveland pig iron in Connal's public stores have not weakened either the makers' or merchants' quotations; and as far as regards warrants, which have been equally firm in price, the holders appear to stick to them for the present, notwithstanding the expense of carrying them owing to dear money. Such firmness in pig iron prices in the circumstances can only be accounted for by the fact that the opinion is general that in 1910 trade will be satisfactory again, and that another period of prosperity will be in progress. Makers are in no hurry to commit themselves to contracts for execution next year, and there seem to be sufficient reasons for their attitude. The buyers themselves take sanguine views of the probable business of next year. Thus the quotations for iron for delivery in 1910 are higher than those which will be accepted for prompt. The rates for delivery over the first quarter of next year are fully 1s. per ton in excess of what is being asked for delivery up to the end of the year. The price of No. 3 Cleveland G.M.G. pig iron for prompt f.o.b. delivery is 51s., No. 1 is at 53s. 6d., No. 4 foundry at 49s. 6d., No. 4 forge at at 49s., mottled at 48s. 6d., and white at 48s. per ton, which may be looked upon as very fair figures, sufficient to afford a reasonable profit to the producers, even with the present comparatively high prices for coke.

German Coke for Cleveland.

There is a report in circulation that Westphalian coke has been bought for consumption at one of the works in this district, but the report is doubted on 'Change at Middlesbrough. No one can trace such a transaction, and it is very unlikely that such imported coke could be cheaper than Durham coke. It is believed that the report has been set afloat to influence the Durham coke market, and bring the quotations down. Certainly no coke has yet been imported. It is true that two or three years ago, when Durham coke was being sold at 24s. per ton delivered at Middlesbrough furnaces, some Westphalian coke was brought over to Cleveland as an experiment, but the experiment did not succeed, and only three or four cargoes were received. The cost of carriage was too heavy, and it is not likely to be any cheaper now. German coke manufacturers will not continue for long sending coke to this country at a loss to themselves.

Hematite Pig Iron.

The makers of East Coast hematite pig iron are well supplied with orders for execution this year, and as they expect a prosperous time next year, they are very firm in their prices, which are maintained at the highest figures that has ruled this year, and they are realising 5s. per ton more than was accepted in the spring. All the industries that consume hematite pig iron are steadily reviving, and it must be inferred that they will consume more pig iron than has been needed in each of the two last years, while America is expected to require a large tonnage. The prospects are, indeed, so encouraging that more furnaces have been re-started this month for the production of iron other than ordinary Cleveland. It is to be taken into account that the supply of hematite iron is not anything like as great as that of ordinary Cleveland iron; there is no stock of hematite in the public stores, whereas over 350,000 tons of Cleveland iron are held. Makers' stocks are not believed to be heavy. The fact that both in this district and the North-West of England additional furnaces are in operation is an encouraging feature. Mixed numbers are very firm at 60s. per ton for prompt delivery, and 62s. 6d. for delivery over next quarter, but a little can be obtained for prompt from second hands under 60s. There is nothing being done in Spanish iron ore; no one here needs to buy for delivery this year, and consumers cannot purchase for delivery next year as the Spanish owners have not decided upon what they will ask, so that merchants dare not take the risk of quoting. The nominal price for rubio ore for delivery in the Tees this year is 17s. 6d. per ton.

American Demand for Cleveland Pigs.

The American inquiry for Cleveland pig iron has almost ceased, and where inquiries do come to hand they result in nothing. A report published in the American papers that an order for 6000 tons of Cleveland pig iron had been placed, is not credited; the transaction cannot be traced on this side. Several orders for hematite iron have, however, been obtained from the States, and there is every reason to believe others will follow; indeed, traders believe that North America will become a good market for British hematite, as well as for spiegel, ferro, and crop ends, good quantities of which have gone lately.

Stock and Shipments of Pig Iron.

Connal's stock of Cleveland pig iron has increased heavily this month; but, nevertheless, on Tuesday there was a decrease for the day of 1158 tons, the first decrease that had been reported for a considerable time. On the 17th the quantity held was 349,537 tons, an increase for the month of 14,052 tons. The stock consisted of 320,615 tons of No. 3, 25,062 tons of other iron deliverable as standard; and 2860 tons of iron not deliverable as standard. The exports of pig iron from the Cleveland district this month to 17th were only 48,214 tons, as compared with 68,909 tons last month, 61,655 tons in November last year, and 83,974 tons in November, 1907, to 17th.

Manufactured Iron and Steel.

Not much buying is reported this week, but manufacturers as a rule are fairly well off for orders and can afford to wait. One of the leading firms in this district supplying shipbuilding material has already on its books orders for next year's execution sufficient to guarantee its earning as good a dividend as it has paid for the past year, and the prospects are that trade will be substantially better. There is no doubt about the revival in shipbuilding, and all the iron and steel producers who supply the yards with materials are again doing a fair trade. The new Talbot steel furnace, which the South Durham Steel and Iron Company started last week at its West Hartlepool Works, is giving very good results. It is of 225 tons capacity and is of the tilting type. The Talbot furnaces at the Cargo Fleet Works have done good work during the last twelve months, but it has only been possible to keep them partially employed owing to the shortness of orders, particularly for shipbuilding and other sections.

Shipbuilding and Engineering.

The improvement in the shipbuilding industry is generally recognised, and new orders are coming forward very fairly, so that builders can now secure improved prices. Messrs. Swan, Hunter and Wigham Richardson, of Wallsend-on-Tyne, have received an order from the Pacific Steam Navigation Company, and the steamer will be engined by the Wallsend Slipway and Engineering Company. Messrs. Lawther, Latta and Co., London, have ordered a large steamer from Messrs. Short Brothers, Sunderland; and Mr. P. A. Grön, of Sandefjord, Norway, who has already two large boats building in this district, has ordered another of 4000 tons. Messrs. Wood, Skinner and Co. have obtained an order for a coasting steamer. Irvine's Shipbuilding and Dry Docks Company, Limited, West Hartlepool, have this week booked an order for a 7400-ton cargo steamer for Messrs. Woods, Tyler and Brown, of London; also another for a first-class passenger steamer for the London and Newcastle service of the Tyne-Tees Steam Shipping Company. There is naturally some improvement in the engineering industry, and there was room for it.

Coal and Coke.

A turn for the better has been taken in the coal trade after a period of great dulness, especially in the steam coal branch. Consumers are keen to buy for delivery next month before the new Mines Eight Hours Act comes into force in Northumberland and Durham on January 1st. It is generally conceded that this will increase the cost of getting the coal, and higher selling prices are likely. Best steam coals have risen to 11s. per ton f.o.b. and smalls 5s. 6d. to 6s. 6d. Best gas coals are up to 11s., and coking and bunker coals vary from 9s. 3d. to 10s. Coke is dearer; most sellers quote 17s. 6d. per ton for furnace coke delivered at Middlesbrough works.

NOTES FROM SCOTLAND.

(*From our own Correspondent.*)

The General Trade Outlook.

CONSIDERABLE additions are reported to have been made to the Clyde shipbuilding orders within the last few days. These embrace some additional Government work and six large steamers to be employed in the chilled meat trade from South America, the cost of each vessel being stated at about £100,000. Inquiries made at labour centres in the Clyde district show that there has recently been a considerable diminution in the percentage of unemployment. While provision will have to be made for large numbers of unemployed, it is not expected that the distress will be nearly so severe as it was last winter.

The Pig Iron Market.

There has been comparatively little business of a speculative nature in pig iron warrants in the course of the week. The high percentage now charged by local bankers for loans on warrants is acting as a check upon such operations, and the condition of the trade generally is likewise unfavourable for transactions of this description. There has been much less business doing both for present and future delivery. A certain amount of encouragement is afforded by confirmation of a report that several thousand tons of Cleveland iron have been purchased for America, while inquiries are being made regarding deliveries over the early part of next year. Business has been done in warrants in this market at 51s. to 50s. 10d., and up again to 51s 3d. cash, 51s. 4½d. and 51s. 3d. one month, and 51s. 11d. to 52s. 0½d. three months. Transactions have also taken place at 51s. 1½d. for delivery in nine days, 51s. fifteen days, 51s. 0½d. eighteen days, 51s. 3½d. twenty-seven days, and 51s. 4d. for 13th December.

Scotch Makers' Iron.

The demand for the ordinary and special brands of Scotch makers' pig iron has been quiet, the purchases both for home and export being reported on a limited scale. Fair deliveries take place under former contracts, and the output is maintained, there being 83 furnaces in blast in Scotland, compared with 77 at this time last year. The prices of makers' iron, owing to the dulness in warrants and the moderate demand for the various brands, have been generally reduced to the extent of 6d. and 1s. per ton. Monkland is quoted f.a.s. at Glasgow, No. 1, 57s.; No. 3, 55s.; Carnbroe, No. 1, 60s.; No. 3, 57s.; Clyde, No. 1, 61s.; No. 3, 56s. 6d.; Gartsherrie and Calder, Nos. 1, 62s.; Nos. 3, 57s.; Summerlee No. 1, 64s.; No. 3, 59s.; Langloan, No. 1, 65s.; No. 3, 60s.; Coltness, No. 1. 89s.; No. 3, 59s.; Eglinton, at Ardrossan or Troon, No. 1, 58s.; No. 3, 56s.; Glengarnock, at Ardrossan, No. 1, 64s. 6d.; No. 3, 59s. 6d.; Dalmellington, at Ayr, No. 1, 62s.; No. 3, 57s.; Shotts, at Leith or Glasgow, No. 1, 62s.; No. 3, 57s; Carron, at Grangemouth, No. 1, 64s. 6d.; No. 3, 58s. 6d. per ton.

The Hematite Trade.

The current output of hematite pig iron in the West of Scotland is at present about the largest on record. Consumption is gradually increasing, and there is a somewhat confident opinion that this expansion is likely to continue. Merchants quote 63s. 6d. per ton for Scotch hematite pig iron delivered at the West of Scotland Steel Works. Cumberland hematite warrants have been purchased in our market at 60s. 6d. cash and 61s. 7½d. for delivery in three months. During the past week thirteen cargoes of hematite ore reached the Clyde, the great proportion of it being from abroad.

Pig Iron Shipments.

The shipments of pig iron from Scottish ports in the past week were unusually small, amounting to only 3279 tons, compared with 7394 in the corresponding week of last year. To the United States 350 tons were despatched, Canada 275, India 55, Australia 286, France 30, Italy 60, Germany 30, Holland 95, Belgium 20, other countries 316, the coastwise shipments being 1762, against 4955 tons in the same week of 1908. The arrivals at Grangemouth of pig iron from Cleveland and district were 11,077 tons, showing an increase of 2113 tons compared with the import of the corresponding week.

Finished Iron and Steel.

There is little or no improvement in the finished iron trade. Home demand is on a restricted scale, while the prices quoted for export are regarded as unremunerative. Steelmakers are receiving orders somewhat more freely for shipbuilding steel, but some of the works are still but poorly employed. There is a fair inquiry for structural engineering material. The demand for thin sheets is well maintained, and galvanised material is meeting with a ready market.

The Coal Trade.

The extremely cold weather that has prevailed this week greatly increased the demand for household coal, and railway transit has been considerably impeded by fog. Supplies are thus curtailed, and merchants have raised their prices 6d. to 1s. per ton. The export department is also affected to some extent by the state of the weather, but shipping prices are so far without material alteration.

WALES AND ADJOINING COUNTIES.

(*From our own Correspondent.*)

Last Week's Cardiff Coal Trade.

THE long-expected Admiralty orders for steam coal have not yet been placed, nor has there been any trustworthy statement that they have gone elsewhere. Leading coalowners appear to be confident that they must come to hand, and they are not ready in granting concessions, even for prompt cargoes. As a rule, 3d. per ton has been allowed, and in some cases 6d., but it will be seen by the list of quotations there is not much difference between them and those of the preceding week. The weather was more favourable, and tonnage came in more freely. It is reported that important orders have gone North. The Austrian Lloyd and Cie Generale Transatlantique are named, but not authoritatively. One of the reports discussed on 'Change, Cardiff, was that the Cambrian collieries had received orders for about half a million tons at close upon 16s. 6d. per ton; also that Buenos Ayres and Rosario Railway had placed orders for 20,000 tons large steam with Ymyshir, Stannard, and Lewes Merthyr, for delivery over coming year, at 15s. 9d. and 16s. Santo Fé is in the market for 20,000 tons best Welsh steam. The Cunard Steamship Line have contracted with the P.D. for 50,000 tons large steam at 14s. 6d. over the first six months of 1910.

Latest Net Coal Prices.

Some difficulty is found in arranging prices over the coming year. What with the political situation, the effect of the Eight Hours Bill, which coalowners and colliers would gladly see repealed, there is considerable difficulty in the arrangement of future business; the tendency is to accept 16s. 6d., but buyers object, and a little time is necessary to settle forward business. On the whole, there is a steadying character observable. House coal improved. Best steam coals are quoted at 16s. 3d. to 16s. 9d.; seconds, 15s. 6d. to 16s.; ordinary large steam, 14s. 9d. to 15s. 3d.; drys, best, 15s. 9d. to 16s. 3d.; drys, ordinary, 14s. 3d. to 14s. 6d.; best Monmouthshire black vein, 15s. to 15s. 3d.; Western Valleys, 14s. 3d. to 14s. 6d.; Eastern Valleys, best sorts, 13s. 9d. to 14s.; other kinds, 13s. 3d. to 13s. 6d.; best house coal, 17s. 6d. to 18s.; other qualities, 14s. 6d. to 16s. 6d.; No. 3 Rhondda, large, 17s. to 17s. 6d.; through, 13s. 6d. to 13s. 9d.; No 3 smalls, 10s. to 10s. 3d.; No. 2 Rhondda, 12s. 6d. to 12s. 9d.; through, 9s. to 9s. 6d.; No. 2 smalls, 6s. 9d. to 7s.; best washed nuts, 14s. to 15s. seconds, 13s. to 13s. 6d.; best washed peas, 12s. 6d. to 13s.; seconds, 9s. 6d. to 10s.; best small steam, 9s. to 9s. 6d.; seconds, 7s. 9d. to 8s. 3d.; other smalls, including drys, 6s. 6d. to 7s.; dock screenings, 9s. 3d. to 9s. 6d. Patent fuel, 15s. to 16s. Coke foundry, 18s. to 20s.; special foundry, 24s. to 27s.; furnace, 17s. to 17s. 9d. Pitwood, 19s. to 19s. 6d.

Newport Coal.

Trade has been rather disappointing, coalowners looking for more vigour, but leading authorities are not disturbed, and are confident of a speedy alteration and advancing prices. Quotations are well maintained, and if a small rebate is made it is for prompt. Future business is expected to stiffen. Latest:—Best black vein, large, 15s. to 15s. 3d.; Western Valleys, 14s. 3d. to 14s. 6d.; Eastern Valleys, 13s. 3d. to 13s. 6d.; other qualities, 12s. 6d. to 13s.; best smalls, 7s. to 7s. 6d.; seconds, 6s. 3d. to 6s. 9d.; inferiors, 5s. 9d. to 6s. 3d. House coal, best, 15s. to 15s. 6d.; seconds, 14s. to 14s. 6d. Patent fuel, 15s. to 15s. 3d. Coke: Foundry, 18s. to 19s.; furnace, 17s. to 17s. 6d. Pitwood, ex ship, 19s. 3d. to 19s. 9d.

Swansea Coal Trade.

Business is but little altered. Supplies are coming to hand freely, and the tendency of prices is to droop slightly. It is thought, also, that the tactics of buyers are to wait in the expectation of easier figures. This the condition of the parliamentary world and the prospects of severer weather would seem to question, and anthracites will be in better demand. Best anthracite is firm at 23s. to 24s. net; second malting, 21s. to 22s. net; big vein, 17s. 6d. to 19s., less 2½; red vein, 12s. to 13s., less 2½; machine-made cobbles, 23s. to 24s. net; Paris nuts, French nuts, German nuts, 26s. to 27s. net; beans, 18s. 6d. to 19s. net; machine-made large peas, 11s. to 12s. 6d. net; fine peas, 10s. 6d. to 11s.; rubbly culm, 5s. 3d. to 5s. 9d., less 2½; duff, 2s. 6d. to 3s. net. Steam coal: Best large, 17s. to 18s.; seconds, 14s. 6d. to 15s.; bunkers, 9s. 6d. to 10s. 6d.; small, 7s. to 9s., all 2½ per cent. less. Bituminous coal: No. 3 Rhondda, 18s. to 18s. 6d.; through, 14s. 9d. to 15s. 6d.; small, 10s. 3d. to 10s. 6d. Patent fuel, 13s. to 13s. 6d., all less 2½ net cash, 30 days.

Australia and Welsh Coal.

Some inquiries have been made at Cardiff with regard to the possibility of supplying coal in districts affected by the strike, but, as suggested on 'Change, the long distance and the high price of Welsh coal militated against the likelihood of business being done to any appreciable extent.

Llanelly Coalfield.

Interest is again centred on the coalfield of Llanelly, from which great things are eventually expected. For some time explorations have been going on by the Great Mountain Colliery Company, and it is now announced that a fine seam has been struck. If correct, it is anticipated that the output in a little time will be doubled. Negotiations are going on for running steamers weekly between Llanelly and Manchester.

Iron and Steel.

There is little improvement in the general condition of the trade. Some cargoes of pig are being sent to Melbourne and also to Vannes. Cargoes of iron are being sent regularly to Bristol from Newport, but there is no improvement in the conditions, the starting of fresh plant at Dowlais being the only hopeful feature. Latest pig iron quotations at Swansea were as follows:—Hematite mixed numbers, 60s. 7½d. cash and month; Middlesbrough, 51s. cash and 51s. 4d. month; Scotch, 56s. 10½d. cash and month; Welsh hematite, 66s. to 67s. 6d., delivered; East Coast hematite, 64s. to 65s. c.i.f. Steel bars: Siemens, £4 15s. per ton; Bessemer, £4 12s. 6d. Iron ore c.i.f. Cardiff or Newport, Mon., 16s. 6d. to 17s., on basis of 50 per cent. iron. Other quotations:—Copper, £59 12s. 6d., and £60 16s. 3d. three months. Lead: English, £13 12s. 6d.; Spanish, £13 2s. 6d. Spelter, £13 5s. Silver, 23¼d. per oz.

Tin-plate.

Animation, and a free inquiry for all kinds are the features of the market. Last week we mentioned that inquiries were coming in from the Pacific Coast; it is now stated that substantial business has been done in that quarter. Quotations are firm; prospects good for some time. Last week clearances were large, shipments and quantity received from works were nearly equal, shipments being 84,808 boxes, and receipts from works 84,715 boxes. Stocks now remaining are 83,727 boxes. New York this week took 808 tons, and substantial loadings are going on. There are rumours of extensive enlargements at Nettlefold's to meet sheet requirements. Latest prices:—Ordinary Bessemer and Siemens, I. C. 20 × 14 × 112 sheets, 12s. 4½d. to 12s. 6d.; ternes, 28 × 20 × 112 sheets, 22s.; C. A. roofing sheets, £8 10s. to £8 15s. per ton; big sheets for galvanising, £8 10s.; finished black sheets, £9 10s. to £9 15s.; galvanised sheets, 24 g., £11 per ton; block tin, £139 15s. cash, £141 17s. 6d. three months.

Welsh Copper Trade.

Messrs. B. Tillett and Councillor Merett addressed a large meeting of copper workers at the Swansea Works on Friday, the intention being to introduce, if possible, the method of Conciliation Boards into the copper trade. It was pointed out that the same difficulties and want of uniformity characterised the copper trade which menaced the tin-plate trade before the Conciliation Board was formed. After the subject had been well debated the meeting approved of the suggested steps, so that there is now a reasonable probability of their being carried out.

Monmouth Valleys.

The authorities are taking measures for promoting a water scheme. The intention is to expend £225,000 by the Abertillery and Abercarn Urban District Council.

AMERICAN NOTES

(*From our own Correspondent.*)

NEW YORK, November 10th.

THE strongest factor in the present industrial situation is the demand from railroads for equipment in the shape of steel cars, bridges, ties, frogs, and general track equipment, in addition to steel rails and material for bridges. A potent factor that will exercise a powerful influence in the rail industry is the double-tracking of most of the western systems, which means rails to lay tracks for not less than 40,000 miles. Just at present the chief activity is in steel plate cars. The Pennsylvania Company will probably increase its orders to 15,000 cars, to be delivered next year. The estimated cost of this equipment is 18,000,000 dols. All of the new cars are to have steel wheels, and the total requirements of the Pennsylvania Company alone will be 120,000 wheels. The shortage of cars now is becoming more apparent. The president of the Central Illinois Company stated on Monday that all of the company's 60,000 freight cars were now in use. In addition to this it has expended during the year 2,000,000 dols. in repairing old wooden cars. The company has ordered an additional 500 refrigerator cars. The Amalgamated Sugar Company of Ogden, Utah, has 75,000 tons of sugar beets piled up between Ogden and Logan awaiting transportation. The roads in that section are taxed to their utmost capacity in handling the heavy tonnage in coal, flour, grain, and other products. The heavy demand for steel products has slightly abated for the present, but this is largely due to the attitude of the steelmakers. Bessemer and basic billets are hard to get, and prices are hardening. The consumption of merchant bars has grown to large proportions, and the inquiries which are now crowding in for spring delivery indicate the probability of a further advance at 2.00 dols. per ton.

Everything indicates an expansion of winter demands. Malleable iron has been very largely taken by engineering plants and foundries. The chief source of activity for this month will be found in the smaller plants furnishing bars and sheets. The manufacturers of all kinds of hardware are finding it safe to enlarge certain lines of their manufacturing capacity, especially those lines connected with builders' hardware. The factories are working to their limit, filling orders that call for deliveries as late as April. A great many hardware plants will be in a position to increase their output by January 1st. The manufacturers of tubes continue quite busy. The builders of locomotives report additional orders for engines to be delivered during the second quarter of the year. The copper market is quiet, and electrolytic is selling at 13 cents. Exports have fallen off temporarily, and production is maintained at the top limit. The tin-plate mills are working to full capacity and selling at high prices. The activity in all the steel mills is keeping the scrap yards empty of heavy scrap.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

THE ARKWRIGHT FOUNDRY COMPANY, of Waterway-street, Nottingham, has appointed Mr. Sydney P. Fraser, of Broad-street House, New Broad-street, E.C., as its London representative.

MR. CHARLES LEONARD AGNEW, of Manchester, has been elected chairman of the Board of Directors of Galloways, Limited, engineers and boilermakers, Manchester, in the place of Mr. Edward N. Galloway, resigned. Mr. Galloway will retain his seat on the Board.

CONTRACTS. — Hamilton Brothers, of 19, Waterloo-street, Glasgow, inform us that they have recently secured an order for thirty-six of their "W.H." motor control panels for the Glasgow Corporation main drainage scheme, outfall works, Shieldhall, Glasgow. Each panel consists of slate 1¼in. thick, having ammeter, ironclad switch, bell-push, and "W.H." ironclad motor starter mounted thereon. The apparatus on several of the panels has to be damp, dust, and gas-proof.—Among the orders recently secured by Sanders, Rehders and Co., Limited, of 108, Fenchurch-street, E.C., for "Sarco" fuel economy specialities are those for the Municipality of East London, S.A., one combustion (CO_2) recorder and four dial draught gauges; the Municipality of Sydney, N.S.W., repeat order for five combustion recorders; the Adelaide Tramway Trust, one combustion recorder, seven dial draught gauges, two dozen pipe thermometers, two dozen high temperature steam thermometers, and one hand gas-testing set; and the Melbourne Electric Supply Company, Limited, four dial draught gauges.

A SEALED tungsten lamp carton, says the *Elecrical World*, is being adopted by many manufacturers abroad, in order to minimise claims made for lamps broken in transit. The lamp may be examined and tested, and even lighted while in the carton. It cannot be removed without breaking the seal, and, therefore, enables a hard and fast line to be laid down as between the sellers and the buyer as to claims for breakage in transit. In case a broken lamp is returned to the sender within a reasonable period, with the seal of the carton unbroken, it is fair to assume that the breakage occurred in transit, and a claim is therefore allowed. The cartons, which are of square cross-section, and thus not likely to roll off the counter or shelf, have a label including brief instructions as to test and conditions of claims. Other advantages for the cartons are that they do not need any packing when cased; the breakage in transit is considerably reduced; improper claims for breakage are prevented, and arguments between the buyer and seller are minimised.

NOTES FROM GERMANY, FRANCE, BELGIUM, &c.

(*From our own Correspondent.*)

From the Siegerland.

In the iron ore trade of the district life has increased. Minette and Nassau red iron ore have also been in good demand. Nothing new or of interest can be reported in the pig iron industry. Fresh orders are often booked at higher prices. German foundry pig, No. 1, realises M. 57 to M. 59; No. 3, M. 56 to M. 58; German hematites, M. 59 to M. 61; Bessemer, M. 59 to M. 61 p.t. at works. Both inland and foreign business in sectional iron has improved slightly, and bars, too, are in fair request. Current rates are M. 105 to M. 106 p.t. for inland demand, and for export M. 97.50 p.t. is given on an average. Only very few orders for forward delivery are being booked, because makers expect prices to advance. The Drawn Wire Convention, at a recent meeting, resolved to maintain the present prices also in the first quarter of 1910. Employment in the wire department is fairly satisfactory. Heavy plates remain neglected, while sheets show a little more life, and the mills have consequently been able to realise M. 130 p.t. in some cases.

Production of Pig Iron.

According to figures given by the Union of German Iron and Steel Masters, the output of pig iron in Germany, including Luxemburg, was for October of the present year 1,113,763 t., as compared with 1,068,345 t. in September, and as against 941,582 t. in October, 1908. Output in the different sorts was as follows:—Foundry pig, 224,627 t., as compared with 190,808 t. in the year before; Bessemer, 33,396 t., as compared with 21,400 t. in 1908; basic, 707,131 t., as against 624,018 t. in 1908; steel and spiegeleisen, 99,139 t., as compared with 59,675 t. in 1908; forge pig, 49,470 t., as against 45,681 t. in 1908. During the period from January to October of present year 10,622,800 t. were produced, as compared with 9,866,247 t. in the corresponding period of the year before.

The Coal Market in Germany.

During the week just past shipments of house coal have been more extensive in Silesia, whereas the demand for engine fuel remains quiet, and lower than production. Coke has been slightly improving, both as regards local and foreign demand.

Austria-Hungary.

Taking it all through there has been but a limited trade done, and the position of the iron and steel market is not favourable. Fresh orders are scarce, consumers showing the utmost reserve. Not the slightest change has taken place on the Austro-Hungarian coal market, demand being about equal to consumption, and stocks therefore remain as before.

Iron and Steel in Belgium.

The market is gaining in firmness, but there is still much room for improvement as regards quotations. Bars have shown a fair upward tendency since July, for £4 6s. to £4 8s. p.t. was the price then quoted, while now £4 16s. and even £4 17s. have been quoted. Girders, likewise, have been advanced 4s. p.t., and a further rise is anticipated. Quotations for pig iron show more firmness than previously also at the Luxemburg blast furnace works. On the 1st of October 37 blast furnaces out of 44 existing were in blow in the Charleroi district, while at the same time last year only 30 out of 42 were at work. The daily output of the above-mentioned 37 blast furnaces is 382 t. forge pig, 250 t. foundry pig, and 4040 t. basic. During the first three-quarters of the present year 115,800 t. forge pig, 66,400 t. foundry pig, and 997,980 t. basic were produced in Belgium. The semi-finished steel trade moves on steadily. A lively demand comes in for house coal on the Belgian market, and in engine fuel also a more animated business was done. Producers do not care very much for forward orders, because they expect quotations to advance later on. Briquettes do not show an improvement, and concessions have been granted here and there, when orders for immediate delivery were in question.

The French Iron Industry.

The prolongation of the Girder-office for a further five years has tended to increase the firmness which has for several weeks been noticeable in the French iron trade. Prices for next year have not yet been fixed either for pig iron or for raw steel. Current rates for consumers are:—Merchant iron, 160f. to 170f. p.t.; hoops, 190f. to 195f. p.t.; girders, 190f. to 200f. p.t.; plates of 3 mm. and more, 180f. to 185f. p.t. In the Nord buyers can obtain merchant bars at 160f. p.t. From the Nord irregular and even decreasing activity is reported in several branches, and some works have not been able to maintain rates. From all other districts favourable accounts are given. In the motor car industry extensive orders have been placed, and the construction shops have fair prospects, 2000 load cars and 288 vans for the Paris-Lyons-Mediterranean Railway, and 600 freight cars of 20 t. for the East, and 800 freight cars and 50 vans for the Nord Railway having been ordered, and there are besides some small contracts for private railways. Firmness characterises the coal market in France. Foreign trade, during the first nine months of the present year, was as follows:—Import, 11,562,398 t. coal, as compared with 10,976,620 t. during the corresponding period the year before; 7,049,060 t. coming from England, 3,088,960 t. from Belgium, and 1,323,909 t. from Germany; import of coke was 1,421,523 t., 1,049,833 coming from Germany, also 786,151 t. briquettes. Export was 785,357 t. coal, 115,671 t. coke, and 134,323 t. briquettes. The Paris-Lyons-Mediterranean Railway is reported to have bought 100,000 t. coal in Cardiff at 13s. 6d. free Marseilles, to be delivered in the period from January to August, 1910, and also the same quantity small coal at 1s. less than was paid last year.

CATALOGUES.

Royce Limited, Trafford Park, Manchester.—This firm has sent us a copy of a new booklet illustrating very effectively its specialities. The illustrations are reproductions of photographs of plant in actual work. The publication is intended as a temporary substitute pending the preparation of the 5th edition of the firm's illustrated catalogue.

Bruce, Peebles and Co., Edinburgh.—Pamphlets 16A and 21A have reached us. The former has reference to polyphase induction motors, which are manufactured in all the usual types to conform to the Home-office and fire insurance rules. Weights and dimensions are given for all the sizes listed, and there are also tables giving outputs, efficiencies, power factors, &c., for both 50 and 25-cycle machines. Illustrations are given showing the company's latest types of machines, both of the squirrel-cage and slip-ring types. The firm also supplies motors with automatic short-circuiting gear. The other pamphlet, No. 21A, has reference to continuous-current dynamos and motors, which are also manufactured to conform with the Home-office and fire insurance rules. Approximate dimensions are given of all the machines listed. Complete tables of technical data are also included for protected, semi-enclosed, and totally enclosed machines. Both pamphlets are well compiled, and they cancel all previous issues. A feature about the continuous-current machines to which attention should be called is that they are fitted with commutating poles.

BRITISH PATENT SPECIFICATIONS.

When an invention is communicated from abroad the name and address of the Communicator is printed in italics.

When the abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent-office Sale Branch, 25, Southampton-buildings, Chancery-lane, London, W.C., at 8d. each.

The first date given is the date of application; the second date at the end of the abridgment is the date of the advertisement of the acceptance of the complete specification.

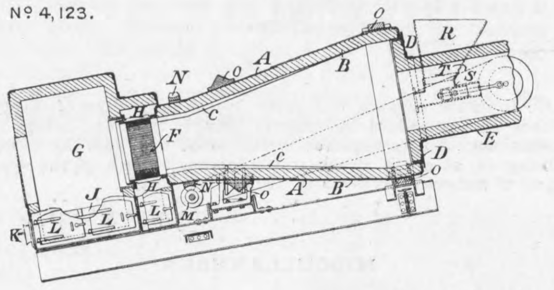
Any person may on any of the grounds mentioned in the Acts, within two months of the date given at the end of the abridgment, give notice at the Patent-office of opposition to the grant of a Patent.

STEAM GENERATORS.

4123. February 19th, 1909.—Improvements in Furnaces, Bell Brothers, Limited, of Clarence Ironworks, Middlesbrough, ironmasters, and Walter Lyulph Johnson, ironmaster, of Clarence Ironworks, Middlesbrough.

The furnace, which is intended for burning shale and coal refuse, consists of a conical shaped shell A lined with fire-brick B having projections C running from end to end tapering to nothing. A stationary end plate D fixed to the flue E, through which gases pass to boiler, is at the larger end. To this end plate D is fixed an automatic feeder S of the plunger type driven by a belt T. At the smaller end there is fixed a revolving grate F, which projects through an opening in the fire-box G, and revolves in a chamber H attached to the fire-box, which is fixed. Preferably, as shown, there are stationary firebars J in this fire-box. Air necessary for combustion is supplied through openings K by means of forced draught. Ash doors are placed at L. The furnace is rotated by means of the worm M, which drives the worm wheel N fixed on the shell A. The furnace is supported by rollers running on roller paths O, and the whole is securely tied and placed on girder frame. The angle of the revolving furnace is preferably such that the material at the bottom of the furnace A moves parallel with the ground line. The shale is delivered into hopper R and fed by plunger type of automatic feeder S through stationary end plate D into the revolving furnace A. The material travels from the larger end to the revolving grate F, and during the passage gives off the gases contained—which pass away to boiler through the flue E - and becomes coked. Most gas is given off at the larger end, and the supply of gas decreases as the cokey nature increases. More area is allowed where most gas is given off, and the area gradually decreases, so that at the point of passing over the revolving grate F the coked material is in a more compact mass. Passing over the revolving grate F the fine shale and dirt pass through the bars, thereby cleaning the material, which passes on and is deposited on the stationary grate J in the fixed fire-box G. Here the coked material is burnt, the air necessary for combustion being supplied by forced draught at K.—*October 27th*, 1909.

Nº 4,123.

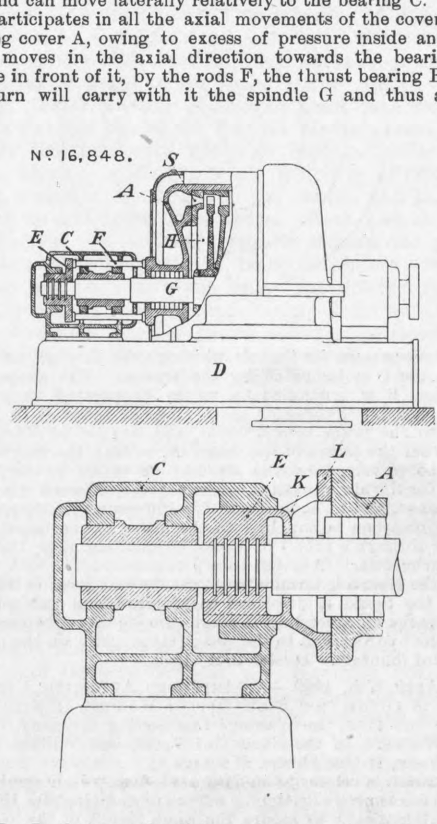


TURBINE MACHINERY.

16,848. July 19th, 1909.—Improvements in or relating to Thrust Bearings, *Joseph Weishaupl, of* 133, *Weinbergstrasse, Zurich, Switzerland.*

In the upper engraving A is the front casing cover of the steam turbine, C is the front supporting bearing resting on the bed-plate D. The thrust bearing E is rigidly connected to the cover A by rods F and can move laterally relatively to the bearing C. In that way it participates in all the axial movements of the cover A. If the casing cover A, owing to excess of pressure inside and great heating, moves in the axial direction towards the bearing C, it will force in front of it, by the rods F, the thrust bearing E, which in its turn will carry with it the spindle G and thus also the wheels H. In that way the distance between the casing cover A or the nozzle ring S and the rotating wheel H will remain practically the same. The steam inlet conditions will remain unchanged, and the wheels H will not foul the case. In the lower engraving the thrust bearing E is arranged between the supporting bearing C and the casing cover A and connected to the latter by ribs K and flange L. According as it is desired to transmit to the thrust-bearing only the axial expansion of the casing coving, or also that of the casing bottom, the thrust bearing is connected more to the casing cover or to the central portion of the bottom.—*October 27th*, 1909.

Nº 16,848.

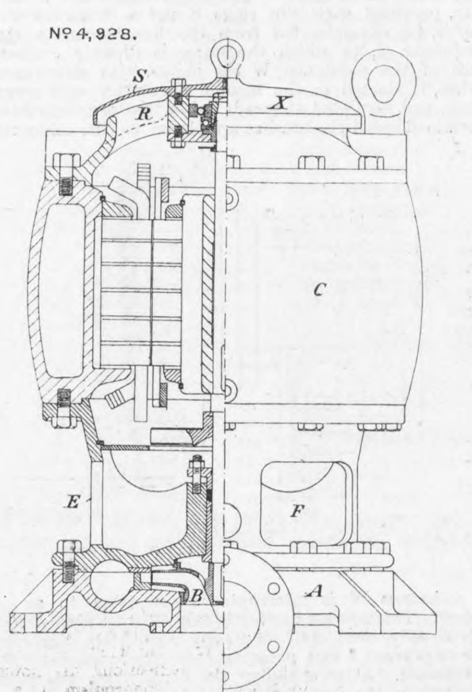


PUMPING AND BLOWING MACHINERY

4928. March 1st, 1909.—Improvements in or relating to Electrically Driven Rotary Pumps, Arthur Benjamin Mallinson, of Prestwich-park, Prestwich, Manchester.

The present invention relates primarily to a method of combining an electric motor and a rotary pump in such manner that the two stationary components are combined into one casing or frame, and the two rotary components are fixed on a shaft common to both. The rotary pump A may be of any usual construction, having its wheel B arranged to revolve in a horizontal plane; above the rotary pump A is placed the electric motor C, which is carried, for example, by an extension E of the pump body, or by supports or the like constituting a rigid connection between the rotary pump and the electric motor. This latter may be of any known construction, and of either the direct-current or alternating-current type. The open spaces F in the extension E of the pump body or the similar spaces between the supports employed as an alternative may be covered, if desired, with wire netting or the like. The top cover of the motor is constructed with openings R to permit of the egress of air, while a cap S placed above them prevents the entrance of water which may fall on the outside. The two rotary components, namely, the wheel of the pump and the armature or rotor of the electric motor, are both fixed on and secured to one and the same vertical shaft, which passes through the pump gland and the upper end of which is carried in a ball bearing fitted in the top cover of the motor. There is also fixed on the vertical shaft a fan of any suitable construction which by its action will cause a current of air to be drawn in through the openings F over the cold body of the pump, whereby the air will be cooled and then blown over and through the magnet windings of the motor and over and through the armature or rotor, thoroughly ventilating them, and finally escaping through the openings in the top cover.—*October 27th*, 1909.

Nº 4,928.

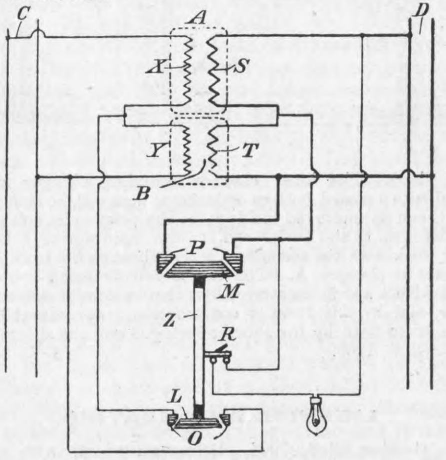


TRANSFORMERS.

23,064. October 29th, 1908.—Improvements relating to Systems of Electrical Distribution by Alternating-current Transformers, John Sedgwick Peck, of Westinghouse Works, Trafford Park, Manchester.

This invention relates to systems of electrical distribution by alternating-current transformers, and in particular to those systems where a main and auxiliary transformer are employed connected in series, an automatic switch being provided for opening and closing a short circuit round the auxiliary transformer, in accordance with the load, so that a saving will be effected in the iron losses of the transformers at light loads. Referring now to the engraving, a main transformer A and an auxiliary transformer B are indicated as connected in series with one another between supply circuit conductors C and distribution circuit conductors D, the transformers A and B being provided with primary windings X Y and secondary windings S T respectively. The terminals of the primary winding Y of the auxiliary transformer B and the terminals of the secondary winding T are connected to the fixed contacts O P respectively of the short circuiting switch Z, the movable member of which is provided with bridge pieces L, M, adapted to engage with contacts O P respectively when the automatic switch Z is in its closed position. When the switch is in its open position, as illustrated, the circuit of an indicating lamp designed for the circuit voltage and connected across the secondary winding S of the main transformer A is closed by means of the switch R, the movable member of the switch R being carried by the movable member of the automatic switch Z, as indicated diagrammatically, the switch R being open when the automatic switch Z is in its closed position. The operation of the apparatus is as follows:—When the switch Z is in its open position, if the auxiliary transformer is in proper order, there will be only a comparatively low voltage across the main transformer winding S, and

Nº 23,064.



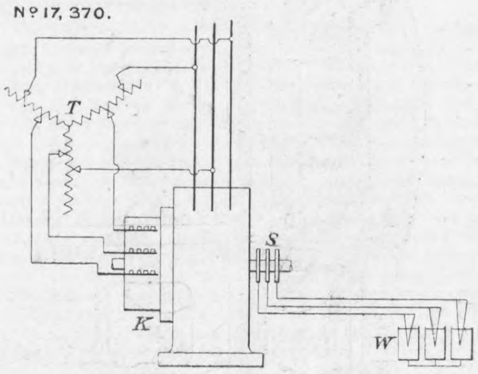
the lamp will consequently not light. If, however, the auxiliary transformer winding is short-circuited, the full voltage of the distribution circuits D will be across the main transformer winding S, and the lamp will consequently burn at full brilliancy. There are eleven other illustrations.—*October 27th*, 1909.

DYNAMOS AND MOTORS.

17,370. July 26th, 1909.—Improvements in and relating to the Control of Polyphase Motors and the like, the British Thomson-Houston Company, Limited, of 83, Cannon-street, London, E C.

This invention relates to the control of polyphase machines of the commutator type, and has for its object an improved method of speed regulation, whereby the speed may be efficiently controlled over a range varying between plus and minus 20 per cent. of the synchronous speed. The engraving shows a three-phase motor, provided with slip rings S and a commutator K. The latter is, for example, fed from the line through a regulatable transformer T, to which the stator is directly connected. By means of the resistance W the motor, with raised commutator brushes, is started in the manner customary with asynchronous motors, and regulated at speeds below that of synchronism. At a determined speed the brushes are placed on the commutator, and the resistance W is interrupted or adjusted to an increased amount. This new connection is only effected when the resistance W is already completely or nearly completely short-circuited in order to prevent a high potential from the commutator during its employment. After changing the connections the motor can be regulated in the neighbourhood of synchronism by a suitable method by adjustment of potential, for example, in conformity with Patent No. 23,288 of 1902, or by shifting the brushes. The stator potential may be varied to start and regulate the machine as an asynchronous motor, in which case, instead of the slip rings and brushes, another short-circuiting device for the armature winding can be used. This device may be automatically operated by a fly-wheel regulator in such a way that on the attaining of a certain speed the short-circuiting connection of the armature is interrupted. The placing of the collector brushes can also be effected automatically in a similar manner.—*October 27th*, 1909.

Nº 17, 370.

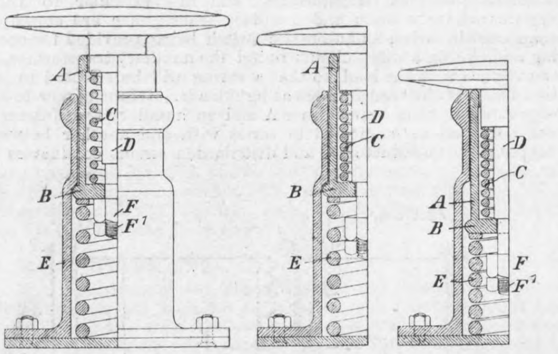


TRAMWAYS AND RAILWAYS.

10,273. April 30th, 1909.—Improvements in Buffers for Railway and Tramway Vehicles and the like Purposes, Robert Eyre, of Marlborough House, 43, Marcliffe-road, Wadsley, Sheffield, Yorks.

This present invention relates to a type of buffer having a compound action, in which the compound action is obtained by employing two separate springs, one acting upon an open-ended inner case or secondary plunger, and the other actuating the buffer rod in the ordinary way, by which arrangement the central spring, which is actuated by the buffer rod, is made of considerable length. The same letters refer to similar parts throughout the several views. The inner case or secondary plunger A is constructed with a closed bottom or internal flange B, so that a shorter spring C can be employed inside it for the primary action and light work direct on to the buffer rod D; the main spring E takes the heavier work with the secondary action through the medium of the inner case or plunger A. The buffer rod D being shortened is secured with a nut F or cotter F¹ to the bottom of the secondary plunger, and by this form of construction a considerable weight may be saved both by the shorter spring C and the shorter rod D. —*October 27th*, 1909.

Nº 10, 273.

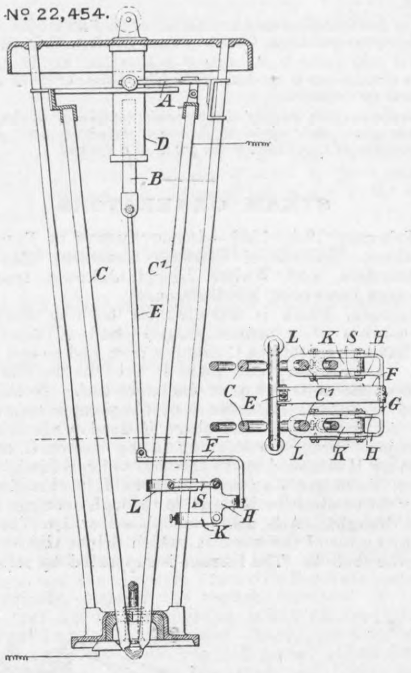


LIGHTING AND HEATING.

22,454. October 22nd, 1908.—Improvements in and relating to Electric Arc Lamps, Sidney Clark Mount and the Beck Flame Lamp, Limited, both of Hayes, Middlesex.

This invention relates to electric arc lamps of the type in which several pairs of carbons inclined to one another are arranged to be drawn apart simultaneously by a common operating mechanism actuated by a solenoid, so that an arc is maintained between one pair of carbons only and particularly to a lamp in which one carbon of each pair rests upon a stop and carries the second carbon by means of a cross carriage and in which the feed takes place upon the burning away of the supported carbon, and the invention consists in the application to such a lamp of the particular construction of striking mechanism. In carrying out the invention as applied to a Beck double carbon lamp having a cross carriage A and gravity feed for the carbons C C¹ the plunger B of the series magnet D controlling the striking mechanism is connected through a link E with an arm F provided upon a member G pivoted to the framework of the lamp by means of brackets K and having arms H which are pivotally connected to each of the shoe plates L which are provided for the respective pairs of carbons by means of links S, the series magnet thus being arranged to effect the required movement of the movable carbon C¹ of each pair. When the current is switched on the plunger is operated and through the mechanism previously described causes the shoe plates L to move the carbons guided by them so that the arc is struck between one pair. When the carbons of this pair have been consumed the magnet plunger falls and brings the remaining carbons together in the usual way, and, the current being on, an arc is struck and continues to burn on the second pair of carbons.—*October 27th*, 1909.

Nº 22,454.

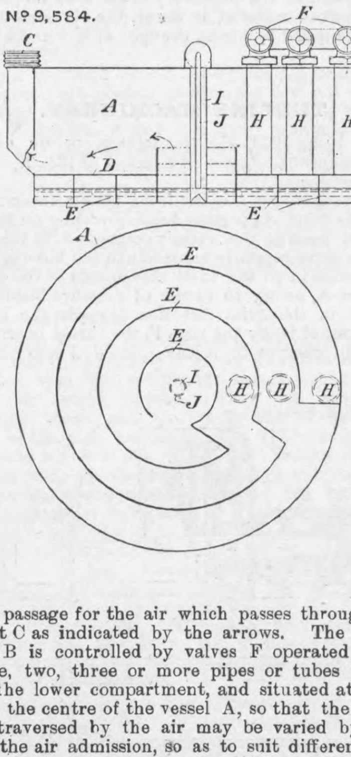


MISCELLANEOUS.

9584. April 22nd, 1909.—Improvements in Carburetting Apparatus, William Ewing, of 158, Saint Vincent-street, Glasgow, Scotland.

This invention relates to apparatus for carburetting air of the kind in which the lower compartment of the carburetting vessel is arranged with a passage in the form of a single helix or the like. The present invention consists in providing two or more air admission pipe or like connections situated at different distances from the centre of the carburetting vessel and leading to said passage so that the length of the path to be traversed by the air may be varied and a combustible gas for power heating and illuminating purposes may be produced. The carburetter proper comprises a vessel A furnished with an air admission connection B and a gas outlet C, and is divided into two compartments by a horizontal partition D from which depend partitions E forming a circuitous passage for the air which passes through an opening to the outlet C as indicated by the arrows. The air admission connection B is controlled by valves F operated to admit air through one, two, three or more pipes or tubes H or the like leading to the lower compartment, and situated at different distances from the centre of the vessel A, so that the length of the path to be traversed by the air may be varied by varying the passage for the air admission, so as to suit different gravities of hydrocarbon, and to compensate for differences in temperature. The hydrocarbon is supplied to the lower compartment from a reservoir through a tube I or tubes terminating near the bottom of the carburetter. Another tube J communicating with the top part of the reservoir terminates at the desired level of the liquid so that the liquid is displaced as required and any oscillation caused by the air ascending through the liquid is obviated. The flow of the hydrocarbon to the vessel takes place on the principle of the bird fountain.—*October 27th*, 1909.

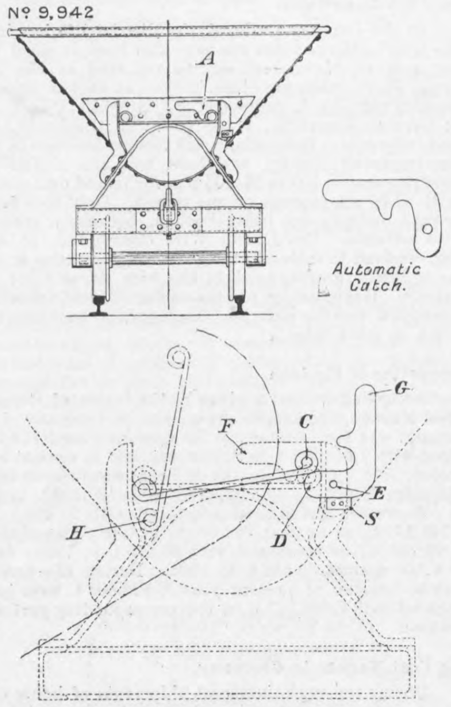
Nº 9,584.



9942. April 27th, 1909.—An Improved Automatic Catch for use in connection with Tipping Wagons, Dumping Cars, and the like, the Wantage Engineering Company, Limited, of Wantage, in the County of Berks, and William Bardill, engineer, Hildon House, Wantage.

This invention relates to an improved form of automatic catch for use in connection with tipping wagons or dumping cars, the object being automatically to secure the same rigidly in the horizontal position after return from tipping. As the point C is returning to the horizontal it comes in contact with point D, which, moving about the point E, immediately brings over the upper part of the catch to the dotted position shown at F, and as one of these automatic catches is fixed on each of two opposite corners of the wagon diagonally the body becomes securely locked in the horizontal position. To release the wagon for tipping, the attendant raises the catch to the point G, when the flat bar rides on the circular path easily until the bent end of the bar engages in the recess marked H, as is usual with this type of wagon. The automatic catch consists of a strong steel forging of the shape as shown. To prevent the catch, as shown at letter G, falling too far backwards, a retaining device is adopted, as shown at S, and this device, which is formed of flat steel riveted to the main angle iron support, being bent round underneath the path of the automatic catch C to strike this on its return.—*October 27th*, 1909.

Nº 9,942.



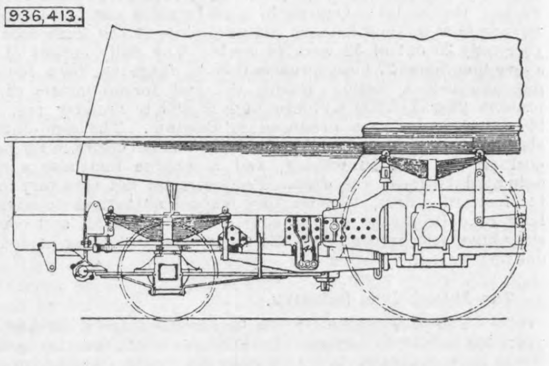
SELECTED AMERICAN PATENTS.

(*From the United States Patent-office Official Gazette.*)

936,413. Locomotive Engines, *Francis J. Cole and Frank F. Scoville, Schenectady, N. Y.—Filed June 14th*, 1909.

This patent is for the transfer of a portion of the weight of a locomotive to a radial truck of the Bissell type by balance levers. The claims are for the combination of a main frame, driving wheels journalled in bearings therein, a radial truck pivoted to the main frame, springs through which weight borne by the main frame is transmitted to the journal boxes of the truck, seats in which the springs are supported on the journal boxes, and floating connections coupling the spring seats to the main frame in horizontal planes. There are ten claims.

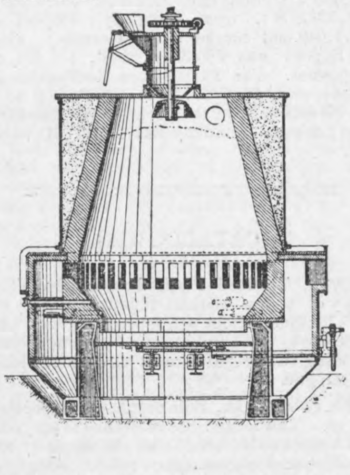
936,413.



934,446.—Gas Producer, *H. I. Lea, Pittsburg, Pa., assignor to the Westinghouse Machine Company, a Corporation of Pennsylvania.—Filed July 24th*, 1905.

In a gas producer, a truncated cone shaped ash chamber, a truncated cone-shaped gas generating chamber above the ash chamber, the two chambers being connected together at their greatest diameters, a blast admission port provided near the top of the gas generating chamber, a liquid sealed bottom for said ash chamber, an annular row of gas delivery ports arranged at the juncture of the two truncated cone-shaped chambers, an annular collecting chamber surrounding the lower portion of said producer, and surrounding the gas delivery ports and a water-sealed recrement discharge port. There is only one claim.

934,446.



In British Columbia platinum is found in many of the alluvial gold workings, where it can be saved as a by-product. The saving of it in a small way is, however, attended with so much trouble that it has been practically neglected and no appreciable production made recently.

THE PROGRESS OF ENGINEERING IN SOUTH AND CENTRAL AMERICA.

(From our Special Commissioner.)

CARACAS, October 25th, 1909.

THERE is probably no engineering market in the world more rich in promise than the States of Southern and Central America. For the most part they are enormously rich in minerals of all kinds, they are watered by great rivers which offer unlimited power, and they present far-reaching areas of undeveloped mining, agricultural, and grazing country which await the coming of transportation to many British manufacturers. Argentina and Brazil for many a year have been lands flowing with milk and honey, but everyone is conscious that only the fringe of their resources has yet been touched, and that in the not distant future South America will offer a field for enterprise unequalled in the world. That Great Britain may share a portion of the wealth that the great States will distribute cannot be doubted. We have, of course, to face keen competition from North America, which starts with the advantages of a better geographical position and a spirit that is more akin with that of the Latin races than ours; but if we will but exert ourselves, and show some of the daring of pioneers, we may have a large share of the market.

The first step to success is, of course, knowledge of the country and the conditions, and in commissioning me to write a series of articles from all the principal states of Central and South America the proprietors of THE ENGINEER have asked me to give special attention to those things which may be directly advantageous to the engineers of Great Britain who seek to establish or extend markets in this huge continent. I shall keep this object in mind, and shall endeavour to show the reader where new markets are to be sought, and how to seek them; at the same time, as, by giving descriptions of existing engineering works, I shall show the lines upon which new works must be carried out.

I have been in the country so far too short a time to attempt any of the useful generalisation which I hope to make later on, and I shall content myself, therefore, with offering as a first article a brief description of the railway system of Venezuela, for I need not remark that a knowledge of the means of transport is one of the very first requisites in formulating a scheme for an attack upon a new market.

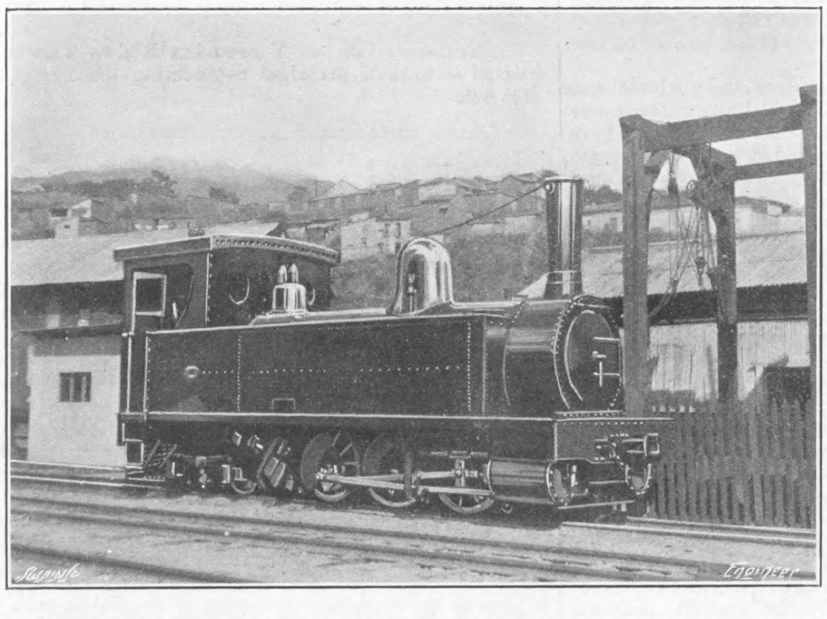


Fig. 1—FIRST ENGINE BUILT IN VENEZUELA (1900)-LA GUAIRA-CARACAS RAILWAY

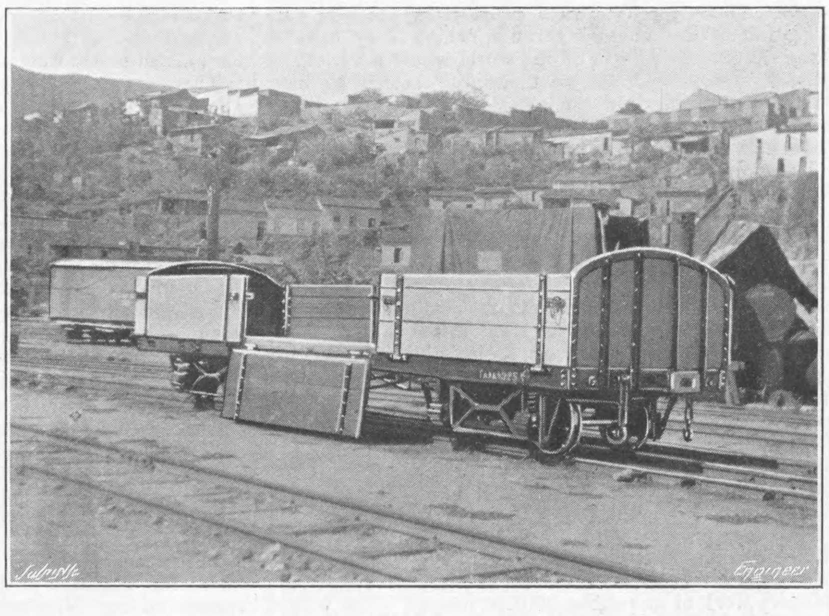


Fig. 2—FREIGHT WAGON (20-TON) ON LA GUAIRA-CARACAS RAILWAY

No. I.—THE RAILWAYS OF VENEZUELA.

At the present time, with perhaps the one exception of Venezuela, an almost feverish activity is proceeding in the direction of railway, tramway, dock and harbour construction in Central and South America. In practically all of the two and twenty Republics forming Latin-America, progress is being made in this direction, although not always in the same ratio. Thus, while the Argentine is expending her millions—or rather our millions, since practically all the capital being employed upon railway and harbour building is British-borrowed—little Nicaragua is contenting herself with the outlay of a few additional thousands, which, however, promise to be intelligently and profitably employed.

In Venezuela an already considerable amount of foreign capital—British, German, French and Dutch—has been laid out, and in none of the South American Republics can be found better examples of costly and difficult railway construction, accompanied, unfortunately, by very unremunerative returns. The confidence of the original capitalists who found the funds for this class of exploitation must have been very deep-seated, for the country, as a whole, presents an almost forbidding and, at the best, a decidedly discouraging appearance when first viewed as a field for railways; and if this same confidence has not been justified by financial results, the fault must be sought rather in political than in economic causes.

Owing to the immense watershed of the Orinoco, with its numerous navigable affluents, affording ample means of communication with the southern part of Venezuela, the railroad lines are located to the north and centre of the Republic. At the present time there are some fourteen different lines in operation in Venezuela, with an aggregate length of line of 850 kiloms., or, say, 531 miles. Some of these lines afford remarkable instances of engineering skill, such, for instance, as the Great Valencia Railway, which, in its total length of 179 kiloms., has no fewer than 212 bridges and viaducts, 86 tunnels and 25 stations. The Bolívar Railway has 134 bridges and viaducts, and the Carenero and Guapo Railway, in the short distance of 33 kiloms., its total length, has 57 bridges and viaducts. Not the least interesting from a constructional point of view is the La Guaira and Carácas Railway, which, in common with the Puerto Cabello and Valencia, the Central, the South-Western and the Bolívar, is of British construction and ownership. The line was built to connect the important port of La Guaira with the capital at Carácas, and although roughly only 11 kiloms. distant as the crow flies, nearly 37 kiloms. of road have to be covered before the terminus is reached.

Starting from La Guaira at 9ft. above the level of the sea, the line rises to a height of 3020ft. at Agua Salud, after which it sinks to 3001ft. upon reaching Carácas. For the greater part of its length the line runs by the side of a precipice that varies from 50ft. at Rincón to 1250ft. at Boquerón. As already mentioned, the length of the line is roughly but 37 kiloms., or 23 miles; and in round numbers there are 10,000 rails employed, of which 6000 are bent to a curve of a 140ft. radius; the gauge is 3ft. and the average grade is 3.75 per cent., although there are portions where the grade is as much as 4.05 per cent.

The following particulars of the grades may prove of interest:—Between La Guaira and Maiquetia the grade is 1.6 per cent.; between Maiquetia and Rincón, 1½ to 3¼ per cent.; between Rincón and Curucutí, 3.26 per cent.; between Curucutí and Zig-Zag, 3¼ per cent.; between Zig-Zag and Boquerón, 4 per cent.; between Boquerón and Pena de Mora, 3 per cent.; between Pena de Mora and Cantinas nearly 4 per cent.; while between Cantinas and Sancho-Orquiz the track is nearly level; between Sancho-Orquiz and La Cumbre—at Catia—the grade is about 4 per cent; while from the summit to Carácas city it is a gentle decline.

In times past a considerable amount of trouble has occurred by frequent landslips, some of which have been of such a serious nature as completely to block the line for several days together. The removal of dangerous portions has, to a great extent, prevented the possibility of further slips, while other improvements have included the removal of many of the sharp curves which existed formerly. After leaving Maiquetia there is a tolerable length of straight line to the Pariata Viaduct, from which point the line begins to climb to Rincón, 288ft. above the sea, thence on to Curucutí, which is 1072ft., and Zig-Zag, which is 1550ft. above the water, and at which point the up and down trains cross. Here also at a distance of about 10½ kiloms. from La Guaira the port is distinctly seen in the distance, being in almost a straight line with the La Guaira sea wall. An interesting engineering feature is here afforded, the up train to Carácas and the down train to La Guaira, although proceeding to different ends of the railroad, are actually running for some time in the same direction. Passing Zig-Zag, the line is cut out of the solid rock and skirts a profound abyss, which at one point reaches to a depth of 1250ft., and is known as the Boquerón Pass. From this point, situated at 2099ft. above sea level, the bottom of the ravine fills up again until it has reached 800ft. below the railroad at Pena de Mora. From here onwards to Cantinas the track winds through a succession of curves to a height of 2904ft., and thence for some 900 yards it moves along the level to Sancho-Orquiz, from whence the final upward climb commences.

In all there are ten bridges and viaducts, eight small tunnels and nine stations, mere halting places. The La Guaira and Caràcas termini are, however, substantial and commodious buildings; but in regard to the latter, which is a wooden construction, it is proposed to make considerable additions, or, if possible, to reconstruct of reinforced concrete. It is quite possible, however, that the finances of the railway will not, for some time to come, enable this proposal to be realised. The plans have been prepared and the design has been adopted. Of this improved station I am enabled to give an illustration, Fig. 3, on the next page.

Although German influence had long been felt in Venezuela, it was only in 1887, when the Government of the day granted to Herr Friedrich Krupp, of Essen, a concession to build a railway from Carácas to Valencia, that British dominance was seriously threatened. There existed at that time three British owned railways, namely, the Bolivar, the La Guaira-Carácas, and the Puerto Cabello-Valencia. It took Mr. Krupp and his syndicate, which was composed of capitalists connected with the Disconto-Gesellschaft of Berlin and the Nord-Deutsche Bank of Hamburg, six full years of hard and difficult work to complete the Great Venezuela Railway, which was not formally opened to traffic until the 1st February, 1894.

Mileage Table.

Elevation, ft.	Miles.	Station.
9	—	LA GUAIRA
65	1·30	MAIQUETIA
	1·67	Viaducto Pariata
288	2·46	EL RINCON
	3	Quenepe
	3·35	Vueltas Coloradas
	4	Buena Vista
669	5	Túnel número 1
	5·25	Mañonga
	5·60	Guarapo
	6·25	Vuelta del Zamuro
	6·50	El Chorrerón
1072	6·97	CURUCUTI
	7·46	Canoítas
	8	Cortada Balleros
1316	8·47	Túnel número 2
	9	Loma Larga
1550	9·80	ZIG-ZAG
	10·90	Las Pailas
1874	11·80	DESVIO DE BOQUERON
	11·93	Túnel número 3
	12·30	Túnel número 4
2099	12·50	Túnel número 6
	13·30	Perro Seco
	13·60	Indios Desnudos
2309	14	PENA DE MORA
	14·64	Túnel número 7
	15·15	Puente las Brujas
	15·60	Puente del Paují
2667	16·60	Ojo de Agua
	17·45	Plan de Manzano
	17·90	Vueltas Blancas
2904	18	CANTINAS
	19	El Chorro
	19·35	Túnel número 8
2892	19·65	Sancho-Orquíz
	20·25	Macayapa (La Cumbre)
3118	21	Catia
3020	22·15	Agua Salud
3001	23	CARACAS

The entire length of the line is 179 kiloms., or, roughly speaking, 112 miles, and it may be considered one of the most strenuous engineering feats as yet undertaken in this Republic. As previously mentioned, Carácas lies at a height of 922 m. (3001ft.) above sea level, whereas Valencia, the capital of the State of Carabobo, lies at an elevation of but 473 m. above the sea, and before reaching its destination the line has to crawl to a height of 1277 m., whence, having passed through the largest of the 86 tunnels, it descends in wide sweeps and curves to Las Moztazas. Between this point and La Begonia the track passes through a succession of further tunnels, and over a number of viaducts, many of which proved extremely costly to construct; indeed, this portion of the line was found more expensive than any other, working out at far above the original estimate of cost.

This difficult portion extends for some 74 kiloms., namely, between Carácas and Los Tijerías, after which the line leaves the mountainous region, gradually descending into the upper part of the rich valleys of the river Tuy. This river is crossed at a place called El Concejo, 9 kiloms. further on, and thereafter runs through the valleys of the Aragua, crossing these from end to end, and in a direction from east to west, skirting the Lake of Tacarigua on its northern shore, and finally reaching Valencia almost entirely on the flat. The last portion of the track from Las Tijerias includes generally some long stretches of perfectly straight lines of metal, having only a very gentle declivity, and passes through rich coffee estates and sugar plantations, all of which yield valuable freights to the line.

It has been observed above that the total number of bridges and viaducts number no fewer than 212, having a total weight of 5500 tons of iron; but none of the constructions offer any especial features of interest. One of the most important of the bridges is that crossing the river Tuy, consisting of two spans of 10 m. each, while that across the river Aragua is an iron bridge 25 m. in length. The river Turmero is crossed by a bridge of exactly the same length and design. The longest and loftiest viaduct is that of Agua Amarilla, situated at kilometre 48, measuring 106 m. in length and 47 m. in height.

Of tunnels there are 86, the most important being those of Calvario at kilometre 1, of Corozal at kilometre 30, and the Cuñaote at kilometre 65. These three tunnels have respective lengths of 285 m., 267 m., and 263 m.

The gauge of the Great Venezuela Railway is 1.07m., the same as that of the Puerto Cabello-Valencia, so that it is possible to run the same trains over each track when necessary, a convenience which cannot be enjoyed between the Great Venezuela and the La Guaira-Carácas Railways, since the gauge of the latter is only one of .915 m. The maximum grade on the Great Venezuela is 2 per cent., as against 8 per cent. on the Puerto Cabello-Valencia and 4 per cent. on the La Guaira-Carácas. The minimum radius of curves is 75, as against 95 on the Puerto Cabello-Valencia and 43 on the La Guaira-Carácas. It is not difficult to understand why the original plans did not call for a common gauge between these three railways, considering the wild configuration of the country through which they have to pass. As in other parts of the world where a variety of railway systems adjoin, no unanimity seems to have existed with regard to the gauges adopted. Thus, out of the fourteen different railways now operating in Venezuela there are five with a gauge of 1.07, five with a gauge of .915, two with a gauge of .61, one with a gauge of 1.00, and one with a gauge of 0.63.

Naturally, upon a line of this length there are to be found an exceptionally large number of stations; in all there are some twenty-five, and both at Carácas and Valencia the termini buildings are of some importance, the former, for instance, having been the private residence of former President Crespo. Many of the minor stations are situated very close together, a few kilometres only separating one from the other, so that frequent stoppages have to be encountered, the journey of 179 kiloms. occupying seven hours. While some stopping-places own populations exceeding 7000, others boast of only from 150 to 200 inhabitants. But, nevertheless, in cattle, fruits, coffee, cocoa, and other agricultural products each contributes its quota to the railway's freights.

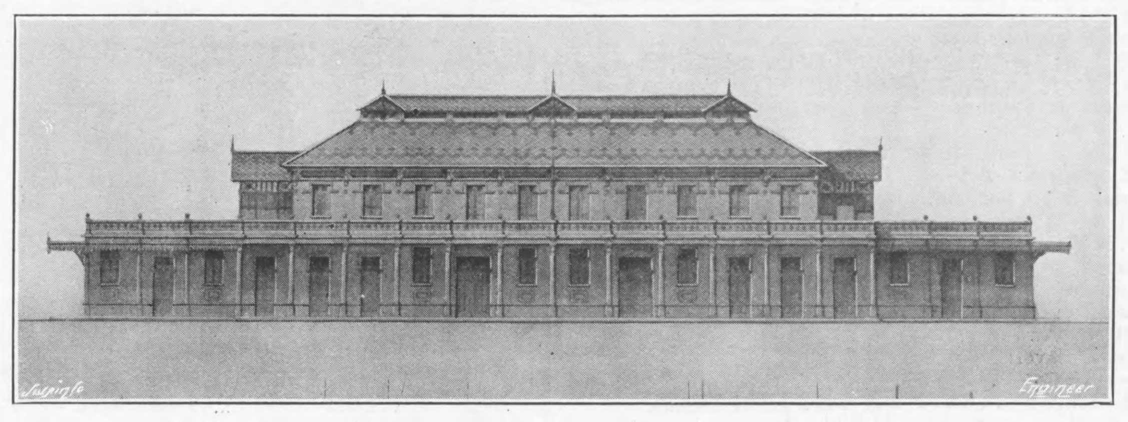


Fig. 3—PROPOSED STATION BUILDING AT CARACAS

The constructional work of this line has necessitated throughout its entire length the removal of earth and rock amounting to over 3,500,000 cubic metres, and masonry work of more than 380,000 metres. The weight of rail per metre is 25.7 kilos., and the sleepers employed are metallic, the same as are used on only three other railways in Venezuela, namely, the Central, the South-Western, and the Bolívar. The remaining ten railways are laid with wooden sleepers. The rolling stock of the Great Venezuela Railway is more considerable, owing to its greater length, than the majority of the lines, but in point of freight-car equipment it is behind that of the Bolívar Railway, and the quality is certainly far from being the best obtainable. The fuel used is coal briquettes, which is the same as is used by all the other railways in Venezuela, with the exception of the Great La Ceiba and the Great Táchira Railways, both of which run in the State of Maracaibo, where wood fuel is plentiful

As an instance of the slowness with which enterprises, engineering and otherwise, proceed in Venezuela, mention may be made of the concession for the construction of the Central Railway, which was granted as far back as 1885, while the line still remains far from its destined terminus. Fortunately for the owners, the concession only dates from "the time of the completion of the line," and as this seems far from being realised, the concession may well be regarded as one in perpetuity. The line is one of 3ft. 6in. gauge (1.07 m.), with a maximum grade of 4, and with a minimum radius of curves of 50 m. Running from Carácas, the capital, the line is ultimately destined to reach Santa Lucia, a total distance of 52 kiloms. (32½ miles). The first portion has been one of great engineering difficulty, some especially heavy construction work being encountered as far as Santa Terésa, after which the track becomes relatively easy. What lends particular interest to this line of railway is the fact that it possesses the only portion of electrified railroad track in the Republic, some 6½ miles having already been electrified, namely, that portion between Carácas and Petare, from which point it is intended to continue the electrification of the line as far as Encantado, a further three miles. The motive power is derived from the Electric Power Supply Company of Carácas, which also furnishes the city with its electric power and light, and supplies the current for the tramway system, not a very efficient one as yet, it may be observed, but, nevertheless, much better than at one time.

There are some twenty-three bridges and viaducts and about fourteen tunnels on the Central Railway, only one short tunnel now remaining uncompleted. There are seven stations, which will be added to in due course when the entire length of the line is completed. At present it is equipped and opened for traffic to kilometre 45 from Carácas, so that there remain 7 kiloms. of the original line finally to complete, and a further 30⅖ kiloms. (19 miles) from Santa Terésa, on the river Tuy, to Cua. The weight of rail employed is 21 kilos. per metre, while the sleepers are metallic. The fuel employed is Cardiff coal. The rolling stock is not large, but has been recently slightly added to, and consists at present of 7 locomotives, 9 passenger cars, and 31 freight cars. No additional stock is contemplated.

The company has had immense difficulties to contend with, owing to the unwarrantable interference of the late President Castro, who attempted to make the company pay duty on constructional material, although the original concession enjoined that this was to be imported free of all duty. For a whole twelve months the construction was arrested while this was being contested, and it was only due to the strenuous efforts and representations of our Minister, Sir Vincent Corbett, that the Government obstruction was finally withdrawn.

The Puerto Cabello and Valencia Railway has from its inception been closely allied with the La Guaira and Carácas Railway, coming into existence in 1885, a few years after the latter. Although controlled by the same board of directors, it is under different local management. The Puerto Cabello Railway has not been of late years as successful as its sister line. From an engineering point of view it is, however, quite as interesting, and may be regarded as one of the scenic lines of Venezuela. In length it is 54 kiloms. (34 miles), and it runs from the city of Valencia to the important port of Puerto Cabello. At one time it was quite the most profitable line in the Republic, as may be gleaned from the fact that some two years after opening it was earning twice the amount of its expenses; but it has, like most Venezuelan railways, fallen upon evil days, partly owing to the general depression of the country and partly to the failure of the Government to carry out its undertakings with regard to the prompt payment of guaranteed interest. The gauge adopted, as already mentioned above, is 1.07, the same as that of the Great Venezuelan Railway, with which it interchanges traffic, so that it is possible to carry goods from Carácas to Puerto Cabello over the two lines without transhipment. The maximum grade is 8 per cent., there being a short stretch of cog-wheel system of some 4 kiloms. in length. The minimum radius of curves is 95 m., while on the line from end to end there are some twenty-three bridges and viaducts, some of which are of great engineering importance, one tunnel, and six stations. The weight of rails per metre is 27.2 kilos., these being laid on wooden sleepers. The rolling stock is in very good condition, although it has not been very much added to of late years. The locomotives consist of 7 engines and 3 rack engines, making 10 in all. The passenger rolling stock consists of 2 first-class, 5 composite, 2 second-class, 3 second-class and brake-vans combined and 1 luggage van, or a total of 13. The freight equipment comprises 24 open wagons, 31 covered wagons, 2 platform wagons, and 40 cattle wagons, or a total of 97. In addition, there is 1 travelling crane and 1 motor-inspection car. The prospects of this railway are somewhat improved owing to the promised revival of the cattle-raising industry, which if it prove as successful as anticipated, will bring considerable and probably permanent freight of a remunerative character to the line.

Railways of Venezuela.

Name of company.	Length of line.	Gauge.	Maximum grade.	Minimum radius of curves.	Bridges and viaducts.	Tunnels.	Stations.	Weight of rail per metre.	Sleepers.	Locomotives.	Passenger cars.	Freight cars.	Fuel used.
	Kms.	Metres.	Percent.	Metres				Kilos.					
Guanta and Naricual ...	36½	1·07	1·50	200	4	—	5	20	Wood	2	10	77	Coal briq'ttes
Carenero and Guapo... ...	33	·915	2	100	57	—	5	22	,,	4	5	34	,,
Maiquetia and Macuto ...	8	·915	2	—	8	—	4	—	,,	2	10	—	Cardiff coal
Caracas and El Valle ...	4	·63	3·50	40	—	—	—	—	,,	3	8	—	,,
Great La Ceiba	90	·915	2	75	43	—	5	14·20	,,	6	4	17	Wood
South Western	88	·61	3·50	45·73	31	—	11	20	Metallic	4	4	46	Coal
La Vela and Coro	13½	·915	·70	117	8	—	3	16	Wood	2	--	—	,,
Santa Bárbara and Vigia...	60	1·00	2	100	37	—	3	—	—	—	—	—	—
Great Táchira	115	1·07	·95	75	3	—	13	—	Wood	5	5	34	Wood

The Bolivar Railway, also a British undertaking, and the oldest railway in the Republic of Venezuela, having been opened for traffic as far back as 1874, has a length of 88½ kiloms. (55¼ miles). The gauge is 1.61, the same as that of the South-Western Railway. The maximum grade is from 2 to 3.50 per cent., and the minimum radius of curves 36.90. This railway is somewhat similar to the Great Venezuelan Railway in regard to its number of bridges and viaducts, there being no fewer than 134 of these in the short distance of 88 kiloms. There are nine stations. The rolling stock consists of 12 locomotives, 9 passenger cars, 68 wagons for merchandise, 5 brake vans, 5 cattle trucks, 91 ballast wagons, 6 timber trucks, 1 mule truck, 22 ore wagons with boxes, 2 hand-geared inspection cars, and 1 automobile inspection car. The company also possesses a small floating plant, including an iron steamer for passengers and merchandise, 3 lighters (two of iron and one of wood), and 5 rowing-boats.

The remainder of the Venezuelan Railways are summarised as to their principal engineering features in the table below.

MOTOR CAR EXHIBITION AT OLYMPIA.

No. II.*

LAST week we referred briefly to the Cowey pneumatic suspension system which was shown applied to cars made by Crossley Brothers, of Manchester. The aim of this system is to obviate the employment of springs, and to do this the inventor introduces four vertical cylinders fixed to the chassis frame. These cylinders each contain a piston, which is coupled to the axle, and the cylinders are charged with compressed air from a common reservoir, the latter being in turn charged by a pump driven by the engine. The cylinders contain a combination of piston, spring, and sleeve in order to allow the appliance to differentiate between movements due to road shocks and those due to variations of load. As the pistons and cylinders do not give the necessary lateral rigidity, longitudinal and transverse radius rods in front and at the rear are necessary, and these are loaded with springs to yield to the vertical movements of the piston-rods.

A notable feature in connection with the latest designs of motor cars is the growing tendency to place the radiator behind the engine, as in the case of the well-known Renault cars. This is advantageous for three obvious reasons. First, the radiator is placed in a position of greater security against damage; secondly, it enables a more pleasing contour of bonnet to be provided; and thirdly, the dust laden air induced by the fan has not to pass round the engine. It is drawn in to the radiator from without the bonnet, and after passing round about the tubes is discharged below the framework of the car.

One of the greatest drawbacks to the employment of chain driving for motor cars has always been the difficulty in connection with lubrication. Most firms did not think fit even to protect the chains from dirt and grit. The Sunbeam Motor Car Company has adhered to the chain drive after all other firms have discarded it, and for rough roads the decision has been amply justified. In the Sunbeam car the chain has always received the protection which it requires equally with the other working parts of the mechanism. By enclosing it in a dust-proof oil-tight case, and providing the necessary lubrication, this form of drive has been so satisfactory that the makers of this car until this year saw no reason to place before their customers an alternative drive. This year, however, conforming to fashion, a live axle car has been produced, the keynote of which is simplicity. The illustration, Fig. 12, represents the chassis of the 12-16 horse-power live axle car. The engine is of new design, and has four cylinders, 80 mm. by 120 mm., cast in pairs. The inlet and exhaust valves are on opposite sides, and are enclosed by dust-proof metal covers which are easily detached by hand. The connecting-rods are steel stampings of H section with white metal bearings. The crank shaft also runs in white metal bearings, and the lubrication of these and the big ends is effectively carried out by means of a gear-driven pump, thus ensuring a constant supply of oil, which returns to the reservoir in the crank chamber, and, after being filtered, is usable again. The bottom of the crank chamber can be removed without disturbing the crank shaft. The ignition system is the high-tension magneto with fixed or variable timing as desired. The engine is controlled on the throttle valve—which is combined with the carburetter—by means of a foot lever. The carburetter is of the Claudel-Hobson pattern. The clutch is of the leather-faced conical pattern, self-contained, and giving no end thrust to the crank or gear shaft. It is easily adjusted. The gear box provides four forward and one reverse speeds, and is suspended at three points. All the shafts run on ball bearings and are short and rigid. The live axle is of simple and straightforward design with bevel gears. Ball bearings are provided throughout; and the wheels are mounted on an outer sleeve, so that the differential shafts do not carry any weight. The brakes are easily adjustable, the front brake being of the external metal-to-metal type, with a large frictional area. The wheel brakes are enclosed in dust-proof drums. Unlike most of the best known petrol car makers, the Sunbeam Motor Car Company believes in forced circulation of the cooling water, and with this object provides a gear-driven pump and honeycomb radiator. A higher powered car built on similar lines and rated at 16-20 horse-power has a four cylinder engine 95 mm. bore by 135 mm. stroke. In both cars the petrol is fed to the carburetter by gravity.

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* No. I. appeared November 19th.

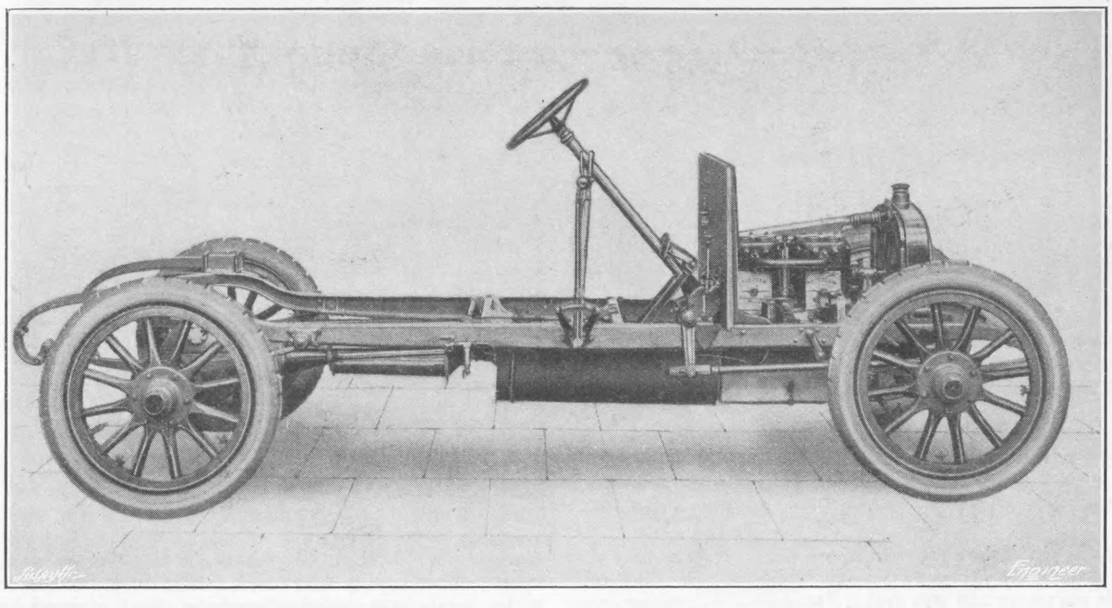

Fig. 12—CHASSIS OF SUNBEAM LIVE AXLE CAR

The Rolls-Royce cars exhibited were all of the same power. They had a six-cylinder engine 40-50 horse-power built up of two sets of three cylinders—a feature which this firm claims to have originated. The frame of the chassis has been lowered somewhat, and the gear box is one piece, suspended at three points from the main frame. The gear shafts have been increased in diameter and additional bearings have been introduced. A novel feature is to be seen in connection with the supply of petrol, which is now carried in a tank at the rear of the chassis, where it is suspended from projections on the side members of the frame. The necessary pressure is supplied by means of a small air-pump mounted on and driven from the gear box. The pump is of the piston pattern, and a silent relief valve fitted on the dashboard prevents the pressure from exceeding 2 lb. per square inch. On this relief valve a cock is fitted for releasing the petrol tank pressure at the end of a journey. This system is better than that which employs the exhaust gases to provide the necessary pressure. In connection with the brakes a small differential gear is now used by which therear wheel brakes are operated, the pressure on the two sets of brakes being thus equalised.

Five distinct models were shown by the Wolseley Tool and Motor Car Company, Limited, Birmingham, namely, 12-16, 16 20, 20-28, 24 30, and 40-50 horse-power respectively. They are all of the live axle type, the drive being transmitted in the three higher powered cars by bevel gearing, and in the lower powers by worm gearing. All have honeycomb radiators and pump circulation, except the 12-16 horse-power car, which works on the thermo syphon system. The suspension is semi-elliptic on the front axle and semi-elliptic on the rear wheels of the short wheel base cars, but for cars with a long wheel base an additional transverse spring is fitted. All spring shackles are fitted with means for lubrication, and multiple disc clutches are used throughout. A double universal joint is fitted in each case between the clutch and gear box, and there is a universal joint at each end of the propeller shaft. Each joint has provision for lubrication and adjustment as required. The smallest model, rated at 12-16 h.p., has a four-cylinder engine 3⅛in. by 4½in. bore. It is constructed with the finish and accuracy which has always characterised this firm's work, the same high-class materials being employed. The engine and gear box are mounted on an underframe, and the live axle is worm driven, the worm being placed underneath the worm wheel. To reduce to reasonable limits the angle of the universal joint to the propeller shaft, the underframe is sloped from the front to the rear. On all models the carburetter is of the two-jet pattern, being practically two carburetters controlled by the same throttle. The small one, which has a mixture pipe varying from ⅜in. to ⅝in. bore on the different models, is used for starting or very slow running only, when the main carburetter is entirely cut off. The continuation of the movement of the throttle opens the main carburetter. A point of interest in connection with engine design is the system of lubrication. The troughs under the "big ends" are supplied with an excess of oil which overflows the sides, all that is not taken up by the bearings finding its way back again to the sump, whence it is again pumped through the bearings. Another neat feature on the pressure-fed models is the combined oil and air pump, one for lubricating purposes, and the other for supplying petrol to the carburetter. The 40-50 horse-power six-cylinder engine has all cylinders cast *en bloc*. These are enclosed in a sheet copper jacket hammered to the desired shape, and fixed on with little screws. The object of casting the cylinders in one is to increase the stiffness of the engine and reduce the length, as the valves are all on one side. One train of gearing serves to drive the fan, the water pump and the magneto, jaw coupling being introduced between each to facilitate dismantling.

The Aster Engineering Company showed a 12 brake horse-power Allsop paraffin engine, the design of which has undergone considerable modification since the original engine was described in THE ENGINEER, June 21st, 1907, as will be observed from the accompanying illustration—Fig. 13. This represents a transverse section taken through the pump cylinder. The two working cylinders are 105 mm. bore by 120 mm. stroke, and they have a fuel vapour pump cylinder placed between them. The function of this cylinder is to prepare and supply measured charges of combustible gas into the motor cylinders, and the operations are as follows:—On the down-stroke of the piston paraffin, with the necessary volume of air, is drawn into the cylinder through an atomising valve A, and a vaporising cone B heated by the exhaust gases, and is thereby converted into a gas. On the up-stroke of the piston the vapour is discharged through a superheater at C alternately into the right and left-hand cylinders, taking along with it the air necessary for combustion. The gas outlet from the pump cylinder is regulated by a mechanically operated valve of variable lift, which is under control while the engine is running. All the valves are mechanically operated, the inlet and outlet being on either side of the engine. Forced lubrication at slight pressure is provided for the big ends and bearings. The engine gives 12 brake horse-power at 1200 revolutions per minute and weighs 3 cwt. 9¼ lb. without fly-wheel. It is being built for the Allsop Motor Syndicate, Limited, 59, Queen-street, Cardiff.

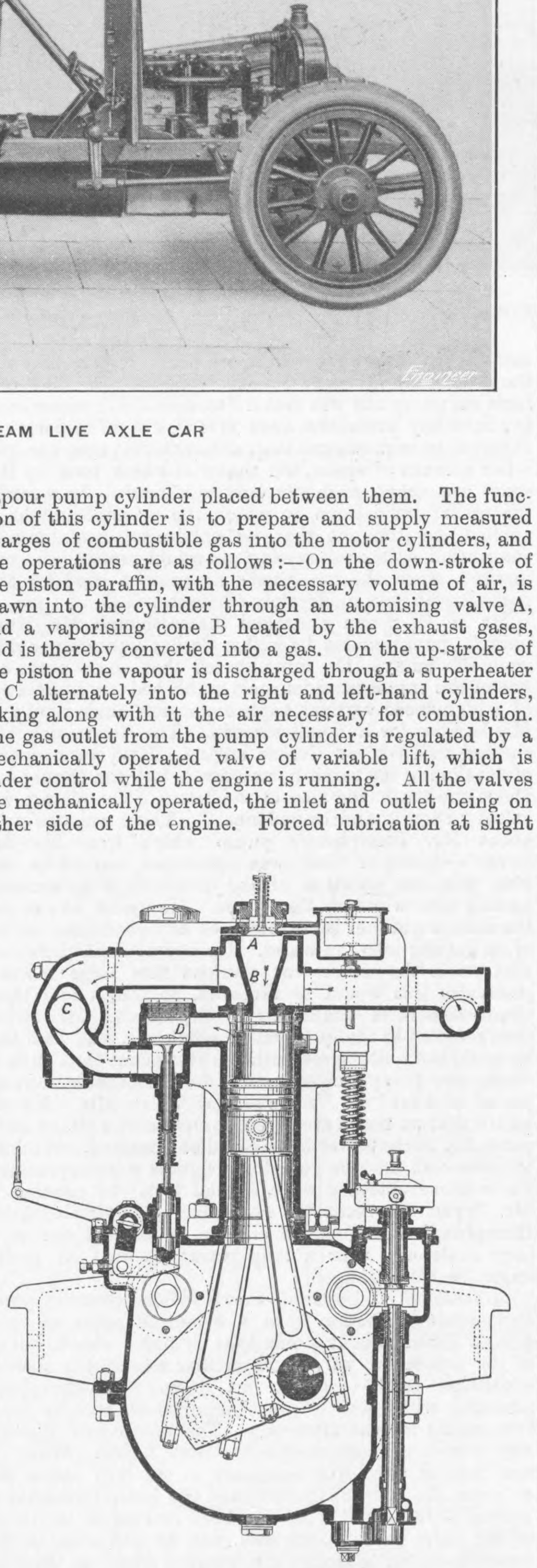

Fig. 13—ALLSOP PARAFFIN ENGINE

Considerable attention is now being given to the production of a satisfactory detachable road wheel. The Riley Cycle Company, Limited, Coventry, exhibited at Olympia a system which is equally applicable to both wood and wire wheels, and which permits a permanent exchange to be made with the spare wheel quickly without disturbing brake fittings, bearings, speedometer rings, &c. Neither the front nor rear axle is changed in any way, but they are provided with inner hubs fixed as usual. Permanently fitted to these hubs are the brake drums, bearings, and other apparatus. The outer or removable hub, which is built up into the road wheel, slides over the inner hub, tapered projecting studs on which engage with corresponding holes in the outer hub, thus transmitting the drive. Each wheel is provided with a special hub cap, which is permanently attached but free to rotate, and is threaded to screw into the inner hub. Enclosed in this cap are automatic locking and withdrawal devices, which provide the means for taking off or putting on the wheel and for automatically locking the hub cap on its thread.

Drummond Brothers, Limited, Guildford, are making a speciality of machine tools suitable for motor car repairers. At Olympia this firm exhibited a really handy universal grinding machine, which is capable of grinding cutters, flat grinding, parallel and taper, outside and internal grinding, and can be driven by power or foot pedal. The bed is carried on heavy standards, and has a long slide, driven by skew and worm reducing gear and hand wheel. The feed motion has stops in both directions and fine adjustment. On the travelling slide is a swivelling table graduated in degrees for taper work, and carrying a headstock with a hollow mandril. This is coned and split at both ends, and has two internal coned sleeves for holding chuck mountings or gripping the work. This head rotates, and the driving gear can be thrown out to leave the spindle free for testing work, &c. The grinding head can be raised or lowered and swung round parallel with or at any angles to the table by means of a screw and nut. The hand wheel has worm teeth cut on its periphery with which a worm can be caused to gear for fine measurements. The abrasive wheel is driven by a round belt from the treadle motion, the arrangement of the drive being very similar to that on a radial foot-driven drilling machine which this firm introduced recently.

INSTITUTION OF MECHANICAL ENGINEERS.

THERE was an excellent attendance at last Friday's meeting of the Institution of Mechanical Engineers, when Mr. Herbert A. Humphrey read his paper on "An Internal Combustion Pump and other Applications of a New Principle." The meeting was one of exceptional interest, for Mr. Humphrey dealt with something which is quite new, and which will in all probability mark a decided step forward in the history of mechanical engineering. Very ably did the author demonstrate to his audience the action of his new pump, and excellent were the models and diagrams which he exhibited. Unfortunately, such papers are but seldom met with. It deals with an invention which, though quite new, has passed out of the experimental stage, and has been put to the test of practical application. It is a paper written by an engineer for engineers, and it has the advantage that the latter are easily able to understand it. We commence to print it on page 562. When the paper had been read, and a hearty vote of thanks had been passed, the President, Mr. J. A. F. Aspinall, who occupied the chair, said that before the discussion was opened he would like to ask the speakers to omit all reference to the value of the paper. It was customary for those who took part in the discussions first to spend some time complimenting the author on his paper. They all knew that the paper which had just been read was a valuable one, and the author knew that it was valuable, and however much praise was bestowed upon the author it would not make his work more valuable. For that reason he would ask the speakers to deal with the technical points at once and to omit all reference to the excellence of the contribution, for that was well understood and agreed upon. This little piece of advice from the President had a very beneficial effect upon the discussion, for much less time was wasted than is usual, the remarks of the various speakers were considerably more interesting, and the discussion proved brighter and better in every respect.

Mr. Henry Davey was the first speaker. He commenced by correcting a statement which the author had made at the beginning of the paper, where he stated that the South Staffordshire Mines Drainage Commissioners had replaced steam engines by gas engines in five of their pumping stations with very beneficial results, the change having led to a considerable economy of working. That statement, Mr. Davey said, was not quite correct. As a matter of fact, the South Staffordshire Commissioners had erected three new steam pumping plants, and gas engines had been put in at five of their stations temporarily where it was not desirable to erect steam plant. The net result of this was that the average cost of pumping against a given head was twice as much with the gas engines as with the steam engines. One of the old steam pumping plants proved twice as economical as the new gas plants. The gas engines were small ones. The author had said that compound condensing direct-driven steam pumps of modern construction and large size were among the most economical of all steam-using plants, and under favourable conditions would give a pump horse-power hour for an expenditure of 18 lb. of steam. As a matter of fact, the steam consumption of such plants did not exceed 12 lb. of steam per pump horse-power hour, and 18 lb. was a disreputable example. Then Mr. Davey turned to the actual cost of working this new pump as compared with steam pumps. He said that the author had obtained a pump horse-power hour with 13,000 British thermal units, but that was not much improvement on the best waterworks engines. If Mond gas cost 2d. per 1000ft., and 85 cubic feet were used per pump horse-power hour, the cost would be .17d. If colliery slack costing 4s. 6d. per ton were used in the boilers of a steam pumping plant, which was the kind of fuel used at the South Staffordshire stations, and assuming that 5 lb. of water were evaporated per pound of coal, also that 20 lb. of steam were used per horse-power hour, the cost per pump horse-power hour would only be .096d., against .17d. with the new gas pump. At waterworks

AMERICAN IRRIGATION WORKS—TRUCKEE-CARSON PROJECT

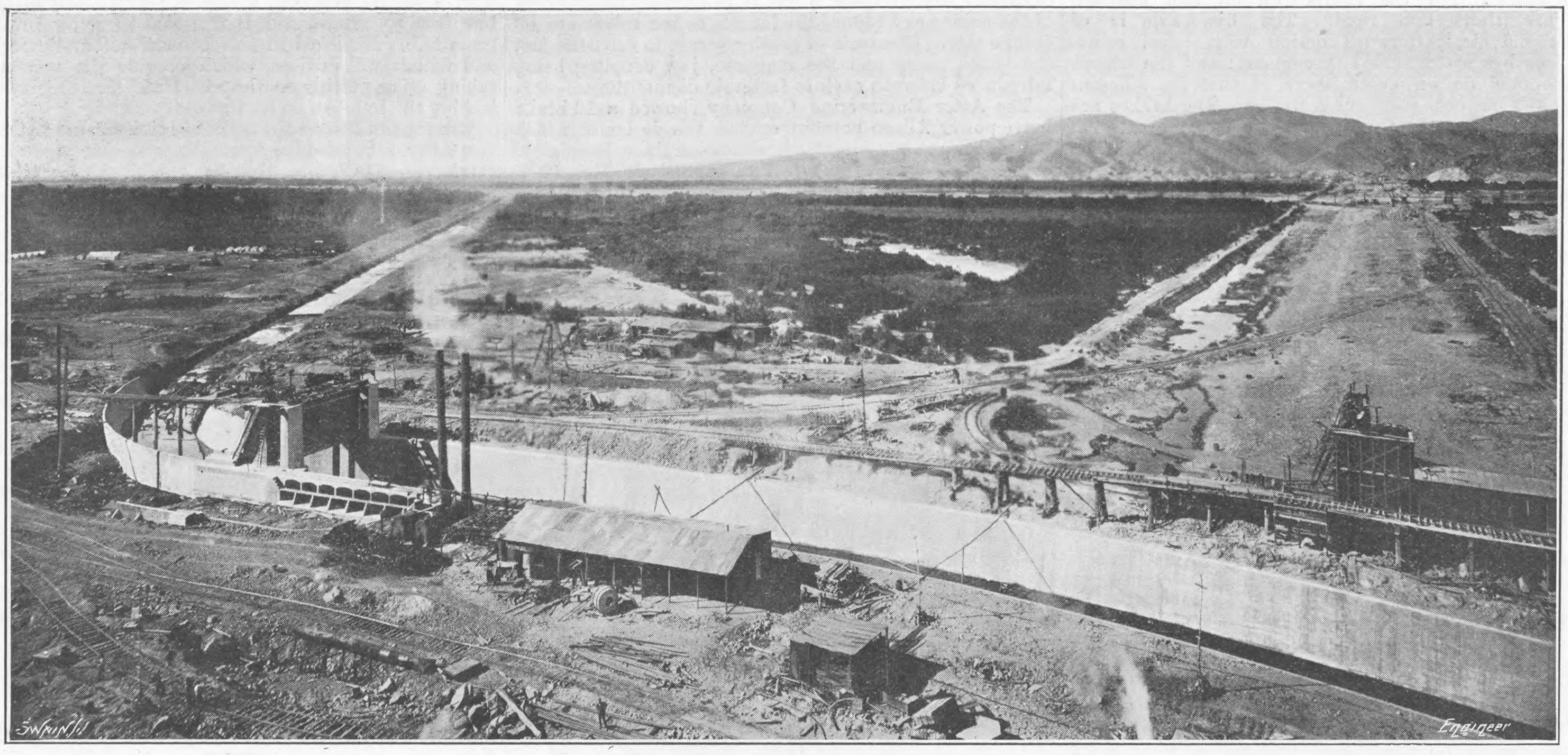

Fig. 47—CONSTRUCTION OF THE LAGUNA DAM ACROSS THE COLORADO RIVER

where coal cost 16s. per ton, and where 8 lb. of water were evaporated per pound of coal, and 12 lb. of steam were used per pump horse-power hour, the cost per pump horse-power hour would be .13d. Thus, although the thermal efficiency of the pump appeared remarkable, the money part of the question was somewhat different. The practice of using a column of water as a fly-wheel, Mr. Davey said, was more than a century old. Thirty years ago he erected a long-stroke double-acting pump at a Durham colliery, which was connected to a long pipe line, and the column of water served as a kind of fly-wheel. The difficulty attending the use of the system was that of finding suitable local conditions which would admit of its application. Referring to the diagram of a suggested central electric station, with a hydraulic coupling between the gas and electric-power equipment, the speaker said that no mention had been made of the cost of such a station, and it was difficult to discuss the suggestion. Next Mr. Davey drew attention to the space which Mr. Humphrey's pump occupies, and went on to show that if the maximum velocity of the water was 10ft. or 12ft. per second, the horizontal pipe between the combustion chamber and the high-level tank would have to be three or four times longer than the vertical pipe leading downwards from the combustion chamber. This meant that if the latter was 200ft. long, then the horizontal pipe leading away to the tank would have to be from 600 to 800ft. long. This made the pump very bulky, and considering the strength which would have to be given to it, there would be a considerable weight of metal.

Professor Unwin, who was the next speaker, first of all referred to the fact that Mr. Humphrey's pump had passed the experimental stage, and that pumps of that type could be built to order. He had known of its existence for the past two years. About a year ago he had made a test on a smaller pump than the one mentioned in his—Professor Unwin's—report. The efficiency proved to be practically the same as that of the larger one which he had recently tested. He thought that Mr. Humphrey had shown considerable ability in designing modifications of his invention. Personally, he could only give his opinion of the pump shown in the diagram on the wall, this being Fig. 1 in the paper. The action of that pump was a real surprise to him. It worked without a hitch under all kinds of conditions. It was possible to play all kinds of tricks with it, such as altering the lift, and the pump seemed to take no notice at all. If they put more pressure on it by partially closing the sluice valve the pump still continued to work absolutely satisfactorily. The efficiency, he thought, was remarkable. If it was compared with other forms of pumps working on low lifts, that was to say, a lift corresponding to that of the pump he had tested, it would be found that the results were highly satisfactory. Mr. Davey had said that 18 lb. of steam per pump horse-power hour was a disreputable figure for a triple expansion pumping engine, and that 12 lb. of steam per pump horse-power hour was the usual consumption for such engines. He thought, however, that Mr. Davey would find that engines working with the low steam consumption he had mentioned were pumping against fairly high lifts, and that 18 lb. per pump horse-power hour was a fair figure for a steam pumping engine operating against a head corresponding to that of Mr. Humphrey's pump. In order to make the comparisons given in his report he had to look round for a triple-expansion pumping engine which was delivering water against a head corresponding to the lift of Mr. Humphrey's pump, and the engines at the West Middlesex Waterworks were the only ones he could find. Continuing, Professor Unwin said that very excellent arrangements were made for testing this new pump, and great care was taken to secure accuracy. The testing arrangements resembled those used in the previous experiment, and the conditions were just the same as would be met with in practice. He thought that the principle had many possible applications. The only fault the pump had was that it was somewhat cumbersome, but in many instances mere size was of no importance. It was to be remembered that, although the pump occupied a fair amount of space, the material which took up that space was cheap, as it was only pipe work. As regarded the other applications to which the principle might be applied, he thought that its sphere of usefulness in connection with compressing air would probably be very marked, since the machinery at present used for that purpose was only moderately efficient.

Mr. W. B. Bryan remarked that although Mr. Humphrey's pump might be bulky, Corliss pumping engines were also bulky. He remembered that some years ago one of the engineering journals published an illustration of a high-speed vertical triple-expansion engine built by Mr. Yarrow for a small torpedo. The illustration also showed a slow-speed Corliss engine. Both were capable of developing the same horse-power, but the former was about one-tenth the size of the latter. The picture was called "Dignity and Impudence."* There was one point about Mr. Humphrey's pump which, from his—Mr. Bryan's—point of view, was somewhat important, and that was the question of the products of combustion finding their way into the water. He would like to ask the author whether there would be any possibility of tar or oil getting into the water. He had no doubt, however, that when the water was pumped into large filtering reservoirs this would be removed, so that under those circumstances it would not matter much. Mr. Bryan then referred to the question of efficiency, and said that he could not quite agree with the statement that 18 lb. of steam per pump horse-power was disreputable, but approved of what Prof. Unwin said about low lifts. He was aware that on test a steam consumption of 12 lb. or 13 lb. per pump horse-power hour could be obtained, but taking the losses all the year round, the figures were appreciably above those obtained on a special test. In conclusion, Mr. Bryan expressed the hope that some trials on Mr. Humphrey's pump would shortly be carried out on a large scale and over a long period, so that its merits might be better judged.

Professor C. V. Boys said that it seemed that the pump approached perfection from a scientific point of view. A good feature about it was that of being able to get rid of the non-return valve, and another was that it enabled expansion to be carried out down to atmospheric pressure, which was of great importance, and no doubt responsible for the efficiency. The pump was remarkably simple as compared with other forms. When all was cold all that was necessary to set it in action was to press the ignition button, and the pump immediately started at full speed. He had been looking at the model of the valve gear on the wall, and he had come to the conclusion that although the pump worked on the two-cycle principle, the valve gear worked four-cycle. He wondered how the author had come to think of such an invention, and how he persuaded himself that it would work. Personally, he felt in the position of the undergraduate who, after having the principle of the syphon explained to him, said, "Yes, sir, but it really doesn't work." From a description of the new pump, it was difficult to believe that it would work as it did. It was the same with the pulsometer steam pump. Continuing, the speaker said that he had asked himself, if such excellent results were obtained with a pump of the size of the one tested, what kind of results would be secured with one very much larger, say, a 1600 horse-power pump? With ordinary gas engines they knew that as the size increased they became less satisfactory, but he thought that in the case of this new pump they could almost conclude that the greater the size the more satisfactory would they become. There was no difficulty to be taken into account, such as that of conducting heat away from the metal, and there were no large castings to burst. The pump could be made out of boiler plate, which was a kind of thing which did not burst. There was a kind of water which contained fine sand, and he had been wondering whether that sand would not in time cause the numerable water valves to leak. There were also the gas inlet and exhaust valves to be considered, and it was very important that the latter should not leak. He had been wondering whether the sandy water continually smacking this valve on the face would not give rise to leakage, and whether it would not be desirable to fit some intermediate arrangement to receive those smacks.

Professor Threlfall, who was the last speaker, drew attention to the great simplicity of the pump, and remarked that the author had produced a gas engine without the usual rods and other parts which it was desirable to dispense with. He had recently been talking to a chemical manufacturer, who said that there was too much artillery business about gas engines for his liking. In dealing with that part of the paper where the author considers the possibility of applying the principle to an electric power station, and said that a Board of Trade unit could be generated for 2 lb. of coal, Professor Threlfall remarked that, compared with the performance of a good gas engine, this figure was somewhat enormous, but if oil and repair costs were going to be practically done away with, then he thought that the scheme would be a very good one. It had been said that the pump was somewhat bulky, but that did not appear to be of much importance, since a thing of that kind required no house. It could be kept out in the open, but it would be necessary to cover it over with a little hay in the winter. Finally, the speaker said that it seemed to him that the invention would be the means of getting rid of the cost of oil and repairs.

The discussion was then adjourned to Friday, December, 3rd.

IRRIGATION WORK OF THE UNITED STATES GOVERNMENT.

No. VII.*

THE TRUCKEE-CARSON DISTRICT.

The Truckee-Carson irrigation district in Nevada provides for the irrigation of 350,000 acres of land at a cost of £1,800,000. It includes what is known as the Forty-Mile Desert, a burning sandy waste which is the driest part of the United States, with the exception of Death Valley in California. Across this desert lay the old "overland trail" of the early gold mining days, and many of the pioneers and fortune-seekers perished along the way, overcome by the heat and dying for lack of water. In a paper on "Home Making by the Government," Mr. C. J. Blanchard, statistician of the Reclamation Service, remarks as follows:—

"We come upon many melancholy evidences of desert tragedies enacted in the early fifties. In excavating canals our great steam shovels have encountered the bones of men and horses who perished of thirst. We know now that much of their suffering was unnecessary. There is plenty of good water not far below the surface of the sands. In fact, the gravediggers, if they had gone a few feet deeper, would have been able to satisfy their own thirst."

In this district, as in the case of the Uncompahgre and some others, the irrigation works have changed the original physical geography. The principal sources of water supply are the Truckee and Carson rivers, which lie in the drainage area or watershed of the "great basin," so that none of the run-off reaches the sea. The waters drain into saline lakes and marshes in the lower part of the basin, and are lost by evaporation. The valleys of the two rivers are quite distinct, but near Wadsworth they are separated only by a low ridge, so that water may be diverted easily from one valley to the other. The Truckee has the larger flow, but the Carson has a much larger area of land available for irrigation. The maximum discharge of the Truckee River is about 10,000 cubic feet per second. The first part of the project was the diversion of water from the former into the latter, for the irrigation and reclamation of land in the Carson "sink" or dry valley where the river is lost by evaporation. The character of the country before and after irrigation has been shown by some of the views accompanying the first of these articles.

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* See The Engineer, February 13th, 1903.

* No. VI. appeared November 12th.

The irrigation system comprises the following features:—(*a*) A diverting dam in the canyon of the Truckee River, diverting the water into a main canal 30 miles long, which carries the water into the Carson valley and terminates at the site of the dam for the Lower Carson reservoir; (*b*) Lake Tahoe, at the head of the Truckee River, will be enlarged by closing some of its outlets, and converted into a reservoir of 200,000 acre-feet capacity; (*c*) two reservoirs will be built on the Carson River: Lower Carson reservoir, 286,000 acre-feet; Alkali Flat reservoir, 200,500 acre-feet; (*d*) main distributing canals along the line of that branch of the Carson which ends in Carson sink, to provide for the reclamation of land in the "sink."

The soil includes sandy and clayey loam and volcanic ash, and requires about 3 acre-feet of water per acre per year for irrigation. The average rainfall is only 4in. per year. The district is about 4000ft. above sea level, and the temperature ranges from 12 to 112 deg. Fah.

The width of the Truckee River at the point selected for the dam is about 160ft. The diversion dam is a concrete wall with sluiceways; it is flanked at one end by an embankment extending across low ground, and at the other end by a concrete wall in which are the head-gate openings of the canal. This wall is at right angles with the line of the dam. The dam proper is 155ft. long, with 15 piers forming sluice openings 5ft. wide. The piers are 5ft. thick, 18ft. long on the base, and rest on a concrete floor or apron 30ft. wide and 8ft. thick. The piers are 15ft. high to high water level, and carry smaller piers which support a concrete service bridge on which is the gate-operating machinery.

Each sluice opening has a bottom gate 5ft. high for ordinary regulation, an upper gate of the same height to pass a large stream, and five top flashboards 12in. high, which may be removed for floods. The lower gate is attached to the end of a shaft or rod whose threaded upper end passes through a revolving nut in the hand-operated mechanism on the bridge. When this gate is raised behind the upper gate, further motion of the shaft raises both gates, and finally pushes up the flashboards. The aggregate waterway is 1200 square feet. The embankment flanking the dam, on low ground, is 1160ft. long, with a maximum height of 27ft., the crest being 3ft. above high-water level. It is 10ft. wide at the top, and has side slopes of 3 to 1 on the water side, and 2 to 1 on the down-stream side. The bank is built of the local sand, gravel, and silt of the river bed, put in place by horse scrapers, without sprinkling or rolling. The water slope is paved with stone.

The canal headworks are of concrete, and the wall extending up-stream from the end of the concrete dam has nine openings for the regulating gates. The openings are 5ft. wide and 7ft. between centres. The gate frames are parts of a steel structure having vertical posts embedded in the concrete piers and a horizontal top girder embedded in the concrete of the service bridge. The arrangement of the gates is practically the same as at the sluices of the dam noted above. The sills are 3ft. 9in. above the floor of the sluices, and 2ft. 9in. above the floor of the canal, in order that the sills may be kept clear, and all heavy silt, &c., carried through the sluices and kept clear of the canal head gates.

The canal is 30 miles long, and has a capacity of 1400 cubic feet per second. It is at an angle of 55 deg. with the river, and a curved wall from the upper end of the head wall forms an entrance basin 65ft. long, reduced in width from 70ft. at the head gates to the 25½ft. bottom width of the canal. A weir in the canal, just below the entrance, discharges back into the river any excessive amount of water admitted through the head gates.

The canal has a width of 25½ft. to 18ft. on the bottom, with a gradient of 1 in 6500. This gradient is increased to 1 in 2400 in rock cuttings, and 1 in 1500 in concrete-lined tunnels. The velocity is about 3ft. per second, with a capacity of 1400 cubic feet per second to the headworks of a future branch canal, beyond which the capacity is 1200 cubic feet per second. On side hill ground the embankments are 8ft. wide on top, with a height of 15ft. above the bottom of the canal, or 2ft. above the water level. Nearly half the length of the canal is made up of curves, the radii of which are mainly 287ft. and 382ft.

The canal is lined to a considerable extent with concrete 6in. thick, extending 2ft. above the water line. This is done (*a*) to make the channel water-tight in bad material; (*b*) to give a smooth surface in rock, and thus allow a smaller cross-section to be used; (*c*) to ensure strength at points where a break or burst would be specially serious, as near railway lines, &c. The transition from the unlined to the lined sections is made by warped surfaces. Any hollow places in the face of the slope were carefully filled with large broken stone, laid by hand. Along the back of the concrete lining, and integral with it, is a horizontal rib of concrete 6in. thick, at about the middle of the slope. In bad ground two ribs were used, about 5ft. apart. These ribs serve to anchor the lining to the ground, to strengthen it against rupture due to the pressure of loose material behind it, and to break up the continuity of any moving or sliding ground, and thus reduce its tendency to move. Fig. 48 is a view of the concrete-lined canal in a loose and broken rock formation.

There are three tunnels, 310ft., 900ft, and 1515ft. long, with portal cuttings 40ft. to 80ft. deep. They are 12ft. wide and 15½ft. high, with a roof radius of 7ft. The gradient of the floor is 1 in 1500, and the velocity is 8.10ft. per second, with water 13ft. deep. The largest tunnel is in earth, and the others are in rock; all have a concrete lining 8in. to 16in. thick, with a 4in. concrete floor. In the earth tunnel the timbering was left in place, and before depositing the concrete for the lining old rails were set vertically in the spaces between the posts of the timber lining.

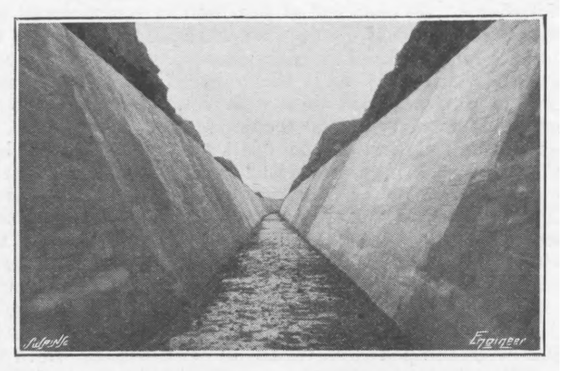


Fig. 48—CONCRETE LINED CANAL

At two wasteways or side weirs the canal bed is dropped 6ft. for a length of 45ft. in order to form a sand catcher or sediment basin with 19ft. of water. In the side are sluice openings 5ft. by 5ft., fitted with Taintor gates. At one of these wasteways the water after passing the sluices flows down a shaft 50ft. deep into a tunnel, which passes under a railway and discharges into the river.

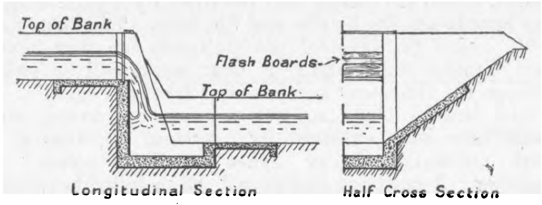
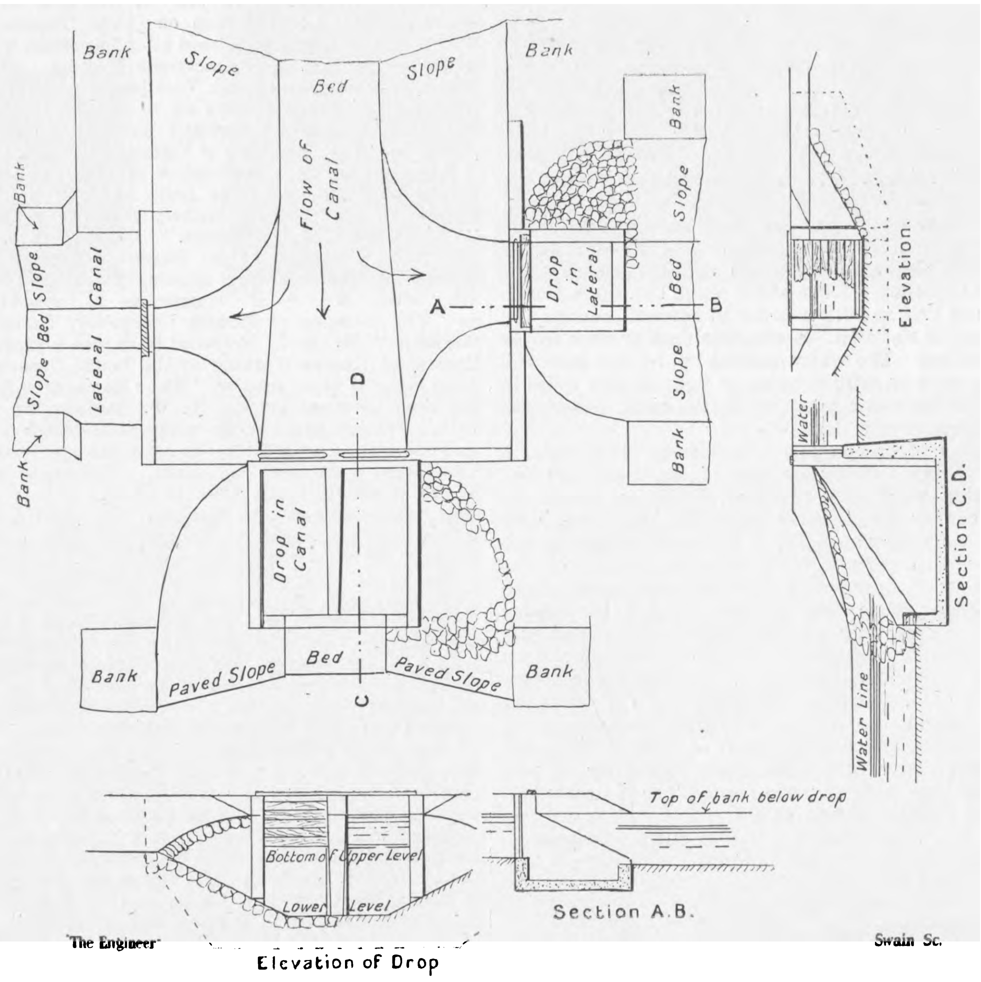


Fig. 49 - CONCRETE DROP FOR CHANGE OF GRADIENT

At the end of the canyon of the river the river turns abruptly in one direction, and the canal turns in the opposite direction. Near this point an auxiliary canal takes off from the main canal, the latter having gates to check the flow, and direct a larger flow into the auxiliary canal when required. Beyond the canyon—in which the canal runs for ten miles—the canal has a bottom width of 14ft., wide slopes of 1½ to 1 and 2 to 1. The depth of water is 13ft., and as the average length of cutting is only 6ft., artificial banks are required to form both sides of the canal. The deepest cutting is 20ft.



The Engineer Swain Sc.

Fig. 50—COMBINED DROP AND LATERAL CONNECTION

Two main distributing canals lead out from the Carson reservoir. The headworks comprise a dam 225ft. long, with twenty-three sluices, 5ft. wide. At right angles to the dam, and at each end, are the head gates of a canal entrance. The lower part of the dam, below the sluices, is a weir with a movable crest, providing for a variation in level. This crest is formed by a steel gate which slides vertically against the face of the dam. Each gate is 17ft. long and 5ft. high.

The south canal is twenty-seven miles long, and has a capacity of 1500 cubic feet per second. The north canal is ten miles long, and its capacity is 400 cubic feet per second. One feature of the south canal is a "drop" giving a vertical fall of 26ft., the power from which will be utilised for pumping water to lands above the level of the gravity flow. The lateral distribution system includes primary, secondary, and tertiary lateral canals. The third of these—or sometimes the second—supplies the farms. Concrete "turnouts" divert the water from a primary to a secondary, or from a secondary to a tertiary canal. The turnout has a stop gate in the main channel, and a diversion gate placed in the bank at right angles to the stop gate. The gate openings are fitted with plain flashboards, and the concrete sides of the diversion opening are rounded off so as to give a good entry for the water. The slope of the land is too great to admit of a continuous uniform gradient for the laterals, and numerous falls or vertical "drops" are put in to effect a change in level. These are concrete chambers of the general design shown in Fig. 48. They are in many cases combined with the turnouts, making a somewhat complicated structure. One of these is shown in Fig. 50.

The sizes and gradients of the larger laterals are adjusted to give a calculated velocity less than 2ft. per second, while the average velocity of the smaller laterals is about 1.6ft. per second. All laterals are so built as to have part of the water section normally above the level of the ground. The slopes on the waterside are 2 to 1. The outer slopes of embankments are 1½ to 1 and 2 to 1. All the lines for lateral channels are set out and staked by the use of a theodolite, regular curves being set out. The dimensions of some of the laterals are tabulated herewith:—

Lateral Channels for the Truckee-Carson Irrigation Project.

Width of base.	Depth of water.	Area of water section.	Height.	Top width.	Gradient.	Velocity.	Discharge.
ft.	ft.	sq. ft.	ft.	ft.		ft. per sec.	cu. ft. per sec.
8	3·5	52·5	5·0	4	0·0004	1·98	104·0
6	3·5	45·5	5·0	4	0·0004	1·90	86·0
6	3·0	36·0	4·5	4	0·0005	1·94	70·0
5	3·0	33·0	4·5	4	0·0005	1·89	62·4
5	2·5	25·0	4·0	4	0·0006	1·84	46·0
4	2·8	26·9	4·0	4	0·0007	2·09	56·3
4	2·5	22·5	4·0	4	0·0006	1·79	40·3
4	2·5	22·5	3·5	3	0·0006	1·79	40·3
3	1·5	9·0	3·0	3	0·0010	1·65	14·8

In view of the clay subsoil, drains are provided along the lateral systems to take care of seepage, drainage, and waste water, and thus prevent the land from being water logged by excessive irrigation. These are ditches, about half a mile apart. They are cut very much deeper than the laterals, as their purpose is to remove water, instead of supplying it.

THE YUMA DISTRICT.

The Yuma irrigation district, in California, lies in the valley of the great Colorado River, and includes lands both in the United States and in Mexico. The district has an elevation of only 100ft. to 300ft. above sea-level, and is in a hot dry climate, with an extreme range of temperature from 22 deg. to 130 deg. Fah. The desert region has a rich alluvial soil, and has a climate adapted to semi-tropical fruits as well as staple products; under irrigation it will produce seven crops of alfalfa in a year. The annual rainfall is from zero to 3in.

The water supply for irrigation is taken from the Colorado River, and it was necessary to restrain and conserve the flow of this river, which ranges from 4000 to 120,000 cubic feet per second. The flood flow is usually in June, following the melting of the snow in the mountains, and inundates the valley to a depth of from 1ft. to 7ft. The control of this stream was a very difficult problem, owing to its varying flow, its constantly shifting channels, and the absence of any bed rock within reach upon which to build the controlling works. The serious character of this problem has been shown by the difficulty, the frequent failures, and the enormous expense of the emergency work required at a point further down stream to check the diversion of the Colorado River, and return it to its natural course, when, through ill-advised work on a private irrigation project, the river was given an opportunity to cut through its bank and partially inundate a great valley lying below sea-level. This work has been fully described in THE ENGINEER, and it is estimated that the lake thus caused will not disappear entirely until 1912.

There is no high dam to form a vast reservoir, as in some of the projects described previously, but the plan adopted was to throw a low diverting dam across the river, with canal headworks at either end. This forms a settling basin, in which is deposited a large proportion of the solid matter which in flood time is carried in suspension as silt and rolled along the bottom as gravel and stones. The river channel is from 1000ft. to 4000ft. wide in the valley, and about 1200ft. at the site of the dam. There being no bed rock within reach, the engineers decided to build a dam directly upon the sand and silt of the river bed, adopting a weir type of dam which has been used extensively in India and Egypt. It is mainly a great rock embankment or weir, with three concrete core walls to shut off the water, while the silt deposited by the water will gradually fill all voids in the rock work in front of the first wall.

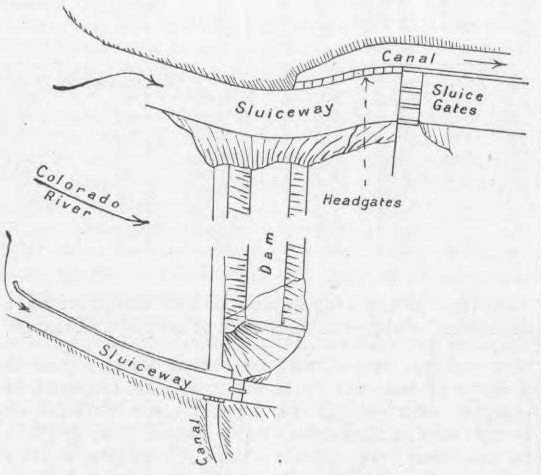


Fig. 51—PLAN OF LAGUNA WEIR DAM

This dam—known as the Laguna Dam—is 4780ft. long, 20ft. high, 260ft. wide on the base. The three concrete walls are 57ft. and 93ft. apart, and beneath the first one is a line of triple-lap wooden sheet piling 6in. thick, driven to a depth of 12ft. to 20ft. in order to prevent seepage and undermining of the dam. A concrete floor or deck covers the rock filling. The water backed up by the dam will form a reservoir or settling basin of eight square miles in area, so that the water taken off at the canal headworks will be comparatively clear.

At one end of the dam is a sluiceway 116ft. wide, in which—at a point below the line of the dam—are two piers forming three 33ft. openings, which are closed by vertically sliding sluice gates 33¾ft. long and 18ft. high. The gates are hollow steel boxes filled with concrete, and are fitted with chains which pass over sheaves on the bridge and carry counterweight boxes of the same length as the gates. These sheaves are operated by gearing from a 20 horse-power electric motor. The maximum water pressure on each gate is 337,500 lb., and the weight of the counterbalance is 48,500 lb. For emergency there is a fourth gate, which is suspended from a travelling platform behind the bridge, and can be moved to any of the three openings by means of slots in the piers. The platform carries a 20 horse-power motor for its propulsion and for handling the gate. The power plant consists of a petrol engine of 100 horse-power, directly connected to a 75-kilowatt continuous-current compound-wound 500-volt generator. The main engine is started by compressed air, for which there is a compressor driven by a 6 horse-power petrol engine.

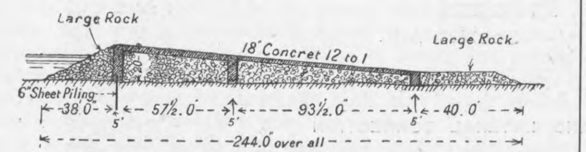


Fig. 52—CROSS SECTION OF LAGUNA DAM

Fig. 51 is a plan of the dam, showing the concrete-lined sluiceway channels with their gates, and also the headworks of the irrigation canals. Fig. 52 is a cross section. In Fig. 47 the broad surface of the dam under construction is seen at the right, extending across the valley to the main channel of the river. In the foreground is the concrete sluiceway channel, and near the two chimneys may be seen the bridge or superstructure from which the sluice gates are suspended. To the right of this are the openings of the head gates for the irrigation canal.

The dam was built in two parts, each extending from the hillside of the valley towards the main channel of the river. A very difficult problem in this work was the final closing of the river channel, which was gradually narrowed from 1100ft. to a gap of 625ft., the ends of the embankment being protected against wash or scour by means of cofferdams. At each end of the dam is a sluiceway, to send the water past the dam when required, or to turn it into the headworks of the main canals. One of the sluiceways is 42ft. wide and the other 116ft. They are excavated in rock and lined with concrete, and have a combined capacity of 20,000 cubic feet per second.

The final closing of the 625ft. gap was effected by unloading rock in two parallel lines about 400ft. apart. Two timber trestle bridges were built for this work, and filling carried on until the entire bed of the channel between the two trestles had been fairly well covered to within about 4ft. of the surface. The final closing then followed, and was completely satisfactory, though not without many difficulties due to recurring floods. For this closing work additional trestles were built from which rock was dumped by trains of side-tipping railway wagons. Concrete for the core walls also was tipped directly from wagons into the moulds. The dam was completed finally in June last.

The distribution system will comprise 20 miles of main canal and 138 miles of lateral canals. The main canal on one side of the river has a capacity of 1300 cubic feet per second, and will be carried under the Gila River by a reinforced concrete syphon 10½ft. diameter and 2700ft. long. The headworks of this canal include a row of 34 openings in the wall of the sluiceway above the dam; the openings are 7½ft. wide, separated by concrete piers 1ft. thick and 11ft. high. The piers support a concrete service bridge, and are grooved to receive flashboards, which are placed and removed by a hand winch. The boards are 4in. by 6in. and 8ft. long. The canal flow is 9ft. above the level of the sluiceway, so that heavy solid matter rolled along by high water will be swept through the sluiceway and excluded from the canal.

Low bottom lands subject to overflow during high water have been enclosed by a system of 75 miles of earth embankments or dykes — called "levees" in America. A pumping system will be installed to remove the surplus water from the low-lying areas.

FORTHCOMING MEETINGS.

III.

FOUR lectures on "Aeronautics" are to be delivered before the Royal Society of Arts during the present session by Mr. C. Turner. The dates of these lectures given on the programme are November 29th, December 6th, December 13th, and December 20th. Before the same Society, the Hon. R. C. Parsons will deal with the subject of "Resilient Wheels for Vehicles" on December 1st, and on the 20th Mr. H. Pearson will present a contribution on "The Diamond Fields of Brazil." The papers to be read after Christmas which relate to engineering are: "Oxy-acetylene Welding," by Mr. H. S. Smith, and "Heating and Ventilation," by Mr. Kenneth Gray. Two juvenile lectures are to be delivered on the 5th and 12th of January by Professor Harold B. Dixon, his subject being "The Chemistry of Flame."

Six papers are to be read before the Railway Club during the forthcoming year. The first, which is by Mr. B. M. Bazley, will be read on January 11th, the subject being "The Railways of Devonshire." On the 8th of February Mr. R. L. Robinson is to present a paper on "Interlocking." The following meeting takes place on March 8th, when Mr. J. F. Gairns is to present a paper on "The Relation of Modern Locomotive Design and Performance." Mr. H. L. Hopwood is to read a paper on "The Control of Engine Working by the Traffic Department" on April 12th. A paper entitled "Some Remarks on Bradshaw" has been promised by Mr. H. W. Bardsley for May 10th, 1910. The last paper on the programme, which is to be read on June 14th, is entitled "The Ashenden and Aynho Line." The author is the Rev. W. J. Scott. We have been requested by the secretary of this Club to announce that the annual subscription has now been reduced. For London members it is now 10s. 6d., and for country members 5s., with an entrance fee of 5s. and 2s. 6d. respectively.

The Leeds local section of the Institution of Electrical Engineers holds its next meeting on December 15th at the University, Leeds. On that occasion Messrs. G. Wilkinson and McCourt are to read a paper on "Metallic Filament Lamps: Their Possible Beneficial Effects on Supply Undertakings." The first meeting of the new year is to take place on January 26th, at the University, Sheffield. On this occasion Mr. H. E. Yerbury will deal with "Equitable Charges for Tramway Supply." At the University, Leeds, on February 23rd, Mr. W. B. Woodhouse is to present a paper entitled "Notes on Overhead Lines." March 16th is the date fixed for the following meeting, at which Mr. E. S. Saunders will deal with the subject of "Electrical Machinery for Iron and Steel Works." This meeting is to take place at the University, Sheffield. The annual general meeting is to be held at the University, Leeds, on April 20th.

"Continuous-current Boosters and Balancers" is the title of a paper to be read before the Glasgow local section of the Institution of Electrical Engineers on December 14th, the author being Mr. W. A. Kerr. Mr. R. M. Neilson has chosen the title of "The Most Economical Vacuum for Power Stations" for a paper which he is to read on January 11th. The papers to be read at the other meetings are apparently not yet decided, as these are the only two which at present appear on the programme.

A good programme has reached us from the Association of Engineers-in-Charge. The next meeting of this Association takes place on December 8th, when Captain H. Riall Sankey will take the chair. The paper to be read on that occasion is entitled "Recent Developments in Impulse-steam Turbines." The authors are Messrs. Konrad Anderson and E. Meden. January 12th is the date fixed for a paper on "Heating and Ventilating of Public Buildings," by T. W. Aldwinckle. On this occasion the president, Mr. Henry Adams, will occupy the chair. Mr. A. Angold has chosen the title of "Modern Arc Lamps and their Application" for a paper which he is to read on February 9th. The chair is to be taken by Mr. Henry W. Handcock. The following meeting is to be held on March 9th. The paper to be presented on that occasion is by Mr. Jacques Abady, the title being "The Application of Recording Instruments to Steam Generation." The chair is to be taken by Mr. W. H. Booth. The annual dinner takes place on March 26th. The last paper of the session is on "Welding and its Application," the author being Mr. Reginald J. Wallis Jones. The chair will be taken by Sir Alex. B. W. Kennedy. The annual general meeting is to be held on September 7th. Discussion meetings will take place on the following Saturday evenings: December 18th, January 22nd, February 19th, March 19th, April 30th.

The Coventry Engineering Society has been promised quite a number of papers, and judging from the titles they should prove useful and interesting contributions. The subject of "Forging Plant" will be dealt with by Mr. F. Somers on December 3rd. Mr. G. F. Gaywood, of the Phosphor Bronze Company, is to read a paper on "Manganese Bronze in Engineering" on January 7th. Two other meetings are to take place in the same month. At the first of these, which will be held on January 14th, Mr. S. F. Edge will present a contribution entitled "Impressions of Automobilism in America," and at the second meeting, which is to be held on the 28th, Mr. H. Hiellfritsch, of Hans Renolds, Limited, Manchester, will deal with "Machine Cutting Tools." Mr. Kilburn Scott has promised a paper on "Uses of Electric Motors for Driving Purposes" for February 11th, and on the 25th of the same month a paper will be read by Mr. J. H. Belcher on "Modern Applications of Electricity to Engineering." Mr. F. W. Lanchester's name appears on the programme for March 4th, but so far his subject has not been settled, and the same applies to Professor T. Turner, whose name is down for March 11th. On March 25th Mr. J. Veitch Wilson will read a paper on "The Origin, Properties, and Uses of Lubricating Oils."

Mr. W. H. Hepplewhite, H.M. Inspector of Mines, is announced to deliver a lecture at Alfreton on Saturday, November 27th, on "Some Aspects of Mine Ventilation." Amongst the subjects Mr. Hepplewhite will discourse upon will be atmospheric air, laws affecting the movement of air in mines, velocities, and frictional resistances, wastage of air through leakage, something new in the construction and setting of wooden doors and cloth sheeting, and hygrometrical tests of the ventilation.

H.M.S. ORION.

WE have ventured on page 556 to offer a forecast of the general appearance of H.M.S. Orion, the new ship for which a berth is now being prepared at Portsmouth. We do not claim for the drawing that it is accurate in detail, but that it is substantially correct we are in little doubt. It is known pretty definitely that the vessel will carry five 12in. barbettes all on the centre line, and since it is obvious that to have only two guns bearing fore and aft would be a retrograde step, the deduction that one barbette must fire over another is obvious. There is, moreover, an excellent precedent in the Brazilian ships Minas Geraes and her sisters, which carry four guns in two lofty barbettes. It may then be taken as fairly certain that the four forward and four after guns will be mounted as shown, and the disposition of the remaining pair alone remains to be considered. Since there would be no object in raising this barbette, and it would be accompanied by the disadvantage of another great weight at a great height, we may safely assume that it will be placed on the same level as the fore and aft barbettes; but whether it will occupy a position forward of the funnels or aft of them is a matter about which doubt is possible. In the only other similar vessel, the Delaware, the group of three barbettes is sternward, whilst we, following current reports, have placed them forward. This appears at first sight to have the effect of bunching all the boilers, machinery and two barbettes into a comparatively short length of vessel; but if we choose to consider that the whole increase of length of between 30ft. and 40ft. over the 510ft. of the Neptune is added to the fore part of the vessel to make room for the additional barbette, it becomes clear that the congestion is apparent rather than real. For the rest we not say much. It is probable that the usual quick-fire guns will be carried on the tops of the shields; but it is by no means unlikely that room will be found also for a few 6in. pieces. We have, however, not attempted to show their positions. That the vessel will have but one mast is also accepted as certain, and that she will in general form follow the design of Sir Philip Watt's other ships cannot well be doubted. We think, on the whole, then, there are good reasons for believing that our forecast is not far from the truth.

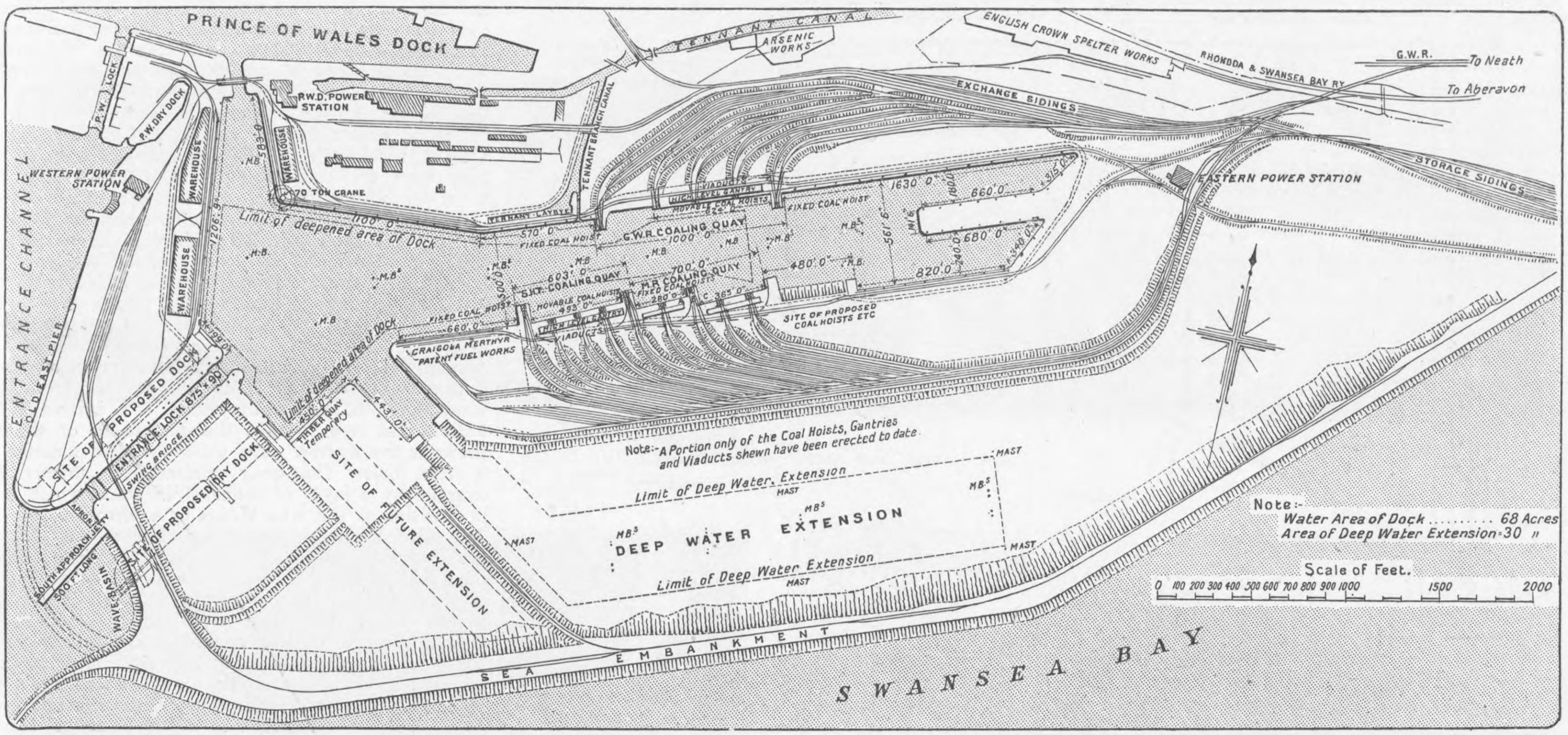
AN EGYPTIAN BRIDGE CONTRACT.

WE are authoritatively informed that the contract for the new road and railway bridge to carry the Egyptian State Railways' system over the Damietta branch of the Nile, near the town of Mansourah, has during the present week been awarded to the Société Anonyme Baume and Marpent of Haine, St. Pierre, Belgium. The present bridge, which is composed of cast iron pillars, was built many years ago, and has proved inadequate for the increasing trainloads of the Egyptian State Railways. The new bridge will have accommodation for a double set of 4ft. 8½in. gauge lines, and also footpaths carried on brackets outside the main girders. There will be three fixed and one double leaf swing spans, each of an average length of about 70m. The piers will be founded on caissons sunk by compressed air, and the masonry abutments are also to be carried out inside cofferdams. The main girders of the bridge will be of the hog-backed type, with a depth at the centre of 9.3654 m. Tenders for the work, which includes the demolition of the old structure, were received from several of the leading British and continental bridge builders, and the contract price submitted by the Belgian firm was the lowest, although they have, it is understood, specified for 2½ years in which to complete the contract; whilst the second lowest tender—that of the Cleveland Bridge and Engineering Company, Limited, of Darlington, was based on the completion of the works within seventeen months.

THE KING'S DOCK, SWANSEA.

No. II.*

In our previous issue we referred to the history of the harbour and docks of Swansea and described the general features of the new King's Dock and the sea embankment within which the dock has been constructed. In our last week's supplement we gave a number of views of the dock and other works, several of which will be referred to in the description which we continue in this issue. A general plan of the harbour and docks will be found on page 526 of our issue of November 19th, and at the top of this page we reproduce a more detailed plan showing the lay out of the new dock and its coal arrangements.


PRINCE OF WALES DOCK
P.W. LOCK
P.W. DRY DOCK
R.W.D. POWER STATION
WESTERN POWER STATION
WAREHOUSE
70 TON CRANE
TENNANT LAYBYE
TENNANT BRANCH CANAL
TENNANT CANAL
ARSENIC WORKS
ENGLISH CROWN SPELTER WORKS
RHONDDA & SWANSEA BAY RY
G.W.R.
To Neath
To Aberavon
EXCHANGE SIDINGS
STORAGE SIDINGS
EASTERN POWER STATION
Limit of deepened area of Dock
G.W.R. COALING QUAY
S.H.T. COALING QUAY
M.R. COALING QUAY
FIXED COAL HOIST
MOVABLE COAL HOISTS
HIGH LEVEL GANTRY
VIADUCTS
SITE OF PROPOSED COAL HOISTS ETC
CRAIGOLA MERTHYR PATENT FUEL WORKS
ENTRANCE CHANNEL
OLD EAST PIER
SITE OF PROPOSED DOCK
ENTRANCE LOCK 875 × 90
SWING BRIDGE
SITE OF PROPOSED DRY DOCK
TIMBER QUAY Temporary
SITE OF FUTURE EXTENSION
SOUTH APPROACH JETTY 500 FT LONG
APRON
WAVE BASIN
Note:- A Portion only of the Coal Hoists, Gantries and Viaducts shewn have been erected to date
Limit of Deep Water Extension
DEEP WATER EXTENSION
MAST
M.B.
SEA EMBANKMENT
SWANSEA BAY
Note:- Water Area of Dock .... 68 Acres
Area of Deep Water Extension = 30 "
Scale of Feet.
0 100 200 300 400 500 600 700 800 900 1000 1500 2000

"The Engineer" Swain Sc.

Fig. 3—GENERAL PLAN OF THE KING'S DOCK, SWANSEA

The excavation of the dock.—The material to be excavated from the dock consisted principally of sand and ballast, but in places considerable deposits of clay were encountered and numerous large boulders. Nearly the whole of the excavation was done by steam excavators, several types of these machines being used. The plant used included the following diggers:—Five Ruston Proctor navvies, two Wilson navvies (crane type), and two German steam navvies (land bucket dredger type).

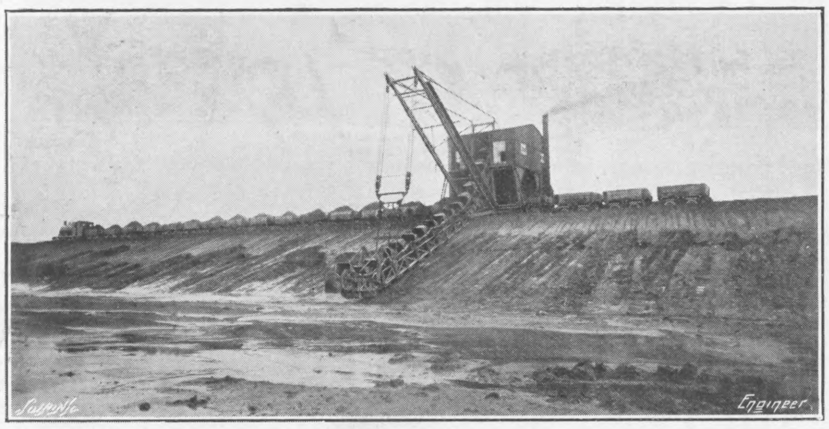


Fig. 4—GERMAN LAND DREDGER WORKING IN DOCK

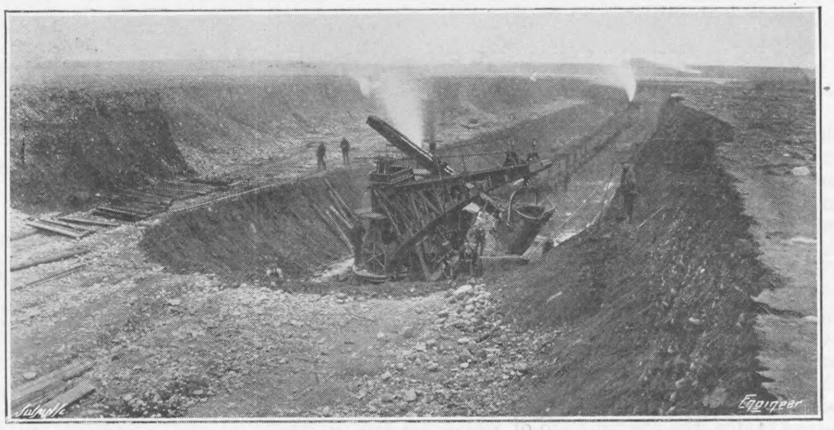


Fig. 5—RUSTON PROCTOR STEAM NAVVY IN CUTTING

A view of a German land dredger working in sand in the branch dock is shown in Fig. 4, and another of a Ruston-Proctor navvy excavating a cutting in the King's Dock is reproduced in Fig. 5. The latter view shows the nature of the material excavated from the site, and the high angle at which it stands. Wherever possible the excavation was done by the steam navvies, the Wilson and Ruston-Proctor diggers being used for clay and ballast and the German type for sand. The excavated material was loaded into trains of wagons, which were run on inclines of 1 in 40 and tipped on to the reclaimed area. In the dock the site of the walls was usually excavated by steam navvy to dock bottom level and trenched below that level; but in places the trenches were commenced at a level of 10ft. above dock bottom and in the communication passage they started at ground level. These trenches varied from 4ft. to 40ft. in depth, and were of ordinary timbered construction. The illustration, Fig. 6, shows the method of constructing the walls after the site had been excavated to dock bottom.

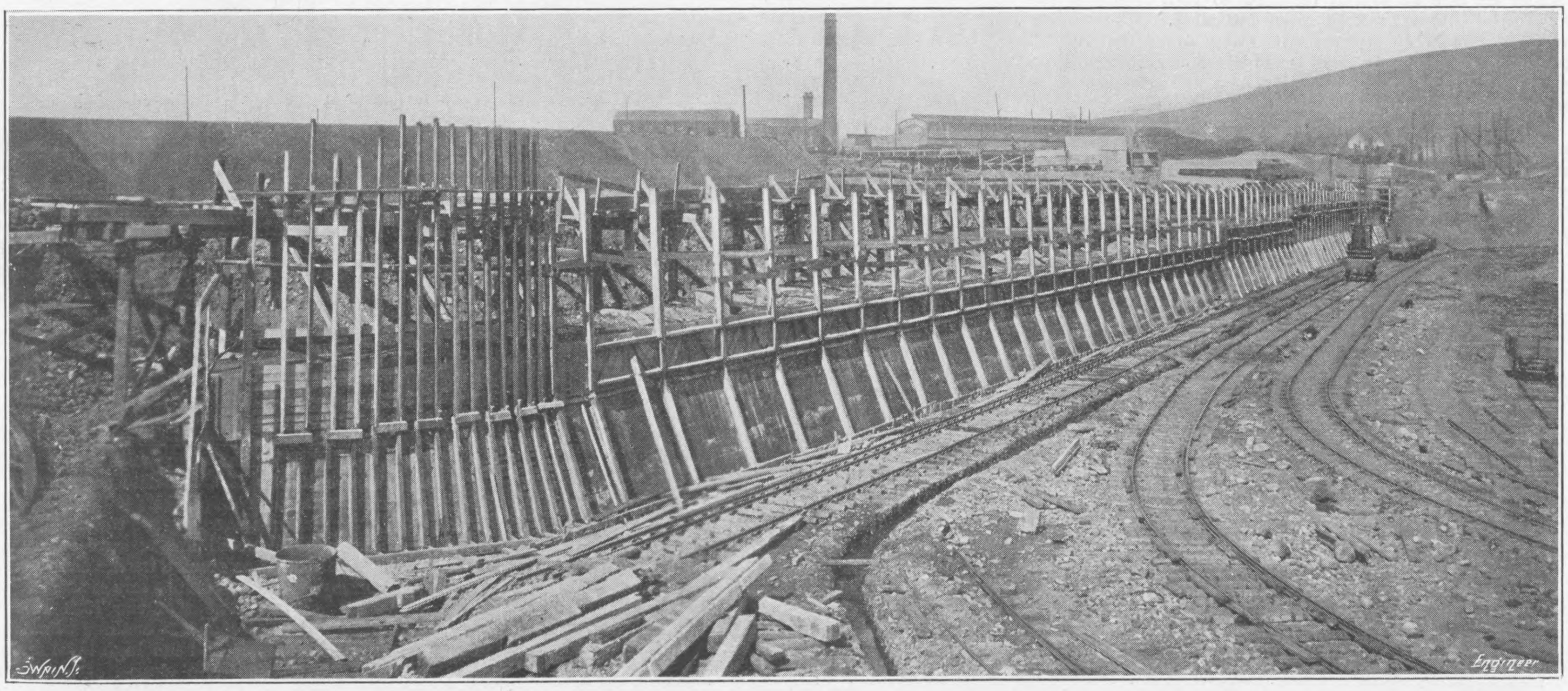


Fig. 6—WEST WALL OF DOCK IN COURSE OF CONSTRUCTION

The material excavated was, generally speaking, of excellent character from the contractors' point of view. For the most part it consisted of compact gravel and sand, with large boulders, but lenticular masses of clay were encountered in places. In only one position was bad ground met with in the wall foundation over a considerable extent, and at this point—in the coaling arm—soft clay was excavated to 28ft. 6in. below dock bottom to secure a good foundation for a length of about 100ft. of the wall.

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* No. I. appeared November 19th.

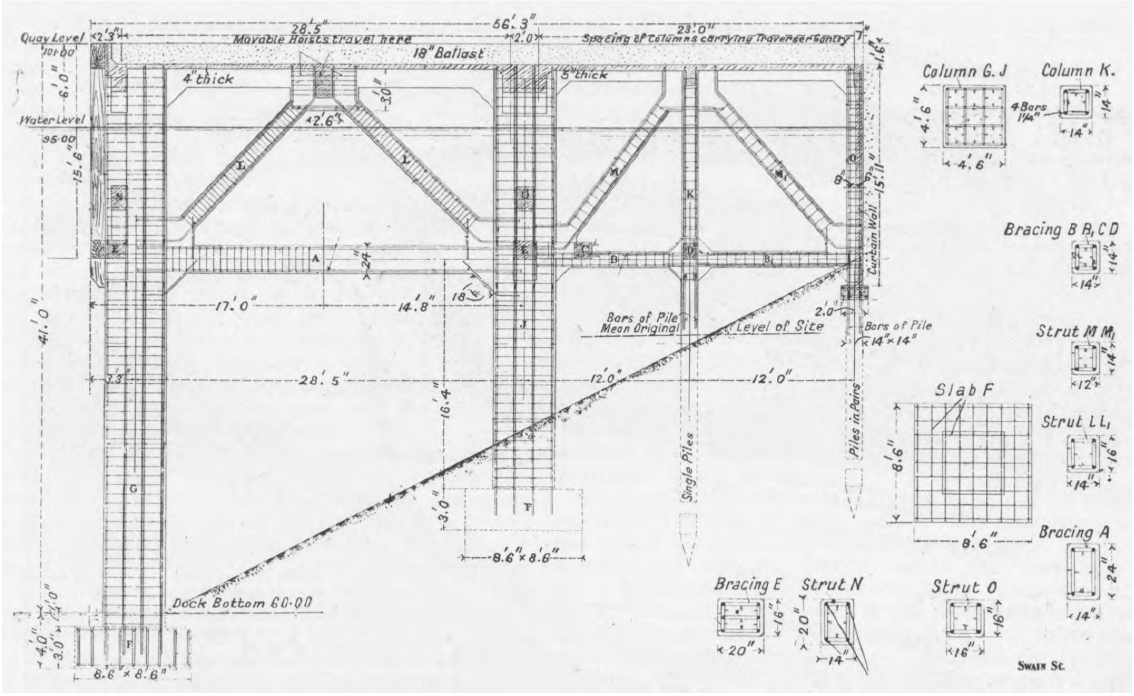

Quay Level
101·00
Water Level
95·00
56′ 3″
28′ 5″
23′ 0″
2′ 3″
2′ 0″
Movable Hoists travel here
Spacing of Columns carrying Traverser Gantry
18″ Ballast
4″ thick
5″ thick
2′ 6″
3′ 0″
6′ 0″
15′ 6″
17′ 0″
14′ 8″
41′ 0″
16′ 4″
12′ 0″
Curtain Wall
Bars of Pile Mean Original
Level of Site
Bars of Pile 14″ × 14″
Single Piles
Piles in Pairs
Dock Bottom 60·00
8′ 6″ × 8′ 6″
4′ 0″
3′ 0″
Column G. J
Column K.
4 Bars 1¼″
4′ 6″
14″
Bracing B B₁ C D
Strut M M₁
Slab F
8′ 6″
Strut L L₁
Bracing A
Bracing E
Strut N
Strut O
20″
16″
Swain Sc.
The Engineer

Fig. 7—CROSS SECTION AND DETAILS OF COALING WHARF

The average level of the foreshore on the site of the dock before excavation commenced was 13ft. below high water. Thus the core or dumpling had to be excavated at an average depth of 22ft. down to the normal bottom level of the dock. As a matter of fact, the excavated material from the dock down to the normal dock bottom, representing a cube of 4,000,000 yards, was insufficient to provide the filling required to make up the reclaimed area to the requisite levels. A portion of the dock has, therefore, been further excavated to a depth of 9ft. below the normal dock bottom, or a total of 44ft. below high water of spring tides. This additional excavation has not been carried nearer to the foundations of any wall or embankment than 60ft. The deepened area is indicated on the plan of the works in Fig. 3. About 480 000 cubic yards of additional material was obtained in this manner.

The deep water extension.—On the south side of the King's Dock a site has been reserved for future extensions of the dock. In order to provide the material required for raising the levels of the reclamation, a considerable portion of the site for this future extension has been excavated to the ultimate depth of the dock, and parts of it to a still greater depth. The site of the future dock is now known as the Deep Water Extension. A communicating passage between the extension and the King's Dock has been completed, and the former is now available as a "lay-by" for shipping, and as a timber pond, suitable moorings having been provided. The communicating passage at its narrowest point is 100ft. in width, and will be spanned by a railway swing bridge, the construction of which has not yet been put in hand.

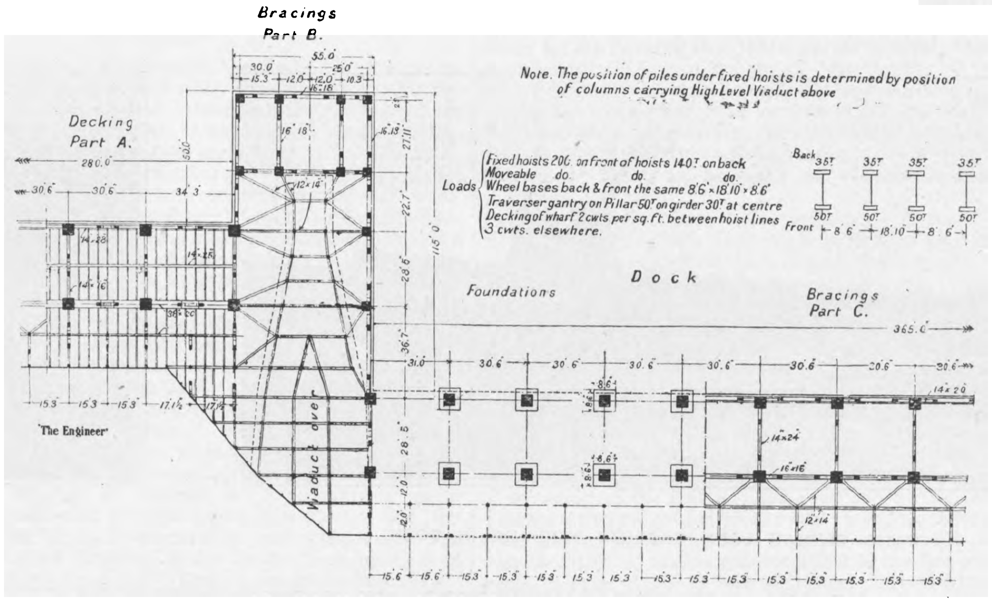

Bracings
Part B.
55.0
30.0
25.0
15.3
12.0
10.3
16×18
Decking
Part A.
Note. The position of piles under fixed hoists is determined by position of columns carrying High Level Viaduct above
Loads
Fixed hoists 200ᵀ on front of hoists 140ᵀ on back
Moveable do. do. do.
Wheel bases back & front the same 8′6″ × 18′10″ × 8′6″
Traverser gantry on Pillar 50ᵀ on girder 30ᵀ at centre
Decking of wharf 2 cwts per sq. ft. between hoist lines
3 cwts. elsewhere.
Back
35ᵀ
50ᵀ
Front
8′ 6″
18′ 10″
D o c k
Foundations
Bracings
Part C.
365.0
30.6
115′ 0″
14×20
14×24
16×16
12×14
15.3
15.6
Viaduct over
The Engineer
Swain Sc

Fig. 9—PART PLAN OF COALING WHARF AND JETTY—SOUTH SIDE OF DOCK

The construction of quay walls in the deep water extension and the provision of the necessary coaling appliances are now all that is required to turn it into a fully equipped coaling dock of nearly 40 acres. A site is reserved to the west of the deep water extension for another arm of the dock, which will be about 1500ft. in length and 250ft. wide. This arm, which will be parallel to the communication passage leading to the extension, will connect with the King's Dock at the south-west corner of the latter—Fig. 3. On the site of the future entrance to the arm the dock wall has been returned at the ends, and a temporary pitched slope constructed with a timber quay over it which maintains the continuity of the dock wall. The docks—including the Prince of Wales Dock—together with the flooded area of the deep water extension make up a continuous sheet of water at one level 215 acres in extent. Some difficulty has been experienced with the unprotected banks at the sides of the deep water extension since water has been admitted into the dock. Portions of the banks have slipped, causing subsidences of some of the rail sidings leading to the coaling wharves. It has therefore been found necessary to construct temporary timber revertments or wharves along a portion of the north side of the extension in order to prevent further damage.

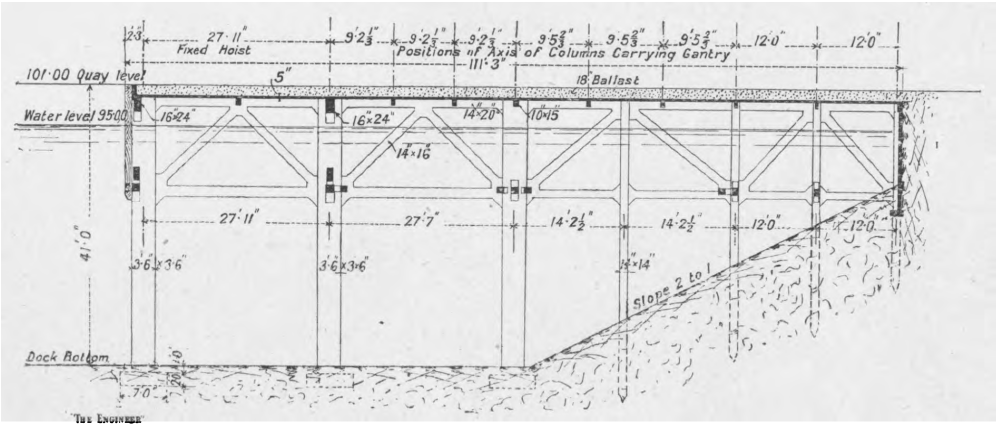

2′ 3″
27′ 11″
Fixed Hoist
9′ 2⅓″
Positions of Axis of Columns Carrying Gantry
111′ 3″
9′ 5⅔″
12′ 0″
101·00 Quay level
5″
18″ Ballast
Water level 95·00
16×24
14×20
10×15
14×16
27′ 11″
27′ 7″
14′ 2½″
41′ 0″
3′ 6″ × 3′ 6″
14″×14″
Slope 2 to 1
Dock Bottom
7′ 0″
The Engineer

Fig. 8—LONGITUDINAL SECTION OF COALING JETTY

Reinforced concrete wharves.—On the north side of the coaling arm the quay for a length of 750ft. is constructed of ferro-concrete on the Hennibique system. The same construction has been adopted for the coaling wharves on the south side of the arm, 1138ft. in length, together with five jetties, which increase the total frontage of the ferro-concrete work on that side to 1413ft. This method of construction was adopted to obtain the greater width of firm foundation required for both the movable and fixed coal hoists, than is possible with solid concrete walls. The ferro-concrete wharves are more costly than the solid wall when compared by the cost per foot of frontage, but there is a saving by the adoption of the former method when the cost of the heavy foundations for the hoists and crane roads at the back of the wall is added to the cost of the latter. The actual cost of the ferro-concrete wharf, including the deck and retaining wall in rear, is about £40 per lineal foot, while the concrete wall costs about £27 10s. per lineal foot.

A typical cross-section of the ferro-concrete wharf on the south side of the arm is shown in Fig. 7. The deck, 56ft. 3in. in width, is carried on two rows of columns, driven piles, and a continuous retaining or curtain wall in rear, all these being of ferro-concrete. All the columns are carried upon armoured slabs, 8ft. 6in. by 8ft. 6in. in plan and 3ft. thick. These slabs are founded at a minimum depth of 4ft. below the dock bottom or slope surface. The columns measure 4ft. 6in., and are armoured with sixteen longitudinal 1¼in. diameter steel bars; they are spaced 30ft. 6in. apart centre to centre longitudinally, and 28ft. 5in. in the cross-section of the wharf. Between the second row of columns and the retaining wall is a row of 14in. ferro-concrete piles spaced 15ft. 3in. longitudinally, while another row of double 14in. square piles forms the foundation for the 6in. ferro-concrete curtain wall at the rear of the wharf. These piles were driven until they ceased to penetrate more than ½in. with ten blows from a 2-ton monkey with 2ft. drop, and, on the average, they were driven to a depth of about 15ft., the maximum depth being 38ft. In places where the driving was particularly hard pits were excavated and the piles set on concrete slab footings instead of being driven. Fig. 9 is a plan of a portion of the coaling wharf and one of the jetties on the south side of the dock. Other parts of the work are generally similar. The extent of the ferro-concrete work is indicated in the general plan—Fig. 3,—on page 551. The bracings and struts are shown in the drawings, and no detailed description is required. The ferro-concrete decking is 4in. thick at the front of the wharf, and 5in. thick at the back. It is carried on longitudinal and cross beams, the dimensions of which are shown in the figures. The top of the ferro-concrete deck is 18in. below the quay surface, the former being overlaid by a layer of ballast 18in. thick, which is kept in position at the wharf edge by a ferro-concrete curb. The columns on the faces of the wharves and jetties are provided with vertical elm fenders 12in. square, longitudinal fenders are also fixed at the deck level and in front of the horizontal ferro-concrete walling. The vertical timber fenders are fixed in position by means of bolts passing through the ferro-concrete columns, and the horizontal timbers are secured by wrought iron straps carried round the fenders and the horizontal ferro-concrete braces. The jetties fronting the south wharf are five in number, and all are 55ft. in width. The projection of the jetties into the dock varies, the middle one, which may be taken as typical, having a projection of 50ft. on the west face, while on the east face the projection is 115ft., the difference being due to the *en echelon* arrangement of the wharf faces and jetties. The construction of the ferro-concrete wharf on the north side follows the design of the wharf on the opposite side of the dock. The construction of all the jetties is similar, and is shown in Fig. 8, which is a longitudinal section through one of the jetties on the south side.

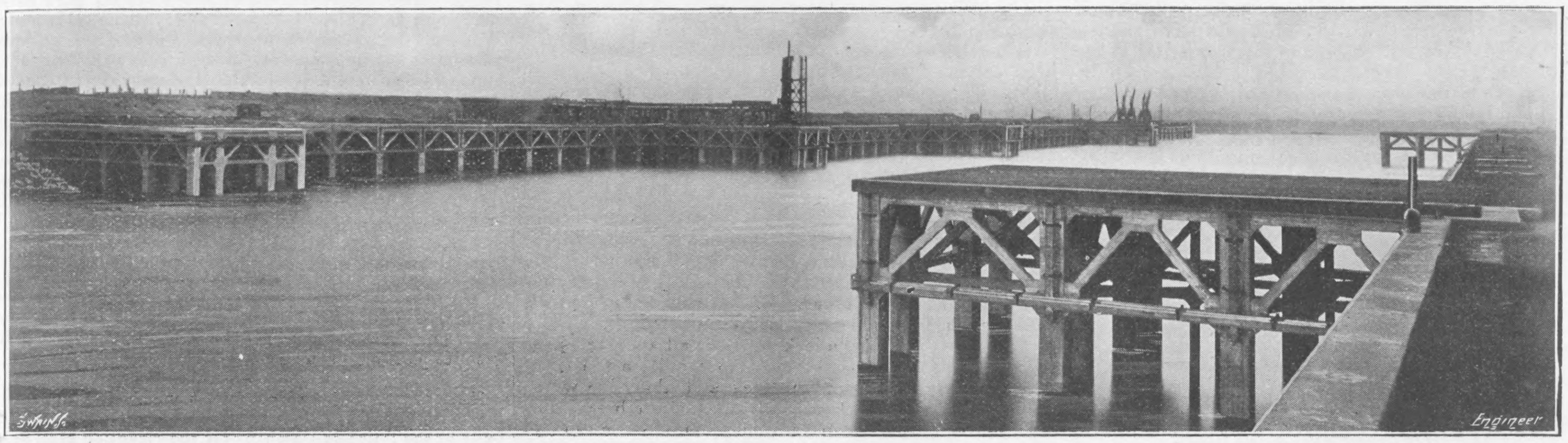
The super load on the wharves is calculated at 2 cwt. per square foot of deck in the way of the movable hoists, in addition to the actual load imposed by the hoists themselves, which is 304 tons for each hoist. The front beam of the wharf, which is 2ft. 4in. by 1ft. 2in. in section, carries a moving load of 200 tons on four wheels, the total wheel base being 36ft. The remainder of the moving load of the hoist, viz., 104 tons, is carried by the back beam, measuring 3ft. 2in. by 1ft. 8in. The deck elsewhere than between the movable hoist tracks is calculated for a super load of 3 cwt. per square foot. The jetties which carry the fixed hoists and the viaducts leading to them are calculated on the same basis as the wharf work, the total load of each hoist being taken as 340 tons. The columns of the hoists are carried upon 3ft. 6in. square ferro-concrete pillars.

The high-level viaducts carrying the rails to the hoists which have been constructed are of ferro-concrete, and those which are about to be erected for the Great Western Railway Company are to be of the same material. Two of the views in our Supplement of the 19th November show portions of the ferro-concrete coaling wharves, and in one a fixed coaling hoist, and the high-level ferro-concrete viaducts are also seen in course of construction. The illustrations on page 553, Figs. 10, 11, 12, and 13, show the ferro-concrete work in various stages of construction. The quantity of ferro-concrete work in the wharves and jetties is upwards of 361,000 cubic feet, while over 20,500 cubic feet have been built into the viaducts already constructed.

Coaling arrangements.—As we have already stated, a large portion of the eastern part of the King's Dock is to

THE KING'S DOCK, SWANSEA—COALING WHARVES AND JETTIES

(For description see page 551)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Engineer

Fig. 10—THE COALING ARM FROM THE NORTH WALL

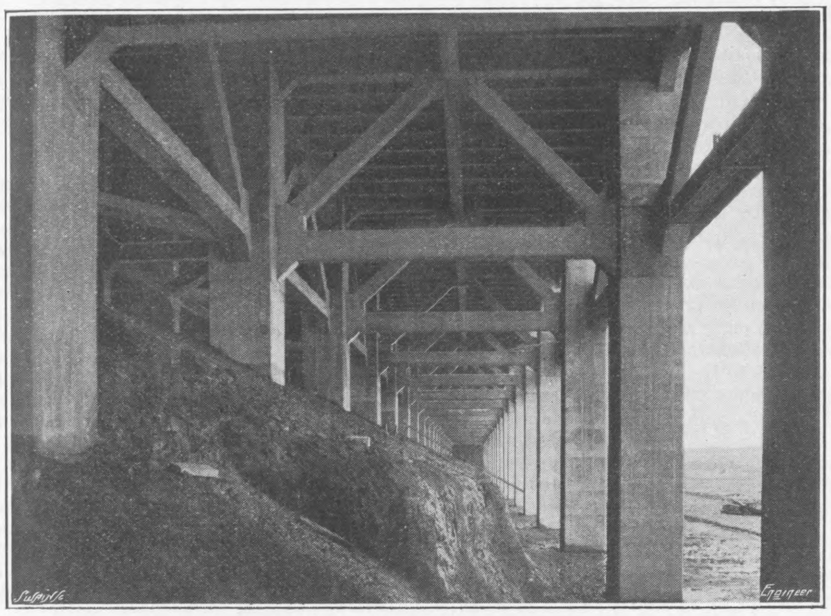
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Fig. 11—FERRO-CONCRETE COALING WHARF FROM UNDERNEAT

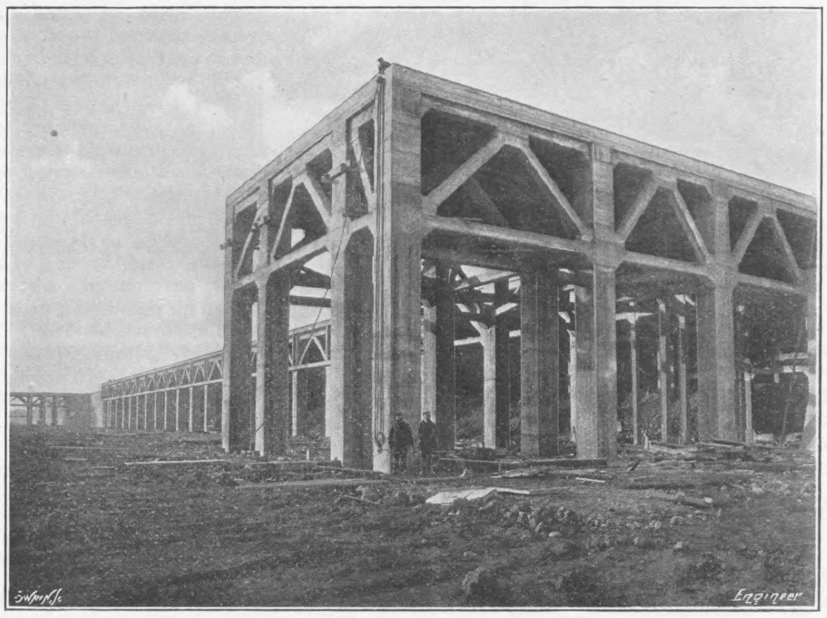
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Fig. 12—VIEW OF COALING WHARF AND JETTIES

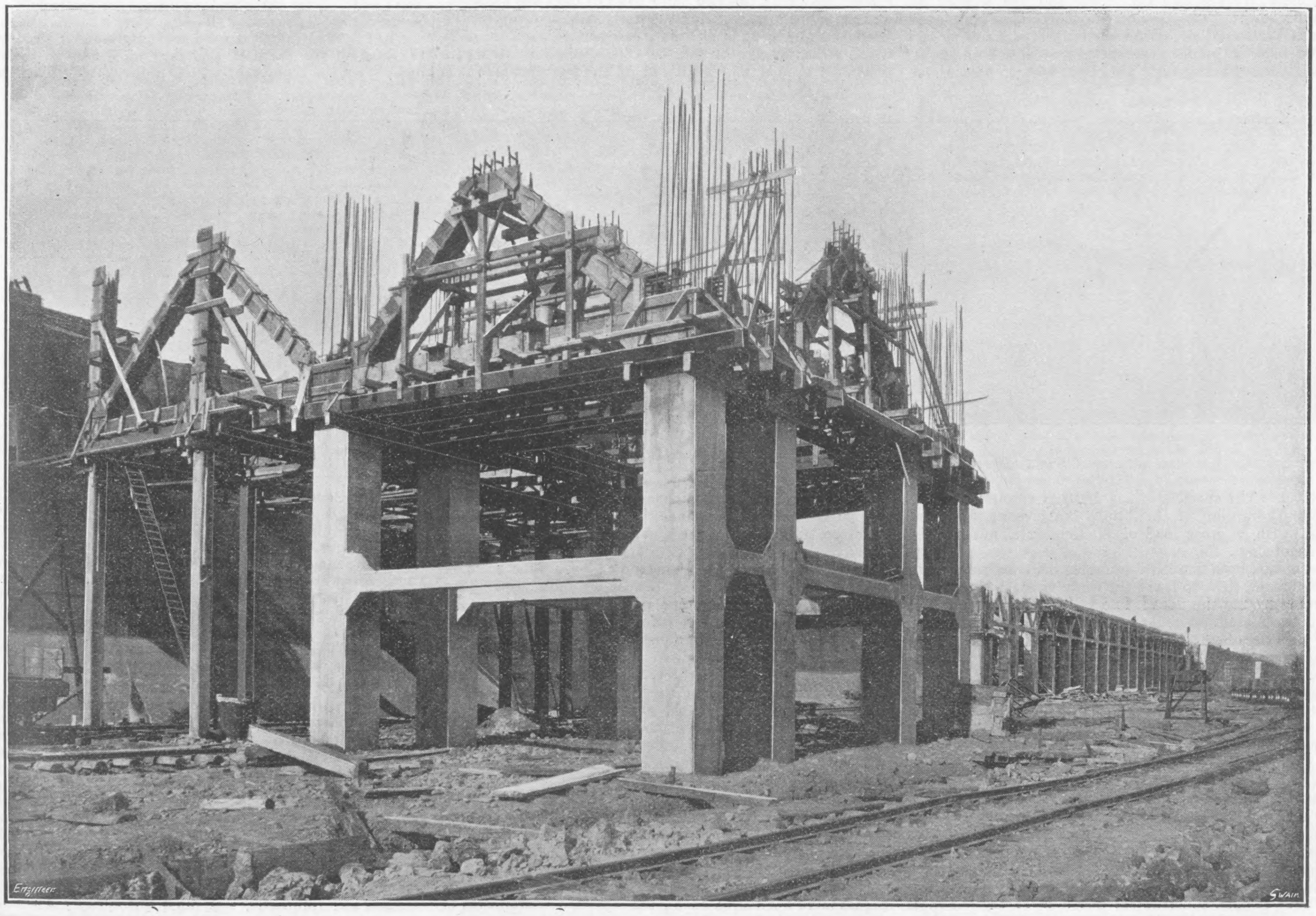
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Fig. 13—FERRO-CONCETE COALING JETTY IN COURSE OF CONSTRUCTION

be devoted to coal traffic, and sections of the coaling wharves have been leased to railway companies, by whom they will be worked. The coaling appliances, including the hoists, gantries and viaducts above the quay level, are being constructed for, and at the cost of, the several occupiers. The whole of the coaling wharf on the north side of the dock, 1000ft. in length, has been taken by the Great Western Railway Company, for which Tannett Walker and Co., Ltd., of Leeds, have erected two fixed coal hoists, one on each of the two jetties at the ends of the wharf. Three movable hoists are to be erected on the wharf between the jetties. On the south side the Midland Railway Company has acquired the middle portion of the wharf, 700ft. in length, with one jetty. On this section one fixed hoist has been erected on the jetty, and two movable hoists, will be placed on the wharf. The Swansea Harbour Trustees have reserved the western section of the south coal wharf, 603ft. in length, with two jetties, for their own use. One fixed hoist is in course of erection for the Trustees, and another, as well as three movable hoists, will be installed later on. The eastern section of the south wharf is allotted to the Rhondda and Swansea Bay Railway Company, which will erect one fixed hoist on the end jetty.

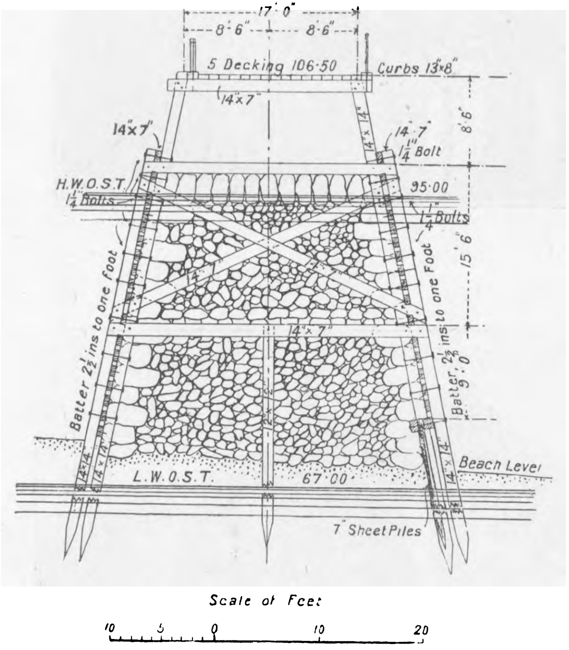


Fig. 14—TYPICAL CROSS SECTION, WEST PIER EXTENSION

It is probable that as the coal traffic develops the section at the eastern end of the south wharf, which now consists of a stone pitched slope, will be covered over by a ferro-concrete wharf and provided with movable hoists. When the coaling scheme is complete, there will be a total of seventeen fixed and movable hoists provided in this part of the dock. All the hoists have been constructed by Tannett Walker and Co., Ltd., and are worked by hydraulic power. They are of the usual type employed in South Wales ports. Each carries a cradle raised and lowered between guides attached to a steel-braced tower, the range of lift being 42ft., viz., from 18ft. to 60ft. above quay level. The speed of lift is 180ft. a minute, and the cradle and framing of each hoist have been designed to deal with a gross load of 30 tons or a net load of 20 tons of coal.

The hoists, both fixed and movable, will be worked on the high level, so as to leave the quay space beneath free for traffic around the dock. The railway sidings are laid out on the reclaimed land to the north and south of the dock, and are carried on inclined embankments rising gradually to the high level of the hoists. The embankments terminate against abutment walls facing the dock, and situated from 100ft. to 200ft. back from the quay face. From these abutments, which may be seen in the view of the Great Western Railway wharf before the erection of the hoists, in our Supplement of November 19th, open viaducts are carried across the quays towards the hoists, in the case of the fixed hoists right up to the latter. In rear of the movable hoist tracks the viaducts stop short at the rear face of longitudinal high level gantries, which are parallel with the hoist tracks. The coal trucks are run from the viaducts on to traversers which travel on the deck of the gantries and convey the trucks to the positions occupied by the movable hoists. The gantries have not yet been constructed, but four of the viaducts are complete, and others are in course of erection. All the viaducts constructed up to the present time are of ferro-concrete. The gradients of the embankments and viaducts are so arranged that a large proportion of the truck-running within the dock area, both loaded and light, will be done by gravity.

The general arrangement of the hoists and sidings is shown in the plan, Fig. 3.

The entrance piers.—With the object of affording protection to the new lock entrance and maintaining the river portion of the approach channel, the West Pier has been extended seaward by the addition of a length of 800ft. This extension has been deflected to the west of the line of the original work, in order to increase the width of the channel at the entrance between the pier heads. Powers have been obtained by the Trustees for the construction of an additional seaward extension of the West Pier by 800ft. When this further addition has been made the total length of the West Pier, which commences near the entrance to the South Dock, will be 4100ft. The old East Pier, 1210ft. long, which forms the approach jetty to the Prince of Wales Dock entrance, has been extended seaward for 300ft., and returned to join the west roundhead at the entrance to the new lock.

On the east side of the lock entrance an approach jetty 500ft. long has been constructed to facilitate the entry and exit of vessels using the lock, and alongside which ships can "bring up." Finally, an eastern breakwater 1400ft. in length has been built out from the western end of the sea embankment in a south-westerly direction, and forms the eastern margin of the entrance channel. The distance between the east breakwater and the west pierhead as now existing is 625ft. The whole of these piers and jetties are constructed of pitch pine and Oregon pine timber with creosoted redwood decking. The eastern breakwater and the extensions of the old East Pier and the West Pier are timber sheeted and loaded with stone rubble to give increased stability to the structures and to protect the channel from wave motion as much as possible. The approach jetty is an open work pile structure, and permits the waves caused by any rebound from the West Pier extension passing through it, and expending themselves in the wave basin or trap behind. The wave basin has been constructed with a rough stone pitched slope on its south and east sides, upon which the waves expended much of their force.

The positions of the several entrance piers and jetties is shown on the sketch plan of the harbour—Fig. 1—in our issue of November 19th. The approach jetty and the Old East Pier Extension have their deck surfaces at a level of 6ft. over H.W.O.S.T., which corresponds to the quay level inside the dock. The New Eastern Breakwater and the West Pier Extension are higher, the decks being 10ft. 6in. and 11ft. 6in. respectively over H.W.O.S.T. The beach level at the sites of the jetty and pier works averaged about 4ft. above L.W.O.S.T. before the dredging of the channel commenced. This dredging has been carried to 14ft. below L.W.O.S.T., so that the total height of the entrance piers above the sea bed in the channel is about 53ft. The dredged channel, however, does not extend close up to the faces of the piers, except in the case of the approach jetty where the piles are driven on the average to a depth of 12ft. below dredged level.

The Old East Pier Extension consists of three rows of piles 12in. square at the inner end and 14in. square further seaward; the two outer rows of piles are battered, and the inner row, carrying the horizontal planking which keeps up the ground in rear, are vertical. The deck width varies from 15ft. 6in. to 16ft. 6in. The structure is heavily braced and strutted; on the channel face it is vertically planked, and the space between the two faces is filled in with stone rubble. The total length of the structure, including the circular return to the lock head, is 600ft.

The approach jetty is constructed with four rows of 14in. square piles spaced 8ft. apart each way. Two rows of the piles are carried up to the deck level, the remaining rows being cut off at lower levels, and form backing piles, except where bollards occur. Abreast the bollards the deck width is increased. The jetty is close sheet piled up to low water, and vertical planking or fendering spaced 12in. in the clear is fixed to the full height of the structure on the channel face.

A typical cross section of the West Pier extension is shown in Fig. 14, and a detailed description is unnecessary. The section of the eastern breakwater is similar, except that the deck level is 1ft. lower.

Entrance channel.—The entrance channel, as we have already mentioned, has been dredged to a depth of 14ft. below L.W.O.S.T., or 2ft. lower than the entrance sill of the lock. The deepened channel is about two miles in length, and extends a considerable distance seaward of the pierheads. The minimum bottom width is 400ft. Lights have been erected on the seaward extremities of the entrance piers. The view in Fig. 15 shows the entrance channel and piers from the West Pier extension at high water.

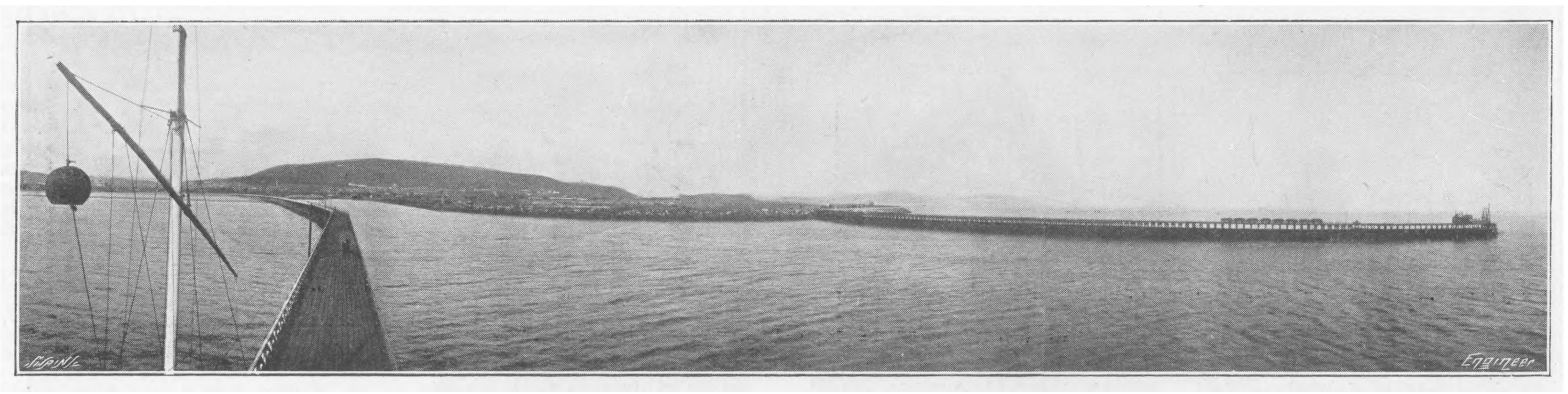


Fig. 15—THE HARBOUR FROM THE WEST PIER, HIGH WATER, 24th SEPTEMBER, 1908

SHIPBUILDING NOTES.

WITH the completion of the Orvieto, the second of the two vessels which Messrs. Workman, Clark and Co. have built for the Orient Line, there is finished a very remarkable contract. When the first of the five new liners was finished, a complete descriptive account appeared in the columns of this journal, and there is no need to recapitulate the many excellencies of the steamers here. It must suffice to say that the Orvieto is in no way behind her sister, the Otranto, or the other three Clyde-built vessels. As a whole, these vessels represent a distinct advance, especially in the accommodation provided for third-class passengers, and they should prove to be powerful instruments in promoting that increased immigration which is one of the first objects of Australian policy.

AT the other Belfast yard—Messrs. Harland and Wolff—work continues to be in a satisfactory state. The new Bibby liner will, of course, be proceeded with, and the construction of the new White Star liners, the Olympic and Titanic, is advancing rapidly, the last frame of the former having been got into position on the 20th inst.

THE memory of an experiment which did not prove a fortunate one is recalled by the statement that the Cairo, built by the Fairfield Company for the Egyptian Mail Steamship Company, has arrived at Glasgow for the purpose of having the alterations carried out which have been made necessary by her new trade. The Cairo and the Heliopolis—a sister ship—are turbine steamers, and were specially built for service between Marseilles and Alexandria. They are fast vessels of very fine form, and carry a great amount of passenger accommodation above the strength deck. It is stated that the new service of the boats is to be in the North Atlantic, and it is perhaps needless to say that some considerable alterations must be effected before a vessel designed for Mediterranean service and comparatively short voyages can be utilised for North Atlantic work.

REPORTS on the actual service performances of the Monitoria are being canvassed with much interest on the North-East Coast. This vessel, it may be remembered, was built by Messrs. Osbourne, Graham and Co., of Sunderland, and is chiefly remarkable for having two circular "swellings" worked into the shell plating of the side. It is stated that the service results bear out the claims of those responsible for the design, and that more deadweight is carried on the same draught than in the cases of sister vessels, and that a substantial saving in coal is effected. With regard to bulk cargoes, no difficulty need be experienced in crediting the former statement, for the whole space involved by fitting the "swellings" before referred to is gained. With regard to increased power, we should desire to have full particulars of the basis of comparison before forming any opinion. In the meantime, so far as is known, no scientific or other explanation has been advanced to account for these experimental results. It may not be out of place to suggest that this vessel may form an appropriate subject for a paper which might be read at a meeting of some suitable technical society.

WITH further reference to our remarks of a fortnight ago concerning vessels for carrying chilled beef, it is understood that contracts for five more of these have been placed by Messrs. Nelson and Co. with Russell and Co. and Cammell, Laird and Co., for three and two vessels respectively.

A LAUNCH of more than ordinary interest took place from the yard of the Fairfield Company on Saturday, the 13th inst., when the Balmoral Castle took the water. This vessel is for the South African service of the Union Castle Line, and will be, when completed, the best equipped and fastest ship in this trade. Nearly 600ft. in length, the Balmoral Castle will be of 13,000 tons gross, and will be driven by twin-screw engines, developing 12,550 indicated horse-power. Another first-class vessel, for the same owners, is being built by Messrs. Harland and Wolff, and two intermediate liners are also being built. An interesting comparison could be made between this vessel just launched and the old Balmoral Castle, owned by the Union Castle Company. The latter's engines, built in 1876, developed 460 horse-power.

THE appointment to the new Chair of Naval Architecture at Liverpool has now been made, and the successful applicant is Mr. W. S. Abell, an Instructor at the Royal Naval College, Greenwich. Mr. Abell had a splendid record as a student, and is known to-day in the profession to have a very highly developed mathematical faculty. Everyone will wish him all possible success in his new and onerous duties. In view of the distinctively mercantile character of the port of Liverpool, it must be regarded as a little unfortunate that Mr. Abell has, so far as is known, no point of practical contact with merchant shipbuilding. This was not so in the case of those who occupy the Chairs of Naval Architecture in Glasgow and Newcastle, and must undoubtedly operate, in some degree, to limit the usefulness of the new appointment.

RAILWAY MATTERS.

Experiments with steam-raising by means of peat have been made by the Swedish railways on the Southern line but they have turned out a failure. According to the report, the peat, especially if used alone, has not shown satisfactory results with the present types of locomotives. In the meantime, however, it is stated that valuable experience has been gained as to how locomotives suitable for peat ought to be constructed, and that the railway authorities are about to recommend the construction of some locomotives especially designed for the use of peat instead of coal.

It is reported that the Russian Government are about to conclude a contract with a big American syndicate, which will develop the Trans-Siberian Railway and lay a second track the whole length of the present line. The project involves an expenditure of hundreds of millions of roubles. President Roosevelt, it is stated, has put forward all his influence to secure the contract for Americans. Two representatives of the syndicate, with full powers, are now in Europe awaiting the Czar's return to St. Petersburg from Livadia to go to the capital for a final settlement of the contract. The Czar will appoint a Russian engineer to report to him from time to time concerning the progress of the work.

It is reported that the London and North-Western Railway Company intends to start at once the construction of the loop line for which Parliamentary powers were obtained two years ago. Probably, the decision has some reference to the proposed Coventry-Arley line, for which there is to be a bill deposited in Parliament next session aiming at connecting with both the London and North-Western and Midland Railways in North Warwickshire. The loop line is, like the projected new one, intended for minerals. It starts on the main line a mile or so below Coventry station, crosses Gosford Green, passes to the north-east of the city, and joins the Coventry and Nuneaton line at Foleshill. Its purposes are to relieve Coventry station of the heavy coal traffic which now comes down from the Bedworth, Exhall, and Wyken mines, and to serve several large works in Coventry, without utilising the present goods station.

There has lately been patented in South Africa an automatic coupler, which seems likely to be adopted by the Cape railways. It has just been put to the test on the Harbour Board tracks from the Customs-house to the South Jetty, Port Elizabeth, where the curves are of the sharpest possible kind. There was a large assembly of railway officials at the trial, who displayed keen interest in the experiment, and at the close voted it to be the most simple and practical coupling they had ever seen. On a very sharp curve beyond the Customs-house the locomotive, to the usual signals, made a series of shunts with loaded and unloaded trucks, and in every case these were most effective, it being demonstrated that there was practically no risk to life and limb. At the South Jetty, where there are some very intricate curves, extensive linking up, uncoupling, and flying-shunt operations were conducted, and in every case the new invention is said to have proved effective.

A committee report to the American Railway Bridge and Building Association gives some figures of the size and cost of engine-houses (round-houses) and turntables for locomotives. Engine-houses on the larger railways are now being built 85ft. to 90ft. deep. Some are 92ft. and 95ft. deep. Concrete is almost universally used for the foundation walls and pit walls, in some cases also for the lower parts of the exterior walls, and in a few instances for the entire structure — reinforced. Composition board or wood is favoured for the chimneys, and these are preferably made with large opening. The cost of frame engine-houses is quoted in the following examples:—Wabash, 42-stall house, £16,900; Lake Shore, 40-stall house, £660 per stall; Boston and Maine—brick walls—£320 per stall; New South Wales Government Railways, 20-stall, £9000. A reinforced concrete engine-house of the Santa Fé at San Bernardino, Cal., recently built, cost £31,600 for 35 stalls, about twice the average price quoted above.

Notice was recently given by the Doncaster Corporation that application is intended to be made in the present month to the Light Railway Commissioners for an order under the Light Railways Act, to authorise the construction in the parish and urban district of Balby-with-Hexthorpe, and the parishes of Warmsworth and Bentley-with-Arksey of a tramway one mile two furlongs in length, commencing in the parish by a junction with the existing railway at its termination in the Doncaster and Tinsley main road, opposite the junction of that road with Cross-street, passing thence along and terminating in that road in the parish of Warmsworth at the junction with Mill-lane. A second line is proposed, commencing by a junction with the existing railway at its termination opposite the junction of High-street with Millgate, passing thence along the Doncaster and Selby turnpike road and the road leading from Bently to Arksey, and into and along a new road, not yet opened to the public, leading therefrom to Bentley Colliery.

In a lecture on "The Development of Electric Working on Main Lines," which was recently delivered in Germany by Dr. Eichberg, attention was drawn to the rapid way in which electrically worked tramways had been developed, compared with the comparatively slow progress made in the same direction on railways. He considered the reason for this was that commercial advantages in railway work from the employment of electricity were only to be expected when the traffic was heavy, the gradients steep or the use of water power possible. Another advantage obtained by the employment of electricity was the absence of smoke—a matter which had received great attention in the United States. Dealing historically with the question of electric traction on main lines, the lecturer first referred to the experiments made on the Baltimore-Ohio line in 1894, and to the use which was being made, both in New York and Paris, of electric locomotives for terminal operation. The various features of continuous current, third-rail operation and of the three-phase and single-phase systems were also described, the great advantages of the last of these as regards simplicity being mentioned.

It will be remembered that a fatal accident occurred on May 21st on the Wolverhampton District Electric Tramways, when a man was found dead on the top deck of a car with his feet resting on the base of the trolley standard and the upper part of his body against the handrail. The Board of Trade has now issued a circular letter to tramway authorities, stating that its electrical adviser, Mr. A. P. Trotter, in the course of his inspection of the car, found signs of a considerable arc on the brass bolt by which the main cable was attached to the trolley head; arcing had taken place between this bolt and the trolley boom at a distance of only about ½in. from the extreme end of the boom, at a place where it was not likely that there had been any mechanical abrasion of the insulation. Mr. Trotter was of opinion that the defect was probably due to a chip of metal in the taping with which the brass bolt was insulated. In addition to this defect, there was a failure of the red lamp warning, due to a discontinuity in the wiring of the lamps. On the car being stripped, the wire was found to be open-circuited behind one of the corner pillars. Owing to the drawbacks attached to the red lamp warning, the Board of Trade have previously expressed preference for an audible signal, and as a result of the accident the Birmingham and Midland Tramways Joint Committee, which works the line, have decided to make a daily test to see that the trolley standards are properly insulated, and to equip all cars with a magnetic blow-out fuse giving a distinctly audible signal.

NOTES AND MEMORANDA.

It is stated that there are in Belgium 48 electro-chemical factories, situated mostly in the manufacturing districts of Liège and Charleroi and in the mining districts round Antwerp and Brussels. Details regarding these factories are: Four employ between 600 and 2000 workmen, seven employ from 50 to 100, fifteen employ between 10 and 50 hands, and twenty-two from 5 to 10 hands. The value of the products last year attained a total of 28 million francs, the goods exported forming 41 per cent. of the whole.

In his presidential address before the Institution of Electrical Engineers, Dr. Kapp said that the well-known Winter-Eichberg motor as first developed for railway work had a series characteristic; recently, Mr. Eichberg had altered the winding so as to give the motor a shunt characteristic, so that it runs at constant speed whatever the load within its range. The motor was started as a series machine, and when up to speed, or nearly so, it was switched over by its controller to the shunt condition. With a motor of this type in his laboratory he had found the inventor's claim that the power factor is very nearly unity at all loads quite borne out in practical work.

The chief advantages of magneto ignition, states Mr. John W. Warr in a paper read before the Manchester local section of Electrical Engineers, are an inexhaustible source of current, the induced current is directly utilised, and the sparks have a higher temperature. The vital parts are not scattered in different parts of the car as is the case with the coil and accumulator ignition. With a spare magneto carried in the car the faulty one can be removed in a few minutes. On the other hand, it must be remembered that the magnets require reflashing periodically, that bearings and platinum contacts require attention, that the working of the magneto is a perpetual load on the engine, and that the adjustment in the timing is not so flexible as with the coil. Troubles do not end when a magneto is installed, for, like the accumulator and coil, it requires discreet handling.

In a paper on "Machine Mining, with Special Reference to South Wales," read to a meeting of the South Wales Institute of Engineers recently, Mr. S. Mavor, of Glasgow, said the progressive increase in cost of production, due to rising scales of wages, associated with diminished output resulting from restrictive legislation were more serious in their incidence in South Wales than in any other part of the country. There, therefore, to all the ordinary inducements to adopt the most modern appliances, a special motive was added by the economic situation. It was no longer open to doubt, and it was fortunate for those concerned, that a large proportion of the coal seams were eminently suitable for the application of machine mining. Machinery had a wonderful levelling-up tendency, and had already gone far in alleviating conditions in the less favoured districts, enabling them to maintain their ground in competition; and no district, whatever its natural advantages, could afford to disregard the means that were available for effecting economies and counteracting the rising costs of production.

In a lecture on "Modern Methods of Illumination," which was delivered before the Illuminating Engineering Society on Monday, November 22nd, Mr. Leon Gaster referred to the immense development of the metallic filament lamp, its advantages to the consumer, and its present drawbacks. He made special reference to the need for a standard specification with which lamps of good quality ought to comply. All lamps passing this test ought to be hall-marked. One result of the absence of such a specification and trade mark was that unscrupulous people might occasionally delude the public by selling inferior but cheap metallic or even overrun carbon filament lamps, which to the non-technical were indistinguishable from good varieties. Large numbers of foreign lamps were known to be bought up cheaply by British dealers who subsequently marked on them their own trade names. It might be added that the same remarks applied to other illuminating apparatus, such as incandescent mantles, though the framing of a standard specification might here be a matter of some complexity owing to the number of different factors involved.

In a paper entitled "Some Experiments on Single and Stranded Low-tension Fuses," read before the Leeds local section of Electrical Engineers by Mr. William Tolme Maccall, the author stated that with regard to stranded fuses, no simple theory is available, because the wires will diminish each other's emissive power to an extent which can be determined only by experiment. All we can predict is that a two-strand fuse will carry less than twice the fusing current of either of its equal wires, and probably more than 1.41 ($\sqrt{2}$) times this current, since its emissive power should be greater than that of a single wire; similarly, for a three-strand fuse, the current will lie between thrice and 1.73 times that of the single wire, and so on. The objects of the experiments described in the paper were:—(*a*) To determine the variations in Preece's "constant," or in the emissive power, with change of diameter; (*b*) to determine the effect on fusing current of house-service fuse holders; and (*c*) to find the ratios of the fusing currents of single and stranded fuses in the open and in fuse holders.

On November 18th Professor Silvanus P. Thompson delivered an address at the inaugural meeting of the Illuminating Engineering Society. For practically only a century, he said, have there been any systematic means of illumination in use in any civilised country. Before the year 1800 there were as means of illumination: daylight, oil lamps, rush lights, tallow dips and wax candles. Only in the larger towns and cities was there any organised attempt to light the streets by oil lamps. In 1819, the authorities of the day stoutly resisted the proposal to light the House of Commons by gas—nothing but wax candles could be admitted. But gas lighting was coming in; and Argand and colza oil lamps were the sole competitors until after 1850 Everything else dates since then—practically during the last half-century. Paraffin lamps were not widely used till the sixties Arc lighting, though tried for spectacular and lighthouse purposes from the fifties, did not come into public use until about 1879. Glow lamps followed three or four years later. Still later came incandescent gas mantles, and acetylene gas lights; while the newest things in both gas lighting and electric lighting are affairs of only a year or two ago.

On Monday night, November 22nd, Mr. Leonard Hill delivered a lecture to the members of the Birmingham and Midland Institute on "The Perils of Divers and Workers in Compressed Air." He pointed out that the bridging of rivers or the tunnelling under them was carried out in all cases by means of compressed air. The workmen had to work under pressure in carrying out the operations of tunnelling and pile-sinking just as divers did who went down to the floor of the sea to salve a wreck or lay the foundations of a pier or dock. The power of men to work in compressed air depended on the power of the body to stand that air. It was altogether an abnormal condition to go into compressed air, for nowhere in natural life had men to work under such conditions. The risk they suffered was a physiological problem, and it rested with the physiologist to devise a way in which the work could be made safe, and to point out the methods which must be used to enable them to carry out their work without loss of life or suffering. There had been in the past most lamentable loss of life and a great amount of sickness among the workers in compressed air. Mr. Hill gave a detailed account of the conditions under which the men worked, and a description of the apparatus they used, after which he discussed the cause of their illness and the methods by which it might be prevented. The lecture was illustrated by lantern, and demonstrations in the use of the diving dress were given by assistants of the lecturer.

MISCELLANEA.

The Technical Committee of the Royal Automobile Club has been asked to consider the expediency of undertaking a test of motor horns on similar lines to those adopted in the recent head lamp trials. in order that motorists may "gain information as to the most effective and least objectionable form of warning instruments for general use."

According to the *Electrical Review* the Austrian Government have received a considerable quantity of radium in an impure condition from Joachimstal. The process of purification will shortly be completed, when at least a gramme will be available for public purchase. Preference will be given to Austrian subjects. A radium institute is being built in Vienna.

It is reported that an electrical steelworks has been opened at Soggendal, Jössingfjord. It is operated by a process patented by a Norwegian engineer. For the time being, only tool steel is being produced, but an extension of the works is contemplated which will facilitate the production of other specialities, Swedish pig iron and bars are imported for manufacturing purposes by the company, in which Dutch capital is invested.

An interesting ceremony took place at the opening meeting of the Institution of Electrical Engineers. Professor Bertram Hopkinson of Cambridge, presented to the Institution, on behalf of his mother, a bust of the late Professor John Hopkinson, F.R.S., who was twice president. It will be remembered that, with three of his family, he met with an untimely death on the Alps in 1898. The bust is a replica of the bust by Mr. Hamo Thornycroft, R.A., which is at Cambridge.

A short circuit on one of the street mains of the three-wire distributing system of the Woolwich Borough Council was the cause of an interruption to the supply for a little more than half an hour on Monday evening. The fault developed at 7.45 p.m., and though the particular section concerned was automatically disconnected, the resulting out-of-balance current caused the station balancer to be put out of order. In this way practically the whole system was affected, and the greater part of Woolwich was without light until 8 20 p.m., when everything was again in order. The actual cause of the fault has not yet been ascertained.

It is stated that a number of influential gentlemen intend to make representations to the Board of Trade by December 23rd for a Provisional Order in connection with the scheme for constructing a shipway across the isthmus between East and West Loch Tarbert. The purposes of the Order are to constitute a body of trustees, and to transfer the harbour, piers, &c., from the present proprietor, and also to construct a pier 260ft. in length, a wharf 390ft. in length, a stone-pitched slope of over 300 yards in front of Harbour-street and Barmore-road, to deepen the harbour, remove the beacon and rocks at the entrance, and construct a shipway about two miles in length for the transport of vessels between the two lochs.

At Reggio, in Calabria, there are to be found some curious instances of houses escaping the earthquake unscathed. A rare example of a building absolutely untouched is the public wash-house recently built on the bank of the Calopenace, which flows to the south of the town. This is an extremely lightly built structure of brick, with slender pillars and eternite roofing. It shows no sign of damage, although houses quite near were ruined. The escape was due to the accuracy of the building, which ensured stable conditions for the structure. A few half-timbered houses, *i.e.*, wood skeletons filled in with walling, scattered about the town, withstood the shocks so successfully that this method of construction appears to be one that should be encouraged.

It is reported that the Swiss military authorities have recently been experimenting with mobile wireless stations in the Alps and the valley towns, with curious results. The first two stations were established at Berne and at Ebikon, in the canton of Lucerne, about 35 miles apart, but communication could not be opened between these two places, whereas messages in English from Poldhu, in Cornwall, and in German from Berlin were received in numbers. The Berne station was transferred to Aigle, and the result obtained was somewhat better, but still unsatisfactory, and it is likely that the mobile wireless stations will be suppressed and a permanent station constructed at Thun in order to establish wireless communication with the military posts on the St. Gothard, Rigi, and the Fort of St. Maurice, which daily receive unsolicited messages from Europe.

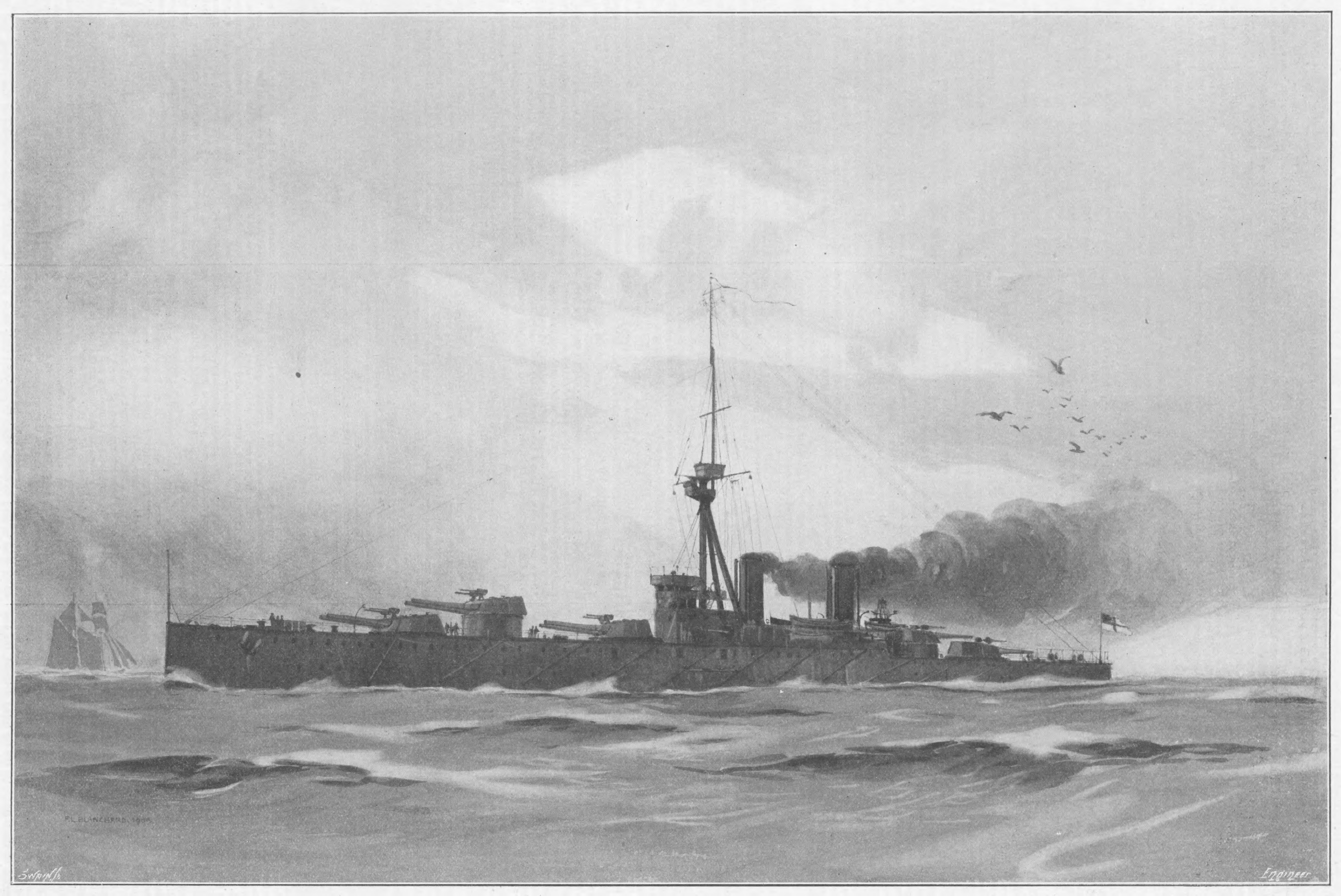
In his address to the Institution of Civil Engineers of Ireland, at a meeting at Dublin, Mr. George Murray Ross, president, said that the syllabus was prepared and the papers marked with due attention to the fact that the by-laws recognised mechanical and electrical engineers. As regards the prospect of work for young engineers, although the openings in Ireland were not very great, still there was a wide field even at home for what might be called municipal engineering. Abroad the prospect for the engineer was encouraging. He went on to observe that in electrical engineering, the improvement of the filament lamp had revolutionised the electric lighting industry in a similar manner to that in which the incandescent gas mantle had changed the aspect of the gas industry. For power purposes electricity was in increasing demand, replacing in their factories the belts and shafting of a few years ago, and their tramways and railways were now driven by electric power.

According to an American contemporary the destruction by an underground fire of a large coal seam, estimated to contain 400,000,000 tons, was effectually prevented at Mauch Chunk, Pa., by building a concrete wall across the path of the fire, which had been burning for a number of years. The shape of the Panther Creek coal basin, where the fire occurred, resembles, in a general way, that of a hand, with thumb extended and fingers held together. The fire had started at the end of the "thumb" and was working along it toward the main body of coal. Before the present work was undertaken a number of unsuccessful attempts had been made to check the advance of the flames, one scheme consisting of putting down rows of deep borings and filling them with wet clay. The scheme finally adopted consisted in driving shafts across the spur, tunnelling, and placing a concrete cut-off wall about 12ft. thick beneath the surface. The total length of the completed wall was about 1050ft., and the deepest part of the seam was 247ft. below the surface. The work was carried on continuously, the men working only 30 min. at a time on account of the heat and gases, for the fire was only 400ft. away.

A lecture was delivered by Mr. H. Brearley before the Sheffield Society of Engineers and Metallurgists on Monday night, at the Sheffield University—Applied Science Department. The subject was "The Use of Microscopic Methods in Relation to Factory Problems." The President of the Society, Mr. J. Rossiter Hoyle, was in the chair. The lecturer dealt with the microscope and methods essentially microscopic as a means of elucidating everyday industrial problems. He showed that the knowledge of this subject must essentially be a practical one, and described how, by means of very homely and inexpensive appliances, the main principles of the subject could be profitably studied. The main subject of the lecture, and the one which appealed most strongly to the audience, was the treatment of steel castings. In the first place, the principles underlying the natural features of steel castings were clearly stated and demonstrated. From the facts presented it was shown that the history of a steel casting could be read almost as closely as a book. The lecturer dealt, in a most interesting manner, with many various features suggested by his subject, and afforded much pleasure and instruction to a large attendance of members of the Society.

HIS MAJESTY'S FIRST-CLASS BATTLESHIP ORION—A FORECAST

(For description see page 550)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H.M.S. VANGUARD.

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TO CORRESPONDENTS.

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REPLIES.

M. W. (Bermondsey).—The circulation varies according to circumstances, but in small engines it is generally on the thermo-syphon system, and in that case the water is used over and over again. In large engines if a continuous supply is used there would be no objection to cooling and purifying it, as it simply passes through a cast iron passage round the cylinder liner. You will find section of engines in our "Gas Engine Supplement," The Engineer, June 23rd, 1905.

J. K. B. (Victoria).—The wheels are put on one axle because the best mechanical job can be made in that way. The only other course would be to have a fixed pin with the wheel running on it, since an inside bearing is impracticable. When it is remembered that heavy side thrusts come against the flange of the wheel, it will be seen that the chance of the bush running true for any time is small. The long leverage provided by the axle going from side to side of the carriage practically removes all racking action on the journal, and the bearings therefore last a long time.

MEETINGS NEXT WEEK.

Manchester Association of Engineers.—Saturday, November 27th. Paper, "The Design of a Winding Engine," by Mr. G. J. Wells, Dumfries.

Institute of Marine Engineers.—Monday, November 29th, at 8 p.m., at 58, Romford-road, Stratford, E. Discussion on Mr. Wm. Henderson's paper "Experiences with Boiler Scale."

The Institution of Mechanical Engineers.—Friday, December 3rd, at 8 p.m., in the Institution House, Storey's Gate, St. James's Park, Westminster, S.W. Extra meeting. Discussion on Mr. Herbert A. Humphrey's paper on "An Internal Combustion Pump, and other Applications of a New Principle."

The Institution of Civil Engineers: Newcastle-upon-Tyne Association of Students.—Thursday, December 2nd, at 8 p.m., in the Lecture Theatre of the North of England Institute of Mining and Mechanical Engineers, Neville Hall, Neville-street, Newcastle-upon-Tyne. Mr. D. Balfour, jun., M. Inst. C.E., will deliver his Presidential Address.

Royal Society of Arts.—Monday, November 29th, at 8 p.m., at John-street, Adelphi, London, W.C. Cantor Lecture: "Aeronautics," by Charles Cyril Turner. Tuesday, November 30th, at 4.30 p.m. Colonial Section. "Agricultural Development in Nyasaland," by Samuel Simpson, B.Sc., M.R.A.S.E. Wednesday, December 1st, at 8 p.m. Ordinary meeting. "Improvements in Resilient Wheels for Vehicles," by the Hon. Richard C. Parsons, M.A., M. Inst. C.E.

The Institution of Civil Engineers.—Tuesday, November 30th, at 8 p.m., at Great George-street, Westminster, S.W. Ordinary meeting. Discussion on papers: "The Single-phase Electrification of the Heysham, Morecambe, and Lancaster Branch of the Midland Railway," by J. Dalziel and J. Sayers. "The Equipment and Working Results of the Mersey Railway under Steam and under Electric Traction," by Joshua Shaw, M. Inst. C.E. "The Effect of Electrical Operation on the Permanent Way Maintenance of Railways, as illustrated on the Tynemouth Branches of the North-Eastern Railway," by Charles Augustus Harrison, D.Sc., M. Inst. C.E. Friday, December 3rd, at 8 p.m. Students' meeting. Paper, "The Design of Generating Stations," by George Ingram, Stud. Inst. C.E. Saturday, December 4th. Students' visit to the London County Council Sewage Outfall Works at Barking.

THE ENGINEER.

NOVEMBER 26, 1909.

The Gas Pump.

THERE is a well-known story by Jules Verne of a professor who, during the performance of a particularly dull and tedious opera—we withhold the composer's name—pumped a copious supply of pure oxygen into the theatre. The effect on audience and actors alike was electrical. Instead of dragging on wearily for four hours, the opera was finished in two, and the audience throughout were responsive to the slightest call upon their emotions, alternating rapidly between tears, laughter and excitement with a quick sympathy which would have astonished the performers had not they also been under the influence of the unwonted supply of oxygen. On Friday evening last, as we listened to the debate on Mr. Humphrey's paper, we found ourselves wondering if the gentleman in the basement who sends up cold air into the lecture theatre was repeating the professor's experiment and oxygenating us all, for the discussion went with a surprising spirit, and speaker after speaker drew, either intentionally or accidently, laughter from a crowded audience. We are, too, the more disposed to regard the oxygen theory as tenable from the fact that the only thing that refused to respond to the stimulus was Mr. Humphrey's wooden model of his valve gear, which, being an inanimate object with no respiratory organs in the physiological sense of the word, was indifferent to the richness of the atmosphere, and resolutely refused to move at all. Even afterwards, when the meeting had broken up and the events of the evening were being re-discussed, the same determination to look at the thorny questions in a light-hearted spirit was obvious, and some even of the most serious amongst us allowed themselves a flippancy which was as welcome as it was unexpected.

It was not that the subject itself was a matter for ridicule; quite the reverse. Every one probably recognised that Mr. Humphrey had brought before the meeting an invention of very great merit, and the reason for the excellence of the discussion is probably to be found in the fact that engineers, with minds jaded by gas engine temperatures, the cutting power of tools, the micro-structure of metals, and the hundred other familiar subjects, had got something entirely new to talk about. Moreover, the author had permitted himself the pleasure of prophesying, and if there is one subject that lends itself more than another to disputation it is the probable developments that lie before any new invention. However, a report of the discussion will be found on another page, and we need say no more about it here than to offer our heartiest congratulations to the Institution which really succeeded in providing, for once at least, a most entertaining, and, need we add, instructive evening.

Of the future of Mr. Humphrey's pump it is as yet too soon to speak with certainty. That it works and works well in the sizes that have already been made there can be no question, all who have seen it in operation being definite as to the ease and certainty with which it acts. But when the inventor asks us to take long strides into the future and see his pump being used for the driving of central power stations and the propulsion of ships we are disposed to think he is hurrying too fast. It is a long way from 16 horse-power to 10,000, and on the road many unexpected difficulties must be encountered. Mr. Davey in an excellent critical review of the paper pointed out some of them, and particular attention may be directed to his estimate that to pump against a head of 200ft. Mr. Humphrey would require a pipe certainly not less than 600ft. long. Now the construction of a pipe of that length, and 2ft. or 3ft. in diameter, to withstand a high pressure, is no light thing to enter upon. Where circumstances permitted it to be straight the difficulties would be great enough, but if in order to economise space it had to be returned or coiled upon itself, they would be multiplied many times. We are far from saying that mechanical skill could not meet and overcome the difficulties; what we do say is that it is too early even to consider such things, and that years of experience with lower lifts must be passed before high lifts should be attempted. And, indeed, Mr. Humphrey has no need to trouble about high lifts for the present, for his pump with an efficiency greater than that of any other water raising device at low heads should have a future before it for irrigation, water supply, sewage pumping, and so on, which should be enough to satisfy the inventor. But even for these purposes, although there can be no question about the mechanical operation of the apparatus, there are other questions which must be satisfactorily answered. For example, if potable water is pumped will it, as Mr. Bryan asked, be injured by the absorption of some of the products of combustion? The combustion of ordinary gas is accompanied by the production of sulphur dioxide, which is readily absorbed by water. Does the water delivered by the gas pump show signs of this? We have raised this point with Mr. Humphrey, and he assures us that he has been unable to trace any acidity in the water leaving the pump. That is favourable as far as it goes. Then, again, though there may be no acid, is there any fouling of the water by tarry and oily products? Again Mr. Humphrey replies in the negative. But the tests have been, so far, made on a very limited scale, and before a definite decision on such an important point can be given a close investigation will be necessary. These things, however, would not affect the value of the pump at all for dealing with sewage, and probably for irrigation either; but for the latter the inventor has quite another problem before him. A great deal of irrigation pumping is done by oil engines in districts where the production of gas is practically out of the question. Can Mr. Humphrey operate his pump on the lines of the oil engine, and, if so, will the products of combustion still remain innocuous?

These are but a few of the practical considerations that will have at some time or another to be faced, but they do not affect in any way the fact that Mr. Humphrey, having in a most ingenious manner removed all the intermediary gearing between his power and the material that power is to act upon, has produced a pump which is free from the bulk of the mechanical losses to which ordinary pumping engines are subject. His pump has all the thermal efficiency of a gun, in that the explosive acts directly upon the projectile to be expelled. That the superiority of the thermal efficiency claimed by Mr. Humphrey may and will be challenged we do not doubt, and we are not surprised that Mr. Davey, on the one hand, as the champion of steam pumping, has protested against the unconditional statement that the best pumping engines required

18 lb. of steam per pump horse-power—the head should be stated—and on the other hand that Mr. Irwin, as a champion of the ordinary internal combustion engine, should, in a letter we publish to-day, claim an equal efficiency with Mr. Humphrey. But both, we think, will admit that whatever it may be now, the new pump, on account of the directness with which the fuel acts upon the water, has greater possibilities of high overall efficiency than any other pumping engine yet constructed.

The Friezland Derailment.

ON the 10th of last August an accident occurred near Friezland Station to a London and North-Western local express train from Huddersfield to Stockport. The train ran off the rails on an easy curve, having just cleared a viaduct. The driver and fireman were both killed on the spot. About thirteen out of a total of eighteen passengers were slightly injured. The permanent way was wrecked for many yards, and the damage done to the engine and rolling stock was very serious. There were several peculiar features about this accident, and it is unusually interesting in that it bears on the fitness or the reverse of tank engines for running at high speeds. The official inquiry was carried out by Colonel Von Donop, and his voluminous report to the Board of Trade lies before us.

At first sight it would seem that this would have to be classed with several other derailments as inexplicable. Nor, indeed, can it be said that it is known now with certainty why the accident occurred. None of the witnesses examined could supply any information explaining why the train left the rails. The engine was excellent of its type, and in perfect order. No fault was to be found with the carriages. The permanent way was admirable. The rails bull-headed, in 60ft. lengths, 90 lb. to the yard. The ballast, broken granite. The precise sequence of events is a matter of hypothesis. On the one hand it would seem that a coach was first derailed; on the other hand there is excellent reason to believe that a leading wheel of the engine first left the line. The train consisted of three coaches only, each with eight wheels. The centre vehicle was a double bogie. The other two had no bogies, but the leading and trailing wheels were fitted with radial axle-boxes. The engine was carried on three pairs of coupled driving wheels, and a pair of trailing wheels fitted with radial axle-boxes. The diameter of the drivers was 5ft. 2in.; of the trailers 3ft. 9in. The rigid wheel base was 15ft. 6in., made up of 7ft. 3in. between the first two pairs, and 8ft. 3in. between the third and middle pair. It had side tanks. Its total weight full was 52 tons, and it was one of a group of eighty similar locomotives specially built for fast local passenger traffic. We need not concern ourselves with what took place before the derailment began. The train was, according to the evidence, running at the usual speed. It was descending an incline of 1 in 100, and rounding a curve of 30 chains, or 1980ft. radius. The elevation of the outer rail was 3¼in. The weather was very hot, but plenty of play was allowed for expansion and contraction in the rails. The position of the engine and train after the derailment was curious. The engine was standing upright at the outer side of the curve, and had turned quite round, so that its leading end was facing towards the rear of the train. The second coach rested diagonally against it; both were mixed up with rails torn from a siding. The leading coach had run some 40ft. past the engine to the right, and had fouled the down line. The last coach had also left the track and stood upright, partly in the six-foot. Colonel Von Donop makes the extraordinary statement that the locomotive must have fallen on its side, and got up on its wheels again. After the accident the line across the viaduct, and for about 50 yards beyond it, was found to have been distorted into curves, alternately to the right and left of its original alignment. These curves were at first very slight, the rails being only shifted a small distance from their original positions, but the curvatures gradually increased, and beyond the viaduct, near where the final derailment occurred, the rails were as much as 18in. out of alignment. On all these curves the two rails were found to be still lying parallel to each other, showing that they had been shifted together. The first mark on the rails which could be connected with this derailment was found on the left-hand rail, almost exactly opposite the south end of the Friezland Station up platform; at that point there was a mark of a blow on the inside of that rail, and ahead of that mark, for a distance of 10ft., there was a distinct mark on the surface of the rail of a wheel having travelled along it diagonally from the inside to the outside. A few feet beyond the point where this wheel mark ended, the outside of the chair under the left-hand rail was marked, and there was a corresponding mark on the inside of the chair under the right-hand rail. A few feet ahead of these marks four chairs were broken under the left-hand rail, and at a short distance further on there was one similarly broken under the right-hand rail. From this point forward along the whole length of the viaduct, and for about 30 yards beyond it, these marks continued intermittently on the outside of the left-hand rail, and on the inside of the right-hand rail, showing that one or more pairs of wheels had been derailed to the left. None of the vehicles was overturned. There is no evidence as to how the driver and fireman came by their deaths. They appear to have been flung off the engine, and killed by contact with the rails or ballast.

After a careful consideration of the very few facts available, Colonel Von Donop comes to the conclusion that the engine left the rails because it was running at too high a speed round the curve. The only evidence to this effect was, however, that of clocks and watches which did not agree. It is to be kept in mind, too, that signalmen only book to the nearest half minute, and that may mean a great deal when the signal cabins are close together. But, on the other hand, the train had been running down hill for some miles before it took the final incline of 1 in 100 down; and we are quite disposed to agree with Colonel Von Donop that the speed could not have been less than 60 miles an hour, and was probably more. If any particular type of engine is fit to get round a curve at a moderate speed, it can only be unfit to get round the same curve at a high speed because it may be overturned or derailed by centrifugal effort—or force, as it is commonly called. Col. Von Donop does not say that this engine was not fit to get round a curve with so large a radius at a speed, say, of 35 to 40 miles an hour, but he evidently holds that it could not get round with safety at 60 miles an hour. Now, at 60 miles an hour, or 88ft. per second, the centrifugal effort forcing the engine to the outside of the curve would have been in round numbers about 6.3 tons. But the super-elevation would have conteracted this 6.3 tons with a centripetal effort of about 4 tons, so that in point of fact, so far as centrifugal effort alone was concerned, there was no danger in running round at even a higher speed than 60 miles an hour. But we have yet another factor to consider. No matter what occurred with the other driving wheels, the leading wheel was no doubt pressed hard against the outer rail. The flange would tend to climb the rail in a way well understood, and climbing would be prevented only by the weight holding the wheel down. The load on each of the leading wheels was 6 tons 3 cwt., the rim velocity was 88ft. per second, the radius of gyration approximately 2.5ft. Therefore each pound in the wheel rim represented a centrifugal effort of, in round numbers, 97 lb. We do not know whether the cranks were fully balanced or not, or whether, as is often done now with coupled engines, the compensating weights were distributed among the wheels. This much is certain—that if there were, say, 50 lb. more at one side of the wheel rim than the other, then there would be once in each revolution a lifting effort of, say, 5000 lb. tending to raise the wheel from the rail. The upward intermittent thrust of the crosshead might easily reach a couple of tons, and would be most active just at the moment that the centrifugal effort in the wheel was most active, and if the engine rolled a little on its leading springs it might very well happen that for an instant there would be next to no load on the leading outer wheel, which would immediately climb the rail. It may be that there was neither a balance nor a compensating weight in the wheel. In that case we would have the weight of the crank or its equivalent, and half that of the coupling-rod. The radius of gyration would be reduced, but the weight would be increased in a greater proportion. There is no other way of explaining why a train could not run round a curve so gentle at 60, or even 70, miles an hours with safety but the one, namely, that the effect of compensating weights, or the absence of balance weights, reduced the force holding the wheel down to the rail once in each revolution so much that a flange pressed against the inside of the rail climbed it. All which points to the necessity for care in the disposition of compensating and balance weights in engines the leading wheels of which are coupled, and on which the engine must depend for keeping the road. So far we have followed Colonel Von Donop, but there remain facts to be considered other than those on which he lays stress; one is that the first marks on the rails were found where the line was straight, just at the end of the station platform. The second is that subsequently the engine and train oscillated so violently to the right and left that the whole track, sleepers and all, was displaced in horizontal waves, the amplitude of which increased until the final derailment, where it had reached 18in. at a point about 720ft. from the first mark. Colonel Von Donop holds that after the initial derailment the engine oscillated; but all the evidence points to the fact, we think, that the oscillation began and went on before derailment of any kind had taken place; and the real question of interest is, What caused this oscillation? Colonel Von Donop points to the fact that the long overhang of the engine at the trailing end might set up oscillation when running down hill; but he does not say why. It is well, perhaps, to add here that there is no available evidence that tank are more frequently derailed than tender engines. Board of Trade statistics, extending over a period of twenty years, show that there is nothing whatever to indicate that there is any greater danger with a tank engine than a tender engine. It may be new to many of our readers to learn that on some of our greatest railways no less than 50 per cent. of the locomotives are tank engines; and that these work a very large proportion—in one case 54 per cent.—of the fast passenger traffic.

It is evident that Colonel Von Donop has given the Friezland derailment very careful consideration. Yet it is doubtful if he is himself sure that he has arrived at a correct conclusion. Having spoken of the leading left-hand wheel being forcibly pressed against the rail, he goes on: "The most probable cause of initial derailment appears to be that owing to the above causes this rail climbing took place, resulting in the derailment of the leading pair of wheels of the engine. I am of opinion therefore that this derailment is to be attributed to the fact that the engine was not of a suitable construction for running round this curve at the high rate of speed at which it was travelling." It is, we think, to be regretted that he does not anywhere in his report say in what way the engine was unsuitable for the speed, save in that it had not a leading bogie or a radial leading axle, and that the wheel base was too long. But, as we have said, these factors must have operated at speeds of 40 or 45 miles an hour, and he has forgotten that on the London, Brighton and South Coast, and on the London and South-Western, engines with coupled leading wheels have been run for many years at high speeds and with perfect safety. We have no doubt that the accident was, in the main, a result of running at too high a speed; but it was not because the general design of the engine was perilous, but because of some other factor, which did not receive any attention during the inquiry.

Bristol Channel Ports.

THE opening of the King's Dock at Swansea on Tuesday last marks the completion of the third of the great dock extension schemes which have been in course of execution at the principal ports of the Bristol Channel for some years past. The fourth of these big undertakings—the extension of the Alexandra Docks at Newport—is not yet completed; various causes have delayed the work in connection with it, and although it had been hoped that the new dock would be opened this year, it is now unlikely that that event will take place for many months to come. On the occasion of the opening of the Royal Edward Dock at Avonmouth last year we drew attention to the dock extension schemes then recently completed, or nearing completion, at Avonmouth, Cardiff, Newport, and Swansea, and compared the dimensions of the dock entrances provided at these ports. It may be of interest to carry the comparison a step further, and consider the internal accommodation provided by the three undertakings already completed and their relative cost. As regards the cost of the works an accurate and fair comparison is difficult and apt to be misleading, for the physical conditions of the sites of the docks vary to a wide extent, and the nature of the equipment provided differs materially in every case. It is, however, of some interest to note that the new works have each cost about two millions sterling. The Harbour Trustees at Swansea will have expended on the new dock and works in connection with it, when the equipment at present ordered is completed, about two millions; for this sum they provide a larger dock and more quayage than either the Avonmouth or Cardiff authorities have been able to do for an expenditure somewhat higher than this figure; but this economy is due in the main to the physical advantages of the site. The engineers and contractors at Swansea found an excellent foundation for the dock works, and the material to be excavated could hardly be bettered from the contractor's point of view. The pumping during construction was almost a negligible quantity when compared with the volumes which had to be dealt with at Cardiff and Avonmouth, or which has to be faced at the Newport works. All the three works we have just named are in distinctly bad and treacherous ground, which necessitated the foundations of walls and locks being carried to a great depth before a sound foundation was reached. Comparison of the total costs of these works is, therefore, in some respects misleading, but at all events it shows that the Swansea Trustees are to be congratulated on having secured for their expenditure considerably greater accommodation than either Avonmouth or Cardiff has managed to provide at a larger capital outlay. At Swansea the new dock has a water surface of 68 acres, with provision for further extension to nearly double this area at comparatively small cost. The quayage already completed and available for traffic in the new dock is over 13,000 lineal feet in extent. The cost of these facilities, including the corresponding improvement of the entrance channel and the provision of the necessary equipment and accessory works, may be put at under two millions sterling. The total cost of the works therefore works out at something like £150 per lineal foot of quayage provided, or if we make allowance for the proportion of the total outlay already incurred, which may be credited to future extensions, the cost per foot of quayage is roughly £100, and the expenditure per acre of water surface about £20,000. In the case of Cardiff, the Queen Alexandra Dock has a water area of just over 50 acres, and there is probably room for the addition of another 25 acres of water surface within the reclaimed area. The quayage extends to 6700ft., and, making a comparison as nearly as possible on the basis of the Swansea figures, we find the cost per foot of quayage already completed is about £300, or £200 per foot when allowance is made for future extensions, and £35,000 per acre of water surface. Avonmouth is a still more costly work; but in comparing the expenditure at this port with the other totals, allowance must be made for the cost of certain works, such as the graving dock, which have not been provided at Swansea and Cardiff. The Royal Edward Dock has a water area of 30 acres and 3730ft. of quayage completed. The cost of the dock works out at between £400 and £500 per foot of quayage already constructed, but if allowance is made for the extensions which are possible at a comparatively small outlay, the cost per lineal foot of quayage can be put at about £300, and the value per acre of water surface is, roughly, £40,000.

There is sufficient similarity in the accommodation and facilities provided by the new works at the three ports to make the comparison from this point of view a fair one. Each one of them may be characterised as an up-to-date and well-equipped commercial dock of first-class capacity. But as we have already said, the comparison is unequal when the natural conditions of the sites are taken into account. The figures do, however, serve to indicate the enormous effect the physical conditions of a site may have on the cost of carrying out extensive dock constructions.

London Trade Schools.

THERE is, as we have recently had occasion to point out, a common opinion that if only you will educate sufficiently you will put an end to many of the industrial difficulties that face us, and particularly to unemployment. This opinion, which has been sedulously nursed for some months past, was reflected by the three hours' debate of the London County Council on Tuesday last. The Council had before it a report of the Education Committee which ended with the opinion that "the National Exchequer should largely increase the grants now made to trade schools and technical institutes, and should, in addition, make substantial contributions towards the expense of trade scholarships. The cost of technical instruction is steadily rising, and ought to rise, but at the same time it is unfair that local authorities should be required to find an increasing proportion of this additional expenditure." We rejoice that this opinion has been adopted by the Council; but the cause of our rejoicing is quite other than that of the educationalists who have brought the motion forward. They see in it the first step towards the extension of a scheme which, no doubt, they honestly believe works for the good of the country; we, on the other hand, see in it an opening for a thorough inquiry into the whole question of trade schools, and the quasi-technical education that is given by the County Council. Unless the Council is able to show conclusively that it is doing work that is really of national value and importance, it has no justifiable claim whatever upon the National Exchequer, and we can well imagine that other parts of the United Kingdom may ask if the London County Council—or indeed for that matter any other Councils—can show any adequate return for the money which it already expends upon trade and technical schools. The matter is one of growing importance, and if the Government are to be invited to subscribe to an increased extent, it will be their duty in the first place to institute a very searching inquiry into the whole system. A commission would have to sit for many months, and it should listen to the evidence, not of educationalists, but of the employers of labour; not of sentimentalists absorbed with the one thought of improving the intellectual status of the masses, but of sound, sober men of business able to balance return against expenditure without any false sentiments, and, above all, without any hobbies as to reformed methods of training youths. We are convinced that if a hundred witnesses were drawn at random from the trades of London and asked their opinion of the value of the Council trade schools, ninety-nine per cent. of them would give a reply that would justify the Exchequer in refusing one half-penny of increased grant to the schools. We have cases within our own knowledge of lads who were crammed with a certain kind of information till they could obtain the certificate of the Council, but were as wholly unfitted to take their place in the economy of an industrial business as if they had never had any training at all, and we have been told by foremen that they would rather take a boy who came to them with no specialised knowledge whatever than the lad with the indifferent nursery training that is given in the trade schools. This is not the time or place to go fully into a very complex question, and we must content ourselves for the moment by repeating our satisfaction at the adoption of the report, because we foresee that it must lead to a searching inquiry into the whole system.

THE GERMAN NAVAL ARCHITECTS.

No. I.

THE eleventh regular meeting of the Schiffbautechnische Gesellschaft was opened on the 18th inst. in the Grand Hall of the Königl Technische Hochschule in Charlottenburg by the president of the Institution, the Grand Duke of Oldenburg, who, after reading a telegram from the Emperor expressing regret that he was unable to be present, invited Professor Stumpf to read his paper on "Continuous Current Steam Engines."

The continuous current steam engine, said Professor Stumpf, is a development of the ordinary steam engine in the direction that the steam behind the piston exhausts at the end of the stroke through a row of ports at half-length of the cylinder. The length of the cylinder is about twice that of the piston itself plus the length dimension of the ports, which, by the passage of the latter, are laid open to the steam space. The steam thus does work till the completion of the stroke and has not to return to the end of the cylinder to make its escape. The cooling of the cylinder walls, and consequent condensation, are thus reduced to such an extent that successive grades of expansion become unnecessary, and a return can be made to the single-cylinder engine. The exhaust ports have about three times the area of ordinary valves, which practically increases the efficiency of the condenser. The piston itself taking the place of the ordinary exhaust valve, the losses due to steam leakage, friction, and extra complication are avoided. The admission ports are in the cylinder covers, which are thus warmed at the outset. During the stroke the hottest steam is that at the cylinder end and the coolest and dampest at the piston; the steam then, with its condensation losses, is carried off at the end of the stroke through the ring of ports. Exhaust steam in no case passes over a heated surface in the cylinder, and there are thus, it is claimed, none of the familiar heat losses. At the ends of the cylinder there is a certain amount of space in which the remaining steam is compressed, its temperature being thereby raised. Experiments are to be made to determine the best amount of clearance to be thus given.

The continuous-current cylinder bears somewhat the character of two ordinary single-acting cylinders joined together at their exhaust ends. The temperature changes gradually from the admission to the exhaust, and the diagrams obtained are good. Experience shows that high temperatures may be resorted to without the slightest difficulty, and that with good work the piston packing gives excellent results. Further, the replacement of a piston is easily and cheaply effected. The new system admits of the employment of much higher temperatures than usual, and in this direction promise is given of new developments. The arrangement of the admission valves in the cylinder cover shortens the passage of the steam into the cylinder to the greatest possible extent, and this circumstance also favours the use of steam of very high temperature. The consumption of steam is as low as in the cases of compound and three-cylinder engines of the ordinary pattern.

With regard to applications, it is shown that the system lends itself well to atmospheric exhaust, condensing, and superheated steam engines, the advantages being especially apparent in connection with the two latter systems. The stresses on the driving gear are unusually small, and the gear can therefore be of relatively small dimensions, while in the mountings and connections simplifications are possible in various ways. Illustrations are given of several installations of this kind of powers ranging up to about 500. A comparison made between a continuous-current engine and one with triple expansion, both in actual work, shows that the number of journals, pistons, pairs of wheels, stuffing-boxes, and excentrics amounts in the first case to 33 and in the second to 228, the consumption of oil being somewhat in the same proportion.

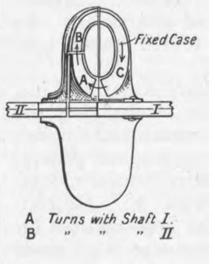
The advantages of the system are further shown as applied:—(1) To steam locomotives, in which the coal consumption is about 20 to 30 per cent. greater in the ordinary engine than in the new type. (2) To portables, in which the combination of boiler, engine, &c., in one is very much facilitated, and the simplification of the parts is such as greatly to favour wholesale manufacture. (3) To rolling-mill machinery, which, with increased efficiency, is considerably simplified. (4) To winding engines, which are estimated to cost one-third less than those of the older patterns. (5) To compressors, blowing machinery, and pumps. (6) To the propulsion of ships, in which the power can be divided over several single cylinders, which, in cases of breakdowns, can each work independently. In this case also steam at high temperature can be taken from the main engines for many purposes for which auxiliary engines have hitherto been provided. Here also the loads on large-powered machinery are stated to be less than those in ordinary engines. In conclusion, Professor Stumpf sets forth that the expansion grades represented by the compound and three-cylinder engines are superfluous complications, and, as a proof that the continuous current system has passed the experimental stage, gives a long list of manufacturers who have adopted or are adopting it.

The second paper was entitled "Eine neue Lösung des Schiffsturbinen Problems." (A new solution of the marine turbine problem.) It was written by Dr. Ing. Föttinger, Stettin, and a *précis* is given below.

The design of the hydro-dynamic transformer, which is the subject of this paper, was worked out by Dr. Föttinger, and about the close of 1896 laid before the managers of the Stettiner Maschinenbau A.-G. Vulcan, who at once took the matter up, and after obtaining the necessary patent protection, put in hand a design for a 100 horse-power engine on the lines proposed. The well-known objections to the universal adoption of the turbine for ship work are:—The wide differences in speed suitable for turbine and propeller respectively, the difficulty in reversing with the arrangements hitherto adopted, and the relatively large space and weight required for low speed turbine plants.

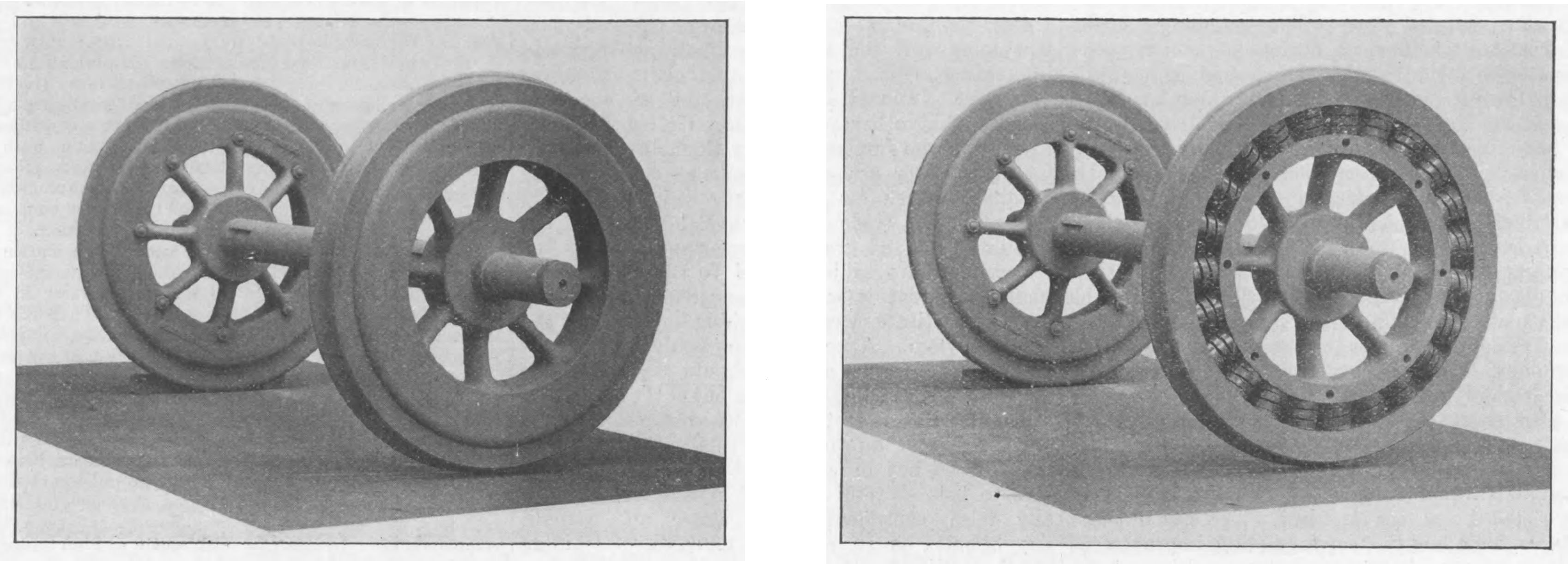
A compromise having to be made between the speeds of turbine and propeller, the former loses about 10 to 15 per cent., and the latter about 30 per cent., so that the net result of the combination is 55 to 60 per cent. of what might be achieved if each of these parts could work under conditions favourable to its own efficiency. Reference is made to the mechanical gearing of De Laval, and to the attempts now being made in America by Melville and others to apply this mechanism on a large scale. The difficulties here met with are pointed out, and a fatal objection to such systems is considered to be the noise made by the toothed wheels. The electric-power transmission also having hitherto proved impractical for marine work, by reason of the great increase of weight of machinery occasioned by it, Dr. Föttinger turned his attention to water-power, and he has now produced a hydro-dynamic turbine, the gradual development of which is described.

The fundamental idea is that of a turbine driven by a shaft and drawing water from a cistern. This water is projected through a pipe and nozzle on to the blades of another turbine, which is thus made to turn a second shaft, the water meanwhile exhausting back into the original receptacle, so that a continuous fresh supply is unnecessary. In the new apparatus these two turbines are combined in one case. Two shafts—I. and II.—set in a line meet together within the case. The case is concentric with the shafts. A longitudinal section through the apparatus discloses a system of turbine wheels taking an oval form above and below the shafting. If we consider the oval above the shafting, it is seen to be divided into a right-hand semi-oval, C, and two left-hand quarter ovals, A and B, the semi-oval being a fixture in one with the case, and the quarter ovals, each containing a revolving wheel. All three parts are bladed. The turbine wheel A in the inner quarter oval on shaft I. imparts the energy given by the latter to some fluid such as water, partly by acceleration and partly by increase of the hydraulic pressure. The jets issuing from A are led directly on to the wheel B—that is, in the outer quarter oval, and connected with shaft II. From B the water passes into C, from which it is led back again to the pump. The process then begins again. The arrangement of the parts A, B, and C can be varied in different ways. In another arrangement illustrated, B is fixed instead of C, and the two shafts turn in different directions. This arrangement is suitable for reversing. According to degree of gearing down required, the system of turbines can be doubled or trebled as desired. An arrangement is illustrated in which two oval turbine systems of the kind described are placed side by side in a single case.



These arrangements are notable for their extreme

SPRING WHEEL FOR TRAMWAYS



simplicity, and the loss of power in the apparatus is very small. With a six-fold speed reduction obtained by a double transformer, an efficiency of 80 to 82 per cent. is obtained, while eight-fold gearing requires a treble apparatus, and gives about 80 per cent. efficiency. By a suitable utilisation of the heat imparted to the water in the process, it is estimated that a saving of from three to four per cent. may be attained, so that the real efficiency is increased by this amount.

To facilitate reversing, the apparatus is further developed, so that the fixed part may have bladings differing in direction, which may be thrown in or out of gear by the turning of a handle. Such regulation of the apparatus as may be required can be effected by a similar manipulation of the fixed bladings or by other means.

In 1907 the Vulcan Company built an experimental apparatus of the double type, which was tested in every imaginable way. The results were so good that a small vessel was built to test the apparatus, the power of which was raised from 100 to 500 by an increase in the speed of revolution. The gearing-down was about 5.6 to 1. The boat was tried under all possible conditions with complete success. In going astern the efficiency was as high as 85 per cent. In the course of these experiments and of the working out of the many designs based on their results, it appeared that the apparatus possessed the following advantages:—(1) Propellers of the large standard patterns may be used with high-speed turbines. (2) The reversing conditions are vastly improved. (3) In view of the increase of efficiency attained the main turbines could be reduced in size. (4) The maximum steam pressures in the main turbines may be reduced considerably, and the cases can therefore be lightened or made of cast iron instead of the stronger materials now necessary. (5) The danger of shafts breaking is considerably lessened. (6) The weight of the machinery and the space occupied by it are very much reduced.

The third paper was entitled "Schwere Werftkrane für die Schiffsausrüstung" (Heavy Shipyard Cranes for Fitting-out Purposes), and was written by C. Michenfelder, of Düsseldorf.

This paper is practically a continuation of another one delivered last year on the crane equipment of building slips. Attention was this time given to the second stage of ship construction—the shipping of engines and boilers and other heavy weights—for which larger and larger cranes have yearly to be provided. A great number of illustrations were given, and the advantages and disadvantages of the different systems in use in Russia, Japan, England, and Germany pointed out. The costs of installation and working of these giants and their permanent advantages in facilitating and cheapening the operations of the shipyard were dwelt upon. Finally, Herr Michenfelder gave expression to the hope that closer and more cordial relations might be brought about between shipbuilders and crane builders, and that a further development of shipyard lifting appliances might be brought about.

"Fabrikorganisation, besonders der Werften." (Organisation of Works—in particular that of shipyards.) By Herr Gümbel, of Bremen, was the fourth paper considered.

Herr Gümbel, who, under the Hamburg-Amerika Line, at one time had special opportunities of studying the organisation of many widely differing German and English shipyards, gave his ideas on the book-keeping and general commercial arrangement of an ideal large concern, comprising shipyard, engine works, foundries, &c. He contended that the book-keeping should be kept distinct for each of the departments, so that the expenses of all kinds attaching to each of these and, as far as possible, those in connection with each article manufactured could be located and a general review of the real conditions in every case rendered possible. Departments devoted to operations similar in their nature should, he considered, be placed under the same head. The arrangement of piecework rates and such like duties would by his system be taken from the foremen and given to a body of clerks and timekeepers, who would also relieve the managing staff of all commercial correspondence. Better co-operation should be obtained between the different branches by improvements in the telephonic and other means of communication, as well as by daily conferences between the departmental managers. Some space is given to the importance of storekeeping, the principle being laid down that, while the stores themselves should be kept by the various departments, their administration should be centralised. The store department should attend to all buying and selling of materials and to the dispatch of finished articles. After touching on the necessity existing for hand-in-hand working between the designing and the executive departments, Herr Gümbel entered upon a general discussion of the management, and of the methods to be employed in the commercial departments, and of the utilisation of the statistical information thereby obtained in the fixing of wages, selling prices, &c., and in determining the real factors influencing profit and loss.

REID-RIEKIE SPRING WHEEL.

THE difficulties of designing a spring wheel which will not only be as simple as the pneumatic tire, but which will approach it as nearly as possible in comfortable running qualities, are considerable. A spring wheel, for which it is claimed that it gives every promise of meeting all the conditions, and that, unlike most such wheels on the market, it is applicable to every type of vehicle from the bicycle to the railway carriage, has for some time been in practical use in the West of Scotland. It is the invention and the outcome of the experience of well-known Glasgow engineers, and it is now being put on the market.

The illustrations herewith show an axle-wheel unit, with which an electric tramway car is fitted, and which is now in daily service on the streets of Glasgow. One of the great difficulties inherent in the spring wheel generally lies in getting the springs to stand up to the work without suffering from fatigue. Springs, as a rule, last well when they are so disposed as to carry a load vertically, but in a wheel where they are placed all round the periphery, those which happen to be—in the course of revolution—horizontal in position are called into play as well as those in the vertical position. They have, in fact, to stand lateral stress, and this duty soon brings about that fatigue which eventually ends in the breaking of the spring. In the wheel under notice, this drawback is claimed to have been efficiently overcome by the simple device of putting the springs in closely all round the inner rim without any fastening other than that due to their compression, and, of course, in the completed wheel, to the keeper ring bolted to the rims, as shown in one of our illustrations. The result is that when the wheel as a whole is subject to any violent jolt from inequality of road surface, the inner wheel rim creeps past the springs, allowing the vertical springs to take up the shock. At first sight, one might naturally feel impressed by the belief that the inner wheel would slip wholly round. The springs, however, are so individually loaded that the weight carried is to a great extent supported by the springs which are in the horizontal position. The wheel is thus kept practically concentric. As the inner wheel is held by friction only, any downward movement due to road inequalities is rectified as the wheel continues to revolve. In other words, there is a temporary elastic creep according to the exigencies of the driving and road conditions, which results not only in sparing the tires, but in maintaining the efficiency and durability of the springs. To encourage this creep, it may be added, the surface on which the springs impinge are slightly greased.

Experience with a motor car to which wheels of the type under notice—but with solid rubber tires as the outer rim—have for a considerable period been fitted, gives a result as to comfort of running which, it is claimed, is virtually equal to that enjoyed when pneumatic tires are used. The Reid-Riekie wheel—made by the North British Locomotive Co. Glasgow—has also been tried with a wooden tread rim, and the results point to a time when with all street traffic vehicles so fitted the noise terror of paved city streets will be reduced to a minimum.

DOCKYARD NOTES.

THE vast new Chinese Navy which was to have been built has vanished into thin air with the arrival of Admiral Sah. The latest reports are that in about four years' time something will be built. Even so, on account of propinquity, Chinese orders are more likely to go to Japan than to Europe.

IT is hardly realised here yet that, in addition to her own dockyards, Japan is making rapid advances with private yards. These have constructed destroyers and torpedo boats, not only for the Imperial Government but also for Siam, and a large series of gunboats for the Chinese Navy.

THE new Argentine battleships which have been taking so long to materialise commenced as 15,000-ton battleships. They are now, though still in the projective stage, 25,000 tons and 22 knot speed. Armament, twelve 12in.; fourteen 6in., twelve 4in., and two torpedo tubes; 4in. to 10in. belt.

THE new German battleships are to be fitted with torpedo net defence.

THE gun trials of the Vanguard were quite satisfactory, and she has now returned to Portsmouth.

FOR some time of late there has been marked increase in the physique of stoker recruits. A very large proportion of those entered in the Portsmouth district are the sons of farmers. These men will, of course, help to do away with that now more or less exploded notion that the stoker is a wild and dissolute character.

THE Brazilian Minas Geraes did 19.04 knots mean speed on her 30 hour trial.

THE French Navy League is at present engaged in getting up an agitation on the French Naval position, which has been steadily sinking for several years. The League very pertinently draws attention to the fact that "French Naval power has been dissipated in the production of *Moucherons*, which, although one of the elements of naval power, are not of themselves able to create that power." Considerable alarm appears to be felt in France over the fact that by the time they are completed the Danton class will be semi-obsolete and the remaining battleships almost entirely so.

THE miniature Dreadnought that Norway projected has been countermanded for the present. A somewhat similar Swedish vessel has also so far failed to materialise.

THE curious report that Turkey intended buying one of the Brazilian Dreadnoughts has been officially contradicted. The Haytian Navy is now almost the only navy left that has not been spoken of in connection with these ships, which, so far as we can ascertain, have always been intended for Brazil and nowhere else.

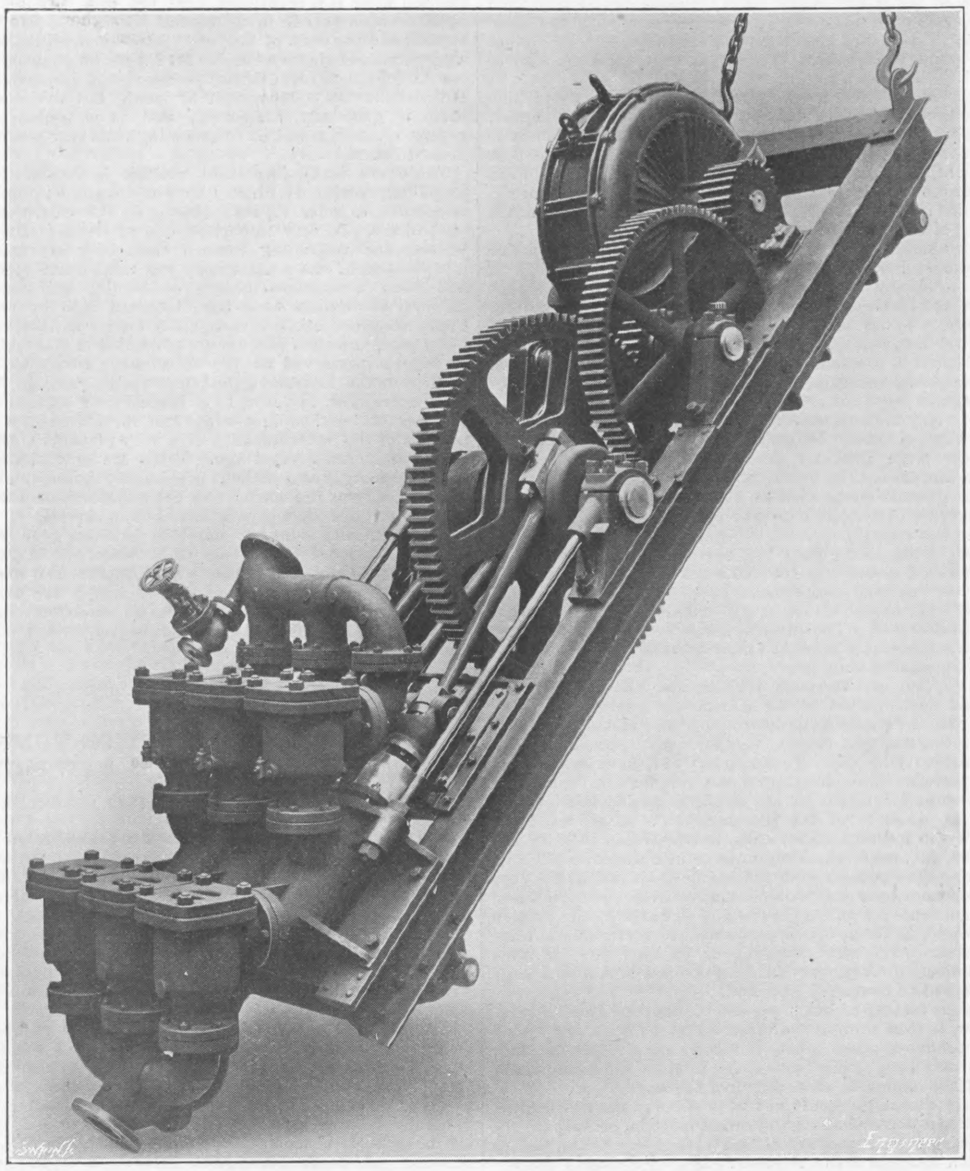
ENGINEERING AND ALLIED TRADES EXHIBITION AT MANCHESTER, 1911.—We are asked to state that rumours to the effect that this Exhibition has been abandoned are without foundation. As a matter of fact, it has been arranged to take place in May and June, 1911, and the management of it has been entrusted to the International Trade Exhibition, Limited, Broad-street House, E.C. A building to contain it of 100,000 square feet area is now under construction.

THE IRON AND STEEL INSTITUTE.—The date of the annual meeting of the Iron and Steel Institute has been fixed for Wednesday and Thursday, May 4th and 5th, 1910. The meetings will be held as usual in the rooms of the Institution of Civil Engineers, and the proceedings will begin by the induction of the new president, the Duke of Devonshire, into the presidential chair by the retiring president, Sir Hugh Bell. The annual dinner will be held on Thursday, May 5th. Under the new by-laws, the Council now have the power to elect honorary vice-presidents from among distinguished members of the Institute, who, by reason of their residence out of Great Britain, are unable to take a very active part in the affairs of the Institute. The Council have accordingly elected the following to the office of honorary vice-president:—Mr. John Fritz (United States), Mr. William Kestranel (Austria), Baron Fernand d'Huart (France), Mr. F. W. Lürmann (Germany), and Mr. E. J. Ljungberg (Sweden).

THE ASSOCIATION OF WATER ENGINEERS.—The fourteenth winter meeting of the Association will be held at the Apartments of the Geological Society, Burlington House, W., on Friday and Saturday, the 10th and 11th of December. The proceedings will commence on Friday at 2 p.m., and on Saturday at 10.30 a.m. The following papers have been promised for reading and discussion:—(1) "Reservoir Outlets," by Geo. N. Yourdi, M. Inst. C.E.; (2) "Evaporation from Water Surfaces," by Sidney R. Lowcock, M. Inst. C.E.; (3) "A Sterile Boring in the Inferior Oolite (Somersetshire)," by William Phelps; and (4) "Ferro-concrete as applied to Waterworks Construction," by Harry W. Taylor, Assoc. M. Inst. C.E. Discussion on papers presented at the summer meeting, entitled "Public Water Supply for Fire Extinguishing," by C. W. S Oldham, borough water engineer, Ipswich, and on "The Control of the Accounts of Municipal Water Authorities," to be opened by E. Antony Lees, Secretary of the Birmingham Corporation Water Department, will also be held.

TREBLE-RAM SINKING PUMP

F. PEARN AND CO., LIMITED, MANCHESTER, ENGINEERS



TREBLE-RAM SINKING PUMP.

THERE has recently been constructed at the works of F. Pearn and Co., Limited, Manchester, a treble-ram pump for rather unusual working conditions. The pump is intended for a mine in South Africa, and is designed to operate at first as a sinking pump, in which case it will first work in a vertical position. Afterwards its position will be altered until it assumes the angle of 45 deg., as shown in the illustration, and finally, after sinking operations have been completed, it will be placed horizontally. The pump is capable of delivering 15,000 gallons of water per hour against a head of 500ft. The rams are 8½in. diameter by 12in. stroke, and are operated through a train of machine-cut gearing by means of a B.T.H. electric motor, which gives 55 horse-power at a speed of 590 revolutions. As will be observed, the pump castings are bolted to H-section steel girders, as are also the crank shaft pedestals, the pedestals and pump barrels being stayed by means of the side rods shown. In this way the stresses are centralised. The pumps are also fitted with suction air and delivery air vessels, which are not shown in the engraving.

Messrs. Pearn have also just completed a set of cross compound horizontal condensing pumping engines capable of delivering 600,000 gallons per hour against 726ft. head, with a working steam pressure of 80 lb. per square inch, for the Shipley Collieries, near Derby. These pumps have two 9⅜in. rams, double-acting, and the steam cylinders are 30in. and 46in. diameter by 30in. stroke. The pumps work at a speed of 38 revolutions per minute.

PROPELLING MACHINERY FOR WARSHIPS.*

By Engineer Vice-Admiral H. J. ORAM, C.B.
(Engineer-in-Chief of the Fleet).

(*Concluded from page* 540.)

A FEW remarks on the consumption of steam in auxiliary engines will now be made. These engines, except in electric light and hydraulic pumping engines, are usually of the single-cylinder type, and their efficiency is therefore small. An average consumption of steam, when exhausting to the condenser direct, of the reciprocating electric light engines which are compound, is about 28 lb. per indicated horse-power. For main circulating engines the consumption is about 45 lb. per indicated horse-power, whereas for pumps, steering engines, capstan engines, and other engines, in which there is little or no expansion of the steam, the average consumption is about 60 lb. per indicated horse-power. These are trial results, and it must be remembered that with wear on service these figures would be increased.

This being so, it is obviously desirable to abstract some of the energy existing in the exhaust steam from such auxiliary engines. This was accomplished by working them on what is called the "closed exhaust," which simply means closing the direct connection of the auxiliary exhaust pipe to the condenser and passing the exhaust steam to the main engines at a position where the pressure is suitable, or through the coils of an evaporator. Relief valves loaded to about 25 lb. per square inch are fitted and allow any surplus exhaust steam to pass direct to the condenser.

Considerable economies are obtained by the the use of "closed exhaust," especially when used in the evaporators, where 1 lb. of gained steam can be obtained from about 1¼ lb. of exhaust steam. When not required in the evaporators, the steam in the case of reciprocating engines is admitted to the low-pressure receivers, and some gain is effected thereby. With the adoption of turbines, however, with their high efficiency in the use of steam of low pressures, the gain from the use of auxiliary exhaust in the main engines has been considerably increased, and this constitutes a very important advantage for turbine machinery as regards warships. Taking a considerable number of ships it is found that by this means the consumption of steam for auxiliary engines is reduced by half, thus:—If the consumption of steam for the main turbines and for auxiliary engines per S.H.P. when not using the auxiliary exhaust are represented by a and b respectively, *i.e.*, a total for all purposes of $a + b$, it is found that the total consumption of steam for all purposes when using the closed exhaust on the turbines will be approximately $a + \frac{b}{2}$. It is interesting to note that the combination of reciprocating engines and turbines recently fitted in mercantile ships is similar to the closed exhaust system, working on the low-pressure turbine.

Economy at low powers is in a warship of more importance than at high powers, and as low powers can only be obtained in the turbine by considerable reduction of initial pressure, there being nothing corresponding to the variation of cut-off with the same initial pressure as in the reciprocating engine, the combination of reciprocating engines using high pressures exhausting into a low-pressure turbine appears economically attractive for the development of the lower powers in warships.

Let us consider the ordinary four-shaft arrangement in battleships, but with a reciprocating engine fitted on each of the outer shafts, and a low-pressure turbine on each of the inner shafts, the total horse-power at full power being about equally divided over the four shafts, the principal object of this arrangement being to obtain the best economy at about one-tenth full power.

Under full-power conditions the initial pressure at the low-pressure turbines would be about 22 lb. absolute, and the exhaust pressure at the reciprocating engines about 2 lb. above this figure. The results of investigation show that at full speed the cruising radius would be approximately the same as that with an all-turbine arrangement. At one-tenth power the cruising radius of the combination would be about 10 per cent. better than an all-turbine arrangement, with cruising turbines in "series," on the basis of a propulsive coefficient of 50 per cent.

At low speeds, however, the distribution of power over the shafts of the combination would be very unequal, and it is difficult to estimate the propulsive coefficient that might be obtained. This, together with the extra consumption of oil, &c., and the inherent practical disadvantages of reciprocating engines, as compared with turbines, appear to more than outweigh the possible additional economy which might be obtained at the lower powers with the combination.

The combination system generally appears suitable for the class of vessel where the designed speed falls below the limit of applicability of an all-turbine arrangement, and, from the results published of such installations, it would appear that in these cases additional economy of at least 10 per cent. could be obtained over good quadruple engines, and at least 15 per cent. over ordinary triple-expansion engines.

Having remarked on the existing types of marine engines, I shall now proceed to a different subject.

The propelling machinery fitted on board our warships must be the best available; the Admiralty are always on the look-out for improvements, and they take note of everything suggested which may appear to have the probable effect of adding to efficiency, although they cannot afford to experiment on the machinery and boilers of our large warships. It is advantageous, therefore, that the question as to whether we are getting this best should be brought under review from time to time. I think it may be fairly claimed that we are, and that there is nothing better or more suitable for naval purposes at present than the machinery recently fitted in the British Navy.

I shall briefly refer, however, to the competing systems for marine propulsion which claim to be suitable for that purpose. There is first the gas engine, which has been before us for many years; the oil engine, which for certain classes of ships is a competing propelling agent; the proposal to interpose between the engine and propeller electrical machines for obtaining certain benefits, and for securing increased economy; and there are others. This electrical proposal, however, refers only to the means of transmitting the power generated, and does not alter the type of engine.

The following remarks are made on these systems in the light of information at present available, but the conclusions stated are, of course, not final, and any discussion which may result will be of value as tending to gradually clear up doubtful points. The good work being done by various engineers in working on these novel problems, is recognised, and it is quite possible that future developments of these plans, and reliable information and experiments, may lead to modification of present conclusions.

Referring first to what is called the electrical propulsion of ships:—

An electrical drive has already been adopted in some ships of small power where the prime mover is an internal combustion engine, in order to overcome difficulties in starting and to avoid complicating these engines with reversing gear. In one system an electrical drive is adopted for reversing or slow speeds only; at other speeds, though the dynamo and motor are coupled to the engine shaft, no electricity is generated, and the internal combustion engine is working directing on the propeller. In this design the capacity of the dynamo and motor is limited to about one-half the power of the engine in order to save weight.

Since the introduction of turbine machinery in warships, proposals to supersede turbines directly coupled to the propeller shafting, by designs where electrical machinery is interposed between the turbines and the propellers, have been made several times.

The system, as proposed, consisted of the employment of economical turbines, at very high revolutions, similar to those in use on land electric light stations, with a dynamo and motor interposed between the turbine and shaft to reduce the speed of the latter to that which is most suitable from the propeller efficiency point of view. The turbines are always run in one direction and reversing can be effected by the change of the direction of the current at the motor.

The claims made for this system are that the loss due to the interposition of the dynamo and motor between the turbine and propeller shaft is more than counter-balanced by the gain due to the more economical steam consumption of high-speed turbines, and that due to a higher propeller efficiency when working at more moderate speeds than is usual in ship turbine machinery.

It is also claimed that the radius of action of the ship will be increased due to an economy when working at low powers, dynamo machines being shut off altogether as required and the remainder worked at or near their economical power, and that although the high-speed turbines and electrical machines are together heavier than the direct-coupled turbines, this is more than compensated for by the lesser boiler power required, consequent on the higher efficiency of the faster running turbines and slower running propellers, so that a complete installation for the same speed of vessel is not only more economical, but no heavier. Further, that there would be an increased economy from working the auxiliary machinery by motors driven from the main generators.

These are the main features of the system; there are varions other claims made, but they are not important compared with the preceding.

The actual figures are the subject of considerable doubt and controversy, and would require much time for an adequate examination. I shall only refer generally to some of the important features.

As regards economy at full power, it must be remembered that the claims are based on figures obtained from trials of electric light stations on shore, and it is somewhat doubtful if the same results will be obtainable when similar units are worked as a battery on board ship with the engines and boilers placed in from five to seven or even more separate water-tight compartments.

It appears that the loss which results at the dynamo and motor is not less than 12 per cent., so that not more than 88 per cent. of the shaft horse-power given out by the turbine would be available as horse-power at the propeller shaft.

The actual steam consumption in pounds per S.H.P. for the propelling turbines in the three ships of the Indomitable class is only 12 lb. at full power, and this without superheating. The figures guaranteed for the steam consumption of the electrical combination from experience in shore electric light installations were given in one case worked out in detail as 12 9 lb. per brake horse-power at the propeller shaft without superheat, and 10.9 lb. with 100 deg. superheat, the vacuum being 28in. It will be seen, therefore, that in the particular case of the cruisers mentioned there is little margin of superiority at full power available for reduction of boiler power, even allowing for the probable improvement in economy of the electrical installation due to the larger units in these ships.

The claim to increased economy at low powers should be realised, as the generators then in use could be worked nearer their maximum output, but it must be remembered that the efficiency of the motor falls off with reduced powers, but the actual amount is doubtful. This feature of the system is the important one as regards machinery of warships. The claim as regards increased power for going astern is also justified.

As regards increased propeller efficiency, it must be remembered that the efficiency now obtained with the slow-running propellers has been the result of many years experience. The early turbine propellers had low efficiencies; experience has enabled these to be increased, but they do not yet reach the figures obtained with the slower running reciprocating engines. There is no doubt that as more experience with small fast-running propellers for such large powers as have only been recently introduced is obtained, the efficiency of the latter will be still further improved. In particular cases, such as in the large cruisers of the Invincible Class, there has been no falling off in propeller efficiency of the faster running screws from efficiences obtained in the slow revolution screws of older cruisers.

No doubt a large diameter propeller assists the manœuvring power of a ship, but the diameter is frequently limited by hull considerations, and electrcally-driven ships, with the same number of propellers, driven slower, would in some cases be limited to practically the same dimensions as in direct-driven installations.

In one design in which the weights of the turbo-generator and motor were quoted, it was found that the increase of engine room weights would be considerable, and that the total increase of machinery weights would be about 15 to 20 per cent. The gain at low powers would require to be very substantial to balance such increases. The substitution of electric motors for auxiliary steam engines would also add to weight, and such auxiliary machinery as steering engines and distilling plant would for the present require to be steam driven.

The electrical pressure proposed in the various plans, has varied from 1000 volts in the lowest, to 2750 volts in the highest, and these are all very high from the point of view of safety, for use in H.M. ships. Also, before any system could be adopted many necessary details would require to be carefully considered, such as freedom from danger of failure due to access of water to the electrical machines or to particular parts of them and the ventilation of the machines, as considerable heat is generated.

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* President's Inaugural Address at the Junior Institution of Engineers, Tuesday, November 16th.

With the interposition of two electrical drives between the turbines and the propeller, in addition to special dynamos as exciters, it is not probable that the wear and tear would be less or that less staff would be required; but rather the reverse.

In the designs submitted to the Admiralty there has been no gain in the space occupied, but in some cases an increase.

It is essential for warship purposes that the small variations of speed required from the propellers when keeping station in a fleet should be readily obtained, and in this respect the electrical systems which have been proposed to the Admiralty are far from satisfactory. The various firms have only proposed to provide for three electrical speeds, full, half and quarter, and have suggested that if anything further were required that the speed of the generators should be regulated. This latter would detract from the economy of the system.

It is recognised that further attempts are being made to meet this condition, which is absolutely necessary as far as warships are concerned, provision for station keeping or the power of making gradual changes of speed throughout the whole range, both ahead and astern being essential.

Finally, there appears to be considerable doubt as to the efficiencies of the various systems proposed, and the figures on which they are based, but speaking generally, the conclusion seems to be that the interposition of a dynamo and motor between the engine and its work, involving when on board ship considerable liability to accident and derangement of the electrical machines, in addition to present risks, has disadvantages such that the practicability of the details should be beyond question, and the gain by its adoption must be shown to be substantial before the system could be fitted in any important vessel. This has not, I think, been done at present. We must recognise, however, the skill and ingenuity with which this problem has been dealt with, and any further developments will naturally receive careful consideration, especially the actual results from installations which are about to be fitted on a small scale. The good work done by electrical engineers on board warships at present in respect to electrical machinery of all kinds is too well known to need any comment from me, and we should welcome their co-operation as regards the main engines if the resulting combination is likely to be beneficial.

We now pass on to some general remarks on the use of internal combustion engines for marine propulsion. It is a difficult matter to make exact comparisons between steam engines and internal combustion engines suitable for large ships, as the powers of the latter installed afloat have not been large, and comparisons of units of 500 brake horse-power in internal combustion engines, and 20,000 to 40,000 brake horse-power in steam engines leaves much to be desired; it must, of course, be remembered that the steam engine is in a high stage of development, and the marine gas-engine installation not so.

A more reliable comparison at low powers can be obtained from a comparison of steam engines and oil engines in boats, for, as the weight of gas engines without the producers, &c., should be about the same per indicated horse-power as that of oil engines for the same speed of revolution and working on the same cycle, this comparison will give an idea of the position of the gas engine in comparison with the steam engine for such powers

In the large power-driven boats carried by warships, it is found that where the total weights of the heavy oil engines and the fuel required for the same radius of action are about the same as for similar boats with steam machinery and coal, the speed obtained with the oil motor boat has not been so great as with the steamboat. As oil fuel is assumed to be available, this could be equally used by the boiler of the steam engine, and if this be assumed the comparison would be still worse for the internal combustion motor. For small boats, where the air-compressor and reservoir for starting can be omitted and hand-starting gear is sufficient, the heavy oil engines may have a slight advantage, but this would disappear if the smaller boats were similarly compared with boats fitted with oil-fired boilers.

This gives a general idea of the results obtained with oil engines which use oil of a flash point of over 200 deg. Fah., and shows that there is practically no gain in respect to weight in fitting heavy oil motors, instead of steam engines, in large power boats of corresponding revolutions. There being practically little difference in the weights of four-cycle oil motors and steam engines, it follows that four-cycle gas engines with producers and cleaning plant must generally be heavier than steam engines and boilers.

The gas engine and anthracite producer plant which was fitted by Messrs. Beardmore in H.M.S. Rattler, after the original steam engines and boilers had been removed, is the largest marine gas engine installation fitted in Great Britain, and we must admit the enterprise of those associated with this experiment, which has added considerably to previous knowledge of the subject. A comparison with the steam engine which was taken out of this vessel shows that the horse-power obtained per ton with the latter was about twice that obtained with the former. This compares the steam engine practice of 1886 with the gas engine practice of twenty years later, but it must be remembered that the gas engine fitted in this ship was an experimental installation, and a future one would no doubt make a more favourable comparison with the steam engine.

This gas engine was not reversible, but was fitted with a reversing clutch, but it is very doubtful whether such reversing mechanisms are suitable for any considerable power, and it is considered that for such powers, either the engine should be a reversible one or be fitted with electrical transmission.

There appears no doubt that gas engines can be made reliably reversible; in fact a set of 500 brake horse-power, already constructed, possesses this feature, so that no difficulty would be apprehended on this account. If a reversible engine is, however, fitted a very large compressed air service is necessary for this purpose, and the capacity of this plant would be a serious factor in a large installation.

There would also be a considerable amount of experimental work to be done with the auxiliaries, such as distilling machinery and steering engines, if this type of engine were fitted, so that generally, the combination of non-reversible gas engines with electrical transmission is the most promising direction for the utilisation of this system.

As regards oil engines, it is no doubt correct that about 17 S.H.P. per ton of machinery can be obtained with special designs for using heavy oil. Each engine, however, is small, and its power cannot be increased very much without decreasing revolutions and increasing the weight for a given horse-power, so that the very large powers required for marine propulsion could only be obtained by multiplication of small units. One could imagine what a very large number of such reciprocating oil engines, each having its valves, cams, &c., would be like if fitted to make up the full power of a warship.

In a paper published a short time ago the figure of 11.6 brake horse-power per ton has been given as the probable weight of gas engines and producers, if fitted for marine propulsion. The tenour of this paper was entirely favourable to the adoption of the gas engine in lieu of the steam engine, so that if this figure errs at all, it would probably be rather over-estimated. Now the steam turbine installation of the Indomitable actually developed 13 8 S H.P. per ton and the Bellerophon 13 S.H.P. per ton. The weight of fuel carried for same radius of action must, however, also be taken account of, and the superior economy of the internal combustion engine is the important factor which causes these engines to be considered for marine purposes. Generally, it may be assumed that the fuel consumption in a steam turbine installation is approximately about 50 per cent. greater than in an internal combustion engine installation using similar fuels, and in considering the weights and spaces occupied by different types of machinery, a proper comparison must include the weights and spaces occupied by the fuel, and if this were done, the internal combustion engine installation would compare more favourably with the steam turbine installations.

Taking a steamship with turbines of 20,000 S.H.P., and carrying 3000 tons of coal, and assuming that the coal consumption per S.H.P. per hour is 50 per cent. more in the steamship than in a ship fitted with gas engines and producers, and assuming that the consumption at low powers would be in the same proportion, then for the same radius of action in a gas engine ship with the same total weight of fuel and machinery, 8 horse-power per ton of machinery would be sufficient in the gas engine for equality of total weight.

As regards space, there is no doubt our present steam turbine installations take up a good deal less space than any gas engine, and probably less than any oil engine installation which it is possible at present to fit. It has been stated that about 0.32 square feet of floor space per brake horse-power would be required for oil engines in a large installation. The corresponding figure in a large turbine installation was 0.28, and this figure would decrease as the power of the turbine installation increased.

In these comparisons of weight, space and fuel, large ship practice has been taken. For smaller cruisers in which a higher speed of revolution is used, and where the boilers are worked with a higher air pressure to obtain the full power, the weight and space for steam machinery would be very considerably less than indicated above, and, further, it is not unreasonable to assume that for future large installations of turbines the weight and space will decrease.

The most important consideration is, however, the practicability of obtaining reliable large gas engine installations and producers for use in ships. Any difficulties with the gas engine itself would, up to certain sizes, I think, be overcome, if a really satisfactory gas producer were available for marine use. This cannot be said to be the case. The use of bituminous or semi-bituminous coal is under present circumstances absolutely necessary, taking into consideration that anthracite can only be obtained at a few ports outside this country.

A producer using bituminous fuel and of a type suitable for marine purposes has not yet reached a practical stage, and until such a producer has been designed and has proved to be thoroughly reliable after trial, the adoption of gas engines on any important scale will be prevented. The invention of a satisfactory producer would give a considerable impetus to the consideration of internal combustion engines for ship use.

The introduction of the steam turbine has had the effect of retarding the development of the marine gas engine, for while comparison with the steam reciprocating engine was not favourable for the reciprocating gas engine, comparison of the latter with the steam turbine is worse. To engineers who have realised by practical experience the convenience and simplicity of the steam turbine, the superior merits of the internal combustion engine, apart from the question of the producer, must be proved to be very great if the indirect crank drive, in connection with all the cams, tappets, &c., required, is again to be introduced.

There is also the difficulty with gas engine installations that the gases are poisonous, and this would require careful consideration in the arrangements for an engine-room of a warship, and suction producers would, as far as this is concerned, be preferable to pressure producers. Also, after stopping or working slow for some time, it is difficult to obtain sufficiently good gas to enable a large increase of speed to be readily obtained.

An attendant feature of both gas and oil engines, from a naval point of view, is that funnels are often stated as not being necessary. The producer gases must, however, be got rid of, and, although it may be possible to arrange to eject the gases under water when the engine is at work, when the engines are stopped an underwater discharge would not be possible in the gas engine, and some fittings corresponding to funnels must be provided.

The foregoing is only intended to be a brief review of the various systems which compete with the steam engine for marine propulsion; an exhaustive examination would occupy more time than the Institution can spare me, but it indicates, in my opinion, that these rivals of the steam engine have not yet advanced much, and the steam engine holds the field for the present. Whether the gas turbine, which would be a more serious competitor than any of the foregoing, is to be successfully developed remains to be seen.

Proceeding now to another subject, one of the features in the recent developments of warship machinery is the adoption of liquid fuel, either wholly or partially, for the production of steam. Its principal advantages for this purpose were fully recognised many years ago, and as compared with coal, comprises:—Greater calorific value for a given weight or space occupied by the fuels; quickness and cleanliness of transport to vessels, and much less labour in transporting and using; greater control over its supply to the furnaces, and cleanliness of stokeholds; considerably less fouling of boiler tubes when under way, and no cleaning of fires necessary.

The difficulties attending its use some years ago were, however, very great, as the methods for burning it did not allow of a fair proportion of its calorific value being realised. When burnt at the rate required for Navy boilers, less than 50 per cent. of its calorific value could be obtained for some years, and dense smoke was produced. The risk of danger from explosive gases given off by the fuel was great; its great cost and limited supply were also disadvantages.

The risk of explosion from volatile gases was reduced to a minimum in H.M. ships by the adoption of a sufficiently high flash point. The flash point first adopted by the Admiralty was 280 deg. Fah., but this has now been reduced to 200 deg. (Abel close test.) This is higher than that allowed by the Board of Trade and Lloyd's Registry, and although the desirability of an identical flash point between the Admiralty requirements and that of other users in this country is recognised, it is considered that greater precautions are necessary in warships, as the spaces on board are more confined and more liable to a higher temperature than those in vessels of the Mercantile Marine, and the effect of an explosion would be more disastrous under certain circumstances.

In determining the safe flash point, the fact must be borne in mind that vapour is slowly distilled off from the oil at temperatures lower than that of the flash point; for example, when the flash point is 150 deg. Fah., inflammable vapour is gradually evolved at 100 deg. Fah. As an illustration of the high temperatures to which certain spaces in warships may be liable, it may be stated that in the case of one destroyer the temperature in the bilges under the boilers, when steaming at full power, was found to be 158 deg. Fah., and, although no oil tanks may be adjacent, it is quite possible and even probable that occasional leaks may occur from the burners, which may find its way to the bilges.

The other difficulties could not be so easily met, but experiments extending over some years were made by the Admiralty, both ashore and afloat, with steam and compressed-air spraying, and many devices obtained both outside and inside the Navy were tried, but none of these proved entirely satisfactory. Both steam and compressed air as spraying agents have important and well-known disadvantages.

Efforts were in consequence made to develop a system free from these objections, and in 1903 a special burner was devised by which the pressure produced by the oil pump was made to effectively atomise the oil. The trials on shore of these appliances eventually resulted in satisfactorily maintaining the full power of the boiler without the production of undue smoke, and at the same time realising the satisfactory proportion of about 76 per cent. of the calorific value of the oil. The system was then fitted to two destroyers, and the trials proved very satisfactory. In consequence of these results, this system is now generally fitted, and the continued satisfactory results obtained have gradually led to an extended adoption of oil fuel burning through the Service.

The full advantages to be derived from the use of oil fuel can only be obtained when it is used by itself, but this course cannot be taken in all the ships of the Fleet, on account of the greater cost and limited supply of oil fuel as compared with coal. Oil as the sole fuel is therefore confined to the smaller vessels, which obtain substantial tactical advantages by its use. Larger vessels, such as battleships and cruisers, only use oil in conjunction with coal, and in these cases the occasions on which oil is used are of a special character.

The influence of the limited quantity of oil fuel available can be realised when it is mentioned that the total amount of crude oil obtained each year from all sources throughout the world is only about 3 to 4 per cent. of the yearly production of coal, and that only a proportion of this is available for fuel. The quantity of oil which can be obtained from British possessions or from countries under British influence is comparatively small, but the production from them is gradually increasing, and it is probable that much greater quantities will be forthcoming from such sources in the not distant future.

There are many important matters in connection with the propelling machinery which I have not dealt with and which it is impossible to refer to, even briefly, in the usual time devoted to an address. A very important one of these is the question of boilers, and respecting these I shall only say that since the introduction of steam machinery and until quite recently, boilers had been a constant source of trouble and anxiety to the Admiralty. Boilers have been inquired into by various Boiler Committees and other investigating bodies at intervals for many years past, and their labours are embodied in many bulky volumes of reports preserved at the Admiralty, which to the diligent student make interesting and instructive reading. We seem to have come now, however, to a condition of affairs when serious troubles are seldom met with, and in this respect the present position of the boiler question is a very pleasant contrast to what it used to be some years ago. Trials are now almost invariably run satisfactorily and without preliminary failures, and after their acceptance from the contractors the machinery and boilers in the vast majority of cases give satisfaction on service.

The Admiralty is largely indebted for these good results to the zeal and ability of the officers and men of the Engineer Branch afloat, also to the contractors who construct the machinery and who are always ready to give the Admiralty the benefit of their experience and advice on questions of machinery design, which opportunities are frequently made use of, and are very highly appreciated.

AN INTERNAL COMBUSTION PUMP, AND OTHER APPLICATIONS OF A NEW PRINCIPLE.*

By Mr. HERBERT A. HUMPHREY, Member, of London.

Pumps play such an important part in every branch of engineering that no apology is needed in bringing before the notice of this Institution a construction of pump based upon entirely new principles. Every engineer is familiar with pumps driven mechanically or by steam, and recently there has been considerable development of pumps driven by gas engines. The South Staffordshire Mines Drainage Commissioners, for instance, have replaced steam engines by gas engines in five of their pumping stations, with very beneficial results, the change having led to a considerable economy of working.

Compound condensing direct-driven steam pumps of modern construction and large size are among the most economical of all steam-using plants, and under favourable conditions will give a pump horse-power hour for an expenditure of 18 lb. of steam. But at the other end of the scale we have the direct-acting steam pump generally working with very little or no expansion. Such pumps are notoriously uneconomical, and frequently use 70 lb. to 150 lb. of steam per pump horse-power hour. It is only the extreme convenience and simplicity of such pumps that induces engineers to tolerate their low efficiency.

Economy of fuel is undoubtedly obtained when an internal combustion engine is used to generate the power for driving a pump, but by the time the mechanical efficiency of the gas engine and the intermediate gearing is taken into account one finds that the economy is considerably discounted, and such a combination of gas engine and pump can never be regarded as a final solution of the problem.

The author's aim has been to produce a pump of great simplicity and strength of construction, in which the explosive force is exerted directly upon the water, and in which no rotating fly-wheel, solid piston, connecting-rod, crank, bearings, or glands of any sort are required; and, as the results of his experiments, several very successful types of pumps have been invented and set to work on a sufficiently large scale to demonstrate their utility and economy.

The idea of exploding a combustible mixture of gas and air to produce pressure on the surface of water, with the object of raising the water, is, of course, not new, and attempts to put this idea into practice date back to 1868. The efforts have all been directed too much along the lines of ordinary pumps in so far that the water lifted has always been forced past a non-return valve, and the operation of such a valve with the explosive force behind it has been inevitably disastrous. In the types of pumps invented by the author there is, when the explosion occurs, a full-bore passage from the combustion chamber to the final outlet, also some of the water pumped to a high level by the energy of the explosion is allowed to return again to compress a fresh combustible charge. When sudden changes of velocity occur in masses of a heavy and incompressible liquid, like water, great difficulty is found in controlling the movement of the liquid, All such difficulties are removed in the author's pumps by allowing the movements of liquid to control the pump, and by causing the mass of liquid moved to be sufficiently large, so that the velocities are never excessive. The mass of water forms a pendulum which swings between the high and low level, and, by its movement alone, serves to draw in fresh water, to exhaust the burnt products, to draw in a fresh combustible charge, and to compress the charge previous to ignition. With the movements of the liquid quite unrestrained by any of the usual mechanical appliances, the result is a pump which works with freedom from shock and noise, and which requires very few working parts.

The subject attains a wider scientific interest from the fact that the apparatus follows a cycle in which the expansion of the burnt products is carried to atmospheric pressure, and so involves a thermodynamic cycle of greater efficiency than can be claimed for the Otto cycle. The underlying principles of the invention are capable of application in many useful directions besides that of raising or forcing liquids, and are especially adaptable to the compression of elastic fluids.

The researches and experimental work, which have occupied three years, constitute an attack upon the gas pump, gas turbine and gas engine problems, and these three have been so closely associated in the author's mind that it is almost impossible to treat the gas pump as a thing apart. It seems natural and proper, therefore, to present the general scientific aspect of the problem first.

Every text-book which deals with the theory of the gas engine contrasts the theoretically perfect indicator diagram with diagrams obtained in actual practice. There is no gas engine on the market working on a cycle which permits expansion of the ignited gases to be carried beyond the original suction volume. As a consequence, when a gas engine is working at full load the exhaust gases are rejected at a high temperature at a pressure of between two and three atmospheres. The energy thus wasted is a considerable percentage of the total energy converted into work, and we must put this waste down as an inherent defect in all existing types of gas engines. The requirements for a perfect cycle are as follows:—(1) The suction stroke taking in the combustible mixture; (2) the compression stroke, the length of which is dependent upon the compression pressure desired; (3) the working or expansion stroke, which should be much longer than (1) in order to fully utilise the work of the expanding gases; (4) the exhaust stroke, which is another long stroke comparable with (3), but the exact length of which depends upon the clearance space.

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* The Institution of Mechanical Engineers.

All four strokes will be of unequal length, and a perfect gas engine should be capable of meeting these conditions.

Again, theory indicates that for great economy we must have high temperatures, and in practice we know that at such temperatures it is impossible to lubricate the piston unless the cylinder walls are cooled. The larger the diameter of the cylinder the thicker must be the walls of the cylinder to resist the bursting pressure, and the more difficult it becomes to conduct away the heat fast enough. Experiments have shown that with the largest cylinders now in use, having a thickness of, say, 4in. of metal, the limit is nearly reached, so that if cylinder walls be made much thicker the lubricating oil would be burnt up and pre-ignition trouble would arise, even with a good circulation of cold water on the outside of the cylinder. Perhaps the chief difficulty which designers of large gas engines have had to meet are those arising from expansion and contraction of the cylinder and piston, which have necessitated somewhat complicated arrangements for cooling the latter by circulating through it high-pressure water, and the use of a large water jacket in connection with the former. Broken cylinder covers, jacket castings and cracked pistons are not nearly so common now as they were, thanks to the great ingenuity and skill displayed in their design, but the necessity for meeting expansion at all points has not tended to simplicity in the modern gas engine. Some years ago the author carried out experiments with a Vogt gas engine, and the trials showed that internal cooling, arising from the use of a water piston, was consistent with a high thermal efficiency. It seems logical, therefore, to conclude that at least in large units the outside water jacket will be dispensed with and internal cooling substituted, and the ideal engine should possess this method of internal cooling.

Let us now for one moment consider the actual construction of the gas engine as it exists to-day. We find a solid piston with its water-cooling arrangements, its piston rings, its piston-rod and somewhat expensive type of gland packing, and the usual connecting-rod, crosshead, and guides, and then the crank shaft and fly-wheel, with the massive bearings, lubricating devices, and strong framework. If we take the Otto engine as the simplest type of engine, and which often dispenses with the piston-rod, we yet have the two-to-one gearing, with the side shaft carrying the cams to operate the necessary levers and valves. How much of all this is really necessary? In answering this question a list of the actual essentials which a gas engine must possess may be made out as follows:—A working cylinder, an inlet valve for combustible mixture, an exhaust valve for burnt products, a fly-wheel, and an ignition device.

Obviously the numerous things which belong to a gas engine outside of these essentials would readily be dispensed with if it were possible to do without them, and we should then arrive at a gas engine in which the energy was delivered direct to the fly-wheel without any intermediate gearing. To retain this degree of simplicity the fly-wheel would also have to fulfil the functions of a piston, which draws in a fresh combustible charge and compresses it in the cylinder. If we imagine everything discarded which first principles do not demand as necessary, our ideal engine will have the following properties and parts:—(1) It must be capable of giving four unequal strokes. (2) It must utilise the whole possible range of expansion down to atmospheric pressure. (3) The energy must be delivered direct to the fly-wheel without any intermediate parts. (4) There must be internal cooling arrangements, so that the cylinders may be made of any size within the limits of structural possibility. (5) There must be an ignition device, but, as there is no two-to-one shaft to operate it, it must be entirely automatic, and depend only upon the compression pressure having reached a maximum. (6) Difficulties connected with contraction and expansion must be eliminated.

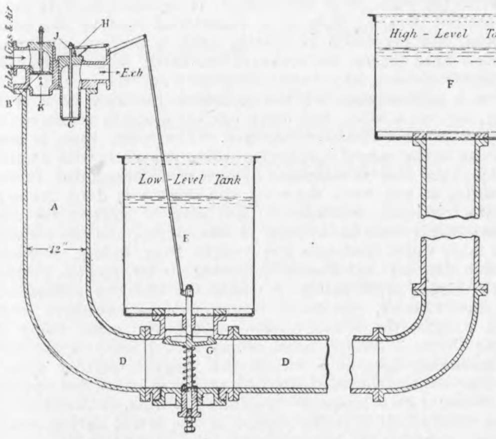


FIG. 1.—*Diagram of the First Experimental Four-cycle Pump.*

These conditions may look sufficiently impossible, but the ideal engine must not only fulfil them, but must be capable of meeting other requirements. Thus, it is surely not wise to take in a whole cylinderful of mixture when the output of the engine is only a fraction of its maximum. All the strokes should be shortened up when the call for power is less, assuming, of course, that the number of strokes per minute are to remain constant, which is generally the case.

Having evolved our conditions for an ideal engine from first principles only, the question is: How far can a practical machine be made to meet these conditions? So far as a prime mover on these lines is concerned, the author believes that a practical solution can be found, but the following considerations tempt him to depart from a direct solution.

Granted that water is needed for internal cooling, then surely it is better to use a water piston. If this piston is made heavy enough, it may well serve as a fly-wheel, but it will be a reciprocating instead of a rotary fly-wheel. Here, then, the temptation to extreme simplicity comes in. Let us for the moment abandon the idea of a prime mover with a rotating shaft, and allow our water fly-wheel to so reciprocate that at each working stroke it leaves a quantity of water at a higher level or pressure. This only requires the fitting of a single water valve, but our final apparatus then becomes a pump instead of an engine, and our gas power appears as water power.

The arguments and conclusions having been stated, we are in a position to proceed with a description of the apparatus employed by the author in carrying out the principles involved. It should, however, be mentioned that the order in which the different types of apparatus are here described is chosen for logical sequence, but is not that in which they were actually invented.

Fig. 1 is a diagram showing one of the simplest forms of construction. It consists essentially of a combustion chamber A, fitted with an inlet valve B for combustible mixture and an exhaust valve C for burnt products. A pipe D connects the bottom of the combustion chamber to a low-level tank E and to a high-level tank F, and between this pipe and the former there is a water valve G. The inlet valve B is normally kept shut by a spring, but the exhaust valve C has no spring to hold it up, and falls by its own weight when pawl H is removed from under a collar J fastened on the exhaust-valve stem. This pawl is operated from the water valve G in the simple manner shown, so that, when the water valve opens it releases the exhaust valves. Suppose all the valves shut and a compressed combustible charge to exist in the top of the combustion chamber. The rest of the chamber and the pipe are full of water. Explosion occurs at a sparking plug K, and the increase of pressure drives the water downwards in the chamber, and forces the column of water contained in the pipe to move towards the high level tank so that a quantity of water is discharged into this tank. From the moment when ignition occurs to the time when expansion reaches a pressure equivalent to the static head of the water in the high-level tank, the excess pressure in the combustion chamber has been increasing the velocity of flow towards the high-level tank, so that at the end of this period the column of water has a considerable velocity. The kinetic energy thus acquired causes the water to continue to flow in the same direction, until the pressure on the under side of the water valve is less than that above the water valve, and the difference of pressure causes this valve to open. This occurs when the products of combustion have expanded to about atmospheric pressure. The opening of the water valve releases the exhaust valve, and now water from the low-level tank flows past the water valve partly to follow the column of water still moving towards the high level tank and partly to flow into the combustion chamber to expel some of the exhaust gases. There is, of course, a tendency for the water to rise in the chamber to the same level as the water in the low-level tank, but usually a little before this level is quite reached the kinetic energy of the moving column has been expended in forcing more water into the high-level tank, and the column has therefore come to rest. At this point of the cycle the spring on the water valve quietly closes this valve, and is assisted by the water now trying to flow back from the high-level tank to the chamber. It cannot flow back far, because there is already a considerable quantity of water in the chamber, and as the column rises further it reaches the exhaust valve and, striking against it, shuts it by impact. The exhaust valve is immediately locked shut, by the pawl shown engaging under the collar of the valve stem, and now that there is no longer any outlet for the small quantity of burnt products which remain, they are imprisoned in the top of the chamber and suffer compression as the water continues to rise, until the energy thus stored in the compressed elastic cushion is equivalent to the energy given out by the falling water. Thus the elastic cushion serves to bring the column of water again to rest, and as the compression pressure considerably exceeds the static head of the water column, a reverse flow is set up while this cushion expands again. If there were no friction losses the water column would be forced back by the cushion to the same point as that from which it started, namely, to a level in the combustion chamber a little below the level of the water in the low-level tank, but it actually does not move quite so far. However, when the water passes the level of the exhaust valve the elastic cushion is again at atmospheric pressure, and the further descent of the water in the combustion chamber tends to create a vacuum, but the inlet valve is only held shut by a light spring, and can, therefore, readily open to admit a fresh combustible charge during the rest of the descent, and until the water column is once more at rest. The state of affairs now reached is of course still unstable, because of the unbalanced pressure due to the head in the high-level tank, and this head produces a second return of the column, so that water ascends in the combustion chamber and compresses the fresh combustible charge. The explosion of the charge by means of the ignition plug now starts a fresh cycle. The operation of the apparatus is so simple that when an actual apparatus on these lines was first tried it ran steadily at the very first attempt.

Although the apparatus just described looks so simple, yet the calculations required in studying the complete working conditions are very complicated. Up to the present the author has not been able to express the results of calculations in any general formula including all the variables involved. Integration on a time base is the only method so far used to follow out the conditions through a complete cycle. It is not, therefore, intended to deal fully with the theory of the pump, but some general observations will be of service.

Height of lift.—In the first place it will be observed that the quantity of water delivered considerably exceeds what might be described as the stroke of the pump or the change in volume of the gases from the time they are ignited until they expand to atmosphere. This is due to the water entrained from the low-level tank to follow the moving column of liquid going to the high-level tank. Consequently, if an indicator diagram could be obtained and the mean pressure of the stroke calculated, such pressure must be in excess of the equivalent pressure due to the head against which the water is raised. The burnt gases always expand down to atmosphere, therefore their mean pressure is less than that obtained in an Otto cycle gas engine, since the stroke is so much greater, and, as a result, the head against which the water is lifted is limited to some 35ft. to 40ft. in most cases. This limitation is, however, entirely overcome by one or other of several arrangements to be described later, which enables water to be raised to practically any pressure which may be required.

Length of pipe.—The length of pipe between the combustion chamber and the high-level tank must be sufficient to contain such a mass of water that its kinetic energy at maximum velocity shall ensure the burnt gases being expanded to atmosphere. This is the limiting condition, but the pump will work with any greater mass of water. If we fix 10ft. or 12ft. per second as the maximum velocity, then the smallest quantity of reciprocating water can be calculated for a given set of conditions. Theoretically a comparatively short pipe of large diameter is better than a long pipe of smaller diameter, for not only can larger quantities of water be pumped without exceeding the maximum velocity of flow, but the time of a cycle is less with the short pipe. With a given difference of pressure between the two ends of the column, the acceleration is the same per unit of cross-section for all diameters of pipe of the same length, and a given volume of ignited gases can therefore expand to atmosphere in a shorter time when the delivery main is of a larger diameter. In the pumps so far constructed the diameter of the delivery main has been made almost as large as the diameter of the combustion chamber, if the latter is of cylindrical form. The periodicity of the cycle also depends on the length of the discharge pipe, and lengthening the pipe reduces the number of cycles per minute. It is found in practice that as the head against the pump increases, the minimum length of the discharge pipe must also be increased, so as to allow time for the water from the suction tank to rise in the combustion chamber before the column in the discharge pipe returns.

Supply tank.—Since the volume of combustible mixture drawn into the combustion chamber is partly dependent upon the level of water in the supply tank, any alteration in this level affects the working of the pump and affords one simple method of regulating the amount of energy developed at each cycle. Thus, by raising the level of the water, smaller charges are drawn in, and, conversely, by lowering the level, larger charges result. A float controlling the inlet to the supply tank may thus be used to regulate the output and power.

Compression pressure.—The thermal efficiency of any apparatus deriving its energy from the expansion of an ignited combustible mixture depends upon the pressure to which the mixture is compressed before ignition; therefore high compression pressures are desirable within certain limits. The fact that the column of liquid which returns to compress the fresh combustible charge in the pump attains velocity in so doing, and then has its kinetic energy transformed into pressure energy, is most useful in this respect, for it enables compression pressures to be used greatly exceeding the static pressures due to the head of water which causes the return flow. Fig. 2 will serve to make this clear. If the ordinate A B represents the pressure due to the static head of water, and if A D represents the distance through which the column of water moves while compressing the charge, the work done is represented by the rectangle A B C D. An equivalent amount of work must be stored in the compressed gases, but as their pressure was only that of the atmosphere at starting, their final pressure will be at E, so that the area A E D is equal to that of the rectangle, and the two shaded areas are equal to one another.

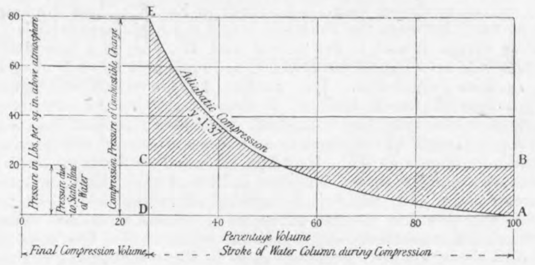


FIG. 2.—*Compression Pressure due to a Lift equal to 20 lbs. per sq. inch*

As the compression pressure is raised, the average pressure throughout the stroke is also raised, which means that the pump can deliver water against a greater head, but the greater head causes a greater compression pressure, and hence the pump is largely self-regulating. Thus, if called upon to pump against a greater head, the compression pressure automatically rises and brings about conditions favourable for the increased work it has to do.

Cushion space.—The volume of the top of the combustion chamber, above the level of the exhaust valve, forms a clearance space comparable with the clearance space of an ordinary Otto cycle gas engine, and the products of combustion which remain in this space are mixed off with the fresh combustible charge, and thus dilute this charge. This fact limits the amount of the clearance space in its relation to the charge volume, and if this proportion is kept at about the same as in gas engines—namely, about 20 per cent.—then it happens that, as the head against which the water is delivered increases, the maximum cushion pressure may rise above the explosion pressure. This is specially the case if a pump designed for using small charges is worked with large charges of combustible mixture, since this is equivalent to reducing the clearance space ratio. Although an astonishing amount of elasticity in working conditions is possible, yet it is desirable to overcome any objection which may be raised on account of the high cushion pressure. This can be done in a very simple way by making the clearance space much greater than in an Otto cycle engine and using an effective scavenging device, so that practically pure air exists in the clearance space, and the combustible charge drawn in can then be richer in gas.

The clearance space being enlarged in this manner enables the requisite energy to be stored in the cushion at a lower maximum pressure.

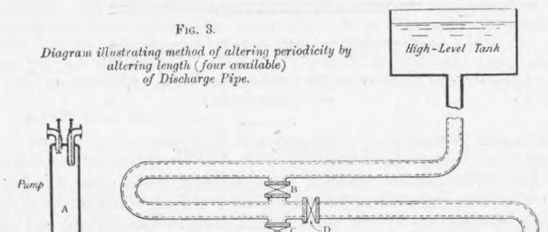
Scavenging.—Positive scavenging arrangements, when applied to gas engines, involve the use of pumps of some kind, and therefore add to the number of parts and to the complication of the apparatus. In the author's pump, scavenging is a very simple matter, as it is only necessary to ensure that there is sufficient inertia in the water on the supply side to prevent this water flowing so quickly into the delivery pipe as to meet the full requirements of the moving column, and the result is at once to cause the moving column to draw part of its water supply from the combustion chamber and thus lower the level therein. Then, instead of exhaust products flowing outwardly past the exhaust valve, when the exhaust first opens, air will be drawn in past this valve, and later, when the water rises in the chamber, to drive out the burnt products, it will leave a mixture of air and products in the cushion space. This, in fact, is what happened in the first pump constructed, for however close the supply tank may be to the delivery pipe there is enough inertia to produce the effect. If a long exhaust pipe is used to conduct away the burnt gases, these gases alone would be drawn back, and, as it is not desirable to work without an exhaust pipe, the scavenging effect can be turned to much better advantage by introducing a special scavenging valve and giving the combustion chamber a suitable shape, and this has been done in later constructions.

Operation of the valves.—All three valves being at liberty to move, so soon as there is any difference of pressure to move them, open and shut quietly unless the speed of working is allowed to become too great. The shutting of the exhaust valve by the impact of water upon it was not expected to take place with such absolute certainty and precision as is actually found; indeed, the exhaust valve was not originally designed as a simple valve, but when this simple form was tried it worked so well that its adoption now forms one of the features of the pump.

The suction which produces scavenging also tends to open the inlet valve—Fig. 1—and draw in some combustible gases which might then be wasted by passing away in the exhaust. This can be prevented by tightening up the spring on the admission valve, but this method involves frictional losses in drawing in the charge.

FIG. 3.

Diagram illustrating method of altering periodicity by altering length (four available) of Discharge Pipe.



This difficulty, and also the necessity for some connection for operating the exhaust valve from the water valve, is obviated by the introduction of a new design of valve gear, which is described later, and in pumps as now constructed the inlet and exhaust valves mutually control one another so that no connection with the water valves is wanted.

Starting, stopping, and controlling.—In first starting the pump all that is necessary is to allow a charge of compressed air to flow into the combustion chamber, and so depress the water level a little below the usual charge volume. If the exhaust valve is now forcibly opened the water will rise in the chamber, close the exhaust valve, and give the cushion and charging strokes. The charge drawn in is then fired and the pump starts working. If the pump is at work and it is desired to stop it, it is only necessary to switch off the current which operates the sparking coil. The pump then stops with a charge of unexploded mixture in it, and can at any time be started again by merely switching on the current. Such simple and instantaneous means of starting and stopping enable the pump to be controlled from a distance—in fact, it can be operated from a switchboard at any convenient place.

The general methods of controlling a gas engine are applicable to the pump. Thus, the inlet valve may be fitted with a throttle valve controlled by the pressure or height of the water, and either the mixture or the gas alone may be governed according to the power to be developed. There is, however, something to be said for allowing the pump always to work at maximum capacity, and then a float on the high-level tank may serve to cut off the ignition, and to switch it on again as the water rises and falls between two fixed levels. The methods of controlling the pump by altering its periodicity have already been referred to, and it is easy to arrange that a portion of the delivery pipe shall be cut out or put into action so as to alter its effective length. This may be done by valves, as shown diagrammatically in Fig. 3. Thus the longest pipe route between the chamber A and the high-level tank will be when valves B and C are closed and D open, and the shortest route will be when valves B and C are open and valve D closed.

Ignition apparatus.—The author has invented an ignition apparatus in which ignition is determined by the compression pressure reaching the maximum incidental to each particular charge. It will be sufficient to describe one form of the apparatus, which is shown in Fig. 4, and is intended to work on the high-tension system with the use of an induction coil. The low-tension circuit supplying the coil is capable of being broken at three points by switches marked *a*, *b*, and *c*. When all three switches are closed simultaneously sparking occurs. In the apparatus shown there is a piston *d* acted upon by the water in the chamber, so that the pressure which exists at any moment in the combustion chamber is transferred by means of a water connection to the apparatus, and acts upon the right-hand side of piston *d*, causing compression of the spring *e*, and a movement of the piston-rod to the left. The piston-rod which projects outside the cylinder has attached to it one end of a band *f*, which passes over a pulley *g*, and has its other end attached to a spring *h*, and in turn the pulley *g* carries a switch arm *j*, which has its movement limited by two stops. When passing between these stops it rides over contact *k*, and closes the circuit so far as this switch is concerned. On the piston-rod is a collar *l*, which at pressures below the desired range of compression pressures moves switch lever *m*, and breaks the circuit at this point, and at pressures above the range of compression pressures, moves switch lever *n*, and breaks the circuit at this other point.

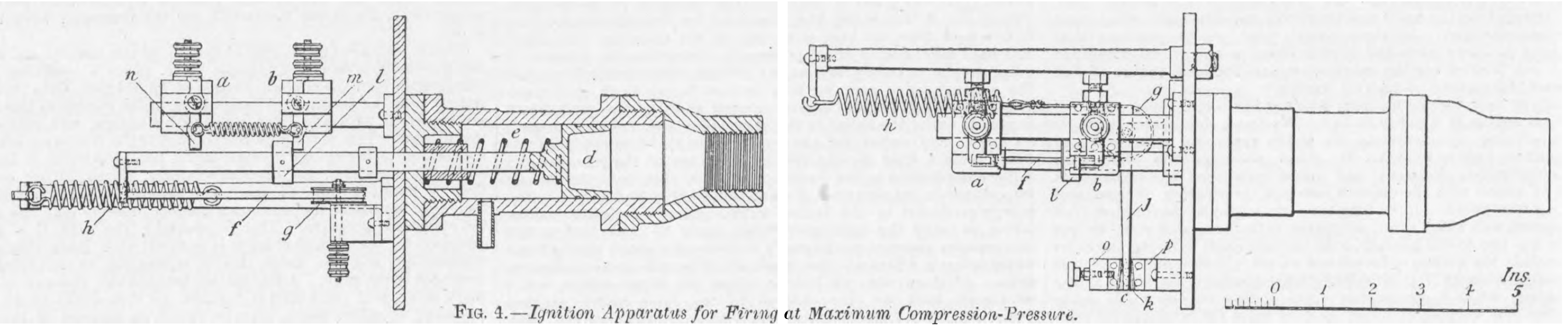


FIG. 4.—*Ignition Apparatus for Firing at Maximum Compression-Pressure.*

The action of the apparatus is as follows:—At atmospheric pressure switch arm *j* is against stop *p*, switch *b* is open, and switch *a* is closed. As the pressure rises, switch arm *j* passes over the contact to stop *o*, and on further increase of pressure switch *b* is closed by the action of its spring. This state of affairs continues until the compression pressure has attained its maximum and begins to decline slightly, the band in the meantime slipping round pulley *g*. As soon, however, as a very small decrease in pressure takes place, the friction of the band on the pulley causes the switch arm *j* to pass on to the contact *k*, and, the other two switches being closed, sparking occurs. The charge is thus fired, and the increase of pressure arising from the explosion causes the switch arm to pass to the stop *o*, and also opens switch *a*. Expansion now takes place and the switch-arm passes from stop *o* to stop *p* as the pressure diminishes, and then switch *a* closes and *b* is opened, so that we again arrive at atmospheric pressure with everything in readiness to start a fresh cycle. In the type of pump already described the cushion pressure gives rise to another maximum, but this pressure being above the range of the compression pressures switch *a* is then open and the passage of the switch-arm *j* over the contact *k* does not in this movement produce a spark. This ignition apparatus is applicable to all types of the author's pumps, and entirely safeguards any chance of pre-ignition, since ignition can only occur just after the compression pressure has attained its maximum. When the pump is to run at a steady load, it is sometimes convenient to cut out the operation of the switch-arm *j* and to set switch *b* in such a position that it closes just at the right compression pressure or slightly before it is reached. In this case there is another spark produced on the cushion stroke, but as there is then no mixture to fire it does no harm. The author has also invented an ignition apparatus which will produce a spark slightly before the maximum compression pressure, whatever this maximum pressure may be; but the apparatus just described has been found so satisfactory that it has been used throughout most of the experiments.

(*To be continued.*)

LETTERS TO THE EDITOR.

(*We do not hold ourselves responsible for the opinions of our correspondents.*)

CENTRIFUGAL FORCE.

SIR,—Discussions like that on centrifugal force now proceeding in your correspondence columns possess a much wider interest than may be apparent at first sight. The superior person may say that the question raised by "Pater" is only one of the "catch questions" to be found in "popular" scientific publications. I think, however, that it is only a manifestation of a desire which has been fostered by such men as Stallo, Mach, Poincaré, Andrade, Hertz, and others to substitute clear rational concepts for mathematical formulæ. It is to be regretted, I think, that with one notable exception all those who advocate clear thinking are foreigners—American, French, German, Swiss—never Englishmen. It has been well said that algebra is a good servant and a bad master. It is not necessary that the use of formulæ should be associated with concepts of any kind. I have, indeed, heard it said that one of its most beautiful characteristics was that its use need not involve any mental capacity. You put a certain proposition in at one end, and out of the other comes the result. Take, for example, the fourth dimension. It is, of course, impossible for the mind of man to form a concept of a fourth dimension, but the mathematician has proved that in fourth dimensional space it would be impossible to turn a bladder inside out, or to tie a knot in a piece of string. There are numbers of statements made to students about which it is either impossible to frame any concept whatever, or which involve glaring contradictions. How, for example, is it possible to frame a concept of a condition of matter in which it does at one and the same time do that which is impossible and yet obey a dynamic law? We are told that force can impart motion to mass, and yet that every force is balanced by another and precisely equal force. The teacher, failing himself to form any concept of the predicated condition, and therefore unable to impart it to anyone else, changes his ground and tells the student that what he is really dealing with is a stress, overlooking or avoiding the noxious circumstance that he has not explained in any way how a stress the two sides of which are equal can impart motion to mass.

The question raised by "Pater" is much the same in kind, only more complex. We are asked to form a concept of a constant acceleration which in the next breath we are told has no existence, and of two forces at right angles to each other which balance each other. The thing is obviously impossible. The result, judging from what is found in text-books, is that no attempt whatever is made to give any rational explanation of that which takes place. I dare not trespass on your space, Sir, by sending you a number of quotations in proof of this statement. I shall confine myself to three. The first is from "Elementary Mechanics," by Dr. Oliver Lodge. This small work, a new edition, completely revised by the author and Mr. Alfred Lodge, Professor of Pure Mathematics at Coopers Hill, was published in 1896. I am not aware that the authors have thought any alteration since that date necessary or desirable.

On page 17 I find: "A point moving in a curve, besides any acceleration it may have *along* the curve increasing its velocity, possesses an acceleration at *right angles* to the curve or normal to the direction of its motion, this acceleration being proportional to the curvature of the curve, and affecting only the direction and not the magnitude of the velocity. Its magnitude is the rate at which velocity normal to the curve is gained by the point. This normal acceleration is called centripetal acceleration, and is further discussed in sections 58-61, where it will be found to be proportional to the square of the velocity of the point as well as to the curvature of the curve; to be equal in fact $v^2 \times \frac{1}{r}$."

The first question asked by the student may, perhaps, be—What is the meaning of "acceleration"? He turns to page 11 and finds: "The rate of change of velocity is called acceleration; velocity may change in magnitude and direction, and the rate of either change is called acceleration."

In a revolving fly-wheel, or in the case of the stone and the string, there is no change supposed to take place in velocity. Therefore the word used in the first passage I have quoted must have some other meaning than that given in the definition.

I turn back to page 17 and I find that Sir Oliver Lodge deemed some explanation necessary, and accordingly goes on: "Athough the point is always *gaining* velocity normal to the curve or along its radius at this rate, it does not follow that it ever *possesses* any such velocity. It is, in fact, impossible for a point to possess any velocity except that along the curve, or at right angles to the radius of curvature, for as fast as velocity *along* the radius is generated, so fast does the direction of the radius change; in the same sort of way that a promise for to-morrow need never be fulfilled, because to-morrow never comes." The italics are the author's.

I do not think that any of your readers will feel disposed to say that such language as this helps them to form a concept of what really takes place when a mass revolves round a centre.

If we turn to Clerk Maxwell's "Matter and Motion," page 96, we find "when a body moves with uniform velocity in a circle, its acceleration is directed toward the centre of the circle, and is a third proportional to the radius of the circle and the velocity of the body," and a little further on: "The force which really acts on the body being directed toward the centre of the circle is called Centripetal Force, and in some popular treatises the centripetal and centrifugal forces are described as opposing and balancing each other, but they are merely the different aspects of the same stress."

Turning now to Rankine—"The Steam Engine and Other Prime Movers"—we have: "It is one consequence of the second law of motion that, in order that a body may move in a curved path, it must be continually acted upon by an unbalanced force at right angles to the direction of its motion." But the third law of motion tells us in the plainest possible language that there is no such thing as an unbalanced force. Passing on we find: "In a machine each revolving body tends to press or draw the body which guides it away from its position. . . . Deviating force and centrifugal force are but two different names for the same force applied to it according as the condition of the revolving body or that of the guiding is under consideration at the time." Further quotation is, I think, unnecessary.

No one, so far as I am aware, has stated that the revolution of a mass is merely an accident of the whole case. The centrifugal effort is apparently precisely that which would be expended in pulling the mass along a straight line equal in length to the diameter of the circle described, in the time occupied by the mass in making half a revolution. The rotary motion *qua* rotation has nothing whatever to do with the matter. The mass is not in this case an active but an inert agent. The tangential action assumed to exist has no existence. The tangential factor does not cause the pull on the string; it could not do it.

There remains for consideration the apparently irreconcilable facts that although the mass is accelerated no work is done. Text-books attempt no explanation of this save that the forces at work are "balanced"; but this will not do, for there is no such thing as an unbalanced force, and so, before any concept based upon words can be formed, we must find some new words to express our meaning. "When," says Poincaré, "we say force is the cause of motion we are talking metaphysics." Speaking of acceleration, the great mathematician writes: "The acceleration of a body is equal to the force which acts on it divided by its mass. Can this law be verified by experiment? If so, we have to measure the three magnitudes mentioned in the enunciation—acceleration, force, and mass. I admit that acceleration may be measured, because I pass over the difficulty arising from the measurement of time. But how are we to measure force and mass? We do not even know what they are. What is mass? Newton replies, 'The product of the volume and the density.' 'It were better to say,' answer Thomson and Tait, 'that density is the quotient of the mass by the volume.' What is force? 'It is,' replies Lagrange, 'that which moves or tends to move a body.' 'It is,' according to Kirchoff, 'the product of the mass and the acceleration.' Then why not say that mass is the quotient of the force by the acceleration? These difficulties are insurmountable."

Lastly, may I point out that no one knows why the stone does not continue to move in a circle after the cord is cut. A normal condition of matter is rotation—for example, Lord Kelvin's vortex theory, to name only one illustration out of dozens. There is a multitude of irreconcilables in the mechanics of the universe. They exist because of our lack of knowledge and brain power. But the business of the instructor of youth is to keep these things out of sight. It would be much better if their existence was frankly acknowledged instead of leaving them to be ultimately discovered by puzzled thoughtful students.

X.

SIR,—I am sorry I have not been able to clear up "Pater's" difficulty. Of course, it is quite possible that the remarks in my last letter are to be found in most text-books, as I should imagine that, since centrifugal force was discovered, nearly everything that it is possible to say on the subject has been said; all the same, I have not been able to consult the book mentioned by "Pater."

Having carefully read "Pater's" letter, though he does not seem to have done the same with mine, I have been struck by a most extraordinary paragraph. The paragraph is this:—"Secondly, let the circumference of the circle be, say, 20ft., and a revolution be made in one second. If, now, the string were cut, the stone would fly tangentially to a distance of 20ft. in one second. The work done then consists in 'accelerating' the stone through a distance of 20ft. in one second." Let us hope it is a slip. Otherwise, "Pater" must think that there is a force acting on the stone for the whole of the 20ft. after the string is cut, or he does not recognise the difference between "acceleration" and "velocity."

Let me quote still another paragraph, which evidently refers to my own letter. "Pater" says: "I cannot for the life of me see how the cutting up of the time of action or space of action of a force can so alter its direction that it can be made to balance another force at right angles to it." This seems to suggest that I thought there were two forces at right angles to each other, though I say distinctly at the end of the letter that there are only two forces acting upon the stone when in motion as assumed, and that these forces are equal and opposite. There is no tangential force at all under the conditions assumed.

Referring again to "Pater's" letter, he says:—"If the pull is due to the movement of the stone, then the reduction of movement must reduce the pull, and in the end there would be no movement and no pull. If by "movement" "Pater" means "velocity," then his conclusion is quite correct, no velocity no pull. If he uses the word "movement" meaning space travelled, then either he does not grasp the meaning of the term "in the limit," or he does nor understand the diagram which he gave in one of his letters, and to which I referred in my last letter, where I pointed out that "he will find that the fewer the number of degrees included in his diagram, the less the amount of work per degree travelled, while the calculated amount of centrifugal force remains practically the same."

"Pater" then wants to know why the same reasoning cannot be applied to the case of a projectile. It is obvious that the two cases are not parallel, when it is understood that in the case he instances, the projectile is moving with a uniform acceleration towards a fixed centre, the centre of the earth, while in the case of the stone it remains at a fixed distance from the centre. If he requires a parallel case, let him consider the case of a weight resting, say, on a table, and being carried along in a train running on a level with a uniform velocity. The case, then, is nearly analogous to the case of a stone travelling in a circle with a uniform velocity at the end of a string. There is no tangential force on the weight, as any work done by the engine is done merely to overcome frictional resistance. The force of gravity represents the centrifugal force in the case of the string, and the resistance of the table which prevents the weight from falling, represents the force exerted by the stone owing to its inertia, or resistance to change of direction. Could the train be persuaded to travel fast enough, the table would not be necessary to hold up the weight, the analogy between the two cases being then perfect. Now, "Pater" must admit that gravity in the case I have instanced does no work on the weight; neither does the table, because the forces exerted by each are equal and opposite; and further, if he is prepared to admit the truth of Newton's first law, he must admit that the engine of the train, having attained a uniform velocity, does no work on the weight itself, but only against frictional resistance.

"Pater's" suggestion in his last paragraph is, of course, impossible, and until he can convince himself that at no time, under the conditions assumed, is there any tangential force acting upon the stone, it is impossible to clear up his difficulty by any argument which it is possible to bring forward in a letter.

November 22nd. FILIUS.

THE "HUMPHREY" PUMP.

SIR,—In your issue of the 22nd October you reprint Professor Unwin's report on the new Humphrey pump. In it he says that the efficiency of the centrifugal pump, working under similar conditions to those under which the pump in question was tested, will not exceed two-thirds, and might be less. Might I say that I do not consider that it would be less than two-thirds, as from experiments recently made I can guarantee that the combined efficiency of a gas engine and centrifugal pump will be not less than 66 per cent., and under certain circumstances would be higher. This is only taking a mechanical efficiency of 85 per cent. for the engine and 78 per cent. for the pump, which could be guaranteed when lifting 1621 gallons of water per minute to a height of 32ft. He further goes on to say that in order to do 16 pump horse-power it would be advisable to use a gas engine of 32 brake horse-power, "owing to its inability to carry an overload." Now, may I ask, is such admitted inability a weak point in the gas engine, and is it necessary or desirable, with such a steady load as pumping, to provide an overload capacity? In my opinion 16 pump horse-power with a centrifugal pump of 78 per cent. efficiency would only require a gas engine of 20.7 brake horse-power. Thus Professor Unwin's figure of 120 to 127 cubic feet of gas of 145 (average) B.T.U. per pump horse-power hour would be reduced to 83 cubic feet, bringing the consumption of fuel in a gas engine and pump to the same figure as in the Humphrey pump. Moreover, in a test recently made in Liverpool with a gas engine of 460 brake horse-power coupled direct to a centrifugal pump, it was shown that the consumption of coal gas of 550 B.T.U. was only 16.4 cubic feet per brake horse-power and 25.3 cubic feet per water horse-power. This is equivalent to 13,915 heat units, which is a similar result to that obtained in the Humphrey pump.

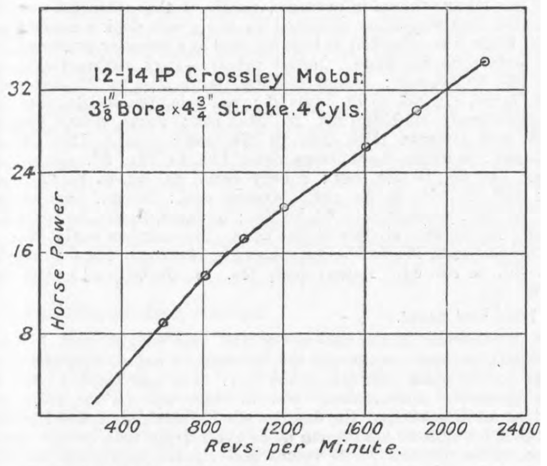
I also notice that in the paper read yesterday by Mr. Humphrey before the Institution of Mechanical Engineers he stated that the consumption of anthracite coal is 1.06lb. per pump horse-power hour, that this is about half the coal consumption of the higher class of steam pump, "and is also considerably less than the ordinary gas engine driving any kind of pump on the same water lift." I should like to point out that on a test carried out by an independent engineer at the Tendring Hundred waterworks with a suction gas engine pumping plant which my firm installed the consumption of anthracite per water horse-power was only .88 of a pound, and that at another pumping station in Surrey, with a somewhat larger plant, the coal used per pump horse-power worked out at .64 of a pound. These figures are vouched for by consulting engineers of high standing, so that they are beyond question. I should add that in both cases anthracite was the fuel used.

I am quite alive to the fact that the Humphrey pump is at present in a more or less experimental stage, and that no doubt the efficiency will be improved later on, but I think that meanwhile, in justice to an old and well-tried servant, namely, the gas engine, it is only right to call attention to these points.

Buxton, November 20th. D. HASTINGS IRWIN.

MOTOR CAR ENGINES.

SIR,—With reference to your very complimentary remarks in last week's issue in regard to the new 12-14 horse-power Crossley motor we note you state that 25 horse-power has been obtained from this motor, which has a bore and stroke of $3\frac{1}{8}$ by $4\frac{3}{4}$ respectively. We would like to say, however, that this figure is very considerably below the power that is actually obtained, because one of these motors on the test stand developed 35 brake horse-power at an engine speed of 2200 revolutions per minute. Of course we know that there has been considerable opposition to these high motor speeds on account of the alleged short life of bearings and vibration. We should like to add, however, that in our motors neither of these objections carry any weight, owing in the first place to forced lubrication with very high oil pressures, and also, secondly, to low bearing pressures, and the extremely accurate balancing of the reciprocating and rotating parts.



The above points, taken in connection with specially shaped inlet and outlet ducts—not necessarily large diameter valves—enable us to produce an engine which gives almost constant torque from 300 revolutions per minute to 2000 revolutions per minute.

We trust that the above remarks may be of interest as showing to what a high degree of development the small internal combustion engine has reached.

(CROSSLEY BROS., LTD.),
A. W. REEVES,
Works Manager (Motor Dept.).

Manchester, November 23rd.

P.S.—We enclose a torque curve which may illustrate the brake horse-power obtained at varying speeds very clearly.

LEGAL INTELLIGENCE.

MINERALS SEPARATION, LIMITED (APPELLANTS), *v.* BRITISH ORE CONCENTRATION SYNDICATE, LIMITED, AND ANOTHER (RESPONDENTS).

On the 16th inst. the decision of the House of Lords was given in this case, which was originally an action brought by the present respondents against the appellants for the infringement of two letters patent, namely, No. 21,948 of 1898, granted to Edward Elmore, and No. 6519 of 1901, granted to Alexander Stanley Elmore. It was tried by Mr. Justice NEVILLE, who held that the defendants—the appellants—had not infringed either patent, but did not arrive at any specific conclusion as to the validity of the second patent, though he held that if the true construction of the specification appended to it was such that it would be infringed by what the appellants had done, it would be invalid for want of novelty. He therefore dismissed the whole action. The Court of Appeal upheld the judgment of Mr. Justice Neville as to the patent of 1898, but set it aside as to the patent of 1901, and made an order that judgment should be entered for the present respondents as to this latter, for an injunction, and for an inquiry as to damages and for certain consequential damages.

In the patent of 1898, pulverised ore was first mixed with water so as to make what was, in effect, a pulp. Thick oil was then added, and as a result the water with the rocky substance or gangue remained at the bottom of the vessel, while the oil entrapped the metallic particles and floated them to the surface, where they were run off. The patent of 1901 was, briefly stated, for the addition of acid to a mixture consisting of pulverised ore, water, and oil. The case largely turned on the amount of oil used.

When judgment was delivered four Lords were present, viz., the Earl of HALSBURY, Lord ASHBOURNE, Lord ATKINSON and Lord SHAW OF DUNFERMLINE. The first-named read the judgment of the LORD CHANCELLOR, who differed from the Court of Appeal, and held that the patent of 1901 could not be sustained. Lord HALSBURY entirely agreed with the LORD CHANCELLOR. He was of opinion that the two inventions were essentially different. Lord ASHBOURNE concurred. Lord ATKINSON said that the decision of the case depended entirely upon the construction of the complete specification appended to the 1901 patent. Taking the specification as a whole, it was not possible, in his opinion, to hold that the invention claimed lay in the mere addition of acid in small quantities to a mixture of ore, water, and a relatively infinitesimal quantity of oil, reduced to a freely flowing pulp. He had come to the conclusion that the specification provided for the addition of a considerable quantity of oil, and not a small quantity as had been argued. He thought the judgment of the Court of Appeal was erroneous, and should be reversed. Lord SHAW, in the course of a lengthy judgment, stated that in his opinion the judgment of Mr. Justice NEVILLE had reached a sound result, after covering with care and completeness the whole grounds of the case. He held that the appeal should be allowed.

As a result the order appealed from was reversed, and the respondents were ordered to pay the appellants' costs both in the House of Lords and in the Courts below, the case being thus decided finally in favour of Minerals Separation, Limited.

UNIVERSITY COLLEGE, LONDON.—A special advanced course of lectures for post-graduate students, telegraph and telephone engineers, and electrical engineers, on "The Theory of the Propagation of Electric Currents in Telegraph and Telephone Cables and in Electric Conductors," will be delivered by Professor J. A. Fleming at University College, beginning on January 19th.

THE IRON, COAL, AND GENERAL TRADES OF BIRMINGHAM, WOLVERHAMPTON, AND OTHER DISTRICTS.

(*From our own Correspondent.*)

Trade Prospects.

THE ironworks are engaged upon orders received some time since. New business is scarce, and the lines that are being given out are nearly all small. It is now accepted by Staffordshire ironmasters as a foregone conclusion that selling will be quiet up to the end of the year. In the bar iron trade the cutting of prices is a matter of much complaint, and it is particularly rife amongst the makers of the commonest qualities. Nut and bolt and fencing and hurdle bars are reported to be selling at £5 15s., and Belgian competition in this brand continues very severe. Unmarked merchant bars are weak, and are now obtainable at £5 17s. 6d., the late quotation of £6 having had to be freely abandoned. District mills are not employed more than about four days a week.

Galvanised Sheets Excellent.

An exception to the condition prevailing in the other branches of the finished iron trade is furnished by the galvanised sheet branch, in which business is showing a tendency to improve. Orders are coming in more freely, and quotations are inclined to stiffen. Prices have recovered a more steady equilibrium, thanks chiefly to a brisk export demand. Leading houses quote £11 and upwards for 24-gauge corrugated sheets, f.o b. Liverpool, and, with a fair amount of business offering, underselling has ceased for the moment to be an element in the situation. The black sheet trade is depressed, business dragging at the low quotations of £7 2s. 6d. for doubles and £7 15s. trebles.

Raw Material Weaker.

With practically no buying in raw material except for urgent necessities, it is not surprising that prices should be losing ground. This is particularly seen in the pig iron trade, the supporting influence of the outburst of buying which occurred at the beginning of September, and which forced up prices, having been entirely exhausted. Production is being curtailed, and it is now only possible to effect sales by substantial concessions of customers. On 'Change to-day (Thursday) in Birmingham a few parcels of pig iron changed hands, but for the most part the market was idle. Low grades of South Staffordshire iron could not be sold at 45s. Part-mine was quoted at about 48s. to 49s., best all mine at 85s., and cold blast at 115s. Northamptonshire common sorts stood at about 47s., and Derbyshire was about 48s. to 49s.

Steel Trade.

The steel trade is featureless, if the loss to this district, noted last week, of the big contract for constructive material to be used in the erection of the new Birmingham workshops of the Midland Railway Carriage and Wagon Company is excepted. That was a severe loss, and though the work (having gone to Cleveland) has been kept in the country, we shall not cease to hear Staffordshire's want of luck in the matter regretted for some time to come. Bessemer half-product sheet bars are offered at £4 15s. to £4 17s. 6d., and other quotations are mild bars £6 7s. 6d. to £6 17s. 6d., angles £5 17s. 6d. to £6, joists £5 15s. to £6, girder plates £6 to £6 2s. 6d., boiler plates £7 5s.

Brass and Copper Tubes Advanced.

In consequence of the continued upward movement in copper, the price of brass and copper tubes has been advanced 1s. 4d. per lb., and the current brass values are now, therefore, as follows:—Brass condenser tubes, $8\frac{1}{8}$d. per lb; brass loco. tubes, $7\frac{1}{2}$d.; brazed and seamless copper tubes, $8\frac{3}{4}$d. per lb. Yellow metal condenser plates are also advanced, and are quoted at $6\frac{1}{4}$d. per lb. It is fully anticipated that should the copper market go higher, as seems wholly likely, a further rise in the prices of these classes of goods will occur in the near future.

NOTES FROM LANCASHIRE.

(*From our own Correspondent.*)

MANCHESTER, Thursday.

A Slump in Pig Iron.

THE month closes with what may be described as a "slump" in pig iron. Although makers still adhere to their official prices, there is still considerable offering of second-hand lots, but demand on spot continues so poor that the lower prices at which the iron is quoted do not tempt buyers. When the overplus has been cleared, matters may be expected to resume their normal course. Although West Coast hematite is lower on the month by 1s. to 1s 6d. per ton for delivery over next year, 2s. 6d. per ton more is asked over and above current rates. East Coast hematite shows little change, but Middlesbrough open brands are 6d. per ton lower. Lincolnshire is 1s. and Staffordshire is 6d. per ton lower. Scotch sorts show reduction of 1s. to 1s. 6d. per ton, but there is a firmer feeling at the close on the part of makers. Forge iron is also firm at the close, but there is little doing on spot. In view of the present political position, it is not expected in commercial circles there will be any revival in this trade for some time to come, and the outlook is most unsatisfactory both for producers and consumers.

Finished Iron and Steel.

Business is still dull. Foreign billets are now nearly on a parity with English.

Copper, Sheet Lead, and Tin.

Sheets show an advance on the month of £4 per ton; tough ingots, £3 per ton; and tubes are quoted $\frac{1}{4}$d. per lb. higher. There is, however, not much inquiry on spot. Sheet lead: Unchanged, but generally steady. Tin: English ingots have been rather variable, but close about £4 10s. per ton higher on the month.

Quotations.

Lincolnshire No. 3 foundry, 55s.; Staffordshire, 53s. 6d.; Derbyshire, 55s.; Middlesbrough, open brands, 59s. 10d. Scotch: Gartsherrie, 61s.; Glengarnock, 60s. to 60s. 6d.; Eglinton, 59s., delivered Manchester. West Coast hematite, 61s. to 61s. 6d.; East Coast ditto, 60s., both f.o.t. Delivered Heysham: Gartsherrie, 59s.; Glengarnock, 58s. to 58s. 6d.; Eglinton, 57s. Delivered Preston: Gartsherrie, 60s.; Glengarnock, 59s. to 59s. 6d.; Eglinton, 58s. Finished iron: Bars, £6 10s.; hoops, £7 12s. 6d.; sheets, £7 15s. to £8. Steel: Bars, £6 2s. 6d. to £6 5s.; Lancashire hoops, £7 5s.; Staffordshire ditto, £6 17s. 6d. to £7; sheets, £7 17s. 6d. to £8; boiler-plates, £7 5s. to £7 7s. 6d.; plates for tank, girder, and bridge work, £6 5s. to £6 7s. 6d.; English billets, £4 12s. 6d. to £4 15s.; foreign ditto, £4 10s. to £4 15s.; cold drawn steel, £9 10s. to £9 15s. Copper: Sheets, £74; tough ingot, £64; best selected, £64 per ton. Copper tubes, $8\frac{3}{4}$d.; brass tubes, $7\frac{1}{8}$d.; condenser, $8\frac{1}{8}$d.; rolled brass, $6\frac{1}{2}$d.; brass wire, $6\frac{3}{4}$d.; brass turning rods, $6\frac{3}{4}$d.; yellow metal, 6d. to $6\frac{1}{8}$d. per lb. Sheet lead, £17 per ton. English tin ingots, £139 10s. per ton.

The Lancashire Coal Trades.

The sudden change in the weather to comparative mildness has prevented merchants realising the higher prices they anticipated for house coal, while the state of the cotton trade is causing a decreased consumption of slack and manufacturing coal generally. Shipping coal may be described as in fairly good demand, and prices have an upward tendency.

The Engineering Trades.

According to the official returns in Lancashire during October, employment continued slack generally. In Oldham, Bolton, and Blackburn district it was worse than a month ago and a year ago, and much short time was reported. It was still good, however, with electrical workers in Oldham, where it also improved with brassfounders.

BARROW-IN-FURNESS, Thursday.

Hematites.

There is again less activity to report in the hematite iron trade. This, however, is not likely to be maintained for long, as the immediate outlook is more encouraging. To some extent the present position has been brought about by the accumulation of stocks in makers' yards and in warrant stores, and this has been accepted as an indication that prices will be reduced in accordance; but this is not likely to be the case, as the consumption of iron is likely to increase, owing to fuller demands on the part of steel, and further inquiry from America. Indeed, some large sales of hematite iron have been made this week for delivery in the early months of the New Year. These represent repeat orders, and are expected also to mean a continuance of business for deliveries in the spring months of 1910. There cannot, however, be much settled activity until there is a better trade done with the Continent, the Colonies, and foreign nations generally, as the iron industry in this district cannot be kept going with the home demand, even when it is comparatively brisk. There has been an increase in warrant stocks during the week to the extent of 1495 tons, and the stocks now bulk at 18,631 tons. There is not likely to be any further increase in stocks this year, as smelters will require all the iron they produce to cover their delivery engagements. Prices are difficult to quote. Nominally mixed Bessemer numbers are at 62s. 6d., but 61s. 3d. is more like the sale price. Special iron is selling at 64s. and 65s., according to quality and specification. Warrant iron sellers are at 60s. $7\frac{1}{2}$d. net cash, with 61s. 6d. three months. The iron ore trade is fairly steady at 12s., 14s. 6d., 18s. per ton net at mines for ordinary medium and best classes.

Steel.

There is an improvement in the steel trade in the Bessemer department, and there is a promise of fuller activity at the mills than there has been recently. This department of the Barrow works is well employed, and so also is that of the Derwent Works at Workington, but the Moss Bay Works at Workington are idle in consequence of necessary repairs and improvements. There is every reason to believe that the Bessemer steel trade will remain brisk for a month or two at any rate, and makers are expecting in the meantime further orders will come to hand. There are not, however, prospects of an improvement in the mild steel trade. Next to no shipbuilding material has been made in this district for nearly twenty months. Merchant steel is in moderate demand.

Shipbuilding and Engineering.

Satisfaction is felt at Barrow at the marked success of H.M.S. Vanguard, which has gone through her gun and steam trials this week with such success and without a single hitch. She steamed at 22.4 knots, 1·4 above her specified speed, and thus proved herself the fastest battleship afloat. Engineers are much busier, and are expecting further orders.

Shipping and Coal.

The exports of iron and steel from West Coast ports last week amounted to 15,590 tons—iron 4435 tons, and steel 11,155 tons—as against 11.461 tons in the corresponding week of last year, an increase of 4129 tons. For the year to date the shipments aggregate at 554,786 tons, against 449,090 tons, an increase on the corresponding period of last year of 105,696 tons. Coal and coke are rather firmer.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

Steam Coal—Between Seasons.

THE condition of affairs in the steam coal trade remains very much as stated last week. Inquiries are being received for next year's contracts for shipping, and the local railway companies are also inviting tenders. The prices obtained for "spot lots" are, however, no criterion of the price that coalowners expect will rule in 1910, and there is no disposition at present to make forward contracts. A considerable quantity of coal has yet to be delivered to the railway companies under old contracts, and this enables coalowners to withhold disposal immediately except at rates a shilling or more in advance of last year. Generally the coal trade is very quiet.

House Coal More Active.

There is a little more being done in domestic fuel, both on account of local and distant districts. The increased supply of "seconds" coal, to which reference was made last week, is still a feature of the market, and these qualities continue in good request; but the abundance of supply retards any advance in household fuel quotations generally. Best Barnsley is quoted from 12s. 6d. to 14s. per ton; secondary descriptions, 10s. 6d. to 11s. 6d. per ton. From West Yorkshire it is reported that both manufacturing fuel and household qualities are in brisk request.

Small Coal and Coke.

In consequence of the decrease in shipment, there is a sensible curtailment of the output, which enables the small coal, used chiefly in the Lancashire and Yorkshire textile districts, to be disposed of, and prices still remain as before—from 4s. 6d. to 5s. 6d. per ton. The short time in the Lancashire cotton mills, therefore, coinciding with the lessened output of coal generally, makes the demand on the coalowners appear to be only normal, though actually a diminished weight of coal is being produced. There is a strong market for furnace coke at former quotations, best washed fetching from 12s. 6d. to 13s. per ton; unwashed, 11s. 6d. to 12s. per ton.

Iron.

The iron market is exceedingly quiet, and no change, by way of improvement, is looked for this year. The prospects of a general election form another disturbing factor, accentuating the situation already existing, and militating against the placing of orders. This remark, of course, applies to business generally. Quotations:—West Coast hematites, 68s. to 70s. per ton; East Coast, 65s. to 67s. per ton, both net, and delivered in Sheffield and Rotherham. Current quotations are as follows:—Lincolnshire, No. 3 foundry, 52s. 6d. per ton; No. 4 foundry, 51s. 6d. per ton; No. 4 forge, 51s. 6d. per ton; No. 5 forge, mottled and white, 51s. 6d. per ton; basic, 52s. 6d. per ton—all net, delivered in Sheffield and Rotherham. Derbyshire, No. 3 foundry, 52s. per ton; No. 4 forge, 50s. 6d. per ton, both net, delivered in Sheffield and Rotherham.

Bars, Hoops, and Sheets.

No change. Business all round very languid, and no signs of any improvement in the near future. Bars, £6 10s. per ton; hoops, £7 10s. per ton; sheets, £8 10s. per ton. The foundries and the finished trades generally are in a depressed condition throughout the district.

The Heavy Industries.

Nothing has yet been heard in Sheffield of further Government orders in connection with battleships. Though the heavy trades at the East End are at present moderately employed, particularly on special lines, new orders are being anxiously looked for in order to provide work for the New Year. The situation at present existing is an improvement on what prevailed at the corresponding period last year, though a large accession of new orders would be required to afford satisfactory employment in the various establishments engaged in the heavy industries.

The Lighter Trades.

These are fairly well employed in several manufactures, more especially in tool steel for the United States. More business is also reported with Germany, and South Africa is taking a larger quantity of mining steel.

NORTH OF ENGLAND.

(*From our own Correspondent.*)

Cleveland Pig Iron.

Buying is almost at a standstill so far as the Cleveland pig iron trade is concerned, and business is duller than it has been for more than two months, while the tone is hardly so sanguine as it has been, and consumers are putting off the placing of their orders for next year's execution until they can judge better how trade and prices are likely to develop in 1910. The general opinion, however continues to be that next year will be a good one for producers of pig iron, but at present there are several circumstances which tend to unsettle the market and prevent buying. This week Wilson, Pease and Co., Limited, Tees Ironworks, Middlesbrough, have blown in a furnace which has been re-lined, and they now have all their three furnaces in operation producing Cleveland pig iron. Four furnaces have been restarted in the North-East of England since the close of last quarter. The prices of Cleveland pig iron have been weak this week. At the close of last week buyers of Cleveland warrants were offering 51s. 4½d. cash, but on Tuesday only 51s. could be got, and on Wednesday there was a further drop to 50s. 9½d. Makers' prices of Cleveland pig iron have dropped 3d. per ton, and they have generally sold No. 3 for prompt delivery at 51s. per ton, while No. 1 has been at 53s. 6d., No. 4 foundry at 49s. 6d., No. 4 forge at 49s., mottled at 48s. 6d., and white at 48s. For delivery over the first quarter of next year 9d. per ton more than these figures is generally asked. On Wednesday the decline in prices of copper led to Cleveland warrants falling to 50s. 9½d. cash buyers—the lowest figure since the middle of September—and No. 3 was reduced to 50s. 9d. for prompt delivery.

Hematite Pig Iron.

Not much buying is at present reported in the East Coast hematite iron market, but makers are well off for contracts, and undoubtedly the prospects are very encouraging, for almost all consumers of this description of pig iron report improvement in trade, and expect a good time next year. There is likely to be a fair demand from America for hematite. Some of the local consumers have bought rather heavily already for next year's delivery. Owing to the increasing cost of production, due to dearer ore and coke, makers of hematite iron are advancing their quotation. Mixed numbers are at 60s. per ton for prompt deliveries, 62s. 6d. for next quarter, and 65s. for delivery over the second quarter of next year. Nevertheless, small quantities are still obtainable from second hands at 59s. 6d. per ton for prompt delivery. At present the demand for Rubio ore is very slack indeed. No consumer needs to buy for early delivery, and merchants will not quote for forward—indeed, they dare not take the risk, because the Spanish mine-owners will not fix upon their rates, and where they do name a price it is much beyond anything the consumer can see his way to pay. The nominal figure for prompt delivery is 17s. 6d. for c.i.f. delivery Tees. Coke is very strong at 17s. 6d. per ton, delivered at Middlesbrough furnaces.

Manufactured Iron and Steel.

A lull must be reported in the buying of finished iron and steel, but that is not of much moment as most producers are well supplied with orders, having sold well for delivery over the first half of next year, and in some cases even further ahead. The prospects are now specially favourable for those producing plates and angles, and it is expected by some that the prices will be put up probably before the close of the year. The heavy booking of orders for new vessels has put most of those who supply materials in a very favourable position, but the iron plate trade seems to be the exception, for at the last meeting of the Middlesbrough Board of Guardians it was announced that a deputation from them had had an interview with the proprietors of the Newport Rolling Mills, who are producers of iron plates, with a view to affording more employment to their men, and thus making it less necessary for them to apply for relief. The firm intimated that the intermittent employment arose entirely through the depressed condition of trade and the lack of orders. They would, however, endeavour to employ the men every alternate week. The firm are going to manufacture steel instead of limiting themselves to iron, and they expect to have the new plant ready in about six months.

Shipbuilding and Engineering.

Business continues to revive in the shipbuilding industry and the prospects for the winter are much more favourable than any one looked for in the early autumn. Some improvements in the rates of freight are reported, indeed, in certain cases there have been advances of 1s. and even 1s. 3d. on the figures that ruled in September, whereas it was expected that on the closing of the Baltic and St. Lawrence navigations there would have been a general drop and heavy additions to the numbers of vessels laid up. A good many old and obsolete steamers are being broken up, and up to 30s. a ton is being secured for these old vessels, because there promises to be a large demand from America for scrap iron and steel, which pays a duty of only a dollar per ton as compared with four dollars under the old tariff. Thus the prospects for sellers of scrap metal must be accounted good. More activity is reported at the engineering establishments, and the number of hands employed has increased, but it cannot be reported that the prices obtainable are satisfactory.

Coal and Coke.

Improvement is reported in the coal trade, and it is expected that there will be heavy deliveries in December from the Durham and Northumberland collieries, as consumers abroad want supplies before the new Mines Eight Hours Act comes into force on January 1st. The opinion is that prices will be put up then owing to the increased cost of getting the coal. That may not come to pass, however, because German competition is unprecedentedly keen; the collieries there have heavy stocks of coking coal and coke, which it is determined to sell at almost any price. In former years Durham collieries have always got the order from the French State Railways for coking smalls, but for next year's delivery the 80,000 tons required will be obtained from Germany, and it is reported that the German prices were 1f. to 1½f. below those of the Durham competitors, which makes their price 8s. 6d. f.o.b., instead of 9s. 9d. as quoted by Durham. Best steam coals are quoted at 10s. 6d. f.o.b., and best gas at 11s.; bunkers at 9s. 6d., and coking coal at 10s.

NOTES FROM SCOTLAND.

(*From our own Correspondent.*)

General Condition of Trade.

There seems to be a widespread impression that the revival of trade has been arrested for the present, and this view gathers confirmation in various quarters. Speculative business has undoubtedly been much curtailed, mainly through onerous bank rates. Railway earnings have proved less satisfactory than was expected, the economies instituted by the different companies having, in the opinion of many, led to a restriction of traffic. The reduction of steamboat facilities in the Firth of Clyde has given rise to great dissatisfaction, and is undoubtedly tending to minimise business at coast towns, and perhaps the best indication that the policy of the railway companies in this respect has been carried too far is found in the resolution of private steamship owners to increase their tonnage in the coming season. On the other hand, the railway companies are suffering from the rapidly increasing tramway and motor facilities, which have spread to all centres of population. The companies have no free resources for the carrying out of necessary contracts, and to add to capital, which is already excessive, and may some day have to be reduced, may well lead to hesitation. Still, with all these drawbacks, the state of trade is undoubtedly better than it was twelve months ago. There is much less unemployment, and some industries, such as woollen manufacture, are now busier than they have been for many years.

The Pig Iron Market.

There has been comparatively little business this week in pig iron warrants. The dearness of money, the poor home inquiry, reports that Americans sometime ago secured the call of a large amount of warrants, and other considerations have taken the heart out of speculative business for the time. Cash business has been limited, and there has also been much less doing for future delivery. Business has been done in Cleveland warrants from 51s. 3d. to 50s. 9½d. cash, 51s. 8d. to 51s. 4½d. one month, and 52s. 3½d. to 52s. 0½d. three months. Sales have also been effected at 51s. 7½d. for delivery in twenty-five days, 51s. 4d. twenty-eight days, and 51s. eight days. There have been few, if any, transactions in hematite warrants.

Scotch Makers' Iron.

Much has been said on 'Change regarding the prospective wants of Canada and the United States, and reports have been current that considerable purchases have actually been made for those countries. Inquiries go to show that lots have been secured for shipment by the regular liners, but so far these would seem to be of moderate proportions. To what extent the trade may develop in the early part of next year, the inquiries now being made can hardly afford any reliable idea. The main difficulty in the arrangement of exports to Canada and the States appears to arise from the heavy freights which the steamship companies are under an obligation to charge by mutual agreement. Were the orders either to Canada or the United States of such bulk as to warrant the chartering of special tramp vessels, the freight difficulty would disappear. Current business in ordinary and special brands is of small proportions. The shipments are comparatively poor, and the inquiry on the part of malleable iron manufacturers is limited owing to very unsatisfactory business in that department. The output is maintained, there being 83 furnaces in blast in Scotland, compared with 77 at this time last year, and of the total in operation 43 are producing hematite, 35 ordinary, and 5 basic iron. Prices of pig iron are steady. Monkland, f.a.s. at Glasgow, No. 1, is quoted 57s.; No. 3, 55s.; Carnbroe, No. 1, 60s. 6d.; No. 3, 57s.; Clyde, No. 1, 62s.; No. 3, 57s.; Gartsherrie, No. 1, 62s. 6d; No. 3, 57s. 6d.; Calder, No. 1, 63s.; No. 3, 58s.; Summerlee, No. 1, 64s.; No. 3, 59s; Langloan, No. 1, 65s; No. 3, 60s.; Coltness, No. 1, 89s.; No. 3, 59s.; Eglinton, at Ardrossan, No. 1, 58s.; No. 3, 56s.; Glengarnock. No. 1, 65s.; No. 3, 59s. 6d.; Dalmellington, at Ayr, No. 1, 62s; No. 3, 57s.; Shotts, at Leith or Glasgow, No. 1, 63s.; No. 3, 58s; Carron, at Grangemouth, No. 1, 64s. 6d.; No. 3, 58s. 6d. per ton.

The Hematite Trade.

The imports of hematite ore continue on a fair scale for the season, thirteen cargoes having reached the Clyde from abroad in the course of the week. The hematite pig iron output is maintained at about the greatest on record, and considerable additions are, no doubt, being made to makers' private stocks; but at present prices it appears to be regarded as quite safe to continue a large production. The deliveries to consumers are considerable, but prices are 6d. per ton easier, merchants quoting 63s. for delivery at the West of Scotland steel works.

Shipments of Pig Iron.

The shipments of pig iron from Scottish ports in the past week were small, being 3600 tons, compared with 4698 in the corresponding week of 1908. There was despatched to Canada 200 tons, Australia 220, Holland 230, South America 34, India 175, France 192, Germany 20, Belgium 100, China and Japan 50, other countries 135, the coastwise shipments being 2246 tons, against 2310 in the same week of last year. The arrivals at Grangemouth of pig iron from Cleveland and district have been 9558 tons, showing a decrease for the week of 2396 tons.

Finished Iron and Steel.

There is no improvement in the malleable iron trade, and the competition from abroad is reported to be increasing. Belgian bars are obtainable delivered in the Clyde about 5s. per ton below the local prices. In some of the ironfoundries more men are being employed. There is a considerable business being done in structural iron and steel. Sheets, both plain and galvanised, are in good demand at steady prices. One or two fair orders for shipbuilding steel have come to hand, but work of this description is insufficient to keep the mills going fully. The local steel makers have still to compete with material arriving from Wales, of which a considerable quantity is being used in shipbuilding.

The Coal Trade.

There has been a rush for coal this week to make up for the block caused last week in business by foggy weather. Both shippers and home users have been purchasing more freely, and the advance made last week in house coal for home delivery is now extended in part to the shipping trade. At Glasgow harbour steam coal is quoted f.o.b. 9s. 6d. to 9s. 9d.; ell, 9s. 6d. to 10s.; and splint, 10s. to 10s. 3d. per ton.

WALES AND ADJOINING COUNTIES.

(*From our own Correspondent.*)

Last Week's Coal Trade (Cardiff.)

Some relief was afforded last week by the news that Admiralty orders were coming, and support was given to the statement by the fact that the usual inquiries were being made. These, up to the date of my despatch, have not come to hand, but little doubt is felt that they will be placed in due course. As the old members on 'Change say, "the authorities cannot do without Welsh coal." The situation is not without anxiety. Stocks have been steadily increasing, and the improvement in tonnage does not keep pace with it. The result has been that small concessions to buyers have followed, though not so much as expected, and that only to prompt business. For forward or December trade sellers do not relax from their quotations. On the whole, the outlook is not bad, and coalowners are hopeful, and say that any day the unexpected may take place, and the beginning of general improvement follow. The bituminous branch is firm; house coals are quietly advancing, and are quoted up to 18s.

Latest Coal Quotations.

Best large steam, 16s. 3d. to 16s. 6d.; seconds, 15s. 6d. to 16s.; ordinaries, 14s. 6d. to 15s..; best drys, 15s. 9d. to 16s. 3d.; ordinary drys, 13s. 9d. to 14s. 3d.; best washed nuts, 14s. to 14s. 6d.; seconds, 13s. to 13s. 6d.; best washed peas, 12s. to 13s.; seconds, 10s. to 11s. 6d.; very best smalls, 8s. 6d. to 9s.; best ordinaries, 7s. 9d. to 8s. 3d.; cargo smalls, 6s. 9d. to 7s. 3d.; inferior sorts, 6s. to 6s. 9d.; best Monmouthshire black vein, 15s. 3d. to 15s. 6d.; ordinary Western Valleys, 14s. 6d. to 14s. 9d.; best Eastern Valleys, 13s. 6d. to 13s. 9d.; seconds, 12s. 9d. to 13s. 3d. Bituminous coal: Very best households, 17s. to 18s.; best ordinaries, 15s. to 16s.; No. 3 Rhondda, large, 17s. 3d. to 17s. 6d.; brush, 13s. 6d. to 13s. 9d.; smalls, 10s. to 10s. 6d.; No. 2, large, 12s. 6d. to 13s.; through, 9s. 6d. to 10s.; smalls, 7s. to 7s. 6d. Patent fuel, 15s. to 15s. 6d. Pitwood, 19s. to 19s. 6d. Coke: Special foundry, 24s. to 27s. 6d.; foundry, 19s. to 20s.; furnace, 17s. to 17s. 6d.

Newport Coals.

Little alteration is to be noted. Occasionally good cargoes have been shipped, and, as authorities state, for a couple of weeks there has been a steadier tone evidenced by large shipments. Last week the total foreign was 73,620 tons and 1256 tons coastwise. Latest prices:—Best black vein, 15s. to 15s. 3d.; Western Valleys, 14s. 3d. to 14s. 6d.; Eastern Valleys, 13s. 3d. to 13s. 6d.; other sorts, 12s. 6d. to 13s.; best smalls, 7s. to 7s. 3d.; seconds, 6s. 3d. to 6s. 9d.; inferiors, 5s. 9d. to 6s. 3d. Bituminous: Best house coal, 15s. to 15s. 6d.; seconds, 14s. to 14s. 6d. Patent fuel, 15s. to 15s. 3d. Coke: Foundry, 18s. to 19s.; furnace, 17s. to 17s. 6d. Pitwood, ex ship, 19s. 3d. to 19s. 6d.

Swansea Coals.

There has been a falling off in attendance on 'Change, and less vigour shown in business, much of the attention usually directed that way being absorbed in the great dock proceedings. Still, trade was regarded as hopeful, and as a member expressed it, the undertone was good. Latest prices:—Best anthracite, malting, 23s. to 24s. net; second malting, large, 21s. to 22s. net; big vein, large, 17s. 6d. to 19s., less 2½; red vein, 12s. to 13s., less 2½; machine-made cobbles, 23s. to 24s. net; Paris nuts, French nuts, and German nuts, 26s. to 27s. net; beans, 18s. 6d. to 19s. net; machine-made large peas, 11s. to 12s. 6d. net; fine peas, 10s. 6d. to 11s. net; rubbly culm, 5s. 3d. to 5s. 9d., less 2½; duff, 2s. 6d. to 3s. net. Other coal: Steam, best large, 17s. to 18s.; seconds, 14s. 6d. to 15s.; bunkers, 9s. 6d. to 10s. 6d.; small, 7s. to 9s., all less 2½ per cent. Bituminous coal: No. 3 Rhondda, large, 18s. to 18s. 6d.; through, 14s. 9d. to 15s. 6d.; small, 10s. 3d. to 10s. 6d. Patent fuel, 13s. to 13s. 6d., all less 2½ per cent.

Iron and Steel.

Dowlais continues to be the one bright spot in the industrial prospect, although the rail bank is not so noticeable as when Indian State rails are on the way. The new plant, I hear, is very generally commended, and in time will be the scene of visiting and inspection; the engines are Philadelphian, and electric power is brought to bear much more extensively than in any other works of the district. The steam and electric power and incline hoppers dispense with a large amount of manual labour. The returns daily compare favourably with the past, and last week there was an acceptable demand for steel bar, a make for which Dowlais has long been commended even when dumping has been rife. Swansea imported 1773 tons of pig last week. Stocks of ingots are accumulating so much in the district that it is expected some furnaces will be laid by for a little. Latest quotations:—Pig: Hematite mixed numbers, 60s. 7½d. cash and month; Middlesbrough, 51s. 1d. cash, and 51s. 5d. month; Scotch, 57s. cash and month. Middlesbrough continues to export pig freely to Wales.

Quotations.

Welsh hematite, 66s. to 67s. 6d., delivered; East Coast hematite, 64s. to 65s., c.i.f.; steel bars, Bessemer, £4 12s. 6d. to £4 15s. Prices at Newport: Rails, heavy, £5 5s. to £5 7s. 6d.; light, £5 12s. 6d. to £5 17s. 3d. Last week Newport dispatched 900 tons steel sleepers and 1000 tons general to Bombay. Other quotations:—Swansea: Copper, £59 15s. cash, £60 16s. 3d. three months. Lead: £13 13s. 9d.; English, £13 3s. 9d. Spanish. Spelter, £23 5s.; silver, 23⅜d. per oz.

Tin-plate.

Another week of active employment was added, since my last report, to the long list enjoyed of late. Stocks are now as low as they have been for a good period. The harbour statistics were—receipts from the works 80,657 boxes, shipments 105,815, present stocks 58,566 boxes. At Llanelly reports are quite as satisfactory, and there I hear that the prospects of a long continuance are fairly assured—at all events, well into the next year. Prices there, as at Swansea, remain about the same. The prospect of an increased output is only a question of a little time, the extensions and other improvements being nearly complete. At Swansea the demand is well sustained, and the inquiry from San Francisco is larger than it has been for a long time. Prices very firm. Latest Bessemer primes, I.C., 20 × 14, 12s. 4½d. to 12s. 6d.; ternes, I.C., 18 × 20 + 112, 22s. 6d. C.A. roofing sheets, £8 10s. to £8 15s. per ton. Big sheets for galvanising, £8 10s.; finished black plates, £9 10s. to £9 15s Galvanised sheets, 24 g., £11. Block tin, £142 2s. 6d. cash, £144 7s. 6d. three months.

Swansea Valley Industries.

The coal trade, especially in the bituminous markets, is slack. At some places, notably the Main, the average work has been three days per week; the great complaint is with the double shift, colliers losing 1s. 6d. to 2s. 6d. weekly. Baldwin's furnaces, Landore, are doing well, and eventually large extensions will be carried out. Mannesmann Tube Company's Works are very busy, and similar good news comes from the Mond Nickel Works, Clydach. Foundries very busy at Landore, Clydach, Morriston, and Llanamlet. Full time registered at all engineering works. Spelter factories and all copper works fully employed.

Llanelly.

The various industries are doing good work, and local foundries are well off for orders, but serious complaints are made with regard to the delay in carrying out the harbour improvements. This delay is generally ascribed to the failure in negotiations with the Bank of England.

Port Talbot.

A decrease was sustained last week. The total harbour business was 36,403 exports and 5305 tons imports. The chief items of export were 26,671 tons to foreign destinations.

Shipping News.

The Terra Nova, of the Antarctic Exploration, is to coal at Cardiff. It is currently reported at Swansea that the service from America will be discontinued to Queenstown and Fishguard be selected.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

The Cowper-Coles Engineering Company, Limited, now has its new works at Willesden in full working order.

Mr. S. N. Brayshaw, of Manchester, is enlarging his works. The alterations include the provision of more room both for storage and for building furnaces, and a loading way is also being built to facilitate the rapid handling and dispatch of consignments.

We are informed that J. Dampney and Co., Limited, of Post-office-chambers, Cardiff, manufacturers of the "Apexior" compound for preventing incrustation and corrosion in steam boilers, are this week removing to the Merchants' Exchange, Cardiff, where they have secured more extensive and commodious offices.

NOTES FROM GERMANY, FRANCE, BELGIUM, &c.

(*From our own Correspondent.*)

Rheinland-Westphalia.

THE accounts that are given from the Rhenish-Westphalian district show employment in all branches to have been increasing. Quotations have not changed, except for Luxemburg foundry pig No. 3, which stands at M. 50 to M. 52 p.t., against M. 49 to M. 51 p.t. last month. The Rhenish-Westphalian bar mills are reported to have resolved, at a recent meeting, to raise the prices for sales in the second quarter on an average by M. 2 p.t. At a tendering for the Railway Administration, Cologne, which took place on the 4th inst., higher rates were generally quoted. Bars in basic, for instance, realised M. 105 to M. 110 p.t., according to the place of consumption. For sheets M. 115 to M. 130 p.t. was quoted, and for iron plates M. 120 to M. 125 p.t. was the minimum price, while boiler plates realised M. 109 to M. 112 p.t., all free Rhenish-Westphalian works.

Coal and Coke.

Both in Silesia and in Rheinland-Westphalia a good business has been done in coal. The cold weather has caused the demand for house coal to increase perceptibly in the last-named district, and the inquiry for engine fuel has also much improved. Deliveries in blast furnace coal have shown a marked rise against last month ; also in briquettes an animated business was done during the week.

Austria-Hungary.

Both raw and finished iron meet with regular demand, but there is little enterprising spirit in the iron industry. In Hungary the stagnation prevailing since August has now given way to healthy employment in nearly all trades, which is partly due to the steady and active business done in the building line Consumption in coal is about equal to production in Austria-Hungary. There has been a general improvement in demand since the beginning of November both in pit coal and in coke. In Bohemian brown coal a decrease in deliveries of 114,587 t. is shown against last year, 921,377 wagons at 14 tons having been delivered in 1908, against 839,603 wagons in the first three quarters of this year. Inundations in the early part of the year are the chief cause of this decrease, as many brown coal works had to stop for some time. The exceptionally mild autumn has also tended to reduce the consumption in house coal.

The Belgian Iron Market.

Orders come to hand regularly in the iron and steel industry. The outlook generally is more promising, and therefore a firm and rising tendency can be noticed in prices. Up to £5 p.t. is said to have been quoted for steel bars, but the average price remains £4 17s. 6d. p.t. A lively call exists for bars, and purchasers often find it difficult to get orders executed within the time stipulated. It is uncertain whether the reduction in the sea freights to India will continue after the 1st of December, and so dealers are anxious to sell as much as possible before the end of November. Iron bars are quoted 2f. p.t. less than steel bars. Plates sell freely at £5 5s. p.t. A healthier tone characterises the nail branch. In the engineering and structural department good employment exists, and manufacturers speak more cheerfully as to the future. Cockerill, in Seraing, is reported to have got an extensive locomotive order for Argentina, and Belgian works are also likely to get part of the heavy-freight car order for the French railways. A quiet business is done in pig iron, but the tendency is firm. Foreign trade in semi-finished steel is lively at 78f. to 80f. p.t. free Antwerp. The girder business lacks animation. The deliveries in engine and house coal have been satisfactory during the week. Anthracite is scarce, and Tête de Moineaux have consequently been advanced 32f. p.t. The prolongation of the Rhenish-Westphalian and Belgian Coke Syndicate has caused considerable satisfaction among producers and consumers. Coke is not expected to change in price during the next two quarters.

The Swedish Iron Trade.

During the last two months Swedish ironmasters have been doing but a limited business, owing to strikes and consequent stoppages. Stagnation prevailed in nearly all branches, and it is hardly saying too much if the decrease in output of iron and steel is estimated at 75 per cent. Even now a number of works remain idle, while others have limited their working hours. Export in pig iron was fairly good, in spite of all ; malleable iron has, likewise, been in satisfactory request, and some large orders in blooms have been booked for America.

AMERICAN NOTES

(*From our own Correspondent.*)

NEW YORK, November 17th.

THE most important feature in the steel market during the past week has been the general advance in prices in finished products. The Carnegie Steel Company has advanced prices on sheet bars from 27 dols. to 30 dols. a ton. That company has just withdrawn its quotations on steel bars, plates, and shapes. Prices have also been advanced on small grades of wire, the average being 2 dols. per ton. Wrought pipe has been advanced a similar amount, and merchant pipe was advanced some time ago. Mills making steel billets and steel bars are speeded to their very highest capacity, but notwithstanding this fact they are falling behind in deliveries. Some mills have sold their capacity on steel bars as much as six months ahead. Steel billet capacity is sold so far ahead that manufacturers are afraid to enter into additional contracts. The demand for ferro-manganese is beyond capacity, and large purchases from outside sources will have to be made. The increase in price of puddled bars has given the puddlers an advance of 12½ cents per ton, making the price 5·50 dols. A general advance has been made in sheet iron of all kinds, and mills are sold far ahead. These facts indicate the present condition of the iron and steel industry, and they also point to a still higher level of prices, which may be reached by the close of the year. The advance in plates and shapes made last week was to have been expected, and in view of it an unusual amount of business was hurried into the mills. At the present time orders are arriving for small lots, and among them are several orders from other countries. Special attention is being given to developing steel requirements in South American countries, in Cuba and in Mexico. The greatest need of these countries is along the line of transportation. Much railroad development is in progress, but the underlying factor of immigration to take advantage of opportunities is still wanting.

In the copper market large sales have not been frequent. The amount of stocks abroad, it is said, has been over-estimated, and consumption there has been increasing. There have been rumours circulating for some time with reference to a copper consolidation of the great concerns. The rumour has it that if there will not be an actual consolidation, a working agreement may be evolved by which judicious control will be exercised over production and the sale of copper. There may be nothing in these rumours, but there is a reason why copper-producing interests should understand each other a little better. There is no economic reason why, under proper management, copper prices should vary from week to week and from day to day. The cost of copper production and of transportation are practically uniform. Consumptive requirements can be fairly gauged. Under harmonious relations, it is argued, it would not be necessary that there should be such frequent manipulative management as is so often seen in controlling the marketable supplies in this country and abroad.

BRITISH PATENT SPECIFICATIONS.

When an invention is communicated from abroad the name and address of the Communicator is printed in italics.

When the abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent-office Sale Branch, 25, Southampton-buildings, Chancery-lane, London, W.C., at 8d. each.

The first date given is the date of application; the second date at the end of the abridgment is the date of the advertisement of the acceptance of the complete specification.

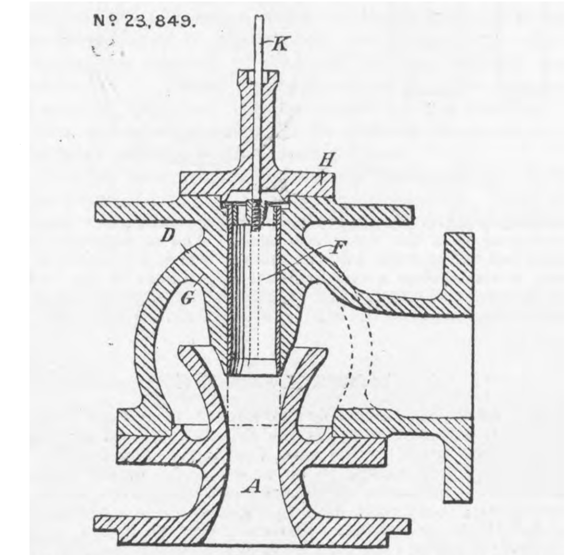
Any person may on any of the grounds mentioned in the Acts, within two months of the date given at the end of the abridgment, give notice at the Patent-office of opposition to the grant of a Patent.

STEAM ENGINES.

23,849. November 7th, 1908.—IMPROVEMENTS IN OR RELATING TO VALVES, The Brush Electrical Engineering Company, Limited, of Victoria Works, Belvedere-road, Lambeth, and William Chilton, of 4, Burton-street, Loughborough, Leicester.

This invention relates to valves of the kind in which the control of the fluid in a duct is effected at a constriction therein produced by means of a converging and a diverging nozzle, or equivalent formation of the fluid way, which is an arrangement that permits of a substantial reduction in the size of valve employed and in the amount of energy required to operate it. The valve proper comprises a hollow cylindrical practically balanced plug F that is open at both ends, and the outside diameter of which approximates to the smallest diameter between the converging and diverging parts of the nozzle A, being either equal to (as shown), slightly less than or slightly larger than such diameter as occasion may demand. This plug F is coaxial with the nozzle A, and freely movable axially along a cylindrical guide G which extends into the interior of the globular part of the valve box D, and to which access can be gained from without the box by removal of a cover H serving as a bush or stuffing-box or guide for a spindle or rod K that is connected at one end to the plug F and at the other to any suitable governor. There are two other illustrations.—*November 3rd*, 1909.

Nº 23,849.

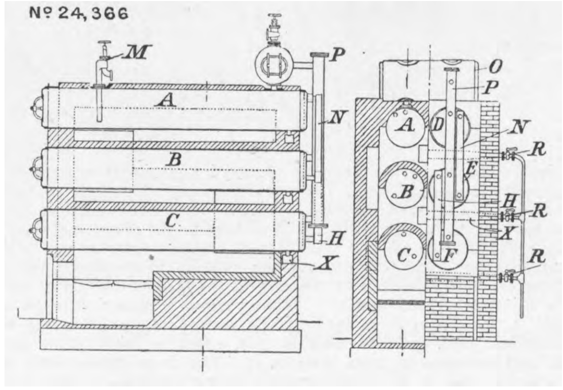


STEAM GENERATORS.

24,366. November 12th, 1908.—IMPROVEMENTS IN AND RELATING TO STEAM BOILERS, *Emile Paty, of 17, rue Gérando, Paris, France.*

The boiler shown has six drums A, B, C, D, E, F. The drums on the same level, viz., A and D B and E and C and F respectively, are connected in pairs by ducts X which are connected also to the clearing cocks R outside the boiler setting. The drums are connected vertically one with another by a double set of pipes. One of these sets serves for the collection of steam, whilst the other serves for the water circulation. The water is supplied through a cock M. To the drums A and D which communicate one with another by the ducts X; when the water reaches the required level in these drums it passes by down pipes N to the next lower drums B and E. From these latter when they are sufficiently full the water overflows and passes by the down pipes H to the drums C and F. It will be seen that by arranging the opening by which the water flows out from the drum into the pipe at a suitable level, the water in the drum can be maintained at any desired height. The steam generated in each of the drums is collected into vertical conduits P which carry it to a steam drum O. The hot gases from the furnace pass directly under the drums C and F and then rise under the drums B and E along which they flow towards the front, then rising under the drums A and D along which they flow toward the rear. It will be seen that the circulation of the hot gases is in the opposite direction to that of the water feed, so that the heat of the gases is used in the most economical manner. Any desired number of drums can be used at each level and there might be any number of different levels according to circumstances.—*November 3rd*, 1909.

Nº 24,366

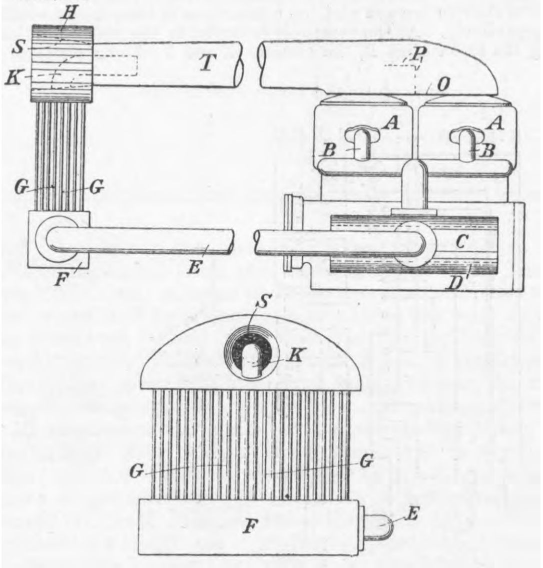


INTERNAL COMBUSTION ENGINES.

6711. March 20th, 1909.—IMPROVEMENTS RELATING TO MEANS FOR COOLING THE CYLINDERS OF INTERNAL COMBUSTION ENGINES, Charles Ewart Robinson, of Sandhurst, St. Peter's-avenue, Kettering.

Referring to the engraving, A A are the cylinders disposed side by side in any suitable and convenient manner, and B B are the ordinary exhaust outlets of pipes which lead to the expansion-box C. The expansion-box may have a central opening D therethrough. The expanded and cooled gases pass from the expansion-box through a pipe E to a box or chamber F, where they further expand and cool. Connected to the box or chamber F are a number of small pipes G G leading to another chamber H. The function of the tubes G G is to break up the gases and still further cool them before reaching the chamber H. The outlet K from the chamber H points into the conical mouth S of a tube of large diameter T, which directs the cooled gases and the air induced through the coned mouth S on to the tops of the cylinders A A. The cooling means are preferably disposed at the front of the engine, and the cone of mouth S of the tube T is arranged so as to directly meet the rush of air as the car or the like is travelling, and so augment the injector action of the tube T. A baffle plate P or equivalent means may be provided in the bell-mouth end O of the tube T so as to direct the cold air evenly on to the cylinder tops. The cold air drawn into the tube T by the cooled exhaust gases mixes with the latter, and is directed on to the cylinders to maintain the latter at a suitable working temperature.—*November 3rd*, 1909.

Nº 6,711.

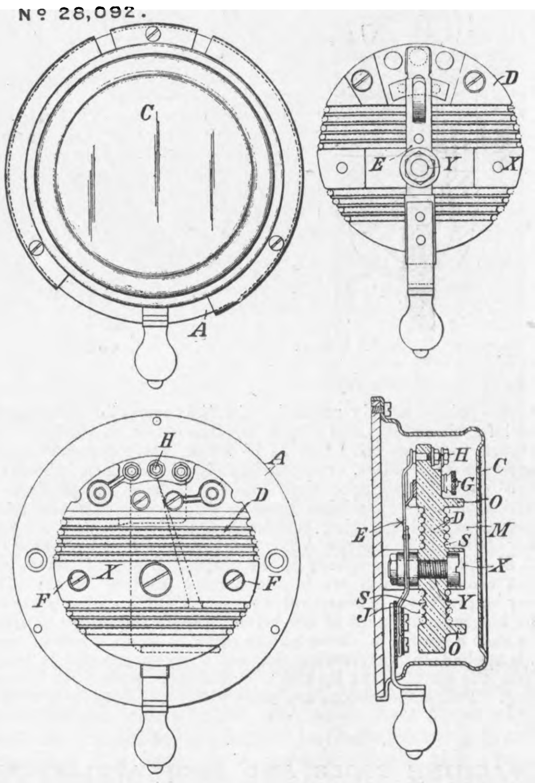


SWITCH GEAR.

28,092. December 24th, 1908.—AN IMPROVED CONSTRUCTION OF REGULATING ELECTRIC SWITCH, Veritys, Limited, of King-street, Covent-garden, London, Middlesex, and also of Aston, Birmingham, and William George Pipkin, of 173, Slade-road, Erdington, Birmingham.

The invention relates to a regulating electric switch of the smaller kind (mostly used for ventilating fans and such like) and to the type in which the switch arm and resistance stops and the terminals and stop connections are arranged upon a single carrier of porcelain, or the like, adapted to be attached to a casing or support. The base plate is represented at A and the casing at C, the casing being a feature enclosing the porcelain carrier D, and the parts it carries and made attachable to the base plate A. The carrier D is substantially in the form of a disc, and has across the middle of each of its faces an outstanding web or rib, through the outer one of which transversely, and through the thickness of the carrier, the hinge or pivot pin Y passes for the pivotting of the switch arm to the carrier, the inner web X being cut away the middle to permit of the moving of the switch arm. The carrier is rigidly attached to the base plate, which is of a flat formation, by the two pins F F which pass transversely through the web or rib X and screw into the base plate in such manner that the inner face of the carrier, except the web or rib, stands clear of the base plate, with the switch arm disposed between the inner face and base plate, one of the features of the invention being the disposition of this switch arm upon the inner or back face of the carrier D, with the circuit terminals G and the resistance stop terminals H provided upon the outer face of the carrier to facilitate, or make easy, the wiring by the simple removal of the casing C. Diametrically across the faces and over the ends of the carrier D are provided a number of grooves S wherein the resistance wires or coils J are placed, these grooves lying within recesses M provided in each face of the carrier

Nº 28,092.

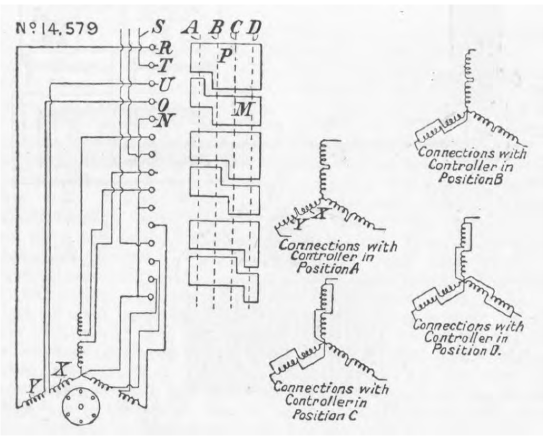


between the web or rib X and bars O of said carrier, these recesses providing effective insulation of the resistance wires from the pivot pin Y, and the terminals and stop connections.—*November 3rd*, 1909.

14,579. June 22nd, 1909.—IMPROVEMENTS RELATING TO CONTROLLERS FOR POLYPHASE ALTERNATING CURRENT INDUCTION MOTORS, *Benjamin Garvier Lamme, of* 230, *Stretford-avenue, Pittsburg, Pennsylvania, U.S.A.*

This invention relates to controllers for polyphase alternating current induction motors in which each phase circuit of the motor primary winding is divided into a plurality of sections which are connected to one another in different series or parallel relations to form the starting and running connections of the primary windings respectively. As the controller is moved to the position indicated by the broken line B, the sections X and Y of one phase of the winding are changed from series to parallel relation as shown, the two parallel circuits being respectively from the conductor S, through contact finger T, contact P, contact finger R, section Y, contact finger O, contact M, contact finger N, to the neutral point of the star, and from conductor S through contact finger T, contact P, contact finger U, section X, to neutral point of the star. As the controller is moved through the succeeding positions C and D of the controller, the sections of the remaining two phases of the primary winding are changed in succession from series to parallel relation, the circuits being similar to those just described. There are nine other illustrations.—*November 3rd*, 1909.

Nº 14,579.

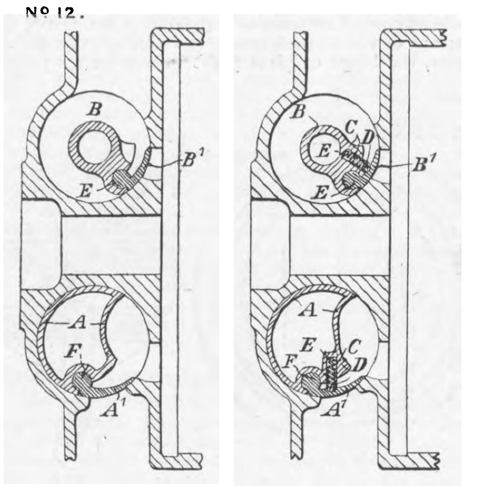

S
A B C D
R
T
U
O
N
P
M
X
Y
Connections with Controller in Position A
Connections with Controller in Position B
Connections with Controller in Position C
Connections with Controller in Position D.

PUMPING AND BLOWING MACHINERY.

12. January 1st, 1909.—IMPROVEMENTS IN VALVES FOR AIR COMPRESSORS, Frank Hargreaves and John George Hudson, both of Soho Ironworks, Bolton.

According to the invention, the valve is of semi-rotary—Corliss—type, but instead of as hitherto the operative edge or lip being formed integrally with the valve, it is in the form of a segmental cylindrical shutter so pivoted to the body of the valve plug that it may move inwards at its cutting-off edge—that is to say, so pivoted that it may move from its seat against the periphery of the valve casing after the manner of a clack valve. It may be spring controlled, and it may be so pivoted to the plug as to be capable of accommodating itself to its seat circumferentially to the valve axis as well as radially to its pivot—that is to say, it may be pivoted at two points axially parallel. In the example illustrated on the left, the inlet valve plug A and the outlet valve plug B have pivoted to them valve lips A^1 B^1 which are comparatively thin segments of cylinders, or approximately of that form. These lips A^1 B^1 have formed upon their interior surfaces remote from the cutting-off edge cylindrical tongues E F parallel with the axes of the valves and engaging counterpart axially parallel recesses in the bodies of the plugs A B. The faces of the segmental lips A^1 B^1 and of the periphery of the plugs A B are, of course, adjacent when the parts are in the normal position shown. There may be provided between valve plug and lip a spring controlling the hinging movement of the latter. A simple manner of arranging such a spring is shown on the right, in which a helical spring C is applied in compression between a hollow plunger D bearing upon the back of the lip and a cylindrical recess E in the valve plug. Two modifications are dealt with.—*November 3rd*, 1909.

Nº 12.

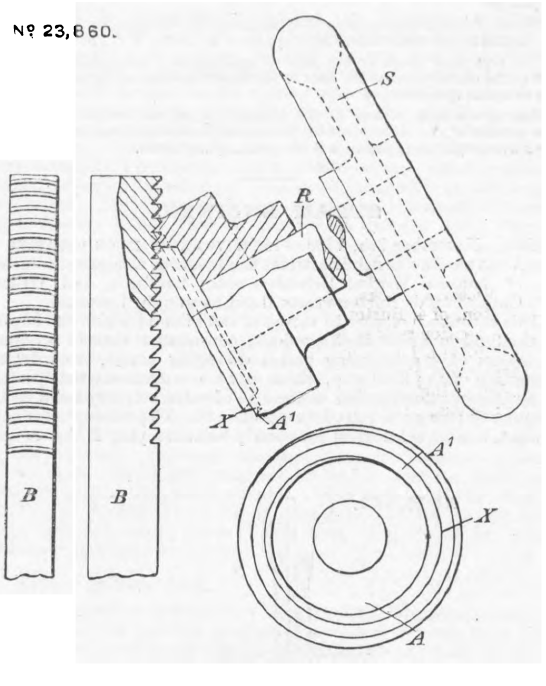


MACHINE TOOLS AND SHOP APPLIANCES.

23,860. November 7th, 1908.—IMPROVEMENTS IN DRILLING MACHINES, Arthur Drummond, of Rydes Hill, near Guildford.

This invention relates to drilling machines and consists in the application thereto of mechanism of the known kind wherein a rotary disc formed with volute projections on its face is arranged at such an angle to a rack as will enable the projections at one part of the disc to engage with the rack teeth and the projections at the other part to clear the rack teeth. A represents the disc, A^1 the volute projections thereon, and B the rack with which the aforesaid projections are adapted to engage in the manner above described. The disc A is provided with an inclined portion A^1 on which is formed the volute projections X^1, and such disc is conveniently mounted upon a spindle R which is carried by the table, or in the radial arm of the drilling machine, according to the type of machine to which it is to be applied, and on the outer end of such spindle is a hand wheel S or other suitable device for operating purposes. The rack B is preferably formed with curved teeth having upper horizontal surfaces and lower inclined surfaces, and is carried by the upright pillar of the drilling machine upon which the table or radial arm is slidably mounted. The spindle R is arranged at a suitable angle to the rack for enabling the volute projections at one part of the disc to engage with the rack and the projections at the opposite part to clear the rack, the said projections being formed inversely to the rack teeth and so arranged as to gear with the latter accurately. The arrangement above described will securely hold the table or arm at any adjusted position, it also enables a very sensitive adjustment of the table or radial arm to be effected and provides plenty of power for obtaining the movement of the arm or table.—*November 3rd*, 1909.

Nº 23,860.

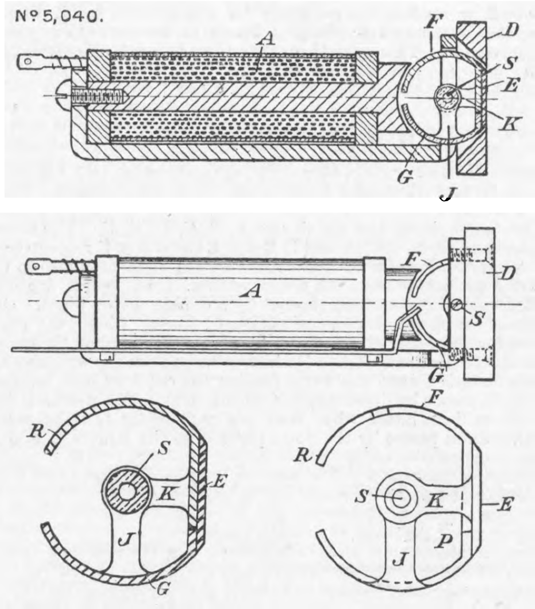


MISCELLANEOUS.

5040. March 2nd, 1909.—IMPROVEMENTS IN ELECTRIC INDICATORS, Alfred Whalley, of the British Insulated and Helsby Cables, Limited, Milton-road, East Edge, Liverpool.

This invention relates to an improvement in the indicating movement of indicators or annunciators, and particularly in connection with those which have a pivoted revolving indicating part. A part G of non-magnetic material forms an arc of a circle, and with a shorter part, parallel to the plane of the front plates, joins the magnetic part at the point P. This also has side or wing pieces J bent so as to unite with K, and form bearings for the pivots. The curved part F is not a true arc having its centre at the bearing S, but the distance from the point R to the centre S is very slightly less than from the point F to S, so that when suspended in position it is slightly further away from the pole piece than when the drum is revolved and the point F comes opposite the pole piece. The flat section E, which is in the same plane as the front of the fixing plate, is formed of ebonite or other suitable material caused firmly to adhere to the metal surfaces, so that the surface of the plate D and of the indicator are in the same plane, and, therefore, there are no protruding parts to interfere with the efficient cleaning of the face of the board, or to be injured by such action. When current is passed through the coil A the drum is rotated as the section of iron F lies in the magnetic field, and the mass of iron is smaller towards the point R, and increases in mass towards F. The drum rotates until the flattened face E is, approximately, at right angles to its normal position, and a curved segment of G is then exposed at the aperture, and slightly protrudes beyond the face of the plate D as a calling signal. When current is removed from the coil the rotating part returns to the normal position by gravity, as the parts J and G are heavier than the upper parts.—*November 3rd*, 1909.

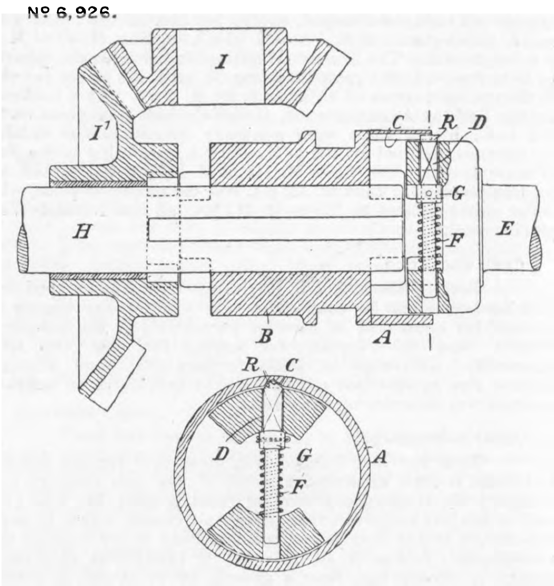
Nº 5,040.



6926. March 23rd, 1909.—IMPROVEMENTS IN OR RELATING TO COUPLING REVOLVING SHAFTS, Alexander Kelly and Christian Dethleff Birck Hansen, both of Napier Brothers, Limited, 100, Hydepark-street, Glasgow.

The device consists of a sleeve A fitted on the movable clutch B having a notch C in its circumference which will pass freely over a projecting knob or pin D on the clutch face of the adjoining shaft, such as the steam gear shaft E, when the shaft is in correct position for coupling up, but which when the shaft is in any other position will present an obstruction to the endwise movement of the movable clutch B, owing to the sleeve A striking against the knob or pin D. The knob or pin D is shown bevelled at its sides at R, and is actuated or pressed outwards by a spring F acting on a collar G or the like, so that the pin may be depressed sufficiently to let the sleeve A pass over it freely, to prevent any damage being done should the steam gear shaft E start before the clutch is engaged. In bringing the clutch faces into proper relative position for engagement the shaft H carrying the clutch B and the sleeve A may be turned by gearing I, I^1 operated by hand in the usual way, the clutch being operatively engaged with the hand gear shaft, and when the knob or pin D is opposite the notch C in the sleeve A the movable clutch B is shifted into engagement with the shaft E. In the upper engraving the clutch member B is shown in mid-position and disengaged from the clutch face of the loosely mounted gear wheel I^1 and the clutch face of the shaft E, the notch C of said sleeve A being in engagement with the pin D, so that the shaft E is in proper position to be coupled to the shaft H.—*November 3rd*, 1909.

Nº 6,926.



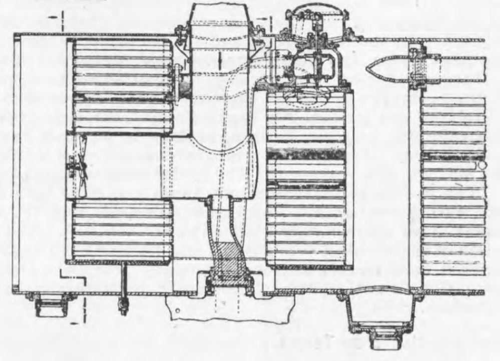
SELECTED AMERICAN PATENTS.

(*From the United States Patent-office Official Gazette.*)

934,729. SUPERHEATER, *H. W. Jacobs, Topeka, Kans.—Filed April 27th*, 1909.

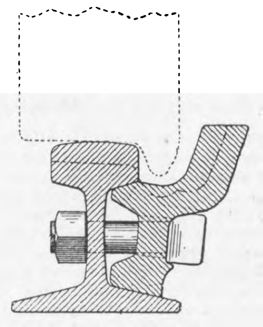
This invention consists in placing a superheater in an extended smoke-box, so far from the tube plate that access can be had to the ends of the flues through a manhole. A large flue is put into the superheater through which boiler flues may be passed for repair. There are six claims.

934,729.



934,784. GUARD RAIL, *C. A. Alden, Steelton, Pa. Filed July* 10*th* 1909.

934,784.

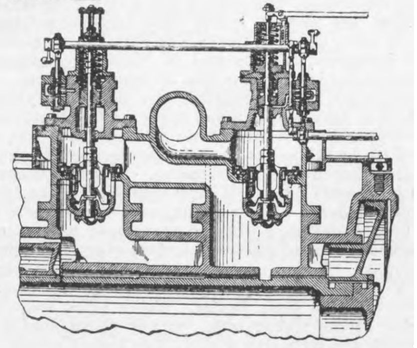


The guard rail is bolted directly on to the track rail as shown. There are three rather long claims.

934,915. ELASTIC FLUID TURBINE, *F. Hodgkinson, Edgewood Park, Pa., assignor to the Westinghouse Machine Company, a Corporation of Pennsylvania.—Filed April* 12*th*, 1905. *Renewed June* 7*th*, 1909.

In a multi-stage elastic fluid turbine, a primary fluid inlet to the high-pressure stage, a secondary fluid inlet to an intermediate stage, independently-operating valves regulating said inlets, mechanism whereby at light loads the secondary fluid inlet valve is held closed and the primary fluid inlet valve is caused to pulsate at constant intervals, the periods of which are proportional to the turbine speed, and means whereby when the primary fluid inlet valve remains constantly open the secondary fluid inlet valve is caused to pulsate. There are twenty-seven claims.

934,915.



THE ENGINEER.

Grinding Machines.

GRINDING MACHINES.

Grinding is certainly one of the very oldest of arts, but the grinding machine as it is known now-a-days is an essentially modern invention. For some thousands of years man was content to use the grindstone simply for sharpening or polishing, and it is only of late that he has discovered that, properly employed, there is no tool approaching it in accuracy and, work for work, none exceeding it in economy. Twenty-five, even twenty years ago, fine grinding was understood by but few engineering firms, but now-a-days there is not a single well-organised machine shop in the land that has not at least one grinding machine, apart, of course, from those used for the sharpening of tools. The grinding of flat, round or shaped surfaces is now a recognised machine shop operation which competes with turning and milling easily on the score of accuracy, and under certain circumstances even in the matter of speed and cost. Indeed, a few years ago enthusiasts were convinced that fine turning was out-dated, and sought to see the lathe reduced to the very roughest work, finishing being reserved for the grinder. Their anticipations have not been realised. The lathe has easily held its own, and the grinding machine has settled down into its proper place in the economy of the machine shop.

Where great accuracy is required grinding is unapproachable, and the abrasive wheel has, moreover, the virtue of producing a surface which appears to be more durable than that left by a lathe, and on that account very desirable for bearing and running fits. Possibly this fact is due to a certain extent to the accuracy of the product, but it seems accepted that a skilful grinder, by the selection of a suitable wheel and the employment of appropriate speeds and feeds, can produce a finish having superior properties to that left by the lathe. It is, however, on the accuracy of its output that the supremacy of the grinding machine really depends. On small machines one ten-thousandth of an inch is not regarded as too fine a limit, and even on big tools one four-thousandth is attainable with care. Such refinements of measurement are, of course, as inconceivable to the human mind as great distances, but it is brought home to us when we know that a grinder will sometimes, in order to remove the amount of material required, merely warm the work by placing his hands upon it. The degree of expansion produced is appreciated by the machine, and when the piece returns to its normal temperature the diameter is found to have been reduced.

In order to obtain such results as this machines of a very high order of excellence have to be employed. They must in the first place be rigid in all parts; the table and the bed must be free from liability to distort and their bearing surfaces must be of great length. The grinding head must be accurate and its spindle must run truly over a fairly long range of high speeds. The work itself must be properly prepared, and it must be carried between perfectly rigid centres and be capable of receiving, if round, a good range of speeds of rotation. Finally, means must be provided for traversing the work and the wheel relatively to each other at various rates. Means for applying the feed automatically at each end of the stroke may also be provided, but are not essential. These are the general qualifications of a first-class plain grinding machine, of which many examples will be found in the following pages. On one point alone can there be any difference of opinion, and that is as to whether the work or the wheel should traverse. As a rule, there can be little doubt that it is better to fix the wheel, but in some cases, as in the grinding up of long shafts, this is prevented by considerations of space. In such cases the wheel head should be given a very long bearing on the bed, so that it may not wear it away locally, one of the principal objections to the traversing wheel being that it gets out of alignment from this cause. There is the further objection that the operator has to travel up and down with the wheel, and he is unable to attend to the work so well as when both he and it are stationary, particularly with a rapid traverse. The moving wheel is, however, largely used, though the consensus of opinion is in favour of the fixed wheel head and moving work where circumstances permit.

A very important matter where minute dimensions are being dealt with is that the centres should be rigidly in line, and it will be seen that nearly all grinding machines have a special form of shear to which the poppet heads are fixed, the rule being that both heads shall be guided by a single vee or surface against which they are pulled by the locking bolts. The shear must also be adapted to support the steadies—most important items in grinding long work—which should be readily removable and easily adjustable. An examination of the illustrations and descriptions which follow will show how these various features are realised in practice; but before turning to actual machines it is desirable to say a few words about the art of grinding and grindstones—or, as they are now called, wheels—themselves.

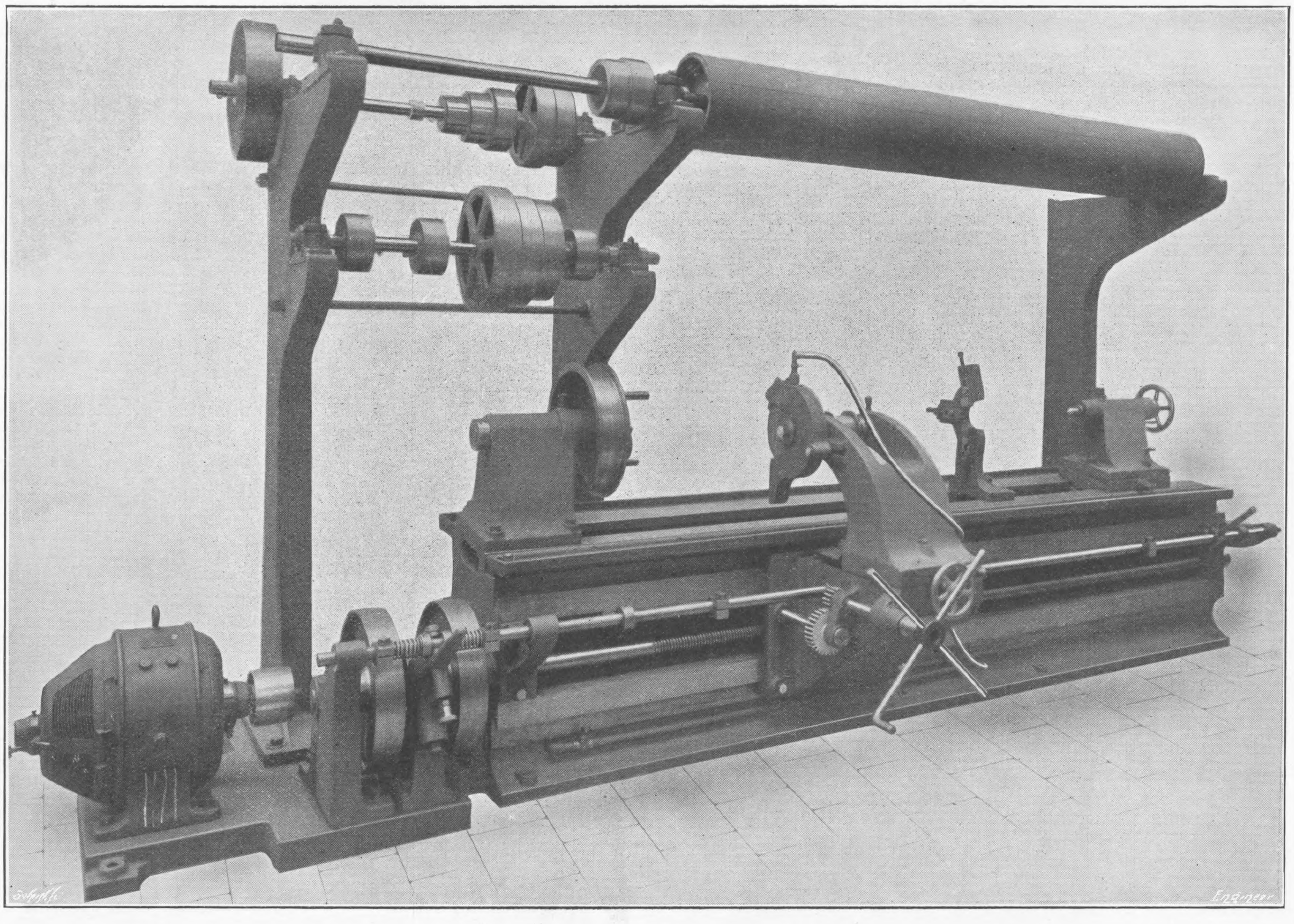


Fig. 1—HULSE AND CO.'S PLAIN CYLINDRICAL GRINDER

The grindstone has been described as a milling cutter with an enormous number of teeth. That definition is accurate as far as it goes, but to make it complete, we must add that the teeth are "inserted," and that they renew themselves automatically. Keeping these points before us, much of the mystery of grinding becomes clear. We see at once how the maximum cut of a wheel is limited. Consider any grain or kernel of an abrasive wheel. Suppose, for the sake of argument, that it is $\frac{5}{100}$in. long. Of this length only one-half can project, the remaining half being embedded in the matrix to give it support. We thus get a tooth 2½/100ths long, and that is the maximum depth we can cut at each revolution of the wheel. Or again, if we bear in mind that in order to keep the wheel sharp we must maintain a regular breaking away of the blunted kernels, we see the reason why a softer wheel must be used on a large diameter or on a flat surface than on a small diameter, for it is clear that if we are cutting a flat surface the area of contact is larger than if we are grinding one of sharp curvature, and it is more difficult for the particles to break off. If we consider the case of the diamond point used for trimming or trueing a wheel, we see the case carried to its limit. The diamond point digs into the matrix and breaks away the hard material freely; we could never do the same thing with a flat-ended tool.

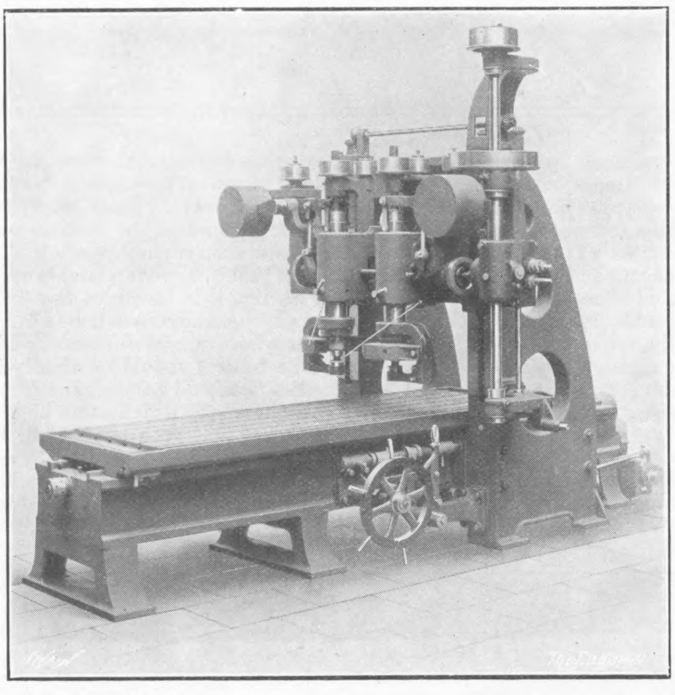


Fig. 2—HULSE'S PLANER TYPE FLAT GRINDER

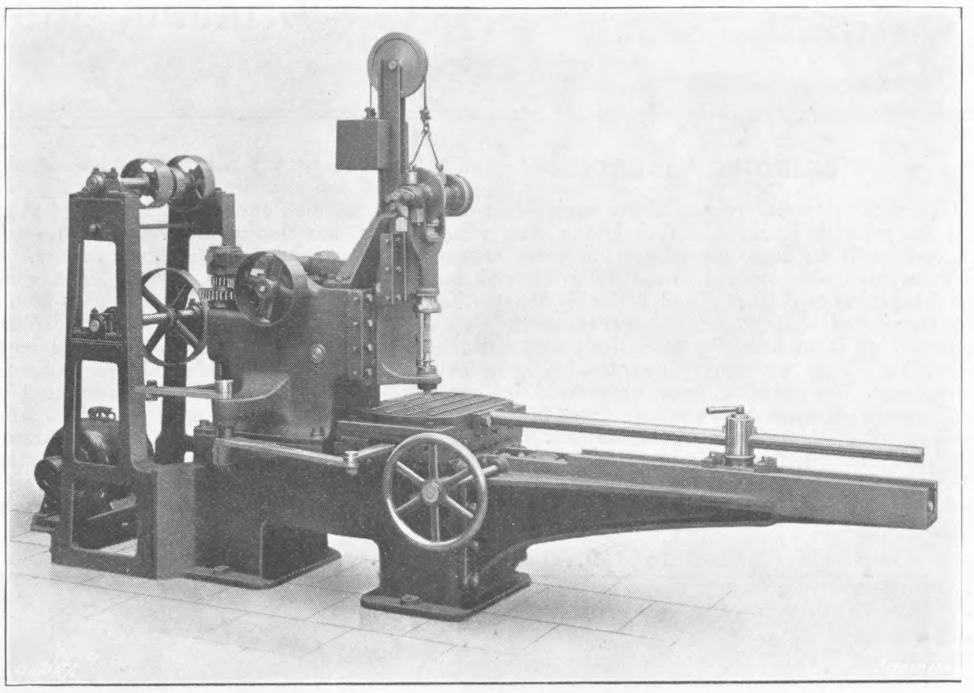


Fig. 3—HULSE'S LOCOMOTIVE LINK GRINDING MACHINE

Of course, there are other agencies at work also, and it is by ringing the changes on them that a skilful grinder gets the best results from his material. He may, for example, vary the speed of rotation of his wheel or the speed of rotation of the work, or both. It sometimes happens that a wheel glazes, particularly when grinding cast iron. In that condition it ceases to cut, and burns a brown mark on the work. The wheel must then be trued with the diamond, and if it is run at a slower speed will cut properly; if not a softer wheel must be tried—a wheel, that is, that sharpens itself more easily. Grinding is full of little problems of that kind, and it requires a considerable practical experience, and a mind quick to grasp the cause of a defect and to suggest a remedy, to make a good grinder. The operator must keep before him the fact that in order to ensure good clean cutting his wheel must break away regularly, exposing new sharp teeth, and the problem he has to face is to find out the grade of wheel that gives the required result on materials of different hardness and different diameter. With a large diameter a soft wheel must be used, with a soft material a hard wheel, and *vice versâ* under both circumstances; but there are a great many grades of stones, and a good many surface speeds at which they may be run, and every change affects the result. Then, again, the grinder has to consider the size of kernel in his wheel. All wheels are made up of grains of some abrasive material—emery, carborundum, alundum, and so on—sifted down till they are all of uniform size, and then mixed with some suitable material into a paste and moulded into the shape required. Now-a-days wheels are, as a rule, vitrified—that is to say, they are submitted to intense heat in a furnace until the matrix runs into a sort of glass which cements all the kernels together. Various sizes of grit are used, generally known by the size of the mesh through which they will pass—as 27 to the inch, for example—but the material used for the matrix has also different degrees of hardness, distinguished by letters. We thus get a wheel, for example, such as 27 K, the figure telling the size of the kernels and the letter the degree of hardness of the matrix. The kernels themselves may be all from precisely the same material and all of the same hardness, irrespective of size. It is easy with a sharp instrument—the corner of a file, for example—to tell by scratching the surface whether a wheel is hard or soft, and an experienced man can even estimate the degree of hardness by this method. There is, it appears, still some uncertainty about the process of vitrifying, and makers are not certain of the result that any given conditions will produce, but, nevertheless, the old complaint that it was difficult to get uniform wheels is no longer true; all reputable makers supply wheels which are true to grade. This has greatly simplified the art of grinding, as it has removed one element of uncertainty. On the other hand, a great deal of very high-class experience has been put into the design of machines, and they have reached the great degree of excellence that is required to ensure the very minute accuracy expected from them. This fact has no doubt contributed not a little to the increased facility of grinding.

Mr. Darbyshire, in his excellent little treatise on Precision Grinding, sums up the whole philosophy of the cut very neatly thus:—"A coarse wheel may be unsuitable because the area of the projecting kernels may be too large to enter the surface of the work without an undue amount of pressure. A wheel should always cut freely, even with the lightest depth of cut, for if we have to use any pressure in the last or finishing cuts, we are likely to either overheat and so distort the work, or else disturb the method of holding it which has been adopted to attain accurate results. For grinding glass a wheel of 150 to 200 grit is necessary, because grit of a larger area cannot be made to enter the surface, and very hard chilled rolls require a similar wheel for finishing for the same reason. Cast iron when highly finished bears some relation to the latter materials, and though it may be finished up to a certain point with a fairly coarse wheel, the wheel will refuse to cut when the kernels are dulled or their area is too large."

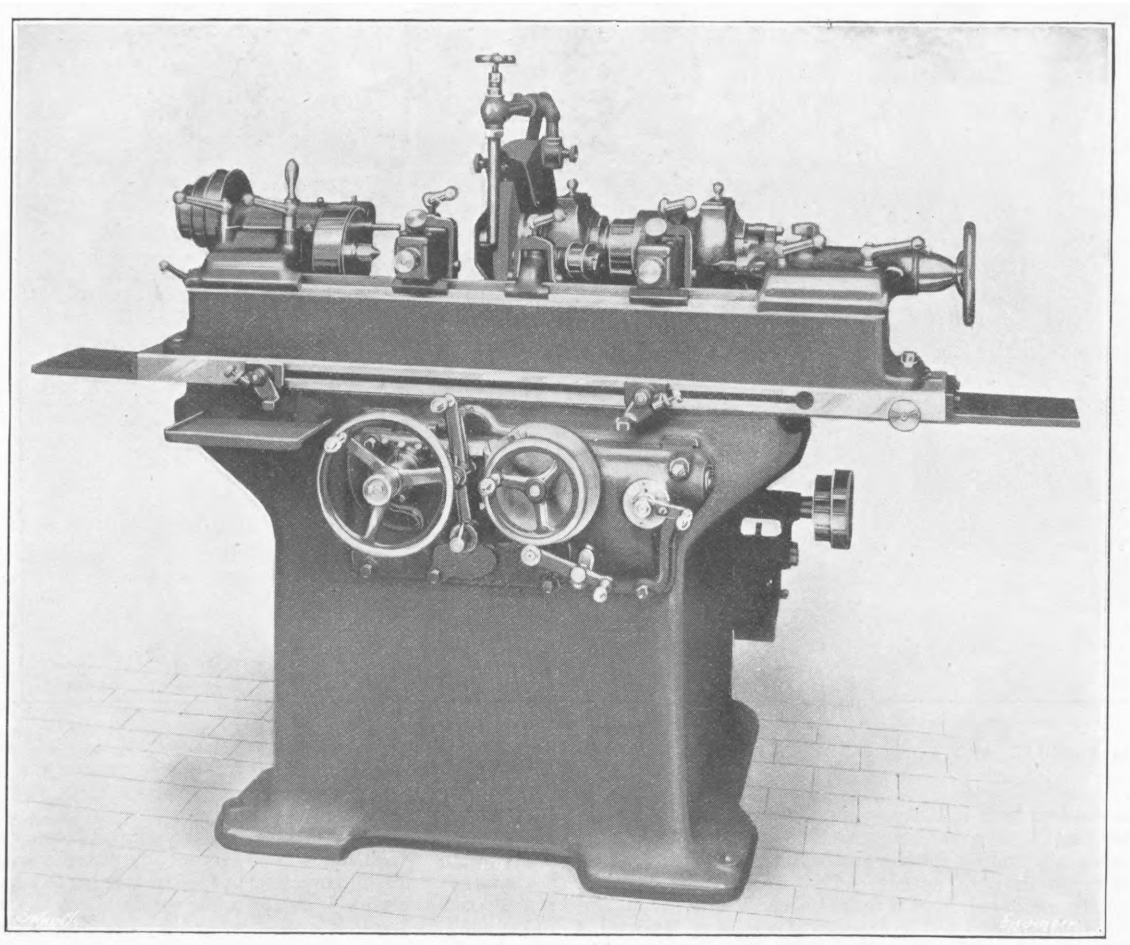


Fig. 4—WARD'S PLAIN GRINDER

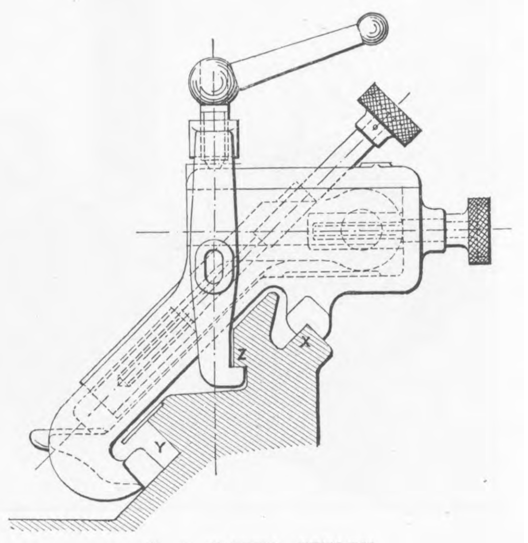


Fig. 5—WARD'S STEADY

Besides the speed of rotation of the wheel and the work, and the grade and character of the wheel, the grinder has to study the question of traverse. His object, of course, is to turn out the work as quickly as he can consonant with the degree of accuracy and the nature of the finish required. Clearly, then, the more rapid the traverse the better, but rate is regulated by several factors. In the first place, it cannot be greater than the width of the wheel. The reason of this may not be obvious at first sight, but let the wheel be regarded, as it justly may be, as a single fixed tool, and it will be seen at once that if the traverse is greater than its width a rough projecting spiral will be left upon the work. As a rule, then, the traverse is less than the width of the wheel, but where it is desirable to remove stock rapidly the traverse may be up to the full width, and with that object in view it is a good plan to make, as some makers do, the side feed independent of the speed of rotation of the work. At what speed the wheel should move for finishing can be settled by no definite rule, save that for very fine finish, a fine cut and a slow traverse are generally considered to give the best result. The object, as a rule, is to avoid anything like spiral marking on the work, as its appearance is often considered objectionable. That it has really any objectionable properties seems highly improbable, in view of the fact that the difference in the diameter made visible by it is immeasurably small. Indeed, some people have said that, if anything, such inequalities are valuable in bearings, as they give the lubricant a better chance of spreading over the surface. The plea may be good, but it appeals to but few grinders, who prefer to see the work left perfectly free from all marks save the curious grain that is quite characteristic of a ground surface, and even this for bearings is frequently removed by a light touch with the finest worn-out emery paper or by lapping.

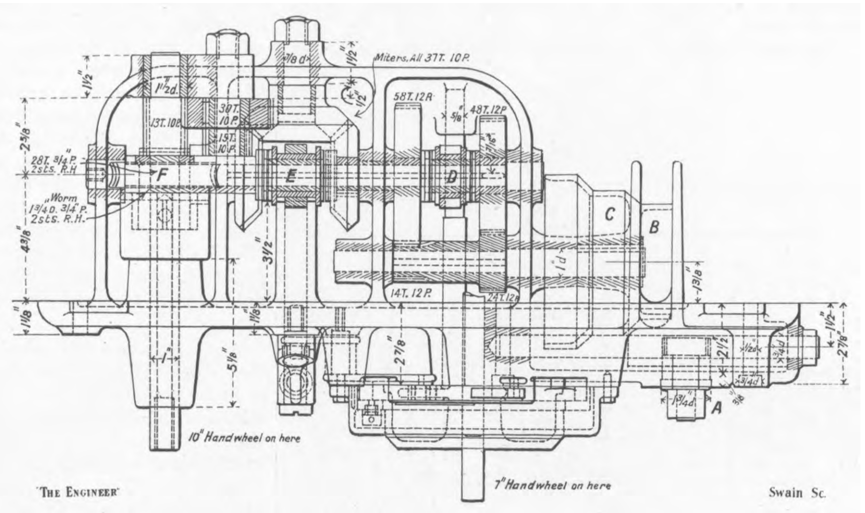
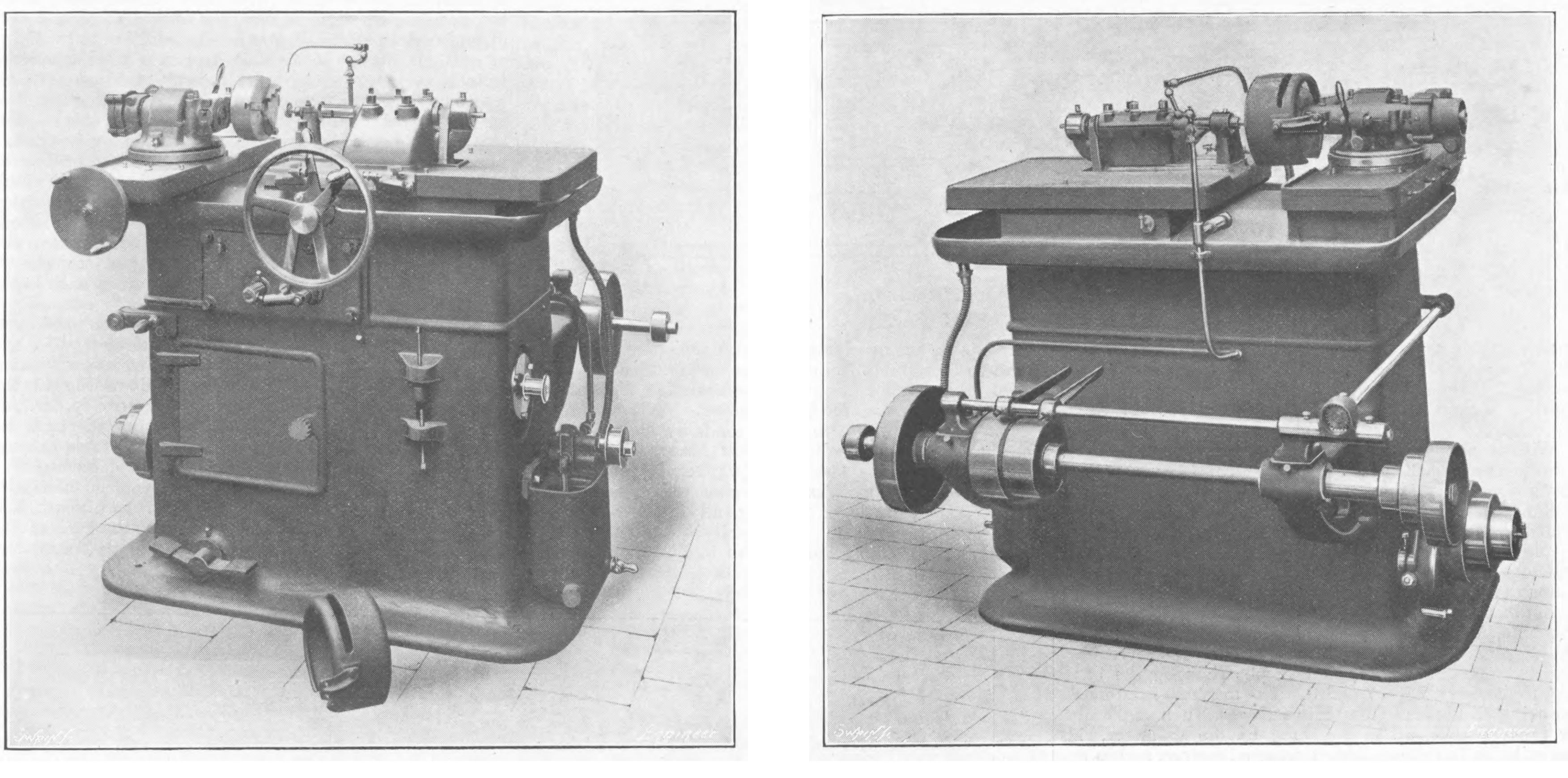


Fig. 6—APRON OF WARD'S PLAIN GRINDER

Another very important question is whether the work shall be ground dry or wet. At one time such an objection was felt to sousing beautiful machinery in water that nearly all grinding was done dry. Now-a-days, however, opinion has changed, and practically all cylindrical work is done with a copious supply of water. Flat work, on the other hand, is, as a rule, still ground dry. In such cases it is highly desirable to provide means for carrying off the fine sharp dust produced. It may be caught on wet cloths hung up in front of the wheels, but a better plan is to provide suction mouthpieces and fans to carry it away. But where possible it is probably best to work wet. Wet grinding, besides having the advantage that this trouble is avoided, is better also for the more important reason that distortion of the work due to local heating is prevented, and the improvement in the means of applying the water, of confining it to certain parts of the machine, and of carrying it back to the sump have been so greatly improved of late years that there is no real objection to it any longer, and wherever it can be employed there should be no hesitation about employing it. A small fact in connection with it, interesting enough to mention, is that the jet requires to be properly designed, or the water will be thrown away from the wheel by the currents of air that leave it as they would a fan. The jet should be the full width of the wheel, and should be applied as near as possible to the point of contact of wheel and work.



Figs. 7 and 8—WARD'S BUSH GRINDING MACHINE—FRONT AND BACK

We turn now from general matters to machines themselves. In preparing this Supplement we have endeavoured to give a good general idea of the scope of grinding machines, and for that reason we have selected a very large variety of types extending from little machines kept exclusively for the sharpening of twist drills up to big machines for grinding heavy shafting or railway wheel tires. We have also introduced a few special types, such as machines for grinding crank pins, the links of valve motions, the heads of ogival shots, and so on, and we have not omitted the special form known as the disc grinder. We do not pretend that all the uses of grinding machines are covered, but we believe that the following pages will give the reader a very just idea of the scope of grinding and of the various forms, types, sizes, and construction of grinding machines.

In concluding this brief introduction we desire to express our thanks to the various makers who have assisted us in its preparation, and particularly to Alfred Herbert, Limited, of Coventry, who gave us the opportunity of studying, under the guidance of Mr. Shaddock, their courteous and able grinding shop foreman, the latest developments of precision grinding.

The machine illustrated in Fig. 1 has been specially designed by Hulse and Co. for plain cylindrical grinding, either parallel or taper. It is of heavy and rigid construction, the bed having ample vertical bearing surfaces at the front for the sliding carriage. Two headstocks are fitted on the bed, one fixed and provided with a driving pulley and a Clement's driver for rotating the work upon dead centres, the other being adjustable along the bed and having a transverse slide permitting of tapers up to 1 in 24 on the diameter being ground. The sliding carriage is traversed along the front of the bed automatically in either direction through reversing pulleys, a guide screw, and double clasp nut. There is also a quick hand adjustment by means of rack and pinion. The automatic travel of the carriage is varied and reversed by means of adjustable stops, and a sliding rod operating a clutch between the reversing pulleys. The grinding head has transverse adjustment on the carriage for feeding the wheel up to its work, the grinding wheel, which is suitably guarded, being mounted on a steel spindle rotating in dust-proof self-lubricating conical bearings. The machine is provided with self-contained driving apparatus, including a two-speed countershaft with long wooden drum from which the emery wheel is driven by a belt, and a three-speed countershaft for causing the work to revolve, besides traversing the sliding carriage. The whole is arranged to be driven by a belt from a constant-speed motor secured on a continuation of the bed-plate of the machine.

The machine shown in Fig. 2 is of the two-spindle planer type, and is specially suitable for locomotive shops for grinding axle-boxes, horn-blocks, slide bars, &c. The bed is 12ft. long, of strong box form, mounted on standards, with wide flat bearing surfaces fitted with automatic lubricating rollers and a tank for collecting the lubricant. The table is 8ft. by 3ft. over the planed part, and has a trough and T-grooves planed out of the solid. It is traversed automatically to and fro up to 8ft. by means of reversing pulleys driven from the main shaft, a steel screw, and gun-metal nut, quick hand adjustment being also provided for setting purposes. The cross slide is adjustable vertically on the uprights up to 2ft. by hand. The two-spindle slides, with spindles 4in. diameter, revolving in hard gun-metal bearings within long counter-balanced sleeves, are adjustable along the cross slide by screws. The spindles have a self-acting reciprocating motion of 9in. vertically, together with means for hand adjustment, and are caused to revolve by means of a horizontal belt and guide pulleys, driven from a pulley on the vertical shaft shown, an adjustable pulley being fitted to regulate the tension on the belt. The two main uprights of rigid box form are firmly keyed and bolted to the sides of the bed, and adjustable stops are fitted to the front of the table to regulate the length of the stroke. The distance from the grinding wheels to the surface of the table is variable from nothing to 2ft. 9in., and that between the spindles is adjustable on the cross slide from 8½in. to 24in.

Another useful appliance for locomotive builders is the link grinding or lapping machine, also made by Hulse and Co., Limited. It is used for lapping out the radius or straight links in valve motion mechanism. It will be seen from Fig. 3 that the headstock, which is bolted to the main frame, carries a vertical counter-balanced spindle, to which combined rotary and reciprocating motions are imparted. To ensure steadiness the spindle carrying the emery grinding roll revolves in two bearings, one above and one below the article being operated upon. The quick rotary motion is communicated to the spindle by a belt-driven bevel friction disc, the slow reciprocating motion being obtained through a rotating cam and oscillating lever driven by a pulley on the headstock. The T-grooved table on which the jig is bolted has compound slides, to the transverse slide of which is imparted a horizontal reciprocating motion, actuated by adjustable lever through gearing driven by the pulley on the headstock and simultaneous radial motion by a connecting-rod and fulcrum, the latter being adjustable along the projecting arm by a screw to suit different radii. There are two sets of driving apparatus arranged to drive by belt from a constant speed motor, the whole being self-contained with the machine.

The machine by H. W. Ward and Co., Limited, illustrated by Fig. 4, is intended for commercial plain grinding. It will take work up to 42in. long by 8in. diameter, and will grind taper up to 14 deg., or 3in. per foot. It is of the type having a fixed wheel and movable slide carrying the work. The wheel headstock is a solid casting, fitted with self-oiling taper, adjustable gun-metal bearings for the wheel spindle. The wheel itself is covered by a substantial cast iron hood, and is fitted with a large water jet. The live spindle in the work headstock is fitted with a toothed wheel, driven by a pinion on a cone shaft carried in the headstock itself. The cone has three steps, from which a belt rises to the long wooden driving drum on the countershaft above. In order to maintain the tension of the belt when the speed is changed from step to step the bearings for the cone spindle can be swung through a considerable vertical angle, the gearing permitting this as the pinion has a planetary motion round the wheel. There are three changes of speed in the countershaft, so that, in all, the work spindle has nine changes. The loose headstock has a spring barrel to accommodate for expansion of the work due to heating. The sliding table is in two parts, an upper and a lower. The latter slides on the fixed bed, whilst the former is pivoted to it near the centre to permit of taper work being ground. It is swung over by a screw finely adjusted by the knurled head seen on the right; a divided collar on this knob permits of fine adjustment. The gearing provides for twelve changes in rate of traverse, and the reverse is effected automatically at each end. The changes are brought about by two of the levers seen on the apron, to the drawing of which—Fig. 6—we now direct attention. By rotating a lever on the shaft A by means of the lever seen in Fig. 4, the fork B is moved along, and the belt moved on to one of the steps of the cone C; thus three changes of speed are secured. The cone is keyed to a spindle carrying two wheels of dissimilar sizes meshing with a corresponding pair on the back shaft; between these two is a clutch D operated by another lever—at the bottom of the apron. This gives two other speeds, or six in all, which are doubled by a two-speed drive from the countershaft; thus giving twelve in all. Following the back shaft in the apron it will be seen that it runs through, a reversing gear to a worm which, through further reducing gear meshing with a rack, traverses the table. The reversing gear is operated by the vertical lever in the front view, which is struck first by one dog and then by the other, and is fitted with a spring plunger of toggle form, which obliges it to finish its stroke to right or left. The table can also be traversed by the 10in. hand wheel on the left of the apron. The cut is put on by the smaller hand wheel through reducing gear, and an attachment is fitted for effecting it automatically at each end of the traverse. The amount of this automatic feed can be varied between .00025in. and .01in. reduction in diameter of the work per reversal of the table.

The shear of the upper table is such a form that no splash guards are required. It is shown in section in Fig. 5, which also shows an adjustable steady. It will be seen that the headstocks are guided by the inverted vee marked X, and steadied by the lower surfaces Y, whilst the clamping screws pull on Z.

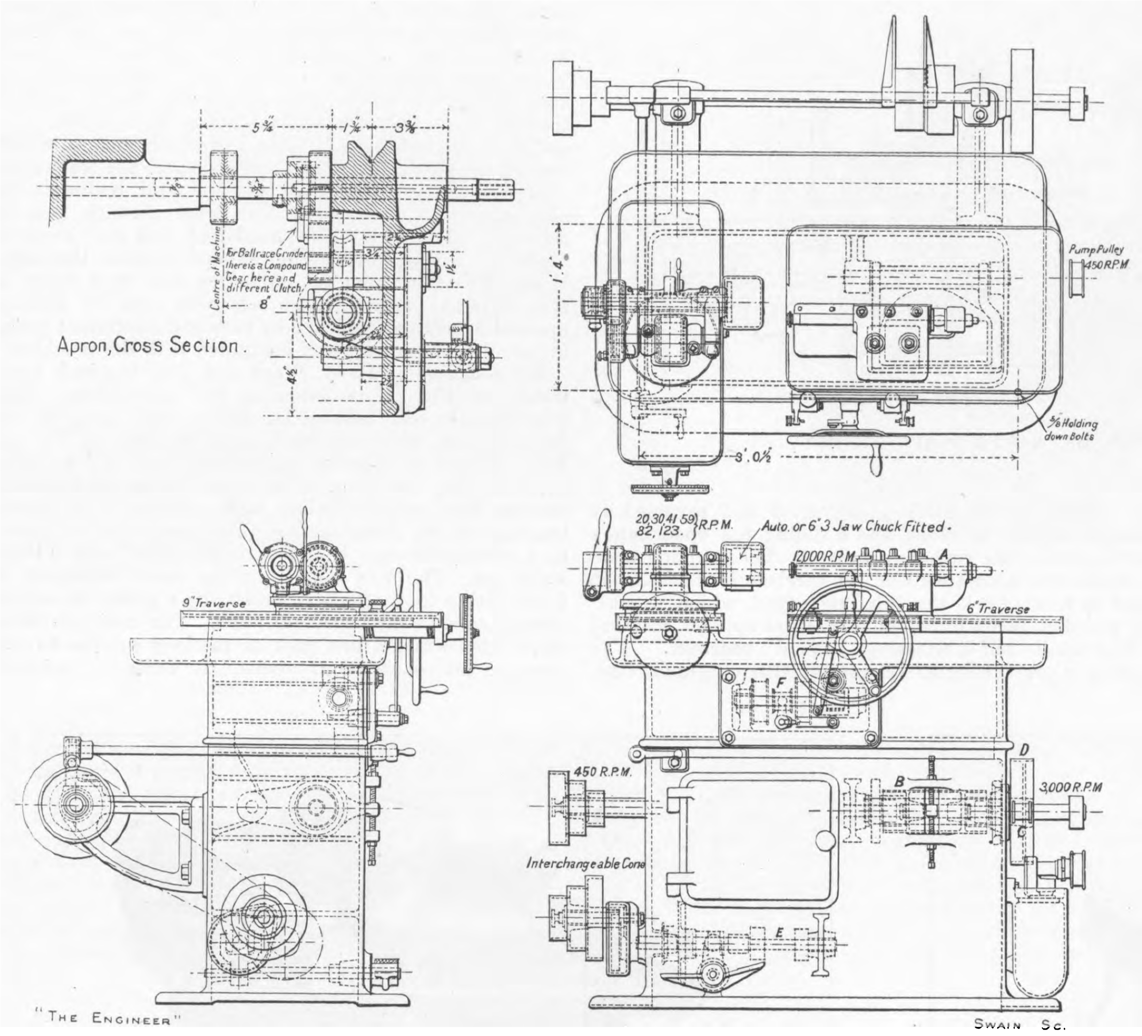


Fig. 9—WARD'S BUSH GRINDING MACHINE

With a countershaft speed of 420 revolutions per minute the wheel speeds are 966, 1210, 1530, and 1940 revolutions per minute and the work headstock speeds 6, 8, 11, 14, 17, 24, 29, 36 and 50 revolutions per minute, whilst the traverse varies between .180in. and 1.61in. per revolution. It will be noticed that the machine is quite self-contained, no spanners or keys being required for its manipulation.

Another very neat machine is the bush grinding machine, illustrated by the drawing, Fig. 9, which H. W. Ward and Co. courteously permit us to reproduce, and by reproductions of photographs showing the back and front views, Figs. 7 and 8. The machine is intended for doing all kinds of small internal work, such as parallel or taper bushes, up to 6in. long by 6in. diameter, ball races, holes in milling cutters, internal gauges, and so on. It is quite self-contained. The general arrangement—Fig. 9—shows nearly all the principal parts.

Take first the grinding-wheel drive. On account of its small size the stone has to revolve at no less than 12,000 turns per minute. The spindle is carried in a substantial casting locked to the sliding carriage. On the spindle is a very small pulley A, from which a belt is taken to a drum B in the body of the machine. To the shaft of this drum is keyed the small pulley C, which is belted to the big wheel D on the countershaft at the back. The drum is carried in a hinged frame adjustable by screws to keep the right tension on the belt. To prevent the tension coming on the wheel spindle the latter slides through a sleeve, and the sleeve runs in ball bearings. Both the spindle and the tube are independently adjustable in length from the head, so that the spindle may be supported right up to the wheel. The carriage receives its traversing motion from crossed and open belts on the pair of wheels E in the base of the machine and the pair F above. Between the upper two is a clutch moved by the reversing lever. The motion is transmitted through worm gearing, &c., to a rack. The wheels E are now driven by a belt on the countershaft, as shown in Fig. 9, and the speed of traverse is therefore constant. Engravings Figs. 7 and 8 show a slightly different arrangement, under which the traverse varied with the speed of the work spindle, but this has now been given up.

The work headstock is mounted on a slide with cross adjustment to give the feed. This headstock has two spindles geared together—see plan, Fig. 9. One spindle is fixed and carries the belt pulley, the other spindle is carried in a frame hinged on the first, and it can be raised up so that the work may be examined and gauged with ease. This second spindle carries the chuck, either a self-centering three-jaw or a draw-back collet chuck. When down in its place it is firmly locked in position. The work spindle runs in adjustable gun-metal bearings with adjustable ball thrust. The feed motion is effected by a screw and hand wheel divided to read half-thousandths of an inch on the diameter of the work. The headstock can be swivelled through an angle of 45 deg., and the base is graduated for adjustment. The work spindle has six changes of speed, and it is clutched in or out by the treadle shown in Fig. 9.

The whole machine, it will be seen, is self-contained, and all parts are neatly cased in. A copious water supply is drawn by a pump from the base and pumped up to the work. By a modification of the same design the machine is made suitable also for face grinding.

Fig. 10 represents a machine made by Geo. Richards and Co., Limited, Broadheath, near Manchester, and in use by many of the leading railway companies. It is used for grinding locomotive engine piston and valve-rods, but is capable of treating all kinds of parallel cylindrical work within its capacity. The machine is made in two sizes to grind work up to 6in. diameter and 5ft. 3in. long and 12in. diameter and 8ft. 3in. long respectively. The work is mounted in dead centres and is driven at a slow speed by a pulley which carries driving pins. This pulley is driven from a countershaft separate from that which drives the grinding head, but receives its motion from the main countershaft, cone pulleys being provided for varying the speed according to the diameter or nature of the work being operated upon. The centres carrying the work are adjustable to any position on the bed, so that varying lengths of work can be dealt with. The head carrying the grinding wheel traverses automatically along the bed, this motion being given by a screw, on the end of which are mounted two pulleys running in opposite directions to each other. A clutch is interposed between these pulleys and is actuated by a rod on which stops are placed. These, by making contact with the traversing head, effect the reversal of the wheel carriage at any desired point. Knife edge levers are used in this mechanism to ensure reversal taking place at exactly the same place each time.

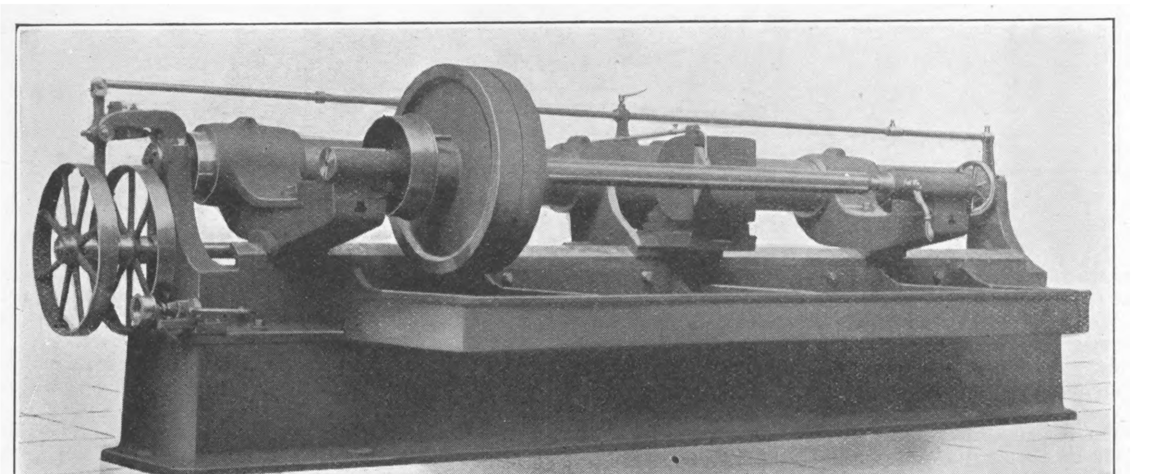


Fig. 10—RICHARD'S PISTON-ROD GRINDING MACHINE

The wheel head is guided by means of a cylindrical guide of large diameter, this form being considered the best for the purpose, and an auxiliary slide formed on the bed serves to take the weight of the head. The head has a cross traverse by screw to accommodate different diameters of work, and on this screw is fixed a worm wheel. The worm engaging with it has a dial, thus providing micrometer adjustment for putting on the feed. The machine can be arranged if desired for the feed to be put on automatically at each reversal. The grinding wheel is 10in. diameter and 1½in. wide. A trough is provided in front of the machine for catching the water which is pumped upon the work as the grinding proceeds. The water is returned to the main frame of the machine—which forms a tank—at the extreme end to that at which the pump is fixed; thus as the water in its course passes through small holes in the webs of the tank, it is delivered to the pump free from grit or other objectionable matter.

A locomotive wheel crank pin grinding machine by Beyer, Peacock and Co., Ltd., is illustrated in Fig. 11. This machine is really a new design of an old model, and the grinding wheel is made to rotate round the crank pin according to the method originally devised by Mr. H. Pearse, chief mechanical engineer of the Central Argentine Railway Company. The machine is capable of dealing with crank pins in wheels of various railway gauges and of a maximum of 13in. radius of throw. It stands upon a strong bed, on which are placed two brackets, each capable of being moved along the bed by means of a rack and pinion. These brackets are provided with screws and nuts for raising the wheels and axle to the desired height, and cramps for securing the axle, and pins for locking the wheels securely in position. The casting on the left hand carries a headstock, which can be moved backwards and forwards on a slide by means of a screw. A reversing motion is provided, and can be actuated automatically by means of an improved tappet arrangement. This motion can be instantly started, stopped, or reversed by hand by means of the lever shown. The spindle upon which the grinding wheel is mounted is of tool steel, and runs in gun-metal parallel bearings. In addition to revolving on its axis, it has a variable excentric motion derived from a system of excentric sleeves, which are revolved by worm and worm wheel, mitre gear, and belt pulley. On the opposite end of the bed is provided a bracket or stay capable of being moved along the bed by a rack and pinion, and having a slide which can be raised or lowered by hand. This is provided with brackets having adjustable centres for fixing the exact position of the axle centre, and for testing the centre of crank pins for right and left-hand cranks. The machine is provided with a pump and water service, and with efficient guards and troughs for protecting the slides and conducting the water back to the tank.

The same makers have lately placed on the market an improved form of their Universal type of lapping and grinding machine for locomotive and other case-hardened work. As will be observed from a study of Fig. 12, the machine now consists essentially of a box body, forming a cupboard for tools, and also containing the tank for the lubricant. The slide for supporting the table has one V and one flat shear, with oil pockets and rollers, and also contains the gearing for operating the table. Motion is derived from worm gearing working in an oil bath, and operated from the driving shaft placed at the back of the machine. The mechanism for reversing the motion of the table has been re-designed, and provides a very sensitive arrangement to enable the reversal to take place with accuracy when grinding links. The table can also be started, stopped, or reversed instantly by the movement of a lever in front of the machine, and a hand wheel is provided for moving the table along the slide. A smaller hand wheel and worm gear allow of finer adjustments to be made when lapping out holes. The auxiliary table used for grinding engine expansion links has now a motion of sufficient length to grind up to 21in., the desired radius in the case of radial links being given by a rod or bar fitted to a swivel bracket at the back of the machine.

When grinding radial links the supplementary table is reciprocated by a stud and die secured to the main table, and working in connection with a transverse slide in the supplementary table; but when engaged in grinding straight links the radius bar is disconnected and the supplementary table is secured to the main table by clips.

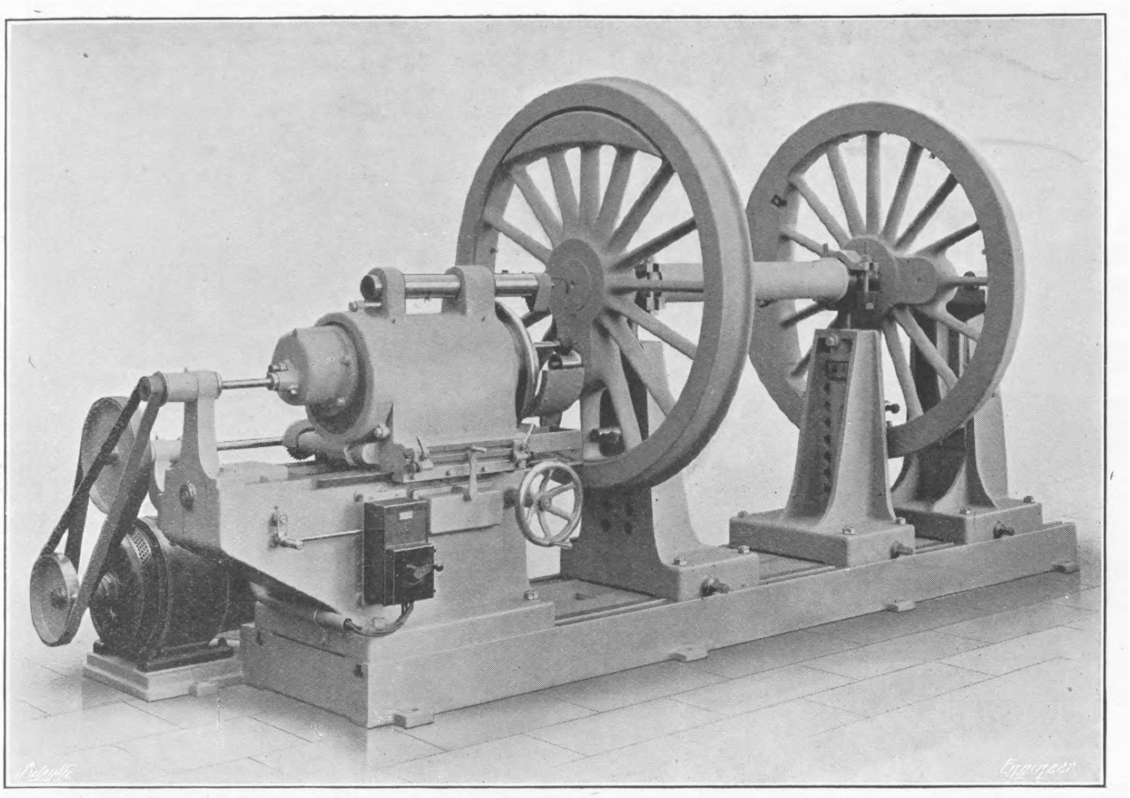


Fig. 11—BEYER, PEACOCK AND CO.'S CRANK PIN GRINDING MACHINE

The grinding head is fitted with a multiple excentric spindle, whereby the grinding spindle, in addition to revolving on its own axis, also revolves in axes of varying excentricity, which can be adjusted by hand to suit various diameters of holes to be lapped. The grinding spindle is carried in ball bearings, and can be caused to revolve at six different high speeds so as to enable wheels of various diameters to be used at their correct cutting speed. A centrifugal pump and efficient water service are provided, the water being conveyed back to a tank in the bed.

A taper hole grinding machine which is being placed on the market by Beyer, Peacock and Co., Limited, Manchester, has been designed to meet the difficulties experienced when using lead or other laps for truing taper or conical holes in locomotive and other kinds of work, and when the shape of the work precludes it from being revolved. The construction of the machine will be understood from the drawing—Fig. 13—which represents end and side elevations. A main body A supports a horizontal cylinder or drum B, revolved at a constant speed by means of the worm and worm wheel C. In the interior of the drum is a carriage or cross slide D, which is capable of being traversed across the drum by means of the hand wheel E and gearing. The carriage supports a hollow shell F, pivoted at the front end of the revolving drum, and capable of being locked at any angle up to the maximum by means of the quadrant and locking screws G. Sliding in the shell F is a second shell or spindle H, which receives a reciprocating movement by means of the rocking lever J. In the spindle H is the fast running grinding spindle K, which is driven by a belt from an overhead countershaft. The rocking lever J derives its motion from the main shaft of the machine through gearing and the worm wheel and hand wheel L. The latter is provided with a clutch to enable either hand or power traverse to be used. The work to be ground is supported on a compound table M, which can be adjusted in any direction. It will be seen, therefore, that the construction of the machine is such that the grinding wheel is traversed parallel to the side of the hole being ground—such surface being at the angle for which the spindle is set—and at the same time is revolved round the axis of the hole. The maximum incline that can be ground in the machine illustrated is 1 in 8 per side—making a taper of 1 in 4—down to a parallel hole. The main driving shaft at the side of the machine is fitted with fast and loose pulleys and belt shifting gear, while a fast-running pump at the back provides for a continuous supply of water to the grinding wheel, the drainage being conducted back to a tank in the bed. It will be observed that all the levers are conveniently arranged on the working side of the machine within easy reach of the operator.

The ordinary grinder made by the Norton Machine Tool Company, of Worcester, Mass., for whom Ludwig Loewe and Co., of Farringdon-road, London, are the agents in this country, of the latest pattern is shown in Fig. 14, and a similar machine fitted up for grinding motor cranks is illustrated by Fig. 15. This attachment is fitted to the standard 14in. by 72in. or 10in. by 50in. sizes of the Norton plain cylindrical grinder shown in Fig. 14, the general utility of which is in no way affected by the attachment. The headstock of the machine is provided with an adjustable centre, whilst the tailstock end is a device by means of which the crank shaft is always located in the machine in relation to a particular shoulder. While the shaft is being thus located the headstock centre is free to adjust itself according to the depth of the centre hole or the overall length of the shaft. The crank shaft duly in position, the headstock centre is clamped and the tailstock brought up to the opposite centre. On the front of the table of the machine somewhat to the left will be noticed a slotted bar, and on the base a bracket and pin which engages the slots; the latter are arranged in relation to the shoulders on the shafts to be ground. The table of the machine is thus located for each separate bearing. The forgings are rough ground on journals and pins to within .03 to .035 of the finished diameter, during which operation the fillets are also formed. After roughing, the shaft is straightened, say, to within .005in., and then ground to the finished sizes in a similar manner, the edges of the wheel having previously been shaped according to the correct radius of the fillets by means of a radial truing device.

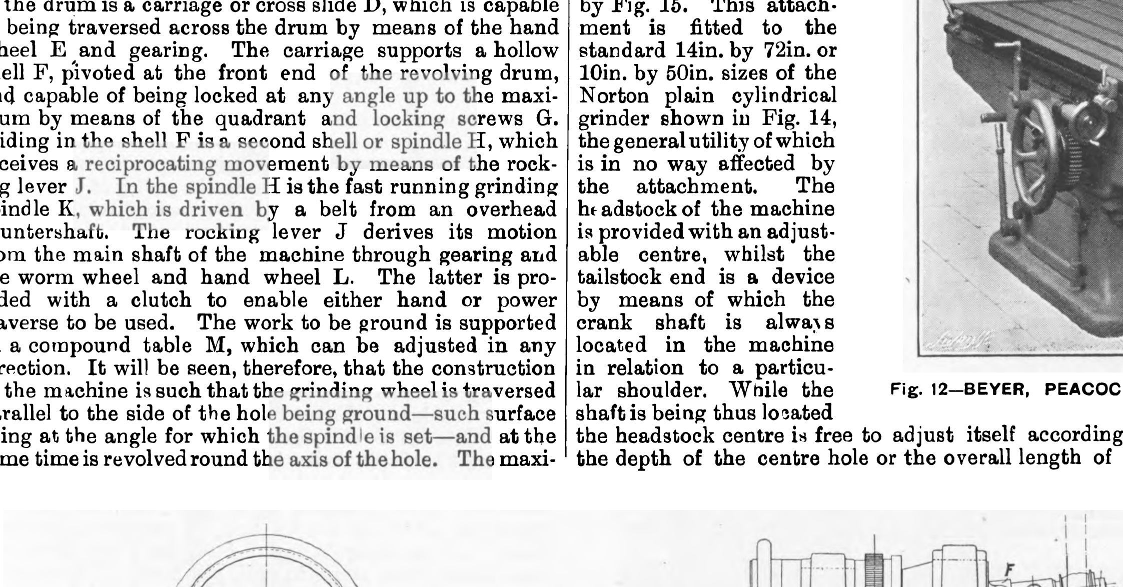


Fig. 13—BEYER, PEACOCK AND CO.'S TAPER HOLE GRINDING MACHINE

We have selected as a good typical example of the Norton cylindrical grinder an 18in. by 96in. machine, which embraces all the features characteristic of this make. As in all Norton machines the wheel is fixed, the spindle being carried in a heavy casting, so that vibration may be prevented—a very important matter. The work is carried between dead centres, and in the machine illustrated by Fig. 14 it may be 8ft. long, and anything in diameter from ½in. up to 18in. The table is compound, the upper portion being pivoted to permit of taper work being done; the maximum taper available is 2in. per foot. Both the table and the work have a long range of speed variation, independent of each other, and obtained, in both cases, by a simple belt-shifting device. All the changes are effected from the front of the machine, and there are no cones on the overhead motion. In both these speed gears one member is a plain drum and the other a stepped cone, a jockey pulley or its equivalent being used to maintain the tension. The machines have also automatic cross feed actuated by a ratchet and pawl, the mechanism of which will be understood by an inspection of the engraving. Six universal steady rests are provided. The wheel has three speeds, and it is usually 24in. diameter by 2in. face.

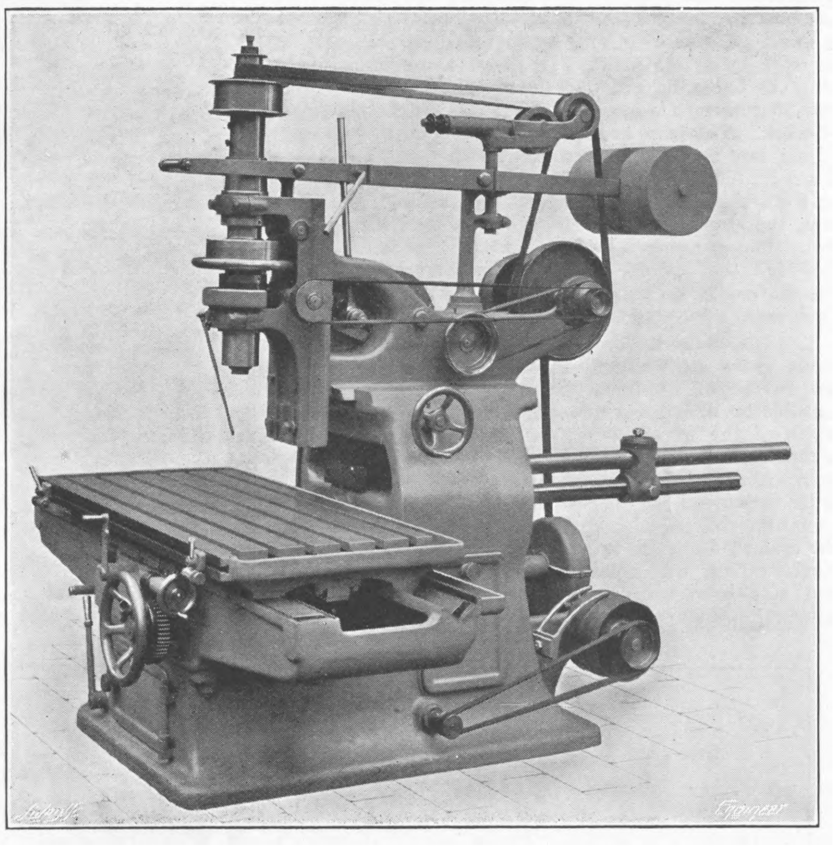


Fig. 12—BEYER, PEACOCK AND CO.'S UNIVERSAL LAPPING AND GRINDING MACHINE

An interesting example of a grinding machine designed for one special purpose is afforded by the machine for grinding the tires of rail and tramway wheels, illustrated by Fig. 17, also constructed by the Norton Grinding Machine Co., of Worcester, Massachusetts. The machine was originally designed to deal only with the wheels of passenger coaches, as, on account of the absolute smoothness and circularity of the work turned out, very easy and quiet running is obtained; but we are informed that it has proved so beneficial in the prevention of flats and high places on wagon wheels that it is also being used for them. As shown, it is only suitable for 4ft. 8½in. gauge, and cannot be used for any other size. The arrangement is fairly obvious from the illustration, but the two dead centres between which the axle is carried cannot be seen. The central belt on the four step cone drives the wheels through the medium of the worm and wheel, whilst the wheels of large diameter are driven direct by belts from the countershaft; another belt drives the self-acting traversing motion, which carries the stone to and fro across the face of the work. This gear can be thrown out of operation at either end by turning a small handle. The feed is put on by hand, and is not automatic. In order to permit the axle to be put into position in the drive bearing a segment of the worm wheel is removable, and in order that the operation of taking out a wheel may be performed with ease an arrangement is provided for stopping the revolution at the right place. This machine will grind carriage wheels up to 44in. diameter, and engine bogie wheels up to 36in. diameter, with an accuracy within .002in. or .003in. From twenty to twenty-five pairs should be turned out per day of ten hours.

A large plain grinding machine for heavy work which has recently been built by G. Birch and Co., Salford, Manchester, is illustrated in Figs. 16 and 18. The first figure shows the machine equipped for external grinding, while the line drawings—Fig. 18—show the internal grinding fixture in position on the front of the wheel head. The drawings also show the details of the apparatus and construction of the machine itself, sectional views being given of the work headstock with its large hollow spindle, and of the emery spindle for external grinding, showing the large double cone bearings, with oil wells and ring lubricating arrangement. The machine is known as the "No. 17" size, and admits work up to 18in. diameter and 7ft. 6in. long. The bed is 14ft. long over the slides, and has an extension at the rear on which is mounted the emery head, and there is a tray for catching the spray from the wheel. The work headstock is arranged with a running spindle for internal work, &c., the spindle having a hole 3⅜in. bore throughout, so that long shafts can be accommodated for grinding their ends, thus increasing the capacity of the tool for certain classes of work. The loose headstock has both spring and screw adjustment to the centre, so that either can be used as desired. The T slot in the top table is planed at an angle, so that the headstocks are pulled against the front face, thereby eliminating errors due to the wearing of the slot. For grinding tapers up to 1¾in. per foot a swivel table is fitted, and for greater tapers than this the nut of the set over screw can be released by withdrawing a pin, enabling the table to be set by hand as required.

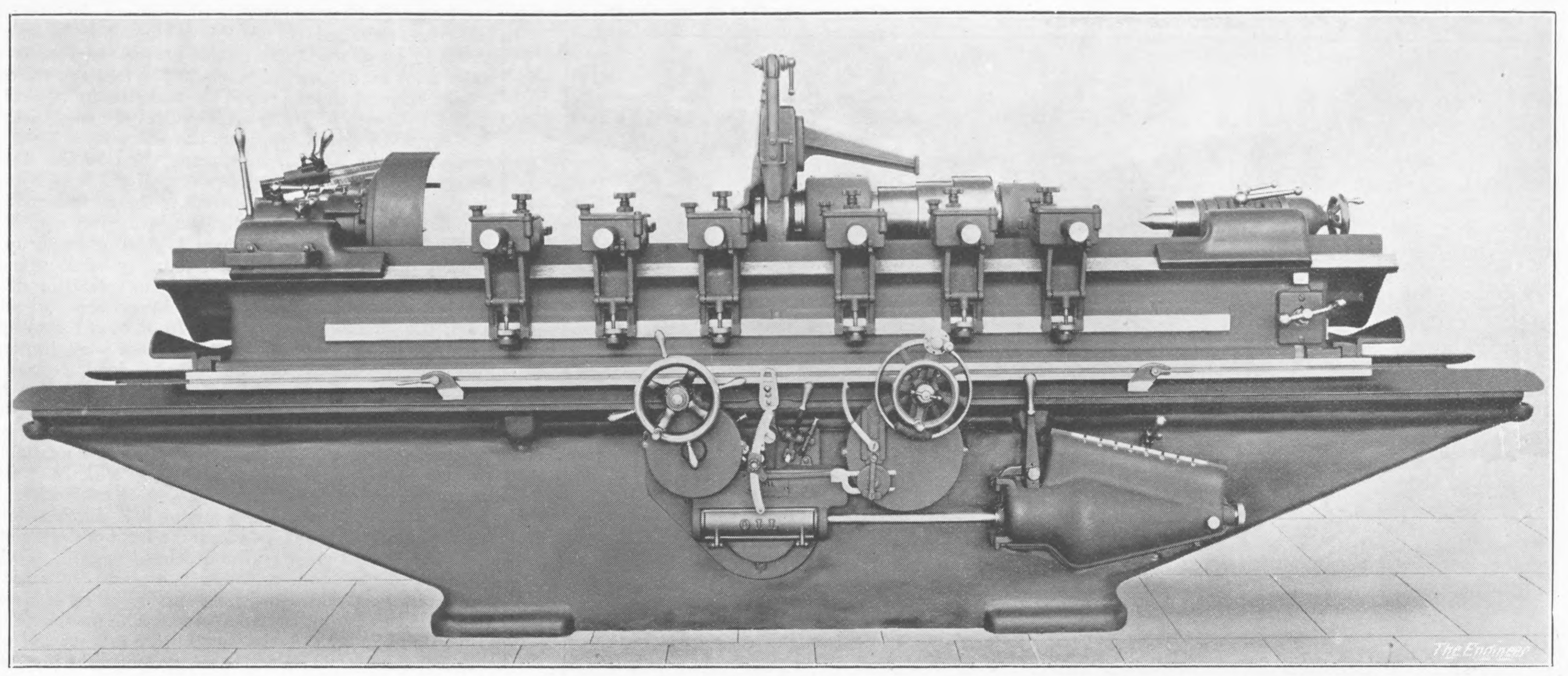


Fig. 14—NORTON PLAIN GRINDER

The mechanism for traversing the table of this machine gives eight changes, varying from ⅛in. to 1¼in. per revolution of the work, thus providing a fine feed suitable for internal grinding or a coarse feed equal to the width of the emery wheel for external grinding. The reversing stops for the table traverse are carried on a rack seen in front of the table to facilitate adjustment, and in order to prevent the spaces between the teeth of the rack becoming clogged with dirt, &c., the teeth are placed on the under side. The emery wheel spindle is of hardened steel, running in phosphor bronze bushes, with an oil well and ring lubrication. The spindle carries an abrasive wheel, 18in. diameter by 1½in. wide, and is driven by a three-speed cone pulley, which allows the surface speed of the wheel to be correctly maintained as the wheel becomes worn. The automatic feed motion will give any feed to the grinding wheel from 0.00025in. to 0.004in. at each reverse of the table, and the feed is independently variable at each end of the table, so that, if required, the feed can be put on at one end of the work only.

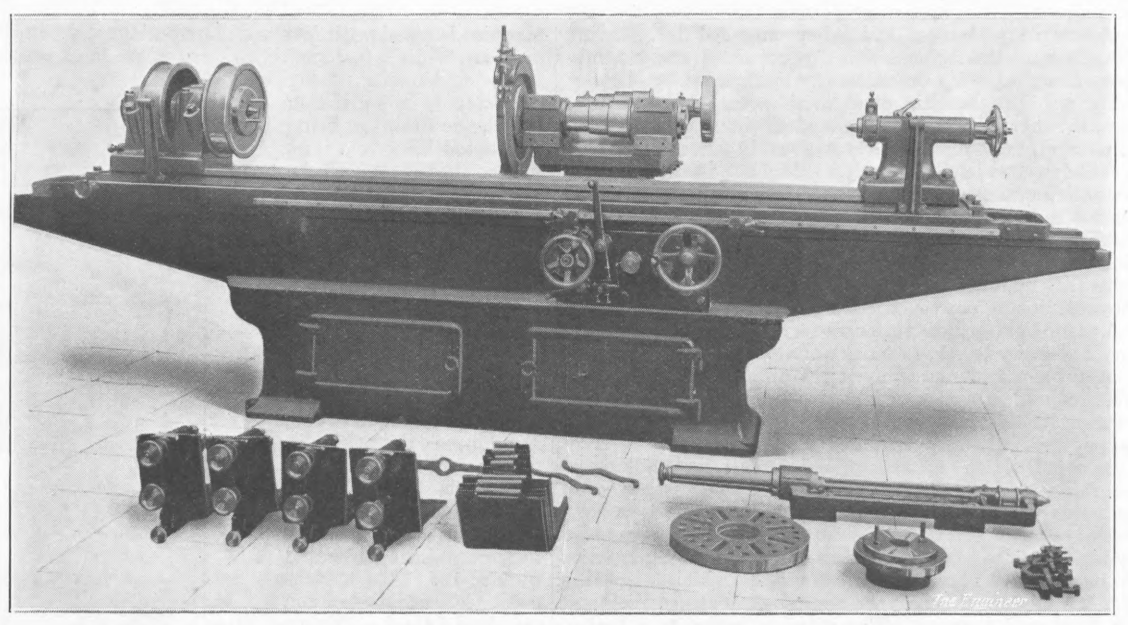


Fig. 16—BIRCH AND CO.'S PLAIN GRINDING MACHINE

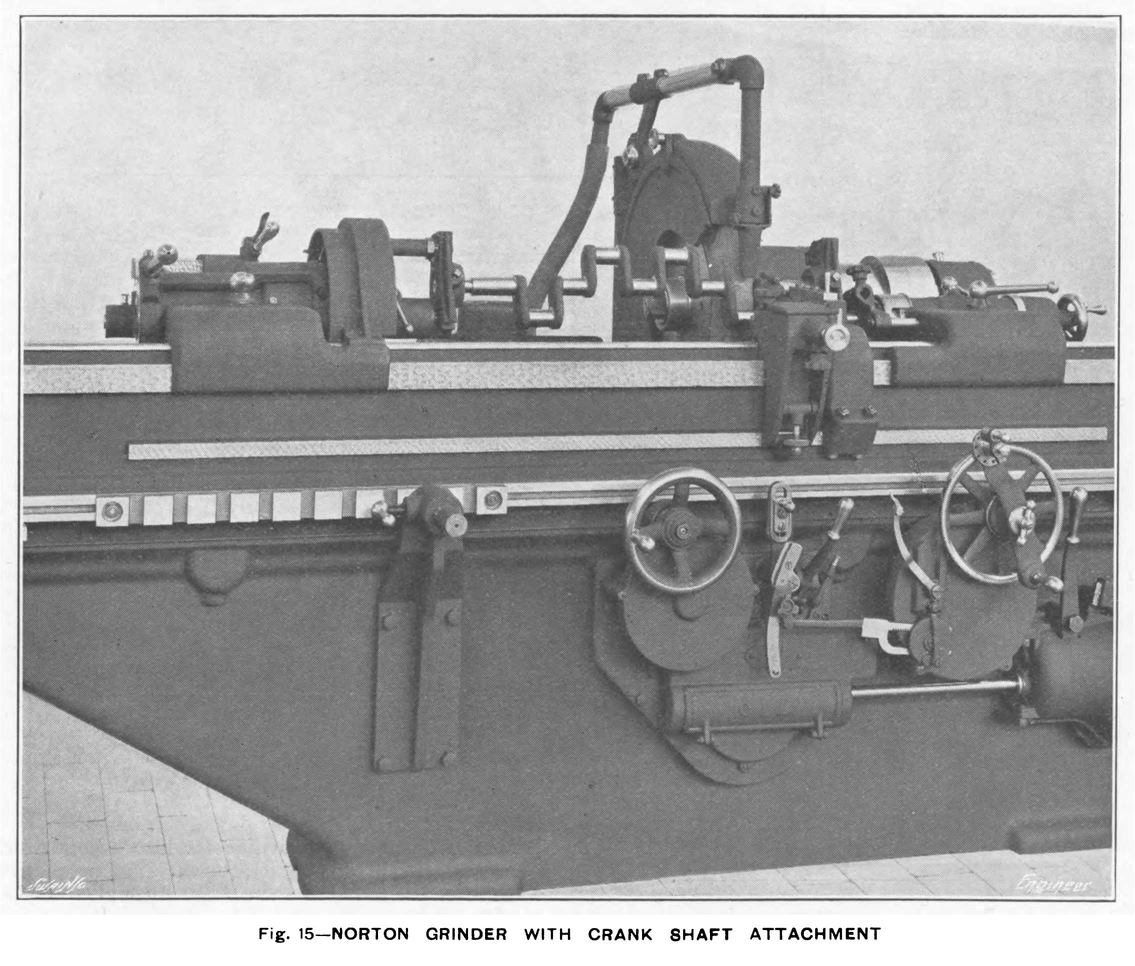


Fig. 15—NORTON GRINDER WITH CRANK SHAFT ATTACHMENT

The internal grinding attachment, as shown in Fig. 18 is bolted on to the front of the grinding head, the wheel flanges being removed for this purpose. The attachment is driven by a countershaft fastened at the rear end of the wheel slide, the countershaft having a cone pulley, which is a duplicate of that on the wheel spindle, with a large diameter pulley for driving on to the pulley of the spindle—see plan. The countershaft is arranged to slide on the headstock, so that the belt can be tightened readily. This attachment is intended to grind holes from 3in. diameter and up to 12in. deep, and will carry a grinding wheel up to 3in. diameter and ½in. wide. The spindle is hardened, and runs in phosphor bronze bushes. The attachment is easily fixed or removed.

Fig. 19 represents one of the smaller sizes of universal grinding machines made by G. Birch and Co. Recently these machines have been improved and brought up to date to enable heavier cuts to be taken. The grinding wheel spindle has been stiffened, and the design of the back rests has undergone alteration. These rests have two jaws swinging on a hinge joint, and are independently set up by screws, one jaw supporting the work below and the other behind. Both jaws are fitted with removable brass steps to suit the work. The stops for reversing the motion of the table are fitted to a small rack in front of the table, giving instant adjustment, and the teeth are placed below to prevent the spaces being choked with dirt. The automatic feed for the emery wheel is stronger than formerly; the ratchet wheel having coarser teeth than usual, the wear is minimised, while the feed is increased. Any amount of feed can be obtained from .00025in. to 0.003in. at each reverse of the table, the feed being capable of independent variation at each end of the table, so that the feed can operate at one end of the traverse only if so desired.

John Hetherington and Sons, Limited, Manchester, build a grinding machine specially intended for treating the surface of carding engine cylinders, drums, pulleys, &c. A general view of it is given in Fig. 21. The base-plate is one casting, planed on the top face, and having ⊥ slots cut out of the solid to receive two end standards and two intermediate standards. The end standards are planed on the top and bottom surfaces, and securely bolted to the base-plate. The intermediate standards are also planed on both surfaces and bolted to the base-plate, but the right-hand one is adjustable longitudinally by means of a capstan head, pinion and rack to suit different lengths of cylinders. These intermediate standards are provided with adjustable capped bearings for receiving the revolving mandril on which the article to be ground is mounted. The longitudinal slide bed is of the box pattern, having a series of box bars and wide top **V**'s machined on the top and bottom faces. It is secured on the four standards, and is fitted with a traversing slide, which is of unusual length to protect the wearing surface from the emery dust. The traversing slide is accurately machined and fitted to the bed with adjustable **V** strip to take up the wear, and the upper face is provided with transverse **V**'s for receiving the grinding spindle head. The latter is made adjustable by means of a hand wheel, square-threaded screw and gun-metal nut for regulating the cut of the emery wheel. The steel spindle is 2¼in. diameter, revolves in long adjustable gun-metal bearings, and is fitted with a double-flanged pulley. The grinding wheel is 14in. diameter by 1in. wide, and its peripheral speed is 2200ft. per minute. The driving of the traversing slide is effected by means of a double-flanged pulley, mitre wheels, square-threaded screw, and gun-metal nut. To regulate the length of the stroke adjustable stops are provided, and there is also an automatic reverse motion. The machine will grind articles from 1ft. to 4ft. 3in. diameter.

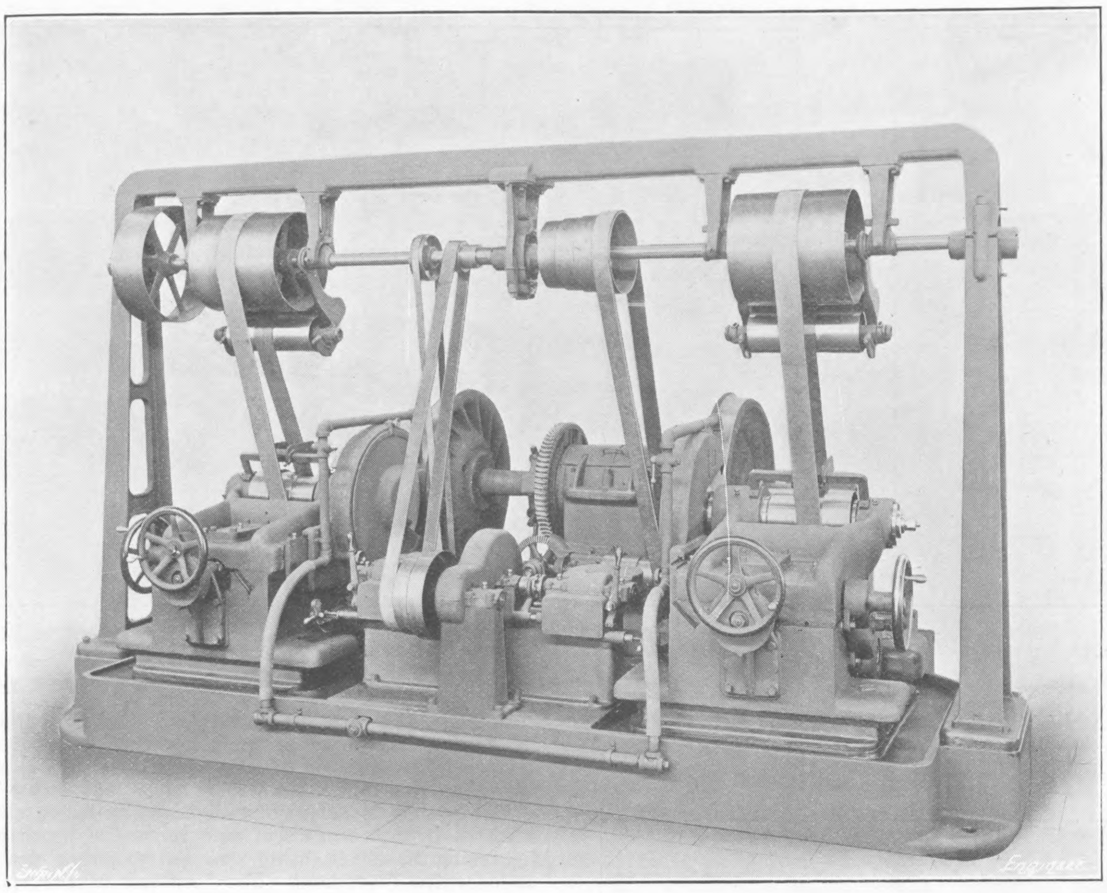


Fig. 17—NORTON RAILWAY WHEEL GRINDING MACHINE

The automatic flat grinding machine, with two spindles, shown in Fig. 22, is made by Kendall and Gent, Limited, Manchester. The bed has planed and surfaced slides, forming a tank for the water, and rests on the foundation the whole length. The table has a trough and T slots planed from the solid, and is moved by rack and pinion, spur gearing and pulleys on flat slides; it is provided with self-acting reversing motion, as well as adjustable stops for regulating the length of traverse. The heavy uprights with vertical slides are rigidly fixed to the bed, and the saddles are counterbalanced, having an independent vertical adjustment by screw and hand-wheel to compensate for varying diameters of emery wheels and depth of work. The spindles carrying the emery wheels are of hard steel, and revolve in long parallel gun-metal bearings adjustable for wear. Each spindle is provided with independent driving and adjustable self-acting reciprocating motion for varying widths. The countershaft is carried in bearings formed on brackets cast with uprights, thus rendering the machine entirely self-contained. To maintain the tension on the belts wheh elevating or lowering the saddles jockey pulleys are provided. The emery wheels are 15in. diameter by 3½in. wide. The dimensions of the machine are as follows:—Length of bed, 15ft.; to grind in length, 9ft. 6in.; width between uprights, 3ft. 5in.; width of table inside trough, 3ft.; self-acting reciprocating motion, from 0in. to 1ft.; distance from centre of spindle to table, minimum, 1ft.; maximum, 2ft.

The same makers are responsible for the machine Fig. 20, which is designed for the rapid internal grinding of all kinds of cylindrical hollow work, having parallel or conical holes, whilst it is also capable of grinding on the face without re-setting. The machine is substantially built, so as to be free from all jar or tremor when working, and consists of a bed of heavy design having accurately planed and surfaced vee slides for the wheel carriage, and also a planed and surfaced slide at right angles for the headstock carrying the work. The centre portion of the bed forms a cabinet for tools. The headstock has a strong steel spindle with hardened and ground conical necks running in phosphor bronze bearings, adjustable for wear and fitted with a self-centering chuck for carrying the work. The headstock is mounted on a slide on the bed and arranged to swivel, so as to enable conical holes to be ground. A stop is

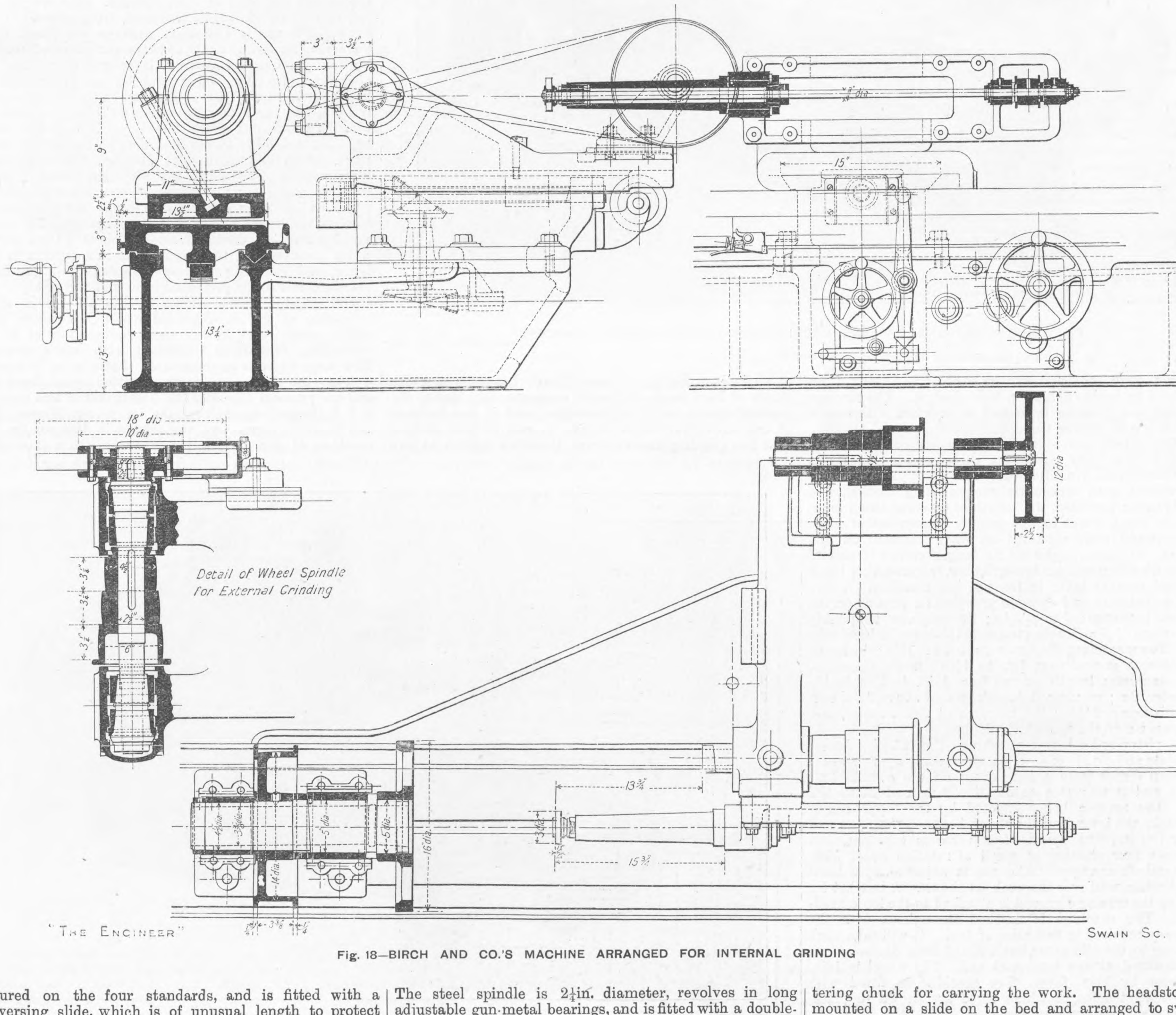


Fig. 18—BIRCH AND CO.'S MACHINE ARRANGED FOR INTERNAL GRINDING

provided for setting dead true when grinding parallel holes. The screw for traversing the headstock on its slide is provided with coarse and fine adjustment, the latter being graduated to $\frac{1}{1000}$in. As will be seen, the spindle and chuck are rotated by means of an electric motor, though provision can be made for driving from overhead by means of belting when desired. The carriage carrying the grinding headstock is provided with means for fixing and driving three high-speed internal grinding spindles, which are suitable for varying diameters of emery wheels. By means of these wheels holes can be ground from ¾in. diameter upwards. The carriage is provided with automatic reciprocating motion, five speeds being provided, the length of traverse being regulated by stops, which can be quickly thrown out of gear. A compound slide mounted on ways formed on the carriage at right angles to its length carries a second emery wheel spindle for face grinding, reciprocating being by hand ratchet lever in front of the machine. A fine hand adjustment and stop are provided for putting on the cut, and is graduated to $\frac{1}{1000}$in.; the stop can be quickly thrown out of gear, leaving the wheel slide under hand control. The maximum diameter admitted is 12in.; the maximum length ground from ¾in. to 1½in. inside diameter, 4in.; maximum length ground from 1½in. to 2¼in. inside diameter, 8in.; maximum length ground above 2¼in. outside diameter, 11½in.; the traverse of table, 15½in.; and the traverse of the headstock, 20in.

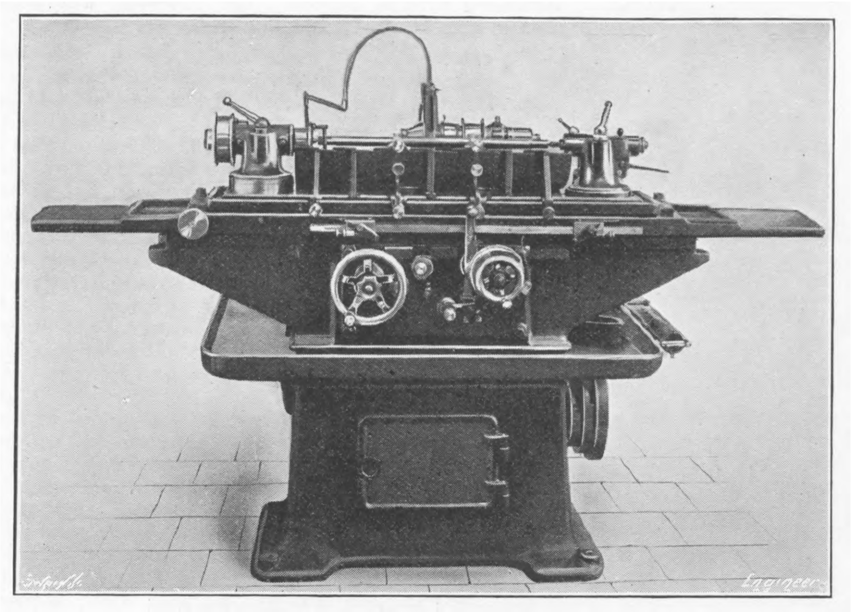


Fig. 19—BIRCH AND CO.'S UNIVERSAL GRINDER

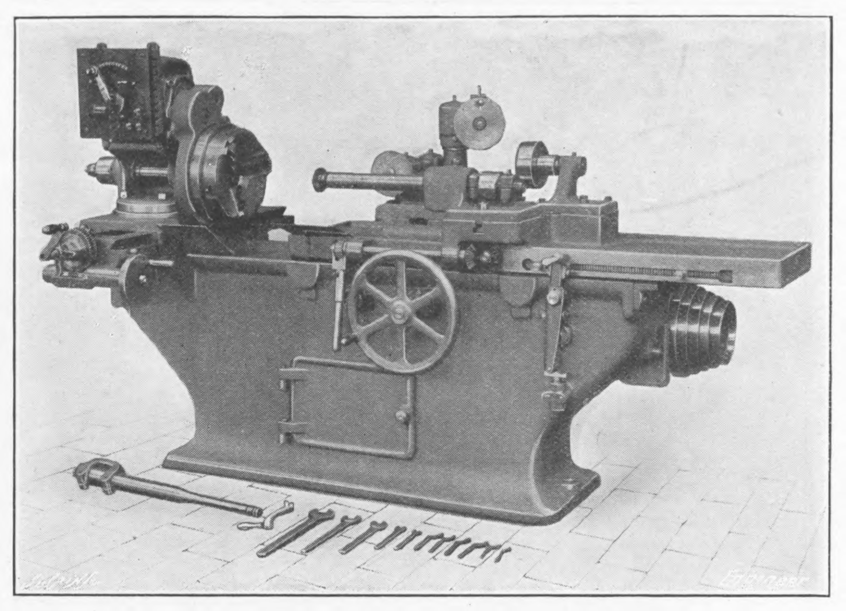


Fig. 20—KENDALL AND GENT'S BUSH AND FACE GRINDER

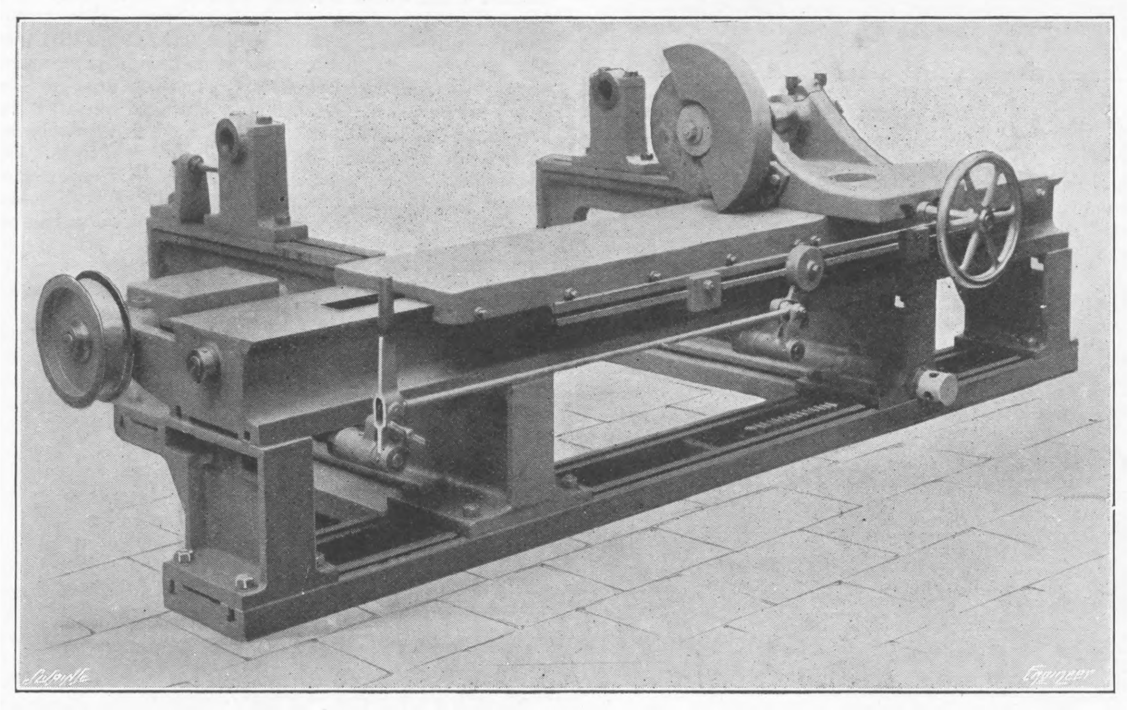


Fig. 21—HETHERINGTON'S GRINDING MACHINE FOR CARDING ENGINE CYLINDERS

The piston-rod grinding machine—Fig. 23—by James Archdale and Co., is of a very simple design. The wheel is driven direct from a long drum on the countershaft above, and it traverses automatically up and down the work, the reverse being effected by the tappet-rod at the back, the lever, and the clutch between the open and crossed belt. The speed of traverse is constant, but there are four changes of speed of rotation apart from countershaft changes. The cut is adjusted by a hand wheel raised well over the work as shown. A bracket for holding the trueing diamond is attached to the loose headstock. The machine is finished throughout with the accuracy required in this class of tool. It will take work 8ft. long by 6in. diameter, but a piston 28in. diameter can be admitted at the headstock end. The wheel is 16in. diameter by 1½in. face. The machine is fitted with removable steadies, of which three are shown in place, but as a rule six are employed.

A special grinding machine of more than ordinary interest is that illustrated by Fig. 24, and made also by James Archdale and Co., Limited. It is designed for grinding the ends of steel shell, and the plan on which it works will be understood readily from the engraving. The reason why projectiles need grinding at all is instructive. It occasionally happens that the points of hard steel shell split spontaneously, due to the internal strains set up by hardening, and it was believed at one time that initial cracks existed in the surface. This fine grinding machine was therefore got out to give the ogival head such a polish that if any cracks existed they could be discovered. We are not sure if the method still continues in use, but several machines have certainly been made. In that illustrated projectiles from 10in. to 13.5in. diameter may be ground. They are held in a headstock fitted with a hollow steel spindle having bearings adjustable and protected from grit and dirt.

This spindle is provided with a self-centering chuck, actuated by a worm wheel and worm, the worm, after tightening the chuck, being arranged to swing clear by an excentric movement. The rear end of the spindle carries an arrangement by which the projectile can be drawn into position for chucking or ejected when desired. This consists simply of a rod which screws into the base of the projectile and is drawn to the rear by rack and pinion.

Arrangements of a familiar kind are, it will be seen, provided for accelerating the speed as the emery wheel approaches the point of the projectile. The special link belt used is automatically traversed from end to end of the coned drums at the same time as the emery wheel traverses from the chuck towards the point of the projectile, by means of gearing, lever and adjustable link work driven from the feed shaft at the back of the machine. The slide carrying the wheel has a radial movement and a self-acting reversing action, enabling the wheel to describe a radius in either direction. This radial movement is actuated from the feed cone pulley through bevel gears, worm and worm wheel, pinion, and rack at its outer radius. The slides are well supported in every position without overhang, and the carriage can be traversed by hand. Adjustable stops are provided to regulate the length of the radial movement. The emery wheel is 2ft. 4in. diameter, and is driven by an electric motor mounted on the carriage, and its spindle is hardened and ground and runs in substantial gun-metal bearings, effectually protected from dirt and grit.

The grinding lathe shown in Fig. 25 serves as an indication of the development which has taken place within recent years in this most rudimentary of all the mechanical operations associated with man's progress. This large tool can accommodate shafts up to 30 tons in weight—the maximum length admitted being about 33ft. and the greatest diameter 3ft. The maker of this machine is J. E. Reinecker, of Chemnitz, for whom Messrs. Pfeil and Co., of London, are the agents in this country. A machine of this description was supplied a short time

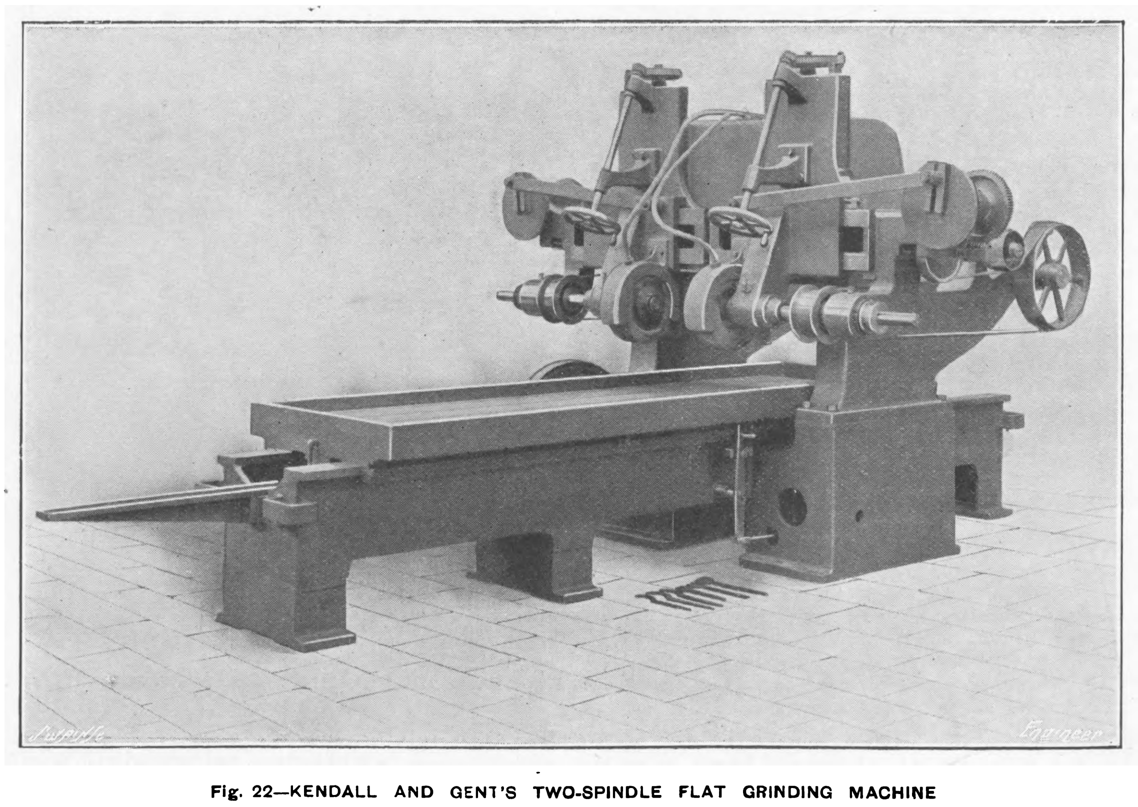


Fig. 22—KENDALL AND GENT'S TWO-SPINDLE FLAT GRINDING MACHINE

ago to Krupps, at Essen, and we understand that another is now in hand for a large firm in Belgium. It will be seen from the engraving Fig. 25 that three independent electric motors—representing a total of 51 horse-power—are employed to drive this machine. The face plate, and along with it the work, is rotated by a 16 horse-power motor, which drives through toothed wheels on to the face plate spindle. On the saddle are carried two motors, one of 30 horse-power driving the grinding wheel, and the other of 5 horse-power for traversing the saddle. Other figures relating to this machine are as follows:—Height of centres, 2ft.; length of bed, 46ft.; length over all, 49ft.; approximate weight, 40 tons.

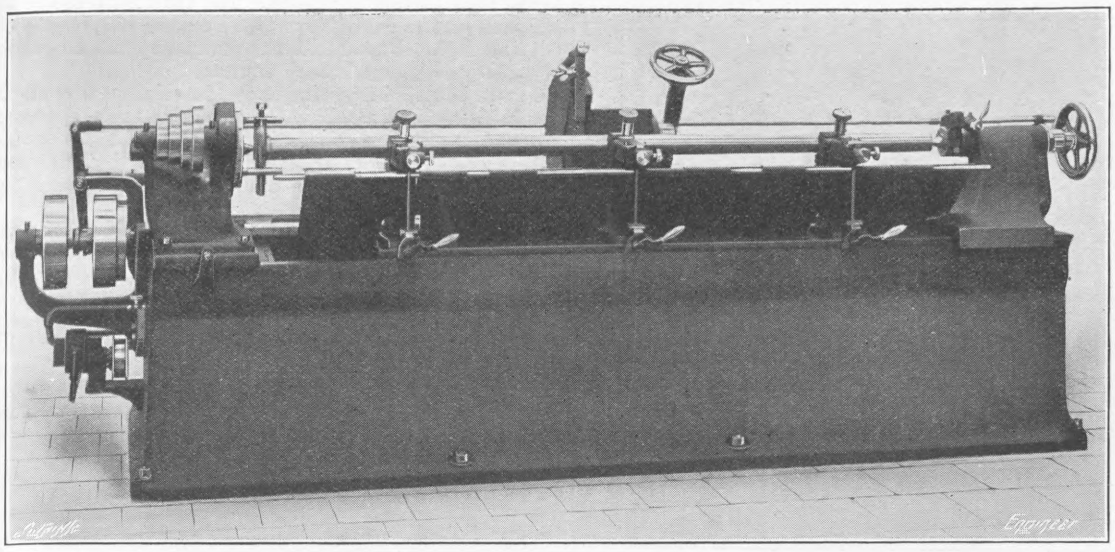


Fig. 23—ARCHDALE'S PISTON-ROD GRINDING MACHINE

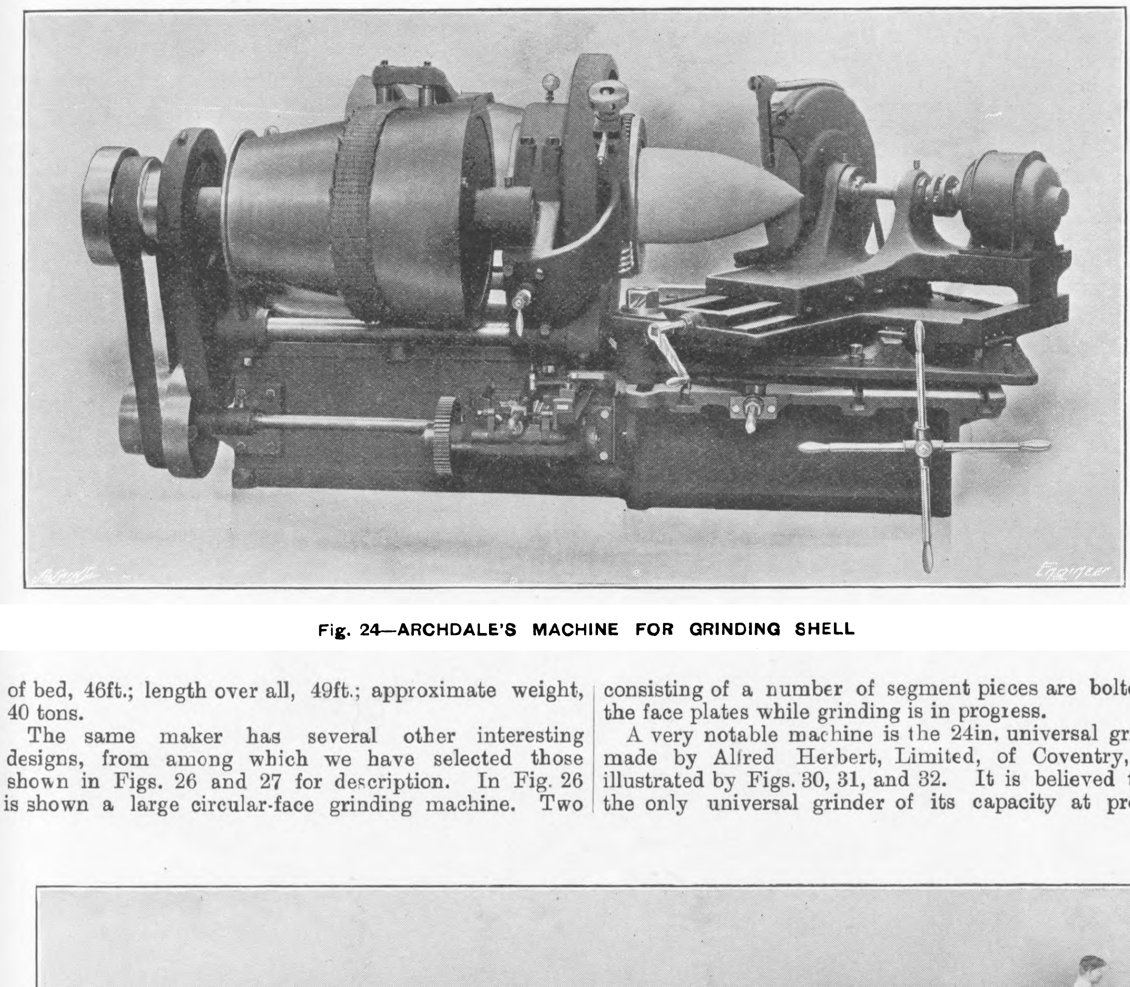


Fig. 24—ARCHDALE'S MACHINE FOR GRINDING SHELL

The same maker has several other interesting designs, from among which we have selected those shown in Figs. 26 and 27 for description. In Fig. 26 is shown a large circular-face grinding machine. Two emery wheels are carried on this tool, one to the left of the engraving, with its axis horizontal, the other with its axis vertical but capable of being tilted as shown. Many varieties of work can be undertaken on this machine, and it is especially well adapted for grinding the faces of piston rings and their corresponding grooves. For work liable to twist when held by the ordinary chucking devices the machine is supplied with an electro-magnetic chuck. The capacity of the machine is sufficient to allow work up to 59in. in diameter and 20in. in height to be taken. A 6 horse-power motor is employed to drive the tool.

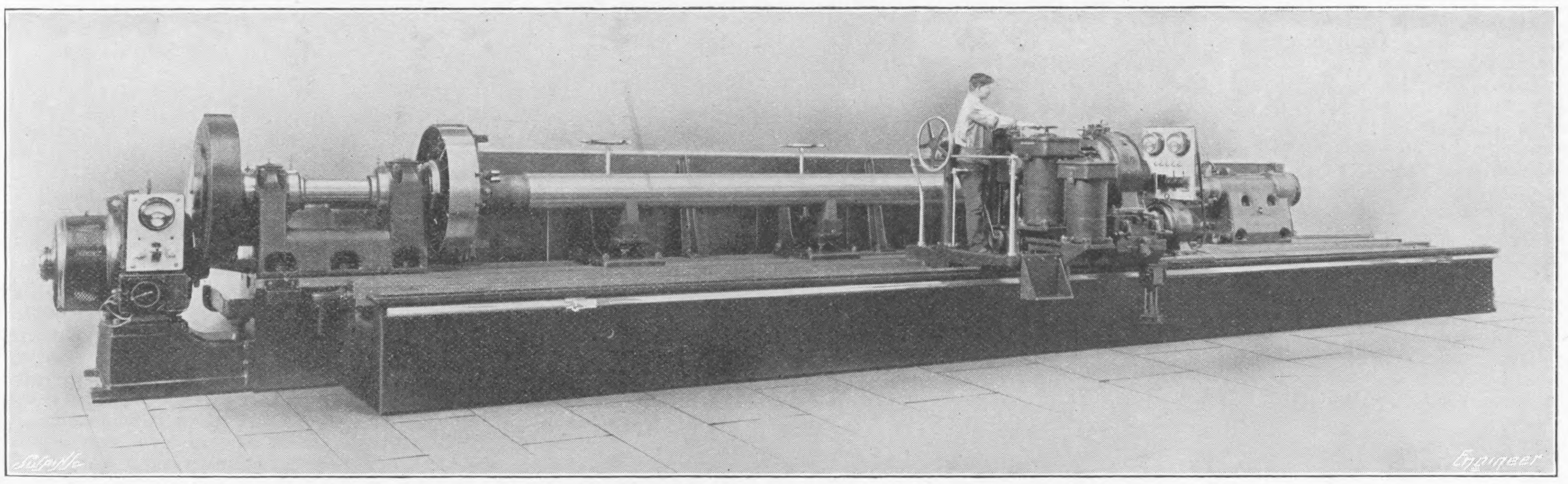


Fig. 25—REINECKER'S MACHINE FOR GRINDING LARGE SHAFTS

The tool represented in Fig. 27 is intended for motor work and other light jobs. Two special face plates are employed, each of which carries a socket to receive the ends of the crank shaft. These sockets are adjustable by a screw, and can be set to give the exact throw required by means of a scale and vernier. Balance weights consisting of a number of segment pieces are bolted to the face plates while grinding is in progress.

A very notable machine is the 24in. universal grinder made by Alfred Herbert, Limited, of Coventry, and illustrated by Figs. 30, 31, and 32. It is believed to be the only universal grinder of its capacity at present on the market, and comprises a number of unusual features which have been dictated by the makers' own experience, and which enhance greatly its handiness. The machine takes a 24in. grinding wheel 2¼in. wide, and has enough power and sufficiently quick feeds to enable the full capacity of this wheel to be utilised, and it will take work 10ft. long between centres. It is of the fixed wheel type.

The body of the machine is in one piece, which carries both the grinding wheel head and the tables, as the illustrations show. It is of very strong form, and it is well ribbed and stayed internally. When it was planed it was determined before proceeding further to test it for distortion, and loads were applied in various probable and improbable ways to endeavour to make it change its shape, but without effect. That part of the body on which the grinding wheel head rests is especially rigid, being well trussed to the parts carrying the table; the form, as the size necessitates, being much stronger than the usual T-shaped design which is customary on smaller machines.

The table is supported for nearly the whole of its length when on the longest stroke, and has automatic traverse in both directions, the reverse being controlled by stops which slide in a tee slot on the front of the table, and which can be rapidly adjusted into any position. They have a fine adjustment screw for accurate setting. The automatic reverse lever is so arranged that the table can be traversed past the stops when required, and it will reverse dead to a line when grinding up to a shoulder.

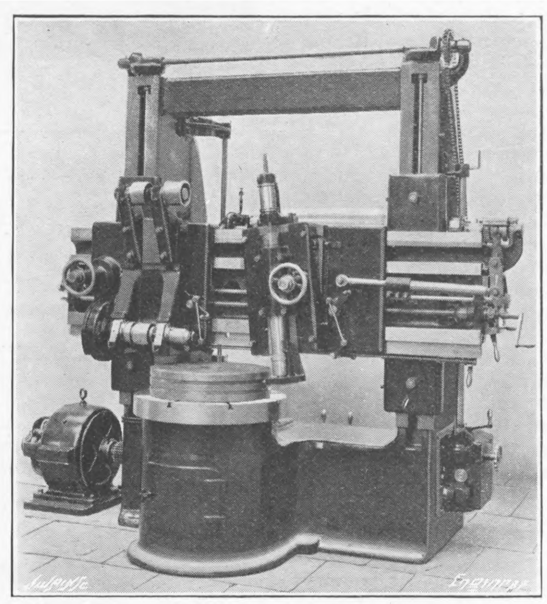


Fig. 26—REINECKER'S CIRCULAR FACE GRINDER

The top table is arranged to swivel for taper work, and is graduated to read to degrees and inches per foot. It is of particularly strong form—seen well in Fig. 32—and is arranged so as to form natural channels for the water used in grinding to pass away. The number of slots seen in the illustrations aid in this.

The work head can be racked along the table into any required position by a hand wheel and suitable gearing—the rack can be seen in Fig. 32—and can be locked at any part of the bed by a device which not only clamps the head to the table, but also binds the traversing gearing, thus effectually preventing the head from slipping back if any hand pressure is put upon it.

For grinding cylindrical work between centres, the spindle for the work head is clamped so that the centre does not rotate, but outside the spindle centre is a face plate for driving the work and also for carrying whatever chucks may be desired for internal grinding, face grinding, &c. This face plate is driven by spiral gears, the driving shaft being placed at an angle of 45 deg. with the machine. The upper part of the work head swivels round for face or taper grinding, the swivelling movements being graduated. When swivelled through 90 deg. the driving pulley is still at an angle of 45 deg. with the machine, only in the other direction, thus ensuring that the belt is never twisted more than 45 deg. from its medial position. This method of driving is found to be exceedingly smooth, and to produce work free from chatter. When chucks are in use the face plate is clamped to the spindle, which rotates with it. The change is effected almost instantly by a locking pin, an indicating trigger showing when the wheel and spindle are in the proper relative position. The spindle is of mild steel, case-hardened and ground, and afterwards lapped on the bearing surfaces.

The tailstock is constructed in a similar manner to the headstock so far as regards arrangements for moving it along the table and locking it in position. It is provided with a screw and hand-wheel feed, and also a spring to allow for the expansion of the work.

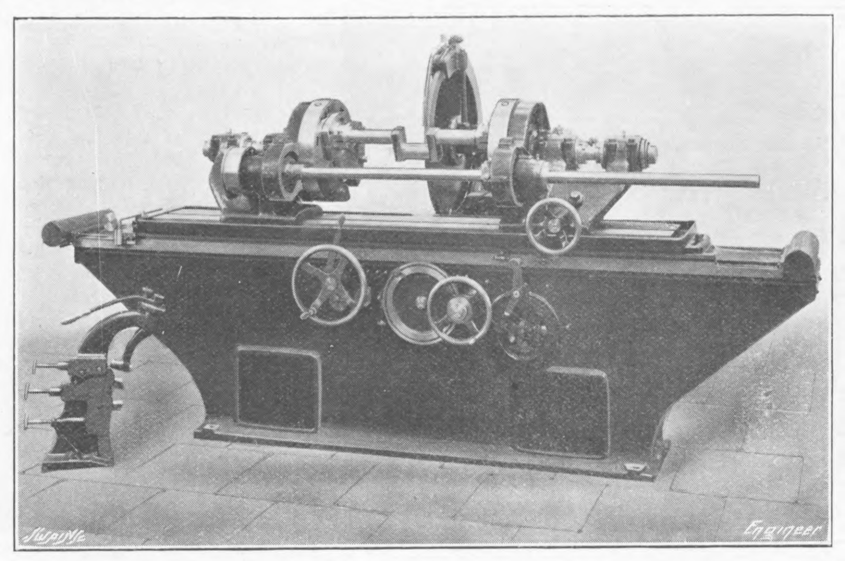


Fig. 27—REINECKER'S CRANK SHAFT GRINDING MACHINE

The steadies, Fig. 28, are of an entirely novel design. The steady blocks are mounted on swivelling arms, the movement of which is controlled by a right and left-hand screw, C D, and the nut in which this screw works is adjustable by a knurled knob F. Thus after the steadies have been set to bear properly on the work by the knob G, they can be moved to and from the wheel as required by the knob F, without altering their position relatively to each other. The action of the steady blocks A and B also holds the work back firmly from the wheel, a feature which is very desirable when grinding work of small diameter. Supplementary steady blocks—see Fig. 29—are provided to bear on the top of the work for the purpose of absorbing vibration. These steadies are clamped to the upper table by a pair of hooks—moved by an excentric motion, and are instantly freed or tightened

The grinding wheel head is a massive casting resting in vee slides, and held down by its own weight, which is great so as to absorb vibration on the anvil principle. This head carries the main grinding spindle, which is very large, and runs in adjustable phosphor bronze bearings, the spindle itself being of steel, hardened, ground, and lapped. The grinding wheel is mounted at the end of the spindle, so that it may be easily changed when desired. The slides on which the grinding head is carried are also very heavy, and rest firmly on their bases by gravity only. The whole of the sliding surface is completely protected from wet and emery dust by means of telescopic sheet steel screens. The wheel head can be revolved by means of a circular rack and pinion, and is graduated in degrees.

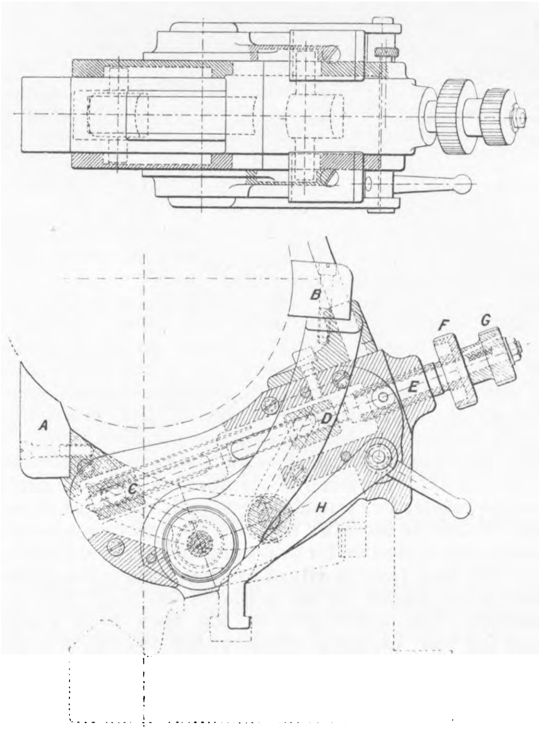


Fig. 28—HERBERT'S STEADY

The cross feed mechanism for the grinding wheel, besides being automatically operated from the reversing lever, can also be manipulated by a hand wheel on the front of the machine, and this hand wheel is fitted with six automatic stops, enabling six diameters to be ground accurately on the same shaft. Provision is made for adjusting all the stops together for compensating for the wear of the grinding wheel. This hand wheel can be seen in Fig. 31. The stops are arranged in six circular plates or rings fastened to the hand wheel, and each of these plates has a corresponding knob. Each ring has an internal rack cut in it, and each knob has a pinion with only one tooth, so that one revolution of a knob advances the plate only a very slight amount. A bigger knurled knob advances all the plates simultaneously.

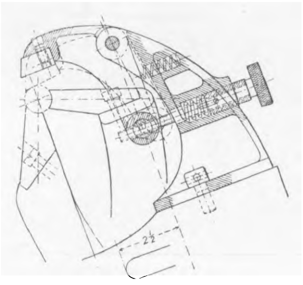


Fig. 29—HERBERT'S TOP STEADY

The cross movement of the grinding wheel head is operated by rack and pinion, a spring device being incorporated in the slide to enable the operating gearing to act entirely without backlash, the movements of the wheel by this means corresponding closely to the indicators of the index discs. This device enables diameters to be accurately ground and the automatic stop to work within the limit of .00025 of an inch.

Incorporated in the design of the machine are two variable gear motions of the type known as Herbert's patented dial feed, such as are used on the makers' milling machines. Each of these feed boxes gives a range of sixteen variations. One of these boxes is used for driving the overhead shaft from which the work spindle is driven, and the other box varies the feed. The changes are made by two hand wheels at the front of the machine, the ranges of these hand wheels being marked for the various speeds and feeds; all that is necessary, therefore, to change the speed of the work or to change the rate of traverse is simply to turn the proper hand wheel into the correct angular position as shown by the indications upon it. The quickest rate of feed was arranged to act as a quick power motion for setting the machine, but it has been found in practice, and we have found ourselves by trial, that the table moves so easily that it is practically no trouble at all to rack it along by hand.

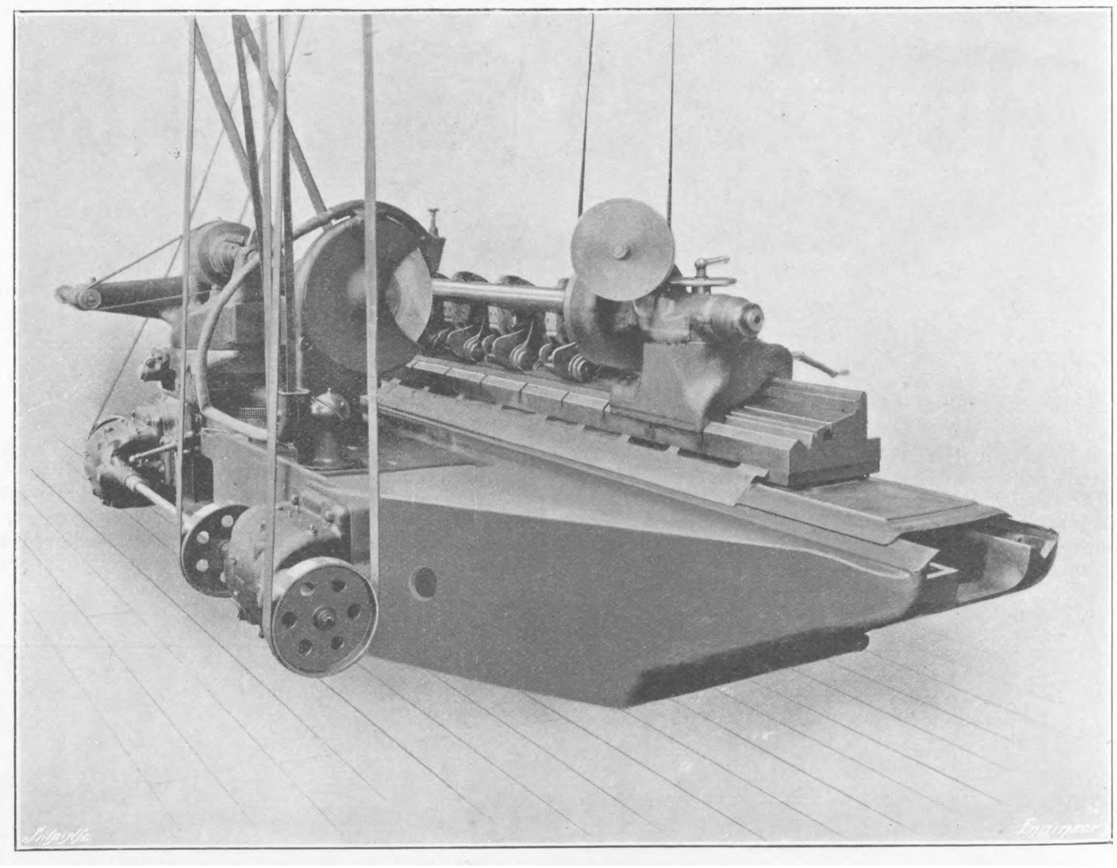


Fig. 30—HERBERT'S LARGE UNIVERSAL GRINDING MACHINE—BACK VIEW

The feed motion within the bed which operates the table is enclosed in a box which can be entirely removed through a hole in front of the machine, and contains a lubricating pump which keeps all bearings automatically lubricated while the machine is running, requiring no attention whatever from the operator. In addition to this, the gears run in a bath of oil. The countershaft, of which, unfortunately, we are unable to give an illustration, supplies motion to the grinding wheel, which has two speeds; the driving headstock, which has sixteen speeds; the table, which has sixteen rates of feed; and the pump. It can be started and stopped, and the fast and slow speeds given to the grinding wheel head by the movement of a single lever situated in a convenient position for the operator.

The water tanks and the pump are self contained in the body of the machine. There are three settling tanks, supplied with strainers to clarify the water before it is again pumped to the wheel. The water is guided back again to the tank by liberal gutters. The tank is hinged to the bed, and can be canted over for cleaning purposes without the slightest trouble. The pump supplies 30 gallons of water to the work each minute.

It will be noted from the above description that all the mechanism for controlling the work and table speeds is grouped together at one point in front of the machine, within easy reach of the workman, and that all speed changes to the work can be made without stopping either the work or the wheel.

A special safety friction clutch is provided to take any shock when changing the table speed, and the reverse of the table is arranged to give a pause at either end of the stroke to allow for the momentum of the moving parts, and also to give time to grind up the shoulders properly.

The machine, which we have examined very carefully, is a magnificent piece of tool craft, both as respects its design and construction. It has been in use at Alfred Herbert's works now for some months, and has, we are told, reduced the cost of the work which it performs to about half what it was formerly.

The following are the leading dimensions:—

Capacity	24in swing 10ft. between centres
Largest diameter admitted in steadies	12in.
Diameter and width of grinding wheel...	24in. by 2¼in.
Diameter and length of grinding wheel spindle bearings	large bearing 4½in. by 12in. small bearing 3in. by 9in.
Changes of grinding wheel speed ...	4
Automatic cross feed of grinding wheel from least ... ·00025in. to greatest ... ... ·002in.	reduction in diameter of work for each reversal of table
Diameter of headstock spindles ...	4in.
Diameter of tailstock spindles ...	3½in.
Number of changes of work speed	16
Number of changes of table traverse	16
Floor space occupied...	7ft. 10in. by 27ft.
Weight...	about 13 tons

A universal cutter and tool-grinding machine manufactured by Alfred Herbert, Limited, of Coventry, is illustrated in Fig. 33. This machine is intended for general tool-room work, and, the makers state, will do almost any variety of circular and surface grinding. The particular feature which gives its universal character to the machine is a combination of quick and slow movements to the two adjustments of the tables. Thus either the longitudinal or the cross motion may be used for traversing the work across the wheel with a quick feed or for putting on the cut with a fine feed, and so enabling a great variety of work to be ground without special appliances. The grinding spindle of case-hardened mild steel is provided with a standard taper hole at each end to carry the short or long arbors on which the emery wheels are mounted. A two step cone pulley is mounted on the spindle, which runs in hard phosphor bronze dust-proof bearings. The tables are mounted on a knee sliding vertically on a long sleeve, which can be swung round the columns into any position. To alter the height of the tables a hand wheel carried on a shaft, and provided with an adjustable index disc, is provided. The tables themselves consist of a pair of compound slides carrying a third and swivel top table for use when taper work is being ground. This swivel table can be removed, thus permitting the

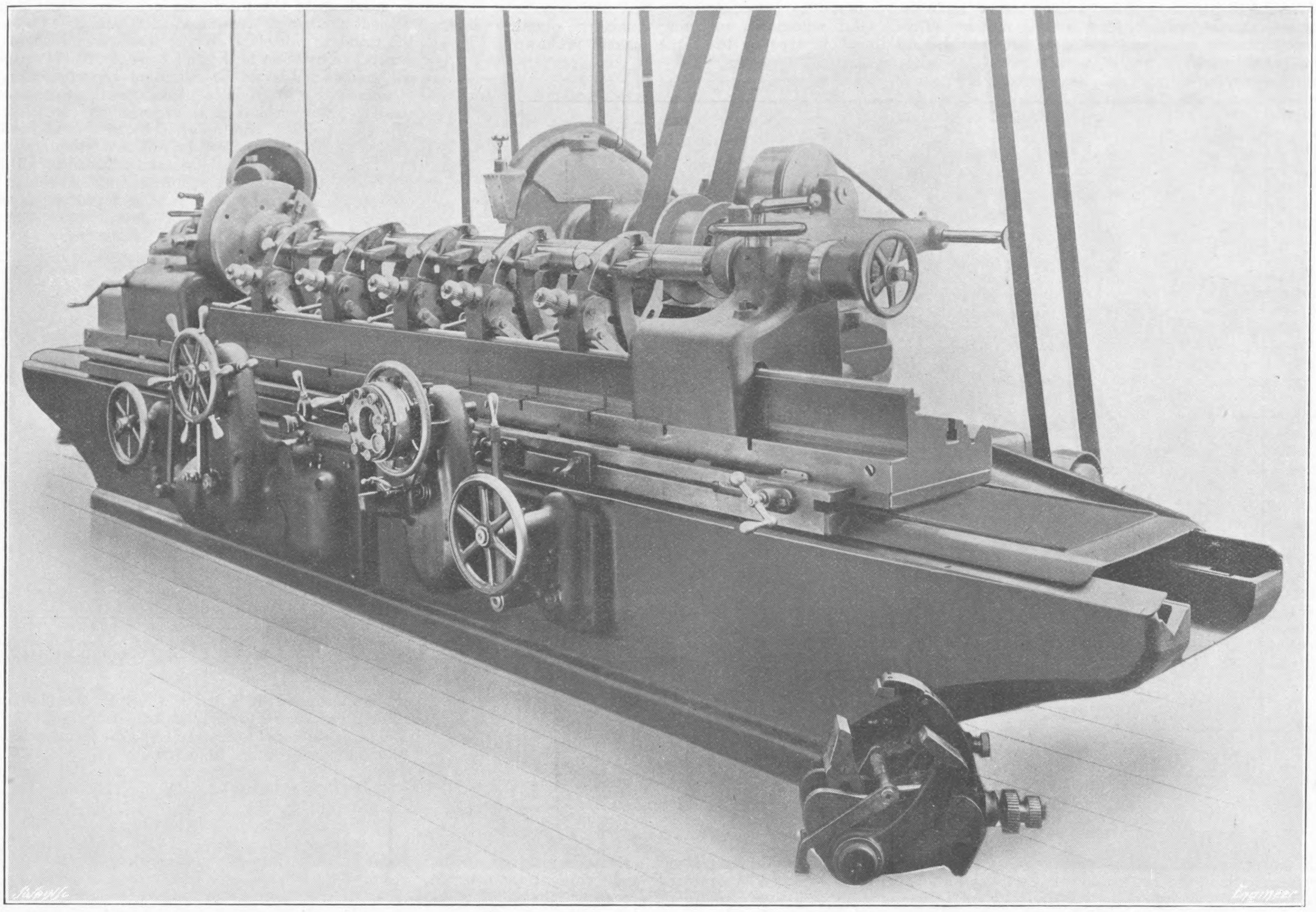


Fig. 31—HERBERT'S LARGE UNIVERSAL GRINDING MACHINE—FRONT

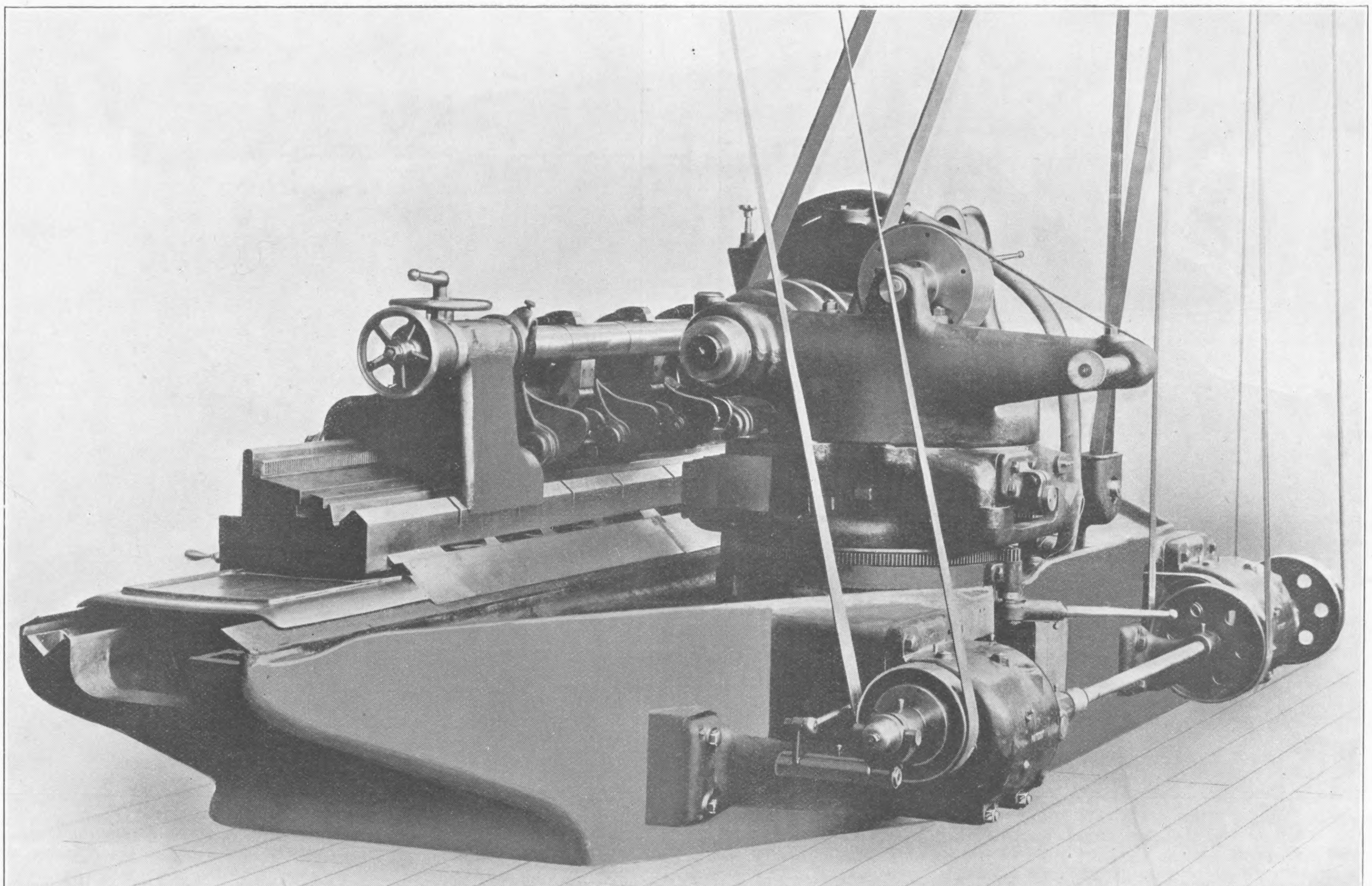


Fig. 32—HERBERT'S LARGE UNIVERSAL GRINDING MACHINE—BACK

longer table beneath it to be used. Owing to the means provided for swinging the table through 90 deg., it is obvious that the longitudinal motion of the table will be used for the feed in one position and for traversing in the other, and correspondingly for the cross motion. Thus two motions, one quick and one slow, are provided for each movement, and it is so arranged that when either slow motion is in use the corresponding quick motion is locked. A water pump of the centrifugal type forms an integral part of this machine, while other accessories and attachments are supplied with it, so as to enable it to encompass the wide range of work for which it has been designed.

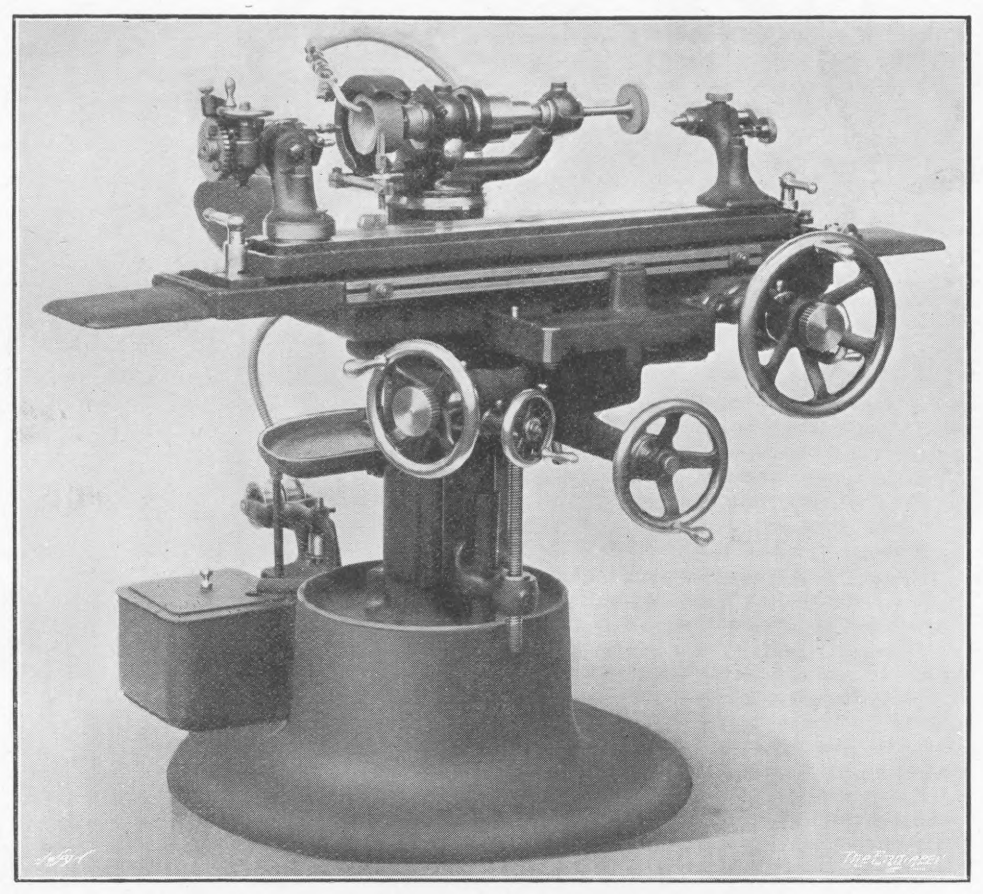


Fig. 33—HERBERT'S UNIVERSAL CUTTER AND TOOL GRINDING MACHINE

Fig. 34 shows an automatic surface grinding machine which has been specially designed by Luke and Spencer, Limited, Broadheath, Manchester, to treat case-hardened and other flat surfaces, hardened dies, &c. It has a rising and falling table to carry the work, while the emery wheel receives a combined reciprocating and rotary motion, the reciprocating motion being derived from a worm and worm wheel clearly shown in the engraving. The traverse of the table is automatic and adjustable, the feed being applied by means of a hand wheel with worm, worm wheel and screw. The size of the pulley on the wheel spindle is 8in. by 5in., and the working speed 1700 per minute.

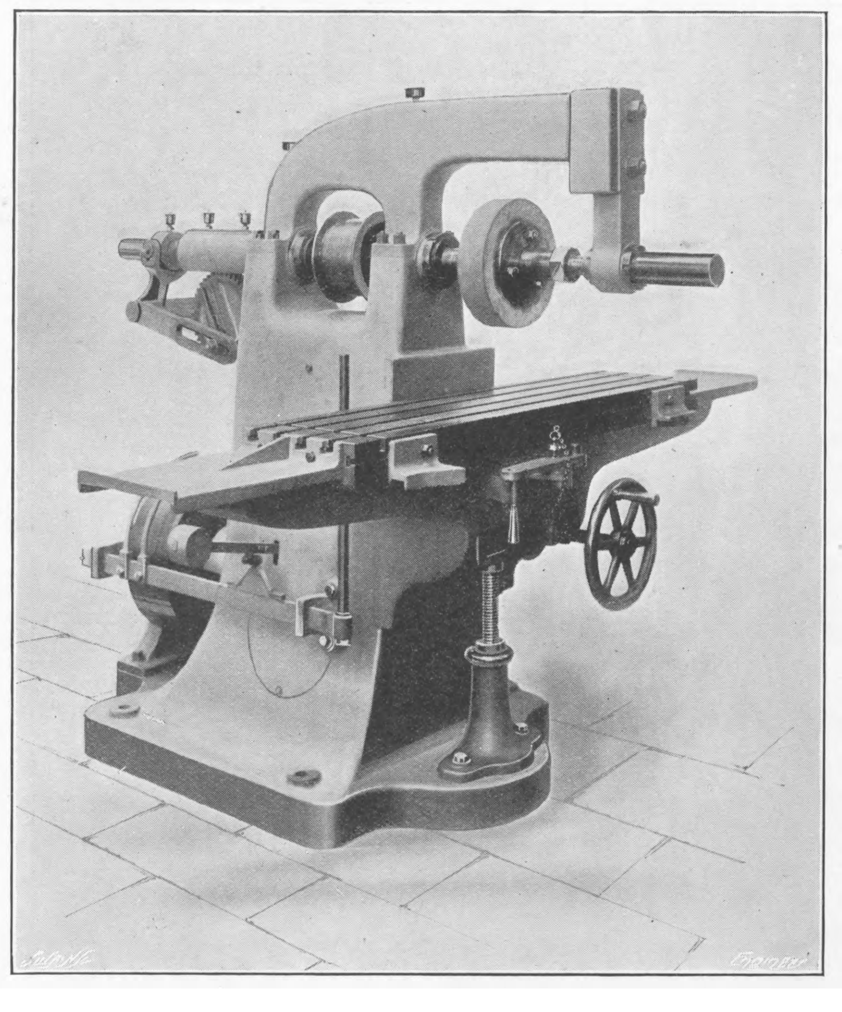


Fig. 34—LUKE AND SPENCER'S FLAT GRINDER

An automatic surfacing machine of the planing machine type by the same makers is shown in Fig. 35. The machine has hand and automatic longitudinal and cross traverse movement and vertical adjustment, together with automatic reciprocating movement of the grinding head. It is provided with fine adjustment throughout. The feed mechanism operates at the end of each return stroke, and there is no automatic knock-off. The cross feed is positive and the vertical feed is by hand, the machine being belt driven. The bearings for the emery wheel spindle are of phosphor bronze, made taper on the outside, being adjustable by means of nuts at each end so as to take up wear and preserve the original alignment. The bearings are secured by means of hinged caps, to allow of readily changing the grinding wheel.

The bed is of strong construction, provided with suitable guides for the table, which is truly surfaced, runs on guides, and is fitted with self-acting lubrication arrangements. It has self-acting longitudinal traverse motion, and adjustable stops for automatic reversing. The cross slide is of sufficient length to enable the grinding wheel to grind up to the maximum capacity of the machine without overhang. It is fitted with hand gear for feeding the grinding wheel on to the work, and also to give vertical adjustment to the full capacity of the machine. All handles and levers for operating and controlling the machine are conveniently placed for the operator, and the feed-gear mechanism is arranged to permit of fine adjustment. The grinding wheel spindle is of hardened steel accurately ground and lapped, revolving in phosphor bronze bearings, adjustable to take up wear in all directions, and efficiently protected from dust and dirt, to work in accurate alignment with the table. The depth of the cut is controlled by a hand wheel at one side of the machine graduated to read "half-thousandths of an inch." The grinding wheel is made of special corundum, and is 12in. diameter by 2in. thick, mounted on safety dovetail plates. The illustration shows a machine suitable for articles 6ft. long by 14in. wide by 12in. high, but other sizes are made.

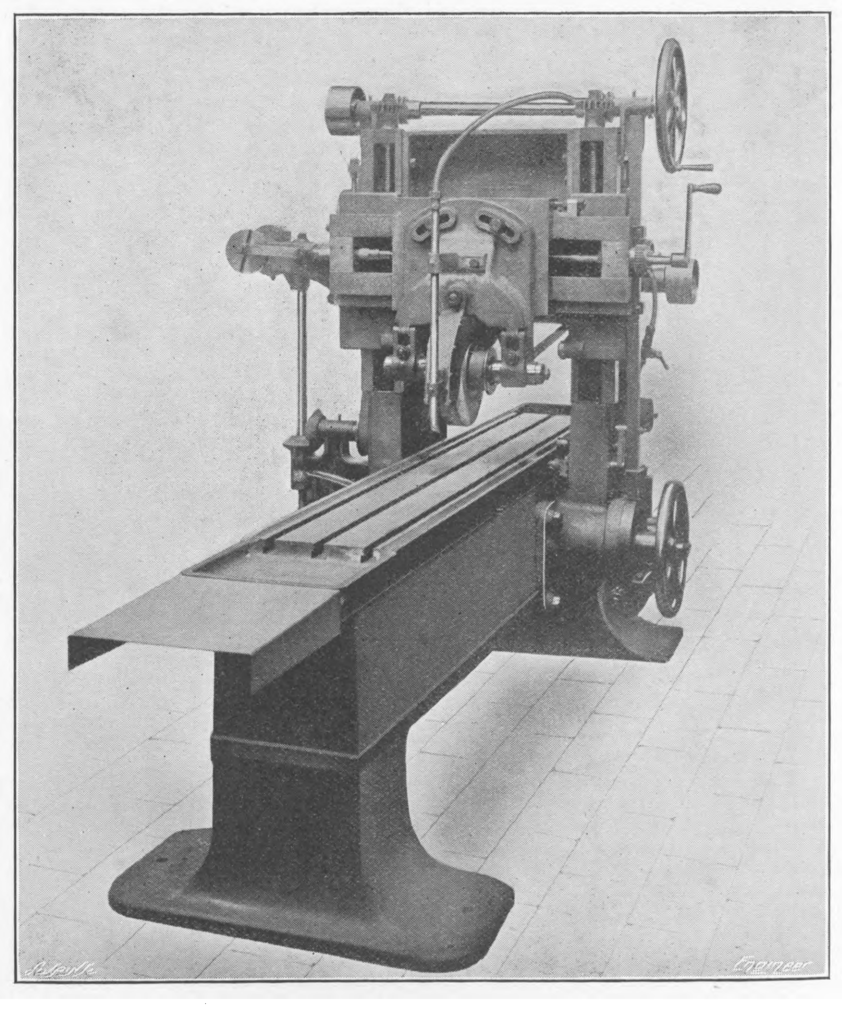


Fig. 35—LUKE AND SPENCER'S SURFACE GRINDING MACHINE

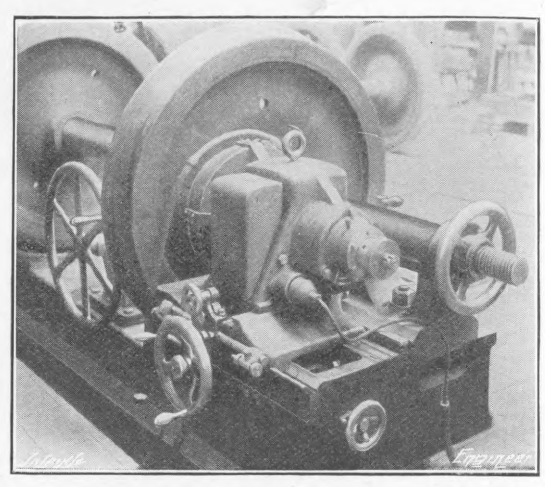


Fig. 36—SCHUCHARDT'S JOURNAL GRINDING MACHINE

The accuracy and fine finish obtainable with modern grinders have both acted towards their adoption in railway shops for many purposes, and in their application to axle grinding we have a typical example of their use. An illustration of this class of tool is shown in Fig. 36. This machine, which is made by Messrs. Schuchardt and Schutte, of Berlin and London, consists of a strong cast iron bed piece, on which are formed two uprights to carry the grinders and the headstocks, the distance between centres being adjustable to suit different gauges. The axles are driven, during the grinding of the journals, by belt from a countershaft. A separate electric motor is provided for driving each emery wheel, so that the two journals may be ground simultaneously or independently. For traversing the saddles in a direction parallel to the axles an independent motor is provided for each, the forward motion being secured by screw and hand wheel. When running at 1500 revolutions per minute the grinding motors take about 1½ horse-power each; to alter the speed as may be necessary when the emery wheel wears down a field regulator is provided. Automatic gear is arranged on the saddle whereby stopping and reversing are secured without the intervention of the man in charge. The speed of the auxiliary motors, which give the saddles their longitudinal motion, can also be regulated so that the most desirable speeds for roughing and finishing can be secured. The water details comprise a small electric pump and the necessary storage tanks and pipes. In the engraving we show the details of the saddle from the operator's position.

In Fig. 37 is shown a grinding machine, also by Messrs. Schuchardt and Schutte, designed for plain grinding either between centres or in a chuck. In this example, as is common in machines of its class, the wheel remains steady while the table carrying the work is traversed past it. To prevent emery dust from falling on the sliding surfaces of the bed, the table is provided with shields at either end. The grinding spindle is arranged to run at from 1370 to 2950 revolutions per minute, there being twenty four different speeds in this range. Work up to 10in. in diameter and 60in. long can be taken by this machine, the table of which is provided with automatic motion for reversing, and can be worked at eight different speeds. In our illustration the machine is shown fitted up with its complement of steadying brackets.

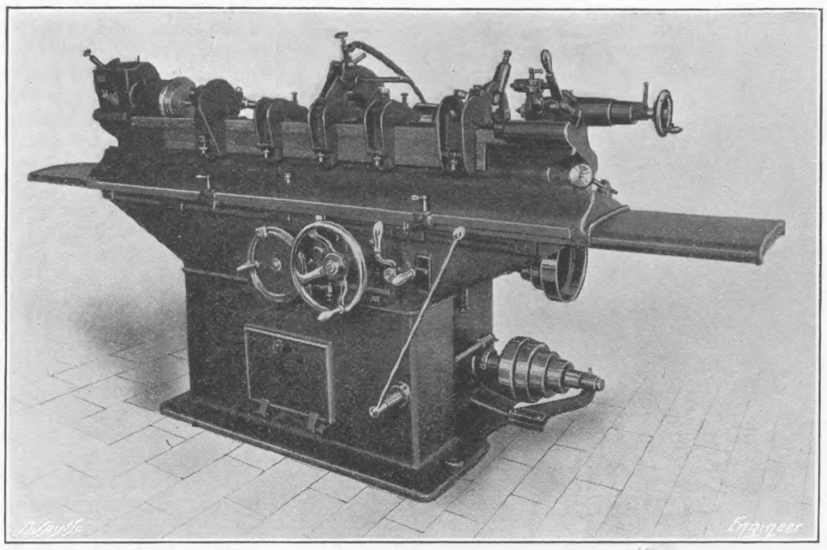
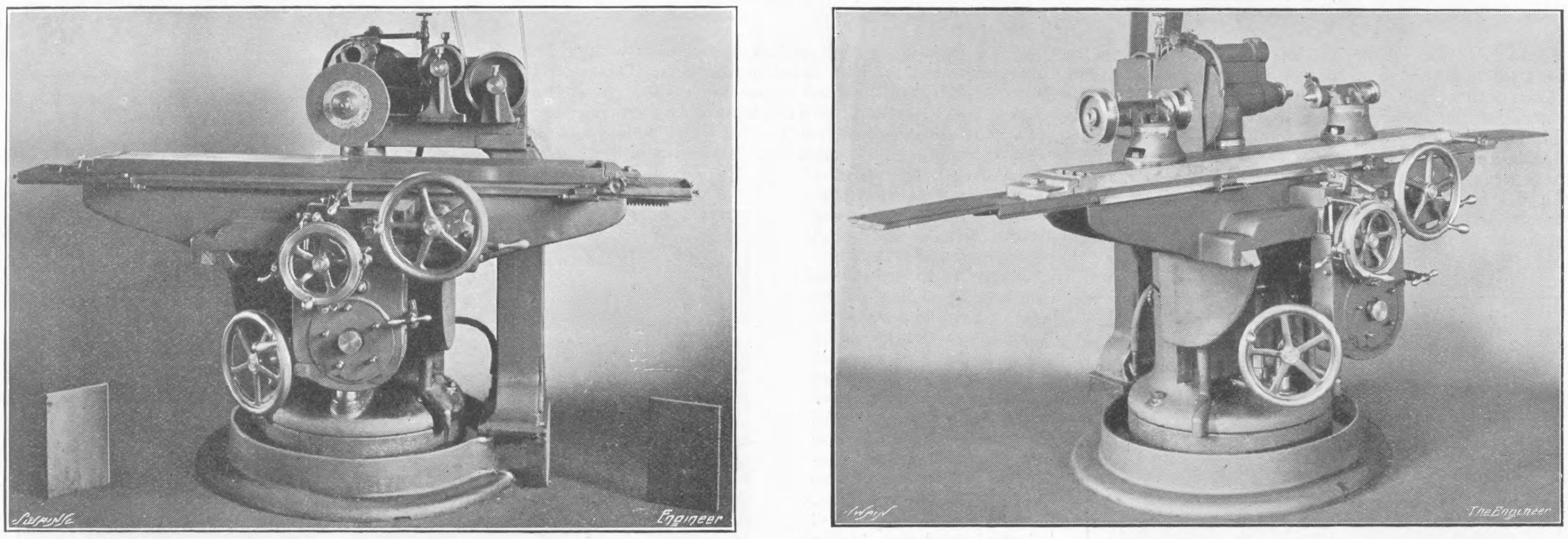


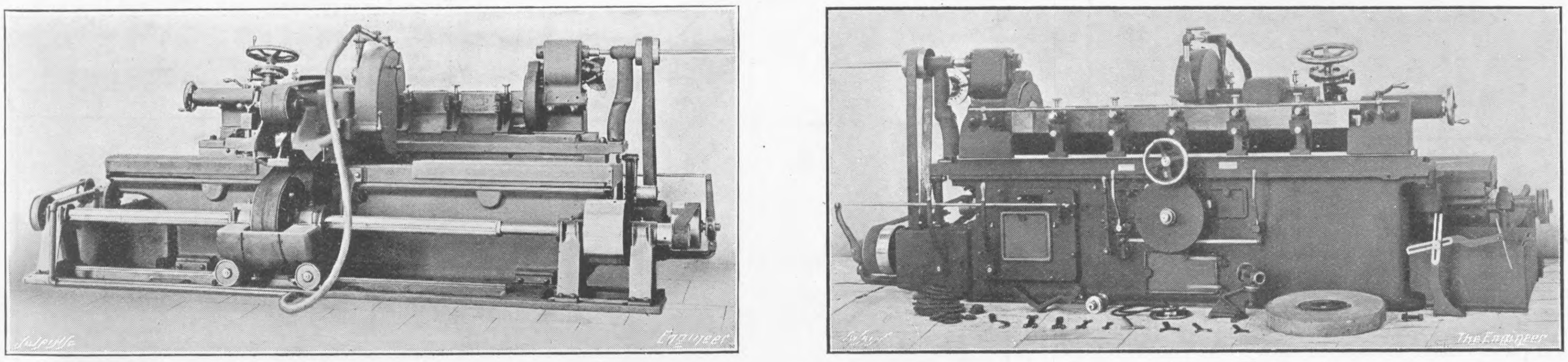
Fig. 37—SCHUCHARDT AND SHUTTE'S PLAIN GRINDING MACHINE

A machine designed to deal with a large variety of work is shown in Figs. 38 and 39. This tool, for the sale of which in this country Messrs. Selig, Sonnenthal and Co., of Queen Victoria-street, London, have been appointed sole agents, is known as the Thompson Universal grinder. The makers claim for it that it can deal satisfactorily with every possible grinding operation required in the machine shop, and that it can, therefore, be installed in place of a variety of specialised machines. In it the head carrying the emery wheel is fixed rigidly in position, and the table with gear attached thereto is mounted on a revolving turret which is carried on the circular base of the wheel post. In Fig. 38 the machine is shown arranged for surface grinding, and in Fig. 39 the table has been rotated through a right angle and the machine altered for grinding between centres. All the movements involved in the change can be quickly effected and the machine readily adapted for grinding straight or taper work between centres for surface or internal grinding and for knife, die, or cutter grinding. For internal grinding an arm carrying the wheel spindle is attached to the head, the power for driving the spindle being taken from a pulley which replaces the emery wheel shown in the engraving. The table can be traversed longitudinally or across either by power or hand, while to accommodate any variations in its height the drum overhead from which power is obtained for driving the work between centres is balanced by a counterweight, so that an even tension is preserved in the belt. A longitudinal traverse of 48in. is provided for, the transverse motion being 8in., and the vertical adjustment 10in. With the ordinary centres supplied with the machine work up to 20in. in diameter and 36in. in length can be accommodated. Higher headstocks are fitted for larger sized jobs. The capacity of the machine for internal grinding can be arranged to suit particular needs, but the ordinary attachment is capable of working up to an internal diameter of 30in. by 4in. deep. All feed motions are finely graduated; as an example we would mention that provided for the cross feed of the table. Here each division on the hand wheel can be made to correspond to a reduction in diameter of $\frac{1}{4000}$ of an inch. Allowing for the full motion of the table in every position, the floor space required for this machine is 13ft. square.



Figs. 38 and 39—THOMPSON UNIVERSAL GRINDER

The grinding machine shown in Figs. 40 and 41 differs from most of its class in the arrangements made for driving the emery wheel. A fundamental feature of its design lies in the fact that during grinding operations the wheel is traversed longitudinally, while the work is stationary as far as movement in this direction is concerned. For heavy work, where a crane has to be employed to lift the job into the machine, an absence of overhead belts and shafts is desirable, and for this reason the above machine has been designed by the Landis Tool Company, of Waynesboro, Pa., for motor driving. Referring to the engraving, which shows a view of the machine from the rear, a horizontal shaft carried in brackets secured to the bed of the machine extends along the whole length, and is driven by belt from a motor or countershaft, if so desired. Attached to the grinding saddle so as to move with it is a carriage running on rails beneath the driving shaft. A pulley supported in journals on the carriage drives by means of a belt led over jockey pulleys the emery wheel, the connection between the driving shaft and the carriage pulley being made by rollers working in grooves on the shaft, thereby rendering the longitudinal traverse of the carriage as free from friction as possible. From the left-hand end of this driving shaft a belt is taken to the pulley of a small pump supplying the water for the grinding wheel. From the other end a belt leads to a fast-and-loose pulley at the front of the machine, whence power is transmitted to the variable speed headstock, which provides means for securing ten different work speeds. The machine illustrated is capable of grinding work up to 16in. in diameter, and 72in. in length, while the horse-power required to drive it varies from 15 to 20. Messrs. C. W. Burton, Griffiths, of London, are the agents in this country for the sale of this tool.



Figs. 40 and 41—LANDIS MOTOR-DRIVEN GRINDING MACHINE—BACK AND FRONT

John Holroyd and Co., Limited, Milnrow, have just completed the electrically driven 12in. by 48in. machine shown in Fig. 42. The machine has been specially designed for reducing shafts rapidly, and is fitted with a 5 horse-power electric motor, which is fitted on the emery wheel head, and drives the wheel spindle through double helical bevel gearing, thereby dispensing with overhead countershafts, long drums, and heavy belts. The motor runs at 1100 revolutions per minute, while the number of revolutions of the spindle is 810 per minute. The grinding wheel is 20in. diameter and 2in. wide. The revolving of the work and the traverse of the emery wheel head are effected by a 2½ brake horse power motor fixed at the end of the machine. This drives a shaft running at 500 revolutions, and extending from end to end of the bed. On the end near the motor is a pulley carrying a 2in. belt, which drives another pulley at the front left-hand of the base, and this drive, after passing through the gear box with a ratio of 1 to 4, drives a two-speed cone. The latter, in turn, drives another two-speed cone on the end of the table, and the power is finally transmitted through the gear box on the fast head to the face plate. This system gives, with belt change and two gear boxes, a range of 16 speeds of the work between 18 and 250 revolutions per minute. The emery head traverse is obtained from the same shaft at 500 revolutions per minute. Inside the bed is a drum with 2in. belt, which drives a cone with eight speeds, and fitted with an auto-belt shifter. This drives through gearing which is all attached to a plate on front of the bed, and consists of eight wheels giving a 4 to 1 change and reversing motion through bevels and shaft to rack gear. This gearing and cone give to the emery wheel slide and carriage a movement of from 8in. to 52in. per minute, with 16 changes and reverse. The reversing motion consists of a circular rack immediately behind the wheel for the hand motion, with stops for actuating rods connected to the reversing lever. The emery wheel head is securely gibbed to a long carriage with flat front and V back slide. It is moved to and from the centres by a hand wheel which works through a worm and wheel to a rack and pinion, a balance weight being provided to keep the wheel from jumping into the work.

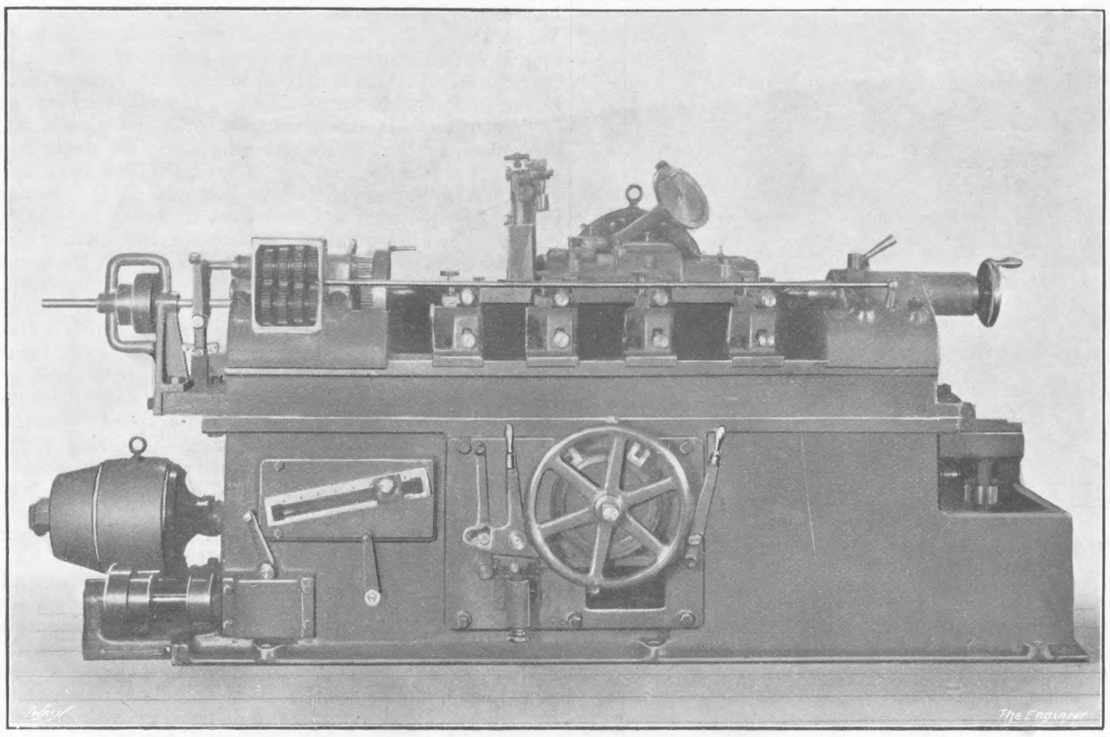


Fig. 42—HOLROYD AND CO.'S ELECTRICALLY-DRIVEN PLAIN GRINDER

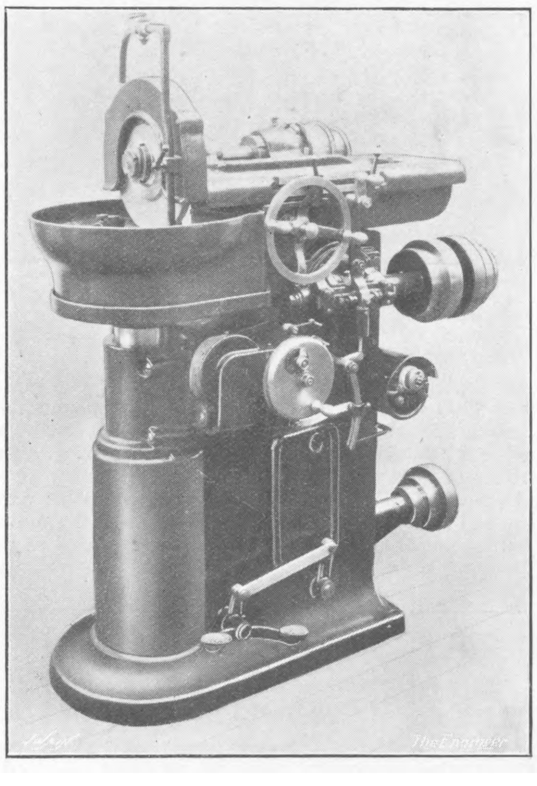


Fig. 43—CHURCHILL RING GRINDER

A special machine has been designed by the same makers for the rapid and accurate grinding of hobs, spiral reamers and milling cutters. We are unable to find space to illustrate it, but a few words of description may be appreciated. The head which contains the moving, twisting, and dividing gears, is worthy of special mention. The main spindle, which passes right through, is 2in. diameter, and slides in a sleeve. On this sleeve is mounted the differential gear, the centre block of which rotates it. At either side is a worm wheel. One of these wheels rotates slowly for spiral motion, and the other quickly at the end of the stroke when dividing. From a three-speed cone motion is transmitted through bevel gearing to the screw and spindle. This spindle and screw are geared together by change wheels at the end of the head, so as to give the pitch of the spiral grooves. Inside the gear box at the end of the head are three gear wheels, one on the shaft which rotates the spindle, one on the screw, and a centre one on the driving shaft. The last slides so that it can mesh with either of the other two. The change gear wheels for the pitch of the spiral are arranged to have the same number of teeth as are used on the universal miller on which the hobs are gashed. The reversing is effected by a stop-rod and spring catch operating a clutch which moves between two bevel gears on the driving shaft. The main drive is provided by a belt running on a loose pulley, and held by a fork, so that it rubs on a fast pulley sufficiently to drive it instantly when the stop catch is removed. This catch is in front of the machine, and is operated by the same lever as is the reversing clutch. On the front of the fixed headstock is a set of change wheels, the ratio of which is such that one revolution of the stop catch disc divides the hob correctly. The driver plate on the end of the spindle is provided with a worm and worm wheel, and small star wheel, so that the hob may be turned for the purpose of putting on the cut. The operation is as follows:—The machine having the hob in place, is started, the hob moves forward, revolves under the emery wheel, until the two run clear of one another. Then the machine reverses, and the backlash in the gears, &c., carries the emery wheel clear of the hob. At the end of the backward movement the reversing operation also withdraws the dividing stop catch, and the hob is moved round to the next gash. At the end of one revolution of the hob the star wheel on the driver plate is moved one tooth, thus revolving the hob forward slightly.

An extension at the back of the base of the machine provides a support for the slides which carry the emery wheel. The spindle revolves in long parallel bearings cast on the head, which is arranged to swivel to any angle. There are two handles for swivelling, and two for locking. The grinding head is carried on heavy slides with vertical and cross adjustment and compensating belt drive. There are no weights or jockey pulleys. The machines can also be fitted with a worm grinding attachment. In this case the emery wheel head is fitted with a vertical slide which is arranged to swivel. This slide carries the emery wheel which has automatic down feed by means of a ratchet. The vertical slide is set at the same angle as the thread of the worm, and at each traverse of the table a ratchet is tripped, thereby giving a feed to the emery wheel down the inclined face of the worm thread. When one side of the worm has been ground, the head is swivelled over to the opposite angle or the worm turned round between the centres, and the other side is ground in the same manner. The belt for driving the emery wheel is arranged to run over jockey pulleys in such a manner that the tension is the same whatever the position of the emery wheel may be.

The plain grinding machine shown in Figs. 44 and 45 has been designed by the Churchill Machine Tool Company, and is chiefly intended for operating on spindles, shafts and rods which can be revolved between dead centres. It is essentially a manufacturing machine, and embodies conveniences for rapid manipulation. The makers have given special attention to the method of fixing the work heads to the table to ensure rapidity and accuracy of alignment. The machine follows standard practice, but in connection with the table travel, a slow speed is provided independent of the ordinary speeds. This arrangement enables a fast speed to be used for roughing out and a slow speed for finishing cuts. The steadies for this machine, Fig. 44, are fixed where needed directly to the table, and besides giving a very rigid support to the article being ground, are easy of adjustment vertically and laterally. It will be noticed that the work table is on an angle, thus obviating the use of loose water guards. The table swivels and enables tapers up to 2in. per foot to be ground. The pump is of the vertical centrifugal pattern, always primed, and not affected by grit. The machine shown is capable of accommodating work 10in. by 90in., and the table speeds are twelve in number, operated from the front of the machine through a gear box,

The following are the leading particulars of this size of machine:—

Maximum swing...	10in. dia.
,, length	90in.
Will grind taper to	2in. per ft.
Wheel spindle bearings	3¼in. by 7¾in,
Size of wheel	20in. by 2in. or 3in.
Number of wheel speeds	4
,, work speeds	12
Number of table speeds	12
,, work rests	5
Fast and loose pulleys	12in. and 16in. by 5in.
Speed of ditto	540 and 405 r.p.m.
Floor space required...	14ft. 6in. by 4ft.
Approximate net weight	5½ tons.

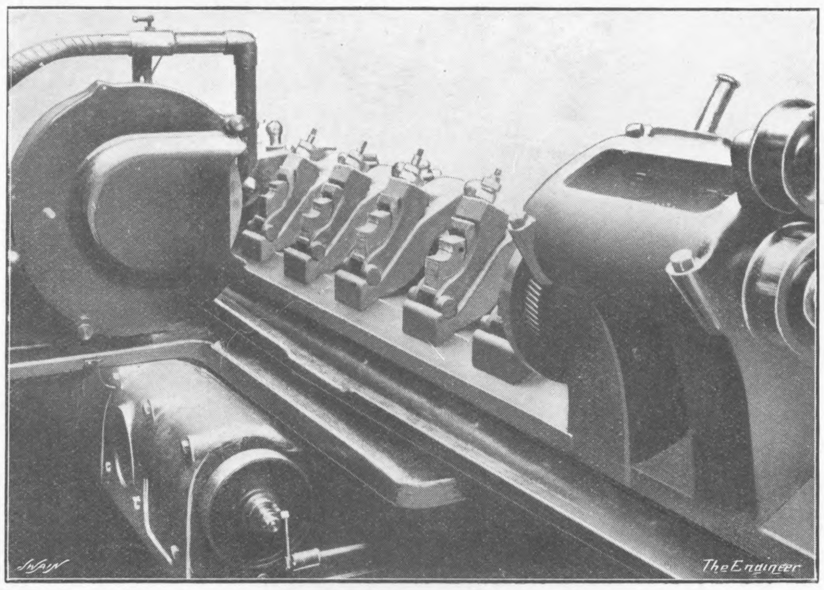


Fig. 44—CHURCHILL PLAIN GRINDER—BACK

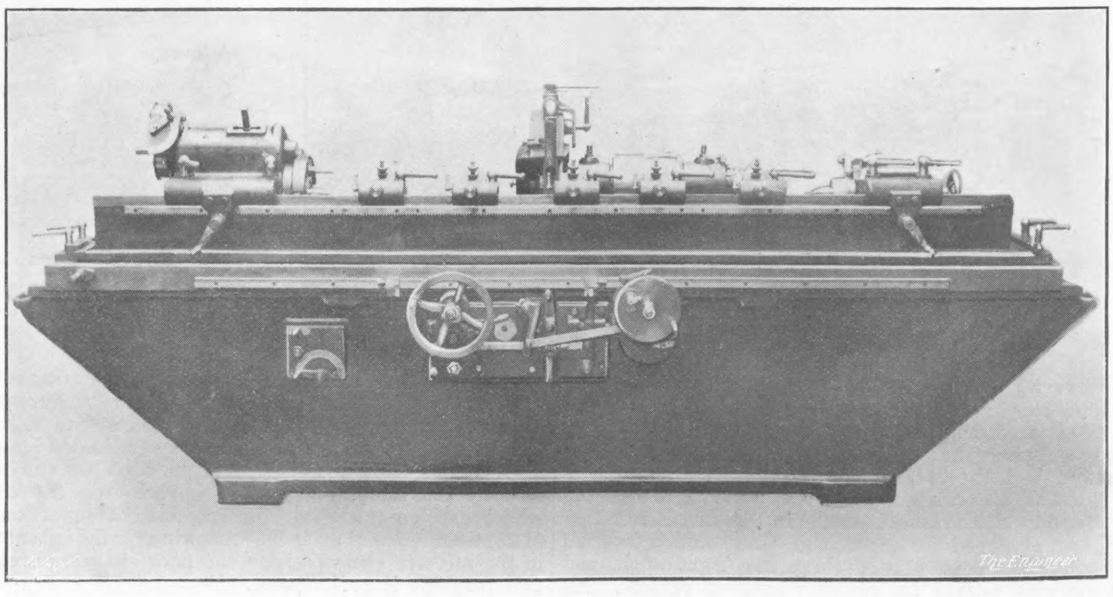


Fig. 45—CHURCHILL MACHINE TOOL COMPANY'S PLAIN GRINDER

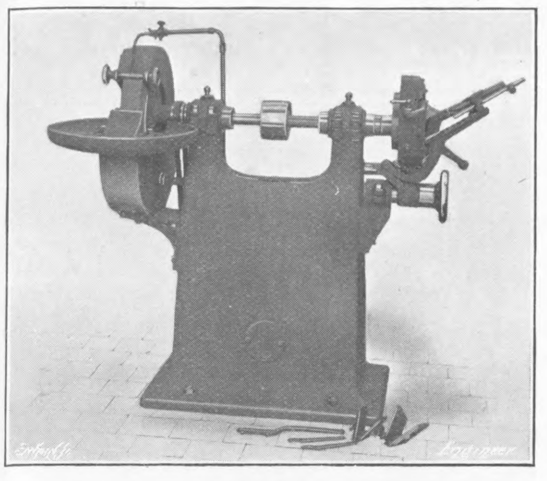
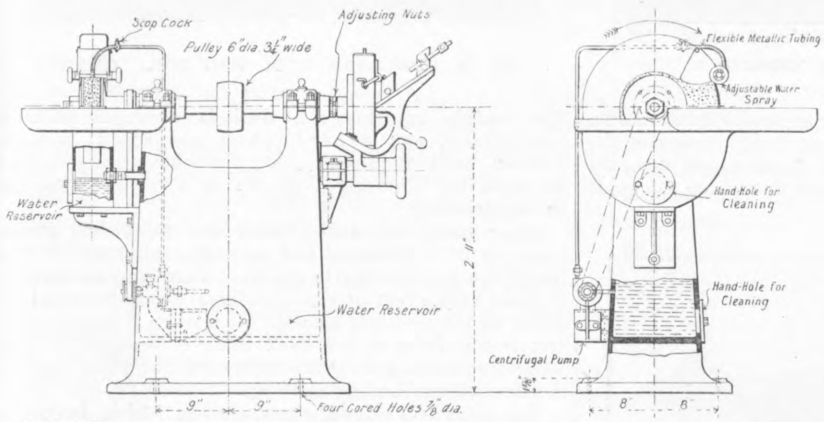


Fig. 46—MITCHELL'S GRINDER



"THE ENGINEER" Swain Sc.

Fig. 47—MITCHELL'S TOOL AND DRILL GRINDER

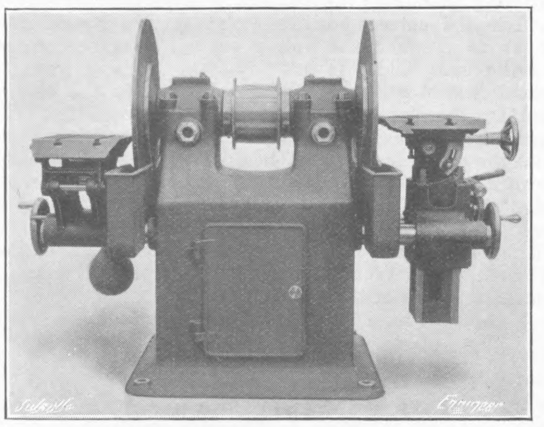


Fig. 48—ROBERT'S DISC GRINDER

Fig. 43 represents a ring and surface grinder made by the Churchill Machine Tool Company. The body of the machine carries a long sleeve, in which revolves a vertical spindle supporting a magnetic chuck. The sleeve has a micrometer vertical adjustment and power feed with automatic stop, enabling a large number of pieces to be ground to absolutely identical thickness. The feed operates at each end of the stroke, and can be varied between .0001 and .00075in. The magnetic clutch is specially made to allow for wet grinding, and has six changes of speed for varying diameters of work. It can be instantly stopped without stopping the machine. The chuck grips or releases the work by the pressure of a button, and requires direct current of 110 to 220 volts, using no more power than an ordinary lamp. The grinding wheel traverses across the work, and is carried on a slide which is adjustable to grind clearance on saws, cutters, &c. The wheel slide is fitted with hand traverse and two rates of power feed, the position of the wheel and the amount of travel being controlled by means of adjustable dogs shown on the front of the wheel slide. Two speeds are provided for the grinding wheel, and the wheel spindle is hardened and ground, and runs in adjustable bronze self-oiling bearings. The pump is arranged to give an ample supply of water to the wheel, and suitable guards obviate splashing. The chuck is 12in. diameter, the grinding wheel 12in. by ¾in., and the vertical adjustment 4½in.

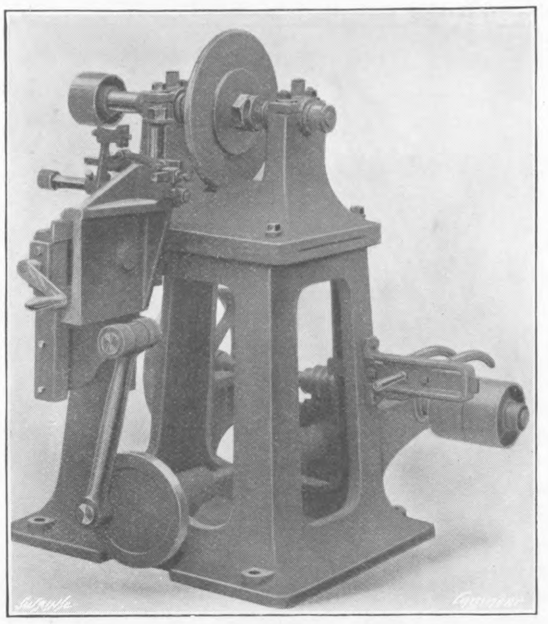


Fig. 49—STERNE'S TOOTH GRINDER

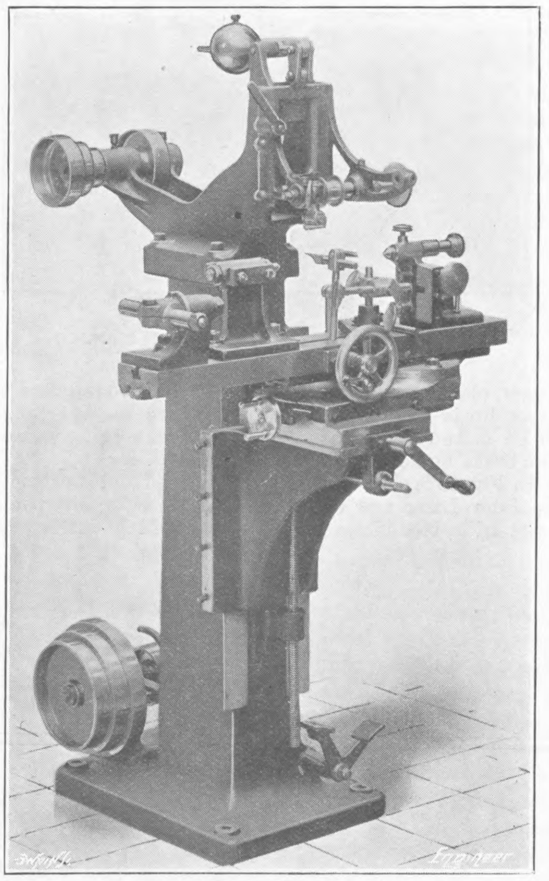


Fig. 50—ARCHDALE'S CUTTER GRINDER

Mitchell's Emery Wheel Company, Manchester, have quite recently introduced a combination machine which will be found particularly useful in engineering workshops. It is a combined tool and twist drill grinder, and is clearly illustrated in the accompanying illustrations—Figs. 46 and 47. The left-hand side is fitted with a 16in. by 2¼in. corundum wheel, which runs in a trough, and has a hood to prevent splashing. The trough and the base both form water reservoirs, and the outlet from each is arranged at a high point so as to allow the grit and heavy grindings to settle and the water to pass as clean as possible. They are each provided with mud-hole and cover, enabling the machine to be cleaned without the necessity of taking it to pieces. The pump on the back of the machine, which is driven off the wheel spindle, is of the centrifugal type, and is unaffected by gritty water. Neither does it require a relief valve when the water is shut off at the stop cock. The spindle of the pump is provided with a packed gland. No rubber tubing is used for the water supply, all the connections being of metal throughout. The water is delivered by the pump to a spray nose piece on the hood, which is adjustable to follow the wear of the wheel. At the right-hand side of the machine there is a 9in. corundum wheel, with 1½in. face, and provided with a special water shield. A tank is formed on the top of this shield into which the wheel, acting as a pump vane, forces the water. This tank is provided with a pipe, which again conducts the water on to the point of the drill which is being ground, and there is a tap for shutting off the water when not required. The wheel spindle is 1½in. diameter, and runs in ring lubricated bearings of ample length. It has a hardened steel nut and lock nut for taking up end play. The oil reservoir to each bearing is of good size, and is provided with an oil gauge and inspection hole and cover for replenishing. The pulley is 6in. diameter, and wide enough for a 3in. belt, the speed being 1100 revolutions per minute.

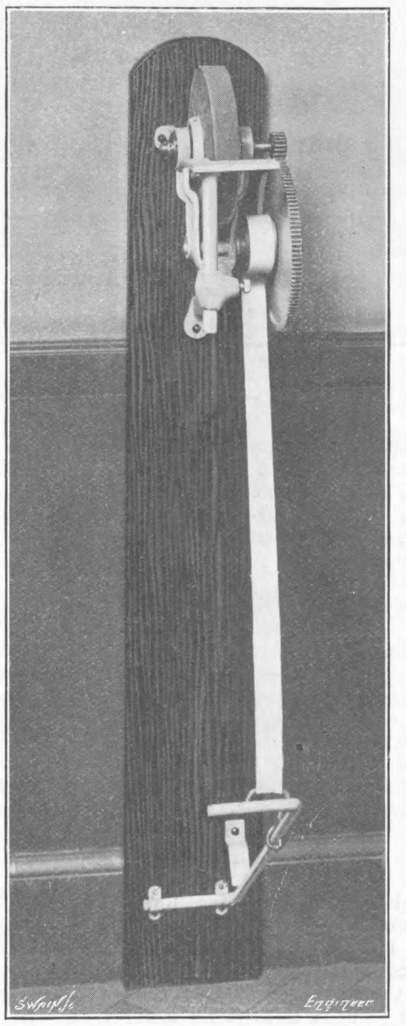


Fig. 51—CROSIER AND STEPHENS' TREADLE GRINDER

The grinder shown in Fig. 48 has been designed by Roberts Brothers, Dukinfield, Manchester, and is intended for the heavier kinds of work. These makers have, as our readers are aware, made a special feature of disc grinders. The table on the left-hand side has micrometer adjustment of 3in. to and from the disc by means of a screw and hand wheel, and has a counterbalanced rocking motion across the face of the disc. The table on the right-hand side is vertically adjustable through 13in. by worm and wheel, a quick cross traverse of 8in. by rack and pinion, graduated angular adjustment and micrometer adjustment to and from the disc. Both tables are slotted out for securing the work. The diameter and length of the spindle bearings are 2¼in. and 10in. respectively, and the system of lubrication is by rings in a well-known manner. The width of the pulley is 6in., the height of spindle centre from the floor 3ft. 3in., the size of the universal table 17in. by 14in., and of the rocking table 16in. by 12in. In this firm's grinders "anti-vibrating" plates are shrunk on the spindles and turned between dead centres. They vary in diameter according to the size of the disc, and besides giving additional support to the disc when operating on large work, prevent buckling taking place. Between the plates and the discs fibre washers are inserted to break up the sound waves and render the machine noiseless. Although this firm makes machines fitted with automatic micrometer feeds, their experience does not warrant them in recommending this form of mechanism, because however fine the pitch of the thread may be the correct feed is never obtained, with the result that if the work is advanced too quickly the emery disc is liable to be destroyed, and if advanced too slowly there is a corresponding loss in economy.

The machine shown in Fig. 49 is designed for grinding up the teeth of wheels, rollers, saws, &c., and has been made by L. Sterne and Co., Limited, Glasgow. The emery wheel, 14in. diameter by ½in. thick, and bevelled to suit the angle of teeth, is mounted on a strong steel spindle by means of turned cast iron washer plates and nuts. The machine carries its own countershaft complete with fast and loose pulleys and a belt shifter. A compound slide rest is fixed to the stand of the machine for carrying the work which is fixed to the top of the horizontal slide. The vertical slide is raised and lowered automatically by a crank and connecting-rod arrangement, actuated by worm gearing from the countershaft. At the end of each stroke the roller is automatically moved round one tooth, thus allowing the teeth to be uniformly ground. An adjustable steadying arrangement is fitted to the slide rest to prevent the roller from turning while being ground. The work is traversed to and from the emery wheel by hand.

Fig. 50 illustrates a universal cutter grinding machine, made by Archdale and Co., Limited. In it the spindle is hardened, ground true, and runs in conical bronze bearings. It is carried in a slide, with V guide and adjustment for wear, and is balanced by a counterweight for use when "copy" or "former" grinding is being done. The table has traversing motion in either direction, and is provided with adjustable stops. It is indexed and arranged to swivel to any angle up to 90 deg., and has vertical and longitudinal adjustment, with extra adjustment to the upper slide. The machine is entirely self-contained, and no countershaft is required. The height of centres is 5¼in.; the size of table, 2ft. 8in. by 4¼in; and the machine will admit between centres, 1ft. 6in.

As an example of a foot-power machine, we illustrate in Fig. 51 a self-contained treadle grinder which has been designed and made by Crosier, Stephens] and Co., of Newcastle-on-Tyne. It is intended to be used not only when there is an absence of mechanical power for driving purposes, but also in any large factory where, its makers claim, it will greatly economise the time spent in the periodic grinding to which tools are subjected by the machinist himself. The frame of this machine is of cast iron, and as shown in the illustration, it is intended to be fastened to a wall or pillar. A hardened steel spindle carries the corundum wheel, and runs in hardened ball bearings. The wheel, measuring 8in. by 1¼in., acts as a fly-wheel, and the makers state that a speed of 3000 revolutions per minute can be easily attained with the foot gear. A machine-cut fibre pinion is mounted on the spindle, while a ball clutch is interposed between the band pulley and the larger gear, which thus allows the grinding wheel to be rotated continuously in one direction by an occasional stroke with the foot.

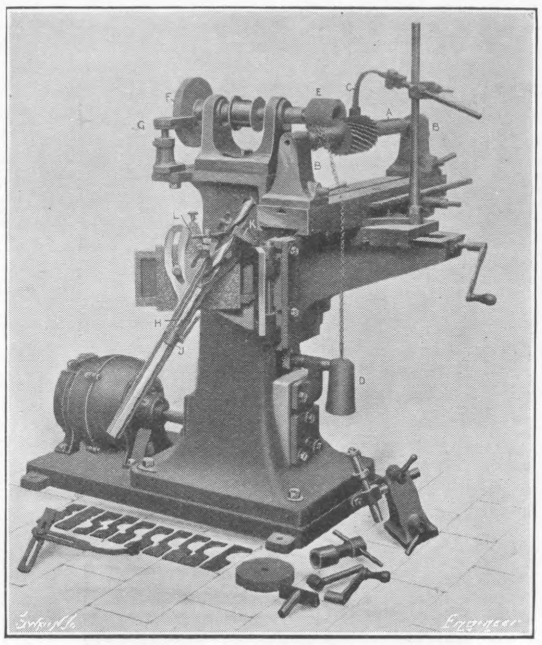


Fig. 52—HULSE'S CUTTER AND DRILL GRINDER

A motor-driven combined milling cutter and twist drill grinding machine, made by Hulse and Co., Limited, Manchester, is illustrated in Fig. 52. It is shown set for grinding cutters, which it can take up to 8in. diameter and 20in. long. It has also a twist-drill grinding attachment, which is readily brought into position or swung clear, and can be used on drills from ¼in. to 3in. diameter. The main frame is of box form, and the fast headstock has a conical steel spindle running in hard gun-metal bearings. The table has vertical, longitudinal, transverse and swivel slides, and is hinged so that it can be swung out of the way. For grinding edge cutters these are keyed upon an arbor A, which is placed between the movable headstocks B. The guide finger C is adjusted to the position indicated, and the cutter to be sharpened is held up against it by means of the chain and weight D. The emery disc E is put in motion, and the back of the tooth of the cutter next above the centre line of the headstocks is brought against its lower face. The cutter is then traversed quickly once or twice transversely by means of a handle—omitted in the illustration—and a cutting edge is produced. To bring another tooth into position the table is traversed endwise by the handle above alluded to till the cutter is clear of the finger, and the latter is then engaged with the tooth next to that which it was previously engaged in, without alteration or adjustment. The operation is then repeated. When the machine is to be used for sharpening twist drills, the cutter grinding table can be swung aside, and the grinding apparatus is brought into position and held by nuts. A disc of suitable shape is substituted for the cylindrical disc used for sharpening edge cutters. Sufficient clearance behind the lips of the drill is first ground by means of the disc F on the rear end of the spindle and the rest G shown. The drill H is next placed with its shank end in the drill headstock centre J, its upper end being supported in the plate K shown, a set of which are provided to suit drills of different sizes. The bracket is adjusted radially to the required angle, and has an indexed slide at the top to receive the plate mentioned. These plates are set one or two degrees to the right to give the requisite clearance. The guide finger L is adjusted to the position shown, and holds the lips of the drill at right angles to the emery disc by which they are ground. After one lip has been sharpened by traversing it by means of the horizontal slide across the bottom of the emery disc, the drill is taken out from below without disturbing the guide finger, plate, or headstock, is turned half round, and the other lip is similarly ground. The machine is arranged to be driven by means of a belt from a self-contained one brake horse-power constant speed motor.

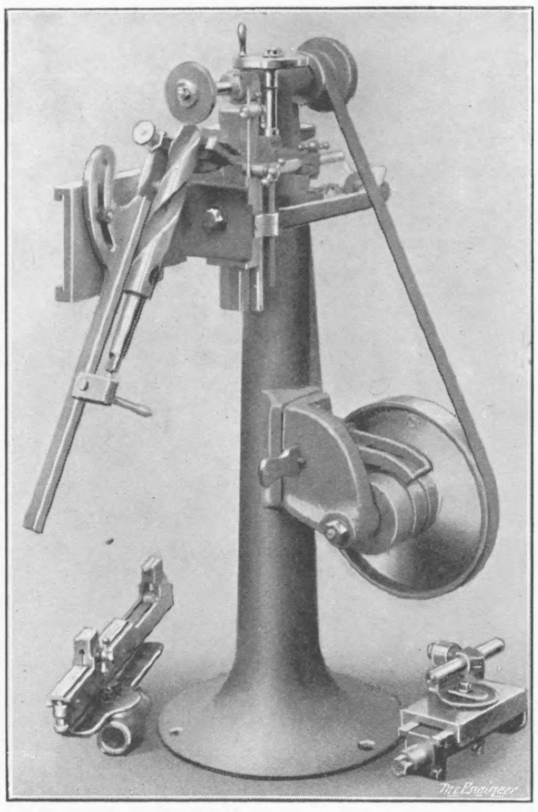


Fig. 53—LANG'S DRILL GRINDER

In Fig. 53 is shown a machine designed and constructed by John Lang and Sons, of Johnstone, for sharpening twist drills, rose bits, reamers, taps, milling cutters, and other small tools. For drills it is arranged to take all sizes from ¼in. to 3in., and it can be quickly changed to suit the varying sizes of the tools, while an easy adjustment allows alterations to be made in the angle given to the cutting lips. The machine carries its own countershaft, and from this a belt is led to the pulley on the grinding wheel spindle. This spindle is provided with corundum wheels at both ends, the smaller wheel being used for the lip-grinding operations, while the larger is intended to be used for the preliminary process of giving the requisite clearance to the drill point. The saddle carrying the drill is arranged to slide horizontally, and a hand wheel and screw give the vertical feed required. An adjustable arrangement is provided for directing a supply of water on to the drill during grinding.

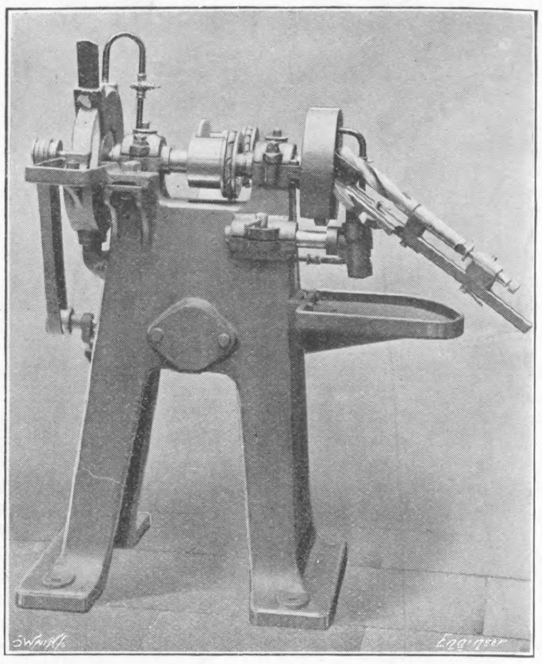


Fig. 54—ROWLAND'S TOOL AND DRILL GRINDER

A combined wet tool grinder and twist drill grinder made by B. R. Rowland and Co., Limited, Reddish, near Stockport, is illustrated in Fig. 54. This compact machine is fitted with a belt driven centrifugal pump for supplying water to the grinding wheels. It is of rigid construction, and on a bracket at the back there is provided a small wheel for thinning the points of twist drills. The machine is fitted with self-oiling bearings.

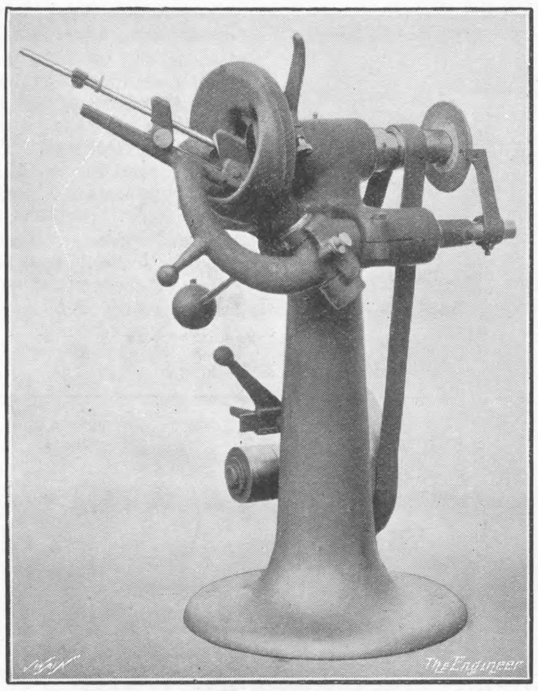


Fig. 55—HERBERT'S TWIST DRILL GRINDER

The twist drill grinder shown in Fig. 55 has been constructed by Alfred Herbert, Limited, of Coventry, with a view to producing a machine which will have increased means of resisting the deleterious action of the wheel swarf and tool dust, while possessing accuracy and convenience in operation. The spindle is mounted on dust-proof and watertight ball bearings of the single track type. These bearings, the makers state, run perfectly cool, and need to be lubricated only at very long intervals. The spindle with its bearings is adjustable bodily in an axial direction for putting on the cut, and to compensate for the wear of the wheel, the oscillating drill holder being fixed in this respect. The end play of the spindle is automatically taken up by a spring. The water supply is contained in the casing which acts as a guard for the wheel, and circulation is set up by the rotation of the wheel which acts as a centrifugal pump, a separate pump being thus unnecessary. A wheel trueing apparatus is carried on the casing, and is always ready for use without disturbing any of the adjustments of the machine. During grinding operations the drill holder automatically sets the drill in the correct position with regard to its diameter, so as to produce the proper conical clearance surface. As the drill holder is not adjustable to and from the wheel, it is at all times rigidly clamped to the column, and is, therefore, very stiff and well supported. The position of the axis of oscillation on this machine is such that the clearance angle of the drill increases progressively towards the centre, thus producing durability of the cutting edge of the sharpened drill. The countershaft, with its fast and loose pulleys, is carried by the column of the machine and runs on dust-proof single-track ball bearings. A grinding wheel for thinning the points of drills is carried on the rear end of the spindle.

NOVEMBER.

The Swansea Harbour Trustees are to be congratulated on the early completion of the new King's Dock, which was formally opened on the 23rd November. The work, which was commenced in July, 1904, has been completed nearly eight months before the contract date, and adds 68 acres to the previously existing water area of the docks. The principal trade of the new dock will be coal, and the arrangement of the berths, sidings, and approaches to the quays have been specially designed with this class of traffic in view. Practically the whole of the coaling jetties and wharves are constructed of reinforced concrete, and constitute the most extensive work which has hitherto been executed in this material in connection with dock or harbour works in this country. The most noticeable feature of the dock works is the exceptionally large proportion of quay frontage to water area. The completed quayage exceeds 13,500ft. in length, and this accommodation has been obtained without unduly restricting the water area and manœuvring space within the dock. Practically the whole of the work has been constructed on a site which was the foreshore of Swansea Bay until its enclosure by a sea embankment nearly two miles in length, within which the dock and its accessory works have been built. The entrance lock is 875ft. long, 90ft. wide, and has a depth of 40ft. over the sill at high water of spring tides. The Trustees have made ample provision for future extensions of the dock on a large scale, and it will be possible nearly to double the accommodation now provided in the King's Dock by a comparatively small expenditure on quay walls and equipment. In a later issue we shall publish a further instalment of an illustrated description of the dock works.

If the vast irrigation project which Sir William Willcocks has prepared for the rehabilitation of Mesopotamia is realised and proves only half as successful as the Assuan barrage and irrigation scheme, with which he was so closely associated in the earlier stages of its development, he will have initiated a work which will have immense effect in the material development of a large area in Asiatic Turkey, and be one of the great engineering feats of modern times. Sir William has been engaged for some years in elaborating his scheme, which he described before a meeting of the Royal Geographical Society on the 15th November. It is only since the advent of the present Government in Turkey that the scheme has entered the realm of practical politics, and funds have at last been assigned for an immediate commencement of a part of the works. Briefly, three millions of acres of the best land in Mesopotamia will be irrigated by means of the construction of a system of canals, weirs, and barrages in the Tigris-Euphrates delta, and the scheme provides for extensions, which, in days to come, may add still another three millions of acres to the land under irrigation. The first section of the work, providing for the diversion of the surplus waters of the Euphrates down the valley of the ancient Pison, will occupy three years in execution. Canals, regulation weirs, and barrages will follow in due course, and by their construction it will be possible not only to irrigate vast areas of land, but to separate the pernicious silt which is carried by the waters of the rivers at certain periods of the year, and allow it to deposit in the great Akkar Kuf Lake, which lies in a depression between the Euphrates and the Tigris. The scheme also provides for the construction of several lines of railway, including one from Baghdad to a point on the Mediterranean, near the ancient cities of Tyre and Sidon, to bring the harvests of cotton, wheat, and other products to the coast markets.

A colliery fire of an exceptionally disastrous character, involving the loss of nearly 300 lives, occurred at Cherry, in the northern part of Illinois, on November 13th. The St. Paul mine, in which the disaster occurred, is lighted by electricity, but the cable in one of the levels had given out, and pending the supply of a new cable oil "torches" were being used in this part of the mine. Some bales of hay were being taken on a truck to the mule stables, when, apparently, one of the bales ran into or near to the flame of one of the torches. The men seem to have lost their heads, and hurled the bale into the shaft in the expectation that it would be quenched in water in the sump. Instead of that, it set fire to the timbering of the lower level, and the fire spread with great rapidity. Efforts were made at rescue, but unavailingly, and the mine had eventually to be sealed. There are, of course, many conflicting statements. The company and its officers state that the mine was safe and well equipped, that the men were careless in handling the hay, and when they found it on fire they could have sent it up at once on the cage. The miners, on the other hand, say that the mine was not safe, there were no fire-extinguishing appliances, the timbering was dangerous, and should have been replaced by brick or concrete at the entrance to the shaft, and that reckless methods were allowed when the electric light system got out of order. They state also that the alarm was not given to the men until two hours after the fire was discovered. Investigation will doubtless bring to light the true facts of the case, but there appears to be no possibility of doubt that from 250 to 300 men have lost their lives in this terrible and sudden disaster.

The report of Mr. W. W. Squire, the engineer to the Bristol Docks Committee, who was appointed by the Home Secretary to attend the inquest which followed the disaster at the Newport Alexandra Docks Extension Works on July 2nd, was issued early in the month as a Parliamentary paper. Mr. Squire's report details the incidents leading up to the disaster, and describes what actually took place, so far as we are ever likely to know. The plans and illustrations accompanying the report enable readers to follow the details of the description, and to appreciate the methods of construction adopted by the contractors, Messrs. Easton, Gibb and Son. Mr. Squire fully exonerates the contractors from blame in connection with the accident, and points out that the only person who might have been fully acquainted with all the circumstances of the collapse of the trench—the walking ganger, Ratcliff—died before his evidence could be obtained. The only criticism Mr. Squire is prepared to make is that it seems to be open to question "whether there was sufficient communication between Ratcliff and his men on the one hand, and between him and his superiors on the other hand." The report emphasises the fact that in trench work of the nature of that carried out at Newport, the risk of danger has already arisen before the remedy can be taken in hand. As to the cause of the disaster, Mr. Squire says little or nothing definite. In fact, the report is inconclusive in this respect, and with regard to the prevention of similar accidents in the future, recommends nothing, except the exercise of great care and prudence. The report does, however, contain a recommendation in agreement with that made by the jury at the inquest, as to the desirability of instituting an inquiry as to how the risks associated with this class of work may be minimised.

Ten days ago the London County Council considered a long report on apprenticeship and trade schools and came to the decision, first, that in view of the national character of the work done in the schools, the Government might be expected to increase the present grant, and, secondly, that the Board of Trade should be invited to assist the *protegés* of the Council through the medium of the Labour Exchanges. We sincerely trust that the result of the decision may be a thorough investigation of the technical training of artisans as it is now conducted. There are very good reasons for believing that the trade schools are not worth a fraction of the sum annually spent on them. On the other hand, the old system of apprenticeship is hardly likely to be revived; it was killed by the factory system, and as long as the factory system endures a return to the apprentices of old is impossible. There is, however, no reason why an improvement of the present system should not be made, and we are glad to find that under the energetic action of the Lord Mayor something is likely to be done. It is, however, earnestly to be hoped that practical employers of labour will be consulted, and that more attention will be given to their opinion than to that of professional educationalists whose understanding of practical factory economics is only too often, as the Council report shows, sadly small.

Following upon the catastrophe to the dirigible balloon, République, the French journal *Le Temps* opened a national subscription with a view to replacing it with one or more airships, and the amount collected, reaching not far short of a million francs, will probably be devoted to the purchase of a dirigible balloon as well as a number of aeroplanes. Meanwhile, the question of providing France with an aerial fleet is seriously occupying the attention of our neighbours, who are alarmed at the progress being made in Germany, where an organised fleet of dirigible balloons is already in existence with suitably equipped sheds at the different strategical points. The organisation is so perfect that production of hydrogen gas has been placed under State control, and wherever the gas is manufactured hydrogen cylinders are stored on wagons ready to be attached to any train to be consigned to any part of the territory at a moment's notice. The army balloon corps is, moreover, constantly familiarising itself with the management of dirigible balloons, ascents being made at all times and in all weathers. Although our French friends are seriously alarmed over the advance made by Germany in creating a fleet of motor balloons, and are urging upon the Government to lose no time in recovering lost ground, it is probable that the inaction of the French military authorities is due to their qualified faith in the dirigible balloon, which is recognised as undoubtedly valuable for revealing masses of troops. But it cannot be relied upon in all weathers, and the French authorities are of the opinion that the aeroplane will be developed sufficiently to allow of this work being done equally well and under much better conditions. Quite a number of aeroplanes can be built at the cost of one motor balloon. While the French are hesitating, the Germans are doing their best with what they have at hand, and possess at present the strongest and best equipped aerial fleet in the world.

The first important discovery of natural gas in Europe is reported from Kis-Sarmas, in the county of Klausenburg, in Transylvania, where an apparently inexhaustible supply has been found. The presence of this valuable economic asset first became known some two years ago, when shepherd boys used to light the vapours rising from the marshes, to the terror of the ignorant country people. Upon a geologist's report the Ministry of Finance directed proper borings to be made, when large quantities of gas were discovered at a depth of 20 m. The borings were continued to a depth of 200 m., when the gas was found in such immense volume that big stones, as large as a man's fist, were thrown into the air by it. At the present time the gas is pouring out of a pipe 20ft. above the ground with a noise that can be heard six miles away. Experts estimate the flow at 70 cubic feet a second. Analysis shows that it is a peculiarly clear methane gas, containing scarcely half of 1 per cent. of nitrogen. A Government commission of experts declare that there is little danger of the supply becoming exhausted, and even if the pressure becomes less in a few decades, new borings would certainly yield large additional quantities of gas. Upon the advice of these experts the Hungarian Ministry of Finance have bought all the gas mining rights for 100,000 crowns, or rather less than £4200. It is proposed to utilise the gas supply in running a large central electrical plant to be built on the ground.

By introducing a Bill that will confer a certain self-government on the ports, the French Government aims at putting an end to a state of things which has always been regarded as a serious grievance by local interests. At present the Chambers of Commerce have no real jurisdiction over the ports, which are under the direction of engineers appointed by the State, and nothing can be done without official sanction, with the result that the administrative machinery moves very slowly on account of the endless formalities that have to be observed. The impossibility of carrying out extensions or improvements without being hindered by red tape at every turn has long exasperated the Chambers of Commerce, which find their own ports practically at a standstill, while the ports of other countries are developing rapidly. Another grievance is that port dues are levied by the State, and are not always utilised for local improvements. The new Bill, however, is giving some satisfaction to the Chambers of Commerce, although, in many respects, it is open to criticism. It is intended to create in each port a Board of Management, of which the chairman will be the chairman of the Chamber of Commerce. He will represent the commercial interests, while the technical work will be undertaken by an engineer appointed by the Minister of Commerce as at present. The Board of Management will be elected partly by the Chamber of Commerce and other local bodies, and partly by the Minister of Commerce, and it is pointed out that under this arrangement the State will still have the upper hand, with the result that there may be friction between the official and local elements. The Chambers of Commerce have always wanted to have complete control over the ports, without State intervention, and they are therefore only getting partial satisfaction by the new arrangement. Nevertheless, it is admitted all round that the appointment of new Boards of Management is a move in the right direction, since it aims at giving local bodies a prominent voice in all matters affecting the ports and suppressing all useless and irritating formalities, whilst at the same time it leaves the management of the ports still under the control of the State.

The piercing of a tunnel which will undoubtedly have a very considerable effect on the future of the Argentine and Chilian Republics, if not on the commerce of the world, was finally completed during the month. We refer to the tunnel through the Andes connecting Las Cuevas in the former state with Caracoles in the latter, which, when it is finished and laid with rails, will form the last connecting link on the first transcontinental railway in South America, joining the Pacific and Atlantic Oceans, Buenos Ayres and Valparaiso being the respective termini. The total length of the tunnel is about 3165 m.—say 1.97 miles, this length including two artificial ends at either side, together 142.70 m. long—and it has been driven at the great elevation of 10,500ft. above sea level by a British firm, C. H. Walker and Co., Limited, Messrs. Livesey, Son and Henderson, of London, being the engineers. It should be mentioned that some preliminary work had previously been carried out by local contractors, but Messrs. Walker took over the operations at the Argentine end, where the excavations had partially collapsed, in February, 1908, and at the Chilian end, where the work was further advanced, in December of the same year. The tunnel has a headway above rail level of 18ft. 0¾in., and an extreme width of 16ft. 5in. It was found necessary to line it throughout with a layer of concrete 1ft. 7¾in. thick. Owing to the rarified nature of the air at the altitude of the tunnel it was found impossible to use steam locomotives in the constructional work—though they were tried—and compressed air engines were employed instead. The whole undertaking has been eminently successful, and it is anticipated that it will be possible to run a through train by next March.

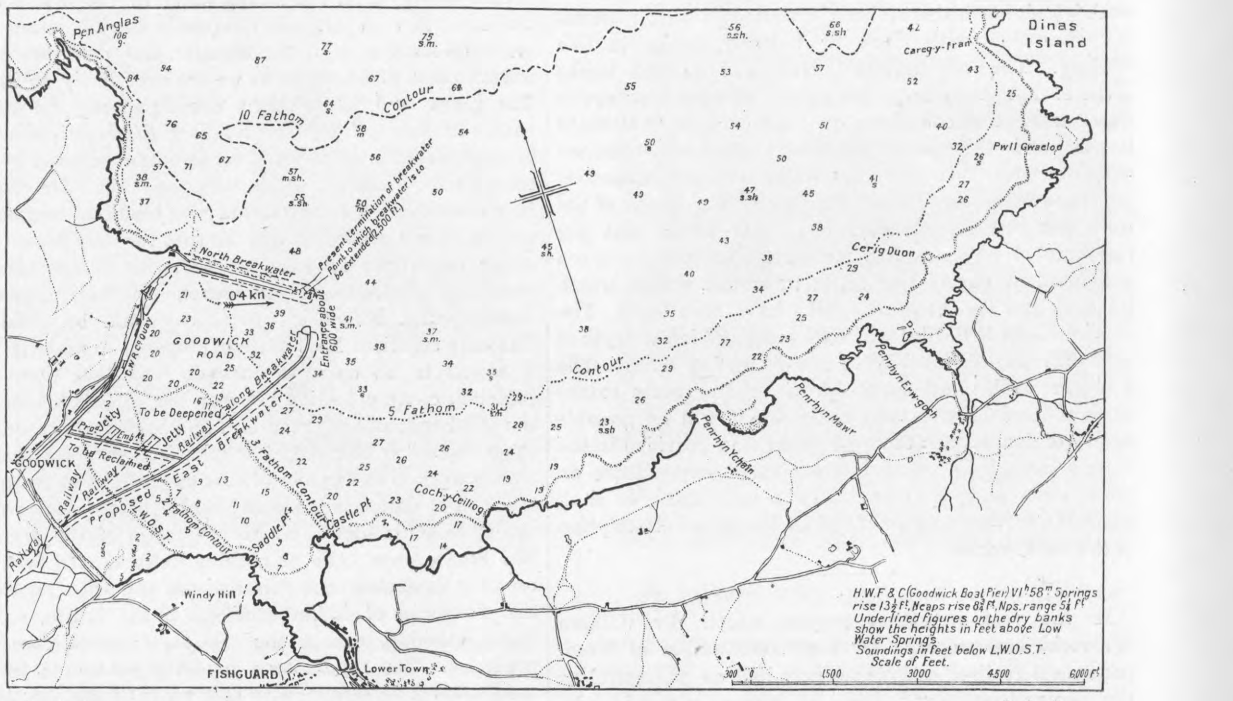
One thing or another is always being done to facilitate the traffic in London, and it is now easier to get from place to place in this vast metropolis than it ever was. But much remains to be done. The increase in traffic and the advent of the motor vehicle have both rendered necessary alterations in our means of communication. The Court of Common Council recognising this, have during the month decided to adopt the Report of the Bridge House Estates Committee advocating the construction of an entirely new bridge between London and Southwark Bridges, and connecting St. Paul's-churchyard with the south bank of the Thames; and also the widening and flattening of the existing Southwark Bridge. These two works, together with the Tower Bridge and the recently widened London and Blackfriars Bridges, should provide sufficient cross-river accommodation for many years to come, but what their combined effect on the traffic passing from east to west, and *vice versâ*, would be is not easy to foretell. There are those who consider that something akin to Holborn Viaduct will have to be at no distant date constructed across Ludgate-circus. Meanwhile, another step has been taken—this time to assist foot-passengers as contrasted with vehicular traffic. We refer to the subways completed and opened for use this week at the junction of Queen Victoria-street, New Bridge-street, the Victoria Embankment, and the approach to Blackfriars Bridge. It is now no longer necessary for a pedestrian to cross the muddy streets at this point at the risk—more or less serious—of his life; but whether or not he will take advantage of this fact remains to be seen. To judge by the small popularity of similar constructions, it is by no means certain that he will do so.

The position of the river Loire would make it one of the most valuable waterways in France if it did not suffer from the drawback of being silted up with sand. The Loire watershed comprises some of the richest country in France, which would provide a huge tonnage of traffic if only the river were kept in a narrow bed instead of being spread out in shoals and sand banks. All the towns from Nantes to Orleans are interested in the question of rendering this river suitable for traffic, and during the past month a congress has been held at Saumur to discuss a reports upon what has already been done, and what it is proposed to do, to transform the river into a vast highway from the centre of France to the Atlantic seaboard. Opinion was divided as to the way in which this undertaking should be carried out, some members of the congress arguing that it would be preferable to make a lateral canal from Nantes to Briare, where it would join the central canals. This project, however, received little support, principally on account of the cost, and it was urged that the Loire could be easily deepened sufficiently for boats of 150 tons up to Tours, and perhaps even to Orleans. The difficulty of the undertaking lies in the shifting character of the sand, but it was reported that a well-known engineer, M. Cuénot, had succeeded admirably in creating a navigable channel between the junction of the Loire and Maine and the town of Montjean. It was previously estimated that the cost of making a channel 1.20 m. deep would be 120,000f. a kilometre, but M. Cuénot obtained a depth of 1.50 m. at a cost of only 35,000f. a kilometre, this being done by making the channel banks with stakes, filled up to keep back the sand. The work is now being continued on towards Nantes, and when completed Nantes will draw traffic from about 400 kilometres of waterways, comprising the Maine, Mayence, Sarthe, and Loire. The success of this enterprise suggests the possibility, and even certainty, of creating a channel at a much lower cost than was supposed beyond the junction of the Maine up to Tours and Orleans, where it would join the canal system of central France, and it was the opinion of the Saumur Congress that the old problem of a "navigable Loire" is at length within measurable distance of solution.

FISHGUARD HARBOUR.

No. I.

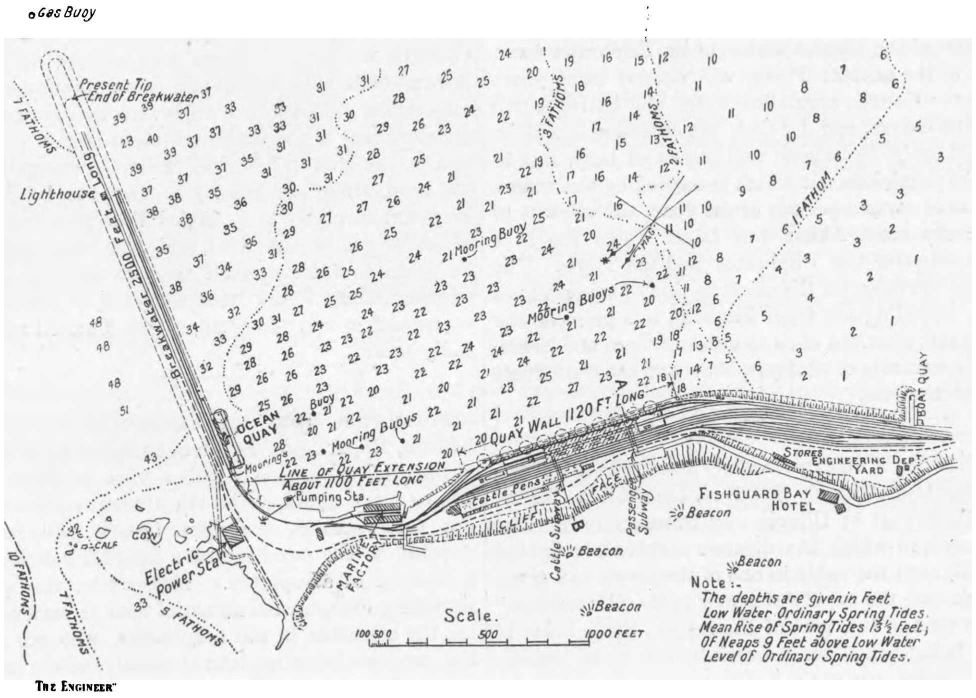
Three years ago, on the occasion of the starting by the Great Western Railway of the cross-Channel service between Fishguard Harbour and Rosslare, we published a description of the harbour works which the railway company had then constructed in Fishguard Bay as the terminus of its South Wales main line in place of Milford Haven, which for over half a century had been the most westerly point on the Great Western system in the principality.* When over fifty years ago Brunel was planning the route for the South Wales section of the Great Western Railway, he considered that the most desirable point for the western terminus of that line would be found in Fishguard Bay, but engineering difficulties supervened which for the time proved insurmountable, and Milford Haven was selected as the railway terminus.



The Engineer Swain Sc.

Fig. 1—CHART OF FISHGUARD BAY

The harbour works, although sufficiently advanced in the summer of 1906 to permit of the opening of the cross-Channel passenger and goods services, were far from complete; indeed, it may be said that if the hopes of the railway company for the future development of the port are realised, the works at Fishguard will be in the process of making for many years to come; and even when all the improvements and extensions now planned are realised there will be scope for still further development if the prosperity and trade of the harbour continue to increase. In the past three years a good deal of constructional work has been carried out at Fishguard, and a commencement has been made with a scheme of extension which is intended to add to the facilities of the port for dealing with transatlantic traffic on a large scale. In the present article we propose to supplement the description we have already published, and to describe in more detail the harbour works recently executed and to be constructed inthe immediate future. The harbour has been constructed with the immediate object of improving the company's connections with the south and east of Ireland, but undoubtedly the directors had in view possibilities with reference to transatlantic traffic, which have at length been realised by the decision of the Cunard Company to make Fishguard a port of call for all its steamers eastward bound from New York. The Mauritania commenced the new service on the part of the Cunard Company, by calling at Fishguard on Monday, the 30th August,* and on her arrival at 1.12 p.m., three special Great Western trains, one for the mails and the other for passengers, were dispatched to Paddington, the first train arriving in London at 6 40 p.m., occupying less than 4½ hours on the journey of 261½ miles. Even better times have been accomplished on subsequent journeys. The railway company now runs special trains in connection with the Atlantic liners carrying continental passengers direct to Dover, in addition to the Paddington service. Not only do the Cunard liners now call at Fishguard on the east-bound passage, but the Booth liners, homeward bound from Brazil and Lisbon, have landed passengers and mails there since April, 1908. There is a possibility that the new arrangement of the Cunard Company will be extended in the future to include calls at Fishguard on the outward voyage. At the present time tenders are used for transferring mails and passengers from the liners, which drop anchor in the bay under the shelter of the breakwater, to the quay. When the ocean quays, to which we shall presently refer, are completed, the largest liners will be able to come alongside the quays and passenger station, rendering the use of tenders unnecessary, except perhaps in heavy weather.


Gas Buoy
Present Tip End of Breakwater
Lighthouse
Breakwater 2500 Feet Long
7 Fathoms
5 Fathoms
10 Fathoms
Mooring Buoys
Ocean Quay
Line of Quay Extension About 1100 Feet Long
Pumping Sta.
Quay Wall 1120 Ft. Long
Electric Power Sta.
Stores
Engineering Dept. Yard
Fishguard Bay Hotel
Subway
Beacon
Note :-
The depths are given in Feet Low Water Ordinary Spring Tides.
Mean Rise of Spring Tides 13½ Feet; Of Neaps 9 Feet above Low Water Level of Ordinary Spring Tides.
Scale.
100 50 0 500 1000 FEET

The Engineer

Fig. 2—PLAN OF FISHGUARD HARBOUR, OCTOBER, 1909

A glance at the chart of Fishguard Bay, which we reproduce in Fig. 1, will show that between Pen Anglas and Dinas Island, the two bold headlands at the entrance to the bay, there is a distance of over three miles, and within the limit thus formed is a deep water area, completely protected on three sides by hills rising to a height of some 300ft. From Fishguard the distance across St. George's Channel to the Irish Coast at Rosslare is only 54 nautical miles, and its distance from New York is 2902 nautical miles as against 2957 miles to Plymouth, 3017 to Liverpool, and 3077 to Southampton.

Early history of the harbour.—The earliest authenticated record of a proposal to construct harbour facilities at Fishguard dates from 1790, when a Mr. Spence made a survey of the bay and reported to the Admiralty on a proposal to construct a pier at the moderate estimate of £14,785 18s. 5d. In 1845, the South Wales Railway Company, with Mr. I. K. Brunel as engineer, obtained powers to construct a line from Chepstow to Fishguard, the intention then being to run a line of steamers from Fishguard to Wexford. When, in 1851, the Great Western Railway took over the line, the works already commenced between Clarbeston Road and Fishguard were stopped, and what was then known as the Haverfordwest branch was continued to Neyland—New Milford—where suitable shelter and harbour accommodation could be obtained at a much more moderate cost than would have been possible at Fishguard. Nothing further appears to have been done in connection with the Fishguard scheme until 1893, when the Fishguard Bay Railway and Pier Company—a separate undertaking in which the Great Western Company at that date had no direct interest—obtained powers to construct a harbour there, and to connect it by railway with the Great Western system. During the succeeding five years the same company obtained powers to acquire the old Rosslare Harbour and several railway connections in Ireland, as well as further powers of constructing new lines. Another company—the North Pembrokeshire and Fishguard Railway—also came into the field with proposals, and in self-defence the directors of the Great Western Railway and the Great Southern and Western Railway of Ireland combined together to form the Fishguard and Rosslare Railways and Harbours Company with the object of acquiring the powers obtained by these two would-be competitors, and completing the works already commenced.

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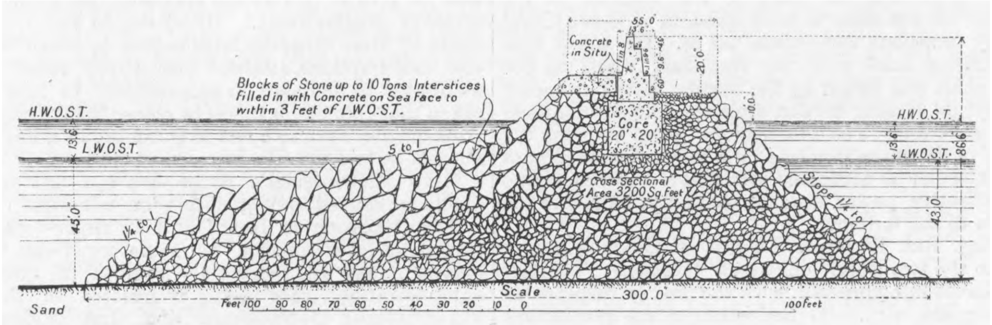
* The Engineer, August 31st, 1906.

* Vide The Engineer, September 3rd, 1909.


Blocks of Stone up to 10 Tons Interstices Filled in with Concrete on Sea Face to within 3 Feet of L.W.O.S.T.
Concrete in Situ
55.0
13.6
Core 20'×20'
Cross Sectional Area 3200 Sq. Feet
H.W.O.S.T.
L.W.O.S.T.
13.6
45.0
5 to 1
1¼ to 1
Slope 1¼ to 1
20.0
10.0
86.6
43.0
Sand
Scale
300.0
Feet 100 90 80 70 60 50 40 30 20 10 0
100 feet

"The Engineer" Swain Sc

Fig. 3—CROSS SECTION OF BREAKWATER

The required powers having been obtained in 1898, the works decided on were rapidly pushed forward on both sides of the Channel, those for which the Great Western Railway was responsible being the extension of the railway to Fishguard Harbour, the construction of harbour works, a small beginning of which had already been made, and the provision of a new double line from Clarbeston-road to Letterston, so as to avoid the use of the very steep and tortuous branch line from Clynderwen. It is interesting to note that a considerable part of the new line follows the line of the works started by Brunel sixty years ago.

The site of the harbour.—The most desirable point for the construction of the proposed harbour was on the western side of the bay, where the cliffs rise almost sheer out of deep water to a height of over 200ft. in places. The cliffs are composed of hard igneous rock—diorite—and when the works were commenced there was hardly a foothold along the entire site of the present quays and railway sidings. At first the engineers had to cart their machinery, &c., from the nearest railway point, Letterston, to the top of a hill known as Pen Cw, a height of 300ft. above sea level, whence plant and men were lowered by ropes to a point where the work of clearing and blasting could be commenced. At the date when the Great Western Railway took over the operations sufficient rock had been removed from the cliff to form a narrow strip of land on which engines, cranes, and wagons could conveniently be placed.

In brief, the original scheme, as planned by the Great Western Railway Company, and now nearing completion, comprised the following works:—(1) The formation of an area under the cliffs whereon quays, rail sidings, workshops, railway station, &c., could be constructed. This area had to be formed by blasting away the cliff and using a part of the material so obtained in reclaiming a portion of the bay seaward of the original high-water line. (2) The construction of a breakwater extending in an easterly direction from the land at Pen Cw for a distance of nearly half a mile. (3) The construction of a quay wall on the west side of the bay, with a railway station and other works. (4) The dredging of a portion of the harbour bed to a minimum depth of 20ft. below low water. Railway connection between Letterston and the harbour works was not completed until 1899; before that date the material and plant for the works had to be brought either by sea or road.

The blasting operations.—The work of cutting away the face of the cliff to provide a site for the railway terminus was naturally the first portion of the scheme to be undertaken. Over 2,000,000 tons of rock had to be removed from the cliff. A large portion of this has been utilised in the construction of the breakwater, the balance being tipped on to the bed of the sea beneath the cliff to fill in behind the quay wall. On the average, the toe line of the original cliff, which also may be taken as approximately the line both of high and low water, lies about midway between the present cliff toe and the quay face. Thus, about one-half of the present site of the terminus yard and quays, which averages 260ft. in depth, is upon the bed of the quarry, and the other half on the reclaimed sea bed. The depth of water over the site of the reclaimed area varied from 0ft. to 12ft. at low water of spring tides before the filling in commenced, and the average may be taken as about 9ft. at low water. The general surface of the reclamation is at a level of 23ft. 6in. above low water. The tidal rise at springs is 13ft. 6in. The larger blocks of rock obtained from the cliff excavation have been used in the construction of the breakwater, the smaller material, as far as practicable, being devoted to the quay filling, and sent to the stone crushers for ultimate use in concrete or as ballast. The total length of the excavated cliff is over half a mile, and the average height from quay level about 100ft.

Since the opening of the harbour in 1906 little blasting has been done on the cliff behind the quay, and a quarry has been opened out immediately to the north of the root of the breakwater at Pwll Hir, whence all the rock now required for the extension of the breakwater and for other purposes is being obtained. A view of this quarry will be found in the Supplement. In the early stages of the work the blasting of the rock was executed by direct labour employed by the railway company, but early in 1899 a contract was let to Messrs. Treglown Bros. to carry out the boring and blasting operations, a price per ton being paid for the rock actually delivered. The greater part of the site was excavated in this manner. A complete installation of compressed air Ingerstoll Sergeant drills was provided for the purpose of drilling holes in the rock. A good deal of the work was done by means of drill-holes, 2in. diameter and up to 20ft. deep, the charges being 20 lb. to 50 lb. of gelagnite, of which explosive 250 tons have been used on the work. For large blasts black powder was employed, headings 5ft. × 3ft. being driven into the rock face, with cross galleries of the same dimensions, the whole forming in plan a T, of which the leg is about 40ft. in length, and each of the cross arms 40ft. The black powder was placed in two charges, one at each extremity of the cross arms, and the chambers built up; the total charge in most cases weighing 14 tons. By the firing of these mines very large quantities of rock have been brought down, in one case as much as 130,000 tons being displaced. Two of the engravings in the Supplement are from the same spot, one before and the other after the explosion of a large mine. The entrance to the heading can be seen at the base of the cliff in the first picture. Fourteen steam travelling cranes of varying capacities, from 1½ tons to 15 tons, were employed in loading the blasted rock on to wagons, blocks as large as 30 tons being tipped from wagons at the working head of the breakwater, as the Titan employed for the construction of that work, can deal with weight up to 15 tons only. Up to August, 1909, 2,620,066 tons of rock had been blasted from the cliff face and loaded into trucks. This vast quantity of material has been disposed of as follows:—

	Tons.
North breakwater (as stone tip)	1,513,099
Quay backing	791,579
Other purposes—buildings, concrete, stone plums in concrete, ballast, &c.	315,388
	2,620,066

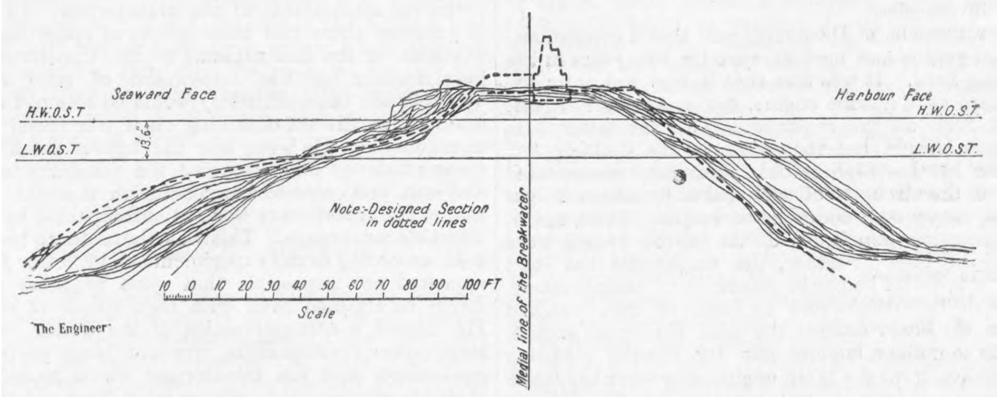

Seaward Face
Harbour Face
H.W.O.S.T
L.W.O.S.T
13.6
Note:-Designed Section in dotted lines
Medial line of the Breakwater
10 0 10 20 30 40 50 60 70 80 90 100 FT
Scale
"The Engineer"

Fig. 4—TWENTY-SIX CROSS SECTIONS OF RUBBLE MOUND IN THE BREAKWATER

The whole of the rock loaded was passed over a weighbridge, and a record kept of the amount loaded by each crane. An average day's load was 1500 tons, though on several days 2000 tons were passed. The ballast crusher is of the gyratory type. Rock, tipped into a large hopper, passes through the jaws, being reduced down to 2in. size, when it drops into a 70ft. elevator, which carries it to a large rotary screen. The screen takes out the ¾in. chippings and sand, allowing them to fall either into the concrete mixer or a reserve bin; the 2in. stones drop into large bins capable of holding 400 tons, under which empty ballast wagons are placed, and are filled by opening the doors in the bottom of the bins. It is thus possible to fill a train of 90 tons of ballast in twenty minutes, the rock not being "hand handled" from the time it is placed in the wagons until it is used by the packers on the line. It should be here mentioned that, in addition to the material required for the harbour works, all the ballast used on the railway works in connection was supplied by the Fishguard crushers.

The Breakwater.—The breakwater is of the rubble mound type, surmounted by an *in situ* concrete apron and parapet. The root of the breakwater adjoins the small rock headland of Pen Cw, whence the structure projects into the bay in a south-westerly direction. Except for a short length at the root end the breakwater is in a straight line. The depth of water on the site of the structure varied from 25ft. at low water close to the inner end to a maximum of about 46ft., the average throughout the greater part of the length being over 43ft. at low water. From the original high-water mark at the shore end to the present seaward termination the structure is 2300ft. in length, and it is now being extended to a total length of 2500ft.

The chart of the bay—Fig. 1—and the plan—Fig. 2—show the situation of the breakwater, while a typical cross section is shown in Fig. 3. The bed of the bay on the site of the breakwater is sand, which extends to a depth of over 30ft., and into which the stone mound has settled to some extent. The rubble mound is 300ft. wide at the base, over 60ft. wide at the top, and nearly 70ft. in height, the rise of tide at springs being 13ft. 6in. and the height of the causeway on the harbour face 10ft. over H.W.O.S.T. The face slopes of the mound are shown in the cross-section, that on the seaward face from half-tide down to 15ft. below low water being 1 vertical to 5 horizontal. The cross-sectional area of the structure is 3200 square feet, excluding the parapet wall, and over 650 tons of rubble are required to form one lineal foot of the structure. Stones weighing from 5 to 30 tons have been used on the sea face, smaller stones being interspersed to fill the voids between the larger blocks; on the harbour face stones of from 1 cwt. to 3 tons weight have been used. The stones on the seaward face are grouted in with concrete above the level of low water, and the mound is capped on the sea side by a concrete apron 6ft. thick, 18ft. wide on the surface, and carried down the sloping face for a distance of about 10ft. The surface of this apron is 16ft. above the level of H.W.O.S.T., or 6ft. higher than the deck level on the harbour face. Behind the concrete apron is the concrete parapet wall, built of 6 to 1 concrete and having a total height of 23ft., the height from the deck level to coping being 20ft. The height of the coping above high water is 30ft., and the total height of the breakwater is in some places as much as 90ft. above the sea bed.

The whole of the rubble mound has been tipped out from the shore, the blocks generally being allowed to take their own positions as they fell from the wagons. The average rate of progress of the breakwater between 1903 and 1906 was nearly 10ft. lineal per week.

The diagram reproduced in Fig. 4 is of considerable interest to harbour engineers, and we are enabled to reproduce it by the courtesy of Mr. Lambert Gibson, the resident engineer of the harbour works. It represents twenty-six cross-sections of the rubble mound taken at distances varying from 300ft. to 1600ft. from the shore. The sections, which are plotted to the same scale, are superposed, and in all cases represent the contour of the mound after successive gales have drawn down the slopes. The majority of the sections represent the condition of the work after several years of exposure to the sea. The designed cross section of the breakwater is plotted in dotted lines. When the construction of the breakwater had proceeded some few hundred feet from the shore and had reached deep water, it was found that the heavy waves striking and sweeping round the working head of the structure during gales from the northward caused large quantities of the smaller rubble in the unprotected face to be drawn down and driven towards the inner or lee side of the work. The effect of a northerly gale can be seen in one of the engravings in the Supplement, which is a view of the breakwater under construction, taken from the cliff at the shore end. It will be noticed that the rubble mound at the sea end has been driven towards the harbour. To minimise this wastage at the unprotected working face, a rough concrete bulkhead, or core, was constructed under the crane and wagon roads, the working face of the bulkhead being kept as far in advance as possible. This concrete core measures 20ft. by 20ft. in cross section, and is roughly rectangular; the top surface forming a foundation for the concrete parapet wall—Fig. 3. No shuttering was used in the construction of the core, but the concrete was deposited between rough dry stone walls formed by hand-packing the rubble so as to serve as side walls of a trench. The concrete was 6 to 1, with a large proportion of rock plums added. This method of construction reduced the wastage and temporary damage at the working face to a minimum, and since its adoption comparatively little of the rubble hearting has been washed over to the harbour side. It is interesting to note that the concrete core or bulkhead has been constructed at an average cost of 5s. per cubic yard.

The concrete in the parapet wall and apron is 6 to 1 throughout, and the former has been built within shuttering. The apron is 6ft. thick, and of insitu concrete measuring 5 cubic yards per foot lineal of the work. A skeleton steel and iron lighthouse tower has been erected on the breakwater, some 300ft. in from the present head of the work. This tower contains a fourth order flashing dioptric light, showing one red flash every five seconds. The focal plane of the light is at an elevation of 46ft. above high water, and an electrically operated fog bell is also installed. The lighthouse will be removed to the seaward extremity of the breakwater when the work is completed. At present a bell and gas buoy, showing an occulting white light is moored about half a cable's length seaward of the end of the breakwater.

Some details of the cost of the breakwater cannot fail to be of interest. The rubble mound, exclusive of the parapet and concrete apron, but including the cost of the concrete core, has cost £78 per lineal foot of the work, or under 14s. per cubic yard. The concrete parapet and apron, which represent 11 cubic yards of concrete per lineal foot, cost approximately £5 per foot of the structure, bringing the total cost to about £83 per foot. At this rate, the total cost of the breakwater when completed to a length of 2500ft. will be something over £200,000. The prices given include the cost of blasting and rock getting, and all establishment and engineering charges.

THE GERMAN NAVAL ARCHITECTS.

No. II.*

In opening the discussion on Professor Stumpf's paper, an abstract of which we gave in our last issue, Herr Missong, of Frankfort-on-the-Main, said the diagrams of the Stumpf engine produced were rather too perfect in character, and the efficiency of nearly 100 per cent. deduced from them must remain somewhat doubtful. On the other hand, efficiencies of 85 per cent. could be obtained with ordinary compound engines. Herr Missong gave some particulars of a steam engine which he had himself patented some ten years ago, and which showed a smaller consumption per horse-power per hour, and a 30 per cent. greater utilisation of the heat than the Stumpf engine.

Director G. Henkel, of Cassel, praised above all things the simplicity of the Stumpf engine. He gave a historical sketch of its forerunners, including the Gräbner engine of 1886, the Schmidt engine of 1893, and the later developments of these of 1894 and 1896 (use of superheated steam in engines with long pistons), and finally referred to the experiments of Professor Schröder in 1894. The latter had brought down the steam consumption to 4½ kilos. per horse-power per hour, a figure which Professor Lewitzky shortly afterwards further reduced to 3.85 kilos. He welcomed the further development of the Stumpf engine, and lamented the prejudice entertained by shipowners against superheated steam. The adaptability of the system to locomotives he would like to see decided by direct investigation, so that they might know how much of the economy was due to the continuous-flow system and how much to the reduction of clearance. French designers had produced very economical compound engines by the expedient of reducing the clearance to ½ per cent. Further, he would like to know whether the tests with locomotives had been made with the breaks in the uniformity of working which occurred in practice.

Director Cornels, of Hamburg, said that a continuous-flow steam engine had been at work for two years in the Reiherstieg Yard. It was true that it was not intended for, nor used as, a marine engine, but, as a matter of fact, it did not fulfil all the requirements of the latter. Its design was simple, but the stress on the shafting, &c., occasioned by the high initial pressures, necessitated increase of the strength of such parts by about 25 per cent., and consequent additions to weight. Then, again, the condensation conditions of the marine engine were somewhat different. Further, the engine did not start well, and this defect had to be remedied by complications, which, with the consequent increase of cost, weighed heavily in the scale against the good old steam engine. Steam for auxiliary engines and for heating purposes could be taken from the main engine only when the latter was at work; it was needed, however, for the lighting engines and similar purposes when the main engine was at rest. Taken altogether, then, the advantages of the system as compared with the marine engine of to-day were not very great.

Prof. Stumpf then replied, and, in answer to Herr Missong, said that the latter's engine was a compound one, and not of the single-expansion continuous-flow type, and that it could not therefore be compared with his own. He called attention to several disadvantages attaching to the Missong engine, and remarked that, although ten years old, it had scored no successes of any consequence. With regard to the Gräbner engine referred to by Director Henkel, this was ten years old, and had no pretension to continuous flow, since the course taken by the steam was at right angles to the axis of the cylinder, while in his own engine it was parallel to the direction of motion of the piston. The Schmidt engine, on the other hand, had an outlet valve, which led the steam back to the head of the cylinder, and the principle of its action, therefore, was that of alternating flow. In reply to the questions with regard to the experiments with locomotives, Professor Stumpf said that these had not been made for show purposes, but had been conducted as far as possible under ordinary working conditions. He said the results of the experiments as given showed how much of the economy was due to the continuous-flow principle and how much to the reduction of the clearance. The drawbacks mentioned by Director Cornels in connection with the starting did not lie in the engine itself, but depended partly upon the resistance of the vessel when beginning to move. Above all, however, his experiments with locomotives engaged in shunting clearly showed that the manœuvring qualities necessary for marine work were not wanting. Further, Professor Stumpf said that he had undertaken to furnish the design for an English marine engine, and had agreed to replace it by another of first rate quality in case it should prove a failure. Before an engineer became a party to such an agreement he must be pretty sure of his ground.

Herr Sütterlin, of Hamburg, in opening the discussion on Prof. Föttinger's paper, an abstract of which we also gave last week, said he considered the work done by the author a very clever piece of modern engineering. Above all he praised the theoretic thoroughness which characterised the design and the clever use of the well-known principle involved. He wished to ask, whether in the transmission of great powers the great heat imparted to the water would not necessitate such a great amount of cooling as to cause practical difficulties. Further, he asked whether the law that the transmission of the turning moment varied with the cube of the number of the revolutions did not cease to hold good in a seaway, and when large propellers were made use of. He asked how the transformer acted when the secondary wheel on the propeller shaft was forced by the inertia of the propeller to continue its turning motion after the transformer itself had been reversed. The illustrations given showing the smallness of the space required by a turbine arrangement with transformer as compared with that of a steam engine of equal effective power seemed to him to be rather too favourable to the former.

Geh. Reg. Rat. Professor Flamm, of Charlottenburg, referred to the two points on which Professor Föttinger had laid stress in connection with the use of turbines as marine engines, viz.:—(1) Reduction of the revolutions so as to obtain a speed suitable for the propeller. (2) The avoidance of the half-speed and reversing turbines, that is to say, convenient manœuvring. With regard to the latter, he agreed with the reader of the paper, but as to the revolutions of the propeller he was, in spite of his high appreciation of the importance of the Föttinger transformer, of a different opinion. He considered that the solution of the problem of the attainment of a good efficiency, even with a high speed of revolution of the propeller, could be arrived at by suitable design of the latter. Apart from investigations in this direction made by himself, he was aware only of those of Ahlborn and Gebers. He suggested that a little assistance given to efforts in this direction might bring forth propeller designs which even at high speeds of revolution would yield somewhat the same efficiency as was attained by the introduction of the transformer. The use of this apparatus could then be avoided. The phenomenon (referred to by Professor Föttinger) of the presence of air in the propeller when working was due to the lowering of the surface of the water above the latter, in a manner which he had repeatedly established in the course of his own modest experiments.

Herr Wimplinger thought the introduction of a new member into the line of the shafting of a turbine arrangement, which itself was specially characterised by its simplicity, was not very happy; this simplicity, and with it the reliability of the working, would, not improbably, suffer thereby. Moreover, the experimental trials with the engine of only 500 horse-power did not admit of a sufficiently definite conclusion being drawn as to the unlimited applicability of the transformer. In the case in question there had been plenty of space and weight available for the dimensioning of the transformer in the best manner for the attainment of good efficiency. Whether the same efficiency would be attained under the cramped conditions obtaining on a war vessel was very questionable. He went into the figures relating to the mean efficiency and discussed the reliability in working and cost, and came to the conclusion that the introduction of the transformer was not accompanied by any considerable advantage. This was the more to be expected that, according to the experiments of Professor Flamm, it appeared not impossible that good propeller efficiency might be attained even with high speeds of revolution. He missed a communication of the details relating to large power developments, in which large pressures and heat effects with the transformer would probably make their appearance, and produce rapid wear and tear of the wheels. He would like, further, to hear something about the vibration and corrosion to which the wheels were liable.

Prof. Föttinger then rose to reply. He said it was natural that there should be many opinions on a new apparatus like his. He had accordingly been careful not to speak in superlatives, and had taken three years to work the idea out. The somewhat scanty literature in existence about high-speed turbines in general displayed more or less bias, and he had, therefore, relied upon the experience of turbine propellers which he had himself collected. For high powers cooling would perhaps be necessary when heat that might be developed could not be utilised for the feed water; but, if so, it would be easily effected. The cooling pump need not be very large, since sea water could be used, which could flow in and out automatically. With regard to reversing, he said that if the propeller went on turning, the transformer would not be filled for a few seconds; even if it were, the diagram showed that the turning movement of the turbine, which during the manœuvre ran on in the same direction, simply increased, without, however, causing any practical difficulties. With regard to the Westinghouse reducing gear, he said that, in spite of its age, this arrangement had not yet got beyond 300 horse-power. Moreover, the toothed wheels here used in course of time became worn, and he doubted whether the system could be applied to an engine of 16,000 horse-power, such as the one for which the Vulcan Company had lately proposed to adopt his own plan. In view of his own experiments with turbine propellers above mentioned, he did not think Professor Flamm's expectations as to an increase of the revolutions of propellers without appreciable loss of effect were likely to be realised. Even the provision of a cover over the propeller to keep out the air was not a complete protection, since Ahlborn had shown that air was introduced into the water surrounding the screw, even from the bow. The introduction of a transformer produced no such complication as had on several hands been suggested; he had not, indeed, asserted that the efficiency of the whole arrangement was greater than in the case of direct driving. The advantage of his system lay in the reduction of the space and weight requirements. As to the pressures occurring in the transformer in the case of high powers he did not wish to make any definite statements; they were not, however, so high as people were inclined to suppose. As to corrosion, he had found that this took place only in one particular kind of pump, and probably depended on the presence of air, which did not get into the transformer; moreover, hot water did not take up air at all. Adverting to the remarks as to want of experience, except with the small apparatus experimented with, he pointed out that such trials had to be made on a small scale to begin with. At any rate, he could state that for greater powers the clearance resistances did not increase progressively. He criticised some statements made by Herr Sütterlin with regard to small steam and coal consumptions attained with a new vessel, which he attributed to mistakes in calculation. In conclusion, he asked that confidence might be placed in his design, so that it should not have to come to Germany as a novelty from abroad, as had so often happened before.

Herr Michenfelder's paper—see our last issue—was loudly applauded, but no discussion followed.

The discussion on Herr Gümbel's paper—see also our last issue—was opened by Professor Laas, who was pleased that an increasing number of questions of administration were being ventilated in the Schiffbautechnische Gesellschaft, and that engineers were becoming more familiar with them. He considered that the organisation should in each case lie in the hands of one man, who, it was true, would have to busy himself with a great variety of things. The sub-division into a number of single elements, proposed by Herr Gümbel, was not always feasible, and the same was the case with the judging of the costs, &c., from the work sub-divisions.

Herr Gümbel admitted that it was impossible to lay down definite rules for organisation of the kind proposed. Such rules must for various reasons adapt themselves to the circumstances of each particular case.

The first paper on the list of the second day's proceedings was a very long one by Professor Romberg, entitled "Ueber Schiffsgasmaschiene"—On Marine Gas Engines—only extracts of which were read to the meeting. After giving a general historical retrospect of the development of the gas engine, the Professor drew attention to the points which would require especial attention in marine work, viz., reliability, economy in working, small weight and space, adaptability of speed of revolution of the engine to that suitable for the propeller, and facility in reversing. Marine gas engines, he said, aimed at the driving of vessels by direct combustion of previously gasified fuel in their cylinders, a medium for the transmission of power from a source external to the latter, as in the case of the steam engine being thus avoided. This was attended with numerous advantages, comprising especially a better utilisation of the heat, the saving of the weight and space otherwise required for the boiler, an increase of the radius of action of the vessel, rapidity in getting ready for work, greater simplicity in operation, &c. Disadvantages were the high combustion pressures and temperatures of the engines, and their want of adaptability to different speeds and to reversing and similar operations.

Professor Romberg sketched the process in the four-cycle engine, consisting (1) in the sucking in of the charge; (2) of its compression; (3) of its explosion and expansion—performing work the while; and (4) of the exhaust; these operations taking place in four successive strokes of the piston. The two-cycle engine, in which the same operations are gone through in two strokes instead of four, might at first sight give promise of halving the weight and space required. It became necessary, however, in this construction to provide separate pumps in order to effect the introduction of the charge at the beginning and the exhaust at the end of the double cycle. These, again, represented weight and space, and the efficiency of the two-cycle process was less than that of the four-cycle one, so that the choice of one of these must be preceded by a careful weighing of their respective advantages and disadvantages. The mechanical complications also of the two-cycle engine were considerable. The two-cycle oil engine had some fundamental advantage over the two-cycle gas engine. The gas pump was replaced by a much smaller-sized fuel pump or gasifier, which was of a simpler nature. To judge from actual constructions, the two-cycle engine did not seem to possess any very considerable advantages over the four-cycle one. For marine work the two-cycle oil engine had considerable advantages over the two-cycle gas engine, but had no fundamental advantage over the double-acting four-cycle engine, the mechanical features of the latter being relatively simple, though still presenting difficulties which, for marine work, would have to be overcome. The double action was a necessity for the attainment of large powers. The constant-pressure process had been realised for the first time in the Diesel four-cycle oil motor. Its importance for marine work lay in its high fuel-economy, and in the possibility of the employment in it of cheap heavy kinds of oil, which were burnt without leaving any residue behind. The speed of revolution possible with this system could be varied within limits in the proportion of one to three. In suitability for marine work the engine was, in this respect, not far behind the reciprocating steam engine. A mixed combustion process by the French firm of Messrs. Sabathé was shortly alluded to as being one of high promise for marine work.

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* No. I. appeared November 26th

Professor Romberg sketched the development of the marine gas engine, and said that it had originally been designed on the lines of the stationary engines on shore, the transmission of the power from the engine to the propeller being effected by the help of belting and wheel gearing. An important improvement was subsequently effected in the adoption of vertical in place of horizontal engines. For small yachts and launches automobile motors had at first been largely adopted. It had proved to be necessary to alter the designs of these in order to adapt them for the special work that they had to perform. The mechanical aspects of these different engines were discussed at considerable length, and favourable mention was made of the American system of designing such motors with interchangeable parts, which, though carefully made, were of cheap materials and not so finished as to please the eye. Illustrations and particulars were given of a large number of actually constructed motors of different sizes and patterns.

Numerous marine gas engines were now being constructed of horse-powers ranging from 100 to 1000. These were on various systems, and for some five or six different kinds of fuel. Amongst other applications, that of the Diesel motor was being applied to submarine boats in several instances. The gas engine proper had first justified its existence in marine work after generators and purifiers had been produced that could be placed on board vessels. Generators for such purposes were now all constructed on the suction-gas principle. For such work good gas was all important. As yet this could be obtained only from expensive fuels, such as anthracite and coke. Bituminous fuels such as lignite and other inferior kinds of coal gave unsatisfactory results. Much trouble was given by tar and dirt which the gas brought with it, and which entailed frequent cleaning of the motor. Professor Romberg considered it probable that the difficulties of gas generation from cheap fuel would soon be surmounted, and said that the gas motor would then, for many purposes, be a practically useful marine engine. The application of large gas engines to marine purposes had not as yet been seriously attempted. The employment of an aggregate of small engines to give the power of a large one was accompanied by several practical difficulties. The speed of revolution would have to be considered. For large powers the small motors hitherto in existence could not be employed. Double-action cylinders of moderate length, somewhat in the style of the reciprocating steam engine, would have to be resorted to. The number of cylinders placed in juxtaposition in an engine should not exceed from four to six; otherwise the long engine became affected by the movements occurring in the hull of the vessel. Speed of revolution must be adapted to the requirements of the propeller. If twelve double-acting cylinders, arranged in pairs one above another, were combined in one engine, a unit of 8000 horse-power could be obtained, and this was sufficient for most practical purposes. The many mechanical difficulties which still existed were pretty certain to be overcome. Particulars of a considerable number of installations of motors in vessels of different kinds were given. Prof. Romberg considered that the development of the large marine gas engine would be a matter of great importance both for commercial and for war purposes.

Dr. Diesel, who rose to open the discussion on Professor Romberg's paper, confined himself to questions of an economical nature. He challenged the assertion that with the development of the oil motor industry the price of lamp oil had considerably increased. He had watched the fluctuations of the oil market prices for years. Whereas the price had formerly been M.25 to M.30 per 100 kilos. of oil, the price in Germany was now from M. 8 to M. 10 per 100 kilos., including a duty of about M. 3.6 per 100 kilos. Oil springs had in our time been discovered all over the world. By the establishment of stores of oil in enormous tanks, and by the construction of large tank vessels, the road had been smoothed for the carriage of the material to market and to the points of consumption. In addition, the circumstance that the by-products of various industries (lignite distillation, &c.), had been made use of for fuel had helped to lower the price, especially in Germany. The result of this was that Germany was independent of foreign supply, and could do without American and Russian oils, even if a considerable development of the oil motor industry should operate in swelling the consumption. For the navy, moreover, the duty of about M. 3.6 per 100 kilos. was withdrawn, so that it obtained oil at from M. 5 to M. 6., free Hamburg. Abroad, also, oil fuels could be had cheaply at all the storing stations, and these were now established all over the world in greater number than coaling stations; oil could therefore be regarded as the ideal fuel for war vessels. A great advantage which war vessels gained by the use of oil engines was the increase in the radius of action, which, with the same bunkers, became from five to six times as great as those of steam vessels. If the Russian fleet in the late war had had oil motors and oil fuel, they could have sailed to the Far East and back without stopping to bunker on the way. With weight of oil equal to that of their coal they could even have gone there and back twice over. The French submarine boats fitted with oil motors had this summer made voyages of 720 nautical miles without having to take in fresh fuel. They were now in a position at once to go over from the defensive to the offensive. The small space and weight, both of motors and fuel, rendered possible the adoption of considerably higher engine powers. Whereas, formerly, 400–600 was an exceedingly high power, they had recently gone up to 1400 H.P. In view of the foregoing it could not be denied that the oil motor must have a future for naval work.

Herr Folkers said the questionable economical conditions of the high-speed ocean liner, no less than the problems of warship construction, were pressing towards a solution of the motor question. He must strenuously oppose the mistaken view of Professor Romberg that the two-cycle motor could not hold its own against the four-cycle engine. He had investigated this question by the help of searching experiments at the Technische Hochschule in Aix-la-Chapelle, and proposed to lay the results before the Schiffbautechnische Gesellschaft at their next meetings. In actual practice, also, the mistaken notions as to the superiority of the four-cycle motor over the two-cycle had been disproved. He could not agree with the theoretical conclusion of Professor Romberg that the charging process was attended with difficulties in the two-cycle motor; neither could he admit that the utilisation of the fuel was less perfect in the two-cycle than in the four-cycle motor. Professor Junkers had conducted searching experiments on the applicability of oil motors, and especially Diesel motors, to marine work, and thereby established the fact that the other requirements of a marine engine—reliability in working, good manœuvring qualities, reversibility, and ability to run at half-speed—could up to a certain point be fulfilled. It was true that the gas engine could not work at one-tenth or one-twentieth of its full power, as a steam engine could, but it was quite possible to construct a slowly running gas engine if only the combustion were ensured. For this a high temperature in the combustion chamber was absolutely essential, and for this, again, it was necessary that the external loss of heat should not be too great. The pressure also had an influence on the transmission and loss of heat. The compression chamber must be made with the fewest possible number of valves and stuffing-boxes, small surface, and simple parts.

Director Bendemann, referring to Professor Romberg's statement that the fuel consumption of two-cycle motors was in all cases greater than that in four-cycle motors, said aeronauts would be very glad to hear by what percentage the fuel consumption of a four-cycle motor was less than that of an equivalent single two-cycle one.

In replying, Professor Romberg said that in 1880 crude oil could be had for from M. 4 to M. 5 per 100 kilos.; now, when the oil motors were being used to a still limited extent, the prices had already advanced to between M. 9 and M. 14 per 100 kilos. Crude oils could, indeed, still be obtained for M. 4 to M. 5 per 100 kilos., but as fuel for motors they were useless, unless safety of working was to be given up. The fuel consumption of a four-cycle was, as far as he was aware, always lower than that of a two-cycle motor. He could not give exact particulars or percentages. These varied in different cases. At all events, he knew of no two-cycle motor that could show a lower consumption than an equivalent four-cycle motor. For the latter about 190 gr. of oil fuel per horse-power could be taken as a minimum, while for the two-cycle motor somewhat more than 200 gr. must be reckoned.

Following Professor Romberg's paper came one from Herr Geh. Marinebaurat Tjard Schwarz, entitled "Ueber Ruderdruckmessungen u.s.w." ("On Measurements of Rudder Pressure, &c."). It contained a description of measuring apparatus designed by the late Herr Marineoberbaurat Wellenkamp, and further developed by his successors, illustrations of which were given. In the course of experiments made with a number of war vessels it was learned that the greatest stress on a rudder was that experienced by it when a vessel turning in one direction had suddenly to make a turn in the other. Stresses on the rudder head about double those given by the Joëssel formula were in some cases registered, but it was not thought desirable to communicate definite results until fresh experiments with the recently further improved apparatus had been carried out. A specially devised photographic camera connected with recording apparatus was made use of to determine the heeling and change of trim experienced by a vessel when turning, the position of the ship with reference to the horizon being shown in a series of impressions. It was suggested that apparatus of this kind might with advantage be adopted on merchant vessels also.

"THE ROCKET'S" DRIVER.

SEVENTY-NINE years have elapsed since George Stephenson's first passenger locomotive travelled on its historic journey from Liverpool to Manchester. The man who claimed to be the engine driver of that train, and whose name was Edward Entwistle, died in the early part of last month at his home in the town of Des Moines, in Iowa. He was born at Tillsley Banks, near Manchester, on March 24th, 1815. At fourteen years of age he was apprenticed to the Duke of Bridgewater, and served in his machine shops at Manchester. At that time locomotives had been in use for about four years for hauling coal, but they had not been employed for passenger traffic, although such use was contemplated. On commencing his apprenticeship young Entwistle was immediately set to work on the construction of locomotives, and in 1830 he was elected to fill that important and responsible post of driver of George Stephenson's famous locomotive, "The Rocket." According to the story which the late Mr. Entwistle used to tell, it seems that a few days before George Stephenson was going to undertake his trial trip, the latter paid a visit to the Duke of Bridgewater's shops with the object of obtaining a suitable driver. The foreman said that he had no man that he could recommend, but added, as he pointed to Entwistle, if you can get leave to take that lad I have no doubt that he will answer your purpose. Accordingly George Stephenson saw the Duke, who gave his permission for Entwistle to become driver of "The Rocket."

It was on a Saturday, about the middle of September, 1830, when these arrangements were completed, and the date of the formal opening of the railway was fixed for the following Monday. On Sunday morning George Stephenson and his driver took "The Rocket" for a trial run. With the engine coupled to a car of gravel they ran down the track for about fifteen miles. When Monday morning came they ran "The Rocket" down to Liverpool to bring back the first passenger train on its trial trip. Great interest, it is said, prevailed among the people, and crowds stood at the dock to watch the train depart, whilst many lined the track along the entire route of 31 miles. Two flat cars upon which were mounted four ordinary stage coaches constituted the train, and it was crowded with people. It was about ten o'clock in the morning when the train started amid cheers and shouts of the spectators, and the run was made with only one stop. It was during this stop that a sad and regrettable accident occurred. According to Mr. Entwistle's version Mr. Huskisson, who was travelling on the train, saw the Duke of Wellington in another coach and the two alighted to shake hands. They stood on the track, and did not notice a gravel train approaching until the crowd shouted to them. The Duke of Wellington escaped, but Huskisson fell under the wheels. He was seriously injured and died in ten hours.

Mr. Entwistle served as driver on the train for twenty-three months, at the end of which time his nerves had become so shaken that he asked George Stephenson to allow him to discontinue the work. The road was so solid and the vibration of the engine so great, Mr. Entwistle is reported to have said, that it overtaxed his nerves. He was afraid that he would have an accident. Mr. Entwistle was very proud of the speed at which it was possible to travel in those days, and when questioned about his early experiences would take great pains to make it clear that he frequently did thirty miles in thirty minutes. In 1873 he left England for America, but before that time there were many railways. The Liverpool and Manchester Railway was extended to London, thus providing rapid transit over a distance of 200 miles. Among the various stories which Mr. Entwistle was fond of relating was one pertaining to a record trip from Liverpool to London and back. It seems that, long after he had ceased to become regular driver of "The Rocket," a Mr. Francis O'Connor, who was editor of a newspaper, asked Mr. Entwistle to take him from Liverpool to London and back by special train, which he ultimately agreed to do. The train consisted of an engine and one coach. It was five o'clock in the evening before the trip was decided upon, but they were back again in Liverpool before five o'clock the next morning. It was 400 miles, and Mr. O'Connor awarded his driver four sovereigns.

EDWARD ENTWISTLE

Mr. Entwistle lived thirty-six years in a simple cottage in Des Moines. For sixty years he was engaged as engineer on locomotives, steamboats, and stationary engines. He always said that his mother's brother, Edward Thompson, was the first engineer on the Great Western, the first transatlantic steamer. At the age of seventy-six, Mr. Entwistle retired. In 1876 he attended the centennial exhibition at Philadelphia for the purpose of seeing his old engine, which was exhibited there. Some years ago a controversy was raging among locomotive engineers as to whether the front of the fire-box of "The Rocket" was originally vertical or inclined at an angle. At a later date, Mr. Worthington, the secretary of the Institution of Mechanical Engineers, to whom we are indebted for the above particulars, communicated with Mr. Entwistle on this point, and the reply he received was that the front of the fire-box of "The Rocket" was vertical. To have lived seventy-nine years after running the first passenger train in the history of the world was a distinction of which Mr. Entwistle was proud. This claim, however, has been objected to on more than one occasion, and doubts have been expressed as to the probability of a careful man like George Stephenson selecting a youth for such an important task as that of driving "The Rocket."

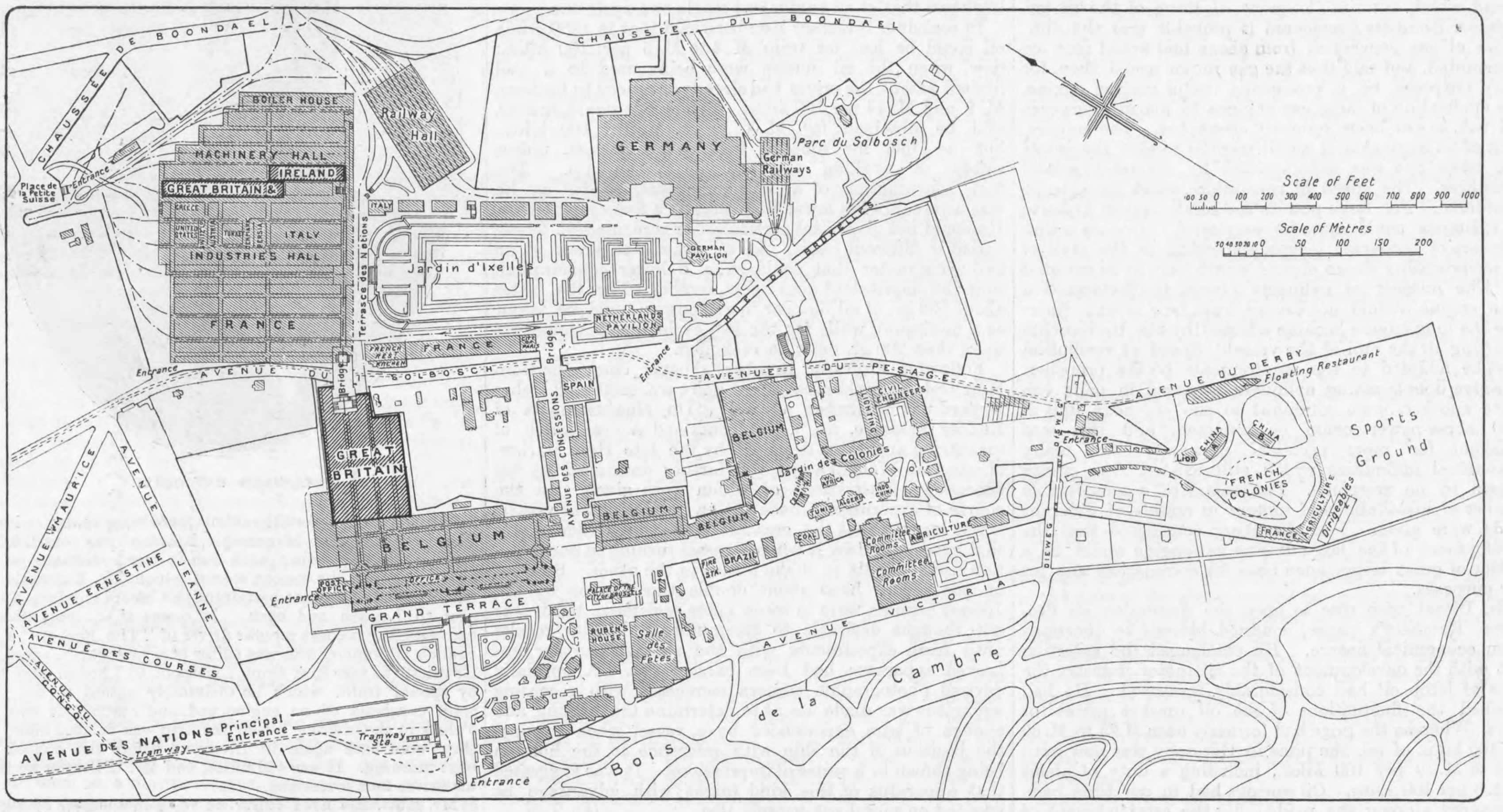
THE FOUNDERS COMPANY.—This ancient City Guild is arranging once more to hold an exhibition, which will be opened by the Lord and Lady Mayoress, in London on 7th and 8th June next year, of castings and models in metals, viz., aluminium, bronze, brass, gold, iron and silver, also of designs in wood, plaster, and any other suitable material for casting, to be competed for by founders, designers, craftsmen, apprentices and improvers, British-born subjects engaged in foundry business or its allied trades. Monetary prizes, as well as certificates and medals, will be awarded.

ROYAL AGRICULTURAL SOCIETY OF ENGLAND.—The annual general meeting of governors and members of the Royal Agricultural Society of England will be held in the Club-room, at the Royal Agricultural Hall, Islington, on Wednesday, December 8th, 1909, at three p.m., to consider the balance-sheet and the reports of the Council and of the auditors; to elect a president and trustees, vice-presidents, and auditors, to hold office until the next ensuing annual general meeting; and to take cognisance of the election of ordinary members of Council made by divisions pursuant to the by-laws.

THE BRUSSELS EXHIBITION, 1910.

The International Exhibition which is to be opened in Brussels next April, and is to continue for at least six months, will be noteworthy in that it will be the first Exhibition for which British manufacturers have had the advantage of the assistance of the recently created Exhibitions Branch of the Board of Trade. So well has this department succeeded in its efforts that even at this early date the whole of the available space has been taken up, practically not one square foot being available.

Having regard to the excellent manner in which this new branch of the Board of Trade has worked and is working, it may not be out of place here to give a brief outline of the events which led up to its inception and of the methods which it has pursued. The department is the outcome of the report of a committee appointed by the Board of Trade in October, 1906. This committee was made up as follows:—Sir Alfred Bateman, K.C.M.G., chairman; Mr. A. Wilson Fox, C.B., of the Board of Trade; Mr. Charles A. Harris, C.B., C.M.G., of the Colonial-office; the Right Hon. Sir James Kitson, Bart.—now Lord Airedale; Mr. Algernon Law, of the Foreign-office; Mr. Malcolm Ramsey, C.B., of the Treasury; Sir Swire Smith, Sir Isidore Spielmann, and Mr. Samuel J. Waring, with Mr. U. F. Wintour as the secretary. This committee held a number of meetings, examined fifty-six witnesses, consulted various chambers of commerce, obtained reports from his Majesty's representatives abroad, and in other ways made themselves fully conversant with the then existing state of affairs as regarded exhibitions, and with the feelings of our manufacturers regarding them.



"The Engineer" Swain Sc.

PLAN OF THE BRUSSELS EXHIBITION IN 1910

In their report, which was issued with most creditable promptitude about ten months after the appointment of the Committee, the results of the inquiry were set out clearly and succinctly. This report was divided into three parts. The first dealt with (1) "The General Effect of Exhibitions on British Arts, Industries and Trades;" (2 and 3) with "the Direct and Indirect Effect of Exhibitions on Trade;" and (4) with "the Effect of Exhibitions upon Art." In their comments on this portion of their report the Committee stated that there seemed to be little doubt as to the part which was likely to be played in all future exhibitions by the principal commercial competitors of this country. At all recent exhibitions the displays made by France, Germany, and other foreign countries have been of increasing importance, and as long as this policy was continued, the representation of British arts and industries at the more important exhibitions would remain a national necessity. It was further pointed out that little if any advantage could be expected to be derived from exhibitions at which this country was inadequately represented. There could be no profit either to the individual or to the nation as a whole in displaying inferior British exhibits by the side of the best productions of our commercial competitors. The second portion of the Report was concerned with the participation of Great Britain in past exhibitions, and Part III. contained the Committee's recommendations.

The first of these was that an improved machinery should be set up which would secure, first, a more prompt consideration of invitations to participate in exhibitions; and, secondly, a more effective representation of this country at any exhibition in which his Majesty's Government might decide to take part. To obtain these objects it was deemed essential that before everything else a continuity of organisation from exhibition to exhibition should be provided. It was accordingly advised that a permanent official should be appointed whose duty it should be to collect full information respecting past exhibitions, and to evolve a proper system for application in the future. It was further advised that instead of forming a separate Government Department for this purpose, the official in question should be attached to an existing department, preferably the Board of Trade. It was strongly insisted on that the permanent expert proposed should be the man who would take the lead in the organisation of all exhibitions. It was thought absolutely essential that he should, at an early stage of the preparations for the Exhibition, visit the site and superintend the details of organisation on the spot, and that later, when the Exhibition was opened, he should be there to control the staff and to give the exhibitors any assistance they might require, and also the benefit of his experience and advice.

It will be unnecessary to enter further into details, and we need only say that the recommendations of the Committee were acted upon in their entirety, and that the Committee's secretary, Mr. U. F. Wintour, was made the first director of the Exhibitions Branch of the Board of Trade.

In the past exhibitors have been put to great expense, not only in the preparation and transport of their goods, but in their reception and erection at the Exhibition itself. Exorbitant prices have been charged for space, as well as for necessary work done, such as the preparation of sites, the laying of foundations, &c. For the Brussels Exhibition—and it may naturally be supposed that a like course will be pursued with later exhibitions—a complete revolution has been effected. First of all, the Exhibitions Department of the Board of Trade undertook to take over a considerable area of space in commanding positions, going so far as to persuade the authorities to allocate to Great Britain and Ireland a large portion of the space which had been specially reserved for Belgium. The actual floor space thus allotted was 203,140 square feet, of which 150,640 square feet are in the Industrial Hall, and 52,500 square feet in the Machinery Hall. On referring to the accompanying plan it will be seen that practically a quarter of the Machinery Hall, which is to be devoted to all nations except Germany—that country having a machinery exhibit in its own building—has been reserved for Great Britain and Ireland.

The next step was to obtain the support of the British and Irish manufacturers, and this was, at first, found to be no easy matter. The experience of the treatment received at, and the results accruing from, past exhibitions, had been such that they were, in the majority of cases, reluctant to spend more money in this direction. As a result of the despatch of some 20,000 circulars, only seven replies were received. However, by perseverance, the Royal Commission—the Chairman of which is the Earl of Lytton—and the co-opted members of Committee, who have all worked untiringly and with praiseworthy energy, have managed to bring about a great change. By means of meetings held in various parts of the country, and personal interviews, many of both of which were attended by the Earl of Lytton himself, the objects of the new department and its methods of work have now become well known, and it has been realised that most of the disabilities which have hitherto attached to showing machinery and goods at exhibitions have been done away with.

When the advantages offered come to be considered, our readers will recognise how much this is the case. For example, one of the great deterrents to exhibitors in the past has been the impossibility of calculating beforehand how much the undertaking would cost. This objection need no longer exist. Taking the pamphlet which was issued in connection with the Brussels Exhibition, we find that the charges for space are set out in detail. These vary from 6s. to 2s. 6d. per square foot, and they included the use of all showcases—with the exception of internal fittings—stands, platforms, railings, and screens, which might be required, the storage of packing-cases and the handling of exhibitors' goods inside the Exhibition, together with the provision of unskilled labour. Providing the goods are delivered before 1st April next, the Royal Commission (*a*) take delivery of the packages at the Exhibition entrance; (*b*) unload and place them on the space allotted; (*c*) remove, store, and return empty packing-cases; and (*d*) re-load them at the close of the Exhibition, providing all unskilled labour for the purpose. These charges are, we are informed, less than half those which have been made in previous exhibitions for ground space alone.

Further than this, with a view to enabling British exhibitors to make an effective display of machinery in motion, the Royal Commission have decided to defray 50 per cent. of the charges made by the Belgian Administration for the supply of steam, gas, and electricity when used for showing machinery producing finished articles or illustrating a process of manufacture. The following are the reduced charges which will be made to exhibitors for motive power in the British Machinery Section:—

Steam at a pressure of 133 lb. per square inch	½ centime per kilogramme.
Gas	1s. 3d. per 1000 cubic feet.
Electricity (2 × 220 volts continuous)	1½d. per kilowatt-hour.

There will also be in the Machinery Hall a supply of water at a pressure of 50 lb. per square inch, for which a charge of 1s. 10½d. per 1000 gallons will be made; and there will also be a plentiful supply which can be drawn upon for condenser purposes or for illustrating the action of pumps, &c., without charge. In the Industrial Hall there are to be two services, for which the respective charges will be 1s. 8d. per 1000 gallons for domestic purposes, and 10d. per 1000 gallons for industrial purposes. Gas will be supplied for lighting in the Machinery Hall at a charge of 3s. 6d. per 1000 cubic feet, and in the Industrial Hall at 3s. 3d. per 1000 cubic feet. For electric lighting current will be available in the Industrial Hall at 110 volts continuous current, and in the Machinery Hall at 2 × 220 continuous current at a charge of 3d. per kilowatt-hour.

There will be direct railway connection with the Exhibition, and arrangements have been made by which certain important concessions are made by the various railway authorities and shipping companies. The Exhibition will be treated as a bonded warehouse, and duty will only have to be paid on those goods which are sold.

The necessary steps will be taken by the Belgian Government for the protection in Belgium of inventions capable of being patented, industrial designs or models, and trade marks shown at the Exhibition. The Exhibition has been certified as an International Exhibition, and an Order in Council has been issued by which British exhibitors will be relieved from the necessity of giving notice to the Comptroller of Patents of their intention to exhibit.

A general catalogue of the Exhibition is to be published in French, and a special catalogue of the exhibits in the British Section will be prepared in French and English. There is also under consideration the publication of a special catalogue for each separate section of British exhibits which is large enough to warrant this course being pursued.

A step has been taken which should prove of the utmost value to British exhibitors. A considerable while ago contracts were entered into by which Belgian contractors undertook to excavate ground and to construct foundations at fixed figures, which, having regard to the charges made at previous exhibitions, are remarkably reasonable. Exhibitors requiring foundations or shafting for machinery must provide them at their own cost, but can, on sending to the Royal Commission drawings with metric measurements figured thereon, and specifications of their requirements, have estimates obtained for them, and the work carried out under the superintendence of a competent engineer employed by the Royal Commission. No charge will be made for assistance rendered in this connection, but though every care will be taken, the Royal Commission will not hold themselves responsible for any errors of construction either in measurement or material used. Crane power will be available for the erection of machinery up to 7 tons in weight, and this service will also be free of charge. Special facilities will be provided for handling heavier weights if application is made to the Commission.

It will be realised by the foregoing that every possible arrangement has been made for the convenience of exhibitors by this new branch of the Board of Trade, which deserves no stinted credit for the manner in which it has organised the British section in this the first Exhibition with which it has to deal. It has certainly shown that cause now no longer remains for many of the just complaints made regarding past exhibitions. The manufacturer can now calculate with accuracy the amount which it will cost him to exhibit. In fact, this is practically all done for him excepting that part which relates to the actual making of the exhibit and the sending out of a special agent to represent him. The strongest possible emphasis is laid upon the necessity for this, and no opportunity is lost by the Director of the Department in urging on exhibitors the fact that unless they are efficiently represented they might just as well not exhibit. The services of interpreters will be free, but the exhibitor whose agent speaks French, or, better still, French and German, will undoubtedly be far and away much better off than he who has in charge of his stand a man who only speaks English.

It would be impossible to give a list of the manufactures which will be exhibited in the British section, but we may say that these will include steam, gas, and oil engines, electrical, textile, pumping, agricultural, sugar, and woodworking machinery; air compressors, machine tools, &c.

The plan given on page 574 will show the position of the two divisions of the British section relatively to the remainder of the Exhibition, and it will be realised that Great Britain has certainly got its full share of space.

A 6000 HORSE-POWER DYNAMOMETER.

It is now generally admitted that the highest efficiency for a marine steam turbine installation can only be obtained by running the turbine at much greater speeds than those which experience shows are most desirable from the point of view of propeller efficiency. The introduction of some form of reducing gear—electrical, hydraulic, or directly mechanical—is, therefore, rendered necessary, and in that designed by Rear-Admiral George W. Melville, ex-Engineer-in-Chief United States Navy, and Mr. John H. Macalpine, a satisfactory form, it is claimed, has been evolved. This gear is of the pinion and spur-wheel type, and has been constructed by the Westinghouse Machine Company, East Pittsburgh, Pa. As the details of its design have already become known in this country we do not here intend to enter fully into their discussion. We may, however, remark that the gear consists of two oppositely threaded pairs of helically cut spurs, reducing the speed in the ratio of five to one, while its chief claim to novelty is the arrangement employed to equalise automatically the tooth contact pressures.

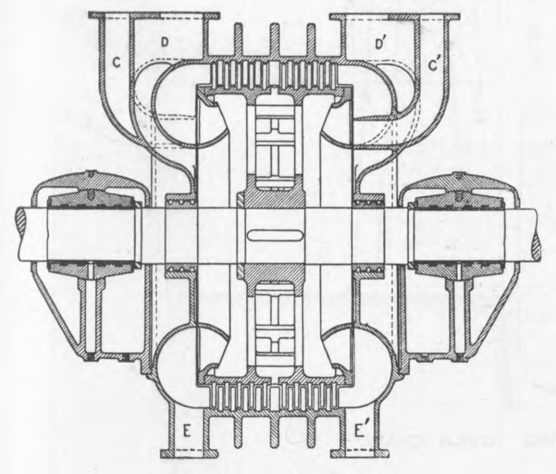


Fig. 1—SECTION OF THE DYNAMOMETER

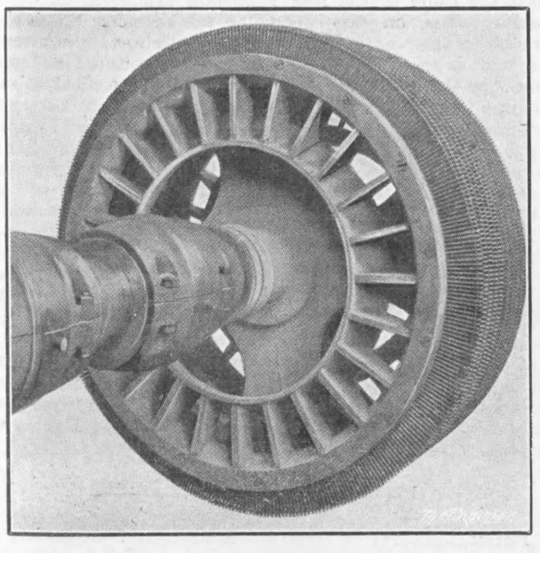


Fig. 2—THE DYNAMOMETER ROTOR

In undertaking the testing of this reduction gear it was found necessary to construct a new hydraulic absorption dynamometer. Some idea of the difficulties which had to be overcome before the testing could be carried out will be understood when the magnitude of the power transmitted through the reduction gear and absorbed in the brake is borne in mind. It was necessary to provide for the continued absorption of 6000 horse-power. To absorb one horse-power entails the generation of 2545 B.Th.U.'s per hour, and therefore provision had to be made in the apparatus designed for the carrying off of a quantity of heat equivalent to that produced by the combustion of 1200 lb. of coal per hour.

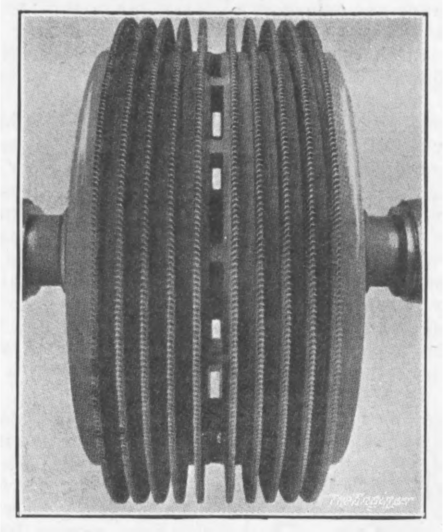


Fig. 3—THE DYNAMOMETER ROTOR

A dynamo with a water rheostat for adjusting and maintaining the load suggested itself as a solution of the problem. Besides being cumbersome and expensive, it was, however, soon seen that the high efficiency of the transmission gear would render the results obtained by this method of very doubtful accuracy, the windage and electrical losses being more or less indeterminate. It was therefore decided to remodel a form of brake used by the Westinghouse Company for testing its turbines of smaller sizes.

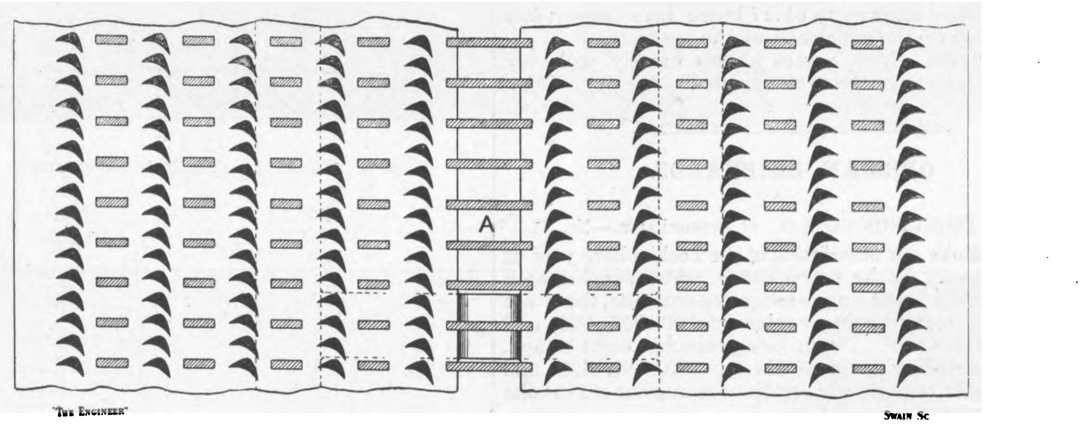


Fig. 4—DEVELOPED VIEW OF A PORTION OF THE ROTOR SURFACE

The design ultimately adopted will be gathered from Fig. 1. In essence, the dynamometer consists of a turbine rotor mounted on a shaft and rotating in a casing, which is provided with blades similar to those of the ordinary turbine. The motion of the rotor circulates water through the dynamometer, and as a consequence the casing tends to turn in a direction similar to that of the rotor. A radius arm forming part of the casing prevents this, and from a knowledge of the force required to hold the casing steady, the number of revolutions, and the length of the arm, it is possible to calculate the brake horse-power of the turbine. The large amount of heat generated is carried away from the dynamometer in the steam from the circulating water, vents for this purpose being provided at D D^1—Fig. 1. Figs. 2 and 3 show views of the rotor, and Fig. 6 a view of the upper half of the casing. Fig. 4 gives a developed view of a portion of the rotor surface taken parallel with the axis of the shaft. Water enters the casing through two passages C C^1—Fig. 1. From the mouths of these passages it is then thrown into the rotor drum, passing in turn through each of the ports in the end pieces, as will be understood by reference to Fig. 2. The water then travels from either side along the inner surface of the drum until it reaches the centre where ports are provided—see Fig. 3 and A, Fig. 4—conducting it to the outer surface. Immediately on leaving these ports it is met by the central row of stationary blades in the casing. These deflect it outwards in two streams, and the water thus travels back towards the outer edges of the drum, passing in turn through rows of moving and rows of fixed blades. It will be seen from Fig. 4 that the moving blades have a form similar to that of the ordinary Parsons turbine, while the stationary blades are flat, and lie parallel with the axis of the rotor

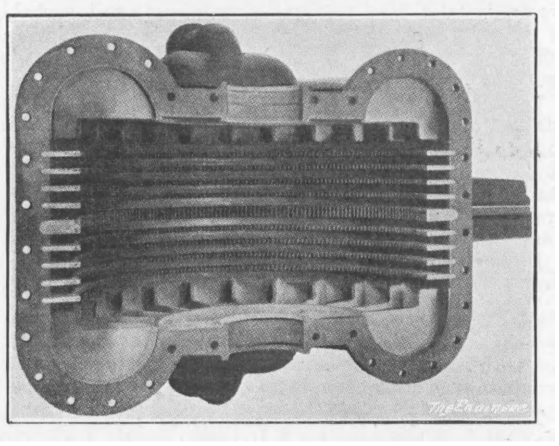


Fig. 6—UPPER HALF OF DYNAMOMETER CASING

In addition, it will be gathered from the engraving that the blades on the rotor are oppositely directed on either side of the ring of central ports.

As the water leaves the drum it possesses a certain amount of torque. This is destroyed by the baffles in the annular spaces forming part of the casing—see Fig. 6. These baffles divide the annular space into a number of distinct compartments from which the only passage available for the water to escape leads it back again into the rotor. The water is, therefore, in constant circulation along the inner surface of the drum, through the central ports, past the blades, and into the annular space, until, after having completed half a round of the casing, it reaches the lowest chamber and leaves the dynamometer as boiling water by way of the passages E E^1. Steam formed in the interior finds an exit by the passages D D^1, which communicate with the more central parts of the drum interior where the lighter steam collects. It is not practicable to carry off all the heat generated in the form of steam, and for this reason an excess of water is circulated through the dynamometer, thus allowing some to escape as boiling water, as already explained. In addition, this affords means for regulating the braking action, a delicate control being given by altering the amount of water supplied.

To measure the force required to support the radius arm when the dynamometer is in action a portable weighbridge is employed. The forces to be dealt with and measured in the experiments for which the brake was designed were, however, not read distinctly. An I section beam with knife-edges at either end was therefore provided. One of the knife edges rested on a fixed support, the other being borne on the platform of the weighing machine. The radius arm was also given a knife-edge, which bore on a point a quarter of the total length of the beam from the fulcrum, so that the forces measured by the weighing apparatus represented a quarter of the forces at the knife-edge of the arm. Fig. 5 shows the general arrangement of the plant for testing purposes, and in this the weighing apparatus will be clearly seen.

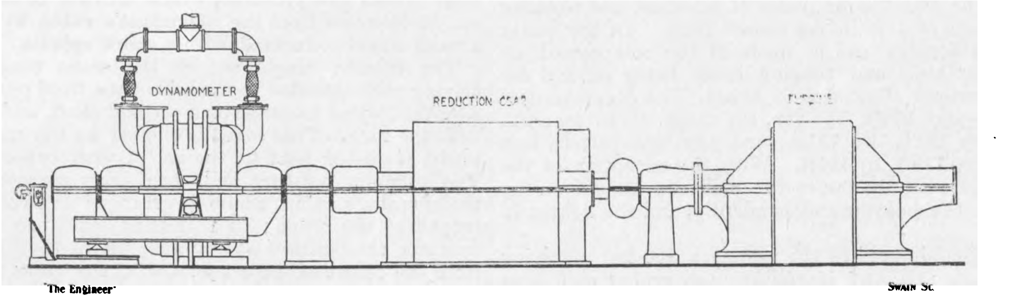


Fig. 5—GENERAL ARRANGEMENT OF THE PLANT FOR TESTING PURPOSES

To measure the efficiency of the reduction gear, it was, of course, necessary to know the input as well as the output. A series of extensive experiments was consequently carried out as a preliminary to the actual trials of the gear, and by coupling the dynamometer directly to the turbine the latter was calibrated and the horse-power developed at all loads and speeds determined. During these tests a poor vacuum was maintained, in view of the great influence which any variation in this quantity has upon the performance of the steam turbine in general. Thus a wider margin for regulation was obtained than would have been the case had the air-pump been called upon to work more nearly at its limit of capacity.

As regards steadiness, sensitiveness, capacity, and other important characteristics of a good dynamometer, we understand that this brake, unprecedented probably in its size, has given entire satisfaction, enabling an efficiency of over 98.5 per cent. to be measured with accuracy.

Testing was started on 7th September last. During the first days the readings were taken at speeds increasing up to 1500 revolutions per minute of the turbine shaft and 300 for the gear shaft. Under these circumstances the turbine was generating more than 6000 brake horse-power. On October 16th a 40 hours' endurance test was commenced.

During this trial the average conditions maintained were as follows :—

Gross weight on scale	4443.4 lb.
Dead ,, ,, ...	388 0 lb.
Net ,, ,, ...	4055.4 lb.
Speed	300 6 r.p.m.
Brake horse-power	6048

The radius arm of the dynamometer being 6½ft. and the distances between the knife-edges on the lever 18in. and 72$\frac{5}{32}$in., the effective length of the radius arm becomes 26.056ft., while the constant for 1 lb. pressure on the scale and a speed of one revolution per minute is in consequence .0049612 horse-power.

As a check on the results given by the dynamometer for the efficiency of the gear, the increase in temperature which the oil bath of the gearing underwent was measured. A supply of oil under a pressure of about 10 lb. circulates through the bearings and is sprayed over the teeth of the reduction gearing. The heated oil was passed through a form of surface condenser where the rise in temperature of the oil was measured.

When the gear was transmitting 5088 horse-power it was found that 591 lb. of oil circulated per minute, though the bearings rose in temperature on an average by 9.86 deg. Fah. Taking the specific heat of this oil at 0.47, it will be seen that the friction losses as indicated by this method amount to 64.17 brake horse-power, and in consequence the efficiency of the gear is 98.75 per cent., a figure which agrees almost exactly with the result obtained from the dynamometer test.

GERMAN SHIPYARDS.

No. V.*

JOH. C. TECKLENBORG A.G., of Bremerhaven.—No. II.

We continue our description of the Tecklenborg yard at Bremerhaven. At the power-house, which supplies both the shipbuilding and engineering departments, there are four steam reciprocating engines of 300, 350, 850, and 1000 horse-power, the steam being raised in eight boilers. The corresponding dynamos develop 130, 180, 420, and 500 kilowatts respectively, continuous current of 240 volts being generated.

An extensive use is made in the works of pneumatic power, and a set of three air compressors capable of dealing with about 3000 cubic feet of air per minute has been installed. The total length of piping in connection therewith is nearly 3300 yards. The main pipe leads to a reservoir at the head of the slips, and from there underground branches are carried half-way down the sides of the slips, where they rise to the surface. At a height 11ft. 6in. above the ground pairs of rigid connections branch off again, and extend the whole length between the slips. From these the further distribution of the air takes place by means of numerous connecting pieces, first through wire-wound and then through light flexible tubes. For riveting the decks travelling air riveters and holding-on hammers are provided.

The engine shop is shown in Fig. 11, and the boiler shop in Fig. 12, page 580. Fig. 13 illustrates a shell-plate bending machine suitable for plates of all sizes, and working at a pressure of 1500 lb. per square inch. In the boiler shop an extensive use is made of the compressed air supply, caulking and tapping holes being among the many operations effected with its aid. The coppersmiths' shop measures 138ft. by 72ft., the forge 230ft. by 56ft., the foundry 262ft. by 131ft., and the new pattern and turning shop 118ft. by 105ft. With the exception of the special hydraulic machines the tools are all driven by electricity, the heavier independently, and the lighter in groups.

For the equipment of the vessels a 150-ton revolving tower crane and two travelling quay cranes of 5 tons carrying capacity and 46ft. radius are provided; while at the north end of the yard an old swing crane of 80 tons carrying capacity is still at work.

The 150-ton crane—see Figs. 10 and 15—built by the Benrather Maschinenfabrik A.-G., differs in several very important particulars from the hammer-headed cranes hitherto constructed, so that a more detailed description of it may be of interest. A slender quadrilateral pyramid-shaped column securely anchored in strong foundations bears the jib, which is connected with an outer framework that entirely surrounds the pyramidal supporting column right down to the ground. Below, this outer frame ends in a ring of I-shaped section made of plates and angles with an outer diameter of 39ft. 6in. The ring bears against four pressure rollers attached to the foot of the supporting column, so that the tilting moment of the crane is transferred to the foundations. The reduction of the foundation surface thus attained enables the crane to be set considerably nearer to the edge of the quay, and its effective radius with a given load is thus increased.

The greatest improvement, however, which was made at the instance of the shipyard, consists in the fitting of a jib crane on the outer arm of the cantilever. For this purpose the latter is arranged as a girder with a travelling crab, and the winding gear on the counter-arm is fitted between the girders. On the upper flange rails are laid for an electric swing crane which can travel along the whole length of the cantilever, that is to say, 220ft. 6in. This swing crane can transport loads ranging up to 20 tons and serves as an auxiliary hoisting apparatus in place of the appliance usually arranged on the crab, so that for loads up to 20 tons it is not necessary to set the main hoisting gear in motion. In addition, objects such as masts, which may be higher than the crane itself, can be dealt with by the auxiliary crane. The principal dimensions of the crane are as follows :—Height of the upper side of the cantilever above the ground, 140ft.; maximum carrying capacity, 150 tons at a radius of 65ft. 7in. from the centre, *i.e.*, at 46ft. from the edge of the quay; maximum radius of the large hook, 125ft. from the middle of the crane, or 105ft. from the edge of the quay, with a lifting capacity of 65 tons; greatest radius of the upper travelling crane from the turning centre, 156ft., with a maximum load of 5 tons, or 144ft. with a load of 20 tons. The greatest height of the swing crane hook at a radius of 156ft. is 167ft. above the ground.

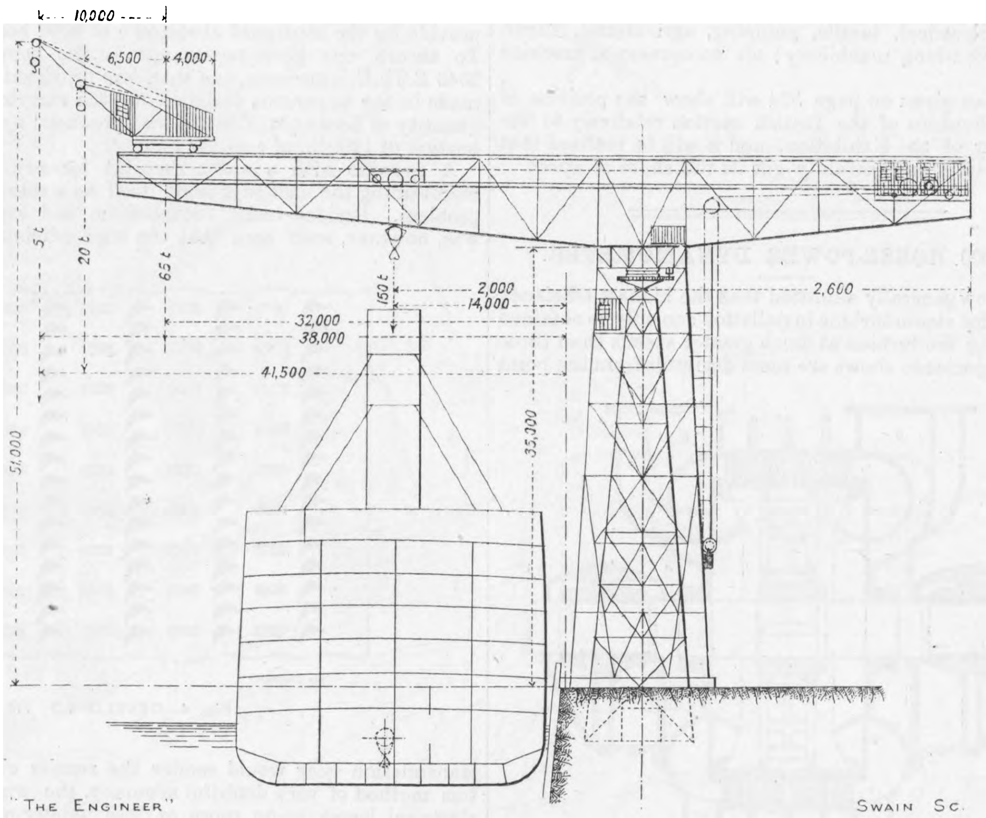


Fig. 10—150-TON REVOLVING TOWER CRANE

The crab rests on four cast steel wheels, and bears five sheaves belonging to the hoisting blocks and two motors, each of 36 horse-power, for driving the travelling machinery. The hoisting gear, which takes the form of a winch, is arranged between the two main girders of the counterweight arm. The hoisting rope coming from the crab is led with ten turns round the two drums of the winch, and passes from there over a block at the back of the framework. The two winch drums are actuated by a single electro-motor through worm-wheel gearing. The hoisting speeds are 5ft. per minute with the 150-ton and 10ft. per minute with the 75-ton load. For stopping purposes there is a magnetic strap brake, while two others, controlled by a governor, prevent the permissible lowering speed from being exceeded. In addition, two sling strap brakes are provided, which, in case of emergency, can be operated from the attendant's cabin by means of a hand wheel connected with a screw spindle.

The turning machinery of the crane consists of a driving rack attached to the end of the fixed pyramid and a toothed wheel mounted on a vertical shaft, and engaging with the rack. This shaft is moved by the motor fitted in the revolving part by the aid of worm-wheel gearing. The turning, hoisting, and crab gears are worked from the operator's cabin, which is arranged at two-thirds the height of the crane; an indicating appliance shows the operator the position at any moment of the lifting hook from the centre of the crane, and at the same time gives the maximum load admissible in such a position. The driving platform for the travelling crane working on the arm is self-contained, so that the crane-man can easily keep under observation all the various movements of the lifting hook. When the small crane is at work, the large crab is run right to the middle of the crane; on the other hand, when the crab is at work, the smaller crane is moved on to the counterweight arm near the centre.

In addition to the dock referred to at the beginning of this description, the yard has two patent slips at the fishing harbour in Geestemünde for drawing up on land vessels of about 150ft. in length. These are principally used for the repair of steam trawlers.

Even in the days of wooden shipbuilding the yard of Messrs. Joh. C. Tecklenborg was noted for the excellent work turned out from it. In addition to a number of emigrant vessels, the German Polar vessel Germania and the Austrian Polar vessel Tegethoff, may rank among its noteworthy productions.

Since the change from wood to iron, the company has turned out about 160 steamers and sailing vessels, the gradually increasing dimensions and improving style of which bear witness to the steady development of the yard. In addition to about 60 steam trawlers, the fleet comprises steamers for the Norddeutscher Lloyd, the Hamburg-Amerika Line, and other large steam shipping companies. The largest vessel hitherto built in the yard is the twin-screw cargo and passenger steamer Prinz Friederich Wilhelm for the Norddeutscher-Lloyd, the dimensions of which are:—Length, 601ft.; breadth, 78ft.; and depth moulded, 41ft. 4in.; her gross register tonnage being 17,082 and her cargo carrying capacity 13,300 tons.

The yard has continued its speciality, the construction of large sailing vessels, from the days of timber to those of iron and steel, and has obtained a world-wide reputation for its four and five-masters. The yard of Joh. C. Tecklenborg has not as yet built war vessels for the German navy, but it will be clear from the description given that, as now reconstructed, it is equal to all requirements in this direction; it has, indeed, lately obtained a contract from the Imperial Navy for a gunboat, and has thus taken its place in the ranks of the warship-building establishments.

NEW FRENCH DREADNOUGHTS.

The estimates of naval expenditure which are to be presented shortly to the Chamber of Deputies show that an entire change has been effected in the immediate naval policy of France since Admiral de Lapeyrère took over the work of reorganising the marine. The previous estimates, prepared by M. Alfred Picard, provided solely for an expenditure upon increasing the efficiency of the navy as it is—that is to say, the money was to be devoted to equipping the ships, replenishing stores, and improving the mechanism of the ports, so as to give a real value to the existing fleet and provide a solid nucleus for extensions later on. Admiral de Lapeyrère, however, is of the opinion that it would be a serious mistake to defer building battleships until this work of reorganisation is completed, and, having satisfied himself as to the value of the new guns and explosives during the recent trials on the Jéna, he has decided to ask for credits for the construction of two battleships, which are to be laid down in 1910. This has necessitated enormous work by the staff, since the Chamber has decided to sanction no further expenditure upon battleships until the plans are completed and the Minister is able to give exact estimates of the cost. This work, which could only be begun after the termination of the Jéna trials, will have to be completed before the debate of the naval estimates, which will take place very shortly. On account of the excellent results obtained with the guns and the new explosives, it has been found necessary to increase the weight of armour, and the displacement of the new battleships has been increased from 22,000 to 23,000 tons. Eight guns, of 305 mm., will be mounted axially in two pairs of superposed turrets, and four guns will be mounted broadside. Eighteen quick-firers, of 138 mm., will be protected by heavily armed casemates. With engines of 30,000 horse-power, the speed provided for is 21 knots. It is hoped to build the battleships in three years, so that by putting two on the stocks every year France will have nineteen battleships in 1915.

Physical Society of London.—A meeting of the Society will be held at 5 p.m. this evening at the Imperial College of Science, Imperial Institute-road, South Kensington. Agenda :—(1) J. W. Nicholson, M.A., D Sc., "The Effective Resistance and Inductance of a Helical Coil;" (2) W. A. Scoble, B.Sc., "Ductile Materials under Combined Stress;" (3) W. Makower, D Sc., and Sidney Russ, D.Sc., "The Recoil of Radium C from Radium B;" (4) C. V. Burton, D.Sc., "The Sun's Motion with respect to the Æther." Council meeting at 3.30 p.m.

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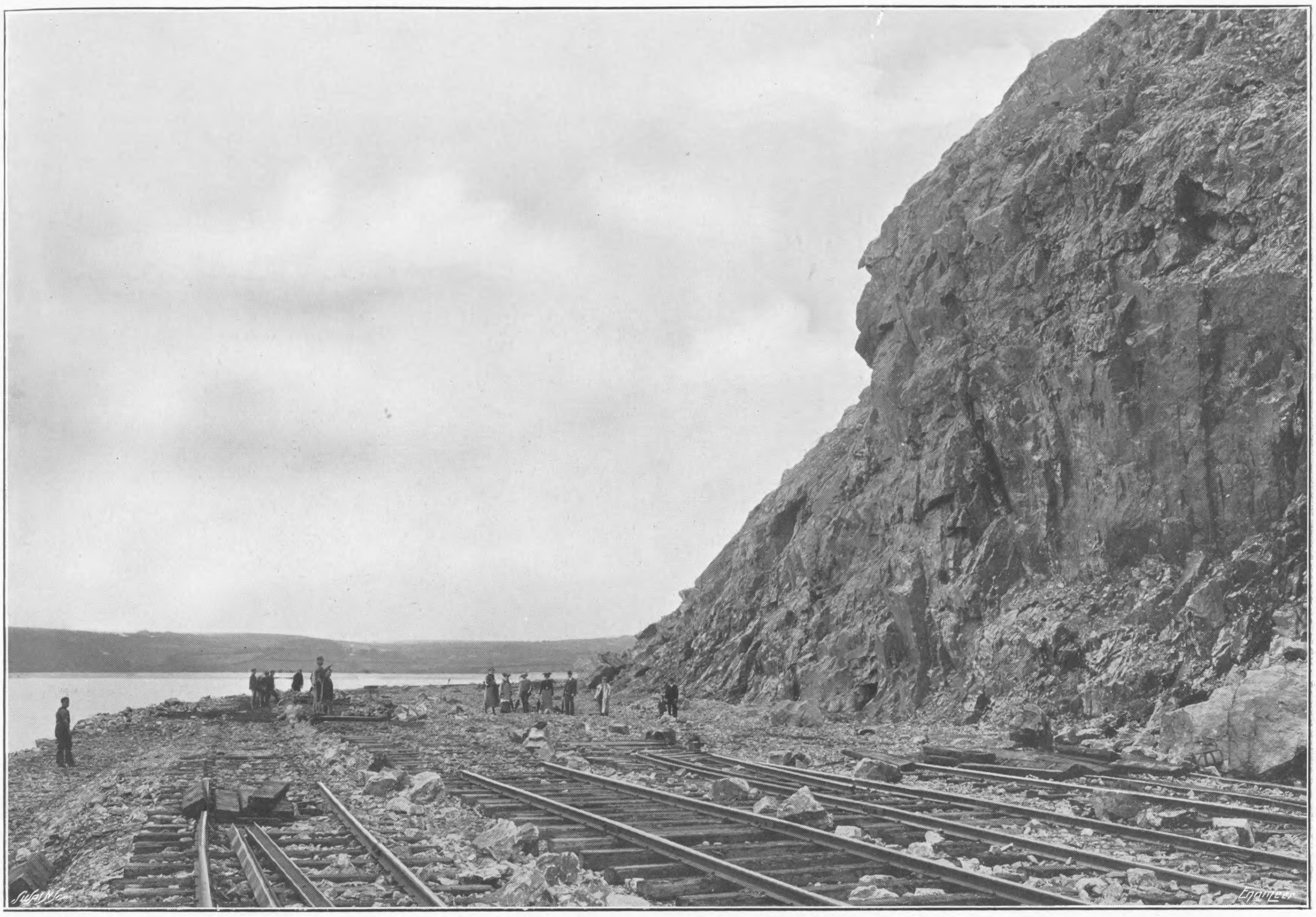
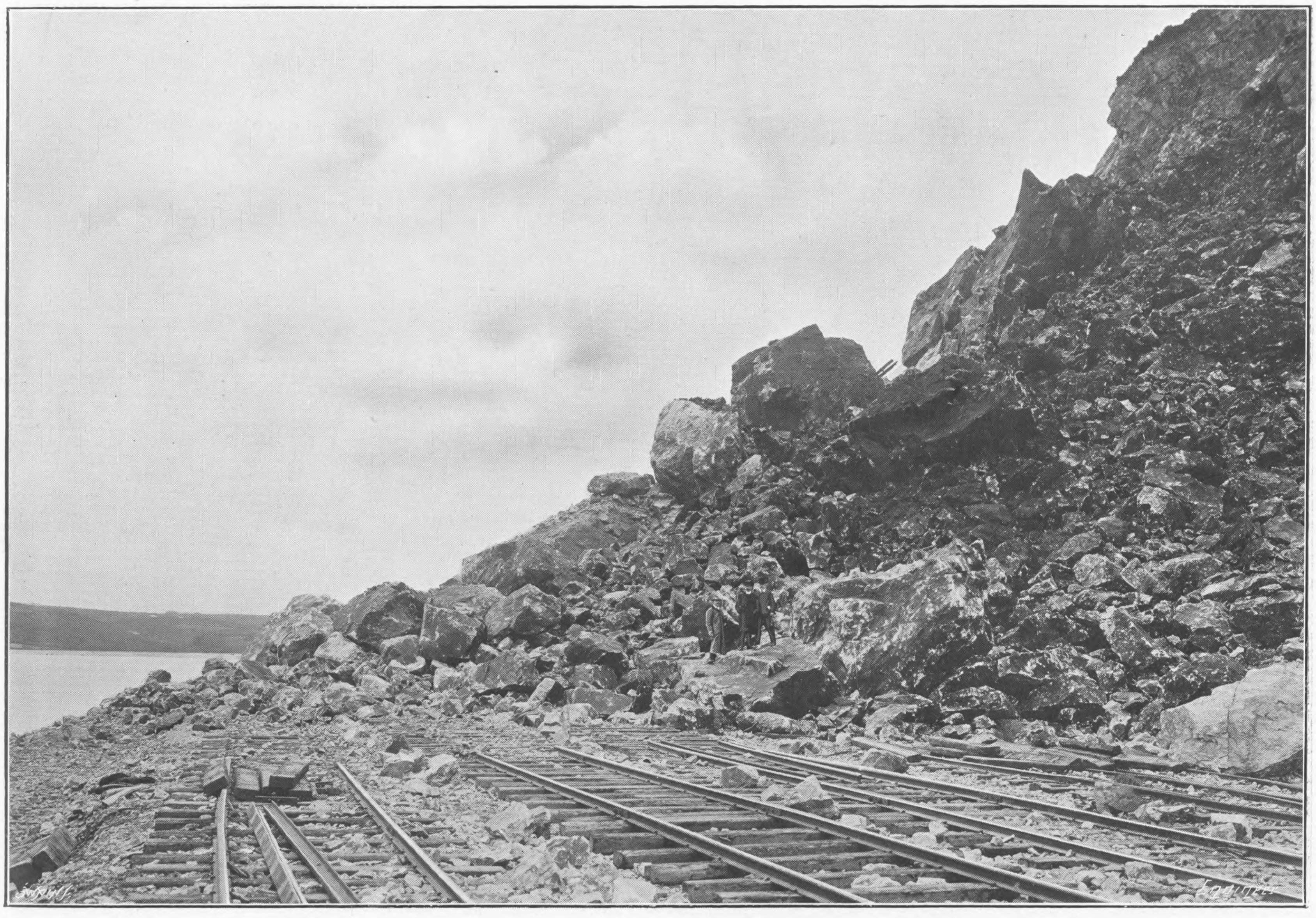
* No. IV. appeared November 19th.

THE HARBOUR WORKS AT FISHGUARD

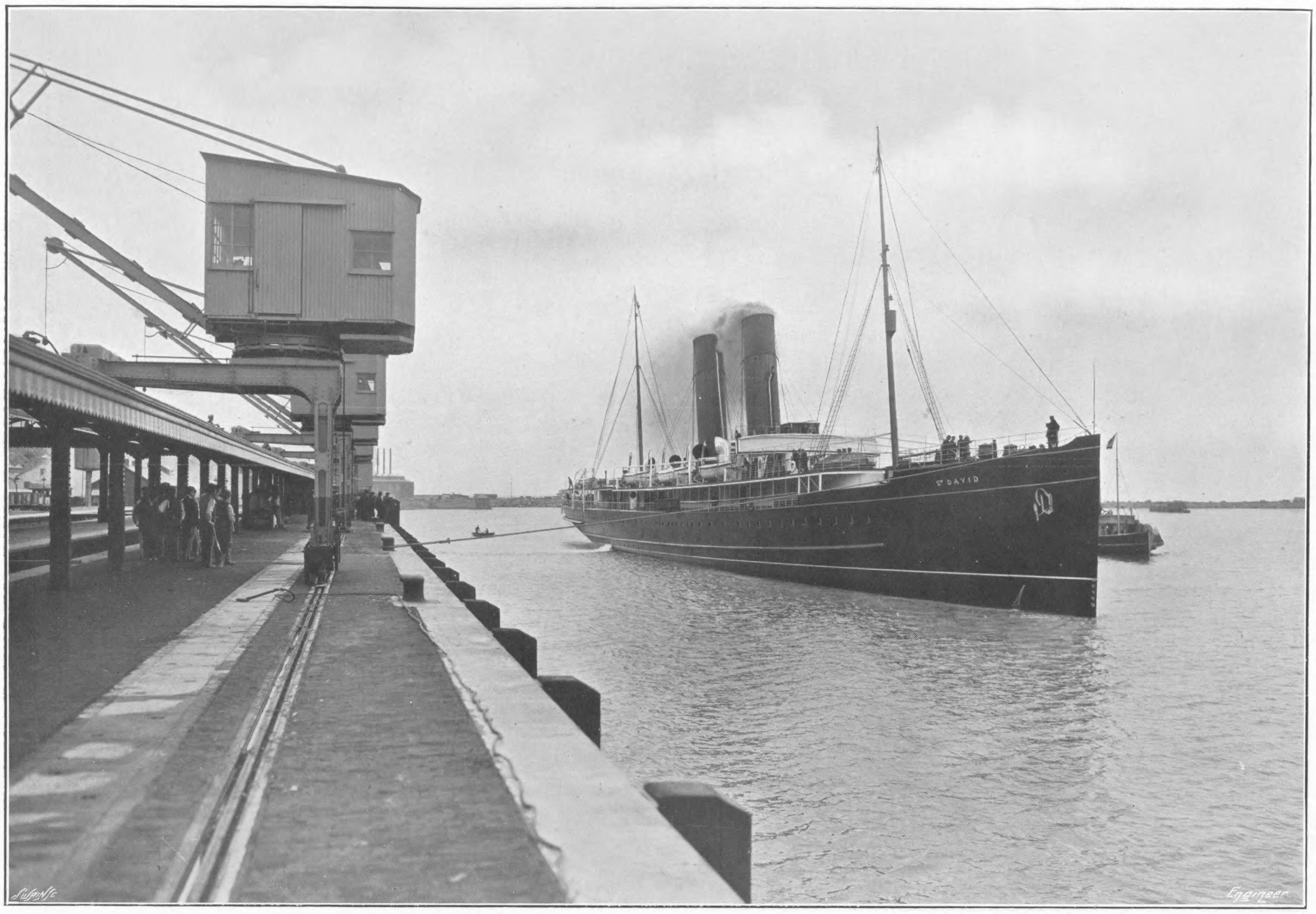


THE MINE BEFORE FIRING, 1st OCTOBER, 1903

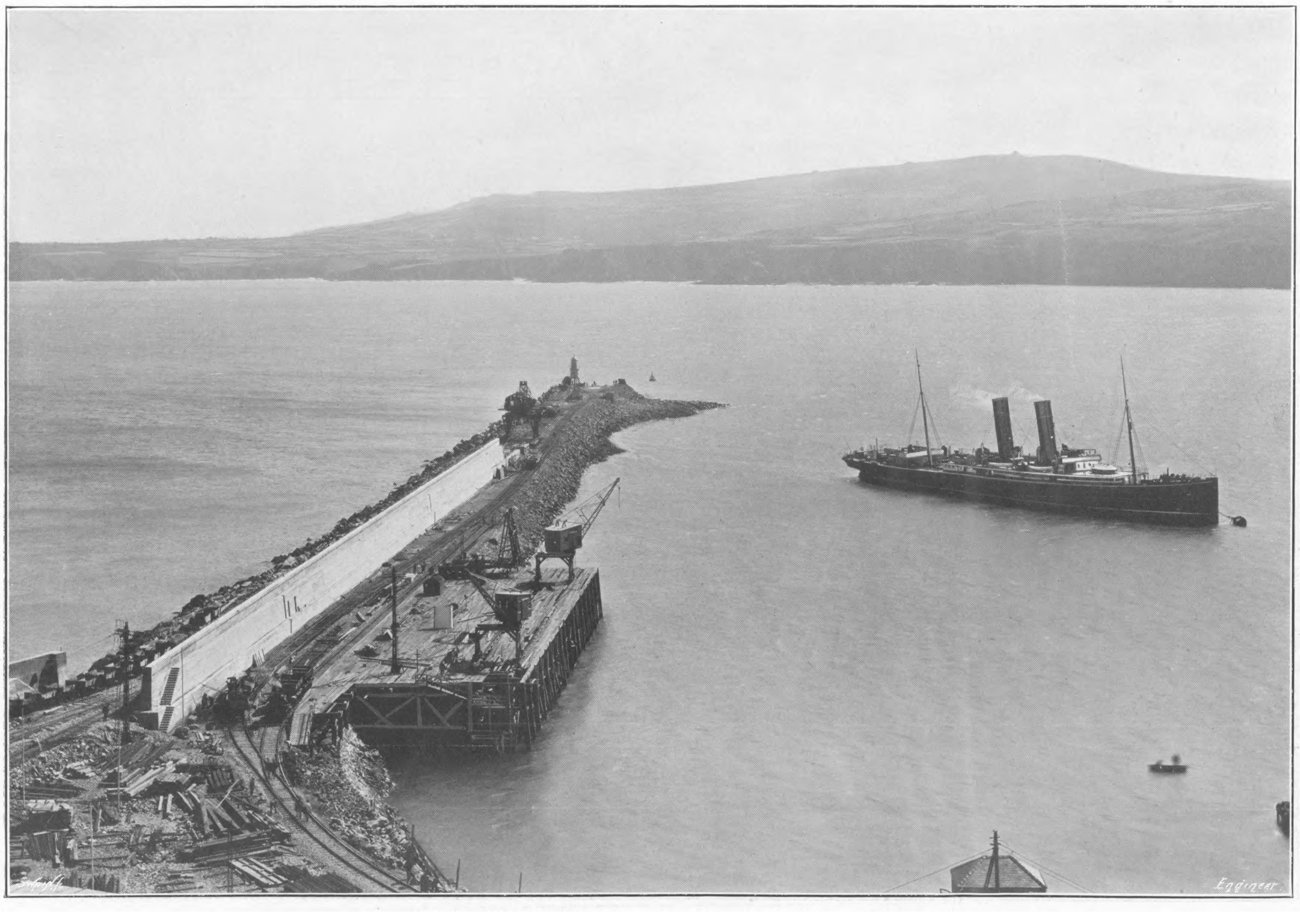


THE MINE AFTER FIRING, 1st OCTOBER, 1903

THE HARBOUR WORKS AT FISHGUARD

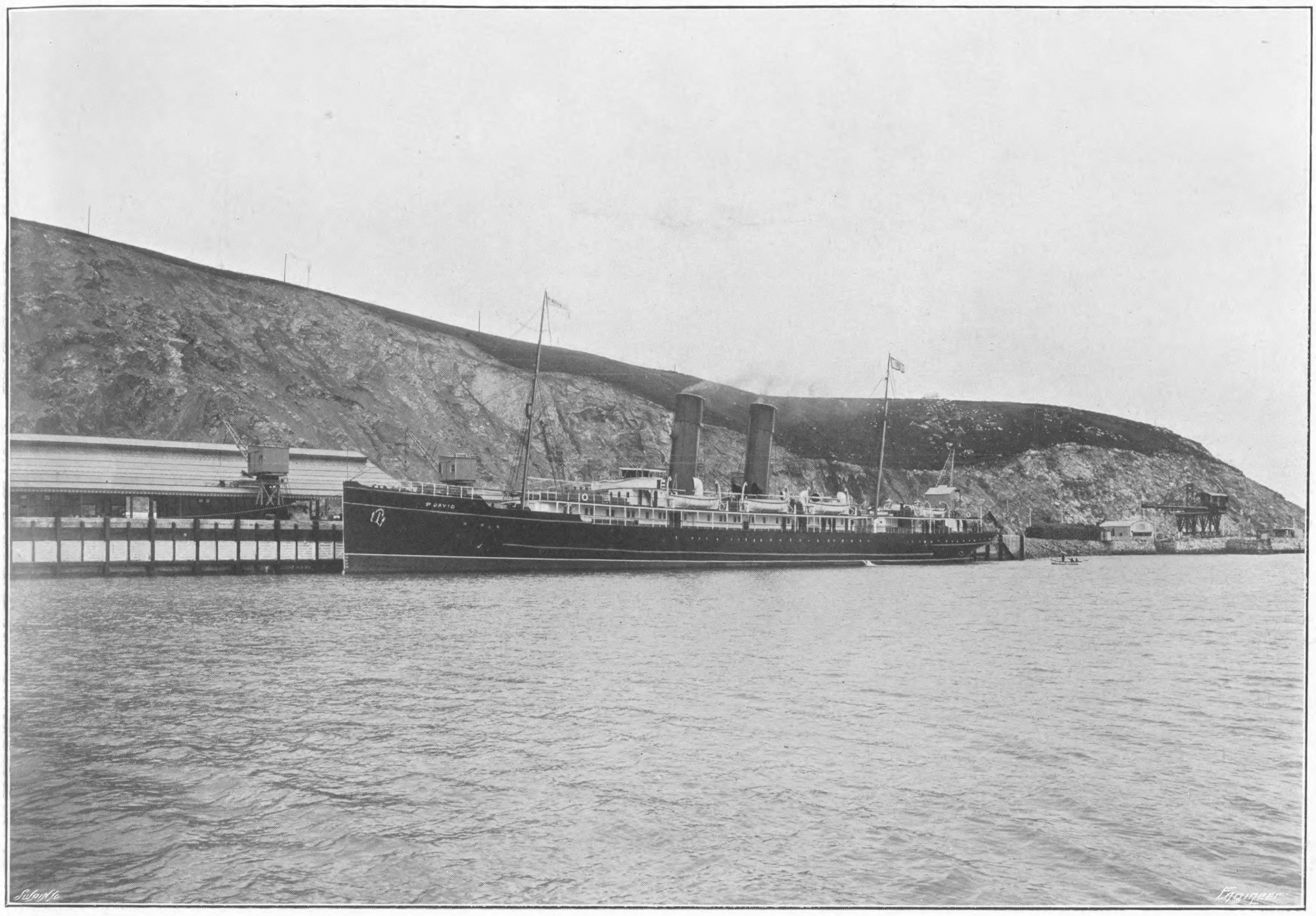

St DAVID
Engineer

THE IRISH BOAT QUAY, 21st JUNE, 1906

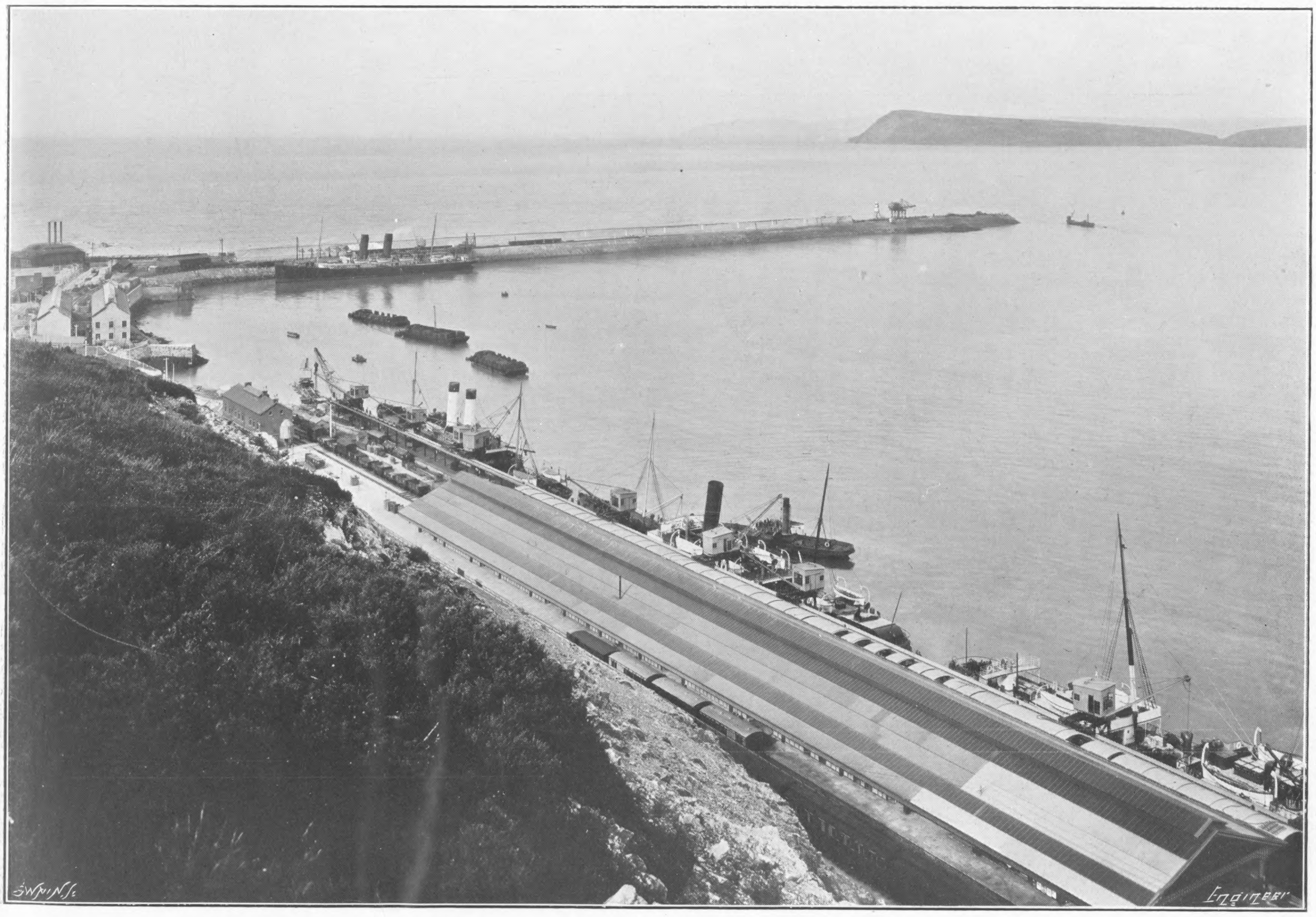


THE OCEAN QUAY AND NORTH BREAKWATER, SEPTEMBER, 1908

THE HARBOUR WORKS AT FISHGUARD

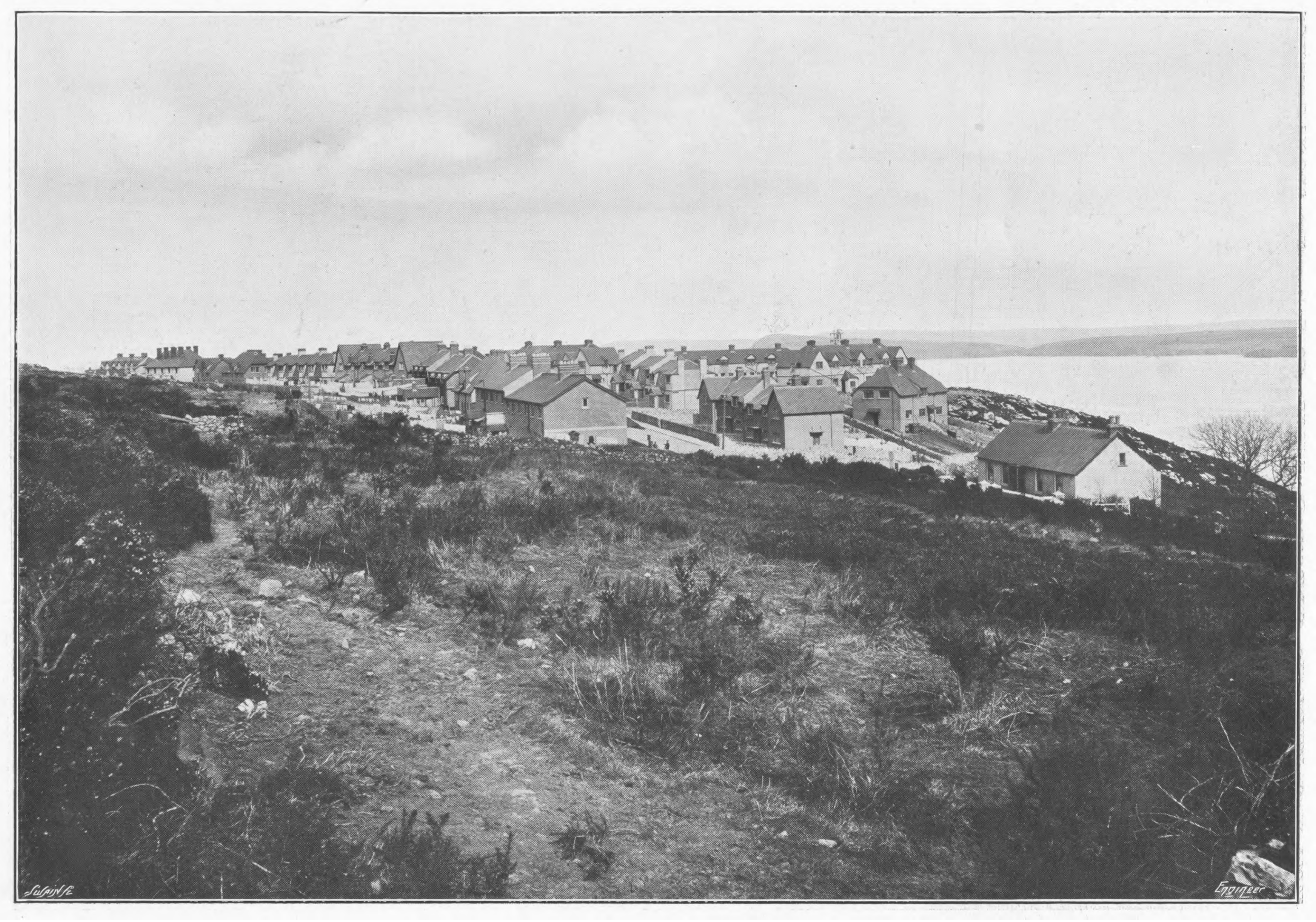


THE IRISH BOAT QUAY FROM THE HARBOUR, 21st AUGUST, 1906

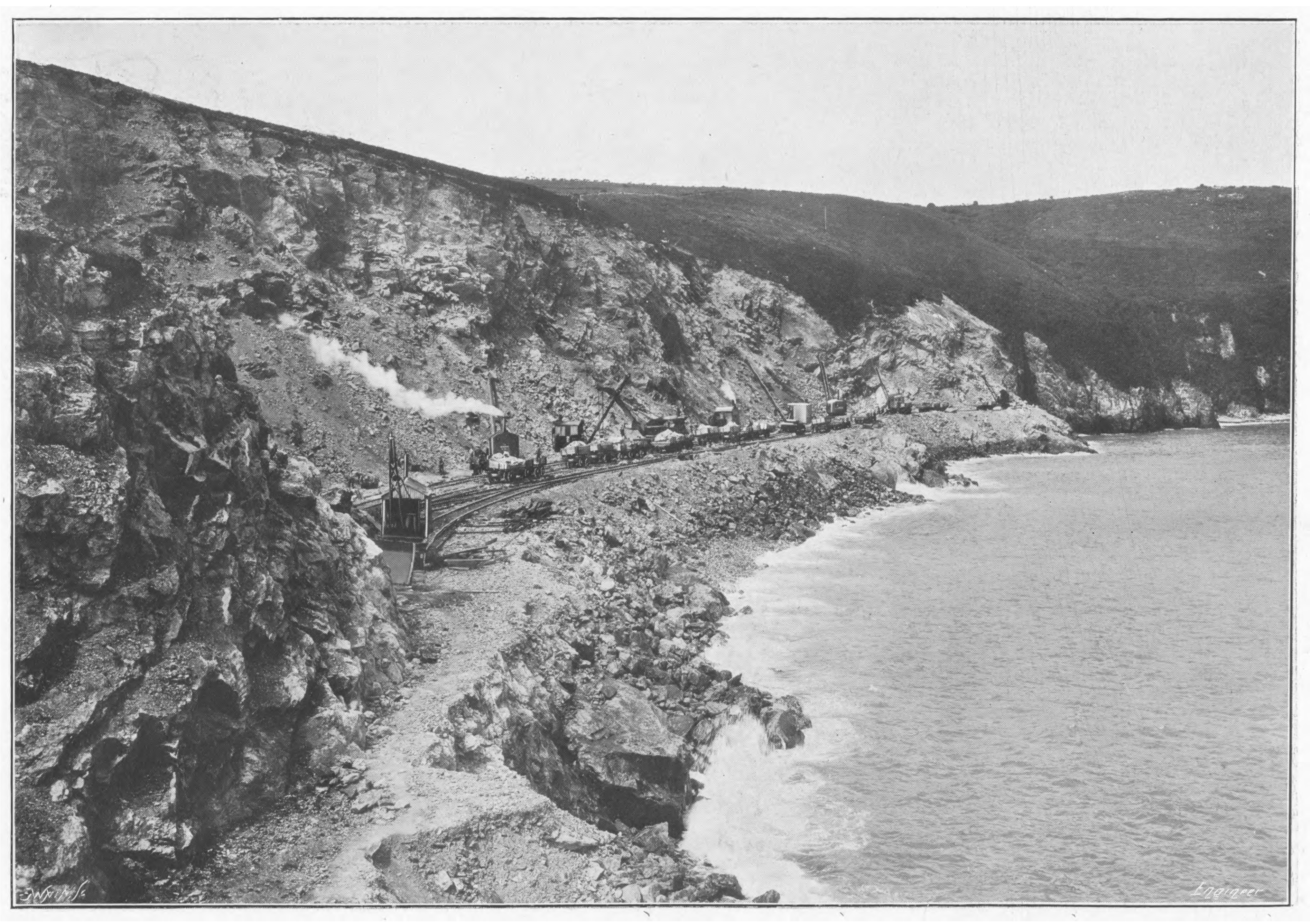


GENERAL VIEW OF HARBOUR, JUNE, 1909

THE HARBOUR WORKS AT FISHGUARD


Swain Sc
Engineer

FISHGUARD HARBOUR VILLAGE, 10th APRIL, 1908



THE PWLL HIR QUARRIES, 8th JULY, 1909

OLD AND NEW GASHOLDERS AT GATESHEAD

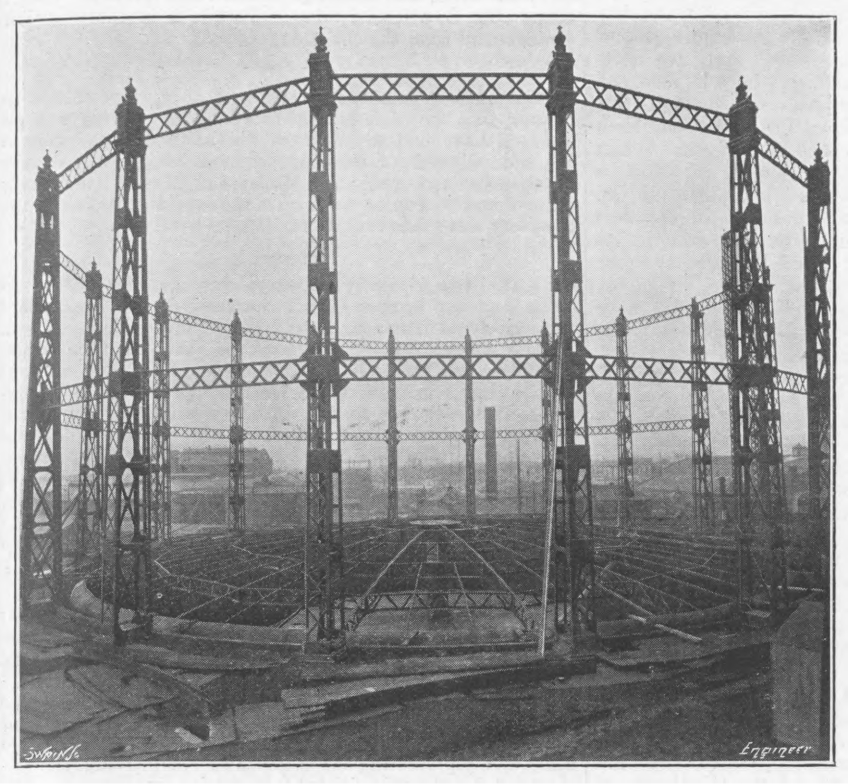


Fig. 1—THE ABANDONED GASHOLDER, 1,750,000 CUBIC FEET CAPACITY

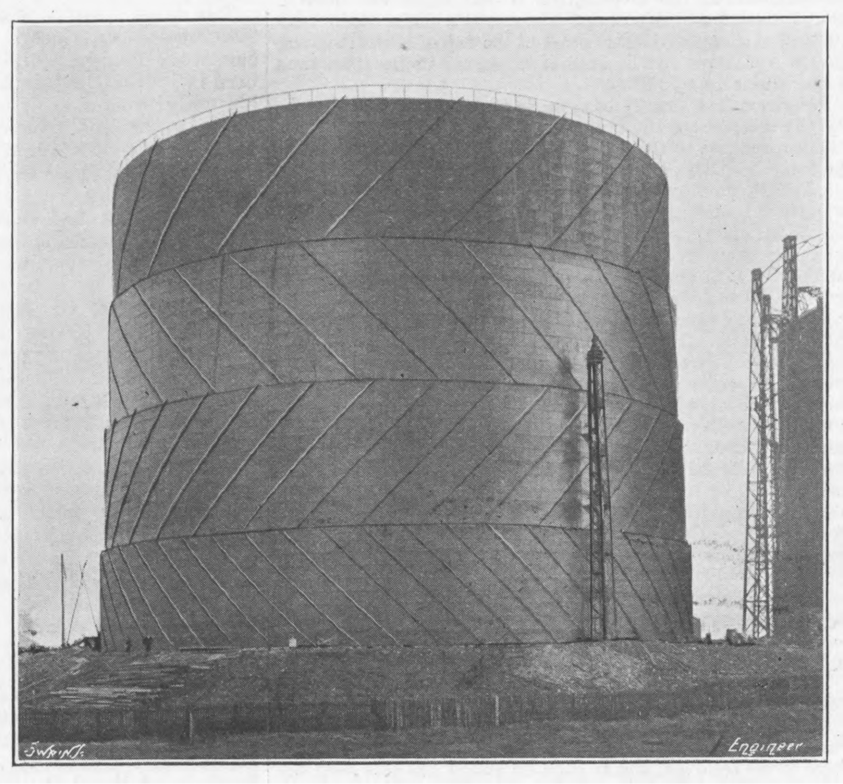


Fig. 2—THE NEW GASHOLDER, 3,500,000 CUBIC FEET CAPACITY

A LARGE COLUMNLESS GASHOLDER.

AN interesting piece of work is represented in the dismantling at the Redheugh Works of the Newcastle and Gateshead Gas Company of a column-guided gasholder, having a capacity of 1¾ million cubic feet, and the construction in the same tank of a spiral-guided gasholder, with storage for 3½ million cubic feet. The column-guided gasholder was built about twenty-seven years ago from the designs of the late Mr. V. Wyatt, and its inner lift was 169ft. 4½in. in diameter by 36ft. 3in. in depth, whilst the outer lift was 172ft. 4½in. by 36ft. 7in. The four lifts of the new spiral-guided holder are each 36ft. 7in. in depth, and the following are the diameters:—Inner lift 164ft., second lift 167ft., third lift 170ft., and outer lift 173ft. The tank, 175ft. 4in. in diameter by 38ft. deep, is in excellent condition, having a concrete bottom and cement-faced dumpling, whilst the wall is of concrete, with an inside brick lining 9in. thick, built in cement, and between the brickwork and concrete are 2in. of pitch. The radial main bars of the roof framing of the holder were of the lattice type braced with circumferential lattice girders, and this framing is now fixed on stanchions in the tank to support the crown when the holder is at rest.

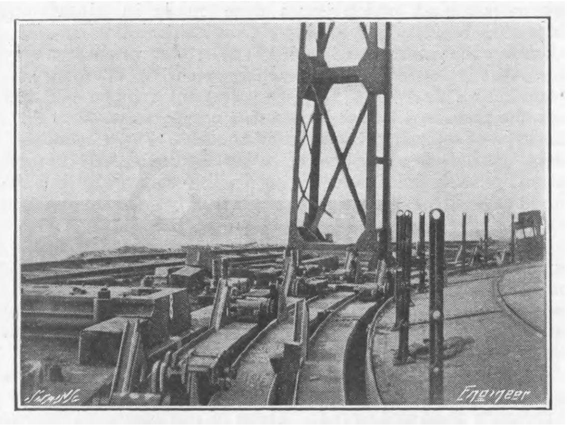


Fig. 3—VIEW SHOWING SOME OF THE CARRIAGES

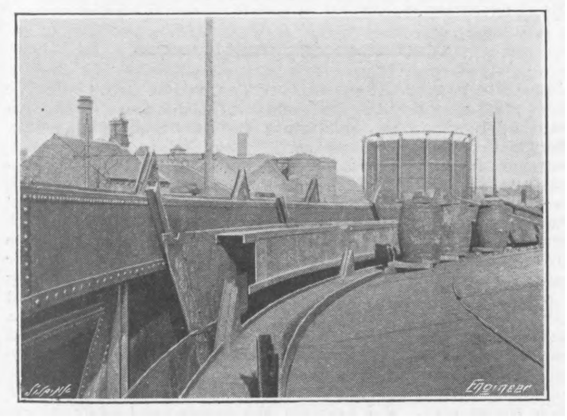


Fig. 4—EXTENDED SIDE PLATES ON CROWN AND TOP

The old holder was guided by eighteen standards of the box type, rectangular in shape, and braced together by two rows of lattice girders, while the members were connected by strong steel angle and tee lattice bracing, secured by covering plates. Sixteen of these have been removed, the bed-plates being used for supporting tank carriages and rollers. These old bed-plates, excepting the two which were allowed to remain for the purpose of supporting the anti-freezing apparatus, have been filled with cement concrete and capped with plates. As previously stated, the old roof framing, with certain additions and modifications, has been utilised for carrying the crown when at rest, and is supported by stanchions. The principal members were shortened in order to admit of the extra lifts introduced, and also the inlet and outlet pipes, which are 3ft. in diameter, and have been altered to meet the extra depth and smaller diameter of the inner lift.

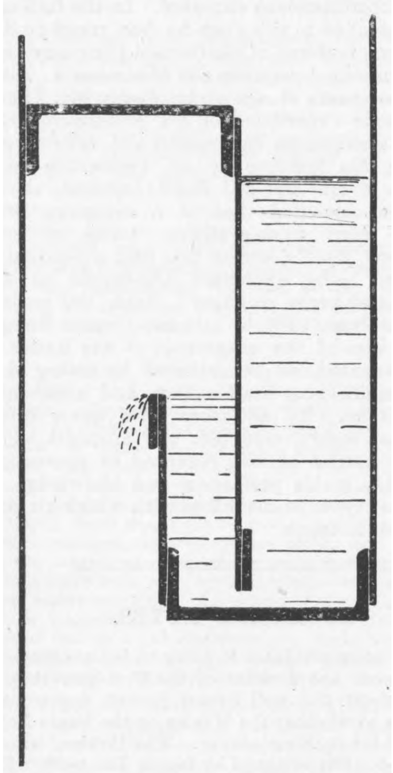


Fig. 5—HYDRAULIC CUPS AND DIPS

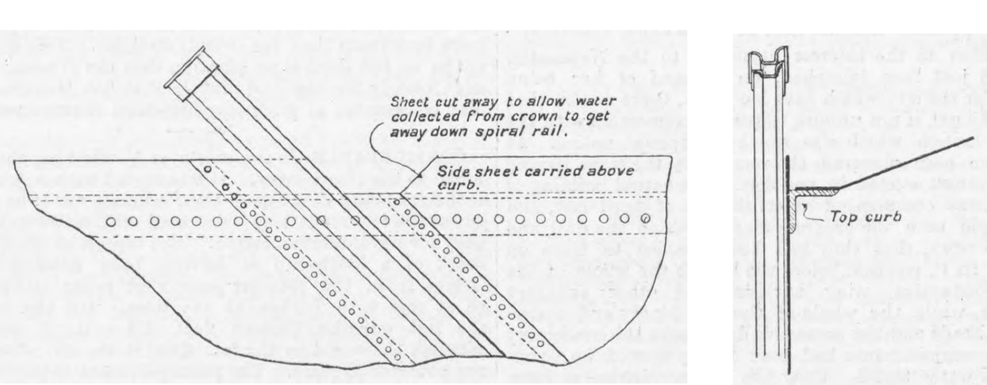

Sheet cut away to allow water collected from crown to get away down spiral rail.
Side sheet carried above curb.
Top curb

Fig. 6—DETAILS OF TOP CURBS

As the new holder is the largest which has yet been erected on the spiral-guided system, some particulars of the constructional details may be of interest. The top curbs—Fig. 6—of the inner lift comprise a 6in. by 6in. by ¾in. steel angle ring at the joint between the crown plates and the side plates, and a further circumferential girder is secured to the outer row of crown plates some little distance from the outer edge, this girder being formed of two 4½in. by 3½in. steel angles with a ⅜in. web. The thirty-six vertical stays are splayed out at the upper end and secured to this inner curb, the stays being of the lattice girder type with ⅜in. thick solid web plates at the upper end and foot, while the latter is further strengthened by a lower curb running around the inside of these vertical stays formed of 8in. by 3½in. channel steel. These vertical stays are 18in. wide at the foot parallel to within 5ft. 9in. of the upper end and increasing to about 3ft. 9in. wide at the top, and are secured to the inner curb as before explained, and also to the side plates and outer row of top plates by rivets. The plating for the sides is ½in. thick at the top, with butt joints, having cover-plates ⅝in. thick. The lower row of the side plates is ⅜in. thick, the rows next the foregoing are ¼in. thick, and the remaining side sheets are all No. 10 B.W.G. Worked into these sheets are the ⅜in. spiral plates, to which are riveted the spiral guides. For the crown, the outer row next to the top curb is ⅜in. thick, having butt joints with 9in. by ¾in. cover-plates. The adjoining row is ⅜in. thick, also butt-jointed with 7in. by ½in. cover-plates. The next row is $\frac{3}{16}$in. thick, the joints being of the ordinary lap type. The remaining rows, excepting that adjoining the centre plate, are No. 10 B.W.G. There are the usual manholes, air pipes, blow-offs, &c., and a substantial handrail round the edge of the crown, supported by strong cast iron standards.

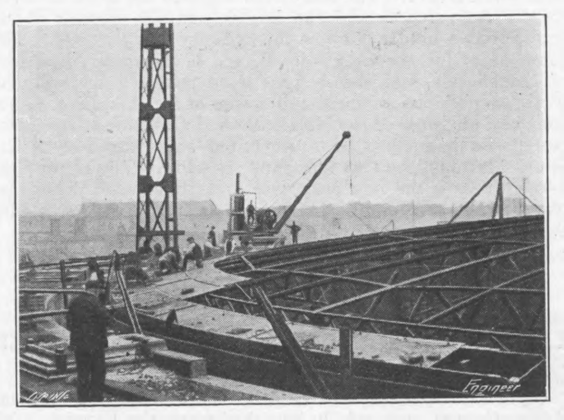


Fig. 7—FRAMEWORK OF CROWN

Concrete piers were formed upon the old dumpling of the tank and carried up sufficiently high to form a square footing for these stanchions to rest upon. The second lift has thirty-six vertical stays, formed of 8in. by 3½in. steel channel, and the top row of side plates is ⅜in. thick, the next row ¼in. thick, the intermediate rows No. 10 B.W.G. The hydraulic cups and dips—Fig. 5—are each 21in. deep by 11in. wide. The vertical stays and sheets of the third lift are practically a repetition of those of the second one. The outer lift, however, has thirty-six vertical stays of 8in. by 3½in. channel steel, and the bottom curves are formed of two 8in. by 3in.

by 20 lb. steel channels, having the usual butt joints with $\frac{5}{8}$in. thick covers, and these are riveted back to back and to the lower row of side plates. The side sheets of this lift are $\frac{3}{8}$in., $\frac{1}{4}$in., and No. 10 B.W.G. thick. As the difference in the diameters of the several lifts is 3ft., there is a space of 18in. between the edge of one lift and the plates of the next lift, and this extra width permits of the top of each lift being used as a platform. The normal difference in the diameters of the lifts is about 12in.

Reference has already been made to the method of attaching the carriages to the tank, and some particulars may now be given relative to the rollers, of which there are 54 pairs on the tank, 36 pairs on the third lift, 27 pairs on the second lift, and 18 pairs on the inner lift. These rollers allow for expansion and contraction, and although they have a firm grip on the spiral rails of the lift, they respond freely to any expansion due to climatic conditions. They have two flanges which gear with and revolve along the front edges of the steel spiral rails, and they have an extension at the back to give a wider bearing upon the fixed axles, where they are applied to the inner lifts. Upon this extension a hexagon is formed so that these rollers may be turned upon their bearings with a spanner in order that the oil holes may be turned to the vertical position when necessary. This speciality, however, is not required on the rollers for the outer lift. These are fixed upon their axles, which have long bearings revolving in specially designed carriages. In order to avoid the disfigurement caused by the unequal washing over the surface of rain-water running from the top of the holder and overflowing from the cups, the upper rows of side plates on all four lifts have been carried about 3in. above the curb and a gutter thus formed around the outer edge of the lifts. Near to the upper end of each spiral rail there is a curved opening in the projecting part of the top plates, and this causes the spiral rails to be used as a medium of travel for the water between the cups of the lifts until it reaches the tank.

It has been found that the use of anti-freezers in very cold weather creates a difficulty. The condensed steam used for keeping the cups and dips free from ice causes an excess of water, which usually overflows the sides of the gasholder and there forms solid ice, and to such an extent has this been the case in Canada that the ice thus formed on the outside of gasometers has prevented one lift from entering the next. This trouble has been entirely overcome by the arrangement which has been adopted in the new gasholder at Redheugh. A continuous ladder gives access from the ground to the crown of the holder, with the lifts in any position. Although the sections of the ladder are in very different positions when the holder is at rest, the ladders come into line as soon as a lift gears with that which follows it, and when the holder is fully inflated there is perfect ladder alignment.

The new gasholder is situated on an exposed portion of the south side of the river Tyne, immediately opposite the Elswick Works, and is 15ft. above the level of the adjoining ground, and whilst fully inflated, it has been exposed to a wind pressure of no less than 52 miles per hour, and to 22 deg. of frost. The old tank was dismantled and the new work erected in its place within a period of ten months. The column-guided gasholder was originally erected at a cost of £11,603, and the estimate for the same work at the present time was £15,211. The cost of the whole of the work involved in the reconstruction of the holder and the erection of the spiral-guided holder of twice the capacity was £18,000. The contractors for the work were R. and J. Dempster, Limited, of Manchester, and the designs were prepared by and the work carried out under the direction of Mr. W. Doig Gibb, the chief engineer of the Newcastle and Gateshead Gas Company, who has since been appointed chief engineer of the South Metropolitan Gas Company, London. The engravings herewith show the new gasholder and that which it has displaced, and three views of different parts of the new holder taken during construction.

THE LAUNCH OF THE SECOND-CLASS CRUISER NEWCASTLE.

ON Thursday, November 25th, the second-class cruiser Newcastle was successfully launched from the Elswick shipyard of Sir W. G. Armstrong, Whitworth and Co., Limited, the naming ceremony being performed by Lady Jellicoe, the wife of Rear-Admiral Sir J. R. Jellicoe. The Newcastle is one of the group of the five vessels of the protected cruiser type included in the Naval Programme for 1909-10, and she has a length of 430ft., a breadth of 47ft., and 4800 tons displacement at load draught. The machinery is being furnished by the Wallsend Slipway and Engineering Company, Limited, and consists of turbine machinery of 22,000 horse-power, calculated to give a speed of 25 knots. Following the launching ceremony, the company of invited guests adjourned to the mould loft, where refreshments were served, and in the course of an interesting speech Sir Andrew Noble recalled the fact that the first ship to bear the name of Newcastle was built at Ratcliffe in 1653, and served under Blake, taking part in two of the greatest feats of arms, the bombardment of Tunis and burning of the Corsair fleet, and in the destruction of the Spanish treasure fleet at Santa Cruz, Teneriffe.

In addition to the interest attaching to the Newcastle, which had just been launched, on account of her being named after the city which gave her birth, there was another very exceptional, if not unique, feature in connection with the vessel and launch, which was worthy of special notice. As would have been observed, the vessel left the ways having her four funnels erected in position. The actual building of the vessel was commenced about the end of April last, and so rapid had been the progress made, both on the hull and machinery work, that they had been enabled to place on board and fix in position before the launch the whole of the boilers, condensers, wing turbines and other auxiliary machinery, while the whole of the machinery and boiler-room bulkheads and the protective deck above the machinery and boiler compartments had been finally riveted up, completed and water tested. Only two heavy weights—namely, the main turbines—remained to be lifted on board, and this operation was to be carried out on the following day. Thus, although the Newcastle was the last but one of her group to take the water, it was more than probable that at the present time she was further advanced and nearer readiness for trials than any of the other four vessels. So far as he knew, no vessel of the size or class of the Newcastle had hitherto been launched in such a condition, and they might therefore fairly claim to have established a record in her case.

OBITUARY.

GEORGE HEPBURN.

THE death is announced as having taken place on the 30th ult. of Mr. George Hepburn, naval architect and consulting engineer, of Liverpool. Mr. Hepburn was born in 1841 at Cults, in Aberdeenshire, where he received his early education, afterwards passing through the course at the local Mechanics' Institute. He was then apprenticed to his father, who was a millwright. When he had completed his time he served for three years as apprentice to the Clyde firm of Randolph Elder and Co. While there he had charge of the erection of the first two compound marine engines made on the two-cylinder principle. These engines were fitted in the steamer Murillo, owned by Robert MacAndrew and Co., of Liverpool, and in 1863 Mr. Hepburn was made chief engineer of this steamer, having as his second in command Mr. R. W. Watson, who at present holds the post of superintendent engineer to the MacAndrew firm.

After sailing in this vessel for two years he was made by Messrs. MacAndrew manager of their liquorice works at Frodsham, but in 1866, when this business was transferred to the United States, he was made superintending engineer in Liverpool to the firm. This position he held for eleven years, during which time he designed thirty-three vessels for his employers.

In 1877 he started on his own account as naval architect and consulting engineer. He was made consulting engineer to the firms of Phelp Brothers, Hatton and Cookson, Job Brothers, John Glynn and Sons, and Taylor, Cameron and Co. amongst others, and designed the vessels of all these firms. He also had an extensive business as arbitrator and scientific witness, and was associated in the latter capacity with the trials connected with the Austral, City of Paris, Delpho, and Kimberley. He was a member of the Institute of Naval Architects and of the Institute of Marine Engineers, and was the inventor of numerous engineering equipments.

GEORGE THOMPSON.

WE have to record with regret the death of Mr. George Thomson, who died at Waterloo, Liverpool, on Tuesday evening. Mr. Thompson since 1903 was associated with the engineers' department of the Cunard Steamship Company, and in 1904 succeeded Mr. Little in the position of superintendent engineer. In the fulfilment of the duties attached to this post he had much to do with the engineering features of the Cunard Company's turbine steamers Carmania, Lusitania, and Mauretania. Although only forty-two years of age at his death, Mr. Thompson had had a wide experience of his profession, and had always been a strenuous but modest and retiring worker. Commencing his training as an apprentice engineer in the works of Harland and Wolff, Limited, at Belfast, his experience included that of a sea-going engineer on the Lord Line among others. Later, he returned to Harland and Wolff's, and at first held a position in the drawing-office, being appointed afterwards to the responsible post of works manager. From this position he left Belfast in June, 1903, to join the Cunard Company's staff. Some idea of the magnitude of the duties which he so ably executed can be gathered by noting that the company's engineering staff ashore and afloat number about 4500 men. By all those who knew him Mr. Thompson was highly respected, and amongst the engineers of his district he was regarded as possessing the greatest ability in his profession and knowledge of the many different types of machines with which his position brought him into touch.

DOCKYARD NOTES.

A CURIOUS correspondence is going on in our contemporary *Le Yacht* between the director of the Fiat-San-Giorgio and Monsieur Laubeuf, the well-known French constructor, on the subject as to whether the Hvalen or the Papin holds the world's record for cruising ability. The Hvalen, which was built for Sweden, was designed by Signor Laurenti. She left Spezia on the 31st July last and arrived at Stockholm on the 2nd October—a total distance of 3600 miles in 64 days, going *via* the Kiel Canal. This averages 60 miles a day.

M. LAUBEUF draws attention to the cruise of the submarine Papin, designed by himself, which ran from Cherbourg to Bizerta, a distance of 2200 miles, in 21 days, an average of a little over 100 miles a day. M. Laubeuf claims that this represents a record rather than the performance of the Hvalen, on the grounds that the rate covered per diem is more important than the overall distance. This may or may not be so, but there is no question that the Hvalen's record is an extremely fine one, and that the Fiat-San-Giorgio Company may be regarded as producing first-class submarines.

CONSIDERABLE doubt exists as to what big ship is to be added to the Greek navy. It was stated with a good deal of authority lately that one of the Pisa class was to be purchased out of the fortune left by a deceased millionaire to the Greek navy for naval augmentation. But reports in the Levant all speak of a battleship as having been determined upon. Greece is in the peculiar position of being fairly likely to be at war with Turkey at any time. On the occasion of the last war the Turkish fleet did nothing worse than astonish the world by the fact that it moved, after lying in one place for 30 years. The principal record of the Greek navy was, however, very little better. The ships certainly cruised further than the Turkish ships did, but the navy proved itself singularly inefficient. Since then the Turkish fleet has been reorganised, and the situation in Greece is necessarily affected thereby.

A NEW system of funnel marking has been adopted for the British Navy. In future, regardless of whether they are flagships or no, ships will carry funnel marking—not by the old system of seniority, but purely and simply following their alphabetical order in their classes. Thus, for example, in the Bellerophon class, the nameship, whether a flagship or not, will always have unmarked funnels. The Superb will carry one band, and the Téméraire, on the principle that T comes after S, will carry two. This is a far more sensible arrangement than the old one.

IT is curious commentary on how they work things in France, that the trials arranged for long range firing against the Iéna have had to be put off for the time being owing to the sum allowed for these experiments having been already exhausted. Apparently the Minister of Marine had already come down to Toulon to witness the experiments when the discovery was made that no funds were available.

VERY little is really known about the new battleship Orion and the cruiser Lion, the keels of which were laid respectively at Portsmouth and Devonport on Monday last. It is rumoured, however, that the Orion will be 545ft. long between perpendiculars. As for the Lion, rumour has it that she will be a Dreadnought in an Indefatigable setting—that is to say, that she will carry ten 12in. guns arranged as in the Dreadnought, or with possibly the two amidship turrets écheloned. This last is perhaps somewhat doubtful. Naval ideas in England seem rather to be running on American lines, with all guns on the centre line, which, when all is said and done, is an arrangement hard to beat for practical purposes, however much more attractive other designs may look on paper.

THE official full-speed trial of the Brazilian destroyer Alagoas took place on Friday last, the 26th inst., on the Skelmorlie measured mile at the mouth of the Clyde during boisterous weather, and the contract speed of 27 knots carrying a load of 100 tons was easily obtained. The trial was under the supervision of Captain A. Rosauro de Almaida and Captain Bartholomeo Francisco de Souza e Silva, these gentlemen representing the Naval and Engineering Departments of the Brazilian Naval Commission in Europe. The Alagoas is the seventh of the ten destroyers ordered from Yarrow and Co. by the Brazilian Government, the Para, Piauhy, Amazonas, Matto-Grosso, Rio Grande do Norte, and Parahyba being already in commission.

A NEW ALUMINIUM SOLDER.

AN aluminium solder has been brought to our notice which appears to answer the purpose for which it is intended in an efficient manner. Joints made with it are claimed to possess that important property of retaining their strength over an unlimited period. The solder is being put upon the market by the Aluminium Patent Non-flux Solder Company, of 10, Camomile-street, London, E.C. We recently attended a demonstration at which joints were made in aluminium strips with rapidity and ease.

Briefly, the method of using the solder resembles very closely the procedure adopted when soldering other metals, except that a steel "bit" is used instead of a copper one, and that the process does not involve the employment of a flux. The type of soldering iron used by the firm, whilst somewhat crude, consisting as it does of a three-cornered file ground flat on its three sides, appears to do the work well, and we should say—although we have not actually tried to make a joint ourselves—that the art of using the solder is easily acquired. Although the appearance of the solder is apt to convey the impression that it is hard, and that its melting point is high, the reverse is the case, for it melts almost as readily as the common tinsmith's material. We are informed that it contains no aluminium whatever, nor anything which will oxidise under the influence of the atmosphere.

Many articles which have been repaired by this process were brought to our notice, and the repairs appeared to be perfectly good and sound. Those of our electrical readers who have experienced difficulty in sweating on the lugs on aluminium conductors may be interested to know that the firm has carried out experiments in this direction, and with the aid of a simple soldering iron such as that described above has succeeded in performing this operation with great ease. We have examined samples of work of this kind, and we should say—although, of course, to be in a position to state definitely it would be necessary to measure the drop in potential over the joint, which we have not had the opportunity of doing—that the electrical connection was very perfect. The firm believes in using the steel soldering iron whenever possible, but for repairing most castings a blowpipe is necessary.

SIR CHRISTOPHER FURNESS AND TRADE PROSPECTS.—In the course of his speech to the shareholders of Richardsons, Westgarth and Co., Limited, at their ninth ordinary general meeting, held at Hartlepool, on Saturday last, Sir Christopher Furness—chairman of the directorate—said: It must be a source of satisfaction to them all to observe that so far as one could gather the worst was really over, and that there were indications of a gradual return, not to anything in the nature of a boom, but to at least normal industrial conditions, as soon as the present unfortunate political unrest gave place to calmer times. It was necessary for them, however, to realise that a new order of things was beginning to prevail, and that, whether trade be good or bad, they would have to take seriously into account an ever-expanding increase in foreign competition. The arena of the conflict also was enlarged year by year, and if British manufacturers were to hold their own some form of intelligent co-operation amongst themselves will have to come into being, and thus to avoid the existing lamentable wasteage in the country. For example, the working and establishment expenses alone of the various mercantile marine engine builders of that coast aggregate fully £300,000 per annum, and in no other leading industrial country in the world would such a large expenditure be tolerated, without some collective effort being made to minimise it. They might doubtless remember that already something had been attempted in this direction, and although in the meantime success is lacking, he was convinced that ere long circumstances would so force their hands as to bring about an intelligent fusion of interests, an arrangement whereby their country would be able to produce at a more natural level of cost than existed to-day. Speaking generally, it seemed to him that what the industries of the country most of all needed was a period of quiet convalescence, freedom from legislative disturbance, a cessation of the harassment which labour troubles involve, and, in short, a period of quiet wherein they might be free to travel calmly and steadfastly on the road to a healthy recovery and renewal of strength.

RAILWAY MATTERS.

The piercing of the Trans-Andine Railway tunnel at the summit of the Cordilleras was completed on November 27th, and the Chilian and Argentine sections were joined with complete success.

The *Journal de St. Pétersbourg* of 3rd November states that the Russian Government have authorised the construction of the following lines:—Kieff to Balta *viâ* Vassilkoff and Kristinovka; Ouman to Nicolaeff *viâ* Olviopol and Voznesensk. The length of these lines will be, in all, about 400 miles.

The *Journal de St. Pétersbourg* of 11th November announces that a company, with a capital of about £4,917,000, is in process of formation to construct a new railway from St. Petersburg to Helsingfors. Following the coast, this line will reduce by 15 hours the journey between the capital and the extreme western point of Finland.

In 1898, states a contemporary, only some 40 electric tramways were in existence, with a capital of approximately £24,000,000, while from the latest returns there are at present 305 undertakings in the United Kingdom, with a capital of £68,199,918, the gross receipts being £12,439,625. The total number of passengers carried per annum amounts to the large total of 2,625,532,895.

The replacing of timber structures with those of steel or concrete on the main line of the Northern Pacific Railway, between St. Paul and Livingston, Mont., states an American contemporary, will probably be completed by the end of 1911. A plant has been erected at Glendive, Mont., for making concrete piles and girders which are to supersede wood in the present pile bridges, except in cases where steel construction is used.

In the House of Commons recently, replying to Mr. Rees, Colonel Seely (Under-Secretary to the Colonial Office) said that the question of constructing a short line of railway from Jinja, on the Victoria Nyanza, to a place on the Nile some 40 miles below the Ripon Falls, was under consideration, but it had not yet reached the stage at which a definite decision could be given in the matter. That was the only extension contemplated at present.

The Erie Railway, in America, has provided one car in some of its suburban trains for those who object to the steam heat and stuffy atmosphere of the regular cars. The cars carry signs reading "Fresh Air," and are started out with the doors, ventilators and alternate side windows wide open. Any person riding in these cars is privileged to close the window next to him, but has no right to insist on the closure of other ventilation openings. The will of the majority of those who ride in the cars will control the turning on of the steam, which may be wanted in very cold weather. Those who find the cars too cold can always move to other cars in the trains. This, it is considered, is a novel but sensible way of solving the vexatious problem of heating and ventilating cars in winter.

In his presidential address before the Institution of Engineers and Shipbuilders in Scotland, Mr. C. P. Hogg did not speak enthusiastically of railway electrification in this country. He said that the suppression of what was, after all, a very efficient machine, the steam locomotive, was still a long way off. While electric traction had practically captured the whole of the tramway traffic—of the 2464 miles of tramways 2286 are electrified and only 52 worked by steam—only 200 miles—single track—of railways in the United Kingdom were partly worked by electric traction, and only 204—single track—wholly worked by electricity. Abroad progress in this direction had been much greater, a fact he attributed partly to their hydro-electrical installations and partly to the fewer legal restrictions on high voltage lines.

On Wednesday last, December 1st, trains commenced running on the South London electrified line of the Brighton Company. To distinguish this line from the many London tubes it is to be called "The South London Elevated Electric." In our issue of February 5th, 1909, we gave a general description of this railway, which is the second line to be operated on the single-phase system in this country. The equipment of the trains is a distinct advance on any hitherto seen in London, as will readily be appreciated from the illustrations given in our issue of February 12th. The average distance on the South London line between stations is, in round figures, 4600ft. The line has a great many curves and gradients, but, notwithstanding this, the average speed including stops is 22 miles an hour, and if the stops are not included it is just over 25 miles per hour. The electrification of this line has presented many unforeseen difficulties, and it has taken much longer to carry out than was originally anticipated. The tests on all the trains, we are informed, have proved very satisfactory, and the results are said to have been better than those guaranteed. The energy consumption per ton mile was some 15 per cent. better than that specified, and the same applies to the acceleration of the trains.

We hear that it is probable that in the new year the fastest non-stop run in this country will be made by the London-Birmingham expresses on the London and North-Western Railway. At present the journey over the distance of 113½ miles is made in two hours, at an average speed of close on 57 miles per hour. It is now contemplated to cover the distance in 1 h. 47 min., or considerably over 60 miles an hour. The fastest scheduled running without stoppage is by the 1.8 p.m. North-Eastern express from Darlington to York—44 miles in 43 minutes, or 61.5 miles per hour. The next fastest is the Caledonian Railway's Perth to Forfar run, 32½ miles in 32 minutes, or 60.9 miles per hour. In the matter of fast runs the North-Western at present stands only tenth on the list, and is beaten by most of the other trunk lines. The race for the Midlands railway traffic has been very marked of late years between the London and North-Western and Great Western Railways. The journey by the former system is, of course, the shorter, and since the Birmingham non-stop expresses of two hours were put on swifter trains have been run by the Great Western too, so that competition is still very keen. The North-Western during the last few days have been running experimental trains between Euston and Birmingham and back, and the results obtained so far leave little doubt that there will be no difficulty in knocking off the 13 minutes.

The Norwegian Railway from Christiania to Bergen extended until recently only as far as Gulsvik, which is 146 kiloms. from Christiania. The whole line was completed a few days ago, and the opening ceremony, consisting in a banquet attended by King Haakon, took place on the 26th of the month. The new railway is of great industrial significance, and is destined to be an important factor in international traffic, because it constitutes a continuation of the railway extending from the North Sea to the Far East through Sweden and Russia. The first preparations for the construction of this railway were made in the middle of the nineties, and consisted in the formation of roads for transporting the necessary construction materials and provisions into the mountains, which in some places rise to a height of 1500 metres above sea level. Workmens' dwellings were built and telephonic communication established. The material for the highest station on the line (Finse) had to be carried for a distance of 15 kiloms. up steep inclines by pack horses and bearers. The transport roads alone cost 800,000 kronen. The railway stations on the elevated section of the line are built of granite. In winter time large stores of provisions, clothing, &c., which cost large sums to transport, had to be deposited in these stations. About 2000 workmen were employed in summer in the mountain passes and in the tunnels; the work proceeded day and night, even on Sundays. The largest tunnel (Gravehals) is 5·3 kiloms, long. It was begun in 1895.

NOTES AND MEMORANDA.

The Baccara (France) glass factory has just produced a new class of glass which, when heated to boiling point and then plunged into water at freezing point, will not break. The principal object was the making of safety lamp tubes superior to those made of the Jena product. The composition of the glass is, says the *Revista Minera*, roughly 70 per cent. bicarbonate of soda, 13 carbonate of manganese, 9 oxide of zinc, and 5 oxide of lead.

A few days ago, Professor Rutherford gave an address at the New Islington Hall, Manchester, on the subject of "Weighing an Atom." He traced the history of the atomic theory in science from the time of Greek culture to the present day, showing how it was really established definitely by John Dalton. The theory, he said, was the basis on which the whole foundation of chemistry rested. The chemist used the atom as a brick in the building of his house. Professor Rutherford then spoke of the movements, the weight, the size, and the constitution of an atom, showing how physicists had been able to determine these details.

The operating costs at the Commonwealth Edison Company's Central Station, Chicago, are estimated as follows:—Fuel 20·8 per cent.; wages of generating staff, 6·1 per cent.; supplies and repairs for generating plant, 4·8 per cent.; battery and sub-station operation and maintenance, 12·1 per cent.; mains repairs and maintenance, 12·2 per cent.; reading and maintenance of meters, 6·8 per cent.; free lamp renewals, 16·6 per cent.; free maintenance of other current-consuming apparatus, 12·9 per cent.; free wiring and free repairs on consumers' premises, 7·6 per cent. Of the total, 31·7 per cent. is for generating costs, and 68·3 per cent. for distribution costs.

According to the *Electrical Engineer* an interesting method for the transmission of photographs by telegraph and telephone, using the ordinary wires, has been invented by Professor Antonio Montagña. The inventor has discovered a system whereby he can decompose the pictures into elementary and graphic signs, which, when separated, can be designated by letters of the alphabet. The letters are transmitted in the usual way, and the operator who receives them is enabled to reconstruct the photograph by substituting the signs corresponding to the letters. The invention can be used by telegraph, telephone, and the wireless system, and photographs can be transmitted any distance.

In a paper entitled "Applications of Electricity to Propulsion of Naval Vessels," which was read before the American Society of Naval Architects and Marine Engineers on November 18th, by Mr. W. L. R. Emmet, the author states that the efficiency of this electrical bond will be about 92 per cent. at all speeds, and this will remain constant through the life of the apparatus. He also doubts whether any other practicable form of speed reduction in such a ratio can be made equally efficient when all friction losses are considered, even if it should be proved that other methods are practicable at all for use in such large ships. The particular type of turbine proposed in this case affords the great advantage of good efficiencies throughout wide ranges of load and speed, as shown by test curves, which characteristics, in combination with the pole changing in motors, are of great value in such a case.

A lecture on "The Circulation of Water in the Earth" was recently given by Professor Boyd Dawkins at Manchester University. There were two definite systems of water circulation in Nature, Professor Dawkins said, one above ground, due to the heat of the sun, and one below ground, due to the heat of the earth. To this circulation of water below ground we might attribute some important effects, notably the equable flow of many rivers. A safe estimate of the amount of rainfall which found its way through the ground was about 10in. in 35. Thus there were a number of wells in and around Manchester, some of which yielded as much as 600,000 gallons a day. They drew their supply from the water which percolated through the superficial gravel and sand in surrounding districts. Professor Dawkins then outlined the water-bearing qualities of the various geological formations, and explained the difficulties presented by limestone and the advantages offered by chalk to those desirous of sinking a well.

In a paper on "Works Organisation with a View to Profit Making," read by Mr. John Batey, before the Birmingham Association of Mechanical Engineers, the author stated that there seemed to be a widespread idea that organising in works for the production of special articles made it necessary to employ an expert in that particular line. This was true conditionally, because if an engineer who has had no experience of that class of work, were set to organise the manufacture of, say, cotton cloth, the ultimate result would not be good. But, given an engineer of general experience, with recognised ability and with brains, he was quite capable of organising a works to produce cheaply, and to make a profit with, some article he has never touched, given that such an article was within the province of pure engineering. It might be a locomotive or a bicycle, a motor car or a steamship, a machine tool or a gas engine, but it made no difference to an organiser, because he could organise up to a speciality in his line, though he has never touched the like before.

The following particulars are given of the non-magnetic vessel Carnegie in a paper read before the American Society of Naval Architects and Marine Engineers:—The materials of construction are: Oak—keel, stern, stern-post, deadwoods, and frames; keelsons and beams, of Georgia pine; decks and spars, Oregon pine; rails and all deck joiner work, of teakwood. The use of iron in the construction of hull, spars, and joiner work was absolutely prohibited, and after exhaustive tests of different metals for non-magnetic qualities it was found that gun-metal composition was perfectly satisfactory, and that was used for practically all fastenings, except where pure copper was suitable. Windlass fittings, winches, anchors, and all fittings ordinarily of iron in this vessel are of gun-metal composition. It was found necessary to resort to the use of hemp hawsers for anchor cable, it being impossible to get anything in metal to suit this purpose. The engine is of the internal combustion, four-cylinder, four-cycle type, of approximately 150 horse-power, using producer gas. Reversing is done through a clutch. The entire engine, shafting, and propeller are of bronze, excepting the pistons, calm-rockers, and other minor parts, which it was deemed unsafe to make of bronze.

The accuracy of gas-producer tests has been taken up in a recent bulletin of the U.S. Geological Survey, the data being based on tests made under the direction of Professor R. H. Fernald. The investigations were made as a result of the great inaccuracies which Professor Fernald states are apt to creep into tests of short duration, due principally to the practical impossibility of bringing the fuel bed to the same condition at the end of the test as at the beginning. The conclusions drawn by him as a result of the tests are summarised as follows:—"That throughout a test the fuel bed should be maintained in uniform condition, with regard to both the character of the fire and the thickness of bed; but that failing in this, special care should be exercised to see that the fuel bed is in the same condition and of the same thickness at the close of a complete test, or at the end of a test period, as at the beginning; that a test should never be started when the producer has been standing idle for some time with banked fires, as the fuel bed will not be in the average condition under which it will be required to work during the test; that if, as the appointed hour for closing the test approaches, the fuel bed is not in proper condition, the time of closing the test should be postponed until the bed naturally assumes the proper thickness and character. No forcing of conditions should be allowed simply to bring the test to an end at a previously determined hour."

MISCELLANEA.

During 1908 the number of new mining claims in Sweden amounted to 544 in all, of which 330 contain iron ore and 110 copper ore, and the remaining 104 other ores.

Reports from all sections of the United States furnish unmistakeable evidence, says the *American Architect*, that the building material interests' prospects for the coming year are brighter and fuller than at any time since 1906, if not in their entire history. The effects of the recent depression seem to have entirely passed.

A new bridge was recently opened at Lea in connection with the viaduct over the Kingsbury and Water Orton Railway. The late Lord Norton many years ago made the old bridge at his own expense, and gave it to the county. By joint contributions of the Midland Railway Company, county and district councils, and a gift of £350 by Lord Norton, there has been substituted for the old Red Birch bridge of steep gradients, a one-span iron girder bridge, with blue-brick abutments.

Good progress is being made with the new reservoirs for London, now being constructed at Island Barn, Walton-on-Thames, and at Chingford. Both were designed by Mr. W. B. Bryan, engineer-in-chief to the Metropolitan Water Board. The Island Barn reservoir will have a water area of 120 acres, and a capacity of a thousand million gallons. The Chingford reservoir has, too, progressed since March. It will cost £341,000, and is to be about three times the size of the Walton undertaking, and to have a water area of 416 acres, and a capacity of three thousand million gallons.

An interesting series of tests has recently been made at the Engineering Laboratories of the Worcester Polytechnic Institute, Worcester, Mass., to determine the relative heat-transmitting properties of copper sheets just as they are received from the rolling mill and similar sheets electrically deposited. The apparatus used consisted of two double-disc Alden dynamometers with the rotating cast iron discs removed. The dynamometers as tested consisted of an outside cast iron casing and four copper sheets with the necessary spacing rings. The dynamometers were identical in every way, except in one the copper sheets were electrically deposited. The dynamometer containing the latter showed an increased heat transmission of more than 30 per cent. over the untreated.

As is now generally known, metallic filament lamps require only about one-half, if tantallum, or one-third, if tungsten, of the current of the carbon lamp of the same candle-power. On the other hand, the new lamps cost about four and six times as much as the carbon lamps, and usually work at 100 volts. Even so, the new lamps have a very wide field of usefulness, and this field has recently been greatly extended by the introduction of 200-volt lamps of low candle-power and reasonable cost, and by the marked improvements in the life and reliability of the metallic lamps, or, as they are often called, the wire lamps. With reasonable care, the effective life of a metallic lamp is from 60 to 100 per cent. greater than that of the carbon lamp, so that the relative cost of carbon and tungsten lamps should really be taken as about one to three, and is even less where the lamps are bought in ones or twos from small dealers. Where many people fail to obtain the full advantages from the new lamps is in installing too many lamps of large candle-power. It is possible to have too much illumination, and especially is it common to find powerful lamps so placed that they are trying to one's eyes.

Some additional evidence pointing to a connection between sun spots and magnetic storms has been furnished by recent records in magnetic observatories. It is known that a spot of unusual size was on the sun's disc at the time of the great storm of September 25th. The sun's rotation brought the spot into approximately the same position on October 22nd, and a storm of quite noticeable character was perceptible from midnight on the 22nd till 8 p.m. on the 23rd ult. Also a storm on October 18th was preceded by one in September, again separated by the interval of one solar rotation. Professor Hale, of the Mount Wilson Observatory, has pointed out that in the course of experiments carried on in the physical laboratory he has observed that light, when subjected to a magnetic field, exhibits the same class of phenomena as he has perceived in sun spots. Professor Hale does not say definitely that solar magnetic conditions are the cause of terrestrial magnetic storms, for investigation has not gone far enough to establish such a theory; but he has furnished additional grounds for the belief that there is an interaction between these magnetic fields of the solar atmosphere and our terrestrial atmosphere, and that such action is related to terrestrial magnetic storms.

A paper by Mr. F. A. Macdonald was recently read before the members of the Edinburgh Association of Science and Arts on "Reinforced Concrete Construction." Among the advantages of reinforced concrete construction, the author stated, were rigidity and absence of vibration, durability, no subsequent outlay for maintenance, and resistance to fire. A general definition of what was meant by reinforced concrete construction might be stated as a combination of concrete and steel in a monolithic type of design, forming a homogeneous whole, in which the maximum of the inherent qualities of each of the two component materials was combined and fully developed. From the economic standpoint the saving of cost was not inconsiderable, and there was also a saving in deadweight, and consequent economy as regards pillars and foundations. The advantages of reinforced concrete construction had been recognised by the Government's great spending departments, and the lecturer stated that important works were shortly to be commenced in Scotland where reinforced concrete would be largely used. Recognising the importance of some standardisation of formulæ both as a safeguard and as a guide, the Royal Institute of British Architects had issued a set of regulations, which were very valuable, and gave data which could be intelligently worked on. Mr. Macdonald hoped that still further standardisation, both of formulæ and notation, for the calculation of reinforced concrete structures would be eventually drawn up and their observance recognised by all designers.

The recent Admiralty order relegating certain of the old 27-knot destroyers to the list of subsidiary vessels, states a contemporary, marks the close of fifteen years' continuous service, these vessels having been completed for sea in the year 1893. The Ferret was the first of these destroyers to be delivered at Devonport, and for some time she was an object of much interest and importance, her commanding officer holding the rank of commander. The Admiralty order referred to will, it is understood, be given effect to gradually, the first vessels to be transferred at Devonport being the Starfish, Sturgeon, and Ferret. As, however, the remaining vessels of the type—over thirty in number—were completed for sea in 1894, and have also been continuously employed, they also may be considered as obsolescent, and will in the near future join the subsidiary list of vessels. The early removal of so many vessels from the active service flotillas would, under ordinary circumstances, be a matter for grave concern, but the Admiralty have made provision for their prompt replacement by new and much more efficient vessels of corresponding speed—27 knots - and only slightly inferior to the Tribal class in offensive and defensive qualities; and it is worthy of note that the launch of the Harpy, one of the pioneer vessels of the new class, took place on Saturday, November 27th, and is to be rapidly followed by that of the remaining vessels of this group. When the older vessels have been removed from the active flotillas it is not intended to dispense entirely with their services, as it is considered they can still do efficient work as harbour defence and mine clearing vessels.

THE SHIPYARD OF THE JOH. C. TECKLENBORG A.G. AT BREMERHAVEN

(For description see page 576)

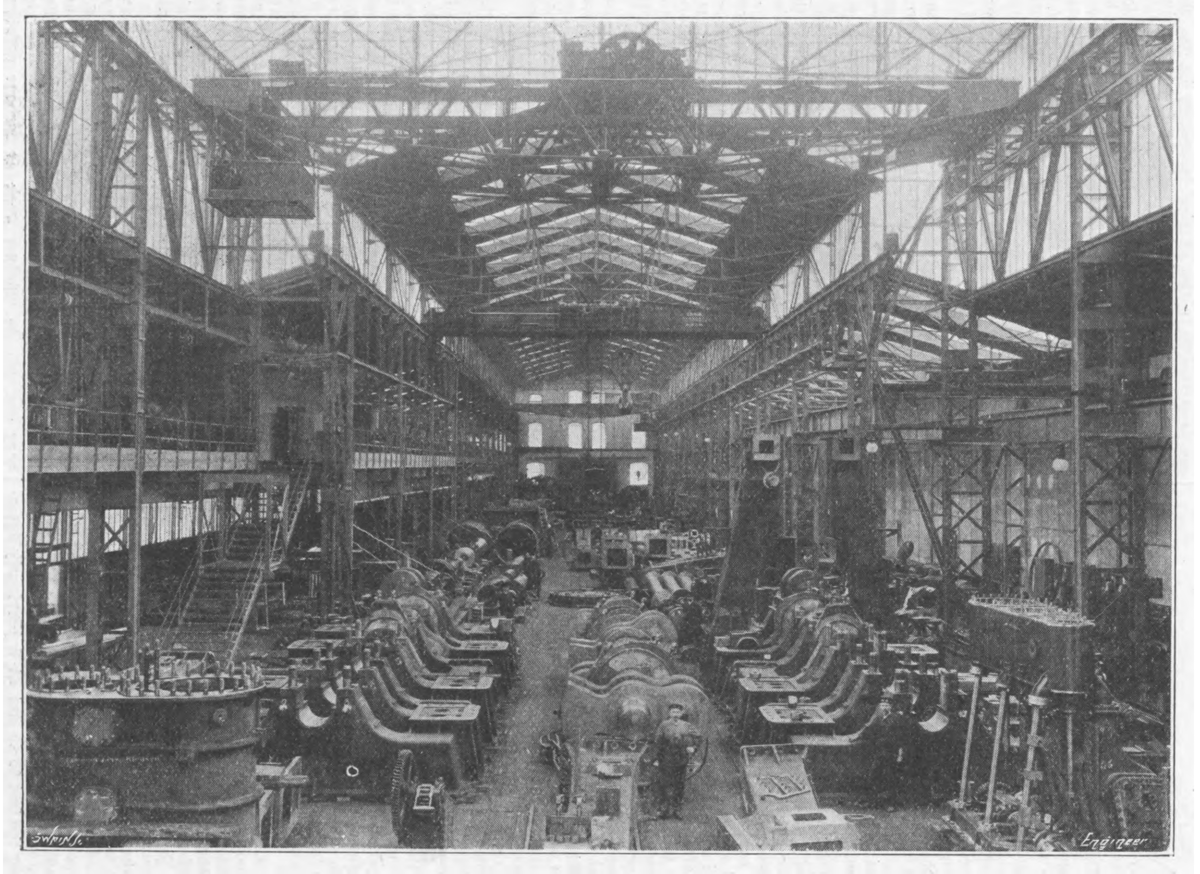


Fig. 11—ENGINE SHOP

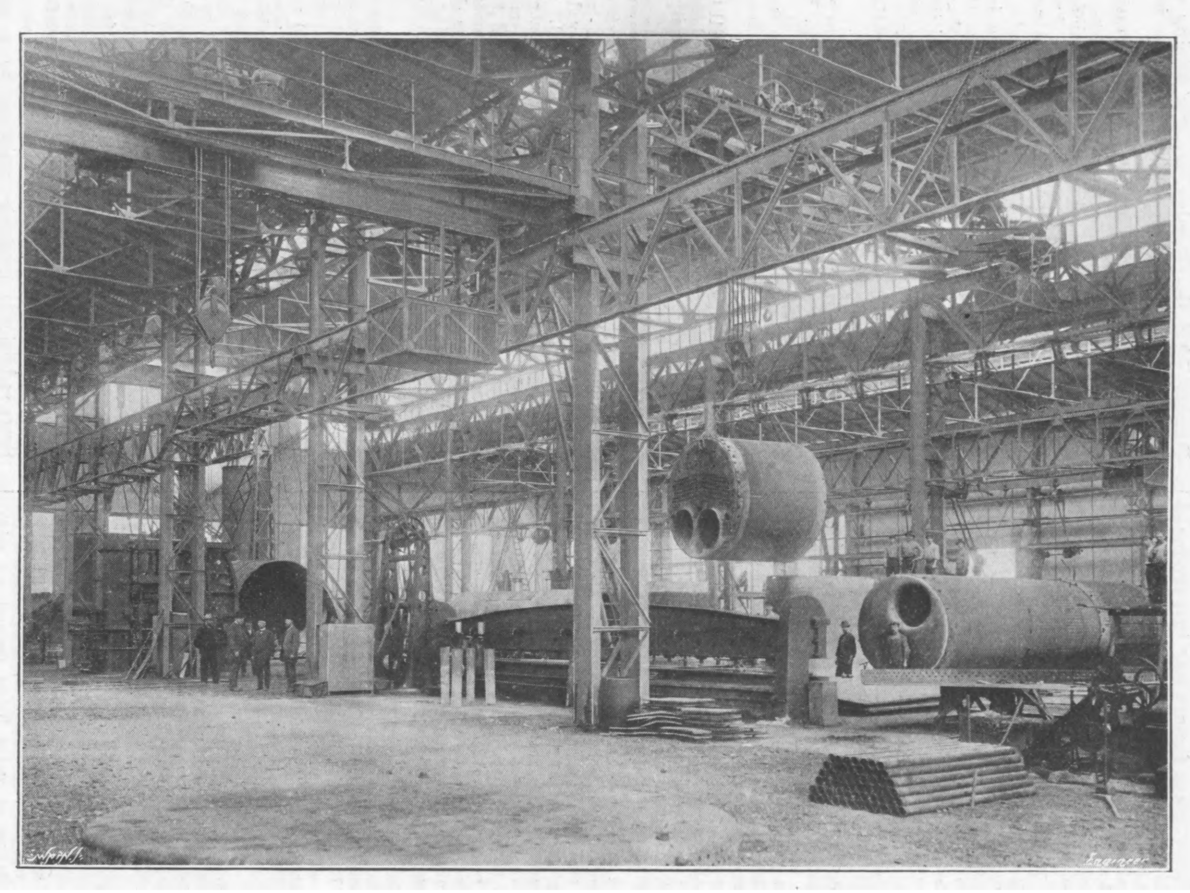


Fig. 12—THE BOILER SHOP

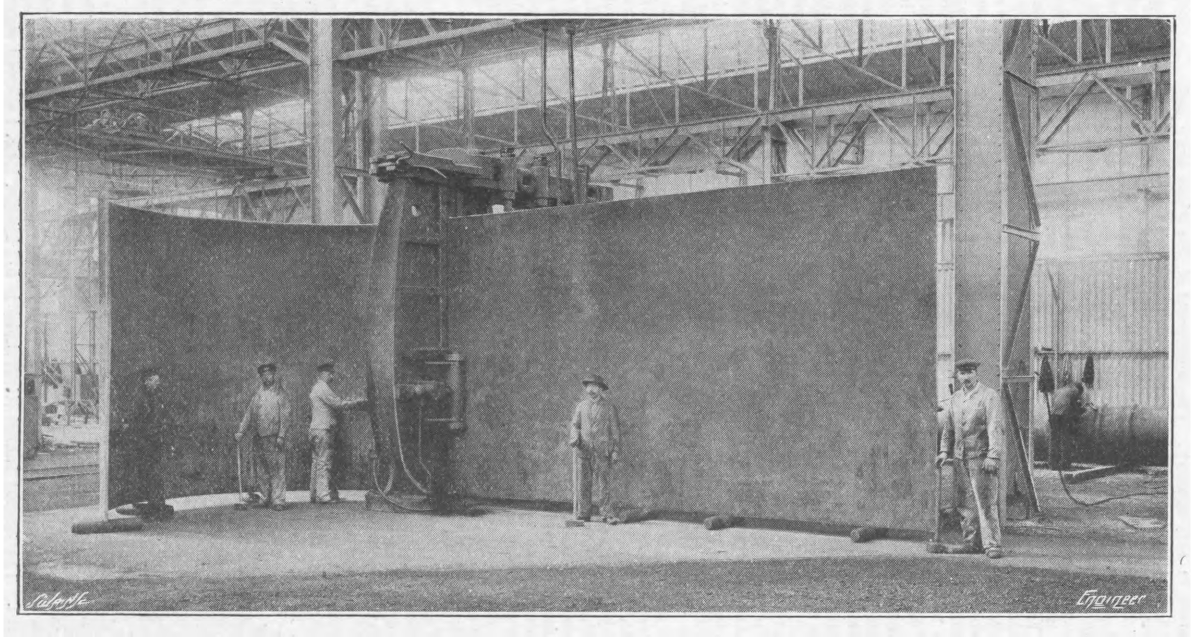


Fig. 13—PLATE BENDING MACHINE

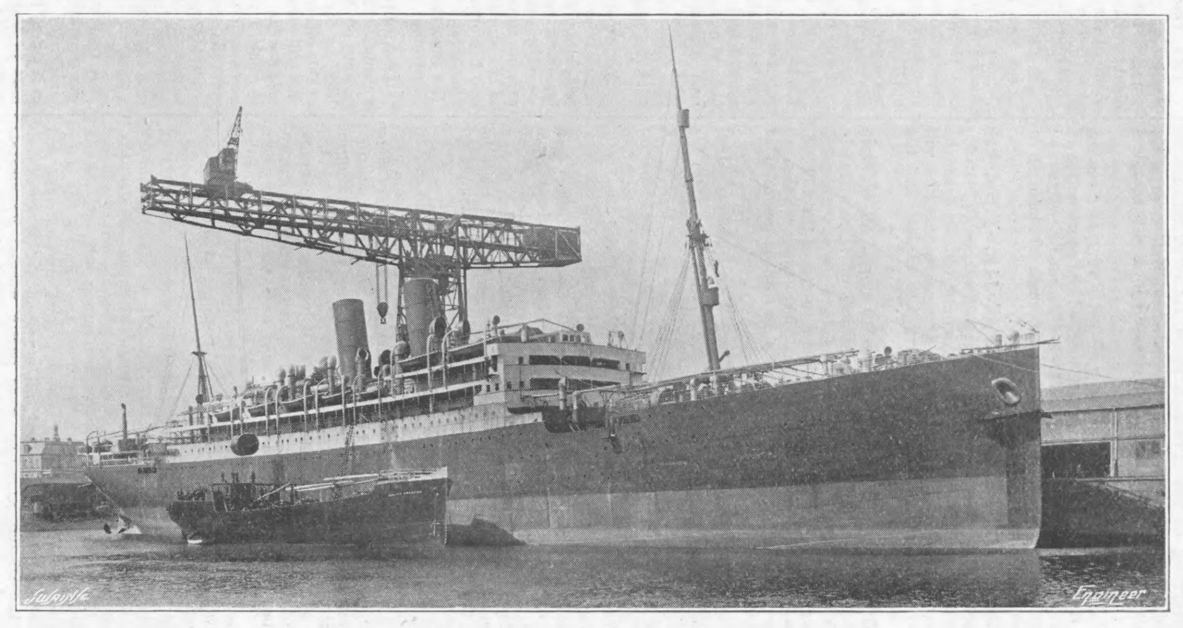


Fig. 14—150-TON REVOLVING TOWER CRANE

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TO CORRESPONDENTS.

☛ *In order to avoid trouble and confusion we find it necessary to inform correspondents that letters of inquiry addressed to the public, and intended for insertion in this column, must in all cases be accompanied by a large envelope legibly directed by the writer to himself, and stamped, in order that answers received by us may be forwarded to their destination. No notice can be taken of communications which do not comply with these instructions.*

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☛ ***We cannot undertake to return drawings or manuscripts; we must, therefore, request correspondents to keep copies.***

REPLIES.

VAGRANT.—Your proposal that part of the weight of a locomotive should be transferred from carrying to driving wheels is old. Patents have been taken out for arrangements of the kind. See abstracts "Aids to Locomotion" at the Patent-office Library.

R. W. (Upton Park).—If you get into a marine shop, and from there get to sea, you might be permitted, after having served at least one year at sea, to sit for examination for a second's certificate. As a rule, however, training in steam engine works is held to be necessary. Get a copy of the Board of Trade "Regulations for the Examination of Engineers in the Mercantile Marine," price 6d.

MEETINGS NEXT WEEK.

INSTITUTE OF MARINE ENGINEERS.—Monday, December 6th, at 8 p.m., at 58, Romford-road, Stratford, E. Paper, "The Engine-room Telegraph," by Mr. J. M. Newall.

SOCIETY OF ENGINEERS.—Monday, December 6th, at 7.30 p.m., in Room 18, Caxton Hall, Westminster. Ordinary meeting. Paper, "The Mechanics of Dust," by C. H. W. Biggs.

GEOLOGISTS' ASSOCIATION, LONDON.—This evening, at 8 p.m., at University College, Gower-street, W.C. Lecture, "The Volcanic and Alpine Regions of New Zealand," by Albert E. Kitson, F.G.S.

THE ASSOCIATION OF ENGINEERS-IN-CHARGE.—Wednesday, December 8th, at St. Bride's Institute, Bride-lane, Fleet-street, E.C. Paper, "Recent Developments in Impulse Steam Turbines," by Mr. George B. Williamson. (Illustrated by lantern slides.)

THE INSTITUTION OF ELECTRICAL ENGINEERS.—Thursday, December 9th, at 8 p.m., at the Institution of Civil Engineers, Great George-street, Westminster, S.W. Ordinary general meeting. Paper, "Notes on Methods and Practice in the German Electrical Industry," by L. J. Lepine and A. R. Stelling.

THE INSTITUTION OF CIVIL ENGINEERS.—Tuesday, December 7th, at 8 p.m., at Great George-street, Westminster, S.W. Ordinary meeting. Paper, "Marine Propulsion by Electric Motors," by Henry Alexander Mavor, M. Inst. C.E. Wednesday, December 8th. Students' visit to Messrs. Barclay, Perkins and Company's Brewery, Park-street, Southwark, S.E.

ROYAL SOCIETY OF ARTS.—Monday, December 6th, at 8 p.m., at John-street, Adelphi, London, W.C. Cantor Lecture: "Aeronautics," by Charles Cyril Turner. Wednesday, December 8th, at 8 p.m. Ordinary meeting. "The Destruction of Plumage Birds," by James Buckland. Thursday, December 9th, at 4.30 p.m. Indian Section. "The Punjab," by Sir James Wilson, K.C.S.I.

THE ENGINEER.

DECEMBER 3, 1909.

Novel Types of Warships?

A CHARACTERISTIC of the sea serpent is that one never knows where it will make its appearance next. Though this is not the "silly" season, we are led to the above reflection by a perusal of the recently published "Navy League Annual," where the gas-engined battleship is again put forward as a possibility to be reckoned with in the immediate future. It is not, however, our present purpose to waste words on this subject. The futility of building up a design on conjectures about a type of machine which is yet in its infancy as regards application to marine propulsion was made fully apparent at the last spring meeting of the Naval Architects. The erroneous deductions frequently made as to the weight and space required for gas engines have been exposed in our columns, and the general situation as to the present impracticability of gas engines in large sizes for warship propulsion was accurately expressed in the presidential address of Admiral Oram to the Junior Institute of Engineers. Nevertheless, we suppose the gas-engined battleship will continue, like the sea serpent, to make occasional visits. We would merely remark that as one of the aims of the Navy League is educational, it should exercise some sort of discrimination as to the matter included in its "Annual," or else label it, as Artemus Ward used to do, with the words "N.B.—this is a goak." The truth is that speculation on ship designs, and warship designs in particular, is fascinating but, on the whole, unprofitable work. The practicability of associating a number of qualities together in a design can only be determined by the trained naval architect after a great many calculations have been made. The design-monger as a rule thinks of the military qualities only—speed, armour, and armament, whereas the naval architect has to determine how much of each of these qualities can be combined in a vessel which shall at the same time have sufficient strength, stiffness, seaworthiness, and stability. Take, for example, a suggestion in another article of the Navy League Annual that some of our obsolete warships could be converted into floating batteries. The writer suggests that such vessels as the old Devastation could have had modern 12in. guns to replace the old 10in., six or eight 4.7in. quick-firers mounted on a superstructure amidships, and the old iron armour replaced by modern. "Thus by *intelligent* modification—the italics are ours—we should have a vessel substantially suited for bombarding purposes." The writer goes on to require minute sub-division of the hull, and torpedo net defence. It all sounds so very simple, yet a little consideration will show that the proposals involve the redistribution of a very large proportion of the displacement, mostly in the direction of adding top weight, and the possibility of doing it without destroying stability altogether is very much open to question. When to this consideration is added the very large expense of removing the old armour and replacing it by new, and of fitting the additional water-tight bulkheads to give the minute sub-division of the hull, the absurdity of the scheme is manifest. If floating batteries are necessary, it would be much cheaper to build new vessels. The question of reconstruction has often been before the various Admiralties confronted with a number of obsolete vessels. The policy of our own Admiralty has almost invariably been against it, as the gain can never be shown to be commensurate with the cost. There is always, too, the further difficulty to which we have previously referred. The general tendency of progress on warships is towards lighter machinery and heavier armour and armament, and to reconstruct a ship to bring her up to date means taking weight from below and adding it on top, with a consequent reduction of stability. The writer of the article to which we have referred goes on to suggest the building of an improved Polyphemus, the line of argument being that speed in destroyers cannot go on increasing indefinitely, that the secondary armament of battleships must be increased in size, and, therefore, the torpedo boat destroyer must be armoured to provide protection against the increased size of projectiles. The writer mentions a proposal, which has been made in an Austrian publication, for a torpedo battleship carrying thirty submerged torpedo tubes and twenty 4.7 guns, and then suggests that the improved Polyphemus could be made a good deal smaller than this, having a 6in. armoured cigar-shaped hull—there is much virtue apparently in the cigar—carrying six or eight tubes, a few 4.7 guns, and able to steam at 28 to 30 knots. We are not much concerned with the assumptions made, nor of the subsequent flight of the imagination by which the writer arrives at the type of vessel which is to replace existing torpedo craft; the reasons for embarking on an experiment of this sort are altogether inconclusive. The lessons to be gained by the construction of these freak vessels are at the best negative, in that they are generally failures, and only serve to indicate what should be avoided rather than to give any positive lead in new construction. The Polyphemus herself was a case in point. As originally conceived by Admiral Sartorius, she was much of the shape of the present submarines, but modifications had to be made to prevent undue pitching, and to give a reasonable amount of stability. These changes consisted in the addition of a superstructure forward and aft, and some 250 tons of ballast in the form of huge cast iron blocks housed in a wide hollow keel. Some of these could be dropped in the event of the vessel shipping water, a precaution considered necessary by the low reserve of buoyancy. Designed primarily for ramming, she had also five submerged tubes, four on the broadside and one at the bow. As an effective fighting unit she was never of any value, and the only excuse that could be urged for keeping her so long in commission was that at the time she had more torpedo tubes than any other vessel in the service, and served as a training ship, though she was never officially recognised as such. We need not recapitulate the early troubles with her locomotive boilers (subsequently replaced by cylindrical) nor the historic "jumping the boom" in Bantry Bay after she was finally completed for service. Her full speed could not be realised without heavy forcing of the boilers, and at natural draught she was barely equal to 14 knots. She was a most uncomfortable ship to live in and a bad sea boat, while her range of stability was sufficiently small to give rise to a certain amount of anxiety in bad weather. Added to this, her coal capacity was so low that the passage from Portsmouth to Gibraltar at economical speed could not be undertaken without calling at an intermediate port for coal.

We have learnt by experience that the safest way in warship progress is development by successive stages. The 1200-ton ocean-going destroyer of the present day is the direct lineal descendant of the earliest torpedo boats of only one-fiftieth the displacement of thirty years ago. So far as one can make any conjecture at all, it appears probable that if a torpedo vessel on the lines of the Polyphemus is to come again into being (*i.e.*, with submerged tubes in contra distinction to the above water tubes of the present destroyers), it will be as a development of the present submarine. In an article on the evolution of submarine vessels, far removed in its tenour from the crude speculation of the two other articles in the "Annual" from which we have quoted, M. Laubeuf considers it will be wise to stop at 600 tons displacement, which will allow a surface speed of 16 knots. The increasing difficulty in providing the necessary power as the size of the submarine is increased will no doubt make progress slow, and unless rapid developments are made in the internal combustion engines used for propulsion, it will be several years before the 600-ton limit laid down by M. Laubeuf, which has already been attained by our own D 1, is exceeded. M. Laubeuf, for reasons of seaworthiness among others, prefers the submersible with a larger reserve of buoyancy to the submarine proper, and if the functions of this type of vessel are to be extended, it may well be that as they grow in dimensions the reserve of buoyancy will be increased, and eventually the ability to dive done away with altogether. Whether such a vessel, which would sacrifice invisibility for the sake of speed and sea-keeping qualities, would be sufficiently useful to justify its existence, depends to a large extent on the development of other classes of ships, but to pursue the matter further would be to enter into those realms of speculation the exploration of which beyond very moderate limits we have already deprecated.

Inland Waterways and Railways.

It is expected that the final Report of the Royal Commission on Canals and Waterways will be presented within the next few weeks, and in all probability the document will be in the hands of the public before the close of the year. There is little likelihood that the Report will be unanimous—in fact, more than one Minority Report may be expected. In view of the interest which is sure to be aroused by the publication of the Report, it is worth while recalling some of the conclusions which have been arrived at by a Commission appointed by Mr. Roosevelt in 1907 to make a similar inquiry into the condition of the inland waterways of the United States. The preliminary Report of the Commission has been published, and deals exhaustively with the general question of inland navigation in the States, detailed recommendations as to works to be undertaken in connection with the waterways being apparently reserved for a later Report. Incidentally, the Commissioners discuss the condition of inland navigations in Europe, and make some shrewd criticisms on the causes which have led up to the existing state of affairs, not only in the United Kingdom, but in other countries, and on the future possibilities of canals and railway transport.

Mr. Roosevelt, in his message covering the Report, stated that the appointment of the Commission was due to "the general and admitted inability of the railroads to handle promptly the traffic of the country, and especially the crops of the previous fall," and this statement is borne out by the findings of the Commissioners. On the other hand, however, the existing inland navigations are not employed nearly to their full, and the Commissioners in a paragraph, which is particularly applicable to the conditions obtaining in our own country, recommend that "any plans for improving the inland waterways shall take account of the present and prospective relation of rail lines to such waterways, and shall ascertain, so far as may be, whether such waterways when improved will be effectively used in the face of railway competition." When one remembers the immense extent of natural inland waterways in the United States and the many efficient canals, the serious decline in the water-borne traffic is a factor which cannot be neglected in estimating the future prospects of inland navigation not only in America but in our own country. The Commissions seek to apply the lessons which they are able to draw from the history and present conditions of European waterways to their own needs, and have come to the conclusion that the revival of interest in waterways, taking place at about the same period in different countries, is due to dissatisfaction with railroad conditions, and to a developing opinion that best results may be secured by the exploitation of both transportation systems—rail and water. As to this belief they say:—"In no country has it been possible to secure satisfactory development of both systems until one was protected against the other. As a rule, it has been necessary to invoke the power of the State to save the traffic of waterways from destruction by railway competition." Yet they believe that this fact by no means demonstrates the economic inutility of waterways, and experience has convinced those countries which have fostered inland navigation that the best and most economic transportation is to be secured only by maintaining both systems at high efficiency. Great Britain is set down as the one exception among European industrial countries in which this fostering policy has not been practised; the reasons for this state of affairs are admirably and succinctly summarised in a paragraph which we quote in full:—"It was doubtless only natural that in Great Britain and the United States the waterways revival should have been postponed longer than in continental countries. It is fashionable to attribute the delay in these two countries to the influence of the railroads, and no doubt this was a factor of importance. But other considerations must be assigned due weight. In England the most important consideration was the easy accessibility of ocean transportation; and, secondly, was the fact that for various physical reasons the construction of canals is more difficult and expensive in England than in most continental countries. England has no such great rivers as the Danube, the Rhine, the Elbe, the Oder, the Seine, and other great water highways of the Continent. The topography of Great Britain makes canal construction more difficult than on the Continent. The country is more uneven, and more locks would be required, involving greater expense. The question of water supplies for the higher levels is so serious as, in the opinion of some authorities, to bar Great Britain from ever securing economically a system of waterways approaching the efficiency of those in France, Belgium, the Netherlands, Germany, and even Austria-Hungary." This expresses very concisely the differences that exist between the United Kingdom and the Continent of Europe, and should be borne in mind by those who use the argument that because Germany, France, or Belgium have found canals profitable we also should do the same. Advocates of waterway development have to face the fact that in different countries it has been found necessary to adopt vigorous measures to prevent the railways from destroying the business of the waterways by the simple process of hauling freight more cheaply than it could be moved by water, and, we might add, more expeditiously. This is a fact which must be explained away in any effective argument in favour of water transportation as against railways. Not only in the United Kingdom, but in Germany, in France, and in Belgium, three countries whose waterway systems have reached the highest perfection, the railways have proved their ability to take the tonnage away from water routes and to keep it away from them. Railways have done this, too, in the face of the fact that they are required to earn not only working expenses, but heavy charges on capital, while the canals are operated in the main free of charge. Practically the only expenses attached to water transportation on continental navigations is that for mere operation of boats and barges. The water highway has been provided at Government expense. Commerce moving on it has not been expected to remunerate the State, or even to pay interest on capital. With the railways thus handicapped, if the waterways cannot take care of themselves the burden is upon waterway advocates to prove the waterways' economic right to survive. On these lines the Commissioners state the case against the advocates of waterway extension and their presentment cannot be too carefully studied. They then proceed to state the case for water transportation as applied to the needs of their own country, and they are certainly able to show that the development of a policy of fostering their waterways in certain directions may be justifiable and desirable if only the principle of restriction of railway competition is admitted.

It is needless to point out that the physical conditions of the waterways, natural and artificial, in the United States are very different from those which surround our own, and while the Commissioners draw their conclusions from the facts of British and continental navigation, and use them in formulating a policy of development for their own needs, it is evident that they do not intend their findings to be applicable to the question as presented in this country, and naturally it is outside their province to attempt the task of supplying an opinion on the future of our own waterways. But coming from a body of expert investigators, whose impartiality as regards the inland navigations of Europe cannot be questioned, the statements we have summarised are of no little value, and it will be of interest to know, when the Report of the Royal Commission is issued, how far they are confirmed by the investigations of that body.

The Purchase of Rolling Stock.

A circumstance which recalls the manner in which orders are occasionally placed with British firms for the delivery of locomotives and rolling stock in general for the Indian railways has just arisen in France, where the question of railway requirements in French colonies and protectorates comes into consideration. The proposed method of dealing with the problem possesses a certain amount of interest in the United Kingdom at the present time. The system, or rather the lack of system, under which contracts are distributed in France has long been a source of complaint on the part of French locomotive and wagon builders, as they have for many years past either been inundated with orders or have had comparatively little work to complete for the home and colonial railways, whether State owned or the property of companies enjoying Government guarantees; and when the builders find that a certain amount of business is being, and is likely to be, again diverted to other countries, so as to effect rapid delivery, they are inclined to conclude that the existence of such a practice is scarcely in the interest of national industries. In the circumstances the leading French firms recently approached the Government with the object of bringing pressure to bear to prevent orders for locomotive and rolling stock being placed in other countries, or at all events to secure greater regularity in the allocation of contracts to native builders. It is noteworthy that this application has been acceded to, in so far that the Minister of Public Works has appointed a Government Commission to inquire into the technical, economic and administrative conditions under which orders are assigned to makers, and the construction of locomotives and rolling stock in France, and to submit recommendations on the subject. The Commission, which has as President the General Inspector of French Means of Communication, is also composed of representatives of the principal railways, various Government departments, locomotive builders, and the iron and steel trades; and the report to be prepared on the matter is to be ready in the short period of four months. The chief object of the commission is to investigate the problem as to the adoption of a more regular course in the distribution of French railway orders, and the commission will in pursuance of it pay visits of inquiry to Germany, Belgium, and England.

The appointment of this Government Commission of Inquiry has been received with satisfaction in France, especially as some railway orders have recently been sent over the frontiers, and as extensive contracts for 1910 are believed to be in contemplation. By a curious coincidence, an unofficial investigation of the identical question was made early in 1908 both with regard to Belgium and France, and the documentary evidence then collected showed an extraordinary variation in the distribution of orders in both countries in a period extending over the twenty-five years ended with 1905, whilst the expansion which took place in the following year was truly phenomenal. The case of Belgium may be left out of consideration, except to notice that the State Railway authorities pursue the same erratic policy in the allocation of orders as the French railway companies, and probably, also, the State Railways, although the Belgian work is apparently all entrusted to native firms for execution. On the other hand, various French orders have been given to German works and Belgian builders, and a Teutonic newspaper actually stated a few weeks ago that in a recent year German works supplied locomotives to France alone of the value of £5,000,000. The assertion is, however, a vast exaggeration, seeing that the total value of the rolling stock, apparently including locomotives, ordered in France in 1906, which is obviously the year referred to, and which was the year of maximum expenditure incurred by the French railways in this direction, amounted only to the sum—enormous enough—of £5,486,000, and of it contracts representing only £968,000 were allocated to other countries. No doubt Germany received the greater portion of the work, and Belgium would probably rank second, whilst British locomotive builders participated to the extent of no more than £27,000; but it is uncertain from the Board of Trade returns whether Great Britain had any share in the provision of the coaches and wagons which were included in the total value of the contracts in that year.

The productive capacity of the French locomotive builders is estimated at 450 engines per annum, whereas the minimum number of engines ordered by the

French railways in a single year during the quarter of a century ended with 1905 was 38, the maximum was 741, and the next highest was 315. With such wide variations in the number of locomotives, and with similar divergences in the case of rolling stock, it is scarcely surprising to find that the lack of foresight in a period of rising prosperity causes a diversion to other countries of a portion of the work which could have been carried out by native builders if it had been equally distributed over other years when trade was less satisfactory, raw materials cheaper, finished manufactures obtainable at lower prices, and delivery more readily and speedily effected. A similar observation was applicable to India a few years ago in so far as British builders were concerned, and also to South Africa and probably Egypt, but it was of a less pronounced character than in France from a commercial point of view. Even at the present moment there can be no doubt that railway material might be bought in Sheffield at a considerable advantage. In the case of India alone a sum of nearly £250,000 was expended both by the Government and the private railways in 1903-4 on the purchase of locomotives from Germany, although the imports from that country in this respect have ceased since that time, but the acquisition of foreign rolling stock, particularly from Belgium, has continued for both classes of railways, excepting for the State lines in 1907-8. Notwithstanding the large loss to the State on the working of the Indian railway system in 1908, the trade of the country is improving, and is now regarded as reviving, and it may be that the needs of the railways in the matter of additional locomotives and rolling stock will soon begin to manifest themselves. As soon as these indications become visible, it should be open both to the State and the private railways to make early preparations for meeting the expected requirements of traffic. If the State is unable to provide the additional £2,000,000 per annum recommended by the Committee on Indian Railways for works and equipment, increased facilities should be afforded the companies for raising any additional capital required for the purpose, and if the negotiations which were recently referred to in the House of Commons are successful, there is hope of an improvement in the future; but this will scarcely affect the question that a more equal distribution of orders over various years is a desirable object which should be sought as far as possible.

NOTES ON THE DESIGN OF SHAFTS, WITH SPECIAL REFERENCE TO HIGH-SPEED ELECTRIC GENERATORS.

By H. H. JEFFCOTT.

No. IV.[*]

22. In addition to avoiding the two mechanical causes of lateral instability treated in my last article, it is, of course, of the greatest importance that a sufficient factor of safety should obtain in any given case. We will examine the factor of safety for a load consisting of flexure, torsion, and rotational stresses.

Let the shaft be under a force X perpendicular to its length at a point distant z_1 from one end (the origin), be under a torsion couple H, and be rotating with a velocity ω. If e, f, g, a, b, c be the six strain components at any point (x, y, z) in the shaft, it may be shown that

$$e = -\mu\sigma(l - z_1)zx + \lambda\left\{(3 - 2\sigma)a^2_1 - 3x^2 - y^2\right\}.$$

$$f = -\mu\sigma(l - z_1)zx + \lambda\left\{(3 - 2\sigma)a^2_1 - x^2 - 3y^2\right\}.$$

$$g = \mu(l - z_1)zx.$$

$$a = -\tfrac{1}{2}\mu(l - z_1)xy(1 + 2\sigma) + \tau x.$$

$$b = \tfrac{1}{2}\mu(l - z_1)\left\{\left(\frac{3}{2} + \sigma\right)(a^2_1 - x^2) + (\sigma - \tfrac{1}{2})y^2\right\} - \tau y.$$

$$c = -4\lambda xy.$$

Where $\lambda = \dfrac{\omega^2\rho(1 + \sigma)(1 - 2\sigma)}{8\,\mathrm{E}(1 - \sigma)}$, $\mu = \dfrac{\mathrm{X}}{\mathrm{EI}l}$, $\tau = \dfrac{\mathrm{H}(1 + \sigma)}{\mathrm{EI}}$, σ is Poisson's ratio, and ρ is the density of the material; a_1 is radius of section of shaft, $\mathrm{I} = \frac{1}{4}\pi a^4_1$.

These are the strains from o to z_1. From z_1 to l the strains are obtained by writing $l - z$ for z, and $l - z_1$ for z_1. If the shaft is under torsion throughout the length o to z_1 only, we put $\tau = o$ for the portion z_1 to l.

23. If the shaft be hollow, of external and internal radii a_1 and a_2, then the strain terms in λ become

$$e = \lambda\left\{(3 - 2\sigma)(a^2_1 + a^2_2) + \frac{3 - 2\sigma}{1 - 2\sigma}\cdot\frac{a^2_1 a^2_2}{(x^2 + y^2)^2}(y^2 - x^2) - 3x^2 - y^2\right\}.$$

$$f = \lambda\left\{(3 - 2\sigma)(a^2_1 + a^2_2) + \frac{3 - 2\sigma}{1 - 2\sigma}\cdot\frac{a^2_1 a^2_2}{(x^2 + y^2)^2}(x^2 - y^2) - x^2 - 3y^2\right\}.$$

$$g = a = b = o.$$

$$c = -4\lambda xy\left\{1 + \frac{3 - 2\sigma}{1 - 2\sigma}\cdot\frac{a^2_1 a^2_2}{(x^2 + y^2)^2}\right\}.$$

24. It is to be noted that if the load X is unidirectional (as gravity) the strains set up in the shaft thereby will vary in direction as it rotates. Thus, the load is of the nature of a rapidly (though gradually) reversed load, and, according to Wöhler's results, the ordinary breaking stress is seriously reduced: a factor of safety of about three will be required.

It is important further that the period of reversal (*i.e.*, the speed of the shaft) should not be nearly equal to the free period of vibration of the particles of the shaft (in the gravitational displacement type), else the alternating displacements may become very great and the strains be cumulative. This period is approximately the period of longitudinal vibration of the loaded shaft. Above this speed the period of reversal of the load is more rapid than that in which the ordinary (gravitational) displacements can occur, and the amplitude of the displacements falls off in consequence. In other words, the shaft tends to straighten out, for, with the neutral axis more nearly straight, the gravitational displacements at any point are less. Further, if a dynamo shaft thus becomes less deflected by gravity, the armature is raised higher in the field than before, and the upper poles exert a greater force than the lower; so that for this reason in addition the shaft will still more tend to straighten.

The higher the speed the greater the tendency for the neutral axis to be straight (instead of curved in the single gravitational loop), while at or near the longitudinal vibration speed there is a possibility of cumulative strains. It should be noted, however, that this speed is considerably higher than that at which dynamos are usually run.

Now, if the factor of safety be taken as dependent on the maximum strain, we may notice that above the longitudinal vibration speed the strains due to the gravitational or flexural load become less. The higher the speed, however, the greater are the rotational strains, so when the rotational strains become great the flexural strains may fall off. If, indeed, the speed be indefinitely great the strains due to the flexural load become evanescent on the ordinary theory of beams. The material along a straight line parallel to the neutral axis and distant r from it would, if the shaft were bent, experience a forced alternate extension and compression of period equal to the period of rotation of the shaft. When the speed is infinite this material would require to have an infinite velocity longitudinally in alternately opposite directions, and this infinite velocity would have to be produced by a finite force (gravity) acting for an indefinitely short time. Hence, the shaft axis is straight at such a speed.

Mathematically, the reasoning is as follows:—Consider a particle of a fibre which is parallel to the neutral axis. Its equation of motion is of the type $a\dfrac{d^2z}{dt^2} + b\dfrac{dz}{dt} + cz = f\sin pt$, where a is its mass, b the coefficient of damping, c the elastic force of restitution, and $f\sin pt$ is the disturbing force at any instant t, so that p is the frequency (multiplied by 2π) of the force. The solution of this equation is

$$z = \frac{f}{\sqrt{(ap^2 - c)^2 + b^2p^2}}\sin(pt + \beta) + \mathrm{A}e^{-\frac{bt}{2a}}\sin(p't + \alpha),$$

where A and α are arbitrary constants, $\tan\beta = \dfrac{bp}{ap^2 - c}$ and the frequency (multiplied by 2π) of free vibration p' is $\dfrac{\sqrt{4ac - b^2}}{2a}$.

If t be sufficiently great the exponential term is negligible, so that the final amplitude of the forced vibration is given by $\dfrac{f}{\sqrt{(ap^2 - c)^2 + b^2p^2}}$. This is maximum when $p = \dfrac{\sqrt{4ac - 2b^2}}{2a}$, and we notice that this value of p approximates to p' when the damping b is small. Thus the amplitude increases from $p = o$ to $p = \dfrac{\sqrt{4ac - 2b^2}}{2a}$, after which it falls off to zero when p is infinite; p is, of course, proportional to the speed.

If we neglect damping we may determine the free period of longitudinal vibration of the particles of the shaft, at which a possibility of cumulative strain occurs. The usual Bernoulli-Eulerian assumptions will be made.

Consider a particle of a thin fibre which is parallel to and at a distance r from the neutral axis in its gravitationally deflected position. The equation of motion for forces parallel to the length of the shaft is $\rho\dfrac{d^2w}{dt^2} = \mathrm{E}\dfrac{d^2w}{dz^2}$, where ρ is the density of the material of the shaft, and w is the component of displacement of the particle parallel to the length of the shaft.

Now $w = r\theta\sin\omega t$, if θ is the inclination of the neutral axis at the point considered to its unstrained direction, and if the neutral axis be supposed to remain stationary, θ is independent of t. Then $-\rho\theta\omega^2 = \mathrm{E}\dfrac{d^2\theta}{dz^2}$. If we assume $\theta = \mathrm{C}\sin kz$ we find $\omega^2 = \dfrac{\mathrm{E}}{\rho}k^2$. Now for a uniform massive shaft of length $2l$, supported at its extremities, $\theta = \dfrac{g\rho\mathrm{A}z}{6\,\mathrm{EI}}(3l^2 - z^2)$, where A is the area of cross-section. In order that ω may represent approximately the free period of the deflected shaft, we determine k, so that the two values of θ are the same at a number of points along the shaft.

Let us choose the points $-l$, $-\frac{1}{2}l$, o, $\frac{1}{2}l$, l, the origin being the middle point of the shaft.

$$z = o \text{ gives } \theta = o \text{ in both equations.}$$

$$z = \pm\tfrac{1}{2}l \text{ gives } \mathrm{C}\sin\tfrac{1}{2}kl = \frac{11\,g\rho\mathrm{A}l^3}{48\,\mathrm{EI}}.$$

$$z = \pm l \text{ gives } \mathrm{C}\sin kl = \frac{g\rho\mathrm{A}l^3}{3\,\mathrm{EI}}.$$

Hence $\cos\frac{1}{2}kl = \dfrac{8}{11}$, and $\therefore \frac{1}{2}kl = 2n\pi \pm 0.75645$.

$$\therefore k = \frac{\pi}{2l}\times\left\{8n \pm 0.963\right\}.$$

$$\text{Hence } \omega = \frac{\pi}{2l}\sqrt{\frac{\mathrm{E}}{\rho}}\times\left\{8n + 0{\cdot}963\right\}.$$

Accordingly the particles of the bar have a free period of longitudinal vibration ω given by this equation, when the curvature of the bar approximates to the gravitationally deflected form. It will be noticed that the fundamental period of this approximate result does not differ much from $\dfrac{\pi}{2l}\sqrt{\dfrac{\mathrm{E}}{\rho}}$, which is the free period of longitudinal vibration of the half bar when straight.

It may be noticed here that Dr. Stodola, in his treatise on the "Steam Turbine," gives a mathematical determination of the period of longitudinal vibration of the particles of a deflected shaft. Unfortunately, there is a serious error in the application of D'Alembert's equation of moments at the outset of the work. The effective, or accelerative, force of the particle parallel to the length of the shaft is duly considered, but the effective force at right-angles to the length, and in the plane of bending, is entirely omitted from the equation of moments. If it were included, the moment of the effective forces about a line perpendicular to the plane of bending would be found to vanish, and so the method of solution fail.

25. In estimating the strength of the shaft, we may follow the greatest strain theory, in which the greatest strain at any point is limited. In this case the expressions for the strains e, f, g, a, b, c at each point are to be transformed to the principal planes of strain, and thus the principal strains e_1, f_1, g_1 determined.

If Φ be the factor of safety, and T_o the longitudinal breaking stress, the maximum greatest value of e_1, f_1, g_1 at any point $= \dfrac{\mathrm{T}_o}{\mathrm{E}\Phi}$.

If we follow the greatest stress theory, we have to limit the maximum greatest of the principal stresses $\mathrm{P}_1, \mathrm{Q}_1, \mathrm{R}_1$ (which are obtainable from e_1, f_1, g_1 and certain elastic constants). The maximum greatest of $\mathrm{P}_1, \mathrm{Q}_1, \mathrm{R}_1$ at any point $= \dfrac{\mathrm{T}_o}{\Phi}$.

The maximum stress difference theory of strength requires that the greatest difference in the principal stresses $(\mathrm{P}_1, \mathrm{Q}_1, \mathrm{R}_1)$ at any point shall not exceed a certain value for the material, the factor of safety being again the ratio of the limiting value to the maximum value present.

26. In general it is difficult to determine the values of e_1, f_1, g_1, and the maximum greatest principal strain. It is easier to examine separately the strains due to flexure, torsion and rotation.

1. *Flexure.*—Strains are

$$e = f = -\mu\sigma zx(l - z_1).$$

$$g = \mu zx(l - z_1).$$

$$a = -\tfrac{1}{2}\mu xy(1 + 2\sigma)(l - z_1).$$

$$b = \tfrac{1}{2}\mu(l - z_1)\left\{\left(\frac{3}{2} + \sigma\right)(a^2_1 - x^2) + (\sigma - \tfrac{1}{2})y^2\right\}.$$

$$c = o.$$

We may note that a, b, c are small compared with e, f, g, since x, y are generally small compared with z. Omitting a, b, c, we can regard e, f, g as principal strains, which are then

$$e_1 = f_1 = -\mu\sigma zx(l - z_1);\quad g_1 = \mu zx(l - z_1).$$

The greatest of these is $\mu zx(l - z_1)$, which is maximum when $z = z_1$, and $x = a_1$. Thus, the maximum greatest principal strain due to flexure is $g_1 = \mu z_1 a_1(l - z_1)$.

2. *Torsion.*—Here the strains are

$$e = f = g = c = o;\ a = \tau x,\ b = -\tau y.$$

Hence $e_1 = -f_1 = \frac{1}{2}\tau\sqrt{x^2 + y^2}$; $g_1 = o$.

The maximum greatest principal strain due to torsion is $e_1 = \frac{1}{2}\tau a_1$, and it occurs at any point on the surface of the shaft.

3. *Rotation.*—The strains are

$$e = \lambda\left\{(3 - 2\sigma)a^2_1 - 3x^2 - y^2\right\}.$$

$$f = \lambda\left\{(3 - 2\sigma)a^2_1 - x^2 - 3y^2\right\}.$$

$$g = a = b = o.$$

$$c = -4\lambda xy.$$

Hence we find

$$e_1 = \lambda\left\{(3 - 2\sigma)a^2_1 - (x^2 + y^2)\right\}.$$

$$f_1 = \lambda\left\{(3 - 2\sigma)a^2_1 - 3(x^2 + y^2)\right\}.$$

$$g_1 = o.$$

The maximum greatest principal strain is $e_1 = \lambda a^2_1(3 - 2\sigma)$, which occurs at any point on the axis of the shaft.

We notice that the greatest strain occurs in the section $z = z_1$, so that we may limit our inquiry to that section.

27. The greatest principal strain at any point due to the combined loads will not be greater than the sum of the greatest principal strains for each load at that point. Further, if the principal planes of strain due to flexure, torsion, and rotation are nearly coincident amongst themselves, we may regard the combined principal strains at any point as equal to the sum of the corresponding principal strains due to each load at the same point.

Let us take three cases in which the maximum principal strain (S) at any point is—

(I.) The sum (S′) of the maximum greatest principal strains at all points due to the separate loads.

(II.) The maximum sum (S″) of the greatest principal strains at any one point due to the separate loads.

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[*] No. III. appeared November 12th.

(III.) The maximum sum (S‴) of the corresponding principal strains at any point due to the separate loads.

Let the factors of safety in these three cases be indicated by Φ', Φ'', Φ'''.

By examining the strains at various particular points due to the separate loads, we find

$$S' \text{ is } \mu\, a_1\, z_1 (l - z_1) + \tfrac{1}{2}\, \tau\, a_1 + \lambda\, a^2{}_1 (3 - 2\,\sigma).$$

Let us take S″ as the greater of $\mu\, a_1\, z_1 (l - z_1) + \frac{1}{2}\, \tau\, a_1 + 2\, \lambda\, a^2{}_1 (1 - \sigma)$, and $\lambda\, a^2{}_1 (3 - 2\,\sigma)$.

Take S‴ as the greatest of $\mu\, \sigma\, a_1\, z_1 (l - z_1) + \frac{1}{2}\, \tau\, a_1 + 2\, \lambda\, a^2{}_1 (1 - \sigma)$, $\mu\, a_1\, z_1 (l - z_1)$, and $\lambda\, a^2{}_1 (3 - 2\,\sigma)$.

The values of the factor of safety are given by

$$E\, \Phi'\, S' = T_o\,;\ E\, \Phi''\, S'' = T_o\,;\ E\, \Phi'''\, S''' = T_o\,.$$

Φ' is certainly less than Φ (the true factor of safety) for S′ is greater than S. In general Φ'', Φ''' will not be greatly different from Φ.

For a more accurate determination of the factor of safety the values of the various constants must be substituted in the expressions for the strains e, f, g, a, b, c, and e_1, f_1, g_1 may be obtained as roots of a cubic equation. The maximum value of e_1, f_1, g_1 can then be determined. In a similar manner the factor of safety may be determined on the greatest stress theory, or on the greatest stress difference theory.

Thus on the maximum stress difference theory—which is gaining prominence in recent experimental work—let D_μ be the greatest stress difference at any point due to flexure alone, D_τ due to torsion, and D_λ due to rotation. Then it may be shown that

$$D_\mu = E\, \mu\, x\, z\, (l - z_1), \text{ if } z \text{ be large compared with } a_1\,;$$

$$D_\tau = \frac{E\, \tau}{1 + \sigma} \sqrt{x^2 + y^2}\,;$$

$$D_\lambda = \frac{E\, \lambda}{1 + \sigma} \cdot \left\{ (3 - 2\,\sigma)\, a^2{}_1 - (x^2 + y^2) \right\}, \text{ if } \frac{x^2 + y^2}{a^2{}_1} < \frac{3 - 2\,\sigma}{3}\,;$$

$$D_\lambda = \frac{2\, E\, \lambda}{1 + \sigma} (x^2 + y^2), \text{ if } \frac{x^2 + y^2}{a^2{}_1} > \frac{3 - 2\,\sigma}{3}\,;$$

and the maximum values of these may be investigated in the same way as has just been done for strains. Then $\Phi \times$ greatest stress difference due to combined loads = maximum allowable stress difference for the material.

In particular, if bending and twisting only be considered, the cubic whose roots are e_1, f_1, g_1 (the principal strains at $x = a_1$, $y = o$ due to the combined load) may be written, if z is great compared with a_1,

$$\begin{aligned} &\alpha^3 - \alpha^2\, \mu\, a_1\, z\, (l - z_1)\, (1 - 2\,\sigma) \\ &\quad - \alpha \left\{ \mu^2\, a_1{}^2\, z^2\, (l - z_1)^2\, \sigma\, (2 - \sigma) + \tfrac{1}{4}\, \tau^2\, a_1{}^2 \right\} \\ &\quad - \mu\, \sigma\, a_1\, z\, (l - z_1) \left\{ \mu^2\, a_1{}^2\, z^2\, (l - z_1{}^2\, \sigma + \tfrac{1}{4}\, \tau^2\, a^2{}_1 \right\} = o, \end{aligned}$$

$$\text{or,}\quad \left\{ \alpha - \mu\, a_1\, z\, (l - z_1) \right\} \cdot \left\{ \alpha + \mu\, a_1\, z\, (l - z_1) \right\}^2 = \tfrac{1}{4}\, \tau^2\, a^2{}_1 \cdot \left\{ \alpha + \mu\, a_1\, z\, (l - z_1) \right\};$$

$$\begin{aligned} \text{so that}\quad e_1 &= \tfrac{1}{2}\, \mu\, a_1\, z\, (l - z_1)\, (1 - \sigma) + \tfrac{1}{2}\, a_1 \sqrt{\mu^2\, z^2\, (l - z_1)^2 (1 + \sigma)^2 + \tau^2}, \\ f_1 &= \tfrac{1}{2}\, \mu\, a_1\, z\, (l - z_1)\, (1 - \sigma) - \tfrac{1}{2}\, a_1 \sqrt{\mu^2\, z^2\, (l - z_1)^2 (1 + \sigma)^2 + \tau^2}, \\ g_1 &= -\, \mu\, a_1\, z\, (l - z_1)\, \sigma \end{aligned}$$

The principal stresses are $P_1 = \dfrac{E}{1 + \sigma} (e_1 - g_1)$; $Q_1 = \dfrac{E}{1 + \sigma} (f_1 - g_1)$; $R_1 = o$. At $x = a_1$, $y = o$ the maximum strain is e_1; maximum stress is P_1; and maximum stress difference is $P_1 - Q_1$.

To determine the bending μ_o that is equivalent to the bending μ and torsion τ combined, we may consider their equivalence dependent on their producing (1) the same maximum strain, or (2) the same maximum stress, or (3) the same maximum stress difference. We hence obtain

$$(1)\quad 4\, (\mu_o - \mu)\, (\mu_o + \mu\, \sigma)\, z^2\, (l - z_1)^2 = \tau^2.$$

$$(2)\quad 4\, \mu_o\, (\mu_o - \mu)\, z^2\, (l - z_1)^2\, (1 + \sigma)^2 = \tau^2.$$

$$(3)\quad (\mu^2{}_o - \mu^2)\, z^2\, (l - z_1)^2\, (1 + \sigma)^2 = \tau^2$$

Or, if M is the bending moment, and H the twisting couple at the point considered, the equivalent bending moment M_o is given by

$$(1)\quad 4\, (M_o - M)\, (M_o + M\, \sigma) = H^2\, (1 + \sigma)^2.$$

$$(2)\quad 4\, M_o\, (M_o - M) = H^2.$$

$$(3)\quad M^2{}_o - M^2 = H^2.$$

THE NEW CAPITAL OF AUSTRALIA.

According to recent cables, and leaving out of account some formalities, we may now consider the question of the site for the capital of the Commonwealth as finally settled by the assent of the Senate. It may be remembered that the ultimate choice involved two decisions—first, as to the locality of the territory to be owned by the Commonwealth; and, secondly, the site within that territory, about as large as an English county, which was to be set apart for the city. About a year ago the first point was settled, and an article in our issue of January 8th last commented upon it. The Yass-Canberra district thus dealt with, was so called because the territory extended, roughly speaking, between two parishes, each having one of these names. The original proposal of the State Commissioner who reported on the question, was that the city should be at the Yass or north-west end of this area, owing, no doubt, largely to the fact that the main line of the railway—Sydney to Melbourne—ran through it. However, as pointed out in our article, this site involved an expensive water supply, and owing to investigations by the Rivers, Water Supply, and Drainage Department, which had been going on since 1906, a decision was arrived at to sacrifice the advantage of a main line connection in favour of a better site from the water supply point of view, at the Canberra or south-east end of the area. This, therefore, is the site which now has been finally approved by the Commonwealth Parliament.

THE NEW GERMAN STEAM BOILER LAW.

On January 1st next a new law, regulating the installation of steam boilers, will come into force in Germany. This law, in comparison with the old regulations in force since 1890, contains many alterations of vital importance to builders and users of steam boilers.

One very important portion of the new law deals with the testing and inspection of plates, and is causing a good deal of anxiety to British firms who make boilers for export to Germany. Hitherto the certificate of the makers has been regarded as sufficient guarantee of the strength of plates, but under the new regulations examination and test must be made by independent experts recognised by the Federal States. At one time it was feared that this would mean that all boilers made for Germany would have to be constructed from steel made and tested in Germany; but representations have been made by the Agricultural Engineers' Association, and it seems not impossible that the German authorities will eventually decide to accept Lloyd's certificates under certain conditions. In any case, it is obvious that the new regulations must result in increased cost and trouble to the British manufacturer and hamper his trade with Germany, and in certain circles it is freely said that that is the intention of the law, and that eventually the Germans intend to prevent altogether the importation of foreign boilers.

Steam boilers are now divided into two classes—land and marine boilers. As the latter are of lesser general importance, most weight is given to the former; and we will confine ourselves to dealing with the alterations which have been made in the laws relating to land boilers.

"Land steam boilers" are held to be such fixed or portable boilers as are not only used on land, but also temporarily on buildings and constructions floating on or moving in water. Hitherto the regulations applied to all closed vessels which were used for generating steam at a higher pressure than the surrounding atmosphere, the only exception being low-pressure boilers, *i.e.*, boilers fitted with a device whereby the steam pressure in the interior of the boiler is prevented from exceeding a surplus pressure of half an atmosphere; these latter are still exempt from the new regulations, and so-called "dwarf boilers" are now also excepted. The latter, in the meaning of the Law, are steam generators whose heating surface does not exceed $\frac{1}{10}$ square metre, whilst the steam pressure must not be more than two atmospheres surplus pressure. They must also be provided with a suitable safety valve. Vessels in which steam taken from another generator is specially heated by the aid of fire (superheaters) are also not subject to the new regulations. Hitherto boilermakers have been left considerable latitude as to the selection of materials and dimensions; the new law, however, makes special provisions as to the stress to which the material is to be subjected, and stipulates for thorough tests of all the materials used in the construction of boilers. If the steam boiler be intended for a working pressure of more than ten atmospheres, no cast iron or malleable cast iron may be used in any part of the boiler walls, whilst brass is only to be used for fire tubes of not more than 80 mm. diameter outside. Hitherto it has been recommended that the flues of a steam boiler at their highest point should lie at least 10 cm. below the lowest appointed water level, but this distance has now been definitely fixed at 10 cm., and in the case of boilers the water surface of which is 1,3 fold of the total grate area, this distance must be at least 15 cm. As feed devices, two feeders have so far been required which were not dependent upon the same operative mechanism, so that each one could, if necessary, be used for feeding the boiler separately. By the new regulations these devices must be of such a size that each one shall be capable of feeding the boiler with double the quantity of water normally required. In the case of steam feed pumps, driven direct by the main steam engine, one and a-half times the normal evaporating capacity will suffice. Hand feed pumps are only allowed provided the product of the heating surface in square metres and of the steam pressure in atmospheres, does not exceed 120. One of the stipulated feed devices may be replaced by the direct use of a water pipe, if it be guaranteed that the actual pressure of the water service at the boiler is always at least two atmospheres more than the steam pressure permitted in the boiler. The lowest permissible water level, hitherto shown by a clearly visible mark, must now be marked by the inscription "Niedrigster Wasserstand;" in boilers with a heating surface of less than 25 square metres the letters "N. W." may be used for the same purpose. Fixed and portable boilers must be fitted with at least one and two safety valves respectively, spring and lever and weight valves being both admissible; in the latter case the pressure exerted on each valve must not exceed 600 kilos. The steam space of every boiler must be fitted with a pressure gauge, the dial being marked to indicate atmospheres. It must also be provided with a fixed conspicuous mark, clearly showing the maximum steam pressure; the movable indicators hitherto used are no longer allowed.

Steam boilers, to be erected at future dates, will not only be examined as to material and strength, but will also be subjected to a thorough internal and external inspection so as to determine if they have been properly built. The final inspection will be made under steam, and the officials making the trials must use an officially provided double manometer. Boilers for a working pressure of more than 6 atmospheres, and such in which the product of the heating surface in square metres and of the steam pressure in atmospheres exceeds 30, must not be erected below rooms which are often entered by human beings, nor above any rooms, excepting cellars. This stipulation does not apply to water-tube boilers, the tubes of which are seamless and have a diameter of 100 mm. outside, whilst the walls of the steam drum are not touched by hot gases. In this case the steam pressure must not exceed 6 atmospheres.

The new law renders things somewhat easier for so-called "dwarf" boilers, or those in which the product of the heating surface in square metres and the steam pressure in atmospheres does not exceed 2. For these one feed device is sufficient, no second watermark is required, and only one safety valve is necessary.

Boilers already in use and complying with the requirements of the old law, need not be altered to comply with the new stipulations until such time as they need a fresh inspection.

COMPULSORY WORKING OF PATENTS.

In two recent cases the Comptroller-General has been asked to revoke patents on the ground of their not being worked in this country. The following is a summary of the facts and decision in each case.

In Knowles *v.* British Oxygen Company—decided on November 29th—the applicant sought revocation of a patent for the manufacture of an oxygen blow-pipe used for cutting plates of metal. The allegation was that the article was manufactured mainly or exclusively abroad. The patentees admitted that the manufacture at the date of the application was mainly carried on abroad; but they said that they could give satisfactory reasons for their inaction, and that there was at the date of the hearing a substantial manufacture in this country. The facts were briefly as follows:—The patent was applied for and granted to a Belgian company on December 29th, 1904, so that the right of the Court to revoke on the ground of non-working did not accrue until December 29th, 1908. From 1905 onwards the Belgian company made attempts to sell the patent in England. In November, 1908, it ordered six blow-pipes to be made and delivered by Aldous and Campbell, engineers, of Southwark. These were delivered early in 1909. In October, 1908, the Belgian company negotiated with Knowles for the purchase of the patent. Finally, on February 16th, 1909, it was sold by the Belgian company to the British Oxygen Company. The following points—*inter alia*—were relied on by the respondents: (*a*) that there were *bonâ fide* efforts to sell the patent in England; (*b*) that the restricted nature of the negotiations was due to the fact that the Belgium firm were anxious to sell the patent only to British firms who could control the supply of pure oxygen; (*c*) that the British Oxygen Company was an owner of plant, &c., which would enable it to carry on adequate manufacture; and (*d*) that at the actual date of the hearing it had in fact made more than thirty blow-pipes under the patent. The applicant relied on the fact that from 1906 onwards the process was exclusively used and advertised on the Continent, and that in reality there was no sale or manufacture in England.

The Comptroller, in giving his decision, said it was natural that the patentees should desire, if possible, to sell their patent to a firm which could guarantee the supply of pure oxygen in his country. This was not a mere blow-pipe, but a blow-pipe to be used in a specific process which necessitated the use of oxygen in its purest form to obtain the best results. It was right that the foreign firm should endeavour to get as high a price as possible from a British firm, inasmuch as the possession of the patent would afford an exclusive opening for the sale of oxygen. It was not disputed that there had already been a considerable manufacture of blow-pipes in this country. It did not appear that anything done had prevented or endangered manufacture of the article in this country. Indeed, that manufacture might benefit by the experiments made abroad, and by the experience gained by the use of the process in various manufactures. In the event the application was dismissed, the respondents being awarded £31 10s. costs.

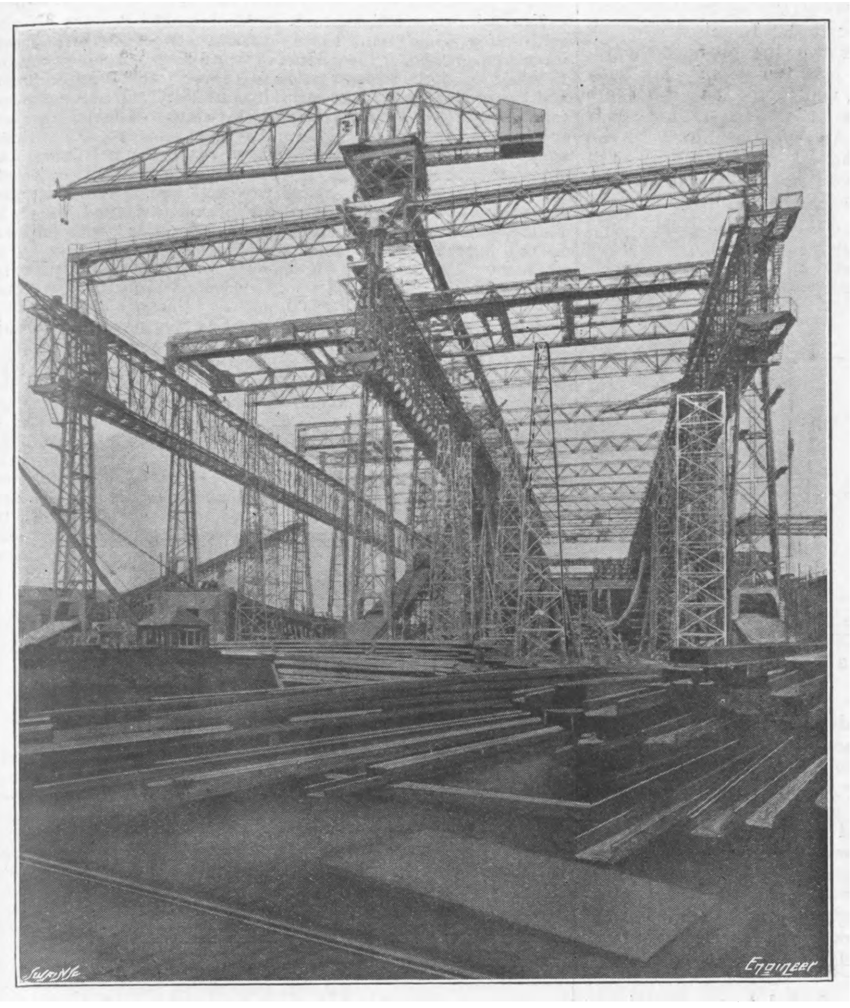
With all respect to the Comptroller, it seems that in arriving at his decision he got somewhat far away from the language of the Act. Thus, we cannot see why the fact that the use of this particular patent may be useful to the business of one particular company should justify the foreign patentee in waiting until that particular company is prepared to pay his price. It should be mentioned, however, that the Comptroller went out of his way to indicate that many of the arguments advanced would have also supported an application for a compulsory licence, which the Court has power to grant if the reasonable requirements of the public are not satisfied.

The next case to which we should like to refer is Jackson *v.* De Dion Bouton, in which application was made to revoke a patent relating to the valve of a motor engine. From the report which appeared in the *Times* of November 27th, it seems to have been admitted on both sides that the patent was of little commercial value, but the applicant desired revocation in order that he might get small De Dion engines from abroad. The respondents admitted there was no manufactrue in England, and that they only sold motors imported from France. They contended that as the patent was useless, and as it could only be used, if at all, in connection with complicated engines, it would have been an unjustifiable expense to set up a factory in England in order to manufacture since August, 1908. The applicant alleged that the defendants were bringing actions for infringements in relation to the importation of motor cars containing this type of engine. The Comptroller, in the course of his decision, pointed out that according to the evidence of the applicant himself the demand here was really for the French-built engine, which was stated to be of very fine workmanship, constructed of excellent material, and it was, therefore, by no means certain that even if the demand for the patented article had continued it would not have been a demand confined to its construction in French engines and French engines only. He also said: "I think the fact that there is no demand for the patented article, and that it is considered as of little or no commercial value, must in almost every case be accepted as satisfactory reasons for non-manufacture. . . . I come to the conclusion with reluctance that I am unable to revoke the patent in question. Neither the present owners of this patent nor their predecessors have done much to help British industry. They have merely been the importers of cars made in France by the French De Dion Company, and they have used their patent rights here, not for the purpose of manufacture, but merely as a means of levying a toll on English purchasers." It is a little difficult to follow the reasoning by which the Comptroller arrives at the conclusion that lack of demand is such a justification of non-manufacture that it precludes a right to demand revocation. There may, as in this case, be a lack of demand for the engine by itself, but the holders of a patent for it may find it a very convenient means of preventing the use of motor cars which are driven by it. One would have thought that its being used in imported motor cars would be sufficient evidence that there was a demand.

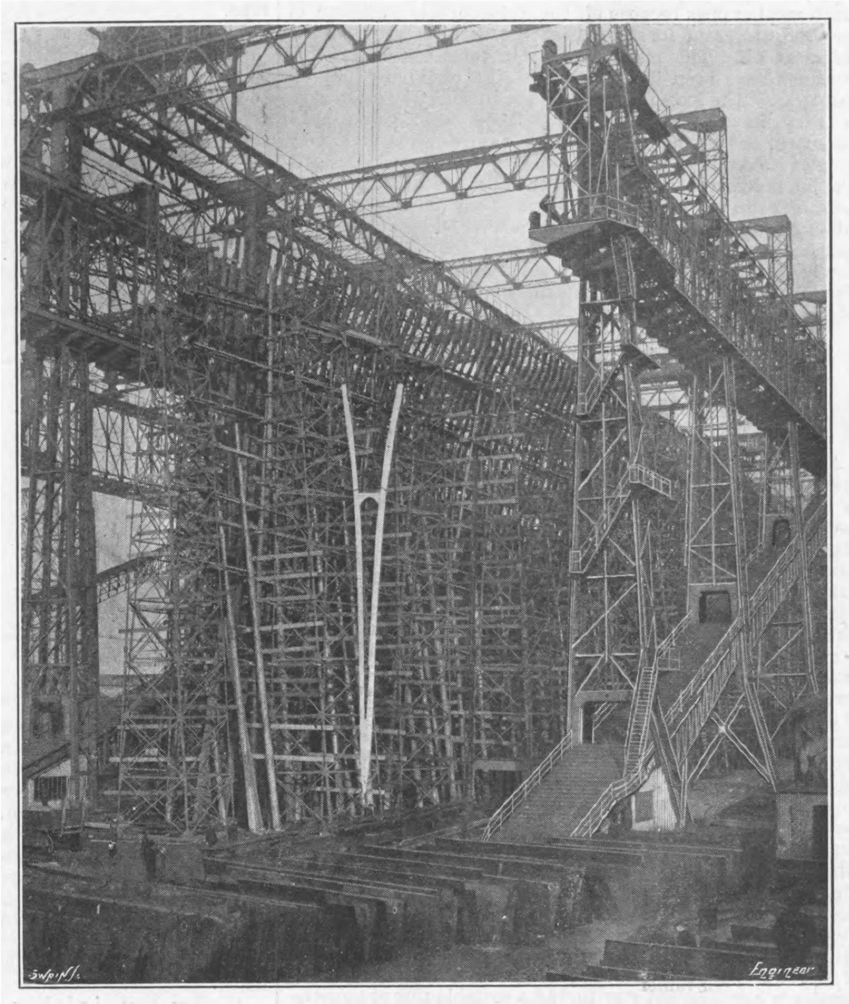
The National Electrical Manufacturers' Association.—The next committee meeting of this Association will be held at Balfour House, Finsbury-pavement, E.C., on Tuesday, December 14th, at 2.30 p.m.

BUILDING THE WHITE STAR LINERS OLYMPIC AND TITANIC

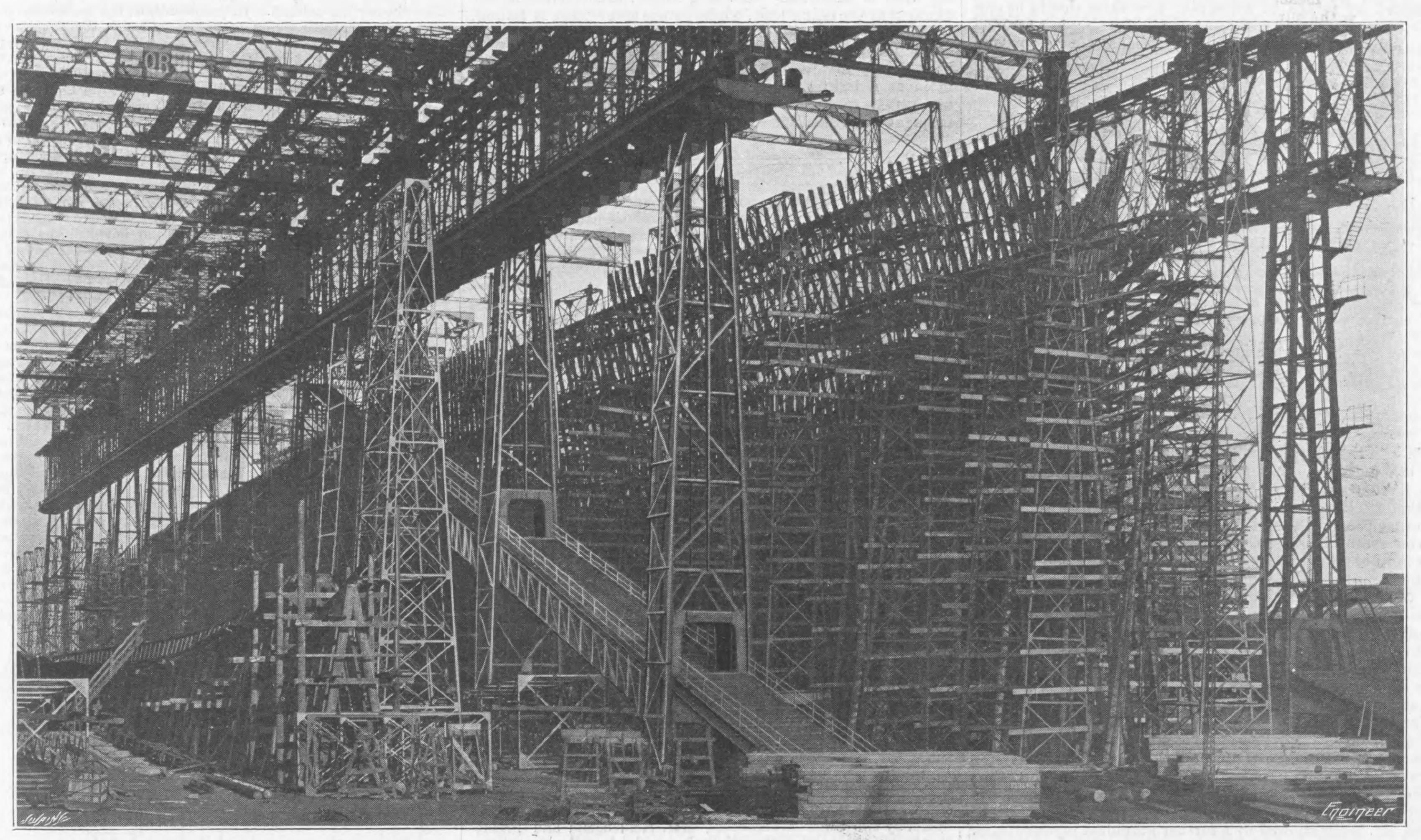
HARLAND AND WOLFF, LIMITED, BELFAST, ENGINEERS



THE SLIPS ON WHICH THE VESSELS ARE BEING BUILT—28th OCT., 1909



THE LAST FRAME OF THE OLYMPIC BEING LIFTED INTO POSITION—20th NOV., 1909



VIEW SHOWING THE OLYMPIC NEARLY FRAMED AND EARLY WORK ON THE TITANIC—18th NOV., 1909

THE WHITE STAR LINERS OLYMPIC AND TITANIC.

BY the courtesy of Harland and Wolff, Limited, we are enabled to give above three views showing the present condition of the two enormous liners, the Olympic and Titanic, which this firm is building for the White Star Company. The keel plate of the Olympic was laid considerably before that of her sister vessel; indeed, a commencement was made on December 15th, 1908, a good while before the gantry which has been specially erected for these two vessels, and which was referred to in the supplement to our issue of 18th June last, was completed. One of the views, which is reproduced from a photograph taken on November 20th, shows the last frame of the Olympic being lifted into position, so that the framing of this enormous ship took just eleven months and five days. Concurrently with the framing a large amount of other work has been carried forward. For example, the entire bottom and water ballast tanks are hydraulically riveted, and contain over half a million rivets. The plating of the sides is now well started, and good headway has been made with the decks and stringers.

The views we give speak for themselves, and require no special reference. The great usefulness of the gantry and its various cranes will be appreciated, and the light erecting pillars employed will be noticed. In the corresponding view to that showing the last frame of the Olympic, may be seen this vessel two-thirds framed and the water ballast tanks, &c., of the Titanic on the next slip. The photograph from which this engraving was reproduced was taken on October 28th last. This latter vessel would have been much further advanced than she is had it not been that there has been considerable delay in getting the large steel castings for her hull delivered. The largest view on the page gives perhaps a better general idea of the present condition of these two hulls than is given in the other two engravings.

TROUBLES IN AUSTRIA.

INDUSTRY and labour in Austria are suffering greatly from the parliamentary crisis. The obstruction of the Czechs having paralysed the activity of the legislature it has been impossible to vote the usual credits for State purposes, and the Government departments are consequently unable to give new orders for the coming year. The steel and iron trades are seriously affected by this condition of affairs, especially the locomotive and wagon works. Delegations of employers and workmen waited on the Minister of Finance a few days ago to urge the necessity of something being done to relieve the situation, but they were told that the Government could not give any new orders at present though they might if they liked go on manufacturing engines and wagons at their own risk in anticipation of orders to be given later. Of the two branches the wagon builders are suffering most. Formerly the railways expended some twenty million crowns a year—about £800,000—on cars, but when trade suddenly improved the demand went up to over two millions sterling. Now that the state has taken over all the big lines, with the exception of the Southern Railway, and there is a tremendous dearth of cars all the time, the manufacturers naturally expected larger orders, but they have actually been getting much smaller ones because of the unfavourable condition of the Budget. And for 1910 they are without any definite orders at all. The result is that in some cases half the workmen have been discharged and the remainder put on half time. The locomotive works are in slightly better case, as they have orders enough to keep them going until February, and by reducing the rate of production they may be able to keep their shops going for some weeks longer. The big industrial corporations generally are anxious to see parliament in working order again. They do not like dismissing workmen in the winter, not only because of the hardships inflicted upon the men and their families, but also because it reacts upon the numerous small tradespeople who are in their turn dependent upon the wages of the working classes.

WINDING ENGINE DESIGN.

A VALUABLE contribution to the proceedings of the Manchester Association of Engineers was made on Saturday last by Mr. G. James Wells, A.M. Inst. C.E., who read an exhaustive paper on the above subject. Starting with a supposed inquiry for a winding engine to perform a given duty, the author first went into the system of steam distribution, mentioning that the type of engine generally used is a two-crank compound engine, with cranks at right angles. The valve gearing must, of course, provide for the engine running in either direction, and since the engine must start from any position on full load, it is necessary to arrange for a very late cut-off with some means of increasing the amount of expansion when full speed has been attained. Most valve gears permit the cut-off to be as late as 80 to 90 per cent. of the stroke in full gear, but it is not easy to arrange for a cut-off at any point from zero to 90 per cent., including the ability to reverse the engine at full speed with a latest cut off in case of emergency. By means of diagrams Mr. Wells showed that there are four positions, or periods, in each revolution when only one cylinder is operative. With regard to the mechanics of winding the problem involves only the application of the simple principles underlying the starting of a mass from rest, accelerating it until a certain velocity is attained and then bringing the mass to rest again at the end of the wind. Under this heading the author showed by equations a convenient way to find a suitable rate of acceleration, or with a proposed rate of acceleration to find possible times for each period of the wind. This led on to a consideration of the design of drums, and the author here explained by means of a diagram how these should be constructed for the purpose of balancing. The simplest arrangement is to connect the two cages by means of a rope passing down into the sump from one cage bottom up to the bottom of the other cage, so that the weight of rope hanging on each side is constant, while the static load is uniform and equal to the load lifted. A usual way is to modify the radii of the drum, so that at the start the loaded rope is at the small end of the drum, and the falling rope is on the largest diameter. The radii of the drum are so proportioned that the moments of the two ropes can be maintained fairly constant throughout the wind. This leads to a taper drum formed of two parts of two cones as in Fig. 1, their bases forming the middle of the drum. The dimensions of such a drum may be found by taking moments due to the rope pull at the beginning and end of the wind, remembering that the difference between these moments at each end of the wind must remain equal.

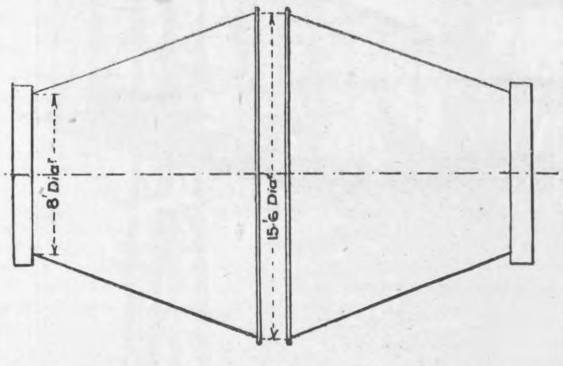


Fig. 1

The author then demonstrated by graphical construction the effect of the continually changing radius of the drum upon the several items in the load imposed upon the engine. He also reproduced graphically a diagram showing the effects of inertia and resistance for this type of drum; and the effect of the pit-head sheaves. From the diagrams so produced Mr. Wells showed by a further graphical representation how the dimensions of the engine can be found.

The great expense and space occupied by the conical type of drum has led to the introduction of a compound type in which there is a smaller diameter parallel for the starting turns to be wound on, mounting up with a few spiral turns to a larger diameter upon which the last turns of the wind are received. This type increases the moment of the descending load and reduces the moment of the rising load, and so tends to reduce the inequality of the static load during the progress of the wind. The proportionate number of taper turns is a matter for judgment, and the examination of several ratios will serve to illustrate the effect of the varying the diameters, &c. A drum of this type is illustrated in Fig. 2. B B are the brake drums, A A are parallel portions, upon which a certain number of turns are wound at the commencement of the hoist, C C are the taper parts, upon each a spiral rope groove is fixed, guiding the rope up from A to D in a certain number of turns, and lastly D is a parallel part upon which the remainder of the turns are wound. There is obviously some difficulty in fixing upon the proportions of such a drum, for the variables are (1) the ratio of the diameters D and A, (2) the absolute diameters, and (3) the number of turns before commencing the climb from A to D. Of these the second is easiest to settle, because the life of the rope is in part dependent upon the amount of bending it receives, and in most cases the diameter A will be fixed at the minimum possible, which depends upon the size of the rope.

The Koepe system was next described. In this system the rope from one of the cages passes over the pit head sheave, thence round the engine pulley, over the second pit head sheave, thence to the second cage, whilst the two cages are connected by a balance rope so that the load upon the rope is constant throughout the wind. An objection made to the system in its original form was the risk of slipping, as with the cage resting on the stops the load was so reduced that the rope was too slack to give sufficient grip for the re-start. Re-capping the rope was difficult, and in case of rope failure both cages were free to fall. These objections, Mr. Wells said, have been met, but the system has not many examples in this country, though in Germany and South Africa it is more widely used.

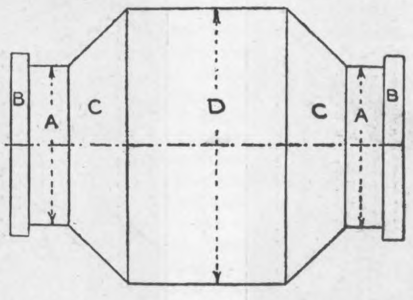


Fig. 2

The Whiting system was next described. This is like the Koepe so far as the single rope and the friction grip pulley are concerned, but two pulleys are employed in the Whiting system, each positively driven by the engine. The pulleys are placed tandem fashion, the spindles being coupled together like the driving wheel of a locomotive. The rope from the pit head sheave passes several times round first one and then the other winding pulley, thence under the engine to a tension pulley, back again to the other pit head sheave, to which it is led round suitable guide pulleys. The tension pulley has frequently a considerable travel, so that by its means some alteration of the levels of working can be readily made.

Another type of winding drum alluded to consists of two discs between which is wound a flat tape-like rope, the coils resting upon each other so that the drum diameter during the wind is continually becoming larger, thus increasing the moment of the rising load, whilst as the empty cage is falling, its effective moment is similarly decreasing. This is another device for obtaining the compensation necessary for equalising the static moment, and at the same time securing a minimum moment of inertia of the drums. In this system two drums are necessary, one for each cage, and a separate ring is frequently provided for the brake.

The Birmingham Association of Mechanical Engineers.—The annual meeting of the Association will be held at the Grand Hotel, Colmore-row, Birmingham, to-morrow (Saturday) evening. The chair will be taken at seven p.m.

The Royal Meteorological Society.—At the meeting of the Royal Meteorological Society on Wednesday evening, the 17th inst., the president announced that the Council had awarded the Symons gold medal to Dr. William Napier Shaw, F.R.S., in recognition of the valuable work which he has done in connection with meteorological science. The medal will be presented at the annual general meeting of the Society on January 20th, 1910.

Stuffing-box Packing.—A new kind of stuffing-box packing, which differs somewhat considerably from other forms, has been brought to our notice by the firm of Richard Klinger and Co., of 66, Fenchurch-street, E.C. It is made of a special material, of a soft, fibrous, and self-lubricating character, and is claimed to possess the highest heat-resisting qualities. We are informed that the process of manufacture is carried out on entirely original lines. The surface of the packing which comes into immediate contact with the piston-rod is provided with a lead grid, through which the correct amount of packing needed for making a tight joint is forced as the pressure is increased. This is claimed to ensure very regular and economical use of the packing. It is said to be suitable for any stuffing-box, and may be used with the highest steam pressures and degrees of superheat. The packing is coloured red on the side where the lead grid is situated, this, as stated, being the side which has to be placed next to the rod. The makers claim that, once the packing is placed in the stuffing-box, it never need be removed, all that is neccessary to maintain a tight joint being to add a small quantity of new packing from time to time to compensate for the small quantity which disappears in working. This new packing, the makers state, combines all the advantages of metal and soft packings, and however much worn the piston-rod is, it will maintain a perfect joint. Judging from the sample which has been sent to us, we should say that it should prove effective, and should be capable of doing what the makers claim for it.

A New Method of Preserving Wood.—Some recent experiments by two Swedish engineers, MM. Heidenstam and Friedemann, on the preservation of timber, and in particular railway sleepers, have resulted in the introduction on a commercial scale of a new chemical preservative. The new substance is known as cresol-calcium, and is produced by the action of cresol—$HO . CH_3 . C_6 H_4$—on slaked lime. A solution of the resulting compound having a 10 to 15 per cent. composition is used for impregnation, which is carried out in exactly the same manner and with the same apparatus as is employed for creosoting, with the exception that with the new material the temperature of 70 to 80 deg. Cent. required for the creosote process is not necessary. The advantages claimed for the method are its cheapness, the cleanliness of the treated material, and its inflammability. In addition, a feature of the process is said to be the ease with which the right amount of preservative fluid can be given to the wood. When dealing with creosote it is well known that much more has to be employed than is actually necessary from a bacteriological point of view. As for its preservative powers, we understand that tests have been, and are being, conducted by various authorities, and that the results so far compare most favourably with other processes. A feature of its action is the formation of a thin crust of chalk on the surface of the timber, thereby reducing the evaporation and loss by washing out which are met with in other cases. For this country Messrs. Blagden, Waugh and Co., 50, Lime-street, E.C., have been appointed sole agents.

AN INTERNAL COMBUSTION PUMP, AND OTHER APPLICATIONS OF A NEW PRINCIPLE.*

By Mr. HERBERT A. HUMPHREY, Member, of London.

(*Continued from page* 564.)

Two-cycle pumps.—The pump so far described is what may be called a four-cycle pump, because there are two outward and two inward movements of the column of liquid in each complete cycle. It would clearly be advantageous to suppress the cushion stroke and the suction stroke, and so produce a two-cycle pump. We are familiar with two-cycle gas engines in which outside pumps are used to draw in the gas and air and to force them into the working cylinder. But the production of a two-cycle pump is arrived at without any such complication, since no outside pumps are required. Up to the present, four types of two-cycle pumps have been constructed, and of these the simplest to explain is that shown in Fig. 5, where A is the combustion chamber fitted with an inlet valve B for combustible mixture and exhaust valve C for burnt products. The bottom of the chamber is attached to a pipe having two branches D and E, and a single valve F which can close communication with either of the branches. One branch leads to a supply-tank containing water at a level *xx*, the other branch leads to the delivery pipe and the high-level tank, and is fitted with a water-valve G, which in this case is shown as closing a suction pipe dipping into a low-level tank H. When the valve F is in the position shown by full lines and the compressed combustible charge exists in the top of chamber A, explosion takes place and water is driven along the delivery pipe towards the high-level tank, the gases meanwhile expanding and imparting velocity to the column of water. When expansion has been carried to atmospheric pressure the exhaust-valve opens, and by this time the pressure on the left-hand side of valve F will exceed the pressure on the right-hand side, and the valve will swing across so as to open communication between the combustion chamber and tank J and to close communication with the delivery pipe. The moving column of water now has to entrain more water by sucking it up from tank H past valve G to follow the moving column. In the meantime, the water-level in the combustion chamber being considerably below the water-level in tank J, water will rise up in the combustion chamber, close the exhaust valve by impact, and cushion the burnt products imprisoned in the top of the chamber above this valve, until their pressure exceeds that due to the static head of the liquid in tank J. A reverse flow now occurs as the compressed cushion expands again, and a charge of combustible mixture is drawn into the combustion chamber. If there is still time for the action to take place, there will be a slight compression of the fresh charge by water again flowing from tank J into the chamber, but the main compression of the charge occurs when the column of water in the delivery pipe, having come to rest, returns, again closing valve G and forcing valve F from its dotted position back to the full-line position, thus giving free communication between the delivery pipe and the combustion chamber and closing communication with tank J. When the water column has been brought to rest by expending its energy in compressing the charge, a spark at the ignition plug ignites the charge and a fresh cycle is started. It is not necessary that the level of the water in tank J should be above the exhaust valve, because if it is at a level *y y* the oscillation which takes place from the tank to the chamber may still carry it far enough up the combustion chamber to close the exhaust valve. The return flow, which draws in the new charge, will then be due to gravity as the liquid in the chamber tends to regain the level of the water in tank J. It is desirable that a pump so constructed should have a dashpot to control the movements of valve F, so that it comes slowly on to its seat in the dotted position and gives time for the water to be started in motion past valve G before communication with the combustion chamber is entirely cut off. If this valve is also controlled in its action of closing on its other seat, it may be arranged that the quantity of water which escapes past the valve back to tank J shall be equal to the quantity of water which moves from tank J to the chamber, and in this case the whole of the water delivered is drawn from tank H, and the returning column in the delivery pipe will then acquire a higher velocity than it would otherwise attain and thus give a higher compression pressure.

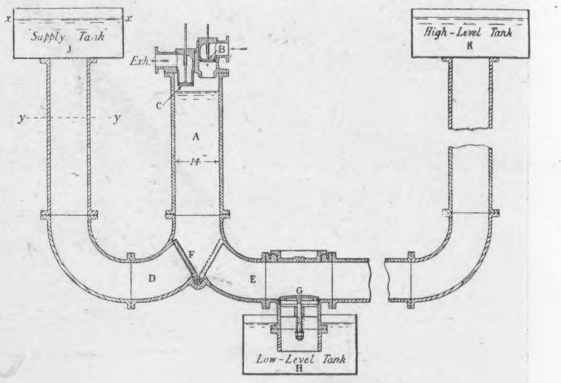


Fig. 5.—*Diagram of Two-Cycle Pump.*

A modification of this pump is shown in Fig. 6, which simplifies the arrangement and permits the use of only one water valve. In this case, between the supply tank and the combustion chamber there is enough pipe to give a certain amount of inertia, and on this pipe is a stand pipe, open at the top, up and down which the water oscillates. Suppose that explosion and expansion have occurred and water is being drawn past valve A. It is clear that the supply will be drawn from the source which offers least resistance, so that the water contained in the stand pipe will first flow past valve A to be followed by water from pipe B so soon as the greater inertia of this mass allows it to flow forward. When, however, the water in the pipe B has once been set in motion, its momentum keeps it moving, although valve A may be shut, so that it causes the level to rise in the stand pipe even above the level

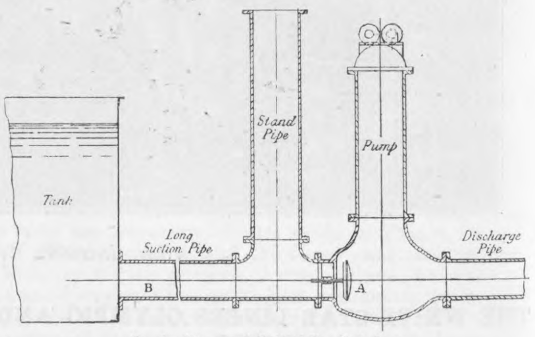


Fig. 6.—*Diagram of Modified Two-Cycle Pump.*

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*The Institution of Mechanical Engineers.

of the water in the supply tank. This brings about a condition of affairs in which, when the water valve A again opens, the level of the water in the stand pipe is considerably above the level of water in the combustion chamber. A quick rush of water therefore takes place, and the oscillation carries the water up the combustion chamber to close the exhaust valve. The necessary supply for this having come from the stand pipe, its level is lowered until it is below the exhaust valve, and consequently gravity causes the level of water to fall in the combustion chamber and so draw in a fresh charge while the column of water in the discharge pipe is still moving outwardly. The return of the column from the discharge pipe closes valve A and compresses the new charge ready for a fresh cycle.

Passing over a large number of modifications of the types of pumps so far dealt with, we come to a pump having two chambers in which the explosions take place alternately. A diagram of this arrangement is shown in Fig. 7, and one of its chief differences from the other pumps is found in the fact that the introduction of the combustible charge does not depend either on cushioning or on an oscillation of the kind described. Both chambers are fitted with the usual inlet and exhaust valve, but a single water valve suffices to supply both chambers. Suppose all the valves are shut and that in the first chamber there exists a compressed combustible charge and that the second chamber is full of water. Explosion occurs in the first chamber and water is driven downwards and outwards from this chamber towards the high-level tank. As the gases expand a pressure is reached which can no longer sustain the water column in the second chamber, so that the water level in this chamber falls and a fresh charge is drawn into this chamber. When expansion is completed we have, therefore, burnt products in the first chamber, a fresh charge in the second chamber, and water at a higher level in the supply tank than in either of the chambers. Consequently water flows from the supply tank towards both chambers and partially clears the first chamber of burnt products by rising to nearly the level of the water in the tank. Water has been entrained through the water valve to follow the column of water flowing towards the high-level tank, and as this column comes to rest and commences to return again, it closes the valve and flows mostly into the first chamber from which the burnt products have a free exit past the exhaust valve. As the water reaches the exhaust valve, and shuts it, it finds only a very small cushion space in the top of this chamber, and its flow in this direction is therefore almost immediately arrested, so that the energy of the returning column is now obliged to expend itself in compressing the combustible charge in the second chamber. When this compression is complete and the water once more at rest, the cycle is ready to be repeated by an explosion occurring in the second chamber. It will be noticed that when compression occurred, the returning column had already moved some distance while exhausting products from the first chamber, and, therefore, it had an initial velocity when starting compression, which causes the maximum pressure reached with this pump to exceed the compression pressures attained with the same head of water in the other types of pumps. This pump is, therefore, suitable for low lifts where high compression pressures could not otherwise be obtained, and the gear required to operate the valves, although interlocking, is quite simple. A very powerful suction stroke is obtained in this pump, because there is a tendency to draw in a charge of combustible mixture equal in volume to that of the expanded products. Considerable throttling is therefore necessary, and it is very easy to work this pump on a small suction-producer plant offering high resistance to the passage of gas. It should be stated that this pump ran perfectly well at the very first attempt to start it.

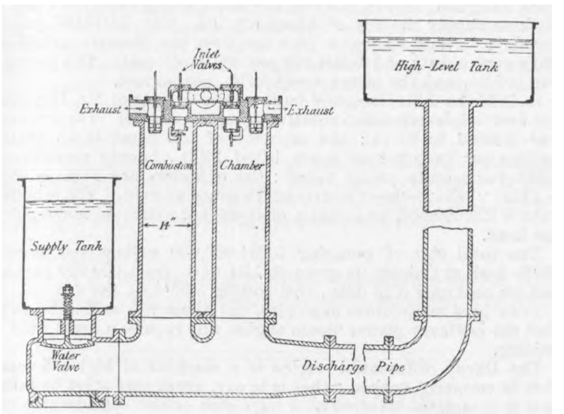
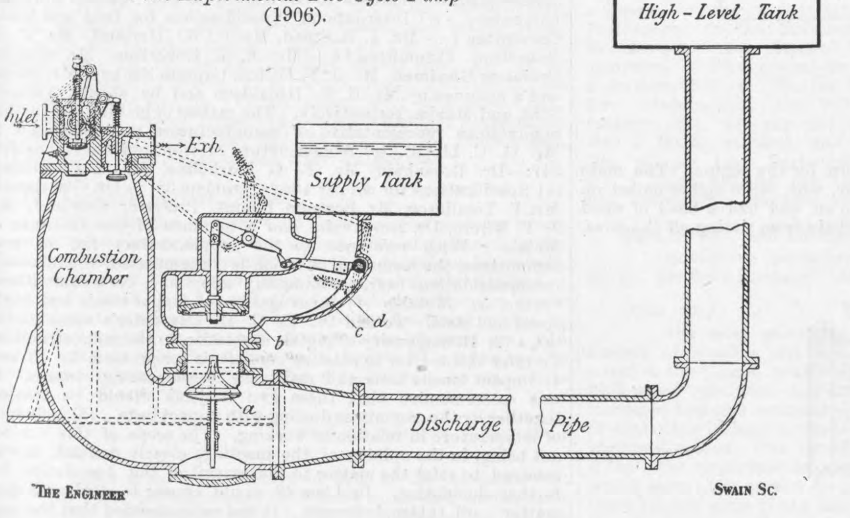


Fig. 7.—*Diagram of Double Barrel Two-Cycle Pump.*

Fig. 8.

First Experimental Two-Cycle Pump (1906).



The Engineer

Swain Sc.

The first pump invented and tested by the author was not one of those so far described, but was a two-cycle pump of more complicated construction. There were, as shown in Fig. 8, two water valves *a* and *b* in the supply pipe, one of which *a* was an ordinary mushroom valve normally held closed by a spring, and the other a valve actuated by trip-gear when the velocity of the inflowing water reached a certain pre-determined amount. The point of tripping was controlled by balancing the centrifugal force of the water flowing round a bend and acting upon a curved plate *c* against a spring *d* which tended to pull the plate into the stream lines. The trip-gear was also utilised to open and shut the inlet and exhaust valves on the top of the combustion chamber. The action of this pump is as follows:—When the column of water in the discharge pipe has returned to give the compression stroke, valve *a* is shut and valve *b* is open. Ignition now occurs, and the water is forced downwards and outwards from the combustion chamber so that the column of water attains velocity, and as the expanded masses approach atmospheric pressure, valve *a* opens and water is entrained to follow the moving column towards the high-level tank. Some water also flows into the combustion chamber and discharges the burnt products. The rush of water round the bend in the supply pipe forces the curved plate into the recess, sets the trip-gear, and opens the exhaust valve, thus allowing the inflowing water to drive out the whole of the burnt products. When, however, the velocity has diminished so that the curved plate can be pulled out by the spring, valve *b* is dropped and the water supply is cut off. At this time, however, the outwardly moving column has not come to rest, so that its further movement may be utilised to draw water from the combustion chamber. This in turn will cause a new charge to be drawn into the chamber until the column of water ceases to move. The return flow now commences and valve *a*, in shutting, opens valve *b*, compression occurs, and the cycle is ready to be repeated. The cycle of this pump is as theoretically perfect as any of the others, but difficulties were encountered in obtaining uniform working and the experiments on this type were abandoned.

Pumps for high lift.—When it is desired to lift water to a height exceeding the head equivalent to the mean pressure of the indicator diagram, an attachment is added at the end of the discharge pipe, as shown in Fig. 9. This addition may consist of a small air-vessel, placed at the end of the discharge pipe close to the large air-vessel into which the high-pressure water is to be delivered. The inlet into the large air vessel is fitted with a non-return valve, and the action, when working in conjunction with a two-cycle pump, is as follows:—When the explosion occurs in the pump chamber the water is forced along the discharge pipe and rises in the small air vessel, gaining velocity and compressing the air therein until the rise in pressure is sufficient to open the valve. The energy of the water column is then spent in delivering water into the larger vessel, and any backflow from it is prevented by the valve closing. There is now sufficient energy stored in the compressed air in the small chamber to produce the return flow of the column towards the pump required to compress the next combustible charge; then the whole operation is repeated. The amount of air in the small vessel has to be adjusted according to the pressure in the large vessel, and the air may expand below atmospheric pressure on the return stroke.

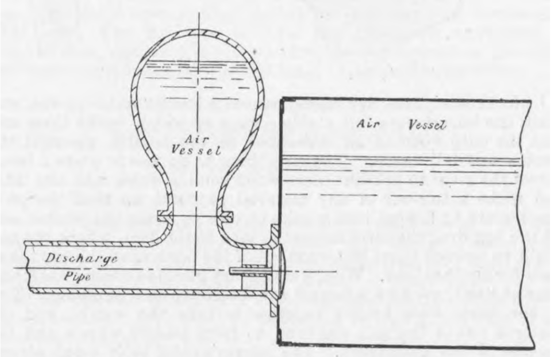


Fig. 9.—*Addition at end of Discharge Pipe when high lifts are required.*

Pumps as air compressors.—The extreme flexibility of the author's system is shown by the readiness with which it can be adapted to the case of compressing air. The column of liquid which reciprocates backwards and forwards from and to the pump can be made to enter an air compressor chamber, fitted with suitable valves, attached to the end of what has so far been called the discharge pipe. The energy of the moving column of water is utilised to compress air, and also to store sufficient energy in an elastic cushion to produce a return flow towards the pump to give the compression stroke. This movement of the column also serves to draw a fresh quantity of air into the compressor. The action may be seen from the diagram of Fig. 10, where, for the sake of variety, the air compressor is shown attached to a four-cycle pump. The pump chamber A is connected to the compressor chamber B by means of the pipe C, and the quantity of reciprocating water is such that when the level is high in the pump chamber it is low in the compressor chamber. The air compressor chamber is fitted with an inlet valve D, an outlet valve E, and two other valves F G, which normally remain open under their own weight, and are so placed and constructed that they allow air to pass them, but not water, since the impact of the latter is sufficient to close these valves. Imagine that there is the usual compressed combustible charge in chamber A and a charge of air at atmospheric pressure in chamber B. Ignition occurs in chamber A and drives outwardly the column of water, so that the level rises in chamber B. Valve G, being open, allows air to escape to atmosphere while the gases are expanding and imparting kinetic energy to the moving column, but as soon as the level of water reaches the bottom of pipe H, which projects into the chamber, the water, trying to rise in this pipe, shuts valve G. The remaining air then suffers compression until the pressure at which the air is discharged is reached, when valve E opens and air is delivered under pressure. Next, the water reaches the level of pipe J, and, in attempting to escape with the air, shuts valve F. There being no further outlet, the imprisoned air is cushioned and the water column brought to rest. The cushion now expands again and gives a reverse flow which drives out the products of combustion from the pump chamber, gives the cushion stroke in that chamber, and causes the cushion expansion and suction stroke which follows. All that has happened in the compressor chamber is that the water level falls, air is taken in and suffers compression again, but not to the extent which causes any air to be discharged. The pressure reached, however, is sufficient to give a second return flow and compress the newly drawn in combustible charge in the pump chamber, and the cycle is ready to be repeated. As the water level falls in chamber B, valves F and G fall by their own weight. It will be observed that by altering the extent to which pipe H projects into the air-compressor chamber the quantity of air acted upon may be varied, and this forms a ready means of adjusting the work of the compressor to deliver a greater quantity of air at a less pressure or a less quantity of air at a greater pressure. Greater elasticity in meeting all possible conditions is provided in the case where water may be taken in or discharged at valves placed one close to the pump and one close to the compressor, but it would occupy too much time to deal with the very large variety of air compressors which the author has invented in connection with his pumps. Naturally, the two-cycle pumps are better suited for this class of work than the four-cycle pumps, and it should not be overlooked that as there is no solid piston the space in the top of the air-compression chamber may contain vertical sheets of wire gauze which hold water and present a very large contact surface for cooling the air, and rendering the compression almost isothermal. The water which abstracts the heat does not remain in the chamber, for, in the case cited, where water valves are used, water is taken in and discharged at each cycle, and an automatic circulation through a cooling tank is set up. It is only necessary to make the tank of sufficient capacity to effect the required cooling.

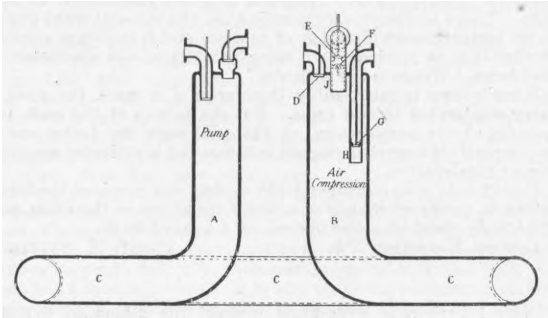


Fig. 10.—*Diagram of a Pump used for driving an Air-Compressor.*

(*To be continued.*)

LETTERS TO THE EDITOR.

(*We do not hold ourselves responsible for the opinions of our correspondents.*)

THE LATENT HEAT OF STEAM.

Sir,—I am sorry that Mr. Royds thinks the publication of his calorimeter tests will serve no useful purpose, as, without this information, it is not possible to judge the trials fairly.

Mr. Royds concludes from the trials that it is possible by oiling to reduce an engine's steam consumption by 15 to 16 per cent., but unless it is known with absolute certainty that no other condition changed, except the oiling, this is purely an assumption.

I hope he will reconsider his decision, as I can see things in Table II. which make me strongly suspect that the steam was wetter in some trials than in others.

If calorimeter tests are relied upon in important trials of this description, the question as to whether the latent heat of steam is a variable or a constant is of vital importance. If the latent heat of steam is accepted as a constant, then 1 lb. of saturated steam at above atmospheric pressure contains more heat than is at present believed. From this it follows that if the wetness of the steam is calculated from the present steam tables, the amount of water in the steam will appear less than it actually is if the latent heat of steam is accepted as a constant.

I have some evidence that, under favourable conditions, and especially with small engines, it is possible for a small change in the wetness of the steam at the engine stop valve to make a large change in the engine's steam consumption without the metal of the engine having anything to do with it.

The question of steam wetness, I feel sure, requires investigation, as I am confident that the wetness of the steam with different types of boilers, with boilers of the same type, and even with the same boiler under different conditions of working, varies to a much larger extent in ordinary practice than is at present realised, if the boiler has no superheater.

I also believe that the steam having varied in wetness explains the anomalies Mr. Wilkinson noticed in the interesting experiments described in the discussion on Professor Dalby's paper on "Heat Transmission."

As regards Mr. Royds' advice to consider the latent heat of vapours produced from other liquids, I have given hours and hours to the question; possibly Mr. Royds can help me out of my difficulties.

I believe I have seen somewhere that the latent heats of ether, chloroform, &c., at pressures above atmospheric pressure were not arrived at by actual measurements, but by calculations based upon absolute zero temperature and the critical temperature, both of which had previously been calculated from Régnault's steam experiments. But before these calculations were made the latent heat of these vapours was measured by actual experiments at atmospheric pressure, the method used being the same as Despretz used for steam.

Although I have searched carefully, I cannot again find this statement. Can anyone help me to do so? I have also searched for any information as to whether actual measurements of the heat contained in these vapours at high pressures have been made, but I can find no trace of this ever having been done.

If Mr. Royds knows of any actual measurements of the latent heat of other vapours than steam at above atmospheric pressure, will he kindly tell me where to find a description of them, as the whole question turns upon the method employed? Was the heat in saturated vapour measured, or was the heat in superheated vapour measured? Régnault measured the heat in superheated steam produced by wiredrawing saturated steam. Southern measured the heat in saturated steam. Southern, therefore, measured the latent heat, but Régnault did not.

Frank B. Aspinall

London, S.E., November 27th.

CENTRIFUGAL FORCE.

Sir,—The main difficulty of "Pater," "X.," and other of your correspondents seems to be that the force acting upon the stone accelerates, and yet does no work on it. It is forgotten that there is just as much deceleration as acceleration. The string is, in fact, a restraint upon the free motion of the stone in a tangential direction. The inertia of the stone is balanced by the tension of the string. Force, velocity, and acceleration are all vectorial or directed geometric quantities, whilst work or kinetic energy is a scalar or arithmetical quantity. "Pater" objects to cutting up the time or space of action of a force into small parts. Then let us take a whole revolution. In a whole revolution the total product of centripetal force and time acting on the stone—or of centrifugal force acting on the central attachment of the string—is zero, because the force has acted equally and for equal times in all directions, and so cancelled itself. How, then, can it have done work on the stone, or whither should the stone be accelerated? Or take a quarter of a revolution, say, from N. to E. The stone at N is flying eastwards with the velocity of X feet per second, and with zero velocity southwards. On arrival at E it is flying southwards with the velocity of X feet per second and with zero velocity eastwards. That is, it has been accelerated from 0 to X feet per second southwards, and decelerated from X to 0 feet per second eastwards. There is always this equality of acceleration and deceleration, hence no work is done on the stone by the centripetal force acting on it, and the kinetic energy remains unchanged.

But assume that for some reason kinetic energy is regarded directionally. Suppose Goliath is advancing from due south upon David, sling in hand. Then the only direction in which the kinetic energy has any value for David is southwards. The eastward directed motion of the stone at its N. position is useless, for it has zero southward kinetic energy. But at its eastward position its whole kinetic energy is southward, and available, and the amount of it is that due to the centripetal force acting on the stone for a quarter of a revolution, reckoned southwards, *i.e.*, from its maximum value at N. to zero at E. The supposed revolution of the sling in a horizontal plane is not believed to be the orthodox method of slinging.

Looking at it another way, there is no force acting on the stone along its circular path. Therefore it is not accelerated in that path. There is always a force acting on the stone at right angles to its instantaneous direction of motion, and it is always altering its direction of motion—*i.e.*, being accelerated—in obedience to that force. Where is the difficulty?

When a force is balanced by the inertia of a mass, the mass is being accelerated by the force. But the inertia of the mass is a function of the acceleration, so that although the forces are in equilibrium, the mass concerned is not so, but is suffering acceleration or deceleration.

It may help your correspondents if they will consider the forces acting on a railway vehicle or a motor car as one or the other runs at a steady speed on a circular rail on a banked track.

London, November 27th. HENRY M. SAYERS.

SIR,—I have read with great interest the discussion that has been going forward in your columns in connection with the above question, and I note that none of your correspondents have any difficulty in proving that if the string is cut the stone will fly off at a tangent. The consideration of work done upon the stone is at once more interesting and more difficult, and carries us into the deep waters of ambiguity. Indeed, a study of the question would seem to show that the standard definitions of acceleration, force, &c., are either fallacious or incomplete. For in the case of the stone and string rotating in the same horizontal plane we have a uniform acceleration towards the centre produced by two equal and opposite forces, which is impossible. Also to accelerate a mass we must have a force acting through a distance, or work done, and so we have two balanced forces doing work, which is again impossible. Hence it would seem that there is no acceleration of the stone at all; yet there is change in direction of velocity, which is acceleration, according to the accepted definitions. What conclusion is one to come to save that the definitions are wrong somewhere? It seems, too, we should have some means to differentiate between change of linear velocity and change in direction of velocity, for surely the two things are distinct, and subject to different laws? But the question is outside my weight, and I must leave its solution to more mathematical readers. LUNDIN.

SIR,—May I suggest that the difference between "Pater" and your correspondents is that he regards acceleration as a change of velocity, whereas they take it as a change of direction. The stone has a constant velocity, but it is always changing its direction, and is therefore always being accelerated. Possibly a development of this idea of acceleration by change of direction would settle the whole matter.

November 30th. H. G.

THE GAS PUMP.

SIR,—Those of us who regularly turn to your pages to quench our thirst for wisdom in matters engineering found a sparkling and refreshing draught in your leading article under the above title. If, Sir, you found reason to suggest the presence of oxygen during the discussion on my paper last Friday, then surely there was ozone in the atmosphere around the editorial chair when you penned the humorous and instructive leader on the gas pump. We welcome such occasional unbending from the full-robed dignity and responsibility which usually attaches to your editorial columns, but in this particular case it has had one unfortunate consequence—the genial effect of the ozone has led you to accept from Mr. Henry Davey a theory which, under ordinary circumstances, you would have first examined for yourself.

Mr. Davey's theory is that, for a discharge pipe of uniform diameter and divided into horizontal and vertical portions, and with a water velocity limited to 10ft. or 12ft. per second, the horizontal portion of the pipe must be three or four times the length of the vertical portion.

Now, Sir, I absolutely deny the existence of any such theory, and I must characterise as absurd the lengths of pipe Mr. Davey has so obligingly calculated for me. In my reply to the discussion I shall deal with this subject, and my excuse for writing you now is that wherever your valuable journal travels it may at once carry this denial with it. If my pump required 600ft. to 800ft. of delivery pipe for a 200ft. lift, as Mr. Davey states, it would indeed be a serious drawback to its use. As I am satisfied with a tenth part of that length, excluding the rising main in which the flow is continuous, you will see the necessity of contradicting Mr. Davey's statement.

Turning for one moment to Mr. D. H. Irwin's letter in your last issue, I do not propose to quarrel with the figures he gives. As a director of Messrs. Crossley Brothers, Mr. Irwin has recently sold me three gas engines of the "most modern type with all recent improvements," and the best consumption he will guarantee is ¾ lb. of anthracite per brake horse-power hour at full load. From many actual results I believe this to be a fair figure. Now, if Messrs. Crossley Brothers can develop a pump horse-power hour for 0.64 lb. of coal, as Mr. Irwin states, may I not reasonably inquire why they cannot at least guarantee the same figure per brake horse-power hour? They would still have all the margin between the pump horse-power and the brake horse-power in hand to play with.

London, November 29th. H. A. HUMPHREY.

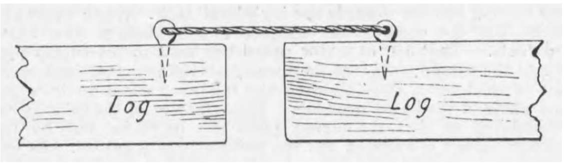
PRIMITIVE ENGINEERING BY CANADIAN LOGGERS.

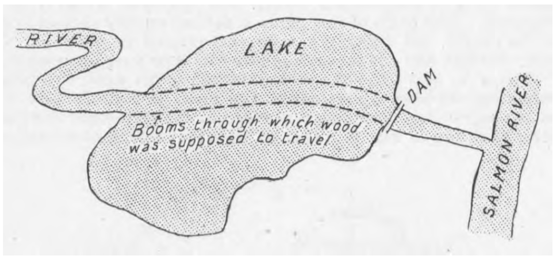
SIR,—I think the following account of a primitive oil marine engine will interest your readers, but first let me give you a rough idea of a logger's cabin and his life, and then you will more readily understand the difficulties in making the boat that I have very feebly described. The logger is naturally a strong, hardy man, and has to rough it in his camp. He gets his three meals a day, and splendid food at that, but very little variation, pork and beans being the principal dainty, and appearing at every meal, served on tin plates, with green tea without milk, also in tin plates but of a deeper variety and free from any enamel ornamentations. His bed consists of three blankets, fairly large, one half of which is used to lie on, the other half being drawn over for covering. His coat is used as a pillow when neatly rolled up.

During the whole time the lumber is being drifted down a stream by the water current or by the gasoline tug where the current is not powerful enough, the men are constantly in the water up to their waists—no specially adapted clothes are used—nor does the logger put dry clothes on when he finishes work at the end of the day. He has his supper, sits by the kitchen fire for an hour or so, and then tumbles into bed with his wet things on, leaving them to dry on him during the night, and he is never any the worse for it.

The contract we had in hand was 4000 cords of pulp wood, chiefly cut in 4ft. lengths; but a large quantity of wood in full lengths of the tree had to be floated down a river 2½ miles to a lake made by a 9ft. dam, along the lake about five miles to the dam, and then two miles down the river to the main salmon river to Scotstown, where the mill was situated.

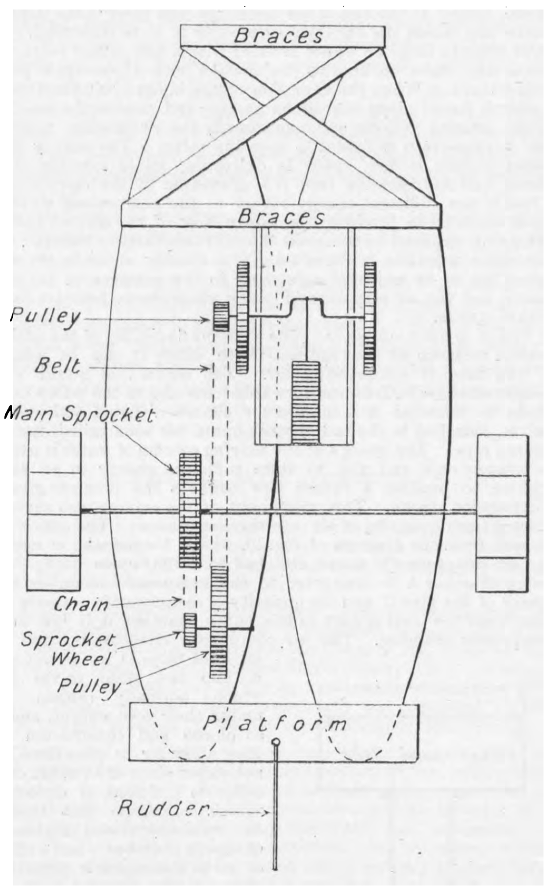
The original idea was to place trees or booms—that is, trees cut down and tied together by dogs connected with a chain or wire thus—along the lake to keep the wood from drifting in all directions; then open the dam gates to make a current, and the pulp wood was expected to drift down over the dam and into the salmon river, *i.e.*:—

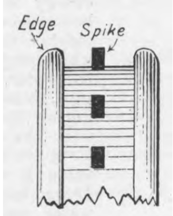




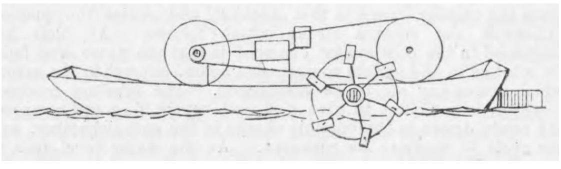
Unfortunately, the dry season caused a loss in water power, and when the booms were full a gale sprang up which broke them and sent the pulp wood in all directions in the lake in amongst the birches and tall weeds. The only thing to do was to place a boom across the river to prevent more wood coming down into the lake, and make a tug out of any material at hand, so that the pulp wood could be floated into a cage or raft by using the booms, and let the tug drag the rafts across the lake to the dam, where the raft could be opened to let the wood out of the booms and the tug taken back for another load. Well, a stationary gasoline engine was found near at hand, used by a farmer for threshing and pumping. Two of the boats were braced together to take the weight, and old material out of the mill was used to form paddle wheels and the balance of the machinery. The logger's chief tools being an axe and a cross-cut saw, you can understand what sort of a job was made. I give you a sketch of the vessel.

The boats were each 30ft. by 5ft. 9in., and were braced together by boards in front and the platform for the engine. The main sprocket wheel was a wooden pulley, with large spikes nailed on to act as cogs for the chain to grip on, and had a bead of wood nailed on the edges to prevent the chain from sliding off the sides, thus:—





The pulley on the engine was 1ft. 5in., the main pulley 3ft. 10in., the sprocket wheel 11in., main sprocket 3ft. 5in., paddle wheels 5ft. outside measurement.



The engine was 6 horse-power, horizontal stationary, International Harvester Company's gasoline, with auto sparker, water cooled.

Absence of covering for the engine in wet weather caused the belt to slip and fall off, water in the gasoline stopped the engine, and so on until it became a positive work of art to keep the boat going. To make matters worse, the chain did not fit the sprocket wheel, and was constantly breaking and needing new links. Furthermore, there was only one speed at which the engine worked, and no reverse, hence a good deal of skill in steering and judgment of distance were demanded. Only once was the engine cleaned during the two months I had it, for it was generally on the go all through the working hours, and if we did shut her down it was to release me to give a hand at something else. The only cleaning it had that time was not thorough. The sparking plug got fouled, and, after being taken out and cleaned, soon fouled again, so I took out the piston-rod, and thoroughly cleared all deposits from the explosion chamber, and that was the only real time she refused me, but she was off again in two hours.

I trust these notes from the wild may interest some of your younger readers at least. G. A. W.

THE ECONOMY OF PUMPING ENGINES.

SIR,—In the course of the discussion which followed the reading of Mr. Humphrey's paper reference was naturally made to the economy of pumping engines. It is not easy to compare the fuel consumption of an internal combustion pump with that of a steam pump. It seems to me, however, that the latter was over-estimated. The following facts may be of interest at the present moment:—

In 1883 the first compound rotative pumping engines ever seen were designed by Mr. Edwin Reynolds, constructed and set to work to supply the city of Allegheny, Pa., with 5,000,000 gallons per day. There were one high and two low-pressure cylinders. They gave a duty of 110,000,000 per 100 lb. of coal. The pressure was 107 lb., and the piston speed 120ft. per minute.

In 1886 the Allis Company built to the designs of Mr. Reynolds the first triple-expansion rotative pumping engine. The pressure was limited to 80 lb.; the capacity of the plant is 18,000,000 gallons per twenty-four hours, lifted 160ft., twenty revolutions, 200ft. per minute piston speed; the cylinders are 28in. + 48in. + 74in. × 60in.—the cylinders are jacketed all over. The reported duty is 129,000,000, or 13.84 lb. of steam per indicated horse-power per hour.

The total cost of pumping 5,204,000,000 gallons per annum 160ft. high at Chicago is given at 7.34 dols. per 1,000,000 gallons, and for coal only 3.15 dols., coal costing 5.95 dols. per ton.

I can give many other examples, but these will suffice to show that the ordinary piston steam engine will require a great deal of beating.

The Davey differential engine is a machine of high efficiency if it is properly worked; that is to say, great care must be taken that it completes its stroke. I have seen one of considerable size working 10in. to 1ft. short at each end, and I have actually known this method of working to be adopted when there was not enough water to keep the engine properly loaded in a mine. The best results with any steam engine can only be got by intelligent management. It would seem that one advantage of the Humphrey pump is that no skill is required to work it.

November 29th. U. S. A.

TRANS-SIBERIAN RAILWAY.

SIR,—Under the heading "Railway Matters," the rumour is reproduced in THE ENGINEER from daily papers "that the Russian Government are about to conclude with a big American Syndicate for development of the Trans-Siberian Railway and laying of a second track." From reliable quarters in St. Petersburg I can affirm that the Russian Government have no such intention. "Russia for the Russians" is the axiom, and Government have to take into close consideration the critical state of Russian industry, lasting for several years. The "Douma" would have also to say a word in the case and strongly object, no doubt.*

London, S.W., November 30th. F. A. F.

INTERNATIONAL TESTING ASSOCIATION.—At a recent meeting of the British Branch of the International Testing Association, representatives to the following committees, already in existence, or about to be appointed, for the investigation of the problems specified were nominated:—A. Metals.—(*a*) Influence of slag enclosures. Mr. J. E. Stead, Dr. W. Rosenhain, Mr. E. F. Law, (new committee). (*b*) Determination of hardness by ball or cone pressure tests (existing problems 2 and 27). Proposed new committee for joint investigations:—Professor Unwin, Professor Goodman, Dr. Stanton. (*c*) Impact tests. New committee proposed:—Mr. W. G. Kirkaldy, Captain M. H. Riall Sankey, Mr. Bertram Blount, Dr. Stanton. (*d*) Method of testing cast iron (problem 25). Existing committee is to be dissolved and the problem to be referred to committee 1, to which it was recommended that the following names be added:—Mr. J. E. Stead, Mr. F. W. Harbord, Mr. W. G. Kirkaldy, Mr. E. Adamson. In connection with the formation of this committee it was further agreed to recommend that a sub-committee on cast iron be appointed. (*e*) Utilisation of magnetic and electric properties of material in connection with the mechanical testing thereof. New committee—appointment of nominees to be referred to the National Physical Laboratory. (*f*) International Specifications for Iron and Steel. Committee 1:—Mr. J. E. Stead, Mr. F. W. Harbord, Mr. F. E. Robertson. Committee 1A:—Mr. F. E. Robertson, Mr. Skelton, Professor Goodman, Mr. J. T. Milton, Captain Sankey, Mr. Stead, and a nominee by Mr. H. F. Donaldson and by Messrs. Vickers, Sons, and Maxim, respectively. The matter of making any further nominations representative of manufacturers was delegated to Mr. G. C. Lloyd. (*g*) Nomenclature of iron and steel (problem 24):—Dr. Rosenhain, Mr. F. C. Fairholme, Mr. L. P. Sidney. (*h*) Specifications for copper alloys (problem 38):—Dr. Glazebrook, Mr. F Tomlinson, Mr. Bertram Blount, Professor Gowland, Mr. J. T. Milton, Dr. Rosenhain, and a nominee of the Institute of Metals. With reference to the supplementary list of new committees, the formation of which is contemplated, the following recommendations were unanimously adopted:—New committees. Section A. Metals. (1) Investigation of copper steels and high-speed tool steel. To add Dr. H. C. H. Carpenter's name to the list. (2) Homogeneity of metals in relation to the microstructure. To refer this matter to existing committee for problem 2. (3 and 4) Impact tensile tests and resistance to alternating stresses. It was recommended that these two subjects should be treated together by the committee dealing with impact tests. (5) Influence of temperature in relation to working. The scope of this subject not being, in the opinion of the meeting, clearly defined, it was resolved to refer the matter to the council of the Association for further elucidation. Problem 43 would appear to deal with this matter. (6) Internal stresses. It was recommended that the proposal by Mr. Mesnager, as to the definition of terms, should be dealt with by the committee on nomenclatures. Section B. Cement.—(1) Cement tests. It was recommended that this matter should be dealt with by committee 41, the following names being recommended for addition to that list:—Mr. A. C. Davis, Mr. P. W. Meik, Mr. Bertram Blount. (2) Reinforced concrete. To add the following names:—Mr. A C Davis, Mr. P. W. Meik, Mr. Bertram Blount. (3) Plastic mortars (committee 42). Add Mr. Charles Watson, Dr. Desch, and R. Curling Styles. (4, 5 and 6) It was recommended that these subjects (Sec. B., Nos. *c*, *d* and *f*) should stand over. (7 and 8) It was recommended that this subject (standard cement, Sec. B, No. *g*) should be referred to committee 42, and further that to committee 30, on finest particles (Sec. B, No. *h*) should be added the names of Messrs. W. J. Cooper, C. W. Sharrock, and V. Earle. (9 and 10) It was agreed to recommend that these two subjects (Sec. B, Nos. *i* and *k*) the weathering of building stone and the weathering of masonry, should be treated together by committee 7, and it was recommended that the names of Mr. Brindley, Dr. Flett and Mr. Mumby be added to that committee. Section C. Miscellaneous.—(1) Wood tests. Mr. W. G. Kirkaldy and a nominee by the Post-office Department. (2) Protection of iron. Mr. Leonard Archbutt, Mr. Brodie, Dr. Rosenhain and Mr. J. Cruickshank Smith.

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* The statement has now been officially denied by the Russian Government.

THE IRON, COAL, AND GENERAL TRADES OF BIRMINGHAM, WOLVERHAMPTON, AND OTHER DISTRICTS.

(*From our own Correspondent.*)

Steel.

THERE was a very quiet market on 'Change on Thursday in Birmingham as regards business, the chief topic of conversation being the political position. Semi-finished steel was in good request for the galvanised iron trade and for the tin-plate trade, both of which industries are flourishing. Bessemer sheet bars were quoted £4 15s., and Siemens descriptions an additional half-crown. In the structural steel trade several firms are well off for orders, whilst others are very poorly employed, there being considerable inequality. Mild steel engineering bars are quoted £6 7s. 6d. to £6 17s. 6d., angles £5 17s. 6d. to £6, and joists £5 15s. to £6. For boiler plates £7 5s. is asked.

Manufactured Iron.

Trade continues very quiet in manufactured iron in all branches except galvanised sheets and best bars. The quotation for the former remains £11 to £11 5s., and for the latter £8 per ton. Other departments are devoid of animation, with quotations unchanged on the week, but with a greater tendency by sellers to make concessions.

Pig Iron Dull.

Deliveries of pig iron are proceeding under old contracts, but new business is very scarce, and prices are weak. Makers quote cinder forge 45s. to 46s.; part-mine, 48s. to 49s.; best all-mine forge, 85s.; foundry, 90s.; and cold blast, 115s.

The Outlook.

It is not expected that business will change for the better until the New Year, some people cheerfully expecting a revival in the spring.

NOTES FROM LANCASHIRE.

(*From our own Correspondent.*)

MANCHESTER, Thursday.

Pig Iron a Declining Quantity.

THE attendance on the Manchester Iron Exchange on Tuesday was above the average. Actual business was, however, on a limited scale. As time progresses, it is quite evident that there will be no improvement in the current year, and this notwithstanding good reports of business for German and American account. There has been a gradual decline in warrant iron during the past week. In sympathy, Middlesbrough brands on spot have declined about 6d. per ton, and in some cases hematite has weakened to a considerable extent. Staffordshire and other sorts of pig iron have favoured buyers. Forge iron has been quiet. Beyond this there is no new feature to report.

Finished Iron and Steel.

The position remains practically unchanged. There has been no official change in prices, but merchants report actual business as exceedingly slow.

Copper.

The reduction in the raw metal has caused a corresponding decline in manufactured stuff. Sheets are £2 per ton lower, and ingots are in buyers' favour. We do not hear, however, of any reduction in tubes, although in some cases there was a tendency to book orders at ¼d. per lb. lower.

Lead and Tin.

Lead: Sheets quietly steady and unchanged. Tin: English ingots ruled a shade easier.

Quotations.

Lincolnshire No. 3 foundry, 55s.; Staffordshire, 53s.; Derbyshire, 55s.; Middlesbrough, open brands, 59s. 9d. to 59s. 10d. Scotch: Gartsherrie, 61s.; Glengarnock, 60s. 6d.; Eglinton, 59s., delivered Manchester. West Coast hematite, 61s. to 61s. 6d.; East Coast ditto, 60s., both f.o.t. Delivered Heysham: Gartsherrie, 59s.; Glengarnock, 58s. to 58s. 6d.; Eglinton, 57s. Delivered Preston: Gartsherrie, 60s.; Glengarnock, 59s. to 59s. 6d.; Eglinton, 58s. Finished iron: Bars, £6 10s.; hoops, £7 12s. 6d.; sheets, £7 12s. 6d. to £7 17s. 6d. Steel: Bars, £6 2s. 6d. to £6 5s.; Lancashire hoops, £7 5s.; Staffordshire ditto, £6 17s. 6d. to £7; sheets, £7 17s. 6d. to £8; boiler-plates, £7 5s. to £7 7s. 6d.; plates for tank, girder, and bridge work, £6 5s. to £6 7s. 6d.; English billets, £4 12s. 6d. to £4 15s.; foreign ditto, £4 10s. to £4 15s.; cold drawn steel, £9 10s. to £9 15s. Copper: Sheets, £72; tough ingot, £62 10s.; best selected, £62 10s. per ton. Copper tubes, 8¾d.; brass tubes, 7⅛d.; condenser. 8⅛d.; rolled brass, 6½d.; brass wire, 6¾d.; brass turning rods, 6¾d.; yellow metal, 6⅛d. to 6⅜d. per lb. Sheet lead, £17 per ton. English tin ingots, £139 10s. per ton.

The Lancashire Coal Trades.

The attendance on the Coal Exchange was quite up to the average. Business generally was rather slow, the change in the weather having caused a diminution in the demand for house coal. The condition of the cotton trade is also causing a diminished demand for slack. At a meeting of Lancashire coalowners it was resolved that no advance should be made, a decision which will be met with approval on the part of consumers of house coal. In fact, it was felt that the advance of a couple of months ago in steam and manufactured coal was not justified by the trade passing.

BARROW-IN-FURNESS, Thursday.

Hematites.

There is no improvement to note in the hematite iron trade this week, and the report of business doing and of inquiries for prompt and forward deliveries is not encouraging for the moment at any rate, yet there is a good feeling in the market, and both buyers and sellers are looking for better times after the New Year has been reached. The production of iron is, however, greater than the sale of iron, and stocks in makers' yards are consequently increasing, but not to a large extent, and some of the iron going into stocks has already been sold, but is not wanted for consumption at present. There is no growth of stocks, however, in warrant stores; on the contrary, there has been a clearance of 300 tons, and the metal now held bulks at 18,331 tons, which is, after all, only a comparatively small holding. The demand for special hematite iron is fairly maintained, and the prices are quoted at 64s. to 65s. per ton, according to quality. Mixed Bessemer numbers are at 62s. 6d. nominally, but business has been done at from 61s. to 61s. 6d., while warrant iron is weaker at 60s. 3d. net cash sellers. Sales of ferro-manganese are well maintained, and there is still a steady demand for spiegeleisen. The make of iron is maintained, and twenty-eight furnaces are making iron. It is not probable that any reduction of output will be determined on at present, as it is expected that better times will be with us in the course of a few weeks. Iron ore is in steady demand, but there is most inquiry for best classes of metal. Prices remain steady at 12s., 14s. 6d., and 18s. net at mines for ordinary, medium, and best classes. Foreign ores are still being largely imported, and by this means smelters can best keep down the prices of native classes of ore.

Steel.

The trade being done in steel is rather better than it has been. The demand for rails is, however, not very pronounced either on home or on Colonial or foreign account, but makers are able to find employment for two-thirds of the mills in the district and it is expected that this condition of things will be maintained for two or three months to come. Prices are at present about £5 5s. per ton net f.o.b. for heavy rail sections. Nothing is being done in plates, and the demand for other classes of shipbuilding material is also quiet. No improvement in this branch of trade is expected until there is much more activity in the shipbuilding trade than at present. Merchant steel is in moderate request. There are prospects, however, of more briskness in the steel trade generally in the beginning of next year.

Shipbuilding and Engineering.

Shipbuilders are on the look out for new orders, and it is expected that before long they will book important work. Engineers are in much more busy times in all their departments, and even greater activity may be expected so soon as the orders recently booked are further forward than at present.

Shipping and Coal.

The exports of iron and steel last week amounted to 11,371 tons—iron 2975 tons and steel 8396 tons, as against 9187 tons for the corresponding period of last year, an increase of 2184 tons. For the year to date the shipments aggregate at 566,157 tons, against 458,277 tons for the corresponding period of last year, an increase of 107,880 tons. Coal and coke steady.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

The Business Position.

THE condition of trade all round seems one of "marking time." Quietude generally prevails, and there appears little prospect of any activity in our leading departments of local manufacture until, at least, the early period of next year. In the coalfield business is largely in a waiting attitude, the contracts for locomotive fuel having yet to be settled, as well as the bulk of the shipping contracts. The iron market continues featureless and dull, while the steel trades are not at all active, although the inquiry for crucible and tool steel for the United States and several other foreign countries is fairly well maintained.

Steam Coal: Contracts and Exports.

Tenders have recently been sent in for supplies of locomotive fuel in the case of the railway companies whose contracts expire at the end of the year. On the results will depend, to a considerable extent, the arrangements to be made with shippers. In the latter instance there is some movement, bunker coal order—a good weight—having been placed by the Cunard and Elder Dempster Shipping Companies. Some small shipping contracts are reported to have been made at from 9s. 3d. to 9s. 6d. per ton, the latter, it is understood, being the figure below which the collieries are not likely to go. As we pointed out last week, however, the prices received for "spot" lots are not to be taken as indicative of the rates that coalowners expect to obtain for next year's supplies.

House Coal—Higher Prices Talked of.

Business continues on the up grade, and further improvement is looked for as the holiday season approaches. Reports vary considerably, but stocks seem to be pretty well worked off, and this condition synchronises with better business at local depôts, as well as on distant account. Consequently, there is talk of a probable early advance of 1s. per ton, and 6d. per ton on nuts. So far, however, we cannot hear of any official step in this direction. Current quotations:—Best Barnsley, 12s. 6d. to 14s. per ton; secondary descriptions, 10s. 6d. to 11s. 6d. per ton. The firmer tone in domestic fuel noted last week in the West Yorkshire district is fully maintained.

Small Coal and Coke.

The situation in regard to slack continues as previously reported. Some considerable sales for shipment have curtailed stocks. Coking smalls firm and in good request. Smalls for Lancashire and Yorkshire mills, 4s. 6d. to 5s. 6d. per ton. Market for furnace coke well maintained. Best washed, 12s. 6d. to 13s. per ton; unwashed, 11s. 6d. to 12s. per ton.

The Iron Market.

Dullness still pervades the pig iron market. Deliveries, having regard to the state of trade, are fairly good. There is a general impression that prices of all irons will be dearer next year, owing to the increased cost of fuel; and ironmasters, therefore, are not disposed to give way in respect of forward contracts. Official quotations are unchanged, viz.:—West Coast hematites, 68s. to 70s. per ton; East Coast, 65s. to 67s. per ton. Lincolnshire: No. 3 foundry, 52s. 6d. per ton; No. 4 foundry, 51s. 6d. per ton; No. 4 forge, 51s. 6d. per ton; No. 5 forge, mottled, and white, 51s. 6d. per ton; basic, 52s. 6d. per ton. Derbyshire: No. 3 foundry, 52s. per ton; No. 4 forge, 50s. 6d. per ton. The figures in every case are net, delivered in Sheffield and Rotherham.

Bars, Hoops, and Sheets.

Quotations as before, and business very quiet. Bars, £6 10s. per ton; hoops, £7 10s. per ton; sheets, £8 10s. per ton.

Steel, &c.

The most gratifying feature of the steel trade is in respect of crucible and tool steel. The improvement recently noted in the United States demand for tool steel, including the high-speed qualities, is fully kept up, and there is also an increased business reported with South America, Germany, and several other foreign markets. The principal demand is in the very best grades. The foreign trade, indeed, is fairly brisk, and if the home requirements were equally good, these departments would leave little ground for grumbling. Unfortunately, however, there are few signs of any immediate revival in the home markets. We do not hear of any fresh movements in regard to marine or railway material. An improvement in both departments, especially in railway steel, is confidently looked for next year. Military material is finding less employment, and new orders would be exceedingly welcome in the armour-plate and projectile departments.

Grinding Regulations.

Several of the new regulations dealing with the grinding of metals and racing of grindstones come into operation on the 1st of this month. The regulations enforcing the provisions of new appliances in factories are delayed by the Home Secretary until the 1st of June next year. Those regulations which have now come in force are of considerable importance to workmen, who will, no doubt, seek to make themselves fully acquainted with the new conditions imposed upon them, and failure to comply with which involves liability to penalties.

NORTH OF ENGLAND.

(*From our own Correspondent.*)

Cleveland Pig Iron.

BUSINESS in Cleveland pig iron continues very slack; the prices have during the last few days declined rather smartly, and some of the traders are inclined again to be pessimistic; certainly the buoyant feeling that was reported a short time ago is hardly appreciable now, and consumers are disinclined to buy for next year's delivery. The action of the speculators is weakening the prices of warrants; they are losing heart, because their anticipations in regard to the American demands for Cleveland pig iron are not being fulfilled, and they are not prepared to keep the iron over the winter season when the expense of carrying it is so heavy. It may be that they will have to accept less for the iron in the early part of next year than the figures ruling now. They are therefore keen to sell without delay, and are bringing down prices by their pressure to dispose of their iron. Much depends upon how the American consumers in the Eastern States are placed. At present they can secure all they want from American ironmasters at prices which compare favourably with ours. It was chiefly the expectation of big American demands this autumn for Cleveland iron that led to the rise in prices that did take place, and, as the demand actually has been a very disappointing one, the speculators are depressing prices by their endeavours to get rid of the iron they bought. The market is weakened likewise by the bad shipments and the rapid increase in stock in Connal's public store. Consumers, therefore, believe they will find it to their advantage to wait, and thus buy from hand to mouth only. It is not usual for consumers to purchase heavily in a falling market, especially with the quietest time of the year coming on, and a general election in prospect. The prices of Cleveland pig iron are lower this week than they have been since the early part of August. No. 3 has dropped to 50s. per ton for early f.o.b. delivery, No. 1 to 52s. 3d, No. 4 foundry to 48s. 6d., No. 4 forge to 48s. 3d, and mottled and white to 47s. 9d., and the quotations for forward delivery are little better than nominal, because of the unsettled and uncertain state of the market.

Hematite Pig Iron.

Producers of hematite pig iron speak well of their business and its prospects, and certainly they are in a considerably better position now than are the makers of ordinary Cleveland pig iron. They can firmly maintain their prices, while those of Cleveland iron are falling. They have not to contend with the holders of warrants as the Cleveland makers have, because there are no East Coast hematite warrants now. Besides this, producers themselves have no stocks, and all they are making is going direct into consumption. All those who are consumers of hematite pig iron are well off for orders, and report trade prospering, and more particularly is this the case in the shipbuilding industry. Some of the hematite makers have already sold a good deal of iron for delivery next year, and thus further advances in quotations may be looked for. Mixed numbers with makers are at 60s. per ton for prompt delivery, and 62s. 6d. has been asked and paid for first quarter next year. Prompt parcels are heard of at 59s. 6d., but they are offered in special circumstances by second hands, who are compelled to sell. Rubio ore is nominally at 17s. 6d. per ton for prompt c.i.f. delivery Tees, but there has been no business to fix the prices actually. It is still impossible to give any reliable information about the forward prices of ore. Furnace coke is firm at 17s. 6d. per ton, delivered at Middlesbrough works promptly, but manufacturers will not take as little as this for next year's delivery. The production of coke is not in excess of requirements, and the home consumption has lately been increased, as also have the exports.

Stock of Pig Iron.

The rapid increase in the stock of Cleveland pig iron in Connal's public store cannot be described otherwise than as an unsatisfactory feature, and it has doubtless operated not a little in weakening prices, for traders looked for a return a good deal better than this. Probably it would have been if business with America had developed as was anticipated. Not since April, 1907, has there been such a stock in Connal's as was reported at November 30th—363,218 tons, an increase for the month of 27,733 tons. At the end of the first half of last year the total stock was under 48,000 tons, or about an eighth of the present quantity. On November 30th the stock of No. 3 Cleveland pig iron in Connal's was 331,833 tons, increase during month 22,823 tons; of other iron deliverable as standard, 28,625 tons, increase 5060 tons; and of iron undeliverable as standard, 2760 tons, decrease 150 tons.

Realised Prices of Manufactured Iron.

The Board of Conciliation and Arbitration for the manufactured iron trade of the North of England have been informed by their accountants that the average price realised by producers in the district for the manufactured iron delivered by them during September-October last was £6 6s. 11·55d. per ton, or 3·39d. more than in the previous two months, and wages for December-January will, according to the sliding scale arrangement, be the same as those during October-November. The lowest price of the recent depression was £6 6s. 7·16d. in May-June last, and there is thus an improvement of 4·39d. As compared with September-October, 1908, the price has fallen 5s. 4·13d. per ton, and over this year the decrease has been 6s. 6·16d., while the rate for puddling is 6d. less and other wages have fallen 5 per cent. It is satisfactory to note increased deliveries of shipbuilding materials.

Manufactured Iron and Steel.

While a lull must be reported in the businesss being transacted in manufactured iron and steel just now, producers are well off for orders, and generally keep their mills in fuller operation than for two years past, especially where plates and angles are produced. Prospects are encouraging, and some of the producers are, it is said, contemplating advances of quotations. Messrs. Bolckow, Vaughan and Co., Middlesbrough, have obtained the order from the Federated Malay States Railways for 6000 tons of steel rails and 500 tons of fish-plates. The quotations in this district for manufactured iron and steel are as under:—Steel and iron ship plates, £6; steel ship angles, £5 7s. 6d.; iron ship plates, £7; packing iron and steel, £5 5s.; steel bars, £6; iron bars, £7; steel sheets (singles), £7 5s.; steel hoops, £6 5s.; steel strip, £6 2s. 6d.; iron ship rivets, £7 5s., all less 2½ per cent. f.o.t. Galvanised and corrugated steel sheets, 24 gauge in bundles, are at £11 5s., less 4 per cent. f.o.b. Heavy steel rails are at £5 5s.; and cast iron chairs £3 10s., both net f.o.b. Shipments of steel last month from the Tees reached 45,324 tons, against 38,518 tons in November, 1908, and of manufactured iron 8862 tons against 8505 tons. Of this, 16,781 tons went to Africa; 14,028 tons to India; and 7378 tons to South America. The quantities to Japan and Australia were smaller than usual. The eleven months' return of manufactured iron and steel exported was 586,019 tons against 529,249 tons in 1908.

Shipbuilding and Engineering.

The improvement in the demand for new vessels continues, and builders are now in such positions that they have in many cases put up their prices. Tyne builders have this year launched 93 vessels, against 99 in 1908, and there are more of the higher classes being built there. The proportion of tramp steamers building is less than in former years. Messrs. Short Brothers, Sunderland, have secured orders for three ocean colliers, each of 7000 tons d.w., for Canada, and it is said that these will be built on the Isherwood system. There is reason to believe that the worst has been experienced in the engineering industry, and more men are employed at the various establishments, but it cannot be said that prices are satisfactory for the employers.

Coal and Coke.

The demand for coal of all kinds shows some improvement, and consumers are pressing for quick deliveries, for they apprehend some trouble in the New Year when the Miners Eight

Hours Act will have come into force in Northumberland and Durham, half a year after it took effect in all other districts. The coalowners and the men's representatives have had various conferences during the last few weeks to discuss the arrangements, but the negotiations have not resulted in anything definite being decided upon. The men have made certain claims about regulating wages, which the employers are hardly likely to agree to. The men want the future basis of wages to be, not the average selling prices, as heretofore, but the average profit realised. The coal trade is therefore in a rather unsettled state, but collieries are working to their fullest capacities, and are likely to be kept going as satisfactorily up to Christmas. Prices have risen, and best steam coals are now at 11s. f o.b., while steam smalls are at 6s. 6d.—advances of 6d. per ton this week; best gas coals are up to 11s., and bunkers realise from 9s. 6d. to 10s., according to quality. Furnace coke is at 17s. 6d., delivered at Middlesbrough works. It is generally expected that higher prices will rule next year, partly because of the increased cost of working.

NOTES FROM SCOTLAND.

(*From our own Correspondent.*)

General Condition of Business.

The iron and metal trades generally are suffering from depression, and there is scarcely anything in the present outlook to arouse expectation of an early revival. Indications of greater ease in the money market might be accepted as a favourable point, from a speculative point of view, were it not that prospects in America and elsewhere are less encouraging than they were a few weeks ago. There is now added the disturbing influence of political agitation, so that the outlook is somewhat clouded at the moment.

The Pig Iron Market.

There has been comparatively little business in pig iron warrants in the last few days. The demand has greatly fallen away both as regards cash and future iron, and there has been a sharp reaction in prices of Cleveland iron. Business since last report has been noted at 50s. 10d. to 49s. 10½d. cash, 51s. 3½d. to 50s. 2½d. one month, and 51s. 11d. to 50s. 11d. three months. Transactions have also occurred at 50s. 9d. for delivery in eleven days, and from 50s. 10d. to 50s. fourteen days. A considerable amount of iron is understood to be carried for delivery before the end of the year. Statistics of business and of shipments are not encouraging. The very most has been made on 'Change of reported inquiries from America and Germany, but so far these have not given much cause for hope as to an early improvement in business.

Scotch Makers' Iron.

There has been a quiet market for Scotch makers' pig iron, but the values of special brands are well maintained. Free at ship in Glasgow harbour, Monkland and Govan, Nos. 1, are quoted 57s.; No. 3, 55s.; Carnbroe, No. 1, 60s. 6d.; No. 3, 57s. 6d.; Clyde, No. 1, 62s.; No. 3, 57s.; Gartsherrie and Calder, Nos. 1, 62s. 6d.; Nos. 3, 57s. 6d.; Summerlee, No. 1, 63s. 6d.; No. 3, 58s 6d.; Langloan, No. 1, 64s.; No. 3, 59s.; Coltness, No. 1, 89s.; No. 3, 59s.; Eglinton, at Ardrossan or Troon, No. 1, 58s.; No. 3, 56s.; Glengarnock, at Ardrossan, No. 1, 65s.; No. 3, 60s.; Dalmellington, at Ayr, No. 1, 62s.; No. 3, 57s.; Shotts, at Leith, No. 1, 62s. 6d. No. 3, 57s 6d.; Carron, at Grangemouth, No. 1, 64s. 6d.; No. 3, 58s. 6d. per ton. The demand for shipping iron has been moderate, and there is no improvement in the wants of home consumers. An additional furnace has been put on the production of hematite pig iron at Coltness ironworks, and there are now 44 making hematite, 35 ordinary, and 5 basic iron, the total of 84 furnaces thus in operation in Scotland comparing with 83 last week and 77 at this time last year.

The Hematite Trade.

There has been practically nothing doing in hematite warrants. Cumberland hematite is quoted 60s. 3d., which is 3d. below the price at which cash business was recently done. Merchants quote Scotch hematite 63s. for delivery at the West of Scotland steelworks. Fair deliveries are being made under existing contracts, but the current fresh business is reported to be comparatively small. Heavy arrivals of hematite ore—19 steamboat cargoes—reached the Clyde in the course of the last six days. Complaints are made that the harbour and railway authorities are not affording adequate facilities for prompt discharge and conveyance of the ore to the ironworks; but some of the congestion is due to the arrivals of vessels that were detained nearly a week down the firth by fog. The imports of ore for the past eleven months amount to about 1,000,000 tons, being 100,000 tons more than in the corresponding period of last year.

The Clyde Shipbuilding Trade.

During the past month 36,377 tons of new shipping were placed in the Clyde, compared with 42,557 in November, 1908, and 31,791 tons in November, 1907. The output of the eleven months reaches 353,905 tons, against 315,206 in the same period of last year, and 523,614 in the corresponding eleven months of 1907. A fair amount of new work has been received in the course of the month, which will considerably more than make up for the tonnage that left the stocks.

Finished Iron and Steel.

There is no improvement in the malleable iron and steel departments. Iron furnaces and mills are very indifferently employed, and prices obtainable are quite unsatisfactory, especially for export business. The steel trade is also depressed, with only partial employment. There is a good demand for thin sheets and some kinds of light material, but the heavier kinds of goods are in comparatively poor request. Founders in some cases report a good business in heavy castings for shipbuilding purposes, but there is a lack of business in other directions.

The Coal Trade.

The coalmasters have raised the price of coal beginning on 1st instant another 1s. per ton, this being the second advance within a few weeks. For manufacturing purposes the demand has only been moderate, and consumers have been complaining about the advance at a time when they are not merely unable to obtain a corresponding rise in their prices, but when their works are actually partly idle. House and splint cones have met with a ready sale, and there has also been a little more done in navigation coal. At Glasgow Harbour the f.o.b. prices now are for ell and steam coals 9s. 9d. to 10s., and splint 10s. 6d. to 11s. per ton.

WALES AND ADJOINING COUNTIES.

(*From our own Correspondent.*)

Last Week's Coal Trade.

It was currently reported on 'Change that several important Admiralty orders had been booked. What the quantities were, or the dates fixed, or even the prices obtained, are kept secret, though, as in former cases, they will ooze out in a little time. The influence of these prices on the market is marked, and that is one reason why they are kept secret; and then, again, buyers are not willing that these transactions should become public property. Upon one head the public may be satisfied, that the leading coalowners are content, and the tone of business has been somewhat improved. The standing grievance in the trade has been the losses incurred by the working of the Eight Hours Act. In all quarters I hear a strong expression of regret that Parliament should have been induced to pass such a measure, which colliers dislike in equal ratio with coalowners.

The French State Railways.

There has been some difficulty in obtaining particulars of these, but the following are given on trustworthy authority:—Pyman, Watson and Co., 100,000 tons small and 32,400 tons large; Moxey, Savon and Co., 50,000 tons small and 75,000 tons large; E. William Cook, 30 000 tons small; Société Commerciale, 30,000 tons small; C. L. Clay and Co., 20,000 tons small; Cory's Trading Co., 18,000 small and 7000 large; Budd and Co., 8840 small; Glanme Pereire, 6000 small; Guerer, Honfleur, 1670 small. This makes a total of 345,000 small and 114,400 tons large. Prices obtained are stated to be equivalent to 7s. 10d. f.o.b. for the small, 14 per cent. ash guaranteed, and 13s. 9d. f.o.b. large; all coal to be second-class Monmouthshire.

Other Large Contracts for Welsh Coal.

On 'Change, Cardiff, this week it was stated that the Orient Steamship Company has contracted for about 150,000 tons of Insole's large steam coal at about 15s. 6d. per ton f.o.b. The Shire Line are stated to have placed contracts for 80,000 large steam at from 15s. 6d. to 15s. 9d. f.o.b.; and a good second-class Admiralty coal, to the extent of 75,000 tons, at about the same figure, is said to have been booked by another firm. So far the Australian strike has not been productive of much business to the Welsh coal trade. A cargo of 7000 tons is reported to be preparing, and other cargoes booked for Eastern ports, with option for Australia, are likely to follow.

Latest Prices at Cardiff.

Best large steam, 16s. 3d. to 16s. 6d.; seconds, 15s. 6d. to 16s.; ordinaries, 14s. 6d. to 15s.; best drys, 15s. 9d. to 16s. 3d.; ordinary drys, 14s. to 14s. 6d.; best washed nuts, 14s. to 14s. 6d.; seconds, 13s. to 13s. 6d.; best washed peas, 12s. to 13s.; seconds, 10s. to 11s. 6d.; very best smalls, 8s. 6d. to 9s.; best ordinaries, 7s. 9d. to 8s. 3d.; cargo smalls, 6s. 9d. to 7s. 3d.; inferior kinds, 6s. to 6s. 9d.; very best Monmouthshire black vein, 15s. 3d. to 15s. 6d.; ordinary Western Valleys, 14s. 6d. to 14s. 9d.; best Eastern Valleys, 13s. 9d. to 14s.; seconds, 13s. to 13s. 3d. Bituminous coal: Very best households, 17s. to 18s.; best ordinaries, 15s. to 16s.; No. 3 Rhondda, 17s. 3d. to 17s. 6d.; brush, 13s. 6d. to 13s. 9d.; smalls, 10s. to 10s. 6d.; No. 2 Rhondda, 12s. 9d. to 13s.; through, 9s. 6d. to 10s.; smalls, 7s. to 7s. 6d. Patent fuel, 15s. to 15s. 6d. Coke: Special foundry, 24s. to 27s. 6d.; foundry, 19s. to 20s.; furnace, 17s. to 17s. 6d.; pitwood, 19s. to 19s. 6d.

Newport Coal.

Steadiness was a feature of the market this week; best coals are in demand, also good seconds. The weather continues to be a deterent. December bookings have been fairly good. Latest:—Very best black vein large, 15s. to 15s. 3d.; Western Valleys, 14s. 3d. to 14s. 6d.; Eastern Valleys, 13s. 6d. to 13s. 9d.; other kinds, 12s. 6d. to 13s. 3d.; best smalls, 7s. to 7s. 6d.; seconds, 6s. 3d. to 6s. 9d.; inferiors, 5s. 9d. to 6s. 3d. Bituminous coal: Best house coal, 15s. to 15s. 6d.; seconds, 14s. to 14s. 6d. Patent fuel, 15s. to 15s. 3d. Coke: Foundry, 18s. to 19s.; furnace, 17s. to 17s. 6d. Pitwood, ex ship, 19s. 3d. to 19s. 9d.

Swansea Coal.

Latest reports are that a fair demand exists, with a steady undertone. Some of the special qualities were noted as follows:—Swansea Valley in better demand, firm; Red vein, no alteration; machine-made coals, no change, firm; German nuts excepted; rather weak. Latest:—Best malting, hand-picked, 23s. to 24s. net; second malting, 21s. to 22s. net; big vein, large, 17s. 6d. to 19s., less 2½; red vein, 12s. to 13s., less 2½; machine-made cobbles, 23s. to 24s. net; Paris nuts, 26s. to 27s. net; French nuts, 26s. to 26s. 6d. net; German nuts, 25s. to 26s. net; beans, 18s. 6d. to 19s.; machine-made large peas, 11s. to 12s. 6d. net; fine peas, 10s. 6d. to 11s. net; rubbly culm, 5s. 6d. to 5s. 9d., less 2½; duff, 2s. 6d. to 3s. net. Steam coal: Best large, 17s. to 18s.; seconds, 14s. 6d. to 15s.; bunkers, 9s. 6d. to 10s. 6d.; small, 7s. to 9s., less 2½. Bituminous coal: No. 3 Rhondda, 18s. to 18s. 6d.; through, 14s. 9d. to 15s. 6d.; small, 10s. 3d. to 10s. 6d., all less 2½ per cent. Patent fuel, 13s. to 13s. 6d., less 2½.

Iron and Steel.

The ironmaking community of Wales were busily engaged this week in discussing the fact that the Transvaal requirements for steel rails had been sent to Russia. The official reason given was that all the manufacturers of steel rails in the kingdom were members of a "ring," and the prices of the ring were from £5 5s. to £5 7s. 6d. per ton f.o.b., which meant £6 2s. 6d. to £6 5s. per ton in Delagoa Bay, as against £5 13s. and £5 14s. quoted by Russian ironworks. The only ironworks not in the ring were asked to give a quotation, and this was the Steel Corporation in Canada, who quoted £5 18s. per ton in East Durban and Delagoa Bay. The sea freight, which accounts for the difference, is 17s. 6d. per ton. It is stated that the saving effected has been £20,000. There is no general improvement in trade. The new plant at Dowlais is turning out satisfactory. A few cargoes have come to hand, pig iron from Grimsby, one of 990 tons to Messrs. Thomas, Newport. Little import of iron ore, but one to Guest and Co. Latest prices at Swansea:—Pig iron: Welsh hematite, 60s. 3d. cash and month; Middlesbrough, 49s. 11d. cash and 50s. 3d. month; Scotch, 56s. cash and month; Welsh hematite, 66s. to 67s. 6d., delivered; East Coast hematite, 64s. to 65s. c.i.f. Steel bars: Siemens, £4 15s. to £4 16s.; Bessemer, £4 12s. 6d. to £4 15s. Bilbao ore, at Cardiff and Newport, 16s 6d. to 17s., on basis of 50 per cent. iron. Other quotations: Block tin, £141 10s. cash and £143 7s. 6d. three months; copper, £158 2s. 6d. cash, £159 2s. 6d. three months. Lead: English, £13 11s. 3d.; Spanish, £13 1s. 3d. Spelter, £23 2s. 6d. Silver, 23½d. per oz.

Tin-plate.

In the Llanelly district there has been a little less activity than was desirable, and inquiries have quieted down; but there is a confident impression that the slackness is only temporary, and good times are yet ahead. The new mills have been started, and all passed off in the most encouraging manner. The extensions are expected to give employment to 300 extra men. In the Swansea district everything continues in a most flourishing state. The mills throughout the Valley are being worked with energy, all of them giving full time daily. This may be clearly accepted, the quantity brought from works during the week almost touching 80,000 boxes. Shipments were limited to 61,724 boxes, and stocks now remaining are increased to 76,729 boxes. At Swansea the demand for tin-plate is well sustained, and prices are firm. Ordinary plate, Bessemer and Siemens, 12s. 4½d. to 12s. 6d.; ternes, 22s.; C.A. roofing sheets, £8 10s. to £8 15s.; big sheets for galvanising, £8 10s.; finished black plates, £9 10s. to £9 15s.; galvanised sheets, 24 g., £11 per ton.

AMERICAN NOTES

(*From our own Correspondent.*)

New York, November 24th.

The scarcity of raw steel material has become so pronounced that importations from Germany are being made, most of them for delivery along the Atlantic coast. Several 1000-ton lots have been taken by eastern mills whose demands upon western mills could not be met. The price delivered 29.25 dols. Western Pennsylvania consumers are now figuring upon importing billets, not so much on price, which ranges from 27 dols. to 28 dols. per ton, but because there is a prospect that they may not be able to obtain them at any price. Sheet bars are also very scarce, and even at 30 dols. orders cannot be placed for delivery during the first quarter of next year. Sheet and tin plates are very active at the advance made ten days ago. The shortage of cars in the coke region is pronounced, and shippers are waiting for 600 cars to come to their rescue. The six large steel car plants controlled by the Pressed Steel Car Company have orders for 160,000 steel cars, against 60,000 same time last year, and by running night and day until next June they will be able to fill the orders now on hand. There is not enough steel wheel capacity in the country to supply wheels for all of these cars, and hence the activity of the Carnegie Steel Company in building a new car-wheel plant, which, it is expected, will be turning out wheels by February 1st.

The plate mills are oversold and some Pittsburg mills were obliged to refuse orders for large quantities from steel car builders, because they could not deliver the steel within four months. They are sold up until the middle of April. The owners of the salmon fisheries on the Pacific Coast have contracted for so much sheet that the mills will find it difficult to fill any more orders before February. The mills making merchant pipe and iron pipe are well over sold, and still more business is coming along. The demand for steel bars has taxed the capacity of the mills, and recent anxious buyers have voluntarily offered premiums without securing the expected accommodation. Four of the larger producers are vigorously expanding their productive capacity. Several manufacturers of wire products have recently refused to book orders for delivery after December 15th. There is a probability of an advance between now and then. Those familiar with the inside of the industry know that there is a great deal of business lurking around for every steel product known, and they know that this demand will have a disturbing effect sooner or later on the present range of prices. The most important legal decision has just been given out by the United States Circuit Court at St. Louis declaring the Standard Oil Company an illegal corporation. The case will, of course, be appealed to the United States Supreme Court. The exports of copper for the first eighteen days of November amount to 15,000 tons, the shipments of the past week being 6800. Electrolytic is strong at 13½.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

We are asked to state that Mr. Conrad F. Mendham, M.I. Mech. E., has removed his offices from 14, Fenchurch-street, to 85, Gracechurch-street, where he is continuing his practice as consulting and inspecting engineer. Telegraphic address: "Pyrotic, London." Telephone: 9471 Central.

Mr. M. J. Stephan, Ph.D., M.I.M.M., has taken Mr. M. C. Carr-Gomm, Assoc. M. Inst. C.E., A.M.I. Mech. E., into partnership, and they are now carrying on business as consulting mining and mechanical engineers and petroleum experts at No. 6, Broad-street-place, E.C., under the style of "Stephan and Carr-Gomm."

Great Eastern Railway Locomotive Department Staff Dinner.—The sixth annual re-union dinner of past and present members of the locomotive department staff of the Great Eastern Railway was held in the Norfolk Room of the Great Eastern Hotel, Liverpool-street Station, on the 26th November, when Mr. S. D. Holden, the present locomotive superintendent, presided over a gathering which numbered fifty-four, some of whom had been drawn from places so far remote as Birmingham, Manchester, Faversham, Ipswich, Brandon, Norwich, Newton-le-Willows, and Hexham, whilst, in addition, the company included a Stratford man, who is at present on leave in this country from India. The evening was a great success. On the proposal of Mr. A. P. Parker, seconded by Mr. T. W. Ford, the present committee, consisting of Messrs. James Holden (chairman), W. F. Pettigrew, J. W. Howard, Godfrey Elliot, A. J. Hill, F. V. Russell, and A. W. Polley (Hon. Sec.), was re-elected with the addition of Messrs. S. D. Holden and D. Gillies. On the proposition of Mr. Collingwood, a vote of thanks to the committee was passed. In responding, Mr. A. W. Polley said it was the desire of the committee to make the dinner as representative as possible, and that if any members would forward the names and addresses of any other old Stratfordians the committee would be glad to receive them.

Contracts.—The Standard Engineering Company, Limited, of 63, Queen Victoria-street, E.C., has secured the order in connection with the heating and ventilation of the new motor cab garage now being built by Messrs. Panhard and Levassor at Acton Vale. It has been decided to adopt the firm's "Stanlock multiple unit system." The building in question is approximately 600ft. long by 300ft. wide, and the scheme embraces not only the heating and ventilation of the garage itself but also the office building, stores, and chauffeurs' mess-room, &c. &c.—We understand that Cryselco Limited, of Kempston Works, Bedford, manufacturers of "Cryselco" carbon and metal filament lamps, has received the contract for the supply of lamps to the Shanghai Municipal Council for the ensuing twelve months.—Meldrum Brothers, Limited, of Timperley, have received a repeat order for three sets of their improved high-pressure Simplex mechanical stokers for a large woollen mill in the Huddersfield district, and also an order from another woollen mill to modify a stoker of another manufacturer to this system.—The choice of the type of plant to be installed for the extensions at the Sydney, N.S.W., generating station has fallen on Willans and Robinson turbines and on Dick Kerr alternators. Two units, of 4000 kilowatts each, running at 750 revolutions per minute, are to be installed.—The contract for eighteen pumps, which will be installed in connection with the waterworks extensions at Toronto, has been given to Jens Orten-Boving and Co., which firm also secured an order for four pumps, with a capacity of 16,000,000 gallons each, for the high-level pumping station.

The Daimler Motor Car Company, Limited.—On the invitation of the Daimler Motor Car Company, Limited, a number of gentlemen travelled by special train from Euston to Coventry on Wednesday for the purpose of inspecting the firm's works at the latter place. On arriving at Coventry, the guests were conveyed by motor car to the works, where a pleasant morning was spent in examining the many processes involved in the manufacture of the well-known Daimler car. The shops at the present moment are fully employed, and are being largely extended to meet future requirements. Under the guidance of members of the firm and their staff, the guests were shown in a most thorough fashion over all the different shops in the works. In these the excellent arrangements made for the economical and efficient manufacture of the component parts of the cars, and for the comfort and health of the workers, were greatly admired by all who took part in the visit. The business of the firm has been almost completely reformed since the introduction of the "Silent Knight" engine, and in the organisation of every detail associated with the manufacture of that engine, and that of the various types of car for which it ultimately provides the motive power, the capable control of the firm's undertaking is readily seen. Luncheon was afterwards served when a party of about 250 partook of the company's hospitality. In the speeches which followed there was expressed a universal appreciation of the arrangements made by the company for the comfort and enjoyment of its guests. Among others, Earl Russell, Mr. A. E. W. Mason, Mr. Philip Dawson, and the Mayor of Coventry spoke on behalf of the guests, while the firm was represented among the speakers by the chairman, Mr. E. Manville, Mr. U. Stratton, and Mr. C. Y. Knight. In the afternoon the guests were conveyed in motor cars to the station where the special train was in waiting for the return journey to London.

NOTES FROM GERMANY, FRANCE, BELGIUM, &c.

(*From our own Correspondent.*)

Rheinland-Westphalia.

THE fact that prices, both for raw and for manufactured iron, have again met with slight advances during this week and the last speaks well for the general condition of the market. It is reported from Düsseldorf that German and Luxemburg forge pig have been raised M. 1 and M. 2 p.t., and steel bars, which were standing at M. 102 to M. 108 p.t. in the beginning of November, are quoted M. 104 to M. 108 now; steel plates M. 110 to M. 115 p.t., instead of M. 108 to M. 115 p.t., and steel plates for boilermaking purposes have been raised from M. 118 to M. 120 p.t. free at works. The Union of German Ironfounders in Hagen has resolved to raise prices M. 2 p. 100 kilos., in consequence of improving demand, and also because the prices hitherto quoted were quite unremunerative. A new contract for two years has been signed between the Steel Convention and the Prussian State Railways for the supply of rails, iron sleepers, and hardware, The basis price for rails was fixed at M. 116, for iron sleepers M. 107, and rates for hardware have likewise been reduced; on an average the present prices are M. 4 p.t. lower than two years ago, but compared with 1904 sleepers realise M. 2 p.t. more, and rails M. 4 p.t. Foreign orders in heavy rails are reported to come in regularly; also in light section rails a good business is done, both locally and on foreign account. Specifications have increased in sectional iron; inland dealers buy freely now, and the outlook is favourable in this department.

Silesian Iron Industry.

There has not been any noticeable improvement in the iron and steel trade since former letters, but all the principal establishments can be reported as in regular employment; new business is coming rather freely to hand in the manufactured iron industry. A report from Berlin says that dealers have offered bars at M. 4 to M. 5 p.t. less than producers. For immediate delivery offers at M. 99.50 p.t. free Düsseldorf are reported to have been made.

Coal.

Symptoms of improvement have heen noticed in the coal trade; blast furnace coke meets with increasing demand, and is very stiff in price. Shipments to South Germany are still rather limited. The want of wagons is causing delay in the Upper Silesian district, but on the whole business moves on steadily, and there is an improving demand for house coal.

Austria-Hungary

Prices having been fixed for the immediate future there was rather more inquiry coming in, dealers purchasing freely now. In some articles, however, a falling off in demand could be felt; the machine and construction shops, for instance, are complaining of a slow and insufficient trade, and they are but indifferently occupied. In the coal trade the condition does not differ from that of previous weeks, a pretty good business being done generally.

Favourable Accounts from France.

Extensive orders that have been placed by local railways have tended to improve the position of the market in France. Negotiations are also being carried on regarding orders for the East and North Railways, orders for 600 20-ton coal wagons, and 800 trucks being about to be placed. Also the Orleans Railway intends increasing its rolling stock, and the outlook, therefore, is favourable in the railway department. The accounts given from other branches of the iron industry also show that a regular activity prevails. All descriptions of fuel meet with good request in France.

Upward Tendency in Belgium.

Favourable accounts continue to be given of the iron and steel trade, orders coming to hand freely in all departments. Considerable firmness characterises the bar trade, and plates also show more animation, especially the lighter qualities. Heavy sorts of sectional iron meet with good request on foreign account. Inland prices for girders have stiffened a little in consequence of the prolongation of the French Girder Syndicate. Foreign competition being less keen on the pig iron market, a stiffening tendency can be noticed in prices. Foundry pig No. 3 is quoted 67f. p.t., while forge pig and basic stand at 61f. and 68f. p.t. Output continues to increase. Of forty-four existing blast furnaces, thirty-seven are at present in blow, with a daily output of 5363 t.; only seven blast furnaces are out, against thirteen at this time last year. During the first ten months of this year 1,322,490 t. were produced, against 987,570 t. in the corresponding period last year, which shows an increase of 334,920 t. For October an increase of 35 per cent. is noted as compared with the same month last year. Semi-finished steel remains steady, and it is generally expected that the prices now ruling will also prevail during the first quarter of 1910. Coal and coke are well inquired for in Belgium, whereas briquettes remain dull. In the Mons and in the Borinage district the keen competition of English and French firms is complained of.

INSTITUTE OF MARINE ENGINEERS.—At the institute of Marine Engineers on Monday, November 22nd, a lecture was given by Mr. A. T. Strohmenger, F.I.C., on "Notes on Coverings for Boilers and Steam Pipes." Mr. John Lang, R.N.R., Member of Council, occupied the chair. In the course of his lecture Mr. Strohmenger said it could be safely assumed that the losses through direct radiation from conveyors carrying heat energy in the form of steam were exceedingly small. From an uncovered boiler or pipe the losses were undoubtedly primarily due to conduction and convection. The properties of a desirable covering might be summarised as follows: It should offer a high resistance to the passage of heat; it should be capable of being easily removed; its efficiency should not be impaired by variations of temperature, the action of steam or water, vibration, rough handling, or physical or chemical changes over a term of years; its specific weight should not be so high as to place an undue stress on the steam pipes; it should have no action on the metal surface lagged; it should be non-inflammable; and its specific heat should be as low as possible. A discussion followed the reading of the paper.

THE ANDREW CARNEGIE RESEARCH SCHOLARSHIP.—A Research Scholarship or Scholarships, of such value as may appear expedient to the Council of the Iron and Steel Institute from time to time, founded by Mr. Andrew Carnegie (past-president), who has presented to the Iron and Steel Institute 100,000 dols. for the purpose, will be awarded annually, irrespective of sex and nationality, on the recommendation of the Council of the Institute. Candidates, who must be under thirty-five years of age, must apply on a special form before the end of February to the Secretary of the Institute. The object of this scheme of Scholarships is not to facilitate ordinary collegiate studies, but to enable students who have passed through a college curriculum or have been trained in industrial establishments to conduct researches in the metallurgy of iron and steel and allied subjects, with the view of aiding its advance or its application to industry. There is no restriction as to the place of research which may be selected, whether university, technical school, or works, provided it be properly equipped for the prosecution of metallurgical investigations. The appointment to a scholarship is to be for one year, but the Council may at their discretion renew the scholarship for a further period instead of proceeding to a new election. The results of the research are to be communicated to the Iron and Steel Institute in the form of a paper to be submitted to the annual general meeting of members, and if the Council consider the paper to be of sufficient merit the Andrew Carnegie Gold Medal will be awarded to its author.

BRITISH PATENT SPECIFICATIONS.

When an invention is communicated from abroad the name and address of the Communicator is printed in italics.

When the abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent-office Sale Branch 25, Southampton-buildings, Chancery-lane, London, W.C., at 8d. each.

The first date given is the date of application; the second date at the end of the abridgment is the date of the advertisement of the acceptance of the complete specification.

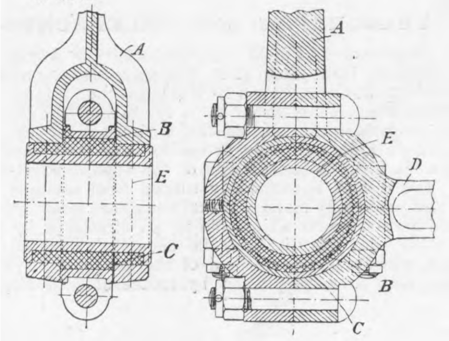
Any person may on any of the grounds mentioned in the Acts, within two months of the date given at the end of the abridgment, give notice at the Patent-office of opposition to the grant of a Patent.

STEAM ENGINES.

6868. March 22nd, 1909.—IMPROVEMENTS IN OR RELATING TO BIG END CONNECTIONS, *Etablissements de Dion-Bouton (Société Anonyme), 20, Quai National Puteaux, France.*

This invention relates to improvements in securing two big ends to a crank pin. This invention is particularly applicable to engines comprising two or more cylinders, each pair of cylinders having a V-setting. In this case each crank pin will carry two big ends, and it is found possible, according to this invention, to arrange them so that the axes of the two connecting-rods lie in the same plane. One of the connecting-rods A is provided with a bifurcated big end as shown. Mounted in this is a ring B of hardened steel. The ring B is provided with an enlarged portion projecting between the two arms of the big end A, upon which is mounted a ring C carrying the big end of the second connecting-rod D. The ring C is provided with flanges or enlarged portions at each edge, which come in contact with the bifurcated arms, and so prevent lateral play between the two big ends. The ring C is lined with two brasses E which form the contact surface working on a crank pin. In constructing the various parts, the brasses E and the ring C are formed in two halves, and the big ends are formed in the usual manner. It is obvious, therefore, that when the two portions of the big end A are clamped together, the brasses E and the ring C, although both are constructed in two portions, will form substantially complete and rigid members. The bearing surface of the connecting-rod D is not large, but this is of no importance, as the two parts in question merely oscillate relatively to each other.—*November* 10*th*, 1909.

No 6868

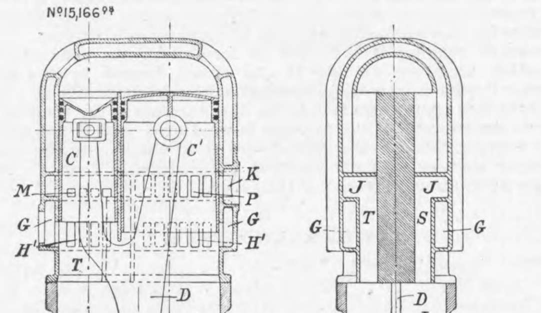


INTERNAL-COMBUSTION ENGINES.

15,166. January 16th, 1909.—IMPROVEMENTS IN AND RELATING TO INTERNAL-COMBUSTION ENGINES, John Badger, of "Langdale," Kimberworth-road, Rotherham, York, and John William Whitaker, of 27, Abinger-road, Chiswick.

According to this invention, two vertical and differential cylinders are employed in a plane at right angles to the axis of the crank shaft, and having their axes parallel and set over on either side of the said crank shaft. The cylinders are fitted with pistons C C¹ which perform the combined function of transmitting power to the crank shaft due to the explosion of the combustible gases and also act as valves for the inlet and exhaust of the gases. The pistons are connected to the crank shaft by a forked connecting-rod D working on the crank pin E. The crank shaft is contained in an enclosed chamber F upon which are mounted the cylinders. An annular collecting chamber G for the explosive mixture is provided, from which leads a serrated passage or port H^1 to the suction and compression chamber I. From the suction and compression chamber I two passages or ports S T lead into a distributing chamber J from which a serrated passage or port M leads into the cylinder on the left. From the cylinder on the right a serrated passage or port P leads into the exhaust chamber K. To ensure a gas-tight crank chamber F, the crank shaft has provided a series of collars as shown.—*November* 10*th*, 1909.

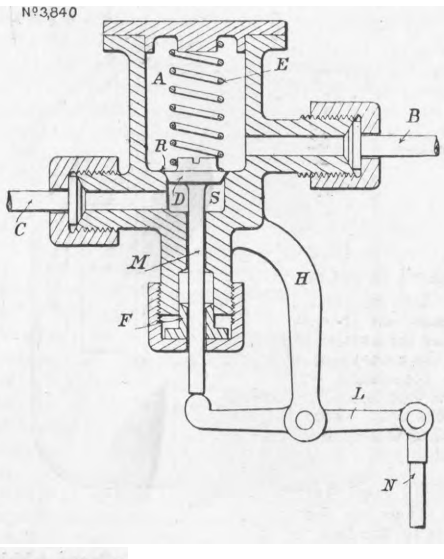
No 15,166⁹⁹



3840. February 16th, 1909.—IMPROVEMENTS IN LUBRICATING SYSTEMS FOR INTERNAL COMBUSTION ENGINES, Frederick Henry Royce, of Nightingale-road, Osmaston-road, Derby.

Two automatic supplies are employed, the one (hereinafter called the constant supply) adapted to give a predetermined amount of oil which is sufficient efficiently to lubricate the engine at low powers without smoking, and which is always in action, and the other (hereinafter called the auxiliary supply) adapted to give a predetermined amount of oil which is sufficient, with the constant supply, efficiently to lubricate the engine at high speeds or increased loads; also automatically controls said auxiliary supply by any suitable means so that the quantity of oil supplied varies with the load on the engine. The constant supply may be either on the splash, drip, or forced-feed system. One method for controlling the auxiliary supply is shown in the drawing, where A is a chamber into which the auxiliary supply of oil is led by means of the pipe B. In the chamber A is a diaphragm R, which forms a second chamber S, from which a pipe C is led, which is connected to the pipes leading to the various cylinders. In the diaphragm is a hole, which is closed by a valve D, which is pressed down on its seating by a spring E, and the stem M of which passes through a stuffing-box F in the bottom of the chamber A. On to a bracket H is pivoted a lever *l*, one end of which is connected by the rod N with the mechanism controlling the throttle valve and the other end of which is adapted to contact the free end of the stem M of the valve D, such a clearance being provided between the end of the stem and the end of the lever as will prevent the valve being opened until the throttle valve has been opened a predetermined amount, and will correspondingly allow the valve D to shut prior to the throttle valve closing.—*November* 10*th*, 1909.

No 3,840

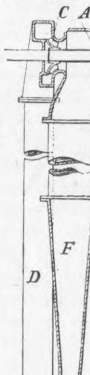


PUMPING AND BLOWING MACHINERY.

18,453. August 10th, 1909.—PROCESS AND MEANS FOR INCREASING THE HEIGHT OF SUCTION LIFT IN PUMPS, *La Société d'Exploitation des Appareils Rateau, of 20, rue d'Anjou, Paris, France.*

In front of the inlet A of the centrifugal wheel B (or of a set of wheels) is disposed a helicoidal wheel C, the discharge passage D of which terminates in an ejector E which is placed in the required position on the suction pipe F G, the latter being as usual provided with a non-return foot valve H. The device works in the following manner:—The pipe F G and the pump B are first filled with water and rotary motion is imparted to the helicoidal wheel C. The non-return foot valve H immediately opens, even if the height of the suction column exceeds 10 m. The helicoidal wheel C takes a portion of the liquid before its entry into the inlet of the pump B and forces it into the conduit D. This by-passed portion of the liquid enters the annular space of the ejector E, whilst the liquid coming from the lower part G of the suction pipe passes through the internal nozzle of the ejector. The liquid coming from D carries along with it the sucked-up fluid and in such a manner that the pressure of the sucked-up liquid becomes increased in the portion F of the conduit forming the outlet of the ejector. If, for instance, the conduit D has a section equal to that of the conduit G whilst the section at F is twice as great, in imparting to the liquid in D a pressure represented by H it has been found that the ejector raises the pressure of the sucked-up liquid by about $\frac{H}{3}$. In the case more particularly of water, if the total height of the column F G be 10 m, everything will go on as if this height were reduced at $10 - \frac{H}{3}$, and it is thus possible to draw from an even greater depth than 10 m. Modified arrangements are dealt with.—*November* 10*th*, 1909.

No 18,453.

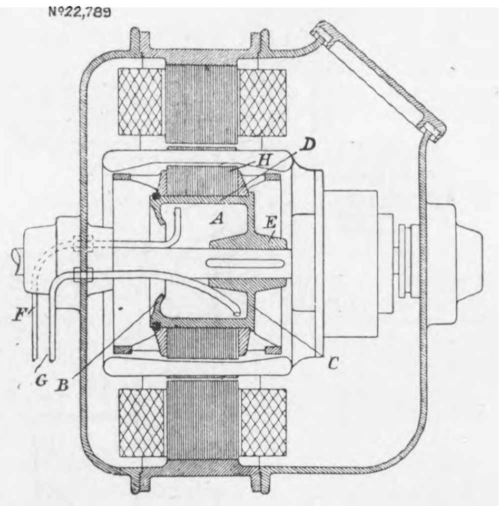


DYNAMOS AND MOTORS.

22,789. October 6th, 1909.—IMPROVEMENTS IN COOLING DYNAMO-ELECTRIC MACHINES, Siemens Brothers' Dynamo Works, Limited, of Caxton House, Tothill-street, Westminster.

The dynamo armature is denoted by A, that part of the armature hub which is keyed to the shaft by E, and the circumference of the hub by D. Baffle plates or edges are denoted by B and C, the latter serving also to connect D and E mechanically together. A tube F conducts liquid to the armature, and the return tube is shown at G. The end or nozzle of the latter is bent so that its orifice points in a circumferential direction which is opposite to the direction of rotation of the armature, in order to facilitate the carrying away of the heated fluid. The nozzle of F is preferably arranged so that it points in a circumferential direction which agrees with the direction of rotation of the armature, and the liquid is thus thrown on to the inner circumference of D at a speed which agrees more or less with the peripheral speed of D itself, splashing being thereby avoided. The inner circumference of D is preferably made in the shape of a cone, having its greatest diameter at that end which accommodates the return tube G. This has the effect of causing the circulating fluid to gradually work its way in a spiral path from F to G, and tends towards economy in the amount of liquid used. The armature core plates are preferably placed in as close contact as possible with D. An automatic arrangement cuts off the supply of liquid as soon as the armature ceases to revolve or as soon as the speed is reduced below a predetermined limit. —*November* 10*th*, 1909.

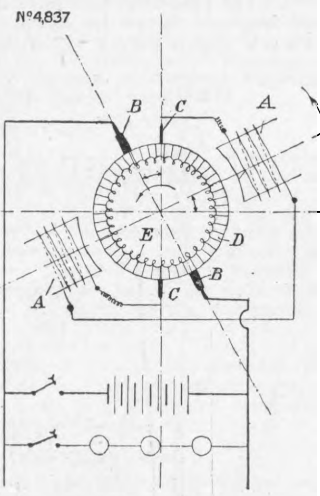
N°22,789



4837. February 27th, 1909.—Improvements relating to Electric Generators Giving Constant Pressure under Varying Speeds, *Georges Derain, of* 32, *rue Rennequin, Paris, France.*

This invention relates to electric generators giving constant maximum pressure under varying speeds of the armature or rotor, and is designed more especially for use in lighting automobiles, railway trains, and generally in all cases where constant pressure is required under varying speeds. The field magnets A A of a bi-polar dynamo are excited through the intervention of two stationary brushes C C receiving the current from the commutator D of the machine. The two movable brushes B B are connected with the main circuit and may be placed on the same commutator as the brushes C C, or on a second commutator of the same armature or rotor E, the poles A A being movable, and in some instances directly connected with the brushes B. When the maximum pressure is exceeded, the electro-magnetic reaction displaces the magnet poles in the direction of the rotation of the armature, and so dislodges the neutral line from the stationary brushes C C. Thus, the excitation furnished through the brushes C C decreases until the pressure of the current in the brushes B B becomes normal. In order to ensure the balance for any degree of excitation under each different speed it is necessary to cause the resisting couple steadying the pole pieces to decrease according to the same law as the value of the exciting flux, which latter is proportional to the difference of potential between the brushes C C, providing the magnetic circuit of the dynamo has not attained saturation. This difference of potential decreases sensibly according to a sinusoidal curve in proportion as the poles are displaced through an angle increasing from 0 to 90 degrees. Therefore, the mechanical equilibrium of the pole-pieces will be ensured with any couple with sinusoidal decrease. This resisting couple may be constituted in different manners, viz. :—By the body weight of the pole-pieces ; by a weight fixed to the same ; by a spring forming a decreasing couple ; that is to say, by a tension spring tending to prevent the poles A A from turning in the direction of rotation of the rotor E.—*November* 10*th*, 1909.

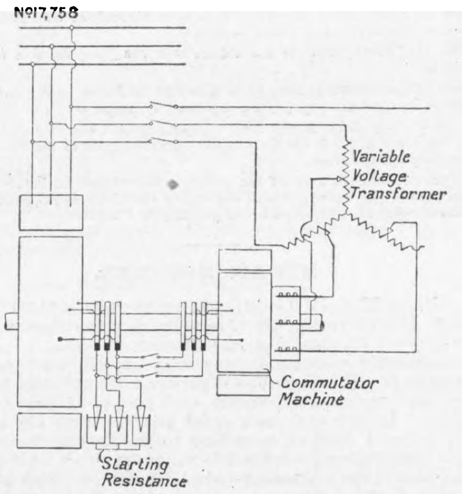
N°4,837



17,758. July 30th, 1909.—Improvements in and relating to the Control of Polyphase Motors and the like, *The Allgemeine Elektricitäts Gesellschaft, of Friedrick Karl, Ufer* 2 4, *Berlin.*

This invention relates to the control of polyphase machines of the commutator type, and has for its object an improved method of speed regulation, whereby the speed may be efficiently controlled over a range varying between plus and minus 20 or 30 per cent. of the synchronous speed. In the case of large induction motors the speed regulation may be obtained by starting the motor as an asynchronous machine and regulating at low speeds by means of rotor resistances, for instance, and at speeds in the neighbourhood of synchronism, modifying the connections of the motor so that it runs as a commutator machine. With such an arrangement the commutator brushes must be raised at starting, otherwise the potential which appears at the commutator brushes would be high enough to cause destructive sparking. According to the present invention the raising of the brushes on the occurrence of destructive sparking is avoided by coupling an asynchronous machine with a commutator machine, the stator of which is unwound or is fed with currents of the same periodicity as the supply, the armature of such commutator machine being fed with currents of the same frequency as the supply and constructed as an asynchronous machine and connected with the first-mentioned asynchronous machine in cascade connection, whereby the speed in the neighbourhood of synchronism may be regulated by the commutator machine which at starting and at low speeds is without current.—*November* 10*th*, 1909.

N°17,758

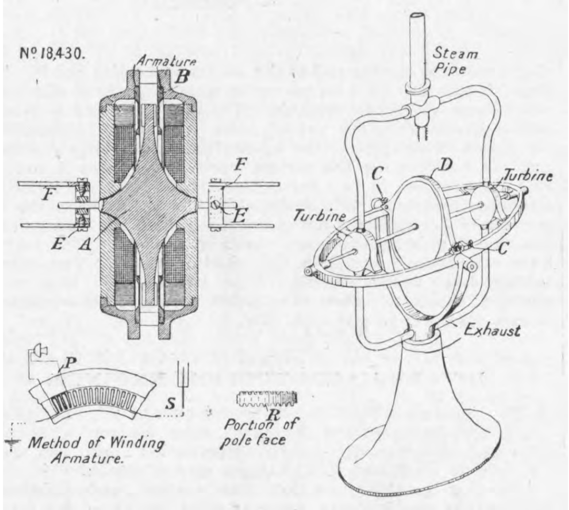


TELEGRAPHS AND TELEPHONES.

18,430. September 2nd, 1908.—Improvements in Apparatus for Producing High-frequency Electric Oscillations, more particularly applicable to Wireless Signalling, *Reginald Aubrey Fessenden, of Brant Rock, Massachusetts, U.S.A.*

There is provided the rotating disc A, shown in section, mounted upon a shaft, and preferably driven by some high-speed motor, such as a De Laval steam turbine of the type illustrated on the right. The disc A is preferably turned from a single piece of metal, and preferably made of nickel vanadium steel. The casing B should have supports adjustable in all directions by means of screws C, so that the disc may be accurately centred when in motion in order to centre the field of the generator. The centering may also be accomplished by means of a bearing ring D, adjustable in position by means of screws E in the supporting ring F, supported on springs. The disc in rapid rotation of course tends to assume its own gravity centre. The sides or edge of the periphery of the disc is preferably slotted as indicated, and the slots R may be filled up with some non-magnetic substance, in order to present a smooth continuous surface and reduce the air friction. Otherwise, the whole machine may be mounted in a vacuum. The armature winding is indicated as formed by the conductor S. Another armature winding is also shown formed by the conductor P, which has a telephone transmitter in series with it. By putting this transmitter into action the currents in the winding P affect the strength of the currents in winding S, and if the winding S be connected to the ground and to an antenna, in the usual manner, electrical signals may thus be produced. There are two other illustrations.—*November* 10*th*, 1909.

N° 18,430.

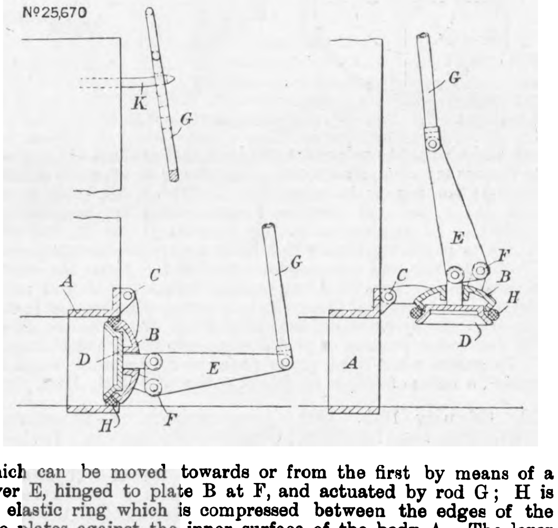


MISCELLANEOUS.

25,670. November 28th, 1908.—An Improved Valve, Arthur John Martin, of 7, Victoria-street, Westminster, S.W.

This invention relates to an improved valve or sluice for use with water, sewage, or other liquids, constructed without any grooves or depressions in the wall of the conduit in which it is placed. A is the body of the valve, B the first plate or disc, which is hinged to the body at C, D is the second plate or disc, which can be moved towards or from the first by means of a lever E, hinged to plate B at F, and actuated by rod G ; H is an elastic ring which is compressed between the edges of the two plates against the inner surface of the body A. The lever may be held in position by any suitable means, such, for instance, as a pin K engaging in a hole in rod G. The lever or the rod may be weighted to assist the closing of the valve, or a screw or toggle joint, or any other suitable device, may be employed for the purpose.—*November* 10*th*, 1909.

N°25,670



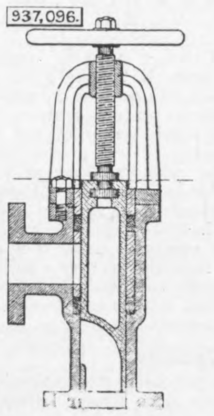
SELECTED AMERICAN PATENTS

(*From the United States Patent-office Official Gazette.*)

937,096. Blow-off Valve, *J. V. Schmid, Philadelphia, Pa., assignor to the Simplex Engineering Company, Philadelphia, Pa., a Corporation of Pennsylvania.—Filed May* 29*th*, 1908.

The drawing explains the nature of this invention. A plunger with longitudinal motion takes the place of a rotating plug. There are five claims.

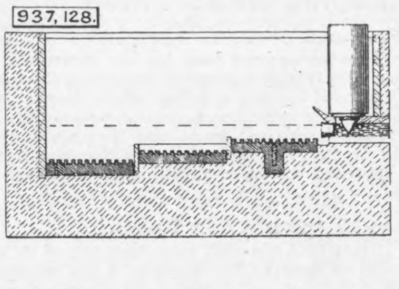
937,096.



937,128. Method of Oxidising Metals Dissolved in Mercury, *J. Whiting, Boston, Mass., and C. F. Burgess, Madison, Wis., assignors to the Whiting Company, Boston, Mass., a Corporation of Maine.—Filed December* 16*th*, 1908.

The patent is for a method of oxidising alkali metals dissolved in mercury, which consists in providing carbon surfaces exposed to an oxidising electrolyte and a moving body of amalgam, and establishing electrical contact between the carbon and the amalgam by means of a metallic connection in contact with the carbon, and a relatively quiescent body of comparatively pure mercury underlying the amalgam. There are four claims.

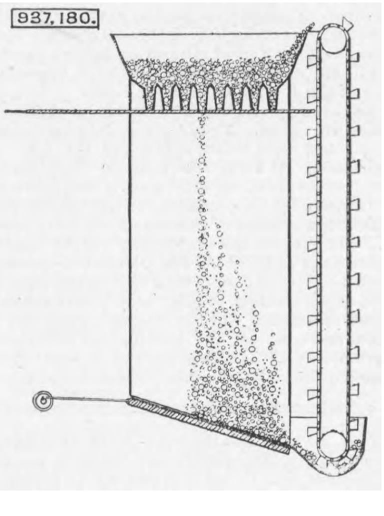
937, 128.



937,180. Method of Finishing Metallic Surfaces, *A. Ridd, Newport, Ky.—Filed December* 15*th*, 1908.

This is a very curious invention for planishing sheet metal, which consists in subjecting the surface being treated to the impact of highly polished hardened steel balls falling from a height. The balls are raised again by a bucket ladder. There are no fewer than thirty claims.

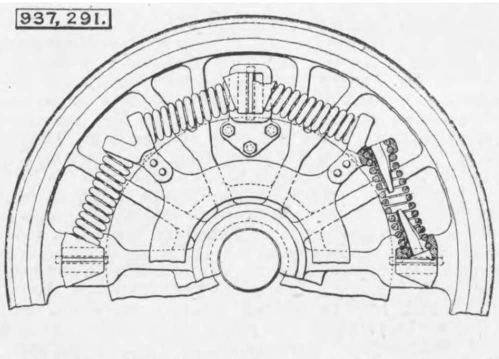
937, 180.



937,291. Resilient Driving Connection *G. M. Eaton, Wilkinsburg, Pa., assignor to Westinghouse Electric and Manufacturing Company, a Corporation of Pennsylvania.—Filed January* 11*th*, 1909.

Something has been heard lately concerning a new scheme for driving turbine actuated propellers by reducing toothed gear, so that the turbine will make more revolutions than the propeller. A part of the gearing is the floating ring, which provides a flexible connection for the gear. This forms the subject of the patent. There are five claims ; the third runs thus :—A resilient driving connection comprising a driving wheel, a sleeve or quill concentric with the axis of the wheel having radial projections extending between the wheel spokes, a floating ring and helical springs tangentially interposed between the ring and the projections and between the ring and the wheel spokes.

937, 291.



FISHGUARD HARBOUR.

No. II.*

The ocean quay.—Since the opening of the harbour in 1906, there has been constructed near the inner end of the breakwater an ocean quay, alongside which there is a minimum depth of water of 30ft. at L.W.O.S.T. The position of the quay is shown in the plan—Fig. 2, page 570—and a larger plan is given in Fig. 5, and a cross section in Fig. 6. The main structure is 274ft. in length, and varies in width from 69ft. to 79ft. At either end are narrow extensions, bringing the total length up to 400ft. The quay is constructed of Jarrah timber throughout, and the deck level is 13ft. above high water. On the deck of the structure a Customs room and a long roof covering have been erected, while the rail tracks are placed immediately behind the latter on the deck of the breakwater. One 3-ton and one 30-cwt. electric travelling cranes have been installed. Beneath the upper deck is a cattle landing. A similar wharf is to be constructed further seaward on the harbour face of the breakwater, when a depth of 43ft, will be available at low water. This quay, when completed, will be used for the direct landing of passengers and mails from Atlantic liners. At present the tenders carrying mails and passengers from the liners come alongside the inner ocean quay which we have just described. In all probability, if the increase of traffic warrants the expenditure, a continuous line of deep-water quay will ultimately be constructed along the inner face of the breakwater for a distance of upwards of 1000ft. The recently completed section of the ocean quay can be seen in course of construction in one of the engravings in the Supplement.

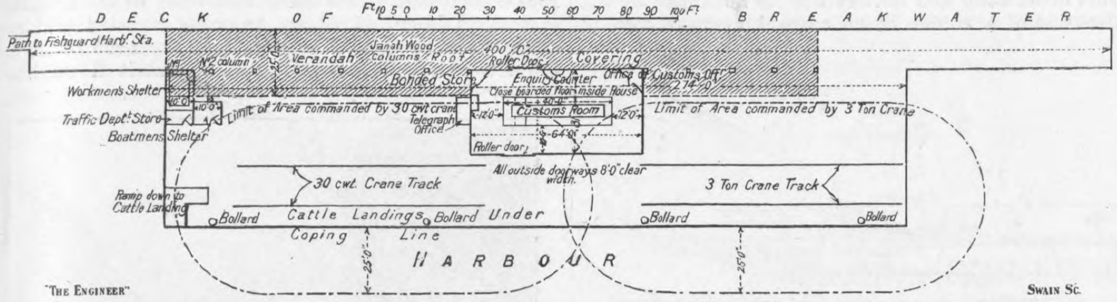

Scale.
Ft 10 5 0 10 20 30 40 50 60 70 80 90 100 Ft
DECK OF BREAKWATER
Path to Fishguard Harbr. Sta.
No. 1
No. 2 column
Verandah
Janah Wood Columns
Roof
400' 0"
Roller Door
Covering
Office of Customs Offr.
274' 0"
25' 0"
Bonded Store
Enquiry Counter
Close boarded floor inside House
40' 0"
Workmen's Shelter
10' 0"
Traffic Dept. Store
Boatmens Shelter
Limit of Area commanded by 30 cwt crane
Telegraph Office
12' 0"
Customs Room
64' 0"
Roller door
Limit of Area commanded by 3 Ton Crane
All outside doorways 8' 0" clear width.
30 cwt. Crane Track
3 Ton Crane Track
Ramp down to Cattle Landing
Bollard
Cattle Landings
Bollard Under
Coping Line
HARBOUR
"The Engineer"
Swain Sc.

Fig. 5—PLAN OF OCEAN QUAY

The quay wall and reclamation.—The quay wall, which forms the western side of the harbour, was 1120ft. in length as originally built. The extension of this quay, which is now in course of construction, we shall refer to later. The completed quay, which is used principally for the Irish boat service, is of concrete construction, and lies, roughly, parallel with the present toe-line of the cliff, the space enclosed between the cliff and the quay wall having an average depth of about 260ft. As we have described above, about one-half of this area is reclamation, the quay wall having been constructed on the sea bed in front of the original cliff toe. The space behind the wall has been filled in with the smaller rock *débris* from the cliff blasting. A cross-section of the wall will be seen in Fig. 7; and other details are also given in Figs. 8 and 9. Photographs of the wall are reproduced in the Supplement, one of which shows a portion of the cattle gallery viewed from the harbour.

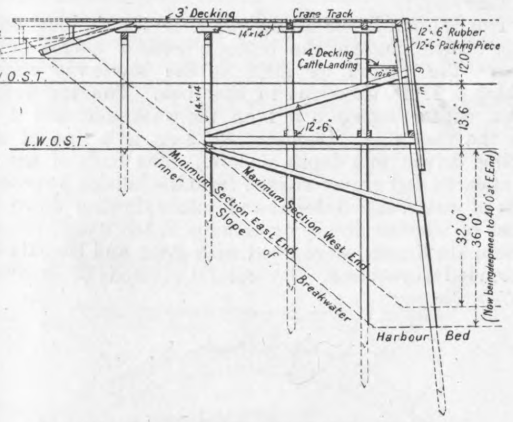

3' Decking
Crane Track
Rails
14"x14"
12"x6" Rubber
12"x6" Packing Piece
4' Decking Cattle Landing
12"x6"
H.W.O.S.T.
14"x14"
12"x6"
L.W.O.S.T.
Inner Slope of Breakwater
Minimum Section East End
Maximum Section West End
12' 0"
13' 6"
32' 0"
36' 0"
(Now being deepened to 40' 0" at E. End)
Harbour Bed

Fig. 6—CROSS SECTION OF OCEAN QUAY

The foundation of the wall is on rock, which, before the work of construction was commenced, was overlain to a depth varying from 10ft. to 12ft. by gravel and sand. A trench was first excavated by a suction dredger removing the sand; a Priestman grab and hopper barge followed and excavated the shingle down to the rock. The rock was then levelled off by divers, and any hollows filled up with concrete in bags, so that a perfectly level foundation was obtained upon which the blocks were lowered by a 15-ton Titan crane, having a 60ft. radius, which travelled upon the rock filling in rear, and later on the completed portions of the quay wall. The concrete blocks, which are gauged 6 to 1, with stone plums in addition, vary in weight from 6 tons to 10 tons, and a total of 5000 have been used in the construction of the wall. The block work is carried up to within 3ft. of high water. Above this level the work is continued in mass concrete, in which the cattle gallery—shown in the general cross-section, Fig. 7, and in the detail cross-section and elevation, Fig. 8—is formed. The wall has an average total height of 50ft., the coping level being 13ft. 3in. over H.W.O.S.T., and the base width 19ft. 6in. The average depth of water at L.W.O.S.T. along the site of the wall before construction was about 11ft., but the harbour bed has been dredged to give a minimum depth of 20ft. all over the area in front of the quay.

The cattle gallery is formed by an overhanging semi-arch, the concrete being reinforced by old 70 lb. per yard bridge rails bent to suitable shapes, as shown in Figs. 7 and 8. The footway of the gallery, which is at a level just above H.W.O.S.T., is finished with deep grooves to give a good foothold. On the seaward side the gallery is protected by a continuous line of double gates hung on creosoted memel timber stanchions placed midway between the Jarrah and Karri timber vertical fenders, which are spaced 13ft. 6in. apart centres. Any one of the gates opposite the gangway between the ship and the quay can be opened and shut back across the gallery, so as to turn the cattle in the required direction. The details of the fenders, bollards, and gates are clearly shown in the figures, and need not be further described. A subway connects the cattle gallery with the pens at the back of the passenger station, thus enabling cattle to be discharged and loaded into trucks out of sight of the passengers. There is ample room for three large cross-Channel steamers to be berthed together alongside the quay at all states of the tide.

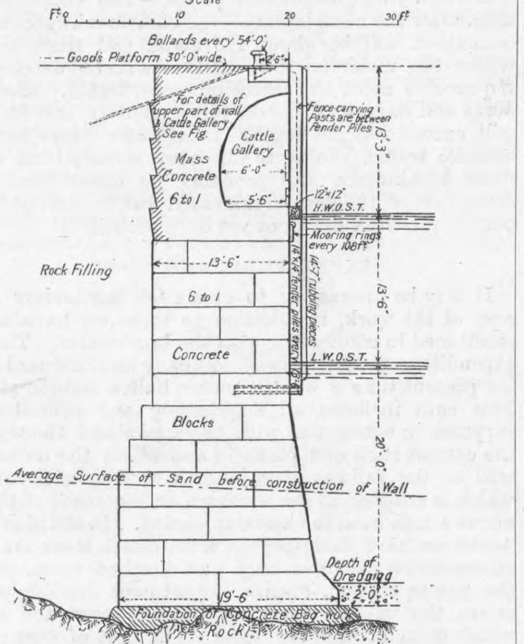

Scale
Ft 0 10 20 30 Ft
Bollards every 54' 0"
Goods Platform 30' 0" wide
2' 6"
For details of upper part of wall & Cattle Gallery See Fig.
Fence carrying Posts are between Fender Piles
Cattle Gallery
Mass Concrete 6 to 1
6' 0"
5' 6"
12"x12"
H.W.O.S.T.
13' 3"
Mooring rings every 108ft
Rock Filling
13' 6"
6 to 1
14"x14" fender piles every 13' 6"
14' 7" rubbing pieces
13' 6"
Concrete
L.W.O.S.T.
Blocks
Average Surface of Sand before construction of Wall
20' 0"
Depth of Dredging
2' 0"
19' 6"
Foundation of Concrete Bag-work
Rock

Fig. 7—CROSS SECTION OF IRISH BOAT QUAY WALL

The passenger station and yards.—The cross-Channel passenger station, which has been constructed behind the quay wall, is shown in the plan, Fig. 2, and a cross-section is given in Fig. 9. The Supplement contains views of the station and surroundings taken from various points, one of them being a good general view of the station and harbour from the cliff above the former. The main passenger platform is of the island type, and is 800ft. long. It is provided with the usual waiting and refreshment rooms and offices. Access is given to and from the boats by means of two sets of traversers that bridge the three lines intervening between the platform and the quay. In case any of the intervening lines are occupied so as to prevent the use of the traversers, passengers go through the subway which passes under all the lines and gives access to the quay and to the railway company's hotel and village. The lay-out of the lines and platforms is shown in the plan—Fig. 2—and a detailed description of them will be found in our issue for August 31st, 1906. Since that date a few alterations and additions have been made which are shown in the plan.

There are two goods platforms, and nine 30-cwt. electric travelling cranes, which run on two rails, one laid on the quay wall and the other on a girder carrying one of the station roofs, and supported by steel-built columns. The cranes can plumb the centre of the hold of a vessel having a beam of 50ft., lying at the quay, and are also capable of loading and discharging from and into wagons on either of the goods lines. The cranes have a lifting speed of 250ft. per minute. The goods platform nearest the quay is protected by a low roof covering half its width for its entire length of 890ft. The remaining platforms are covered by a girder span roof 68ft. wide overall, and 470ft. long. At the north end of the quay is a fixed 21-ton electric coaling crane, and three electric capstans are provided. The cattle pen platform is 650ft. long, and contains 65 pens; the fences are made of old rails, and a slaughter-house is provided. Altogether there are upwards of six miles of sidings in the station yard, in addition to the eight main lines of rails. The sidings provide accommodation for 650 goods wagons, and there is ample space for considerable extension when traffic demands it. The traversers to which reference has been made are, when out of use, kept under the platforms and are drawn forward and raised in the opening between the platforms by electric power. There are two sets of traversers, one at either end of the station. When the station has been used for the reception of transatlantic passengers and their baggage the spaces between the platforms have been filled by temporary long wooden platforms mounted on low railway wagon frames which are run along the rails. These movable platforms are several hundred feet long, and, with the fixed platforms, provide when in position a broad level space between the quay and the trains, on which the Customs examination of baggage can be carried out with comfort and expedition.

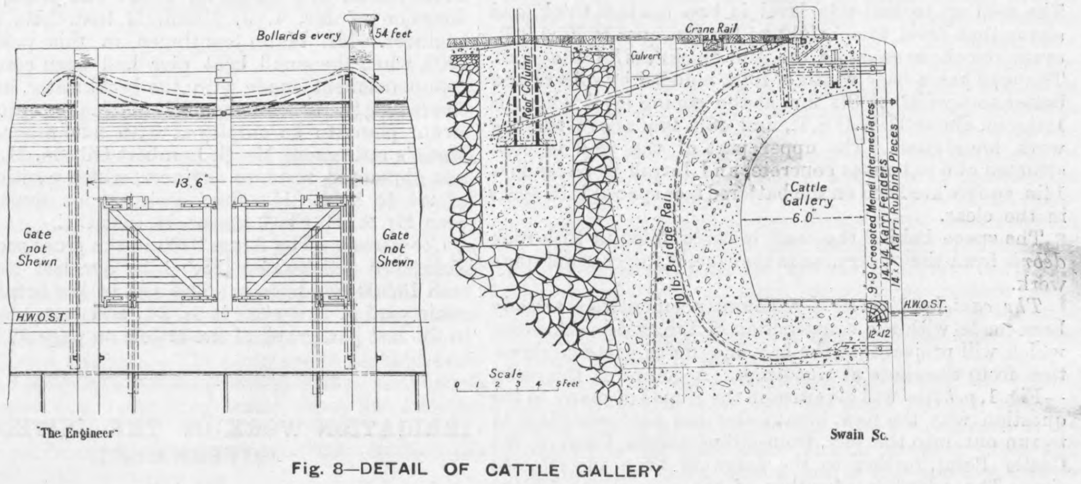

Bollards every 54 feet
13' 6"
Gate not Shewn
Gate not Shewn
H.W.O.S.T.
"The Engineer"
Crane Rail
Culvert
Roof Column
Cattle Gallery
6' 0"
70 lb. Bridge Rail
9"x9" Creosoted Memel Intermediates
14"x14" Karri Fenders
14"x7" Karri Rubbing Pieces
H.W.O.S.T.
12"x12"
Scale
0 1 2 3 4 5 Feet
Swain Sc.

Fig. 8—DETAIL OF CATTLE GALLERY

Power station, electric lighting, &c.—We described the electric power and light station, which is situated at the north end of the yard, in our earlier notice of the works. In the three years that have passed since the description was published there has been very little added to the plant that then existed. It will be sufficient to note that all yards and buildings are lighted by electricity, and electric heating is employed in the buildings. The cranes, capstans, traversers, and other machinery are also supplied with electric power. The railway company has also provided a water supply for the works and the village which has sprung up at the top of the cliff above the harbour, and forms part of the estate of 80 acres which has been acquired by the railway. No less than 120 houses and cottages have already been built by the company for the accommodation of its work-people at Fishguard. A view of a portion of the village is reproduced in the Supplement.

Dredging and anchorage.—The sheltered area of the harbour approaches half a square mile in extent, but a considerable portion of this at the head of the bay is a shallow water area, which is not available for anchorage except for small craft. A portion of this shallow area will be reclaimed when the extension scheme now in progress is completed. The bottom of the bay is soft, and affords excellent holding ground, and the harbour is free from strong currents; the maximum outward flow from the harbour at springs is under ½ knot, and in the approaches the current seldom exceeds $\frac{7}{10}$ knot, the average at springs being well under ½ knot.

An area of about 38 acres in front of the Irish boat quay, where the original depth was considerably under 20ft., has been dredged to a minimum depth of 20ft. at L.W.O.S.T., and the sheltered area, with a depth not less than this figure, is now nearly 90 acres. When the east breakwater is completed and further dredging carried out the deep-water sheltered area will be increased to 150 acres and the enclosed water space to about 175 acres. The total quantity of material dredged from the harbour bed to date is 1,300,000 cubic yards, a portion of this being lifted by a suction dredger and the balance by bucket dredgers and grabs. The deepening of the harbour alongside the ocean quay is now in progress, and in a few weeks there will be a minimum depth of 40ft. at low water available up to and alongside the quay. A large suction dredger hired from the Mersey Docks and Harbour Board is now employed on this work.

EXTENSION SCHEME.

The scheme of extension which is now in progress may be divided into two parts for the purpose of description. The first section is the extension of the Irish Boat Quay to the north-east to join up with the root of the breakwater. The second portion includes the works sanctioned by the Act obtained by the company in the session of 1908, and comprises the construction of a breakwater on the east side of the harbour, the reclamation of a large area of foreshore, construction of wharves and jetties, and the building of a short line of railway to connect the east side of the harbour with the main line.

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* No. I. appeared December 3rd.

The quay extension.—Over one-third of this work has already been completed. The new wall will be over 1100ft. in length, and extends from the northern end of the Irish Boat Quay over the bed of the bay in a straight line to a point near the root of the breakwater inshore of the Ocean Quay. The depth of water on the site of the wall averages about 20ft. at L.W.O.S.T. The construction of this wall will add a strip of additional quay space 1100ft. in length and over 130ft. wide on the average to that already existing. The new quay will be used for both cross-channel and transatlantie traffic.

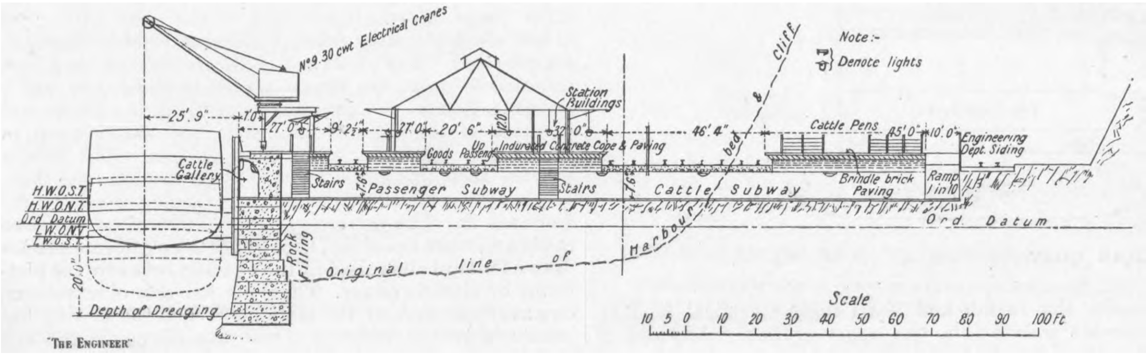

Fig. 9—CROSS SECTION OF IRISH BOAT QUAY AND RAILWAY STATION

A cross-section and part elevation of the wall are shown in Fig. 10. The method of construction differs from that adopted for the Irish Boat Quay; no cattle gallery is provided, and the face of the wall above low water is battered 1 in 9. The foundations are prepared in the same manner as those for the Irish Quay. The lowest course of blocks is founded at a level of about 2ft. below dredged level, or 22ft. below low water, and rest upon concrete bag work carefully levelled by divers.

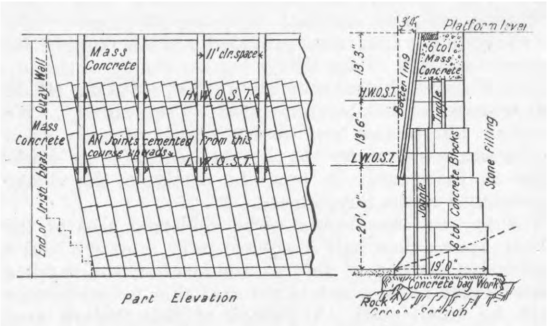

Fig. 10—QUAY WALL EXTENSION

The bag work throughout the work will rest upon rock. The concrete blocks are 6 to 1, and vary in size frm 4½ to 10 tons. The whole of the blocks are laid with sloping bond, the angle being 79 deg. to the horizontal. The sloping courses are 3ft. in thickness, the blocks on the outer face being joggled at the joints thus :—

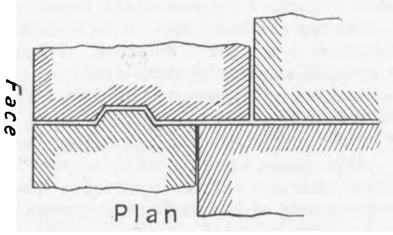

Fig. 11—BONDING OF THE BLOCKS

The wall up to half-tide level is two courses thick, and above that level, to a height of 3ft. 6in. over H.W.O.S.T., every block extends to the full thickness of the wall. The wall has a base width of 19ft., reduced by offsets and batter to a width of 8ft. 9in. at the coping level, which is 13ft. 3in. above H.W.O.S.T., and 48ft. 9in. above the bag work foundation. The upper part of the wall is constructed of 6 to 1 mass concrete, and Jarrah wood fenders 14in. square are fixed on the battered face spaced 11ft. apart in the clear.

The space behind the wall is being filled in with rock *débris* from the quarry, as in the case of the original quay work.

The east breakwater.—A commencement has already been made with the construction of the east breakwater, which will project into the bay in a north-easterly direction from the shore at Goodwick. A glance at the chart—Fig. 1, p. 570—will give rise in the minds of many to the question why the new breakwater has not been planned to run out into the bay, from either Saddle Point or the Castle Point, further to the eastward than the selected site. The adoption of either of these positions for the root of the breakwater would have necessitated the construction of heavy sea walls along the south shore of the bay under Windy Hill, in order to form a reclaimed area for the construction of a line of railway to the breakwater and, in addition, had the breakwater started at Castle Point, the old Fishguard harbour and the approach to the town of Fishguard would have been obstructed. On the other hand, the construction of the inner part of the breakwater on the selected site is a comparatively inexpensive work, owing to the shallow water extending nearly 2000ft. from the shore. The selected site is conveniently situated for railway connection with the main line from Fishguard Harbour to Litterston. This connection is now being made, and the tipping of rubble stone to form the breakwater mound at the root end is already in progress. The breakwater will extend across the bay in a north-easterly direction, and is to be about 5800ft. in length from high-water mark on Goodwick Sands to the head. The structure will be generally similar to the north breakwater, but only at the outer end, where the depth of water is about 40ft. at L.W.O.S.T., will the section be as great as that of the north work.

Reclamation.—The inner portion of the bay between the east breakwater and railway will be reclaimed by the construction of a rubble stone embankment—2145ft. in length—behind which will be tipped dredged material and stone waste. This reclaimed area of about 60 acres is to be utilised for future extensions of sidings, cattle yards, &c., and it is proposed to construct a couple of timber jetties projecting into the harbour from the cross embankment.

Dredging and deep-water quays.—The enclosed water area, after the completion of the east breakwater and reclamation, will be about 175 acres, and those portions where the water is now shallow will be deepened as required to meet the development of traffic. About 100 acres will have a depth of 40ft. and over, and 150 acres will exceed 20ft. in depth. Deep-water quays for transatlantic traffic, similar to the quay already built on the north breakwater, will probably be constructed along some part of the east breakwater, but the details of this part of the work have not yet been settled.

EXPENDITURE AND STAFF.

It may be interesting to give a few particulars of the cost of the work, in addition to those we have already mentioned in connection with the breakwater. The total expenditure of the railway company at Fishguard up to the present time is a little under half a million sterling. This sum includes all engineering and administration expenses in connection with the works and the whole of the construction and plant in and about the harbour, as well as the railway works north of Goodwick Station, which is situated at the southern or inner end of the bay, about a mile from the harbour station. In addition to the works we have described in some detail, there are many others which we have only just touched upon, such as the power station, marine department workshops and stores, the village, water supply, and plant, the cost of which is included in the total. The cost of that part of the scheme of extensions which has already been carried out, including the construction of a considerable portion of the quay extension, is also included. When the east breakwater reclamation and jetties are completed the expenditure will probably have reached to over £1,000,000.

With the exception of a large portion of the blasting work, the labour on which was let as a piecework contract, and some of the labour on the quay wall, practically the whole of the work has been carried out by departmental agency under the direction of Mr. J. C. Inglis, Pres. Inst. C.E., the general manager and consulting engineer to the Great Western Railway Company. When the railway company took over the works in 1898 they had already been in progress for about two years, under the direction of Mr. I. J. Mann, M. Inst. C.E., as resident engineer. Mr. Mann continued in this position until 1902, when the small boat pier had been constructed, a commencement made with the breakwater, and an area cleared at the base of the cliff sufficiently wide to enable steam plant to be employed with advantage. On Mr. Mann's retirement Mr. G. Lambert Gibson, M. Inst. C.E., was appointed resident engineer, which position he continues to hold. His chief assistant for some years has been Mr. A. H. Clark, Assoc. M. Inst. C.E.

Correction.—The figure 3200 in the cross-section of the Fishguard breakwater, Fig. 3, in our last issue, should read 13,200 square feet. The cost of the breakwater per cubic yard of the work is 3s. 2d., and not 14s., as given in the last paragraph of the article on page 572.

IRRIGATION WORK OF THE UNITED STATES GOVERNMENT.

No. VIII.*

MISCELLANEOUS.

The Okanogan district.—The Okanogan irrigation district, in Washington, is in a region remarkable for its mild climate, and this region extends north into British Columbia. While there are places in the north-west where a temperature of 50 deg. below zero is known, this particular section—sheltered by hills and open to the warm winds—has a genial and equable climate. It has ideal conditions for fruit growing, both as to fertile soil and mild climate; in fact, it is said that there never has been a "killing" frost to damage the fruit crop. Under such conditions farmers are naturally willing to pay charges much higher than usual for the privilege of a constant and ample supply of water, and the introduction of irrigation has caused a marked increase in the price of land. The irrigation district has an area of nearly 12,000 acres, the soil being largely volcanic ash, sand, and gravel. It is 1000ft. above sea level, with an average rainfall of 8in. per year, and with a temperature range from 10 to 105 deg. Fah.

The Salmon River is closed by a dam to form a storage reservoir of over 400 acres in area, with a capacity of 13,000 acre-feet. This dam was built by the hydraulic system, as described below. An outlet tunnel of reinforced concrete, 6ft. by 6ft. in section, discharges the water into the river channel below the dam, and it flows about 12 miles to a point where the channel is crossed by a concrete diversion dam, or weir, with headworks for the main irrigation canals. There are 60 miles of main canals, ranging in capacity from 100 cubic feet to 30 cubic feet per second. Fig. 53 shows a part of one of the canals, cut through rock and lined with concrete to give a steady flow. The capacity of the small smooth channel is equivalent to that of a much larger channel with rough sides, so that a good deal of rock excavation was avoided in this way.

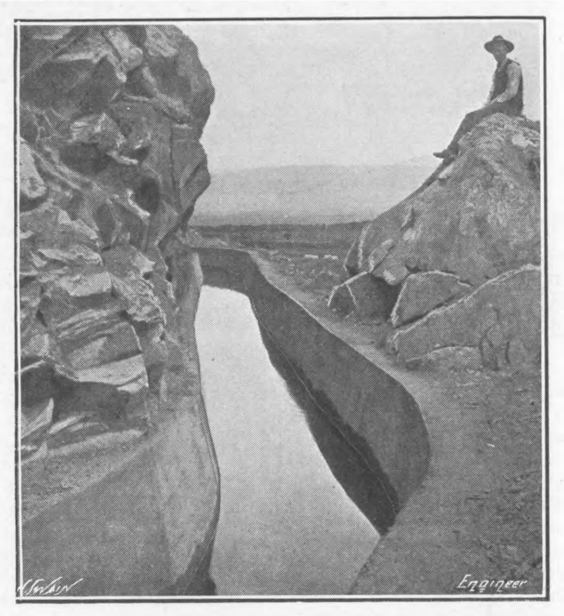

Fig. 53—CONCRETE-LINED CANAL

The Salmon River storage dam is 1050ft. long on the top, 865ft. long on the bottom, with a height of 60ft. above the ground, or 50ft. at the wasteway channel, which is 180ft. wide, cut in the rock. The top width is 20ft., with a slope of 3 to 1 on the water side and 2 to 1 on the rear side. Beneath the dam is a line of sheet piling, driven to a depth of 33ft. The body of the dam is of earth and gravel washed from the hillside by powerful jets of water, the material and water flowing down long lines of wooden flumes or troughs to the site of the dam. The main flumes were lined with steel, and laterals were extended as required. By careful methods of excavation and of sluicing or washing the material into place the finer material was kept in the middle portion, with gravel on each side, and coarse gravel and loose rock on the outer portions. There is practically no clay in the work.

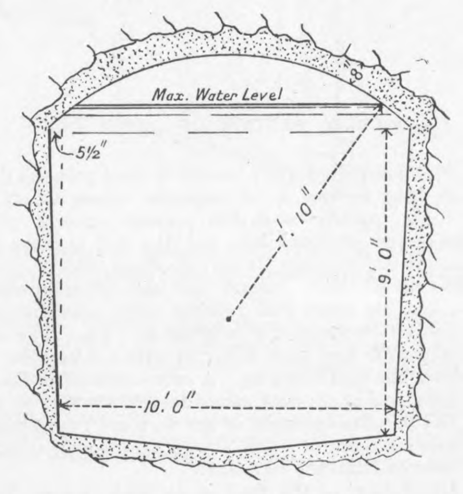

Fig. 54—TUNNEL ON IRRIGATION CANAL

The Strawberry Valley District.—This irrigation district, in Utah, includes about 60,000 acres at an elevation of 4500ft. above sea level. The soil is sandy loam and gravel, with deep black loam in the bottom lands. The annual rainfall is about 18in. Artesian water is found at many points, and is used for domestic supply. Water for irrigation will be drawn from a reservoir—30 miles distant—formed by a rock embankment dam across the Strawberry River. This dam is 42ft. high. A tunnel four miles long, driven through the mountains forming the rim of the "great basin," will carry the water to Spanish Creek, from which a main canal 20 miles long will extend to the irrigated lands. In earth the canal is 16ft. wide on the bottom, with side slopes of 1½ to 1, and 6½ft. depth of water. Its capacity is 500 cubic feet per second, and the velocity 3ft. per second. In rock, the canal has a bottom width of 9ft., with slopes of ½ to 1; the capacity is the same, but the velocity is 6.3ft. per second.

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* No. VII. appeared November 25th.

The tunnel is shown in Fig. 54, and has a gradient of 3 per 1000. A steep mountain ridge rises 1500ft. above the tunnel, and a road twenty miles long had to be built through difficult country from the nearest railway to both ends of the tunnel. The gradients are from 1 in 20 to 1 in 28, with curves so laid out as to allow the use of six-horse teams. Water power from a high-level canal is used for the generation of electric current, which is transmitted to the tunnel and used for operating the air-compressors, narrow gauge locomotives, and other machinery. When the tunnel is completed, the electric current will be used to operate pumping plants to raise water for the irrigation of a track of land above the level of the water supply system.

The Klamath District.—This irrigation district comprises lands in California and Oregon, and has as a special feature the combination of both irrigation and drainage. A number of lakes and large swamp areas are included within the district, and these will be drained so as to give additional area for cultivation under irrigation. The south canal is 15ft. to 18ft. wide on the bottom, with side slopes of 1½ to 1. One of the smaller canals is partly in embankment, and has the part immediately under the canal built in 6in. layers, each sprinkled and rolled. This forms 60 per cent. of the embankment. The triangular side portions were built in 12in. layers. Most of the material in excavation was earth that could be ploughed by six-horse teams. Some indurated material required blasting before it could be removed with horse scrapers. Another work is a timber flume or open rectangular conduit built on trestle work. This is 4300ft. long, 11ft. wide, and 6ft. deep.

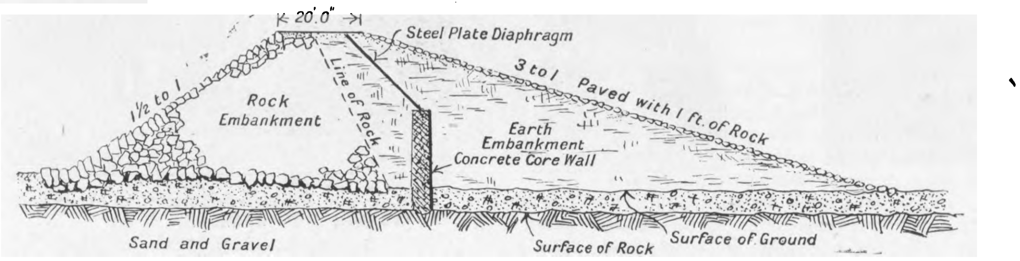


Fig. 55—AVALON IRRIGATION DAM ON THE PESCOS RIVER

The Carlsbad District.—This district in New Mexico presents an interesting feature in a large dam of peculiar construction, replacing a private company's dam which was breached by a flood in 1904. The Avalon Dam across the Pecos River is 1350ft. long, 50ft. high above the river bed. A concrete core wall is built on the rock, but does not reach to the top of the dam, the upper part of the core being a steel plate diaphragm anchored to the concrete as shown in Fig. 55. The up-stream part of the dam is an earth embankment, and in this the core wall and steel diaphragm are embedded. The down-stream portion is a loose rock embankment. The district has an area of 20,000 acres at an elevation of about 3100ft. above sea level, with an average rainfall of 12in. per annum.

The Yakima District.—This district, in Washington, on the Pacific slope, will provide for the irrigation of a series of valleys in the drainage area of the Yakima River, the total area being nearly 500,000 acres. A very extensive system of works has been planned by the Government engineers, and the cost will be about £3,000,000. The works will be taken up in divisions, however, each providing for a complete system for a certain part of the lands. Existing private irrigation systems in the district have been purchased by the Government, and will be worked into the more comprehensive system. The soil is largely volcanic ash and loam, and there is an annual rainfall of 7in. to 9in. The elevation above sea level is from 650ft. to 2000ft. A storage water supply is to be obtained by building dams at the outlets of several mountain streams, giving a combined capacity of 805,000 acre-feet. One of the interesting structures is a concrete wasteway conduit carrying off the surplus flow in a main canal. This is shown in Fig. 56. It is partly a trapezoidal section, and partly a semicircular section of 8ft. diameter, the latter in rock cutting. At intervals there is an 8in. cut-off wall, 2ft. deep, to prevent water from creeping along the bottom, and drainage is provided for by a pipe laid in a trench filled with coarse gravel.

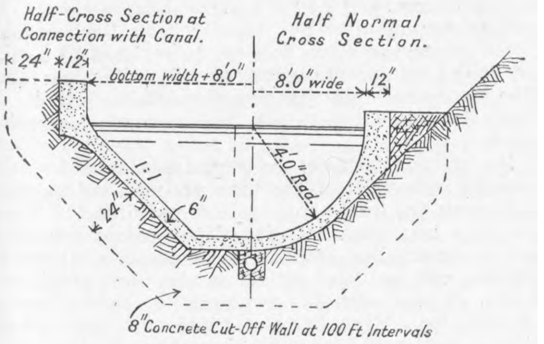

Half-Cross Section at Connection with Canal.
Half Normal Cross Section.
24"
12"
bottom width + 8.0"
8.0" wide
12"
4.0" Rad.
1:1
24"
6"
8" Concrete Cut-Off Wall at 100 Ft Intervals

Fig. 56—SULPHUR CREEK WASTEWAY

The St. Mary's District.—We close this series of notes with the following reference to the main canal of the St. Mary's irrigation district in Montana. Some of the sections in cutting and embankment are shown in Fig. 57. This shows also the culverts of 24in. concrete pipe, made in 24in. lengths, and laid with mortar joints. The end sections are flanged to form portals, and some of these flanged pipes are used along the culvert to prevent water from working along the outside of the culvert.

The canal has a capacity of 850 cubic feet per second, and its dimensions are as follows:—

Section.	Bottom width.	Depth of water.	Area in square feet.	Side slopes.	Velocity in cubic feet per second.
	ft.	ft.			
1	7	6½	98	1¼ to 1	8·66
2	7	6½	98	1¼ to 1	8·66
3	14	8	144	½ to 1	5·80
4	27	8	312	½ to 1	2·70
5	27	8	312	1½ to 1	2·70

PRESENT CONDITIONS OF THE WORK.

A brief review of the present condition of the work on the several irrigation districts described will be of interest, this review representing the progress up to August last.

1. *Shoshone District.*—The work as a whole is nearly half completed, and the great dam is 78 per cent. finished. On July 3rd the highest known flood in the river occurred, amounting to 17,000 cubic feet per second, and flowing 17ft. 4in. deep over the unfinished dam, which sustained no injury. About 7000 acres are already being irrigated.

2. *North Platte District.*—About 74 per cent. of the work for this district is completed, and the main Inter-state canal is carrying 1200 cubic feet per second.

3. *Salt River District.*—The work is 82 per cent. completed, and the same applies to the great dam. The main canal is being finished, while the electric transmission line and sub-station are completed.

4. *Belle Fourche District.*—The work as a whole is 70 per cent. completed; the main embankment being 75 per cent. finished. In July 85,000 cubic yards were deposited, making a total of 1,221,000 cubic yards, and 1250 concrete blocks were laid to pave the water slope.

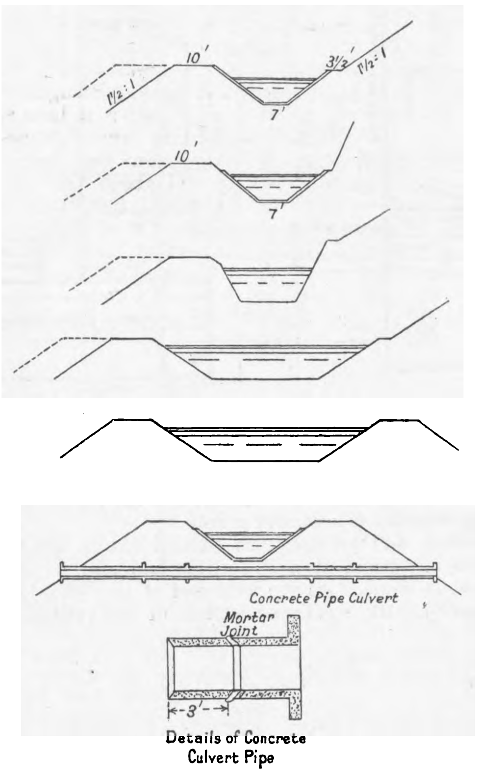


Fig. 57—SECTIONS ST. MARY'S CANAL AND CULVERT PIPE

A railway branch line is being built through the district.

5. *Minidoka District.*—The gravity system is completed, and the pumping system 57 per cent. The hydro-electric station is under construction.

6. *Payette-Boise District.*—This is 79 per cent. completed, and work is being finished on the distributing canals, so that water can be delivered next season.

7. *Huntley District.*—The works are 96 per cent. completed, and water is being distributed.

8. *Williston District.*—The works are 66 per cent. completed, and the power-house, pumping plants, and canals are in operation, supplying water from the Missouri River.

9. *Buford District.*—The works for this district are 38 per cent. completed.

10. *Garden City District.*—The works are 96 per cent. completed, and the pumps are in operation at the wells.

11. *Uncompahgre District.*—The headings of the six-mile Gunnison tunnel met July 6th, with variations of 0.04ft. centre line, 0.32ft. in gradient, and 0.86ft. in distance. The tunnel is 81 per cent. completed, and the entire work of the district 52 per cent.

12. *Truckee-Carson District.*—The works are 90 per cent. completed, and the water stored in Lake Tahoe has been turned into the Truckee River, whence it is diverted to the main canals.

13. *Yuma District.*—The Laguna Dam is finished, and the general work is 71 per cent. completed.

14. *Okenogan District.*—The dam built by sluicing is 68 per cent. finished, and the work as a whole 94 per cent. finished.

15. *Strawberry Valley District.*—The works are 34 per cent. completed, but the work on the main tunnel is only 14 per cent. finished, with an advance of 306ft. in July.

16. *Klamath District.*—Work is 38 per cent. completed, and water is being supplied to the first unit of 20,000 acres.

17. *Carlsbad District.*—This is completed, but the quantity of water stored by the dam is not yet sufficient to meet the demands.

18. *Yakima District.*—The works are 67 per cent. completed on the Tieton and 37 per cent. on the Sunnyside sub-district.

19. *St. Mary District.*—Work is 18 per cent. completed, and the excavation of the main canal is in progress.

THE WORKS OF DRYSDALE AND CO., LIMITED, YOKER, GLASGOW.

The firm now known as Drysdale and Co., Limited, commenced business as engineers in Glasgow in the year 1874. Mr. J. W. W. Drysdale, the principal of the business to-day, had at that time associated with him as partner the late Mr. Louis Pirie, and the firm was consequently styled Drysdale and Pirie. In 1884, on the death of Mr. Pirie, the name of the firm became changed to Drysdale and Co., and when in 1908 it was necessary to acquire a new site for the works the company assumed its present designation. The works were at the beginning of the firm's career situated in Fordneuk-street, in the east of Glasgow, and here for 34 years the manufacture of all varieties of centrifugal pumps and their associated engines were carried out. An increasing demand for the company's products entailed a corresponding increase in the workshop capacity, and when the natural limitations of the original site had been reached as far as farther extension was concerned, it was determined to acquire a new situation for the works, and to build new and up-to-date shops.

The position ultimately chosen for the farther enterprises of the firm was on the right bank of the river Clyde at Yoker, a district which had already attracted the favourable attention of several other engineering firms. To this new ground the tools and plant of the company were transferred during the New Year holidays and the next few weeks of 1908.

The expedition and careful direction of the removal reflect great credit on Mr. Wm. Drysdale, the works manager, and son of the founder of the firm. Before commencing to remove, the new power plant, shafting, cranes, &c., had been installed in the Yoker shops, and for some time preceding the date of changing, late working in the old shops had been resorted to, thus keeping the work in hand at the time well ahead. All the foundations for the tools having been prepared in the new shops, the actual removal was commenced in the last week of 1907. A double shift was worked at both ends throughout the change, and during each day sufficient material was carted to the Yoker shops to keep both the day and night shifts at that end fully employed on its installation. As a result of the careful organisation given to all details, at the end of January, or in about five weeks from the commencement, everything had been removed from the old works, and the greater part of the new works had been running for about a fortnight. It is estimated that on account of the removal no work on hand at the time suffered a delay greater than that of a week. As soon as any machine had been fitted up on its new site it was worked by two shifts, and this arrangement largely contributed to the reduction of time lost.

The general arrangement of the new works will be gathered from Fig. 3, where it will be seen that the shops consist of five bays varying in width from 25ft. to 40ft., and having a length of about 220ft. The axes of the bays run parallel with the direction of the river Clyde at this point of its course, a space of sufficient extent to permit the erection of two 25ft. bays and one 30ft. bay having been left between the shops and the river for future extensions. On the east the site is bounded by the ground belonging to the ship repairing works of Messrs. J. Shearer and Sons; to the west, the extensions of the future have been fully provided for. On the side lying inland from the river the site has for its boundary the Balloch branch of the Caledonian Railway Company's system, and from this a line is led into the works. A road runs between the railway and the works, and facing on to this are the office buildings, where the commercial and drawing departments are engaged. Adjacent to the offices, and with its frontage also to the road, is the pattern shop, a well-lighted building fitted with all modern tools for the production of the high-class and intricate patterns requisite in the pump-making industry. A large three-storey pattern store close to the pattern shop lies at right angles to the road on the east boundary, and to this a fourth floor may be added if desired in the future.

Between the above buildings, comprising the offices, pattern shop and store, and the main shops, a space of ground 90ft. in width and running the entire length of the present site has been left. This is sown in grass, and with its cinder paths adds much to the pleasing appearance of the works. Two 40ft. bays will be erected here whenever the workshop capacity has to be increased.

While there are no special machines employed on the company's products, the work being such as is easily accomplished with the ordinary run of tools, we would emphasise the careful manner in which the shops have been laid down and future extensions provided for. The

THE WORKS OF DRYSDALE AND CO., LIMITED, GLASGOW

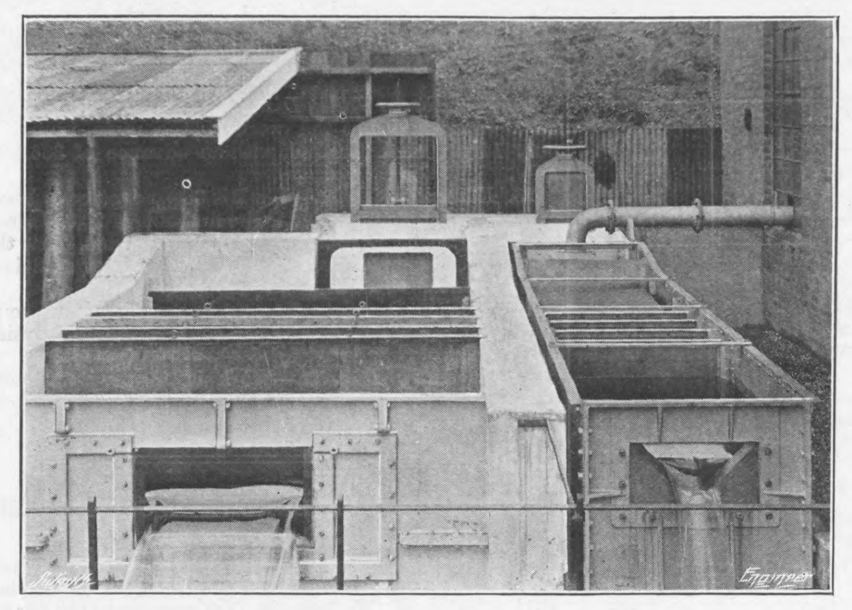


Fig. 1—MEASURING TANKS

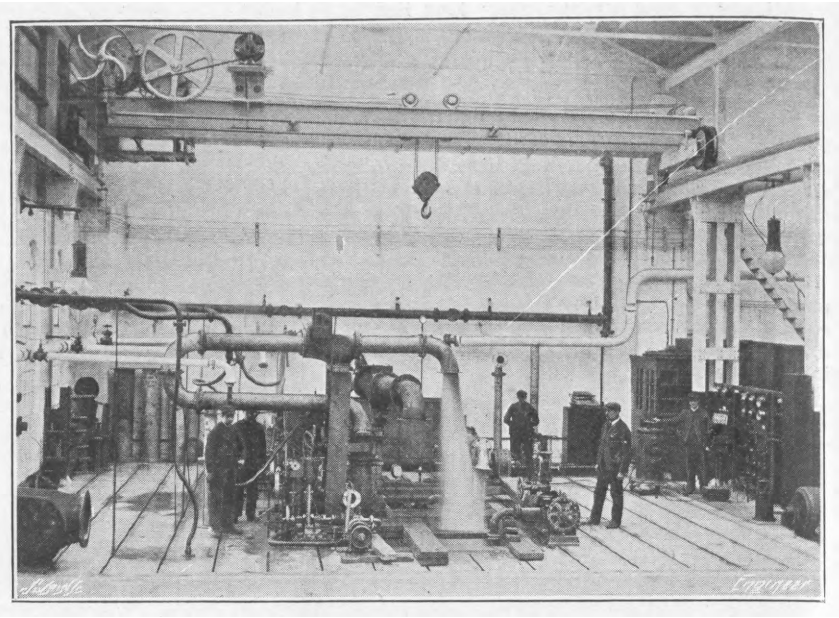


Fig 2—TESTING DEPARTMENT

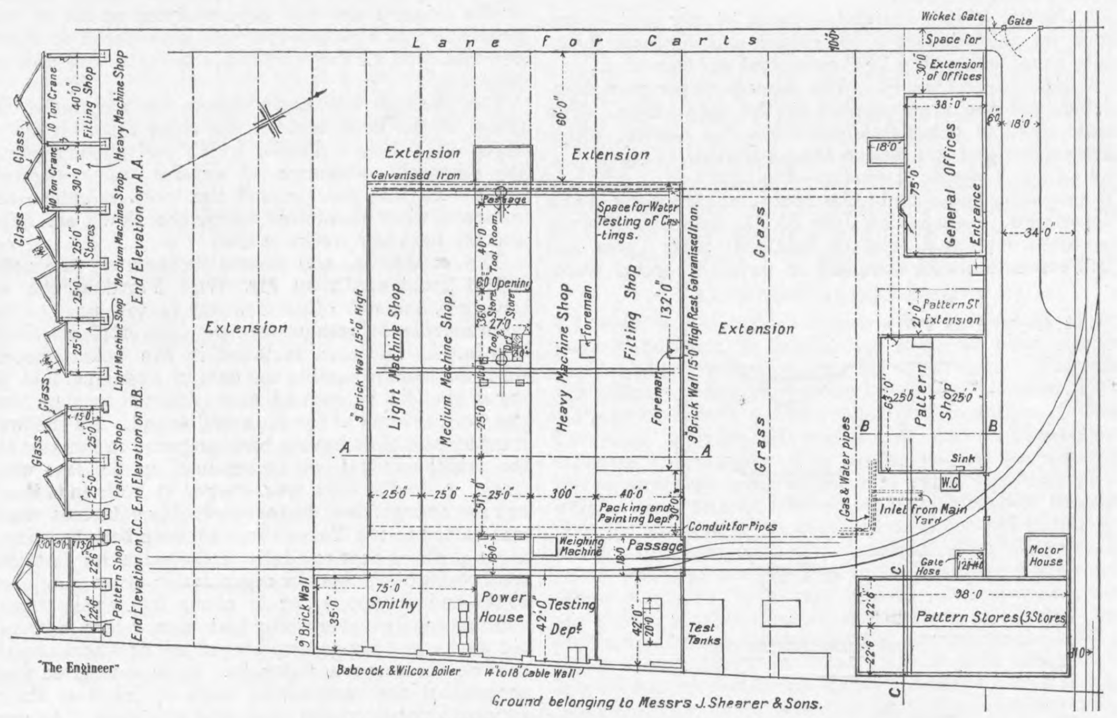

Lane for Carts
Wicket Gate
Gate
Space for
Extension of Offices
General Offices
Entrance
Extension
Galvanised Iron
Passage
Tool Room
Tool Store
Store
60 Opening
Space for Water Testing of Castings
Light Machine Shop
Medium Machine Shop.
Heavy Machine Shop
Foreman
Fitting Shop
Foreman
9" Brick Wall 15'0" High
9" Brick Wall 15'0" High Rest Galvanised Iron.
Grass
Grass
Extension
Extension
Pattern St Extension
Pattern Shop
Sink
W.C
Gas & Water pipes
Inlet from Main Yard
Packing and Painting Dept
Conduit for Pipes
Weighing Machine
Passage
Gate Hose
Motor House
Pattern Stores (3 Stores)
9" Brick Wall
Smithy
Power House
Testing Dept
Test Tanks
Babcock & Wilcox Boiler
14" to 18" Cable Wall
Ground belonging to Messrs J. Shearer & Sons.
Glass
10 Ton Crane
Fitting Shop
Heavy Machine Shop
Medium Machine Shop
Stores
Light Machine Shop
Pattern Shop
End Elevation on A.A.
End Elevation on B.B.
End Elevation on C.C.
"The Engineer"

Fig. 3—GENERAL PLAN OF THE WORKS

firm does not undertake its own requirements in castings beyond the supply of the patterns, and as cast material enters largely into the work carried out suitable provisions have been made for its reception, handling, and storage. Parallel with the eastern boundary wall, and at a distance of about 45ft. from it, the railway siding runs across the end of each of the five bays, and is continued out on to the space lying next the river. The ends of the bays thus cut off are utilised as a testing department, casting store, power-house, and smithy, taking them in the direction in which they are passed by an entering truck.

Each bay is occupied by a separate department, the arrangement being such as to require the minimum amount of handling of the material during its passage through the different stages from its entry into the works until it arrives at the testing tank as a component part of the completed pump or engine. The first bay, lying nearest the river boundary, is occupied by the light machines, and is suitably placed relatively to the smithy, where all the lighter forgings required for the pumps and engines are made. In the second bay the medium machines are placed, and at the end it is, like the first, in communication with the smithy. A two ton overhead electric crane, by Messrs. Geo. Russell and Co., Motherwell, serves this bay, the material handled in the first bay being sufficiently light to dispense with a crane service. The third bay is divided into two parts, fenced round with wire netting. A general store occupies the east half bay, a tool and drawing store the west, while the passage left between the two is bridged by the assistant works manager's office, whence an excellent view of most parts of the five bays is obtained. In the general store the finished details are tested and inspected as they arrive from the shops, and are stocked until called for by the erecting shop. The firm has a well-known design of steam engine, which is made in all sizes from half horse-power upwards, and the parts for these, as far at least as standard sizes of the design are concerned, are put through the shops in batches at a time. These parts are all made to limit gauges, while jigs are universally employed. In the general store these details are subjected to inspection, and are held in readiness to meet requirements at the shortest notice. The tool store looks after the supply and maintenance of the entire stock of tools used on the machines, and is provided with suitable tool grinders.

Heavy machines occupy the fourth bay, which has the castings store situated at its end. A ten-ton overhead electric crane, by Royce, of Manchester, serves this bay, and as it runs along the entire length it can be used to discharge wagons arriving at the east end. The machines in this shop include large vertical and horizontal boring mills and lathes, and are for the most part independently electrically driven.

Fitting and erecting are carried out in the fifth bay, which is worked by a 10-ton electric and a 2-ton hand overhead crane. At the west end of this shop provision is made for the hydraulic testing of the castings as they are delivered from the machine shops. Passing down the bay the space is devoted in turn to the fitters' benches, painting, and packing department, and on the east side of the railway lines to the testing department, where the performance of every pumping set is determined.

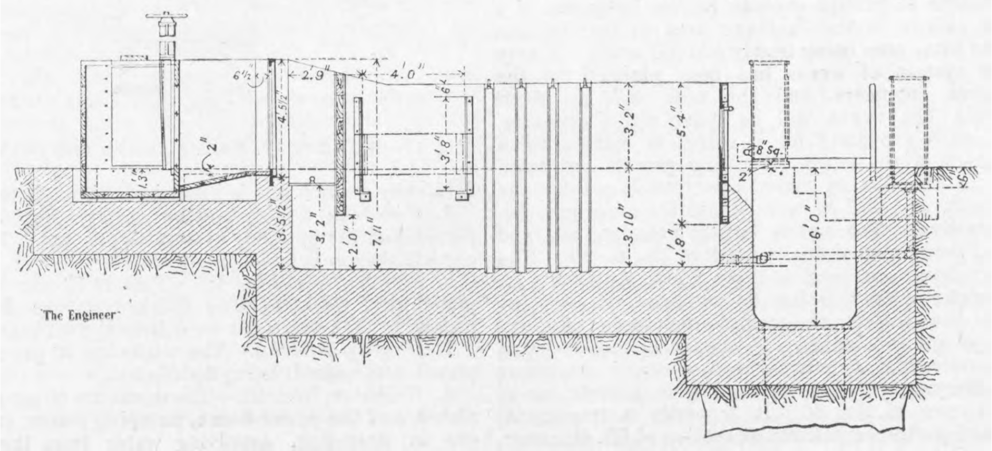

6½"
2.9"
4.0"
6"
4.5½"
2"
3.6"
3.2"
5.4"
8" Sq.
3.5½"
3.2"
2.0"
7.½"
3.10"
1.8"
6.0"
13'
"The Engineer"

Fig. 4—LONGITUDINAL SECTION OF LARGE MEASURING TANK

Throughout all departments a concrete floor has been laid down, a comfortable footing for the workmen being provided at the benches and elsewhere by 3in. by 11in. planking. Two sets of narrow gauge lines for the works bogies run across the shops, one set being laid at the western end, the other running across at the centre, and passing between the tool and general stores.

The provisions for testing the completed sets of pumps and their engines are elaborate, and the measuring weirs, which were installed only a few weeks before our representative visited the works, call for especial mention. At the end of the fifth bay, as already mentioned, the testing department is situated so that the final stage in the construction of the pump is reached at a point close to the railway siding, and therefore suitably placed for dispatch. The testing details comprise a tank 20ft. by 8ft. by 14ft. to 17ft. deep, whence the pumps during a test draw their supply of water. Along one side of this tank provision is made for the testing of steam pumps, a full range of pipes supplying steam at any pressure up to 300 lb. per square inch and the necessary exhaust pipes being found here. On the opposite side of the tank the electrically driven pumps are tested, and for this purpose alternating current at any pressure up to 600 volts is available, while the neighbouring power station of the Clyde Valley Electrical Power Company can be drawn upon for further supplies.

For ordinary shop' tests water meters are used to measure the output from the pumps, but some months ago the firm determined to fit up a very complete measuring apparatus on the notch principle. Two measuring tanks have been laid down just outside the main shop buildings and close to the testing tank, and in Fig. 1 we reproduce a photograph of these while running. The larger tank is constructed with concrete walls and cast iron front, and has a maximum capacity of 12,500 gallons per minute. For smaller flows the rectangular notch giving the above flow can be replaced by a smaller one with a maximum capacity of 3500 gallons per minute. The method of interchanging the notches will be seen from the figure, where the smaller notch is shown in action.

For still smaller flows the second tank is used. In this case the side walls of the tank are made of galvanised sheet iron, the front being again of cast iron. A V-notch having a maximum capacity of 600 gallons per minute, and a rectangular notch, with a capacity up to 1250 gallons, can be fitted at will to the front of the small flume, so that with the two tanks a very full range is provided for. Each flume is fitted with four perforated vertical baffles, and, as will be seen from Fig. 4, where a sectional elevation of the large tank is shown, the water, as it enters through the sluice valve from the distributing box, is stilled and strained first by a horizontal sieve, then by a fixed vertical baffle descending to within 2ft. of the tank bottom, and finally, before reaching the first of the four baffles, by a horizontal wooden float working in four guides on the side of the tank. In order that both tanks may be used simultaneously, a pipe 9in. in diameter is led from the testing tank inside the workshops, and delivers water to the smaller flume on the down-stream side of the sluice valve.

As the water falls over the notches it is taken away by a sump in communication with the testing tank inside the adjacent building. To measure the head of water over the weirs a 4in. pipe is led from the front of each to instruments within the workshops. The pipes thus led away are in communication with the tank at its lowest level, and at this depth the water is practically still. Hence in the measuring instruments the level recorded is the true statical head over the weir—that is to say, they record the height of water as if it were measured at a distance sufficiently far up-stream from the notch to prevent the result being vitiated by the velocity of the water as it flows over the crest. The instruments employed for measuring the head are of the float gauge type, and were supplied by Kelvin and James White, Limited. For the rectangular notches Francis' formula is employed, the values of the constants involved having been carefully determined on the experimental notch of similar proportions in the James Watt Engineering Laboratories at Glasgow University. For the V-notches the ordinary single term formula is used.

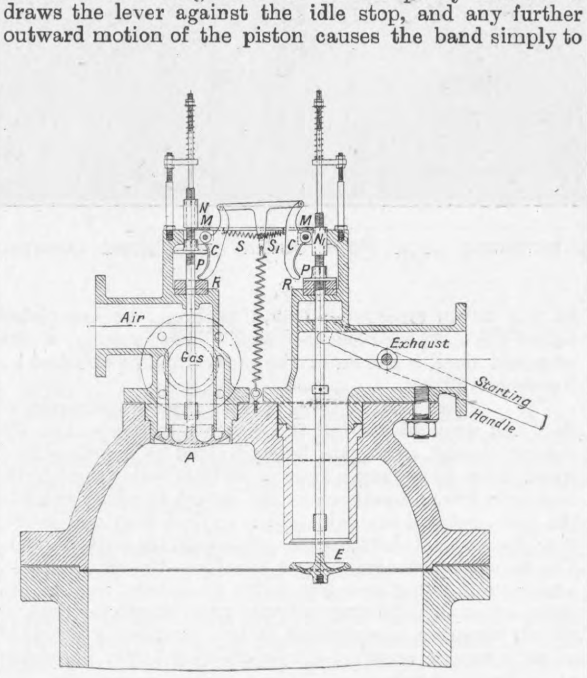
Drysdale and Co., Limited, make a large range of centrifugal pumps, and with the high-speed steam engines associated with their name their pumping sets are widely known, being employed for such purposes as supplying cooling water to condensers, sand dredging, ship salvage work, irrigation, and many other uses in all parts of the world. On page 606 we give some views showing the interior of a few of the departments.

IMPRESSIONS OF THE HUMPHREY PUMP.

A WELL KNOWN waterworks engineer who went down to Dudley Port to see the Humphrey pump at work, after looking at it for some time, observed with a sigh: "Well, I suppose we've got to have it, but it will make a —— ugly engine-room." That remark sums up not inaccurately a good deal of modern power engineering. The turbine has robbed the engine-room ashore and afloat of much of its interest and beauty—one soon wearies of watching a Russian iron casing even when it *is* neatly finished with brass bands; and now comes the gas pump to deprive us, we are told, in due course of the great engines whose dignified comportment it was a privilege to witness. The Humphrey pump is nothing at all; just a pipe with an air chamber at one end and an explosion chamber at the other, the latter surmounted by a few fittings, which, by their periodical intermittent motion show that the thing is really alive. But it is, nevertheless, one of the most interesting inventions in power engineering that has been seen since the dynamo astonished the world, and we believe a short account of an inspection of the experimental apparatus in its latest form will not be without interest.

In our issue of October 22nd we described and illustrated the plant that was tested by Professor Unwin. The explosion chamber used then was a conical vessel bolted to the cylindrical water valve box. Its capacity was such that the pump might be described as of 16 pump horse-power. It has now been replaced by a larger chamber, which, instead of being conical, is a plain cylinder made of two flanged cast iron rings bolted together. It is made in two parts simply in order that the volume of the chamber may be reduced for experimental purposes by removing one ring. This cylinder stands upon the original water valve box, and it works at the disadvantage that its capacity is too great for the valve area, and hence the number of strokes has to be few to enable sufficient water to enter. As a matter of fact, when we saw the pump at work a few days ago, it was making eight cycles a minute, or not more than half the speed it will attain when its own valve-box is fitted. The cylinder is closed by a domed top, in which are situated the three valves for admission, exhaust, and scavenging. A section of the two former is shown herewith, which illustrates the actual apparatus now at work. The admission valve, it will be noticed, is near the summit of a chamber, which in plan is kidney shaped, whilst the exhaust valve is placed a good deal lower. The action of the valves is extremely pretty, because it is entirely automatic and without any actuating mechanism whatever, the original attachment with the water valve having been given up. In the position shown it may be imagined that the exhaust has just opened by its own weight, and the products of combustion are being driven out. It is required at this stage to hold the admission valve up, and this is effected by the steel plate or bolt M M., which is free to slide sideways. As shown, one end of it projects beneath the nut N on the admission valve spindle, and prevents that valve from falling. It will be observed that the spring S is in tension tending to pull the plate to the right, whilst S_1 is slack. Suppose now that exhaust is complete and the returning water has struck E and raised it against its seat. As soon as the nut N_1 is raised high enough, the plate M is pushed under it by the tension of the spring, and the valve is held up. At the same time the admission valve is left free to fall. It does not do so at once, because the pressure in the chamber is keeping it on the seat, but as soon as the water retires it drops by its own weight till the plate P strikes the rubber pad R, and is then full open for the admission of air and gas. But during its fall the lever C is pushed over, on account of its cam face bearing against the plate P, the result being that the tension is now put on spring S_1, and the plate M M is ready to shoot back under N when the valve is again raised. This takes place on the compression stroke, but though the exhaust valve is then free to fall, it is supported by the pressure in the chamber until expansion is complete, when it drops by its own weight. It will be noticed that in both valves the seat is at the bottom of a short cylindrical part, so that even before the valve seats the aperture is practically closed, and there is no waste of gas when the valve seats. Scavenging is effected in this way. After the explosion has taken place, and the water is moving outwards, as soon as the pressure gets below atmosphere the scavenging valve is sucked open and fresh air is drawn into the cushion chamber. This air does not mix much with the products of combustion, but lies on top of them. Then when the water returns it drives out the products through the exhaust valve, but entraps the fresh air in the cushion chamber. Hence all the products of combustion, except the very small portion which may have mixed with the scavenging charge, are driven out: In the ordinary course, to ensure that the air enters by the scavenging valve, and not simply back through the exhaust—in which case if the exhaust pipe were long the products of combustion lying in it would be drawn back—a non-return valve is put on the exhaust. When, however, we saw the pump, scavenging was not being employed, because the water valve area being so small, all the suction obtainable was needed. The non-use of it appeared, however, to make no difference to the action of the pump, which exploded with absolute regularity and with great certainty.

It was originally expected that ignition would give trouble because the points were being continually soused with water, and a large Lodge ignition apparatus was at first employed, and may still be seen in the engine-house. It was, however, found that by a simple modification of the ordinary commercial ignition plug an ordinary trembler coil and battery, such as are used on a motor cycle, would do all that was required, and are now always used; but in order to be fully up to date a magneto operated by the timing gear is now being made, and will be tried shortly. The timing gear is one of the most ingenious details of the whole apparatus. The object to be obtained is to fire the products at the very instant when compression has reached its maximum wherever the level of the water may be at that time. This is secured by fitting a miniature piston and cylinder to the cylinder wall; as the compression increases this piston is pushed outwards and pulls one end of a steel band that passes round a small pulley, the other end being attached to a spring. On the pulley is a lever working between two stops quite close together, one of which is the firing contact. As the pulley revolves it draws the lever against the idle stop, and any further outward motion of the piston causes the band simply to slip on the pulley. As soon, however, as the pressure in the cylinder begins to fall the band starts to return and instantly moves the pulley in the opposite direction until the lever makes contact and fires the charge. Full details of the apparatus will be found on page 564 of our issue of Nov. 26th, but we think it worth while to call attention again to this very elegant detail which, it will be seen, absolutely ensures that ignition takes place at maximum compression.



THE LATEST FORM OF VALVE GEAR

Mr. Humphrey tells us that one of his many visitors made a particular request that he should be allowed to find out how the apparatus worked for himself, and that he studied it for an hour and a-half in the snow and then had to give it up. But if he had had any inkling of the principle involved—the swinging to and fro of the water—he would have found two or three external indicators of what was happening within. As one enters the works the first thing to be seen is the old boiler used as an air vessel—which, by the way, is too small for the present pump, and prevents a high speed being used—and on this air vessel is a pressure gauge the pointer of which tells the whole story of the cycle. You see the needle go up to the maximum, 15 lb. or so, equivalent to the head against which the pump is working; then it falls to 7 lb. or 8 lb. as the air in the chamber expands, driving back the water and forcing out the products of combustion; then it rises again a few pounds as the water on its return swing compresses the air in the air vessel whilst it draws a new charge into the cylinder at the other. Then again it falls whilst compression takes place, and instantly afterwards rises to the maximum as the charge is fired. This dial is a very fascinating detail to watch.

Then the exhaust, too, tells a good deal about the cycle, particularly the fact that expansion takes place down to atmospheric pressure, for it is practically noiseless and quite cold to the hand, though it is accompanied by a cloud of steam evaporated by the explosion. At first one is surprised to find the exhaust so cold, but on consideration it is seen that since it has done all the work it can do, and has been even expanded below atmosphere, there is no reason why it should be hot. The steam, too, is quite cold, and it is a nice point how it exists at all. The whole engine, indeed, works cold, even the breech of the cylinder being scarcely appreciably warm to the touch.

Starting the pump is the simplest thing imaginable. So that we might see the operation, it was allowed to settle down until the water level, as seen in a large gauge glass fixed on the side of the cylinder, was at rest. Compressed air was then admitted, and the water was depressed nearly to the bottom of the glass. Then the exhaust valve was opened for an instant and the pressure allowed to escape quickly; the water immediately rose beyond its level and then fell again, sucking in a charge which it compressed by rising again. At maximum compression the automatic gear ignited the charge and the engine was off. For two or three cycles it appeared to be warming up to its work and then went away with perfect regularity at about eight strokes a minutes.

The thing after all is said and done that strikes one most about the pump is its surprising simplicity. There are literally no working parts in the accepted sense of the word except the few small bits of mechanism that control the valves and the little device for firing on maximum compression. Apart from these, the only things that move are the suction valves, and they are of a very simple nature. There is a large number of these, but they shut so quietly that not a sound is audible outside the casing when they close. It may thus be surmised that they will enjoy a long life. On the other hand, the exhaust valve does go on to its seat with a bang as it is driven up by the water, but it does not appear to suffer from the impact, the fact that it never gets really hot no doubt adding to its wearing qualities.

Of other interesting points about the pump, plenty of information will be found in Mr. Humphrey's paper and the reply he made to the discussion, which will be found on another page. One point of considerable interest is whether the pump can work on a suction lift or not. That it can be made to do so Mr. Humphrey has convinced us, but as patents are pending it would not be right to say anything of the method to be employed at the present time, save that it adds hardly appreciably to the complications of the design.

THE KING'S DOCK, SWANSEA.

No. III.*

The entrance lock.—The entrance lock is placed at the south-western corner of the King's Dock, and is 875ft. long between the pointing sills of the inner and outer gates, and 90ft. wide at coping level. The lock is subdivided by intermediate gates into two compartments, respectively 500ft. and 375ft. long. Over the outer and middle sills there is a depth of water of 40ft. at H.W.O.S.T., and 12ft. at L.W.O.S.T. At neap tides the depths are 32ft. 3in. and 19ft. 9in. at high and low water respectively. Ships drawing 31ft. will therefore be able to enter the dock at high water of any tide in the year, and the majority of vessels using Bristol Channel ports can enter the lock at almost any state of tide, so that for all practical purposes it may be considered a deep water lock. To obtain a greater depth at low water of spring tides would have entailed the dredging of a much greater length of approach channel; the expense of doing this, and the difficulty of keeping the channel clear at a considerable distance from the shore, in an exposed situation, would have been out of proportion to the small advantage obtained thereby. As it is, the depth of 12ft. over the entrance sill at L.W.O.S.T. is greater than that of any other port in the Bristol Channel, at the same state of tide, with the exception of the Barry deep water lock, where the depth at L.W.O.S.T. is 13ft. 9in.

The side walls of the lock are vertical, the upper portions, which are faced with Staffordshire blue brick, projecting over the lower part of the wall, as in the case of the dock wall, which we described and illustrated in our issue of November 19th. The overhang is 6in., and the corbel courses are of granite. The details of the wall-face need not be described further, following as they do the section of the dock wall. The floor of the lock is of concrete throughout, the mass being 6 to 1 with large stone plums, and faced with 4 to 1 concrete. All other concrete faces in the lock are also finished 4 to 1. The invert curve is a flat one, the rise to the sides of the lock being 4ft., and the normal thickness of the floor 8ft. at centre, increasing to 12ft. at the sides. Under the gate recesses the thickness of the floor is increased.

The dimensions of the side walls and other principal features of the lock are shown in the plan and sections—p. 600. In a few minor details the work as executed is at variance with the figures. Notably the swing bridge is skewed to the lock, not at right angles as shown, and the chambers for the hydraulic opening and closing machinery for the gates are not as shown in the drawings. Throughout the work granite—from Sweden—has been used only for the important wearing surfaces, such as pointing sills, caisson chases, roller path seatings; in sluice chambers, openings, and seatings; for corbel courses, copings, hollow coigns, &c. It was originally intended to construct the ladder and chain recesses, and many of the coigns and edge courses in hard Pennant stone, but all these have been built of strong granolithic concrete composed of granite chippings and cement.

At the outer end of the lock a concrete apron has been constructed for a length of 150ft. seaward of the entrance sill, with its surface at the level of the dredged entrance channel, 14ft. below L.W.O.S.T. The east wall of the lock is returned towards the root of the approach jetty, while the west wall is carried out to form a roundhead at its junction with the extension of the old east pier. At the inner end of the lock the west wall terminates in a

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* No. II. appeared November 26th.

THE KING'S DOCK, SWANSEA

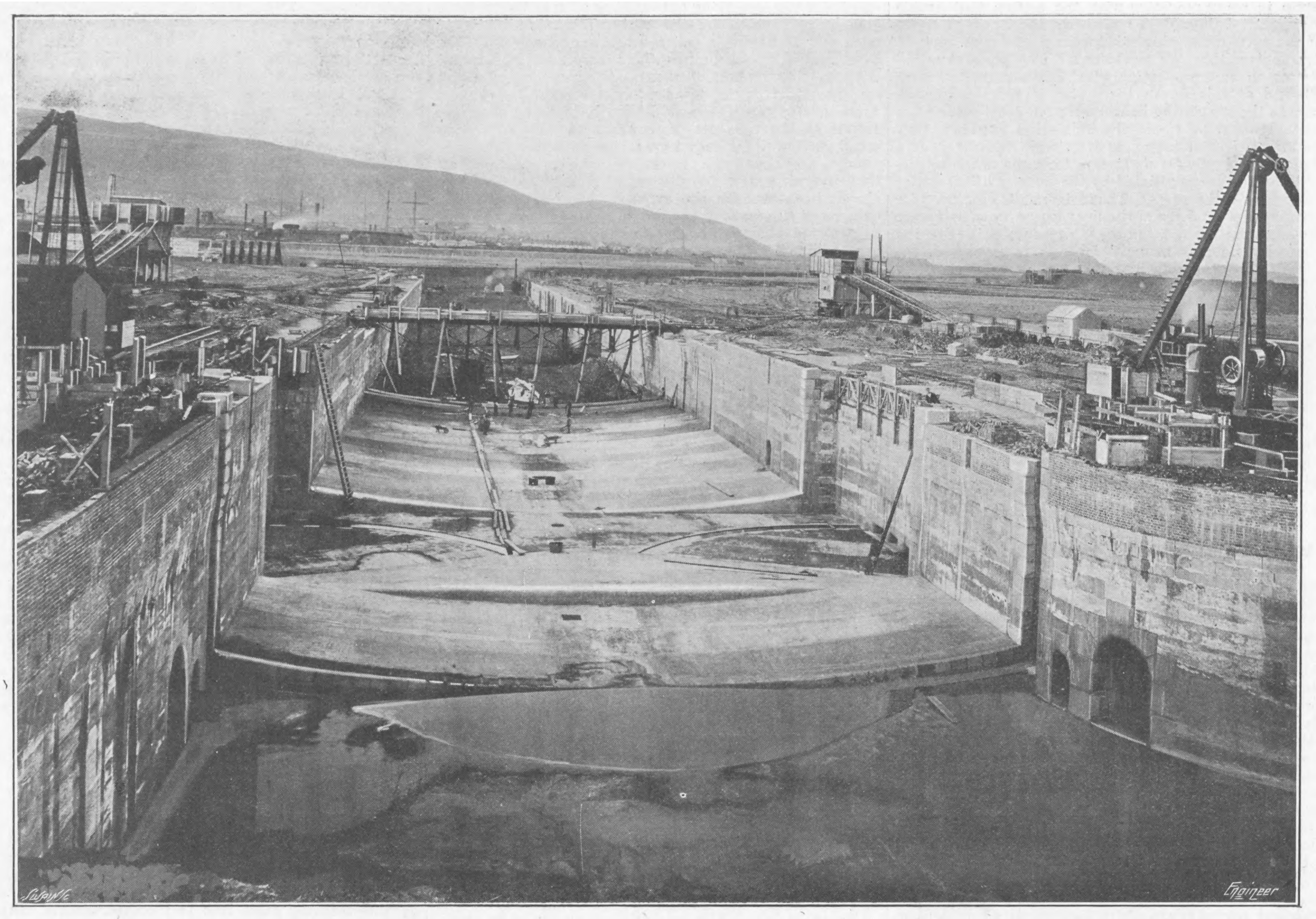

Fig. 16—ENTRANCE LOCK FROM OUTER END DURING CONSTRUCTION

round head, which will form a part of the entrance to the second lock which it is proposed to construct in the future. This additional lock will probably be 1000ft. in length between the extreme gates and 100ft. in clear width. On the opposite side of the lock, at the inner end, is a corresponding round head. Caisson chases have been formed in the side walls, and stops in the floor of the lock at each end for the reception of ship caissons or timber dams, when it may become necessary to empty the lock for repairs or in case of disablement of the gates. The caisson or caissons have not yet been built.

The main sluices, which are placed in shafts over the main filling and emptying culverts, 6ft. by 10ft., are raised and lowered by direct acting hydraulic presses. In addition to the six main sluices, the lock is provided with four floor sluices, 4ft. by 6ft., for clearing the gate chamber floors of any accumulation of mud. The paddles of all the sluices are of greenheart timber, working on polished granite faces. The culverts are lined with Staffordshire blue bricks, backed with hard red bricks.

The lock—see p. 600—is furnished with eight hydraulic capstans, four of which are capable of exerting a pull of 7 tons, and the other four of 5 tons direct from the barrel.

We have already stated that a temporary stone and sand dam, which formed a continuation of the permanent sea embankment, was constructed across the site of the entrance to the lock between the west end of the sea embankment and the seaward end of the old east pier extension. It was necessary to remove this temporary dam before the completion of the work in connection with the lock in order to permit portions of the work in the approach to be proceeded with. A temporary concrete block dam was therefore constructed across the entrance lock at its outer end, resting on the apron. This second dam also formed an additional protection in the event of any failure of the outer dam. The concrete dam was removed when the whole of the work in connection with the lock had been completed, divers being employed in dealing with the parts below low water. A view of this dam in course of construction will be found in our issue of October 2nd, 1908. The construction of the lock has been favoured by the presence of an excellent foundation, which has enabled the work to be carried out with considerable economy.

Views of the lock in several stages of its construction will be found in our Supplement of November 19th and above. The general arrangement of the lock in relation to its surroundings is shown in the plan of the dock in our issue of November 19th.

Proposed dry dock.—It is proposed to construct a large dry dock on the site adjoining the lock on its eastern side. This work will not be carried out by the Harbour Trustees, but negotiations are in progress with a syndicate for the construction of the dock, plans for which have already been prepared. The dock will have an entrance at either end, and thus be accessible from both the dock and the entrance channel. This arrangement will also permit of its use as an emergency lock, if it should be completed before the proposed second lock. The outline of the proposed dock is shown in the general plan published on November 19th.

The lock gates.—The three pairs of gates are generally of steel and wrought iron, of the water-borne type, and are alike in design, each gate being divided by means of two water-tight decks and a central vertical water-tight bulkhead into five compartments, the lowest of which extends the full length of the gate, and is in free communication with the outer water through openings in the bottom deck. The two compartments above this form the air chamber, and the remaining two are water chambers free to the outer water through open scupper pipes at the top deck of the air chamber, the position of this deck being arranged so as to ensure a proper excess of weight over buoyancy at all states of tide.

Drawings of the outer and middle gates are reproduced in Fig. 17. The details of the inner gates are similar. Two views in our supplement of Nov. 19th show the gates erected in the lock. The underside of the gangway platform is at the level of the lock coping, or 6ft. above H.W.O.S.T. The sills of the outer and middle gates are at a level of 12ft. below low water, or 46ft. below the coping. The inner sill is 5ft. below L.W.O.S.T., so that this pair of gates are 7ft. less depth than the other two pairs.

The gates are flat on the sill side, and curved on the pressure side, 51ft. 9in. long from centre of heel post to centre of meeting face, and 6ft. 8in. in width over the rib angles at centre. The outer and middle gates are 47ft. $5\frac{1}{2}$in. deep, and the inner gates 40ft. $5\frac{1}{2}$in. deep. Those parts of the plating which come in contact with the water, and are inaccessible at low tide, are of wrought iron, the remainder being of mild steel, the thickness of the skin plating varying to suit the water pressures from 1in. to $\frac{3}{8}$in., the boundary angles of the ribs and decks varying from 6in. by 4in. by $\frac{3}{4}$in. to 4in. by 4in. by $\frac{1}{2}$in., and the spacing of the ribs being also decreased from top to bottom. The top, bottom, and two water-tight decks bounding the air chamber are plated throughout, the intermediate ribs being plated at the ends and strongly braced in the centre; in addition to the plated central bulkhead mentioned above plated intercostal diaphragms are provided on each side at a distance of 12ft. 6in., forming continuous stiffeners throughout the depth. Further stiffeners are introduced in the bottom compartment to take up local stresses from the sills, and the ends of the gates are formed with heel and meeting plates 1in. thick.

The heel posts, sill timbers, and mitre posts are of greenheart, all pieces being in one length, secured to the gate by galvanised bolts; the heel posts are stiffened by strong spur plates and angles, and the sills backed by girders securely stiffened from the bottom deck. These greenheart timbers were fitted in position at the works of the builders, and, in order to ensure the greatest possible accuracy in the workmanship of all the meeting faces, the design was arranged to allow of complete sections of the gate forming the heel post, meeting post, and sill respectively being riveted and finished with the timbers fixed and delivered in single pieces, special arrangements being made at the lock for erecting the heavy weights, in some cases as much as 22 tons.

Cast steel pivots and caps are provided at the bottom of the heel posts, the former seated in dovetailed recesses in the masonry, and secured by lewis bolts, and the latter to the gates by fitted bolts, mild steel bearing blocks being interposed between the pivots and caps. The cast steel top pivots engage with forged steel anchor straps carried in heavy cast iron anchor blocks bolted to the masonry and concrete of the top of the quoins, and each further secured by three mild steel land ties carried well back into the wall, and fitted with cast iron washer plates.

Cast iron roller paths with diagonal joints are laid on the floor of the entrance, and on these travel cast steel rollers, 3ft. diameter and 16in. wide, bearing in hinged cast iron carriages, capable of adjustment from the top of the gates by forged steel spears attached to the curved skin. The spears are 6in. diameter, and are fitted with cottars.

The gates are surmounted by platforms of pitch pine, with elm curbs, carried on framed steel supports from the top deck, and provided with hatches giving access to all the interior compartments of the gates through trunks or manholes. Collapsible hand-rail standards, with two tiers of hand chain, are provided on each side of the gangways. Pitch pine fenders or rubbing pieces are bolted to the sea or flat faces of all the gates, both vertically and horizontally.

Levers are placed between the gangways and the top decks to communicate the thrust or pull, as the case may be, of the hydraulic opening and closing machines to an extension of the vertical intercostal diaphragms on the meeting post side of the centre immediately behind the roller spears. These levers, which are of massive proportions, are pivoted to a fixed point on the anchorage vertically above the centre of the hollow quoin, the gate end terminating in a turned pin in a bored hole in the extension above referred to. The point of application of the opening and closing forces is situated at 10ft. 9in. from the swinging centre, at which point a mild steel pin 7in. in diameter is provided to take the end of the connecting rod from the direct-acting hydraulic rams which operate the gates. Details of the opening lever are given in Fig. 18.

Hydraulic ejectors for clearing the air chambers of water in case of necessity are placed on the bottom decks of the air chambers, the suctions being arranged to draw at will from sumps in either of the two compartments. The valves controlling the suctions are operated from the top platforms, the pressure being supplied from dock mains through a swivel union at the top of the heel post.

Each leaf of the outer and middle gates weighs over

220 tons, exclusive of the path, pivot, and anchorage. The inner gate leaves weigh over 186 tons each. All the gates were constructed by the Thames Ironworks, Shipbuilding, and Engineering Company, Limited. The hydraulic opening and closing machinery, which is shown in the general drawing of the gates—Fig. 17—has been supplied by Sir W. G. Armstrong, Whitworth and Co., Limited.

Bridges.—The swing bridges have been supplied by Sir William Arrol and Co. The large skew swing bridge over the entrance lock is 177ft. 6in. long, the long arm being 114ft. 6in., and the short arm 63ft. The clear span is the width of the lock, viz. 90ft. The bridge, which is seen in the view of the lock in our supplement of November 19th, is of the parallel lattice girder type, the clear width between girders being 16ft. A single line railway is carried across the bridge, which is also paved for foot and cart traffic. The weight of the bridge, about 375 tons, is carried by a cross girder under the longitudinal girders, under which again are the rotating drum and the lifting ram. The bridge is lifted and rotated by hydraulic power, and auxiliary hand-power hydraulic presses and hand winches are provided for lifting and rotating respectively in the event of failure of the hydraulic power supply.

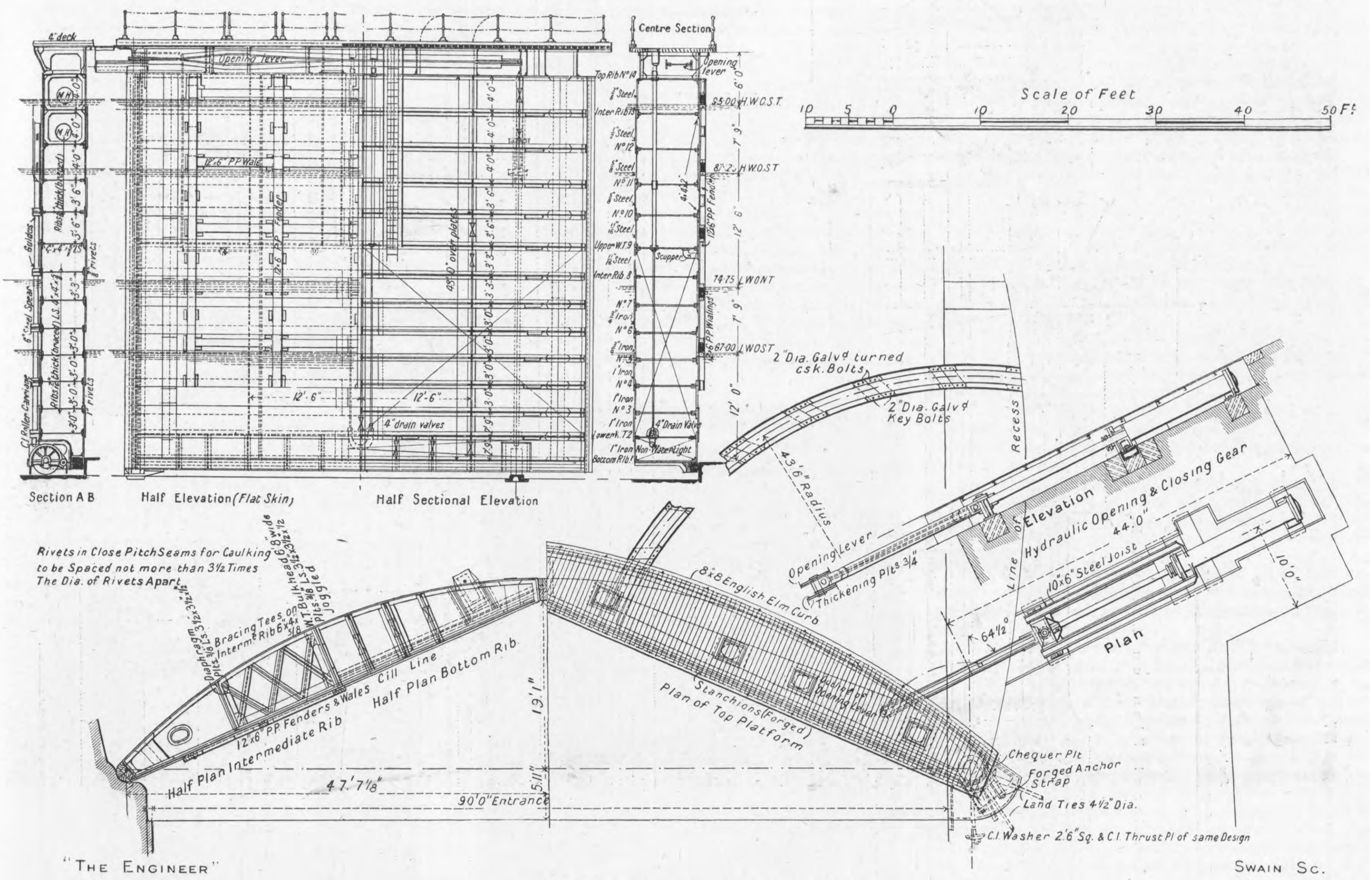
Centre Section
4" deck
Opening lever
Section A B
Half Elevation (Flat Skin)
Half Sectional Elevation
Scale of Feet
10 5 0 10 20 30 40 50 Ft
12'-6"
4" drain valves
4" Drain Valve
Top Rib No. 14
Inter Rib
Upper W.T.9
Inter Rib 8
Lower W.T.2
Bottom Rib 1
Scupper
25.00 H.W.O.S.T.
87.2 H.W.O.S.T.
74.75 L.W.O.N.T.
67.00 L.W.O.S.T.
12'-6" PP Wale
2" Dia. Galvd turned csk. Bolts
2" Dia. Galvd Key Bolts
43'6" Radius
Recess
Opening Lever
Thickening Plts. 3/4"
8"×8" English Elm Curb
Hydraulic Opening & Closing Gear
44'.0"
10"×6" Steel Joist
10'.0"
Elevation
Plan
64½°
Line of Recess
Rivets in Close Pitch Seams for Caulking to be Spaced not more than 3½ Times The Dia. of Rivets Apart.
Diaphragms
Bracing Tees on Interm Rib
Bulkhead
12"×6" PP Fenders & Wales Cill Line
Half Plan Bottom Rib
Half Plan Intermediate Rib
Stanchions (Forged)
Plan of Top Platform
19'1"
5'11"
47'7⅛"
90'0" Entrance
Chequer Plt
Forged Anchor Strap
Land Ties 4½" Dia.
C.I. Washer 2'6" Sq. & C.I. Thrust Pl. of same Design
"THE ENGINEER"
SWAIN SC.

Fig. 17—OUTER AND MIDDLE LOCK GATES

The swing bridge over the communication passage, between the Prince of Wales Dock and the King's Dock, is similar to that over the lock, except that it spans a clear opening of 70ft. only, carries a double line of rails, and is of plate girder construction. Its total weight is about 425 tons.

There are several other smaller fixed bridges in connection with the works, among them those spanning the Tennant branch canal on the north side of the dock. These bridges were supplied by Handysides, Limited, of Derby.

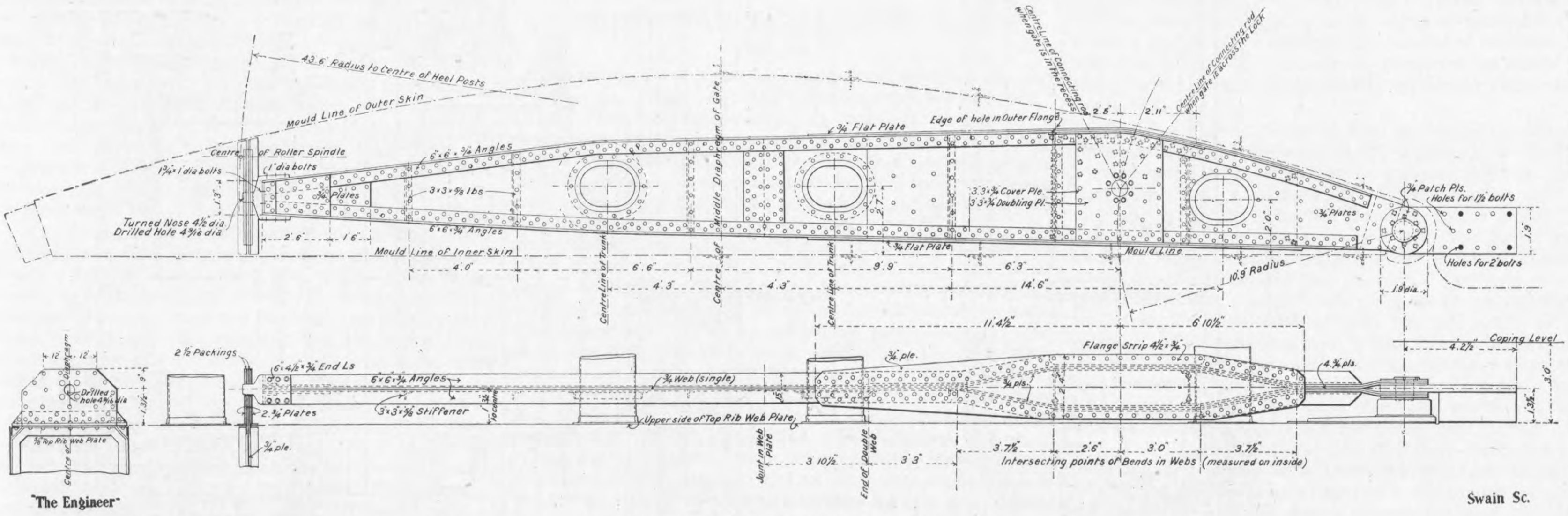
43.6' Radius to Centre of Heel Posts
Mould Line of Outer Skin
Centre of Roller Spindle
1" dia bolts
1¾" dia bolts
Turned Nose 4½" dia
Drilled Hole 4¾" dia
6×6×¾ Angles
3×3×⅝ lbs
¾" Flat Plate
Edge of hole in Outer Flange
3.3×¾ Cover Pls
3.3×¾ Doubling Pl.
Mould Line of Inner Skin
Mould Line
10.5' Radius
¾" Patch Pls.
Holes for 1½" bolts
Holes for 2 bolts
Centre Line of Trunk
Centre of Middle Diaphragm of Gate
4'.0"
6'.6"
4'.3"
9'.9"
6'.3"
14'.6"
11'.4½"
6'.10½"
Flange Strip 4½×¾
Coping Level
2½ Packings
6.4½×¾ End Ls
6×6×¾ Angles
¾" Web (single)
2⅝" Plates
3×3×⅝ Stiffener
Upper side of Top Rib Web Plate
¾" ple.
Joint in Web Plate
End of Double Web
3'.10½"
3'.3"
3'.7½"
2'.6"
3'.0"
3'.7½"
Intersecting points of Bends in Webs (measured on inside)
"The Engineer"
Swain Sc.

Fig. 18—GATE OPENING LEVER

Transit sheds.—Two single-storey transit sheds have been erected on the west wharf between the lock and the communication passage—one 400ft. long by 120ft. wide, the other 400ft. by 60ft. They are both steel-framed buildings with steel roofs, the whole covered with galvanised corrugated sheeting. The larger shed is intended for the storage of tin-plates, and the smaller one for tin-plates awaiting shipment. The span of the larger shed next to the quay is to be furnished with an electric overhead crane travelling at high speed with an inverted jib crane suspended from the crab, so as to enable bundles of galvanised sheets to be picked up from any part of the floor and deposited outside the shed, where they will be lifted by wharf cranes and dropped into the hold of the vessel. For this purpose the side of the shed next to the quay is composed entirely of doors which pass one another, so that a load of galvanised sheets can be passed out at any required point. The floors of both sheds are granolithic, with a true, smooth surface for easy barrowing.

Hydraulic power plant.—The Swansea Harbour Trustees have employed hydraulic power for working their dock machinery and cranes for over half a century, and the relative advantages of the system already employed at the docks and electric power were carefully considered by the Trustees' engineers when the time came to decide as to the system to be adopted for the King's Dock. It is unnecessary to enter into the question of the relative merits of the two systems; the pros and cons as affecting Swansea were set forth in much detail by Mr. C. S. Meik in the course of the discussion on dock equipment at the engineering conference at the Institution of Civil Engineers in June, 1907.[*] The Trustees ultimately decided to install hydraulic power for working most of the machinery of the dock, including the coal hoists, cranes, swing bridges, gate and sluice machinery, and two new power stations have been erected, one at the eastern end of the reclaimed area and the other near the Prince of Wales Dry Dock. The eastern station is equipped with three cross-compound surface condensing pumping engines, each 500 indicated horse-power, and capable of pumping 730 gallons per minute against an accumulator pressure of 750 lb. per square inch. The engines are compound, with cylinders 23in. and 45in., with 36in. stroke; the fly-wheels are 12ft. diameter. Each engine has four force-pumps of the single acting plunger type. A surface condenser is provided for each engine; circulating water is drawn from the dock and delivered into the condenser by a double-acting pump, driven off the main engine, which delivers water through the condenser on the up-stroke and lifts the return water from a well below the engine-room floor into an overhead tank on the down-stroke.

Steam for these engines is supplied by four Lancashire boilers each 30ft. by 8ft., with the adjuncts of Green's economisers, Hotchkiss circulators, auxiliary feed pumps, &c. The power-house contains room for another set of engines and an additional boiler should an extension in the future be required. The Western Station is similar in every respect to the Eastern one, except that it contains one set of engines and one boiler less. The pumping plants have been supplied by Galloways Limited, of Manchester. The pressure water is carried round the dock to the various machines in a main 8in. diameter, made by the British Mannesmann Tube Company, Limited, of solid drawn steel tubing in 36ft. lengths coupled together with wrought steel flanges, spigot and socket, and jointed with the solid gutta-percha rings usual in this class of work.

Cranes.—The whole of the hydraulic cranes in connection with the dock have been supplied by Sir W. G. Armstrong, Whitworth and Co., Ltd., who have also made the hydraulic machinery for working the gates, swing bridges

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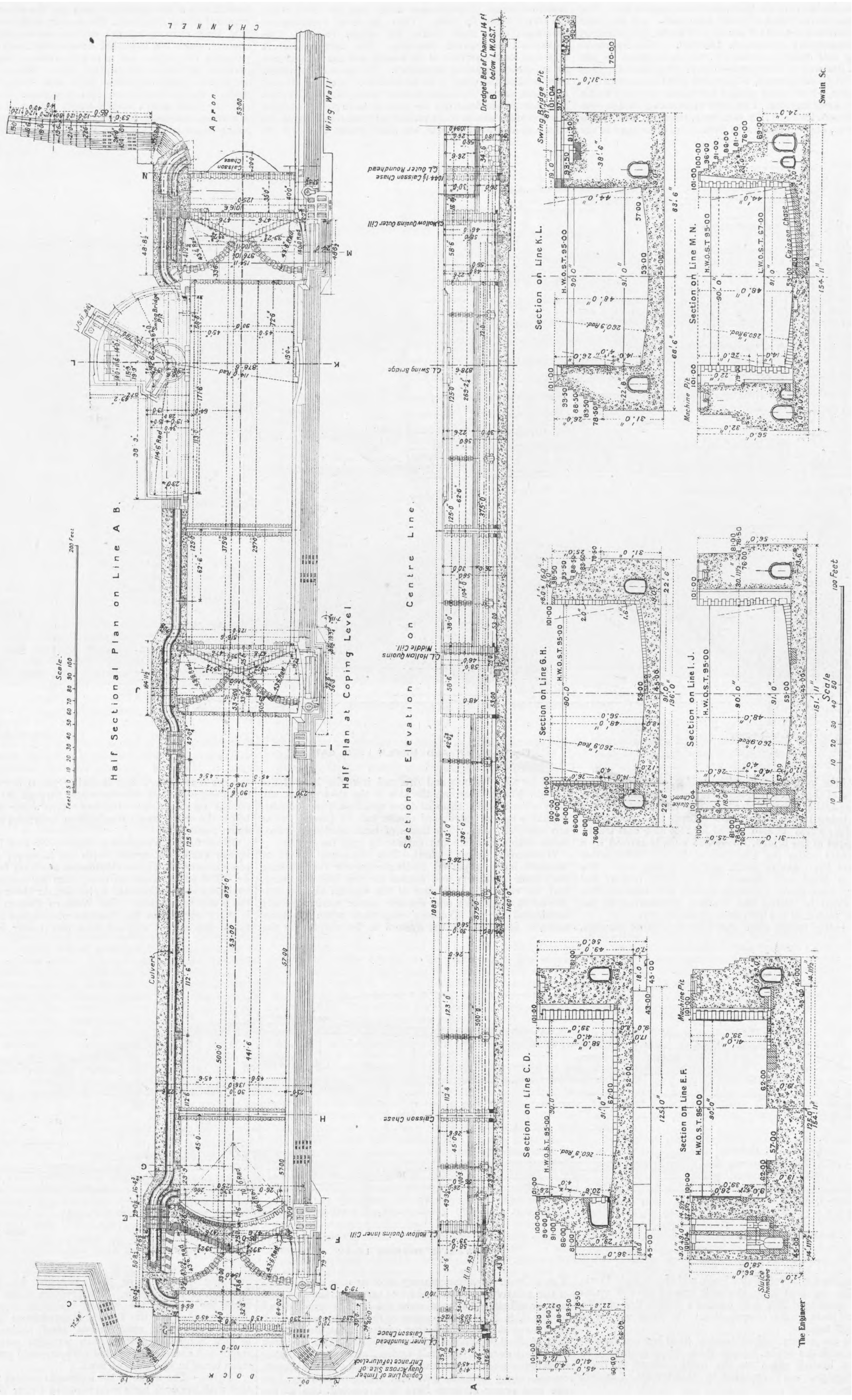
[*] THE ENGINEER, June, 1907.

THE KING'S DOCK, SWANSEA—THE ENTRANCE LOCK

(For description see page 597)


Channel
Apron
Wing Wall
Caisson Chase
Swing Bridge Pit
Half Sectional Plan on Line A B.
Half Plan at Coping Level
Sectional Elevation on Centre Line.
Dredged Bed of Channel 14 Ft below L.W.O.S.T.
C.L. Outer Roundhead
C.L. Hollow Quoins Outer Cill
C.L. Swing Bridge
C.L. Hollow Quoins Middle Cill
C.L. Hollow Quoins Inner Cill
C.L. Inner Roundhead
Coping Line of Timber Quay Across Site of Entrance to Future Lock
Culvert
Dock
Scale
Feet
Section on Line K.L.
Section on Line M.N.
Section on Line G.H.
Section on Line I.J.
Section on Line C.D.
Section on Line E.F.
H.W.O.S.T. 95.00
L.W.O.S.T. 67.00
Machine Pit
Sluice Chambers
100 Feet
Swain Sc.
The Engineer

and the lock sluices. At the north-east corner of the dock—see Fig. 3 in our issue of November 26th—a 70-ton fixed hydraulic crane has been erected. The crane, which we illustrate in Fig. 19, is provided with machinery for giving a variable rake to the jib with a minimum of 45ft. radius from the centre and a maximum of 60ft. It is capable of lifting the full load from 30ft. below to 60ft. above quay level. The pedestal is an open braced structure of steel, the four pillars of which are bolted to concrete foundations. The upper portion of the crane, consisting of the jib, framing, ballast box, and machinery, is carried on a steel platform turning about a steel centre pivot, the weight of the moving parts being taken on four steel segments—two at the front beneath the jib, and two at the back beneath the ballast box. These segments work on a ring of live steel rollers revolving on a circular steel roller path secured to a massive circular girder built into the top of the pedestal.

The lifting machinery consists of a hydraulic engine of the three oscillating cylinder type, driving through spur gearing a cast iron drum. The lifting rope, which is 4$\frac{3}{4}$in. circumference, works over a set of four to one blocks in the lifting purchase, the two ends of the rope being led over conveyance sheaves fixed in the jib head to fast ends on the drum, the arrangement being such that the stress is taken equally on eight parts of the rope. The drum has right and left handed machine-cut grooves enabling both ends of the lifting rope to be wound in simultaneously, and the drum is of such a length that no over-lapping is necessary. The lifting gear is provided with two sets of change wheels, the higher gear being capable of lifting the full working load of 70 tons at a speed of 10ft. per minute, and the lower gearing being capable of lifting a load of 35 tons with a corresponding increased speed. Clutches are provided for changing gear, and a powerful brake is also fitted.

The luffing or derricking machinery consists of two direct-acting cylinders bolted to an inclined steel frame at the back of the moving platform, the crossheads of the two rams, which work downwards, being coupled by a solid forged steel beam, to the ends of which are connected a built steel framing or stays attached to the jib head. This luffing crosshead or beam works in steel guides and is fitted with gun-metal sliding faces. The turning machinery consists of a separate three-cylinder hydraulic engine actuating through spur and bevel gearing a steel pinion engaging with a turning rack, which is attached to the lower roller path. A special brake is fitted to the turning mechanism to lock the jib in any position. The speed of turning is 135ft. per minute, measured at the jib head at maximum rake. A large steel ballast box is provided at the rear of the revolving platform, and contains ballast sufficient to relieve the centre pivot and holding down bolts of any undue strain.

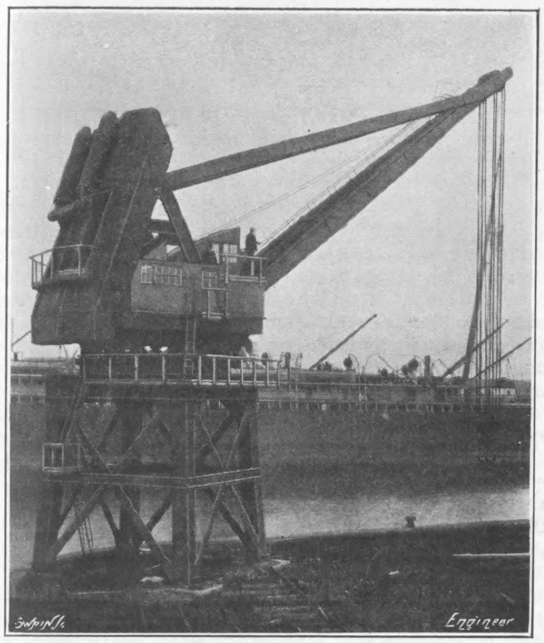


Fig. 19—70-TON HYDRAULIC CRANE

A 10-ton movable hydraulic crane is provided on the west wall of the dock. This is of the arched pedestal type, running on rails of 13ft. gauge, with a 13ft. wheel base. Hand travelling gear is provided at all four corners for moving the pedestal along the rails. The lifting machinery is of the ordinary pillar type, where the lifting cylinder and ram are contained between the pillar plates. The rake is 50ft., and the range of the lifting hook 60ft. Sixteen 2-ton movable hydraulic cranes, with fixed rake, are placed on the west and east walls of the dock. These are practically similar to the 10-ton crane, excepting as regards their power, the rake and range of lifting hook being identical in each case. On the south wall of the coaling arm four 2-ton movable cranes are provided, with luffing machinery, consisting of an inverted cylinder and ram attached to the back of the pillar. To either end of the ram crosshead are attached two wire ropes, led over conveyance sheaves at the top of the pillar to the jib head. The maximum rake of these cranes is 50ft., and the minimum 30ft. In all other respects these cranes are the same as those of fixed rake on the west and east walls.

The whole of the cranes, with the exception of the 70-ton fixed crane, are of the pedestal type, allowing trucks and vans to pass through underneath.

Electrical equipment.—An electrical plant is now being installed by the Harbour Trustees for the supply of electricity for lighting and power for their own use, and that of works, &c., on the estate. It is proposed to utilise electric power for light high-speed cranes and other machinery, hydraulic power being employed for the heavier duties. The electric plant consists of Willans-Peebles turbo alternators; sub-station equipment by Crompton and Co., Ltd.; and Lancashire boilers, economiser and superheaters by H. and T. Danks, Limited. The system of supply is 3000 volts, 50 periods, three-phase alternating current. This current will be used for motors of over 50 horse-power, and transformed down to 460 volts for motors under 50 horse-power. The current for lighting will be supplied from the various sub-stations. The high-tension current will be transformed down, by means of motor generator sets, to 250 volts direct current.

The dock quays, main roads, sheds, warehouses, &c., will be lighted by arc and incandescent lamps. Electric cranes are being erected in the sheds for transhipping the goods from the sheds to the quay, and electric cranes are to be installed on the quays of a similar type to the hydraulic cranes for the loading and unloading of ships. An electric transporter is also to be used for the transhipment of pitprops, iron ore, &c., direct from the ships to the unloading ground.

Conclusion.—The total cost of the new works when fully equipped with coal-handling appliances, warehouses, and machinery will be about £2,000,000. Mr. P. W. Meik, M. Inst. C.E., of Westminster, and Mr. A. O. Schenk, M. Inst. C.E., the engineer to the Harbour Trustees, are jointly responsible for the design and execution of the work, for which Messrs. Topham, Jones and Railton, Limited, of Westminster, are the general contractors. Mr. R. S. Oldham, M. Inst. C.E., is the resident engineer, and the contractor's agent is Mr. M. W. Henty, Assoc. M. Inst. C.E., who succeeded Mr. A. M. Smith in that position in 1908. We are indebted to the engineers and the several contractors for information, and for the use of the plans and photographs from which our illustrations have been prepared.

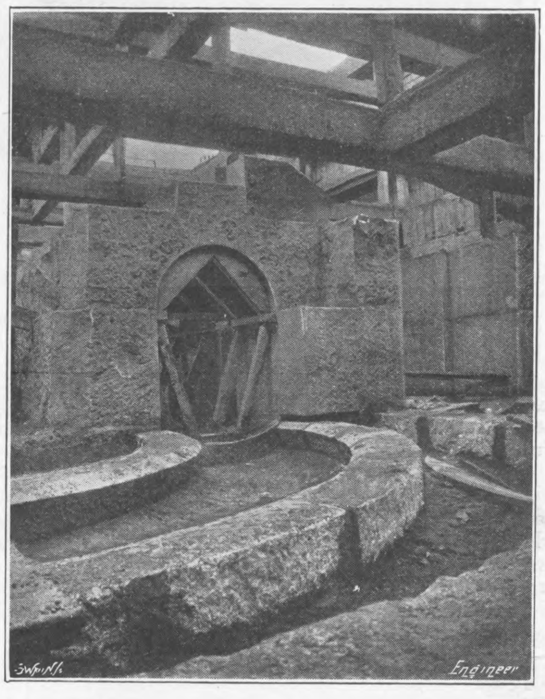


Fig. 20—CULVERT IN LOCK WALLS

Correction.—In the general plan of the King's Dock, on page 551 of our issue of November 26th, the site of the proposed lock on the north-west side of the existing lock is incorrectly described as "site of proposed dock." The deep water extension and a portion of the area adjoining it should have been shaded to indicate water.

THE GERMAN NAVAL ARCHITECTS.

No. III.*

The third paper read on the second day was one by Dr. Ing. Fr. Gebers, entitled "Neuere Propellerversuche" (New Propeller Research). It was in the main a description of apparatus used in the Uebigau tank, followed by particulars of results obtained, and by some mathematical deductions from the latter. Dr. Gebers began with a defence of the law of mechanical similarities which had lately been called in question in Germany. He showed that it would hold for the resistance of the ship itself if the water were a perfect fluid, and that under actual conditions it held for the form resistance only, the skin resistance having to be determined separately on the Froude method. With regard to the propeller, he found that the law was still more applicable, the correction required for frictional resistance being of much less importance than in the case of the hull; but he stated that for a practical demonstration of its correctness more experiments would be needed. The Uebigau tank, in which the experiments were conducted, has already been described in the columns of The Engineer—see October 9th, 1908. Its dimensions are 312ft. by 21ft. 4in. by 11ft. 6in. The maximum speed of the towing carriage is somewhat more than 16ft. per second. The work done by the propeller was measured by the help of a propeller dynamometer, made by Fuess, of Steglitz, near Berlin. Runs with the propellers of various dimensions were made at corresponding speeds. At low speeds the experiments were disturbed by the formation of eddies, which suffered air to penetrate down into the water about the propeller. In these cases the law of mechanical similarities ceased to hold. From the results given it is apparent that the efficiency of a propeller rapidly decreases when, with a given number of revolutions, the speed of motion ahead decreases; as, for instance, when the thrust is increased in towing. Taylor's statement that thrust and turning moment vary with the square of the speed was not altogether confirmed. Experiments were likewise made on the speed and direction of the particles of water surrounding a model propeller when turning and when moving ahead respectively. The results obtained were given in tabular form, but, like the propeller experiments, were declared to be still incomplete and more or less of a preliminary character. A comparison of the calculated values with those obtained in actual practice encouraged the hope that, on the resumption of the experiments, sufficient material would be obtained to enable a method for the mathematical treatment of the propeller question to be devised.

The discussion was opened by Herr Helling, of Altona, who did not believe that Newton's law of mechanical similarities would hold in the case of cavitation. Experiment had shown that the latter was comparatively more pronounced in the cases of large propellers than in those of their relatively small-scale models. He did not think that attempts to increase the speed of propellers without undue loss of efficiency would meet with success.

Geheimrat Flamm said that, in his opinion, the Gebers experiments proved that it would be possible, by the aid of scientifically and systematically conducted investigations, to increase the efficiency of the propeller—perhaps with a higher speed of revolution. Above all he directed attention to three phenomena:—

1. The retarding effect of the outermost part of the surface of the propeller blades at a speed at which the slip was equal to zero.
2. The diminution of the speed of the water flowing from the propeller near the boss, which was fully explained by the sleeve-like formation observable in the pictures of his own propeller experiments.
3. The depression of the surface of the water above the propeller, which again proved that the action of the latter was to be looked upon as exercising suction rather than pressure on the water.

Dr. Pröll, of Danzig, and, later in the discussion, Herr Wagner, of Stettin, said that the results of Herr Gebers' experiments agreed with results obtained by themselves, the former with a steam launch and the latter with models.

Dr. Förster, of Hamburg, pointed out that experiments made on propellers alone did not enable conclusions to be formed as to the efficiencies of these when fitted on their vessels.

Dr. Gebers, in his answer, said that he was quite alive to the influence exercised by the after-body of the ship on the propeller; it was necessary, however, to begin with the study of the conditions attaching to the action of the propeller itself. The complication due to the form of the vessel was too great to be taken into account at once. The cavitation phenomena in connection therewith were also quite different from those with the propeller alone, and he had for this reason refrained from drawing definite conclusions with regard to them from the results of the experiments so far made by him. Moreover, when the proceedings were suddenly stopped, he had not yet concluded his investigations in this direction.

The last paper on the list, which was read by Herr Miersch, of Charlottenburg, was entitled Schiffsantrieb, mittels Turbo-pumpen and Strahl-propeller, and dealt with the propulsion of ships by means of turbo-pumps and jet propellers. Herr Miersch entered into a detailed mathematical discussion of the merits and demerits of the screw propeller, in particular in combination with the steam turbine, when it was unable to run at the high speed suitable for efficiency. After showing that the theoretical efficiency of the screw propeller could never reach the value of unity, and that its mechanical efficiency would probably not exceed .7, he passed on to the consideration of the main subject of his paper. He said that the failure of previous attempts to apply jet propellers in combination with centrifugal pumps had been due to imperfections of the latter, which had since been removed, and further to the want of a suitable main engine. The only engines suitable for driving the centrifugal pumps required were the steam turbine and the gas turbine, the former of which at least was now available. The earlier experiments would have given better results if the suction principle had not been neglected.

The illustration given of the jet propeller showed a bell-mouthed tube through which water was to be driven by a centrifugal pump driven by a steam turbine. Round the tube was a somewhat shorter casing of from one and a-half to twice the diameter of the latter. The bell-mouth of the pipe projected into the larger end of another shorter bell-mouthed tube of larger diameter, which might be called the jet-pipe. Between the two pipes there was a considerable clearance space, through which water from without was sucked, much as in an injector. The sectional area of the stream issuing sternwards from the jet-pipe was thus considerably augmented, and passed aft with a considerable reduction of its speed. For going astern, the pipe, the bell-mouth of which was bent outwards and doubled over, was moved aft till it bore against the jet-pipe and did away with the clearance space. At the same time the entrance at the fore end of the pipe was closed and an annular passage opened for the water into the space between it and its casing. At the fore end of this space the water was diverted through a clearance space between pipe and casing, so that it issued in a direction opposite to that of the inflowing current, *i.e.*, in the direction from stern to stem, thus driving the vessel astern.

In general appearance the jet propeller was not unlike a screw propeller deprived of its blades. The smallness of its dimensions enabled it to be placed in the most suitable position in the after body for propulsion, and the case was of such strength that propeller-brackets and such like encumbrances might be dispensed with. When the vessel was moving ahead the water sucked into the jet pipe through the clearance space was diverted forwards so as to meet the sternward current from the pipe. This looked like a source of loss of energy, but Herr Miersch asserted that such was not the case. The transformation of the energy within a closed space proceeded, he said, entirely without loss. This he declared to be the leading idea in the apparatus. The arrangement of the apparatus was such that the rapid currents produced were for the most part bounded, not by the walls of the pipes, but by water, and this was considered to add materially to the efficiency of the propeller. In going astern it was estimated that sufficient resistance would be developed to stop the vessel in from one to two minutes. With regard to the turbo-pump, Herr Miersch considered that the efficiency of .8, with which it is usually credited, might be much improved upon, and sketched out a design embodying suggestions to this end.

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* No. II. appeared December 3rd.

To show the advantages of his system as regards space occupied he gave illustrations of the after end of a twin-screw passenger and cargo vessel with reciprocating engines and screws, and with turbo-pumps and jet propellers respectively, about two-thirds of the engine-room proper being apparently entirely saved in the latter installation.

Provided the jet propeller worked with a better efficiency than the screw, which he expected, Herr Miersch considered that, in view of the advantages of the combined arrangement, it would be sure to come into general use. The decision would have to be left to practical experiment. The advantages of the jet-propeller arrangement were:—Saving of weight and space; abolition of shafting, bearings, and stuffing-boxes; abolition of the circulating and air pumps, and the possibility of using the turbo-pumps to keep down the water in case of collision. The disadvantages were:—The possibility of the suction openings of the propeller becoming choked, and the chance of inaccessible parts of the jet apparatus rusting away. In conclusion, Herr Miersch asked the profession to give unprejudiced consideration to his proposals, and hoped that they might soon be realised in actual practice.

After a short discussion, the proceedings terminated.

THE SMITHFIELD CLUB SHOW.

THE engineering exhibits at the Smithfield Club Cattle Show, which was opened last Monday at the Royal Agricultural Hall, Islington, are well up to their usual standard, and all the firms which are generally to be found there are represented, most of them having stands in precisely the same positions as last year. The show is always bright and interesting, for when one tires of viewing machinery there are other fine exhibits to be seen in the form of cattle, ranging very considerably in size and power, and most of them being exceptionally well lagged; there are no "light tractors" in the cattle department.

Marshall, Sons and Co., Limited, of Britannia Ironworks, Gainsborough, have an excellent show of machinery. There is one of the firm's new oil tractors mounted on springs. This is intended for all kinds of road haulage, and it is also adapted for general farm work, such as ploughing, cultivating, hauling mowers, &c., and for driving thrashing machines, chaff cutters, and other farm machinery. Simplicity of construction and low running cost, we are informed, have been the subject of careful consideration. With paraffin at 6d. per gallon, it is claimed that an acre of land can be ploughed at a cost of 3s., and from six to ten acres of land can be ploughed in ten hours. An illustration of a tractor similar to the one exhibited is shown in Fig. 1. A 6 horse-power compound spring-mounted traction engine which is built in accordance with the latest practice, is also on view. Another exhibit on this stand takes the form of a 6 horse-power single-cylinder portable engine. The bottom of the cylinder is planed to fit the boiler, and the latter has a strong flange extending from each end, as well as at the sides, and it is bolted on the shell of the fire-box. The working pressure is 120 lb. per square inch. A large thrashing machine is also exhibited on this stand.

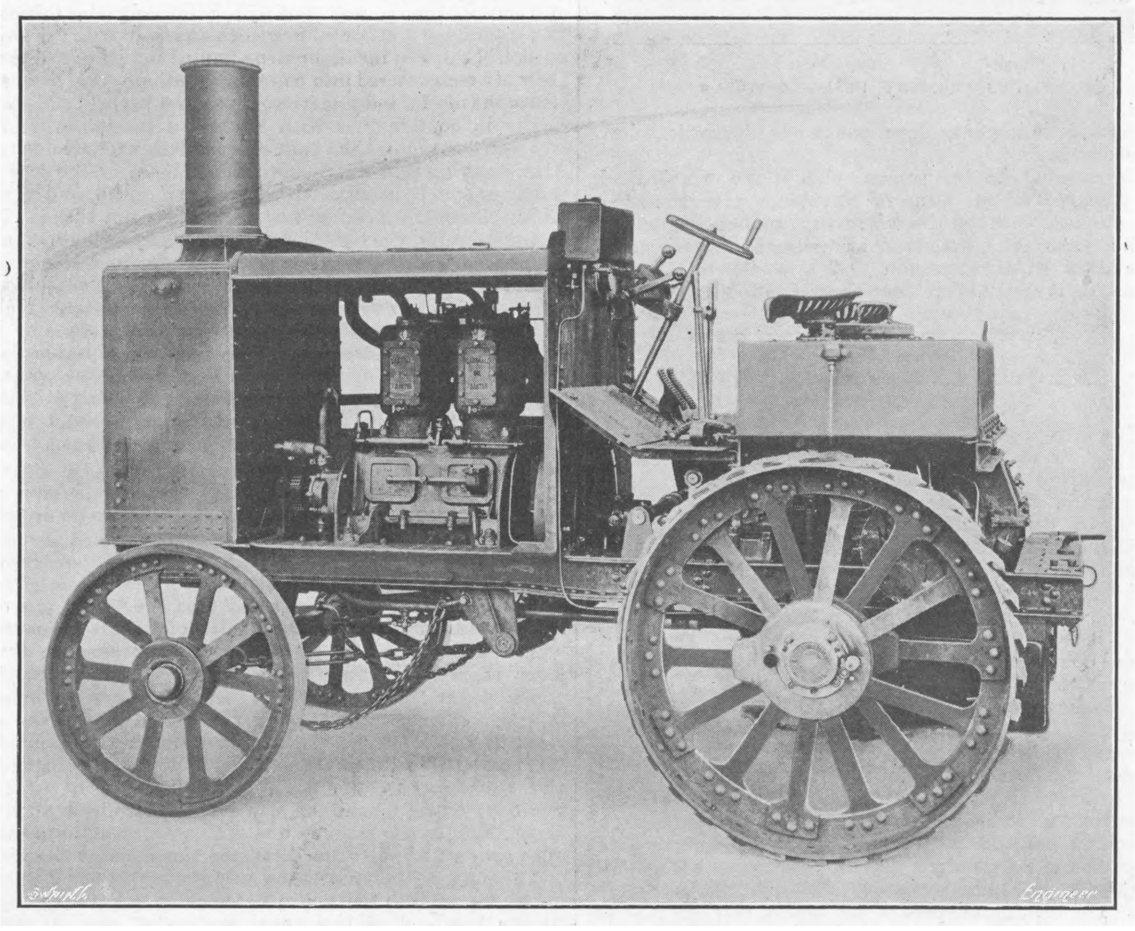


Fig. 1—MARSHALL'S OIL TRACTOR

Ruston, Proctor and Co., Limited, of Lincoln, are also showing some very creditable exhibits, and the 7 horse-power compound steam tractor, shown in Fig. 2, is one of these. It is constructed entirely on modern lines, and the finish is excellent. Among the good features to which attention may be called are—the countershaft is square, thus dispensing with keys or feathers; the steam chest is on top of the cylinder, and one cover serves for both cylinders; the working pressure is 180 lb. per square inch; with the aid of the usual starting valve both cylinders can be supplied with high-pressure steam, thus giving greater power when starting; and the engine has a large coal bunker and water tank. All motions are of extra deep section, and they are case-hardened. The travelling wheels are provided with large "tee" ended spokes of heavy section. On the same stand there is a "Ruston" double-crank thrashing machine. The method of lubricating this machine is a feature to which particular attention is directed, the firm's new ring oiler bearings being fitted to all outside shafts and spindles. The machine has an iron drum of improved pattern with extended face-plates. An improved barley awner is fitted, in addition to the usual "creeper," on the back end of the machine. In addition, the firm is exhibiting a 4ft. clover huller, a five-knife power chaff-cutting machine, and a 2½ horse-power oil engine.

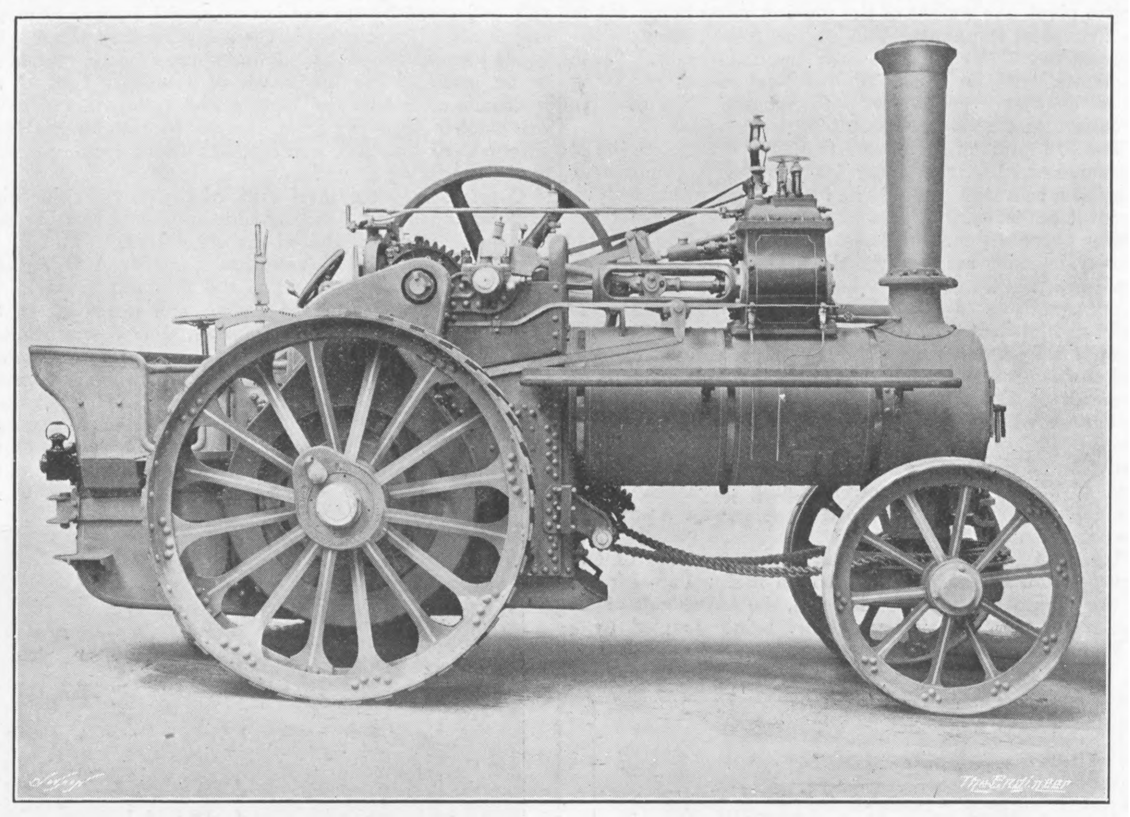


Fig. 2—RUSTON-PROCTOR'S 7-H.P. COMPOUND STEAM TRACTOR

John Fowler and Co., of Leeds, are exhibiting many things. There is a compound ploughing engine for working on the double system of steam cultivation. It is fitted with a governor and equilibrium throttle valve, so that the engine may be used for thrashing, sawing, pumping, &c. The winding drum carries 500 yards of steel rope, which is coiled on the drum by means of the firm's patented self-acting gear and adjustable rope guide pulleys. The firm's improved double-crank compound road locomotives are also shown. There is a 55 horse-power engine, also a compound spring-mounted tractor. Its weight empty is under 5 tons, and can be registered and used under the regulations of the Light Locomotives Act. The tractor is fitted with a recently patented safety clutch gear, the two speeds being controlled with one handle. When one speed is put into gear, the other gear is automatically locked, and the mechanism renders it impossible for the two speed gears to come into operation at the same time. The firm is also showing working models of various steam cultivating implements and samples of wire ropes for steam cultivation, &c.

The exhibits on the large stand of Clayton and Shuttleworth, Limited, of Lincoln, include a fine 6 horse-power single-cylinder portable steam engine, a compound steam motor tractor, an improved finishing thrashing machine, and two agricultural engines. The portable engine is of the makers' standard pattern, the outstanding features claimed for it being simplicity and economy. Little change has been made in the design of the firm's compound steam motor tractor, and it would not be easy to suggest where improvements could be made. The finishing thrashing machine is entirely in accordance with modern design, having self-oiling bearings throughout, and the firm's latest type of barley awner. The spindle of the barley awner now passes through the machine, and is fitted with a pulley at one end. From this a belt drives the small blower. This is a decided advantage over the arrangement in which the blower was driven from the riddle crank. Another improvement is that the spindle is now provided with three bearings instead of two. A much simpler method of adjusting the barley awner has also been adopted than hitherto. As regards the new features of the firm's traction engines, mention should be made of the fact that the cylinders are now fitted to a pressed steel seating riveted to the boiler instead of being mounted on the usual cast iron saddle. With this arrangement the steam enters the cylinders direct from the boiler, thereby ensuring dryness and freedom from priming. In the compound engines the high and low-pressure steam chest covers are placed at the sides instead of being above the cylinders; this arrangement, it is claimed, rendering the valves more accessible. The pumps are of the new geared type, in which the speed of the plunger is greatly reduced, with a consequent diminution in the wear and tear. The first and second motion gear wheels are fitted between the hornplates, although the cylinders are constructed with the steam chests at the sides. This has been attained by a special arrangement of the valve gear. Usually where external steam chests are employed the first and second gear is placed outside the hornplates and the engine made wider to suit these conditions.

On the stand of Richard Garrett and Sons, Limited, of Leiston, there is an exceptionally interesting exhibit, which takes the form of a single-cylinder superheated steam traction engine for driving threshers or other machinery, as well as for continuous road haulage. This is an entirely new departure in the direction of traction engine design, and the exhibit receives more than an ordinary amount of attention. As the result of many trials, we are informed, the engine has proved to be considerably more economical than those working with saturated steam. The fuel and water consumptions are said to be from 30 to 40 per cent. lower than those obtainable with the ordinary type of single-cylinder traction engine having only one cylinder. We are also informed that it shows an improvement in fuel and water consumption amounting to as much as 10 to 15 per cent. as compared with a compound traction engine using saturated steam. The coil of pipe which constitutes the superheater is placed in a chamber above the ordinary smoke-box, and out of the way of the boiler tubes. Another special feature about this engine is that it has a balanced piston valve instead of the usual flat D valve. The engine is also fitted with the firm's corrugated fire-box. On the same stand there is also a seven horse-power single-cylinder traction engine of the firm's usual type, and intended for general purposes; also a 5-ton Garrett compound steam motor tractor, an "Express" type road locomotive, and one of the firm's 4ft. 6in. heavy type patented finishing threshers.

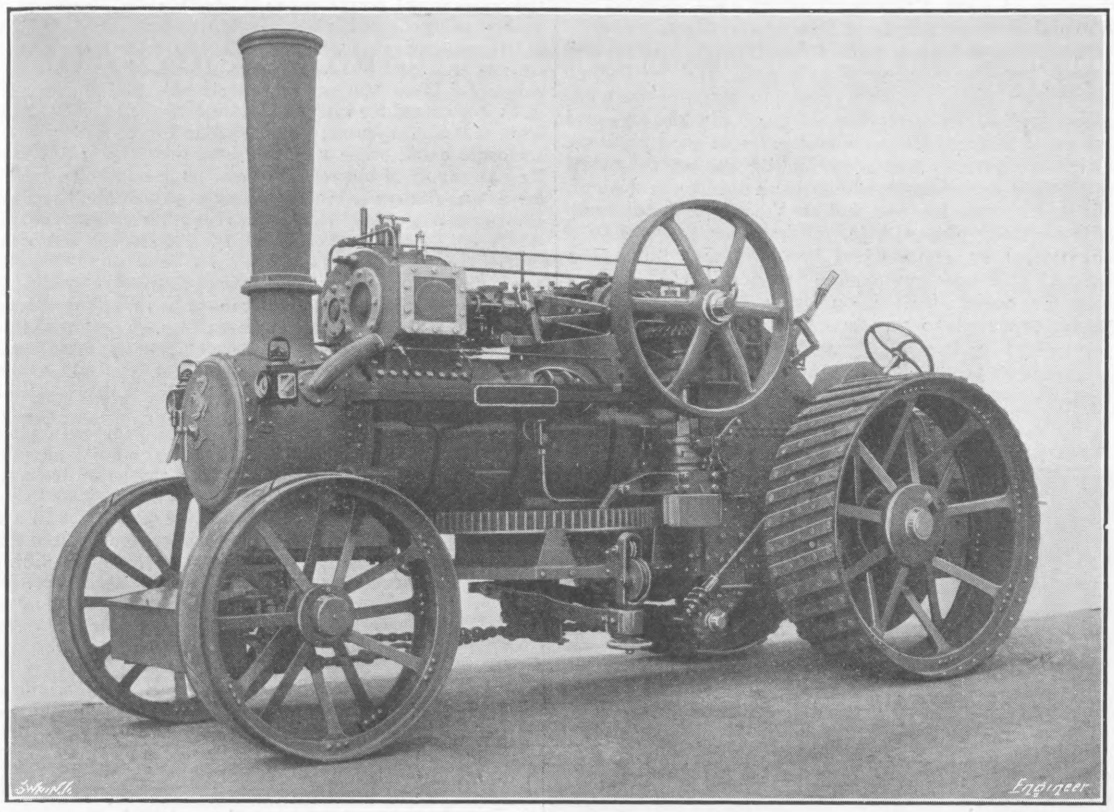


Fig. 3—AVELING AND PORTER'S PLOUGHING ENGINE

Aveling and Porter, Limited, of Rochester, Kent, are exhibiting a road locomotive, a motor tractor, and a ploughing engine. The latter, which is shown in Fig. 3, has several features worthy of attention. In the first place, it will be observed that it has a longer smoke-box than is generally fitted to engines of this kind. Several advantages, we are informed, have been gained by lengthening the smoke-box. A better draught is said to have resulted from the design, and it has been found that steam can be raised more rapidly than is possible with the engines having shorter smoke-boxes. Less fuel consumption is also said to have resulted, and lastly, the smoke-box never gets hot. It will be seen that in this engine the steam chest is at the side of the cylinders. Another special feature is that the guide pulley of the winding drum can be turned through almost any angle, thus enabling the plough to be pulled from nearly any position without moving the engine, which is an advantage in an awkwardly shaped field. A middle bearing is employed for supporting the crank shaft. The engine is rated at eight nominal horse-power. The clutch for starting and stopping the winding drum, it will be observed, is mounted on a vertical shaft driven by bevel gearing at the top.

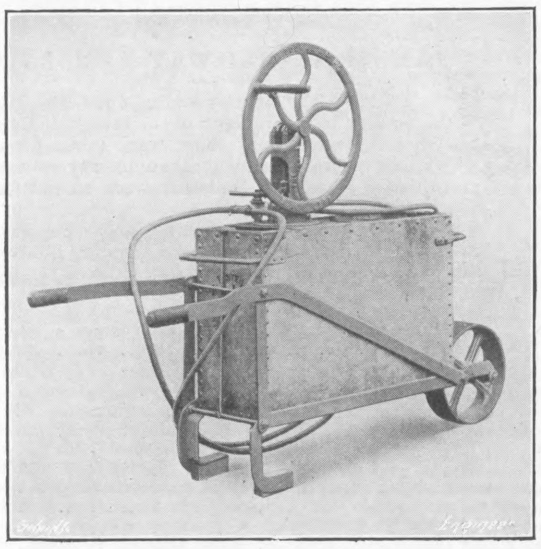


Fig. 4—SPRAYING MACHINE

James B. Petter and Sons, Limited, of Nautilus Works, Yeovil, are, as usual, exhibiting their standard oil engines and pumps. It will be remembered that this firm's oil engines belong to that class in which there is no lamp or external flame except for a few minutes when starting. The "Handy-man" engines, as they are called, work on the well-known four-cycle or Otto principle, and consume ordinary paraffin or lamp oil.

Ransomes, Sims and Jefferies, Limited, of Ipswich, are showing an extensive display of agricultural machinery, including traction, portable, and vertical engines. Also a thrashing machine, ploughs, a swath turner, horse rakes, cultivators, &c. Crossley Brothers, Limited, of Openshaw, Manchester, are also well represented, and are showing some excellent oil and gas engines, and a suction gas plant, all of which are admirably suited for agricultural service. Another firm exhibiting a gas engine and producer is that of Davey, Paxman and Co., Limited, of Colchester, and on the same stand some well finished traction engines are to be found. A good selection of oil engines are also on view on the stand of Richard Hornsby and Sons, Limited, of Grantham, who also exhibit a blinder, a straw trusser, mowers, ploughs, and a drill. The firm of Capel and Co., of 168, Dalston-lane, N.E., are represented this year, their exhibits taking the form of petrol engines suitable for agricultural and general purposes. An oil engine, a windmill, and some pumps constitute the exhibits of the firm of Ockenden Limited, of 126, Southwark-street, S.E. Pitler and Co., of 22, Bush-lane, E.C., have a well-arranged stand on which are to be found petrol engines, a horse rake, pumps, a sprayer, and other agricultural implements. Fairbanks and Co., of 78-80, City-road, E.C., are showing portable horizontal and vertical stationary engines, pumping plant, and an oil engine. Petrol and oil engines, a pump, lifting jacks, &c., are to be found on the stand of Fairbanks, Morse and Co., of 87, Southwark-street, S.E. The Campbell Gas Engine Company, Limited, of Kingston, Halifax, is well represented this year, the exhibits comprising oil engines, gas engines, and a suction gas plant.

Alfred Dodman and Co., Limited, of King's Lynn, are showing vertical and horizontal engines, a boiler, and a spraying machine. The latter, which is illustrated in Fig. 4, is useful not only to the agriculturist but to others also, for it is capable of dealing with many kinds of liquids. For example, it can be used for spraying paint for covering walls, &c. It will be observed that the machine is operated by means of a hand wheel instead of a straight lever, as is more customary. It will also be seen that the pump is driven by means of a small crank. The pump works at a high pressure, and it is capable of supplying the liquid to four jets at once. The pump is fitted with a special relief valve, so that in the event of the operator continuing to turn the hand wheel while the jets are shut off the relief valve opens and the liquid is simply returned to the tank from which it was originally pumped. Hollow gun-metal ball valves are used in pumps which are very light. A strainer is provided to prevent any foreign matter finding its way into the pump. Two kinds of nozzles are provided, one set giving extremely fine jets, whilst the other set is suitable for use with thick liquids, such as lime, &c. An efficient agitator is provided inside the tank, by means of which the liquid is constantly kept in motion. The pump can easily be removed from the tank.

Fielding and Platt, Limited, of 73a, Queen Victoria-street, E.C., are showing an oil engine, a gas engine, and a gas producing plant. On the stand of Brown and May, Limited, of North Wilts Foundry, Devizes, Wilts, there is a steam tractor, also a thrashing machine and a portable engine. A special feature about the thrashing machine is that it has three fans. The exhibits of Blackstone and Co., of Stamford, include portable and stationary oil engines, swath turners, a horse rake, turnip cutters, &c. The firm of William Allchin, Limited, of Globe Works, Nottingham, is showing a fine traction engine, provided with all the latest improvements. A traction engine, a steam plough, a ploughing engine, and some pumps are exhibited by the firm of J. and H. McLaren, of Midland Engine Works, Leeds. A steam tractor is being shown by Savage Brothers, Limited, of St. Nicholas Ironworks, King's Lynn. W. H. Wilcox and Co., of 23 36, Southwark-street, S.E., have a good display of machine belting, hose, and other goods needed by machinery users. Weighbridges, weighing machines, scales, &c., are to be found on the stand of W. and T. Avery, Limited, of 14-17, Cow Cross-street, E.C. Cultivators, windmills, and harrows are among the exhibits of the Shelby Manufacturing Company, of Rye Works, Hanover-street, Peckham.

VICTORIAN RAILWAYS.

A record result is shown in the working of the Victorian railways for the year ended 30th June last, a surplus of £235,043 being shown after meeting working expenses, interest on loans, gratuities and pensions, which has never before been achieved. The revenue in goods traffic increased by 13.52 per cent. over that of the previous year, which is practically all attributable to the favourable grain harvest. The dining car service which was started during the year on the Sydney and Adelaide express trains and on the Mildura line was a new source of revenue. Working expenses increased £123,542, which was mainly due to additional train mileage required to deal with the larger goods traffic, to advances in salaries and wages, and to the payment of £90,863 into the Railway Accident and Fire Insurance Fund, as compared with £15,667 in the previous year.

A different system is adopted with regard to the disposal of the surplus revenue on the Victorian railways to what operates in the other States. It has been the custom to pay the surplus revenue into the Railways Additions and Improvements Fund and the Railways Interest Reserve Fund, but for this year it has been decided to suspend the operation of this Act, and for the State Treasurer to allow the Railway Commissioners' interest at the rate of 3½ per cent. per annum on the amount so credited until it is made good to the two funds mentioned.

A contract was entered into with Messrs. R. W. Cameron and Co. on account of the Lorain Steel Company for the supply of 12,257 tons of 80 lb. and 1571 tons of 100 lb. steel rails, equal to about 108 miles of track at £5 7s. 9d. per ton, exclusive of duty, delivered into trucks at Melbourne.

Result of the Working Compared with the Previous Year.

		Year ended June, 1908.	Year ended June, 1909.
Average miles open		3,396	3,397
Total miles open		3,396	3,410
Cost of construction	£	41,928,567	42,485,323
Average cost per mile open	£	12,345	12,459
Gross revenue	£	3,873,368	4,178,124
Working expenses	£	2,285,897	2,409,439
*Net revenue	£	1,587,471	1,768,685
Special expenditure and charges	£	47,058	—
Interest charges and expenses	£	1,483,807	1,430,093
Pensions and gratuities	£	—	105,415
Surplus	£	52,681	235,043
Train miles		10,383,408	11,290,578
Passengers carried, number		74,907,425	81,020,620
Goods and live stock, tons		3,754,861	4,166,786
Gross earnings per train mile		7s. 5·57d.	7s. 4·81d.
Working expenses per train mile		4s. 4.84d.	4s. 3.22d.
Locomotives, tractive power, lb.		—	8,150,048
Carriage stock, floor area, sq. ft.		—	345.164
Truck stock, carrying capacity, tons		—	116,110

* Exclusive of St. Kilda and Brighton Electric Street Railway.

The Physical Society's Annual Exhibition.—This exhibition, which is to be held on Tuesday the 14th inst., will differ from that of previous years in that it will be open in both the afternoon—from 3 to 6 p.m.—and in the evening—from 7 to 10 p.m. Short discourses will also be delivered at 4 and 8 p.m. by Professor C. V. Boys, F.R.S., on "Soap Bubbles," and at 9 p.m. by Professor S. P. Thompson, F.R.S., on "Combinations of Mica and Selenite Crystals." The following firms will be exhibiting:—Bausch and Lomb Optical Company; British Radio-Telegraph and Telephone Company, Limited; Cambridge Scientific Instrument Company; Casella and Co.; A. C. Cossor, Limited; H. W. Cox and Co.; G. Cussons, Limited; the *Daily Mirror*; J. H. Dallmeyer, Limited; Elliott Brothers; Everett, Edgcumbe and Co.; Gallenkamp and Co.; Gambrell Brothers; F. Harrison Glew; J. J. Griffin and Sons; Hicks and Co.; A. Hilger, Limited; India-rubber, Gutta-percha, and Telegraph Works, Limited; Isenthal and Co.; Marconi's Wireless Telegraph Company; Leslie Miller; Muirhead and Co.; Nalder Brothers and Co.; Nalder Brothers and Thompson; Negretti and Zambra; Newton and Co.; R. W. Paul; Pitkin and Co.; the Reason Manufacturing Company; Ross, Limited; Siemens Brothers and Co., Limited; Snell and Tinsley; Strange and Graham; Synchronome Company; Weston Electrical Instrument Company; Carl Zeiss, Limited. We understand that invitations have been given to the Institution of Electrical Engineers, the Faraday Society, the Optical Society, and the Röntgen Society. Admission in all cases will be by ticket only, and therefore members of the societies just mentioned—including also the Physical Society—desiring to attend the exhibition should apply to the Secretary of the Society to which they belong.

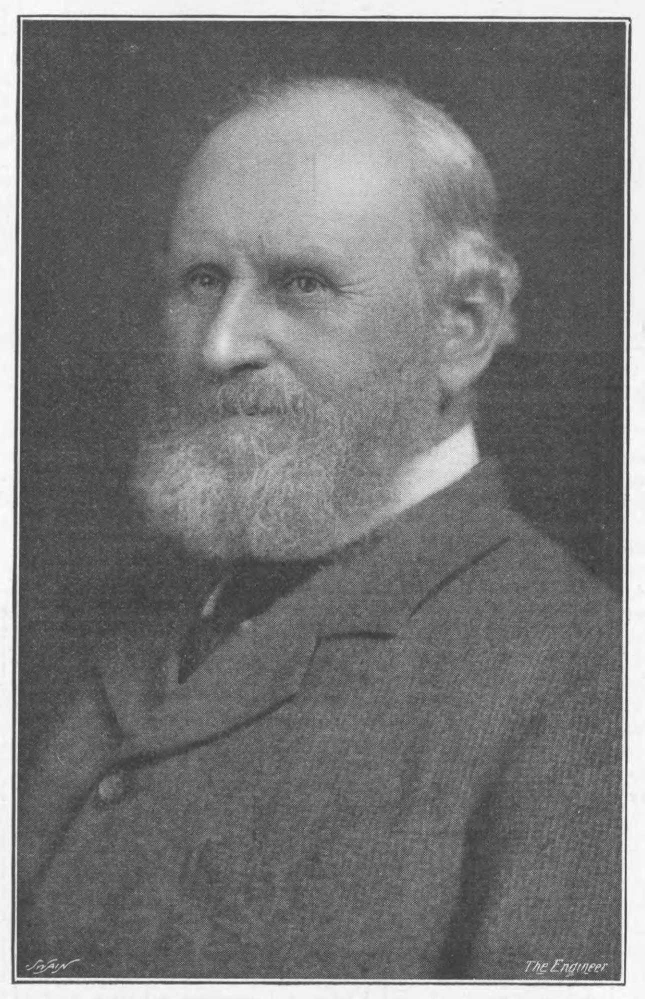
West of Scotland Iron and Steel Institute.—The annual dinner of the members of this body was held in the Grosvenor Restaurant, Glasgow, on December 4th, Mr. P. M. Cunningham presiding over a company of three hundred. Among those present were:—Mr. C. R. Askwith, K.C., Labour and Statistical Department of the Board of Trade; Rear-Admiral F. B. Adair; Mr. George Beilby, LL.D., Chairman of Governors of Glasgow and West of Scotland Technical College; Professor Magnus Maclean, Engineer-Commander G. A. Haggarty, R.N.; Mr. G. C. Lloyd, Secretary Iron and Steel Institute. Rear-Admiral Adair, in responding for "The Navy," remarked that within the last twelve or fifteen years there had grown up a naval rival to us in the North Sea such as we had not had before our eyes since the old French wars. It was a rivalry we did not fear, but it was one for which we had the utmost respect, and it was just such a stimulus as the Navy wanted. If our opponents were seeking to make a reputation, it was our Navy's ambition to pass on to successors as glorious a record as had been inherited. Dr. Beilby, in proposing "The West of Scotland Iron and Steel Institute," referred to the need for industries being better organised, more scientific, and more complete in regard to technical knowledge and skill. The British iron and steel industry was no longer the iron and steel industry of the world. New nations were coming into the arena of industrial competition, and even in the East they had Japan, India, and China all shaping towards the making of great industrial countries. Competition was now world-wide, and that could only be properly met by putting ourselves in the best possible position as to equipment, education, and scientific knowledge. Why should not the University, the Technical College, and the Iron and Steel Institute unite as one in an effort to make Glasgow renowned all over the world for its achievements in metallurgical science? Let a great strong school of metallurgy be established to which men from all parts of the world would flock.

OBITUARY.

HILARY BAUERMAN.

It is with deep regret that we have to announce the death of Professor Hilary Bauerman, which took place at his house in Balham on Sunday morning, the 5th inst. Professor Bauerman had been seriously ill for about ten weeks, and the immediate cause of his death, which took place peacefully, was heart failure.

Professor Bauerman was, apart from his other qualifications, which were not few, among the foremost authorities on mineralogy and metallurgy of his time. His whole life was spent in the study of these sciences, and his knowledge and abilities in this direction were widely acknowledged, his services being frequently requisitioned when abstruse points came up for decision. His professional career began in 1851, when he entered the Royal School of Mines, which he left in 1853 in order to proceed to the Freiberg Mining Academy, where he stayed until 1856. Before he left, that is to say, in the year 1855, he was appointed assistant geologist to the Geological Survey of Great Britain, which post he held until 1858, when he was employed as geologist to the North American Boundary Commission. This work lasted some five years, and terminated in 1863. Between the years 1863 and 1888 he was busily engaged in surveys and explorations abroad, and as showing how wide was his field of activity, we may say that the countries which claimed his attention included, besides Great Britain, Arabia, the Red Sea and the Gulf of Aden; Arizona; Asia Minor; Bengal Beraro and Kumaon; Brazil; North and South Carolina, Colorado, Granada; Lapland; Mexico; Michigan; Missouri; Peru; Portugal; Savoy and Sweden. At different times during his life he had practically visited the whole of Europe, including even the Eastern parts of Russia. His experience was consequently exceptional, and might almost be called world-wide, and being gifted with a wonderful memory, which remained to him unimpaired until his end, his fund of information concerning the subjects which he had made particularly his own was inexhaustible.



HILARY BAUERMAN

His whole life, however, was not devoted to survey. Much of it was taken up in teaching other people what he had learnt with so much assiduity. As a teacher, and especially when teaching individually, his influence was great and far reaching. As early as 1883 he was appointed lecturer on metallurgy at Firth College, Sheffield. Between the years 1874-1879 he was joint Examiner in Mining and Mineralogy for the Science and Art Department. His last official appointment was as Professor of Metallurgy to the Ordnance College, Woolwich, from which he retired in 1906 after nearly twenty years' service. An incident which occurred during this period is worthy of recording as being typical of the man. It occurred during a lecture at which a number of labelled samples of minerals was being shown and discussed. It happened that a student made his way into the lecture theatre before the lecture, and removing one of the labels, substituted for it one bearing the inscription "Bauermanite." The Professor during the course of his lecture referred to the various samples, beginning thus, "This is a piece of gneiss, this is a piece of granite, this is a piece of quartz," and so on—then taking up the "Bauermanite" sample, and without a change of countenance, "this is a piece of —— impertinence,"—and without hesitating a moment continued his reference to the remaining minerals.

So greatly were his attainments appreciated that he was made a juror in the Mining and Metallurgical departments of practically every exhibition of recent years, beginning with that of Paris in 1878 and continuing with the Inventions and Antwerp Exhibitions of 1884, that of Chicago in 1893, of Paris in 1900, of St. Louis in 1904, and lastly of the Franco-British Exhibition last year.

His literary ability was of no mean order, and his work in this direction was extensive. In addition to many important papers read before learned and technical societies, his name is perhaps best known in connection with his classical book on the "Metallurgy of Iron," and with the treatise on "Metallurgy," by Phillips and Bauerman. He was also the author of "Descriptive Mineralogy," and of "Systematic Mineralogy." For many years he was a valued contributor to the columns of The Engineer, and we may state that at 6 o'clock on the morning of the day before his death he dictated a review of the last issue of the "Annuaire of the Bureau des Longitudes." He had, at his own request, reviewed preceding issues of this work for us for a number of years. His knowledge was by no means confined to his own particular subjects, and we frequently received contributions from his pen on matters widely different from mining or metals. Indeed, his interests extended over many sciences and arts other than those with which his name is most associated. For instance, he was universally recognised as one of the highest authorities on crystallography, a subject which with him had become an absorbing hobby. He found no greater delight, and was rarely more delightful himself than when with no more appliances than an old envelope picked out of the waste-paper basket he would, simply by deft folding—accompanied always by a constant puffing and blowing, and many a joyul chuckle—develop some extraordinary figure in solid geometry. There are, we understand, amongst his remains a great number of these paper forms, and it has been suggested with a good deal of reason that they should be collected and given to some museum. That they were all made from flat paper by simple folding and cutting is a fact that always excites interest and surprise, but at the same time they are of high educational value.

Professor Bauerman belonged to many societies and institutions at home and abroad. Of these he was honorary member of three, namely, the Chemical, Metallurgical and Mining Society of South Africa; of the Institute of Mining and Metallurgy; and of the Iron and Steel Institute. He was an associate member of the Institution of Civil Engineers, a fellow of the Geological Society, and an associate of the Royal School of Mines. In 1897 he was awarded the Howard Prize of the Institution of Civil Engineers, and in 1906 received the gold medal of the Institute of Mining and Metallurgy.

As a man he was of a most charming disposition, and was much loved and honoured by a wide circle of friends and admirers. He was of a strongly artistic temperament—a trait of his character not generally known—and was a great admirer and excellent judge of good pictures. His sense of humour was keen, and he was a most genial companion on excursions—altogether a man to be desired. In his enjoyments he was unlike the majority of men. Hardly anything pleased him, for instance, more than a mathematical or geometrical problem, and he was a voracious and comprehensive reader. He had a passion for books; indeed, on those days on which he might be expected to pay us a visit we were careful to hide any valued volume, lest he should take a fancy to it and run off with it. He was perfect master of five or six languages.

GEORGE WILLIAM HAWKSLEY.

The death is announced of Mr. George William Hawksley, founder of the firm of Messrs. Hawksley, Wild and Co., Brightside Boiler Works, Sheffield. Mr. Hawksley was apprenticed to his uncle, a millwright at Owlerton, Sheffield, and subsequently went to the Hyde Boiler Works of Mr. Daniel Adamson. While engaged at Hyde he met Mr. Matthew Wild, who was then foreman in the boiler yard. In 1860 these two gentlemen started the business at Sheffield, which developed into one of the most important boiler-making establishments in the country. At a later period Mr. Hawksley purchased two extensive dye works at Wakefield and Halifax. He was in his 74th year.

HOSPITAL WARMING AND LIGHTING.

In one of the sections of the Electrical Congress at Marseilles last year some interesting papers were read, followed by lively discussions, upon the lighting of and supply of heat for all purposes, including cooking and baths, to large buildings. We have received a paper on this subject published two months ago in the journal *Gesundheits-Ingenieur*, or *Sanitary Engineer*, of Berlin. It makes a comparison of the costs of three systems for a hospital of 800 beds. The estimates are for general warming, baths, cooking, washing and lighting and workshop power. In each case there is centrifugal force-pump circulation of hot water.

In the first there are two condensing 100 horse-power cylinder steam engines, two direct-coupled 60-kilowatt dynamos, an accumulator battery, two boilers of 70 square metres heating surface each, and 2200 electric glow lamps of 16 candle-power. This installation costs £8550 in capital outlay, the interest and amortisation of which is reckoned at £831, which, with other expenditure, makes the annual expense £1306.

The second estimate is for two steam turbines with direct-coupled dynamos 60 kilowatts each, battery, four boilers of 60 square metres heating surface each, and the same electric lighting equipment. The capital cost sums up to £7550, on which the interest and amortisation is taken as £753. With working costs the total yearly cost comes to £1308, practically identical with that of the first scheme.

The third estimate is for gas lighting and gas engines for the mechanical power required, the general warming and heating being effected by special steam boilers. Two gas engines of 16 horse-power each, four boilers of 50 square metres heating surface each, and 600 Auer lamps of 60 candle-power each are supplied. Here the capital cost is only £2750, on which £273 is assumed for interest and amortisation. The working costs of the gas systems alone are found to be £780; but, on the other hand, other working costs, including extra pumps for the supply of hot water to various parts of the building, are £468. Thus the total costs per year are £1521. This is 16.3 per cent. greater than either of the other two schemes. This result illustrates the fact that in engineering the smaller capital cost often means the greater total annual expense. The paper shows the general arrangements only by diagram, and the merits of such designs cannot be judged except upon information as to details. Although we agree that the main conclusion is correct in general direction, we must admit that the arithmetic of the estimates presented is not convincing. We are no sticklers for arithmetical exactitude, and especially in this class of work it is quite impossible to calculate accurately the various quantities required. But when it comes to an emphatic declaration that $3\frac{1}{2} \times 36 = 120$, we do not hesitate to stand by the opinion that a 5 per cent. error in arithmetic is worth avoiding in a calculation in which three-figure data are assumed, such as 13.8 kilos. steam per horse-power hour. Again, we show above an 16.3 per cent. difference in annual cost, whereas this light-footed reckoner gaily states the same difference as 30 per cent. The error in this last is 84 per cent. Nevertheless, the author is at pains to consider with some minuteness the difference between the two above-mentioned figures, £1306 and £1308, and to explain that it is "practically counterbalanced" by the less costly foundation needed by the turbines and by the greater heat wastes in the reciprocating engines; two variations which he has left out of account and which we may assure him would amount to much more than £2 per year. His "interest and amortisation" calculations are also somewhat primitive. He keeps to the pleasing factor of 10 per cent. for *all* items, engines, turbines, dynamos, batteries, gas and electric lamps, pipage, pumps, tanks, reheaters, &c. &c., except buildings, which he takes at 7 per cent. All these items are calculated separately and with great care, but all at 10 per cent. In scheme II. and III. he omits all wages, while inserting £60 for this item in I.; and yet both items and totals are run out to 10s.

We ought to say that these estimates are for low steam pressure, only 6 lb. per square inch above atmosphere, with surface tube condensers. The fuel is taken as hard coal at 20s. per ton for I.; coke at 25s. per ton for II. and III. In I., 22 lb. of steam are allowed per horse-power hour, and 30 lb in II. The summer lighting is assumed to use $\frac{3}{10}$ the kilowatt-hours of energy required for the winter period of 200 days.

AMERICAN RAILWAY ACCIDENTS.

During the quarter ending June 30th last, according to the Bulletin of the Interstate Commerce Commission, there were fewer people killed in train accidents than in any previous quarter since the Bulletins were commenced eight years ago.

The figures are as follows, and comparison may be made with the corresponding quarters of the years 1907 and 1908, if The Engineer of October 23rd, 1908, be referred to:—

	Passengers.		Trainmen.	
	Killed.	Injured.	Killed.	Injured.
Collisions	1	355	17	272
Derailments	6	715	49	315
Miscellaneous train accidents, including boiler explosions	—	16	4	201
Total train accidents	7	1085	70	788
Coupling or uncoupling	—	—	16	277
Other work about trains	—	—	14	2243
In contact with overhead or side structures	—	6	15	191
Falling off engines or cars, or in getting on or off	27	787	54	1255
Other causes	10	8:8	35	207
Total other than train accidents	37	1651	135	4173

The same Bulletin gives the advance figures for the fiscal year which ends on June 30th, 1909. The corresponding figures for the years 1905, 1906, 1907, and 1908 may be found in our issue of June 18th last. The figures for 1909 are:—

	Killed.	Injured.
Passengers—		
In train accidents	131	5,865
Other causes	204	6,251
Total	335	12,116
Servants—		
In train accidents	520	4,877
In coupling accidents	161	2,353
Overhead obstructions, &c.	75	1,229
Falling from cars, &c.	481	10,259
Other causes	1218	33,086
Total	2456	51,804
Total passengers and servants	2791	63,920

RAILWAY MATTERS.

Considerable importance is attached in Ottawa to the opening of the Canadian Northern Quebec Railway, over which the first train between Quebec and Ottawa ran on Monday last.

At a number of its more important stations, such as Howrah, Asansol, Moghal Sarai, Sutna, Allahabad, Jubbulpore, and Delhi, the East Indian Railway is erecting new turntables with a larger diameter to suit the heavier types of locomotives recently put to work. These turntables are to be 60ft. in diameter.

According to the *Railroad Age Gazette*, the Mexican Railway, which recently equipped thirty of its locomotives to burn oil, has been unable to get an adequate supply of this fuel, and has had eighteen engines reconverted into coal burners. The oil company which failed to carry out its contract, it is reported, bears the expense of the change.

According to the *Industrial World*, Pittsburgh, the bids recently received for the supply of ten locomotives for the Argentine Northern Railway were as follows:—Henschel and Sons, Germany, 9860 dols. per engine; the American Locomotive Company, 9742 dols. per engine; Havre Forges and Foundry Company, 9950 dols. per engine; North British Locomotive Company, 10,104 dols. per engine; Baldwin Locomotive Works, Philadelphia, 10,365 dols. per engine.

At a meeting of the North-Eastern railwaymen of all grades held at Middlesbrough on the 5th inst., to consider the concessions granted to the workmen under the recent award of Sir James Woodhouse, respecting wages and working conditions, general dissatisfaction was expressed with the award, and a resolution was carried by 155 votes to 20 declaring that the terms of the award were an insult to the intelligence of the men and a mockery to their labour, and that a conference be called to enforce a standing day of eight hours for all grades.

The railway which is being built round the Hangchow Bay to Ningpo is wholly a private Chinese enterprise. On the first 37 miles from Shanghai south-west, which were opened last May, there are ten stations and forty-eight bridges. The country is nearly level, and the numerous rivers to be crossed form the chief obstacle. The rails came from the works near Hankow, the sleepers from Korea, the rolling stock mostly from America, with one of the four locomotives from Germany. The cost of the completed part was about £8100 per mile.

The work of extending the electric zone of the New York Central Railroad as far as North White Plains is proceeding quite rapidly, and it is expected that by the first day of next year it will be in full operation. The temporary terminus at Wakefield, where steam and electric locomotives are interchanged, will then be abandoned. The new sub-station is being erected at Tuckahoe and another one at White Plains. Each will be equipped with three 1000-kilowatt rotary converters and nine single-phase transformers of 375 kilowatts capacity each.

The question of sleepers is receiving some attention in India just at present. The Oudh and Rohilkhand State Railway is experimenting with some Californian red wood sleepers, supplied by a San Francisco company. These sleepers measure 9ft. 6in. by 10in. by 5in. It is difficult to understand why it should be necessary to go so far for the timber. Some of the Burmese woods—if nothing nearer could be obtained—would provide excellent material. Indeed, the Burma Railway Company has just placed an order for 100,000 sleepers made of Burmese Pynkado timber.

The Pennsylvania tunnel system from Harrison, N.J., to New York City and Long Island was, says the *Engineering News*, traversed by the first official train on November 18th. President McCrea, of the Pennsylvania Railroad, Vice-president Rea, and a number of other officials and guests made the trip. As the electric equipment is not ready, a steam locomotive had to be used. The tunnels themselves are completed, but work is still in progress on the New York terminus and the Long Island yard, and the electric line equipment has yet to be placed. The company has stated recently that the whole system will be opened to traffic by June, 1910.

The Battle River Viaduct of the Grand Trunk Pacific Railway, $675\frac{1}{2}$ miles west of Winnipeg, completed in December, 1908, is a steel-plate girder viaduct 2772ft. long between abutments nd 184ft. high from base of rail to low water, or about 139ft. average height above ground. It comprises a 150ft. deck truss span crossing the main part of the river channel, one 70ft. plate girder span and fifty-one 50ft. plate girder spans, resting on twenty-six steel towers. Thus the tower spans are of equal length with the intermediate spans, *i.e.*, 50ft. The substructure is of concrete, the two river piers and most of the land footings being founded on piles.

Notwithstanding the general depression characteristic of the year, says a consular report from France, the gross earnings of the six great French railways companies amounted to £65,480,000, compared with £64,280,000 in 1907. Among the several companies the largest amount fell to the Paris, Lyons and Mediterranean, with a length of line of 5962 miles, its gross receipts being £20,544,000; next in order was the Orleans Railway, with 4614 miles of line and receipts £11,033,000. The third place was occupied by the Northern, whose receipts amounted to £10,969,000 on 2356 miles. On the Eastern Railway, with 3128 miles, the earnings were £9,236,000. The Western Railway, with 3690 miles, came fifth with £8.711,000, while the Southern Railway realised £5;025,000 with 2156 miles of lines.

Instead of one southern division of the Midland Railway there will in future be a southern and western division, and the directors have appointed Mr. Harry Powell Miles and Mr. Frank H. Frere respectively to have charge of these. Mr. Miles's most important work has been done as resident engineer in charge of the construction of the southern section of the New Mills to Heaton Mersey line, which includes the Disley tunnel, $2\frac{1}{2}$ miles in length; the West Riding lines between Royston and Thornhill, and the Huddersfield Railway. Mr. Frere was connected with the Liverpool Overhead Railway and the Great Central Railway extension to London, which included the Catesby tunnel. He was appointed resident engineer on the Midland Railway in 1899, and had charge of the widening of that company's system from Trent Station up the Erewash Valley to Pye Bridge, a length of about 14 miles, of the reconstruction of the viaduct over the river Trent near to Trent Station, and of the remodelling and rebuilding of Nottingham Station, a work of considerable magnitude.

Commenting on a recent discussion by the New York Railway Club on surprise and efficiency tests, an American contemporary remarks that even the best of automatic signals cannot prevent collisions. It is necessary to take account of the train crew, as is well shown by the statistics published by the Interstate Commerce Commission. In these it was seen that out of the 152 preventable collisions and derailments during two years, 21 cases were due to negligence on the part of drivers to observe signals. It must be conceded, therefore, continues our contemporary, that the best of signal systems, maintained by a good staff of properly paid men, must be supplemented by something which will teach the drivers the importance of observing all rules and signals. Up to the present there has been nothing devised so good as surprise tests, by which the manner in which signals and rules are obeyed is actually examined and recorded. It is a troublesome and exasperating thing to do, but so is the surprise fire drill required once a week on all passenger steamships.

NOTES AND MEMORANDA.

The telescope which is being installed in the Transvaal Observatory will be the second largest in the British Empire. It will be 35ft. long and have an aperture 26in. in diameter.

Letters can now be automatically registered in Berlin by an automatic penny-in-the-slot machine placed in the post-offices, which specially stamps the letters and saves the sender from waiting.

Cotton-seed and cotton-seed cake have been, we hear, very successfully used for the generation of gas to drive a 30 horse-power gas engine in Nigeria. Six hundredweight of cake is sufficient for nine and a-half hours' running.

What is declared to be the largest and most expensive leather belt ever made for driving purposes has been recently shipped from New York. The belt is 240ft. long, 6ft. wide, three-ply thick, and was constructed at a cost of £1200. To make the belt the hides of 540 steers were required.

In his opening address, recently delivered before the Leeds local section of the Institution of Electrical Engineers, the President, Mr. W. M. Rogerson, gave some details as to the reduction in the cost of producing electrical energy during recent years For this purpose he compares the data of 1898 with those of 1908. In the former year, taking six typical generating stations, he finds that the average cost per unit sold was 1.85d. In 1908 this figure, taking the same generating stations, was reduced to .78d.

Some excellent work has recently been carried out by steam navvies on the Panama Canal One navvy working in the Culebra district excavated 45,694 cubic yards of earth in twenty-six working days. A steam navvy working eight days in the Culebra district and eighteen days in the Empire district excavated 16,755 and 26,518 cubic yards respectively—a total of 43,273 cubic yards, the second best record for the month. A third in the Culebra district made a record for one day by excavating 2549 cubic yards of rock and earth.

"Failure of a fly-wheel," says our American contemporary, *Power and the Engineer*, "usually begins by the starting of a minute crack on the under surface of the rim at the point of greatest stress, viz., near the ends of the arms adjacent to the rim joint. The cracks gradually deepen until failure occurs, with all its disastrous consequences. These minute cracks are visible to an experienced eye, and careful inspection will aid materially in the prevention of fly-wheel explosions." Our contemporary would seem to have had quite an extensive experience with this class of accident.

At Haltem, in Westphalia, near the site of the Aluso fortress, erected by Drusus in the year 11 B.C., was recently found a bronze vessel containing a dried black mass, which Professor Kassner has decided to be Roman ink. The mass was found to consist chiefly of soot and tannate of iron. It also contained smaller quantities of ferric oxide, copper oxide, clay, magnesia, gypsum, phosphoric acid, carbonic acid, alkalies, and sand. These ingredients probably represent chiefly accidental impurities which have found their way into the old inkstand, but some of them may be due to the chemical action of the ink on the bronze vessel. The presence of an aromatic substance suggests that the ink was imported from Italy, where the use of perfumed ink was common.

Ten years ago 93 municipalities had electric generating stations, which had cost £5,734,938, while about 70 companies had expended a total capital of £5,261,763 in the same direction. At the end of 1908, which is the latest date up to which the returns are available, there were 541 undertakings, 338 of which belonged to local authorities and 203 to companies or private individuals, the total capital involved being £40.016,300 and £40,722,000 respectively. The capital laid out both by private companies and local authorities had, therefore, increased in about equal proportion. The total lamps connected, equivalent to 8 candle-power, ten years ago, were 4,106.727, and these had increased in 1908 to 35,056,700, while the output in Board of Trade units sold both by companies and municipalities had increased in this time from 60,125,500 to 749,594,200.

The Indian Meteorological Department collects and distributes current weather information, supplies climatological data, sends storm and flood warnings, and provides time signals. It also aims at ascertaining facts which shall be of practical usefulness in future, and includes the experimental and theoretical examination of the physical processes, alike on the earth or the sun, which determine the weather. It has lately published a meteorological atlas of the Indian seas, which contains a large amount of information valuable to ship captains. It has also recently opened additional stations, which have made it possible for storm warnings to be given with decidedly greater efficiency. On the scientific side, the investigations of the electrical conditions of rainfall undertaken by Dr. Simpson have led to definite and important results. He claims to have discovered the long-sought explanation of thunderstorms, and shown that it lies in the breaking up of drops of rain carried upwards by air currents and the consequent formation of a strong positive charge on the rain with a negative charge in the air.

Discussing the question of the "Water Supply for the Lock Canal at Panama," in a paper read before a recent meeting of the American Society of Civil Engineers, Mr. Julio F. Sorzano sought to prove that during the three or four months' dry season on the Isthmus the various leakages and necessary uses of the canal and its structures would so reduce the water level of the lake at Gatun that it would be impossible to maintain in the canal the 40ft. depth which the present design prescribes. The various causes of loss of water were given as follows:—Surface evaporation, border evaporation, percolation through the bottom and sides of the reservoir, lockage water, normal waste contingent to lockage, water for hydro-electric plants, structure leakage and waste, accident losses; and, finally, a general grouping of miscellaneous losses, such as the needs of the local population and industries, the uses of passing vessels, &c. A computation was given in the paper which proved to the satisfaction of the author that all these leakages and necessary uses would so reduce the water during the dry months that the capacity of the lock canal during that time would be less than would be sufficient for twenty round trips a day, and that at no time after the first month of that dry period would a 40ft. draught be available.

In a paper read before the Institution of Electrical Engineers by Messrs. G. Wilkinson and R. McCourt reference is made to the economy which can be obtained in the case of arc lamps by substituting large candle-power metallic filament lamps, and also to the fact that the smaller metal lamp may be used as a most effective competitor against the incandescent gas mantle for side-street lighting. From the result of many photometric tests of gas mantles in the roadways it is proved, the authors state, that the average candle-power of a 3ft. incandescent gas mantle does not exceed thirty candles, while with metallic filament lamps 30 candle-power can be obtained for 33 watts. Taking the price per unit for street lighting purposes at $1\frac{1}{2}$d., the price per hour for 30 candle-power is $\frac{50}{1000}$d. Taking the price of gas at 2s. $2\frac{1}{2}$d. per 1000 cubic feet, the cost of 30 candle-power per hour is $\frac{80}{1000}$d., so that for 1000 hours the cost of electricity is 4s. 2d., against 6s. 8d. for gas, but the renewals in the case of electricity (assuming the life of the lamps to be 1000 hours) cost 3s., and for gas (assuming the life of the mantles to be 400 hours) cost 10d., making the totals—electricity, 7s. 2d.; gas, 7s. 4d. These figures do not include the extra cost of labour in the renewals of the gas mantles nor the cost of breakages of chimney glasses, which frequently occur, nor the extra cost of cleaning the gas lanterns.

MISCELLANEA.

As we go to press, we regret to learn of the death of Mr. Edward Tangye. He was one of the five brothers who founded the well-known firm of Tangyes Limited, Birmingham.

There was a rumour on Thursday afternoon, though it lacked official confirmation, that the Thames Ironworks Company, Limited, is to receive an order for building one of the new Dreadnoughts.

The longest masonry span in the world is said to be the Grafton Bridge, now being completed by the city of Auckland, New Zealand. It is 910ft. long and 40ft. wide, and the middle arch has a span of 320ft., and a roadway elevation of 147ft. above the lowest part of the valley which it crosses.

The Secretary of the Institution of Mechanical Engineers requests us to announce that applications for grants from the Bryan Donkin Fund, in aid of original research, must be sent to the Council as soon as possible. The first award will be made in February and the amount available will be £27. Conditions of the award can be obtained on application to the Secretary.

According to *Indian Engineering*, arrangements are being made in connection with Sind irrigation for immediately throwing a dam across one branch of the Lyari River. The work is to be carried out at an estimated cost of Rs. 141,810, of which the Karachi Port Trust contribute Rs. 65,000 and assume liability for half of the cost of any pitching which may be necessary within five years of completion of the dam.

The Washington Aqueduct, after forty-six years of of service, is in excellent condition, according to the last annual report of Major Jay J. Morrow, of the United States Corps of Engineers. This aqueduct crosses 26 valleys on 4 bridges and 22 embankments containing culverts. The only signs of deterioration were found, it is reported, in unlined portions of the conduit where a small quantity of rock had fallen from the roof and side walls. It was noted that the mortar in the brick masonry in the lined sections, although inferior to present-day Portland cement, had not been washed out of joints to any great extent. Recent experiments showed that 90,000,000 gallons per day is about the maximum carrying capacity of the aqueduct.

The depth of water in the middle of the Berlin Stettin Canal will be 3 mm. (9·84ft.), and the breadth at the surface in ordinary soil 33 mm. (108·24ft.). In soft, peaty ground it will be from 37 mm. to 38 mm. (121·4ft. to 124.6ft.). For a distance of 16 miles the bed and banks of the canal will have to be puddled with clay, the surface of the canal there being above the water-level of the surrounding country. At one point the canal crosses the valley of the river by an embankment provided with a culvert 160 mm. in length. The eleven locks for the descent into the Oder Valley are begun. One of them has a fall of 9 m. (29.52ft.). The question of building a lift besides the series of locks has not yet been decided. The 37 canal bridges are all to be built of steel.

During the heavy storm last week there were several disastrous wrecks. Among the most sad of these is that of the Ellan Vannin while she was on a journey from the Isle of Man to Liverpool. For some time the fate of this vessel was uncertain, but later on the position where she sank in the Mersey Channel was discovered. There are at present various theories as to how the accident occurred. A diver who was sent down to make an examination gave it as his opinion that she had been swamped by a heavy sea. Other theories were that she collided with one of the flashing light buoys, and another that a disablement of the steering machinery was responsible for the accident. A later report states that a further examination by divers has shown that the ill-fated vessel had broken in halves.

A collapsible steel dam has, says the *Engineering Record*, been in use for some time in Bear River Canyon, near Garland, Utah, about thirty-five miles above the point where this stream empties into Great Salt Lake. It is essentially a steel crest, built upon an existing crib dam of the Utah Sugar Company, which may be lowered to reduce the water level on the upstream side and enable driftwood and floating matter that might injure the structure to be carried off. In order to place the steel dam in position it was necessary to cut down the old dam 5ft., so that when the steel portion had been built its crest was at the same height as that of the original dam. The steel addition is hinged to the main structure in such a way that it may be folded into a longitudinal pocket or slot, reducing the height about 4ft. and eliminating the danger of water cutting around the ends of the structure during floods and washing out the canals and headgates.

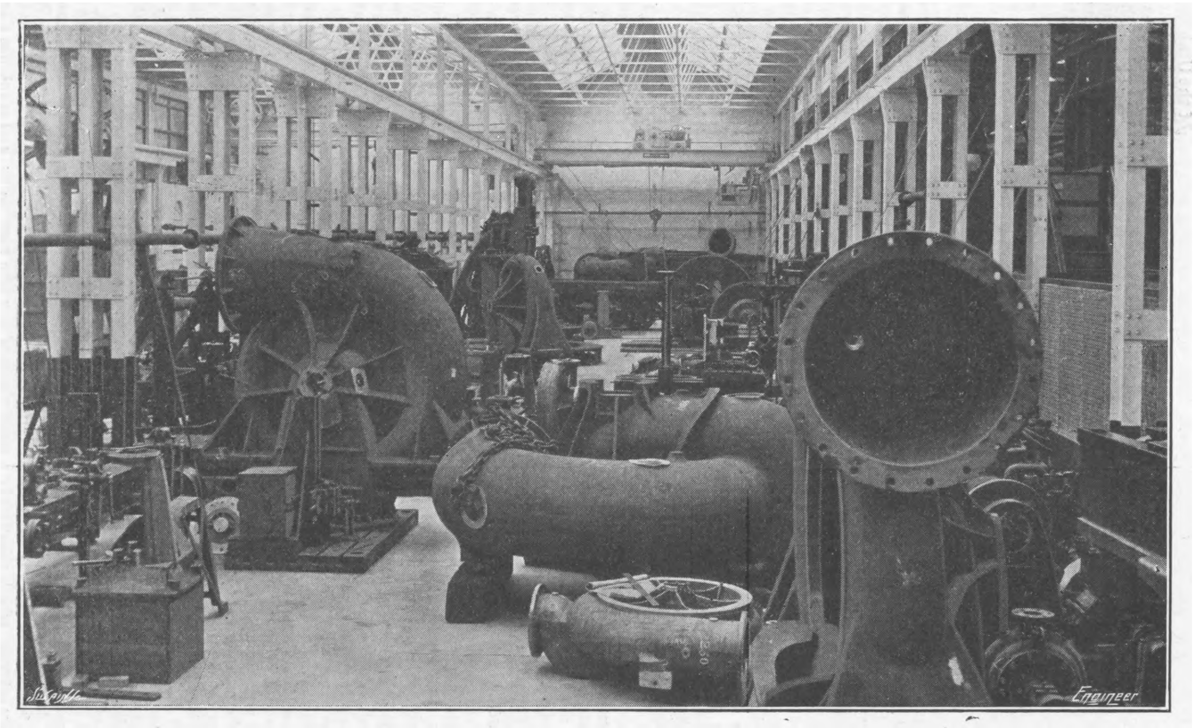
The United States battleship North Dakota on her official trials considerably exceeded her contract requirements. The contract speed was 21 knots. On her three hours' full-speed trial she did 21.64 knots with 31,400 shaft horse-power. Her maximum shaft horse-power developed was 35,150, while the maximum speed on a mile, uncorrected for tide, was 22.25 knots. A good deal of interest centres in the increased steaming radius made possible by the high efficiency of her Curtis turbines. With a coal consumption of 105 tons per 24 hours at the ordinary cruising speed of 12 knots, as compared with 111 tons burned on her sister ship the Delaware, fitted with reciprocating engines, it is possible for the North Dakota to steam further without recoaling. We understand that calculation from results of her trials have shown that her steaming radius at 12-knot speed is 9000 knots, while at 19 knots it is 4600 knots, and at the maximum speed of $21\frac{1}{2}$ knots it is 3000 knots.

The whole of the ten 12-in. Mark XI.-XII. B.L. 50-calibre, 67-69-ton guns, forming the main armament of the battleship Collingwood, at Devonport, are, says the *Western Morning News*, now in position on board, together with their working machinery and protecting shields, representing a combined weight of nearly 3000 tons. The expeditious manner in which the outfit of the last pair of barbettes were handled is worthy of commendation, and reflects much credit on all responsible for the movement of the weapons and their mountings. The celerity displayed will be understood from the fact that each of the turntables, weighing 160 tons, was placed in position on board in less than half an hour. The forward state of the boiler-rooms has enabled steam to be raised for working the hydraulic machinery, thus enabling the barbettes to be moved round as required for making adjustments. The last of the 4-in. guns are ready for lifting into position, and it is expected that the entire gun armament will be completed by the middle of the month.

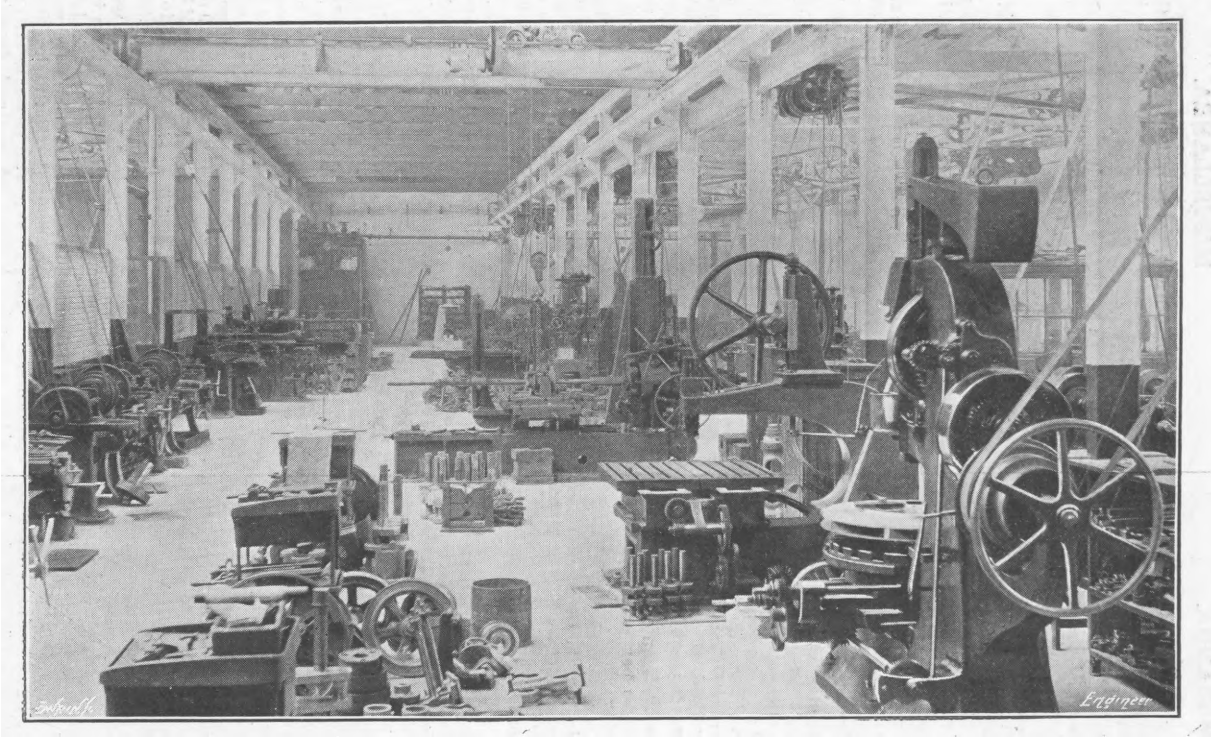
"In the first nine months of this year," says the *Sheffield Daily Telegraph*, "while thousands of our iron and steel-workers have been tramping the streets wageless and hungry, we imported from foreign countries £5,860,000 worth of iron and steel. At least half that value, in one form or another, represents wages. Taking the average iron and steelworker's wage at 30s. a week, we find that nearly 50,000 foreign workmen have had employment in the production of iron and steel goods for our markets." To put it in another way:—"In each of the first nine months of this year we imported very nearly 100,000 tons of iron and steel, or, to be exact, 877,651 tons between January and September. This is more than 22,000 tons a week. Taking the average wages cost at £3 per ton, this means that by importing foreign iron and steel this year we have been depriving our own workmen of more than £66,000 a week in wages. We have been paying wages to foreign workmen, and profits to foreign employers, while many of our own men, mills, and machines have been standing idle."

THE WORKS OF DRYSDALE AND CO., LIMITED, GLASGOW

(For description see page 595)



HEAVY MACHINE SHOP



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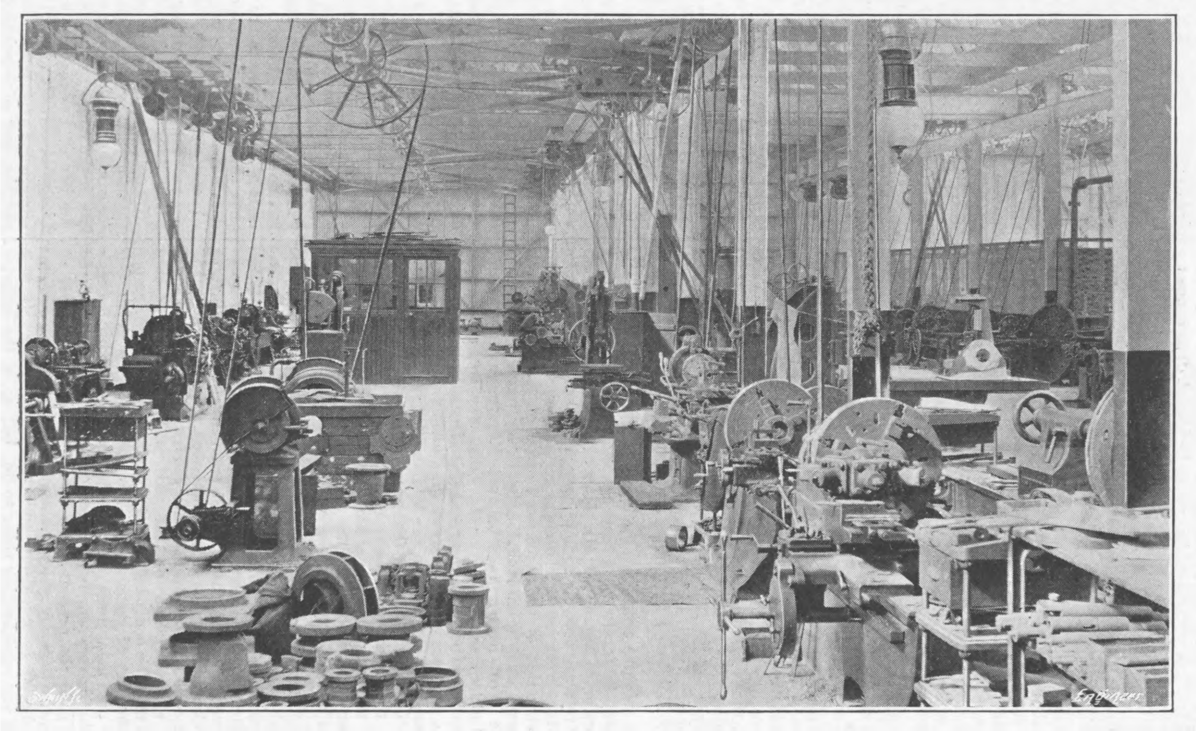

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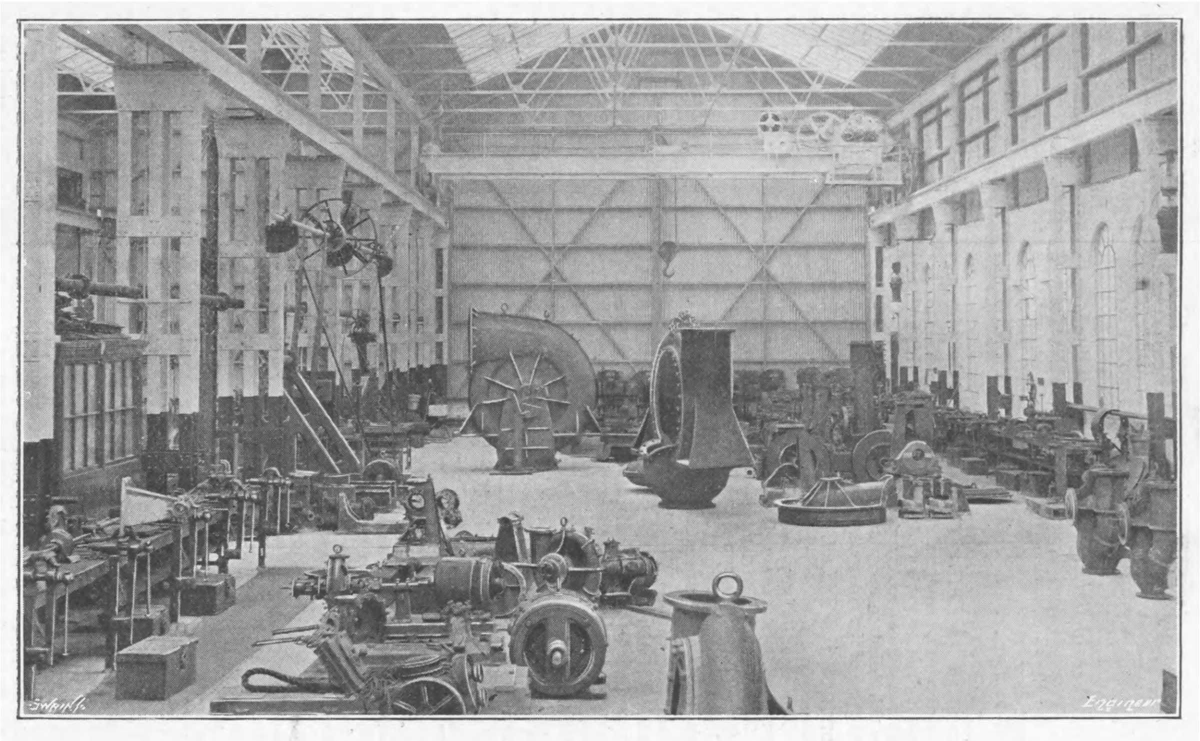

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TO CORRESPONDENTS.

☞ *In order to avoid trouble and confusion we find it necessary to inform correspondents that letters of inquiry addressed to the public, and intended for insertion in this column, must in all cases be accompanied by a large envelope legibly directed by the writer to himself, and stamped, in order that answers received by us may be forwarded to their destination. No notice can be taken of communications which do not comply with these instructions.*

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☞ *We cannot undertake to return drawings or manuscripts; we must, therefore, request correspondents to keep copies.*

REPLIES.

J. S.—We have no knowledge of electricity being used for the propulsion of torpedo boats or destroyers. Your informant is possibly thinking of submarines, or has seen some of the projects for electric propulsion.

INQUIRIES.

ANEROID.

Sir,—I recall having seen somewhere a description of an aneriod fitted with a cylindrical chamber, having circumferential corrugations instead of the usual flat chambers with concentric corrugations. I shall be much obliged if any of your readers can put me on its track. H. L.
London, December 7th.

MEETINGS NEXT WEEK.

Liverpool Engineering Society.—Wednesday, December 15th, at 8 p.m., at the Royal Institution, Colquitt-street, Liverpool. Ordinary meeting. Paper, "The Theory of Suspension Bridges," by Mr. L. H. Chase, M. Inst. C.E.

The Junior Institution of Engineers: Birmingham Local Section.—Wednesday, December 15th, at 8 p.m., at the Great Western Hotel. Mr. H. Horsburgh's paper on "The Design and Maintenance of a Cement Works" will be read and discussed.

The Royal Scottish Society of Arts.—Monday, December 13th, at 8 p.m., in the Hall, 117, George-street, Edinburgh. Communication: "Some Recent Developments in the Use of Producer Gas for Power Purposes," by Professor R. Stanfield.

Royal Society of Arts.—Monday, December 13th, at 8 p.m., at John-street, Adelphi, London, W.C. Cantor Lecture: "Aeronautics," by Charles Cyril Turner. Wednesday, December 15th, at 8 p.m. Ordinary meeting. "The Diamond Fields of Brazil," by Hugh Pearson.

The Institution of Mechanical Engineers.—Friday, December 17th, at 8 p.m., in the Institution House, Storey's Gate, St. James's Park, Westminster, S.W. Ordinary general meeting. Papers: "Mild Steel Tubes in Compression and Under Combined Stress," by Mr. William Mason. "Compound Stress Experiments," by Mr. C. A. M. Smith, B.Sc.

The Institution of Electrical Engineers.—Thursday, December 16th, at 8 p.m., at the Institution of Civil Engineers, Great George-street, Westminster, S.W. Ordinary general meeting. Paper, "Some Quantitative Measurements in Connection with Radiotelegraphy," by Dr J. S Fleming, F.R.S. "Efficiency of Short Spark Methods of Generating Electrical Oscillations," by Dr. W. H. Eccles and A J. Makower.

Royal Meteorological Society.—Wednesday, December 15th, at 7.30 p.m., at the Institution of Civil Engineers, Great George-street, Westminster, S.W. Papers: "The Variations of Currents of Air Indicated by Simultaneous Records of the Direction and Velocity of the Wind," by William Napier Shaw, LL.D., F.R.S. "South American Rainfall Types," by William G. Reed. "The Study of Phenomenal Climatology,' by William G. Reed.

The Institution of Civil Engineers.—Tuesday, December 14th, at 8 p.m., at Great George-street, Westminster, S.W. Ordinary meeting. Paper, "Railway Signalling in India," by Charles William Hodson, C.S.I., M. Inst. C.E. Friday, December 17th, at 8 p.m. Students' meeting. Paper, "The Foundation and Construction of Dock Walls," by H. T. Tudsbery, Stud. Inst. C.E. Saturday, December 18th, at 8.30 p.m. Students' Visit to the Printing Works of Messrs. Edward Lloyd, Limited, Salisbury-square, E.C.

THE ENGINEER.

DECEMBER 10, 1909.

The German Dreadnoughts.

An extraordinary diversity of opinion appears to obtain as to the merits of the German Dreadnoughts compared with corresponding vessels of the British Navy. In Germany there are two distinct classes of opinion. One school holds that the Nassau represents the last word in everything. They point out that she brings as many big guns to bear as the Dreadnought in any position, and that she has in addition a 6in. battery that is lacking in the British vessel, whilst her lesser speed is explained away by the argument that speed is for cruisers, not for battleships. Thus one view of the picture. Quite another aspect is given to it by retired German naval officers, who complain somewhat bitterly that the mountains have been in labour and produced a mouse. These officers argue that the vessels of the Nassau class are simply adaptations of the British Lord Nelson, and that they in no way justify the theatrical secrecy in which their construction was shrouded. They point out that the disposition of the artillery is such that there are always four big guns unavailable; and they ask, somewhat pertinently, wherein lies the triumph of carrying two more big guns than the Dreadnought, and yet in not having a single extra gun to use. They admit circumstances in which the 6in. batteries of the Nassau would be of considerable advantage, but against this contend that British Dreadnoughts, having the speed gauge, would be more or less in a position to choose the range, and would obviously maintain a distance at which the 6in. gun was relatively useless. In fine, supreme disappointment would seem to be the dominant note with these gentlemen.

Between these two conflicting opinions the truth is probably to be found. When all is said and done, it cannot be claimed for the Nassaus that they represent any novelty. They are simply perfectly commonplace developments of the Deutschland class, with big guns substituted for the 6in. upper deck guns of those ships. Of novelty, such as is embodied in the Dreadnought design, there is nothing whatever, and it is further rumoured, on fairly good authority, that they draw at least 3ft. more than they were designed to draw. This may be put down as a case against them. Of our own Dreadnoughts it may, on the other hand, be said that they were produced on the assumption that the importance of the 6in. gun was an exploded idea, and that the naval battle of the future would be entirely decided by the big gun. The more cautious Germans have accepted the big gun, but retained the 6in. also, so as to be on the safe side. The value of the 6in. for battle purposes is one of those problems that only the next naval war can decide. But its utility as an anti-torpedo armament can hardly be exaggerated. That we have somewhat tardily realised this, is perfectly clear from the fact that the 12-pounders of the Dreadnought gave place to 4in. guns in later models, and in the Neptune to 4.7in. guns. It is probable that upon these secondary guns the issue of a fight would be ultimately decided. The big guns in either design are so nearly equal that any battle result must depend upon gunnery pure and simple. The issue is therefore left to the secondary armament and its, at present, unknown value. It is, however, difficult for any unbiassed critic to arrive at any conclusion other than that the German policy of "going slow" and retaining the 6in. gun, is the safer; even though that retention entails corresponding disadvantages, such as unduly increased draught and the overloading of a ship with more guns than she can reasonably be expected to carry upon her displacements. Our Dreadnoughts represent a bold plunge into the unknown, likely either to be quite right or altogether wrong; whereas German design has proceeded on the principle of striking a mean, so as not to be altogether wrong, whatever results the naval warfare of the future may produce.

This peculiar conservatism is characteristic of Germany, which has never believed in giving hostages to fortune. It is an old proverb that "nothing can be won without taking risks." In our Dreadnoughts we have taken these risks with an almost abnormal candour. It rests with the future to show whether we were justified or not. Incidentally, it should be remarked that up to the very last moment a very strong body of opinion in German official circles was in favour of a uniform secondary armament of 4in. guns, instead of the mixed 6in. and 3.4 armament that has been provided. Even, therefore, across the North Sea, absolutely definite opinions by no means prevail. But we feel that it is well that the public should realise that in our naval policy we have taken far bigger steps than other nations have been inclined to take, and that these facts cannot but add to the general sense of unrest that obtains. British naval construction to-day is, by the force of circumstances, of the nature of a vast experiment. We do not pretend to say whether that experiment is right or wrong. That the future may, unhappily, have to decide.

The Common Denominator.

In the course of the discussion on Mr. Humphreys paper, which was concluded on Friday night, one speaker very aptly remarked, with regret, that there was no common denominator in mechanical engineering to which questions of relative merit could be reduced. The proposition will apply outside mechanical engineering; but confining ourselves to this last, we may say that its meaning is that so long as questions are looked at from different points of view, so long will it be impossible to arrive at anything more than a general agreement. Thus, for example, if we take Mr. Humphrey's reply to Mr. Davey's criticisms, we see that he gained a mere dialectical advantage by showing on the screen a great differential pump, and beside it an internal combustion pump, so small by comparison that he had to explain that it was not a "hooter." Both engines could deal with the same quantity of water; but the Davey engine was lifting it 1500ft. from a mine, while the gas pump could not lift it more than about 15ft. Indeed, it could not do the work of the Davey engine at all. This may be taken as an extreme case, but many others will suggest themselves to our readers. Locomotive performance, for instance, is greatly in need of a common denominator; in fact, the discussion of the subject must be endless unless one is found. The common denominator is, in effect, a standard of merit, and so long as this standard varies, and each disputant sets up his own, so long will agreement be impossible.

Now, there are, in effect, two standards of merit in mechanical engineering. One is the discharge of its duties by the machine, the other is the amount of money which the doing of the work costs. The cost is the more important of the two in most cases, because it is that which the purchaser of the machine cares most about. We are not arguing that he is right. We are not arguing at all. We are simply putting facts before our readers; and every engine builder, every machine tool maker, knows that the money cost is the first thing considered by the purchaser. One steam engine may be much better from a thermodynamic point of view than another. The cotton spinner cares nothing for that. He does care that his engine runs with such regularity that he can spin fine numbers; that it shall not be stopped for repairs for long periods—we can name very powerful engines which have run for eight or ten years without any repairs worth mentioning—and that the coal bill shall be light. It is obvious, of course, that engines may be made which will satisfy any one or two of these conditions. They will content the souls of some men, while to others they are thoroughly bad, simply because they fail in one respect. High expansion may give a first-rate economical result; but the engine might be quite useless to a cotton spinner, for because on account of its irregular turning moment he could not produce high priced thread. Here money comes in again.

Going a little further, we may say that the first common denominator to be settled is cost. We may take two standards, one the scientific, the other the commercial. Unfortunately, it is the first that seems to attract most attention from those who read papers and those who discuss them. The reason is no doubt that people do not like to talk in public about their private affairs. They will not mention the prices at which they sell their machines, much less what they cost to make. Again, those who use them are not often disposed to speak about their coal or oil bills. Unfortunately, indeed, the steam engine or the gas engine user, even if he attends the meetings of engineering societies, rarely contributes to the general store of information. The result is that a tendency exists to ignore the commercial side of mechanical engineering; and when a listener who has heard a great deal about the relative merits of two engines expressed in thermal units asks what that means done into pounds, shillings, and pence, it comes as a shock to his hearers. On Friday night a comparison was drawn between the cost of working with producer gas engines and steam engines. The argument was all in favour of the gas engine, expressed in weight of fuel required per hour to develop a horse-power. But the aspect of the matter changed when it was pointed out that the coal used by the steam engine was slack, costing 6s. 8d. a ton, while the gas producer worked with anthracite, costing over 25s. a ton. Here the cost of fuel was the common denominator, not the weight of fuel.

It is certain that if only people would agree when they entered upon a discussion that they would keep in view one, or, at the most, two definite points for consideration, disputes would lose much of their acrimony. They would be shortened, and their value would be very much increased. So long, however, as a multitude of factors is raised for consideration, so long will it be unlikely that maximum good will come of the interchange of opinions. If the behaviour of superheated steam in a cylinder is to be mixed up with that of saturated steam in the superheater, and that again with the relations existing between the superheater and the furnace and boiler, nothing but mental confusion can result. The common denominator of the steam user is in this case very simple. On the whole, how much will the annual total outlay on power be reduced by using superheated steam? This is not the point of view favoured by the man of science. He does not think along such a line. He is solely interested, not in saving money, but in reducing the missing quantity, or getting more thermal efficiency. This is to be regretted, for the utility of the scientist might be greatly augmented if he would refuse to regard "money grubbing" as derogatory to pure science. The days are, we hope, past when a very eminent mathematician boasted in his college that he had never produced a formula of the least practical value in his life. There are among us now a limited number of scientific men who have done good service to practical engineering, and who are proud of it, although it means in the end only pounds, shillings, and pence. Their numbers may be increased with great advantage.

It may, perhaps, be said that we have forgotten the other common denominator—to wit, efficiency—efficiency in the fullest and broadest sense of the word. We have done nothing of the kind. Not much examination is required to show that efficiency is in the main swallowed up by and included in the commercial standard. For example, a locomotive engine might be highly economical in every way, costing little to build, wanting few repairs, burning little fuel, safe, fast, and steady, and yet terribly expensive to work, because it could not keep time without a pilot. Here we are down once more to the bed rock. A duty has to be performed—that of hauling trains. What will the performance cost? It is because this way of looking at engineering questions is so inadequately appreciated that papers and discussions are so often disappointing. To listen to some speakers it might be imagined that they were in that happy position when money is of no consequence; while others appear to consider all questions of pecuniary profit and loss as beyond the province of engineering societies and institutions of all kinds. All this is a mistake, and does harm, because it deprives the world in many cases of the aid which well trained and powerful intellects could give. The scientific engineer devotes his energies to saving small quantities of fuel, or discovering where heat escapes. If he could devote his abilities to showing how maximum efficiency—we have tried to explain what a large meaning the word has—can be combined with minimum expenditure, it is at least probable that he could accomplish something noteworthy. The commercial factor is, we repeat, *the* common denominator.

Apprenticeship.

ANYONE who listened to the series of seven-minute speeches—dull, instructive, or lurid, according to the speaker—at the Mansion House Conference on Friday last, must have been left with the impression that the education of youths of the artisan class in this country is chaotic. The impression is perhaps not far wrong, for at the present time there is, of course, no such definite scheme of training as the bound apprenticeship of old. On the other hand, however, it must be borne in mind that if a different type of training or education had been required, it would have grown up with our industrial progress. Apprenticeship died because apprenticeship was not wanted. It did not fit in with the factory system, and it became an anachronism. That it can be resuscitated, save in a small way, we do not believe, unless the world resolves to put the clock back one hundred years, throw the bulk of its machinery to the winds, and stop once for all the specialised operation.

We find ourselves wondering sometimes when we listen to discussions on apprenticeship if the speakers have really grasped the secret of cheap production; if they really understand that the manufacturing methods which provide them with all sorts of commodities at absurdly low prices would be impossible if it were not for a system of manufacture which is as inimical to apprenticeship as fire is to water. Let us take one familiar example, out of many score which might be selected. The bicycle chain that we buy now-a-days for a few shillings would have cost in days gone by as much per link as we now pay for the whole. It is manufactured even in single works by the mile, and from beginning to end there is no hand work on it, in the handicraft sense of the word. Depending upon the nature of the chain, there may be from twenty to thirty operations on every link, and each one of those operations is performed on a highly specialised machine by an operator who has literally nothing else to do but feed the machine. In nearly all chain factories we believe girls are employed on the work, and we doubt if a more depressing spectacle is possible than a large building full as it can hold of stamping presses, drills, &c., before each one of which is seated a young girl, frequently no more than a child, hour after hour, day after day, pushing with deft fingers a small atom of steel into the insatiable mouth of the machine—a machine which has been endowed with a higher intelligence, within its limited capacity, than the human operator. What opening is there for apprenticeship under such a system? And what opening is there for apprenticeship under scores of occupations that make no greater demand upon the knowledge and skill of the artisan? Absolutely none. The employer asks for the display of very little intelligence. All he requires is a measure of manual dexterity, so small that it may be acquired in a few hours, a certain very small degree of the power to select which, though it could be given by machinery, is cheaper purchased from a human being. We have laid stress upon this point because, when we discuss the technical training of boys and girls, we absolutely must not lose sight of the fact that, whilst on the one hand we talk of improving their intelligence, we are on the other tacitly degrading it. Competition, and the necessity of satisfying the millions, has rendered the invention of rapid and cheap processes inevitable, and every one of those processes depends for its success upon the amount of skilled labour per unit of product—not that it can employ, but that it can dispense with. That is a fact we must bear in mind. The clothes we wear, the pens we use, the cycles we ride, the matches we strike, and a hundred other commodities so familiar that the process of manufacture has never cost us a thought, are made by methods which depend for their success upon the degradation of the intelligence of the operator. For this state of affairs no one is to blame; the whole world is responsible. It is the mud which Progress has splashed over her garments in her impetuous haste.

We shall perhaps be told that this class of labour represents only a small fraction of the whole, and that although in it apprenticeship is impossible and unnecessary, in others it is possible and beneficial. That is true, but true only to a limited extent. There are, of course, many industries in which apprenticeship could be served, but it is extremely doubtful if in many it would be industrially profitable. The object of apprenticeship is to teach a youth all the branches and mysteries of a given trade, and in the old days it was necessary that every man should know all those branches and mysteries before he could describe himself as a qualified journeyman. Now in very many industries, and certainly in many branches of mechanical engineering, it is neither to the profit of the employer or the workman that the latter should know more than a very limited amount about any save one specialised operation. As long as that is the case a revival of the bound apprentice is impossible. We do not deny for a single instant that from many points of view apprenticeship is desirable. We thoroughly believe that the old system turned out better men, and that the steady training had a very good effect upon the character of the youths; but, at the same time, we cannot shut our eyes to the fact that it cannot be made to fit in with modern conditions. The unions have recognised this, for in many cases they have formally withdrawn, or allowed to fall into disuse, the qualifications that were at one time demanded of members. Professors also have recognised it, and they make a practice now of condemning premium apprenticeship, and urging their students to enter the shops as ordinary workmen for what small pay they can obtain. On all hands, indeed, the decline of the bound apprentice is accepted as practically inevitable. That is a fact which we believe to be indisputable, and if, as we all recognise is desirable, some better training of our young men is to be secured than that which at present obtains, we must look for it—we say it with regret—in some other direction than the revival of the bound apprentice.

The Exhaust Steam Turbine.

THE utilisation of waste heat is a matter of the highest importance, and one which for several years past has exercised the minds of many engineers, and many and various have been the attempts to solve the problems it presents. We need only recall the SO_2 engine which about six years ago was brought to notice, and was taken up by numerous firms of engine builders of the highest standing. Excellent results were obtained, and the intrinsic difficulties of dealing with a substance like sulphur dioxide, owing to its rapidly corrosive action under certain conditions, and to the necessity of absolutely tight gland packings, had been overcome on a practical and large scale, at any rate up to a point. But the advent of the exhaust turbine has entirely stopped the development of the SO_2 engine and all similar devices, although the thermal economical results obtainable are not quite so good. The steam turbine, however, has the advantage of greater simplicity; there is no change of working substance, the capital cost is less, and although, as above pointed out, the SO_2 engine had reached a practical stage, yet the very smallest leak in its condenser meant the production of sulphuric acid and complete collapse of the condenser in a few hours. Very special jointing of the condenser tubes was, therefore, necessary, and it would have taken some years of experience before it could be said that any security could be felt that this danger no longer existed. As is well known, the reason the reciprocating steam engine cannot take advantage of a very low vacuum—say over 27in.—is that the pressure of steam is then so low and the volume so great that an impractically large cylinder would be needed. In the SO_2 engine advantage was taken of the fact that the vapour pressures of that substance are high at even quite low pressures, and thus small cylinders could be used. In the exhaust turbine the pressure of the steam does not directly come into play, but it is the steam velocity that is the determining factor, and this latter depends only on the heat fall. It is useful to note, in this connection, that a heat fall of 5 B.Th.U. produces theoretically a steam velocity of 500ft. per second, but practically slightly less, and that in the neighbourhood of 27in. vacuum this heat fall represents a difference of pressure of only 1.2 lb. per square inch, and the specific volume is 250 cubic feet, whereas in the neighbourhood of atmospheric pressure a difference of pressure of 10 lb. per square inch is needed, and the specific volume is 25 cubic feet. It is further to be observed that the turbine is more efficient at the low-pressure end than at the high-pressure end, because the viscosity and leakage losses are less. The above are the broad reasons why exhaust turbines can generally be advantageously applied.

In practice two distinct cases present themselves. In the first the reciprocating engine is of the non-condensing type; in the second it is of the condensing type. When a non-condensing engine has to be dealt with it may be assumed that the reason is that, owing to the difficulty and cost of obtaining condensing water, there would be no economical gain in making the engine work condensing. The greater gain due to an exhaust turbine may turn the scale in favour of condensing. No change need be made in the reciprocating engine, and it is to be observed that the cylinders are of the right ratio. The engine merely exhausts into the turbine instead of into the air, and may be said to know nothing about the change. In this case, with a moderate vacuum of 24in., the exhaust turbine can develop approximately 60 per cent. of the power of a moderately economical non-condensing reciprocating engine; thus the steam consumption per indicated horse-power is reduced by the addition of the exhaust turbine by 37 per cent. If a good vacuum of, say, 27½in. is obtained the increase of power is about 90 per cent., and the reduction of consumption per indicated horse-power is 47 per cent. It will thus be seen that, even with a moderate vacuum, good results are obtainable. For instance, if it be supposed that the reciprocating engine requires 20 lb. of steam per indicated horse-power, then with a 24in. vacuum the addition of an exhaust turbine will enable an indicated horse-power to be obtained for a consumption of 12.6 lb. of steam. In the second case, when a condensing engine has to be dealt with, if the engine is very economical and is not overloaded, the addition of an exhaust turbine will not be advantageous. But if the engine is uneconomical, or if it is overloaded, there will be an advantage, and the more uneconomical and the more overloaded the greater the advantage. Mr. S. N. Bailey, in a recent paper read before the Manchester Association of Engineers, gives an example of an economical but overloaded engine. Originally it worked at its economical load with a steam consumption of 12.2 per indicated horse-power, but in course of time more and more work was added until the engine was greatly overloaded and the consumption went up to over 13 lb. The exhaust turbine, which has been installed, will allow of still more load being put on, and, as the vacuum has been improved at the same time, the steam consumption will be reduced to about 11 lb. per indicated horse-power. Mr. Bailey also gives an instance of a very large exhaust turbine of 5000 kilowatts capacity which takes steam from two 7500 indicated horse-power Allis Chalmers reciprocating engines. At the moment this is probably the largest exhaust turbine in existence, and it is interesting to note that on the above figures it adds 50 per cent. to the power available.

The case of numerous small engines, generally, if not always non-condensing, delivering their exhaust into one turbine must not be omitted. It was probably one of the first cases put into practical operation, and it admits of very great economical gain, because such small engines are extremely uneconomical. Such engines very often work with great variation of load; that is, they deliver varying amounts of exhaust steam, and to equalise matters, as far as possible, Rateau designed his accumulator, which at first consisted of a large quantity of scrap iron placed in a boiler shell, but now is a special arrangement of heat storage in water. This device gave Rateau a great lead in the application of exhaust turbines, which naturally were of the type bearing his name. Other manufacturers, however, soon realised the commercial advantages of the system, and now every type of turbine is used with low-pressure steam. Controversy has inevitably arisen respecting the merits of the various types, and in particular whether the impulse type or the reaction—or strictly impulse reaction—type is most suitable. Complete discussion would be too lengthy; we will content ourselves by pointing out that the hydraulic efficiency of the impulse type is, roughly, 75 per cent., and that of the impulse reaction is, say, 78 per cent.; viscosity losses are, as a rule, less with the latter than the former, but at high pressures leakage losses are greatly in excess in the case of impulse reaction, those of the impulse type being almost negligible, so that at high pressures the impulse type has practically the greatest efficiency. Hence the advantage of the combined type now coming so much to the front. At low pressures, however, the leakage losses are small, so that the impulse reaction type is practically the most efficient. The impulse type exhaust turbine must, therefore, seek for advantages other than economical ones, and it is difficult to see where they may reside.

Although a good vacuum is essential for good economical results, and a turbine can take advantage of a good vacuum in a way a reciprocating engine cannot do, the cost of obtaining such a vacuum may, in some cases—when water is scarce, for instance—be prohibitive, and, in the paper already referred to, Mr. S. N. Bailey truly remarks: "In aiming at a high vacuum, we can easily expend in capital outlay and power required to work the condensing plant more than can be saved in steam consumption; on the other hand, we can as easily cut down these figures to a point where we do not get a sufficient return from our exhaust steam." His concluding sentence is also worth quoting: "A mighty waterfall appeals to the layman as having capacity for enormous work; its very roar seems to strike it home to him, but how many consider the silent pouring away of power through chimneys, or in the more audible and visible discharge of steam into the air, surpassing a thousandfold the power of Niagara?"

INSTITUTION OF MECHANICAL ENGINEERS.

AT last Friday's meeting of the Institution of Mechanical Engineers the adjourned discussion on Mr. Humphrey's paper, entitled "An Internal Combustion Pump, and Other Applications of a New Principle," was resumed, when a great deal was said about the new pump's merits and demerits, and the sphere of usefulness which it has before it. The President, Mr. J. A. F. Aspinall, occupied the chair.

Professor A. Chatterton, who was the first speaker, remarked that at the previous meeting the author's pump had been discussed from the point of view of the large user, but he intended to deal with it more particularly from the small user's standpoint. In the south of India he had been endeavouring to introduce oil engines for driving pumps for irrigation purposes. About 200 pumping stations of that kind had been put down. His experience had shown him what the people wanted for lifting water for irrigation purposes. Where land was valuable it was undesirable to have a pump that took up a lot of room, but for irrigation purposes in India that was of little importance. On page 10 of the paper the author had stated that the length of pipe between the combustion chamber and the high-level tank must be sufficient to contain such a mass of water that its kinetic energy at maximum velocity should ensure the burnt gases being expanded to atmosphere. This, it was stated, was the limiting condition, but the pump would work with any greater mass of water. He thought that if the pipe was not long enough the water would come to rest too rapidly. One great advantage of Mr. Humphrey's pump was that of being able to get rid of suction pipes. They all knew the trouble that foot valves gave.

Turning to the question of efficiency, the speaker said that according to Professor Unwin's report of the trials carried out at Dudley Port, when working at maximum capacity the pump required 12,000 British thermal units per pump horse-power hour, and at two-thirds load 13,596 units were required. In India eight 160 horse-power Diesel oil engines had been put down for lifting water 15ft. In trials carried out two years ago it was found that at full load these engines required 13,000 British thermal units per pump horse-power hour. At two-thirds load the figure rose to 17,000, which was a great contrast with the Humphrey pump. He had found that with a small suction gas plant running in India and using charcoal 14,000 British thermal units were required per pump horse-power hour. As regarded oil engines working with residual petroleum and driving centrifugal pumps with open impellers, he had found that 50,000 British thermal units were required per pump horse-power hour. With pumps having closed impellers the figure was reduced to 40,000. Thus it would be seen that the Humphrey pump required only about one-third of the amount of fuel as compared with small oil engines driving centrifugal pumps. It appeared that the result of using the new pump in the place of small engines and pumps would be the means of using one-third of the fuel, and also saving the greater part of the cost of lubricating oil.

The speaker then went on to refer to the importance of providing the Indian agriculturist with pumps having simple mechanism. The men who had charge of the pumps in that country only got about 5s. a week, and they were not good at dealing with complicated things. The Humphrey pump got rid of practically the whole of the mechanism, and it seemed to him that it had a great future before it in India. Some years ago a commission which was appointed to report on the irrigation question estimated that there were about 16 million acres of land which might be irrigated with advantage. He thought that there was probably room for £60,000,000 worth of pumping plant. There were about 3½ million wells throughout the whole of India. He thought that the author's suggested arrangements for compressing air might well be employed for raising the water from the wells in India. A most important point was the question of the sources of fuel. There were no gasworks in that country, and it would not be practicable to put up suction gas plants of the ordinary kind. Something simpler than the arrangements necessary for the use of petrol was required for the native. Small suction gas plants worked with wood in sizes from 4-5 horse-power were needed. He fancied that few people had any conception of what the present methods of pumping in India cost. It was carried out to a large extent by cattle, and the cost was enormous.

Mr. Liddell Simpson remarked that at the last meeting Mr. Davey did not seem to realise that the comparison which the author had made in his paper referred to pumps working at low lifts. He thought that his comments about steam engines were very remarkable. The steam engine which had been selected for comparison was driving a high-duty pump with a low lift, and its consumption was considered very good. He was aware that the performance could be improved somewhat with the use of superheated steam. He had recently had an opportunity of seeing a large Humphrey pump in use. It was a very interesting plant. The small amount of mechanism was really remarkable. The pump referred to in Professor Unwin's report was not working under the best conditions. He thought the arrangement shown on page 14 of the paper was a very good one for altering the periodicity by varying the length of the discharge pipe. It would be noticed from that diagram that there was a by-pass which enabled the length of the discharge to be varied in a very simple manner. He would like to ask the author whether, in view of the exhaust being so cold, he had ever thought of exhausting the gases into a vacuum to enable the pump to suck the water up, for the present pump in its simplest form had its suction pipe below the water level. The speaker then went on to refer to the small amount of space which the new pump occupies as compared with the ordinary slow-speed steam pumping engines, and drew attention to a diagram on the wall which had been prepared to illustrate this point.

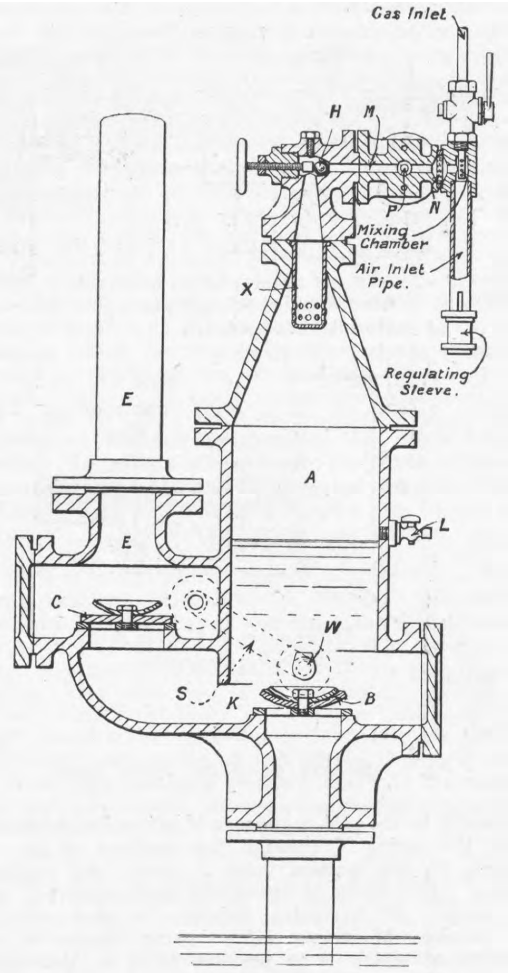
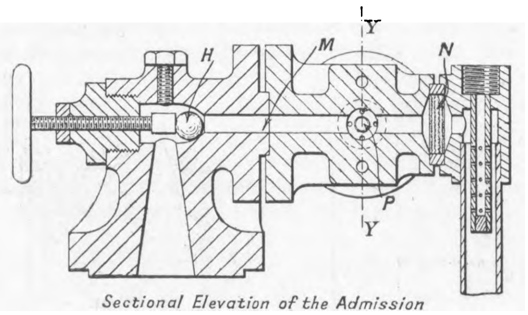


Fig. 1—JOY'S GAS PUMP

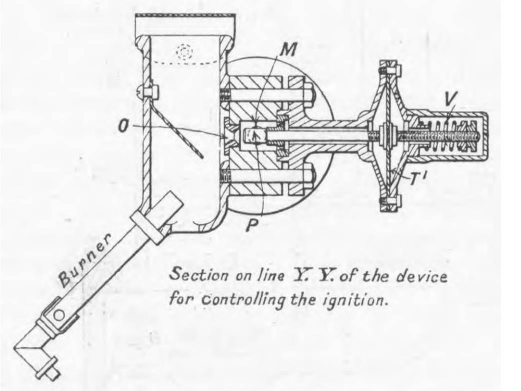
Dr. Hele-Shaw first of all referred to page 29 of the paper, where the author deals with the question of jet propulsion for ships by means of his pump. It seemed to him that the bulk and weight of the pump precluded its use for passenger steamers, or even on fast-going cargo steamers. The use of petrol for such service was out of the question. The speaker, however, dealt mainly with a statement which the author makes on page 2 of his paper. In that part of the paper Mr. Humphrey had stated that the efforts had all been directed too much along the ordinary lines of ordinary pumps, in so far as the water lifted had always been forced past a non-return valve, and the operation of such a valve with the explosive force behind it had been inevitably disastrous.

He could not agree with that statement, for he had tested a pump of that kind, invented by Mr. Bertram Joy, which operated in a highly satisfactory manner, Then Dr. Hele-Shaw went on to describe this pump with the aid of a diagram on the wall, which diagram is reproduced in Fig. 1. The pump, it was explained, was designed on quite a small scale. It lifted 1050 gallons per minute, against a head of 18ft. The suction lift was 2ft.

The speaker then went on to describe the action of the pump, which is as follows:—To obtain an initial explosion means, such as a hand pump, is provided for the introduction into the working chamber through a cock, such as L, of a combustible gas. The initial charge having been introduced into the working chamber A, is automatically ignited at the port O—Fig. 2—by means of the burner. The pressure due to the explosion drives the water—or air in the case of the chamber containing no water at starting—out of the working chamber through the delivery valve C, the suction valve B closing automatically. When the water in the working chamber is so far discharged as to uncover the port K, the exhaust gases pass into the delivery pipe or rising main E, at first by their own pressure, and afterwards by the kinetic energy of the column of water in the pipe or main. As soon as the water in the rising main becomes stationary, or nearly so, the pressure due to its head causes a spray to issue from the jet W, which scours the interior of the working chamber, and by its cooling effect causes the hot gases left in the chamber rapidly to contract, and so increases the suction effect. When the pressure in the working chamber becomes equal or nearly equal to atmosphere, both the valves H and B open, the former to admit gas and air and the latter to allow a fresh charge of water to flow into the chamber. Meanwhile, the partial vacuum in the port or passage M has the effect of closing the ignition valve P, thus preventing ignition occurring until the pressure conditions approximate that of the atmosphere, by which time the working chamber is again charged with combustible gas and water. As soon as the depression in the port or passage M is insufficient to overcome the spring V through the medium of the dia phragm T^1, the ignition valve P opens and explosion ensues. This cycle of operations then continues until the supply of explosive mixture is shut off. In the passage M there is a gauze screen N, the function of which is to prevent firing in the mixing chamber, the screen acting on the Davey lamp principle. The opening of the valve-box into the working chamber takes the form of a perforated pipe X, the purpose of which is to protect the valve H from the water jet. It will be seen that the jet W is connected with the delivery pipe by means of a pipe S, so that the jet is constantly under the head of water in this pipe. The pipe S is fitted with a cock—not shown in the drawing—for the purpose of shutting off the jet when starting. The lift of the pump can be varied by altering the opening of the valve H with the hand wheel on the left. An illustration of an actual pump of this type is given in Fig. 3.



Sectional Elevation of the Admission Port & Valve, the Mixing Chamber & Firing Port.



Section on line Y. Y. of the device for controlling the ignition.

Fig. 2—IGNITION GEAR OF JOY'S PUMP

Dr. Hele-Shaw said that he was prepared to admit that the gas consumption of such a pump would be somewhat high, but drew attention to the fact that it was sometimes expedient to sacrifice a little in that direction for the sake of simplicity. He then went on to refer to some tests on various types of small pumps, including the pulsometer pump and the injector, the latter, he said, using in one instance as much as 418 lb. of steam per horse-power hour.

Mr. Emerson Dowson, among other things, referred to the fact that the author had given the results of an analysis of the gas used in his pumps; but he thought that if Mr. Humphrey had included the results of analysis of the exhaust gases the information would have been more interesting, for it would show whether complete combustion was obtained or not. The speaker also referred to page 38 of the paper, where the author states that with his suggested electric station, with hydraulic coupling between the gas plant and electrical machinery, a Board of Trade unit could be generated with 2 lb. of anthracite coal. He would point out that gas engine makers were prepared to guarantee 1 lb. of coal per brake horse-power, and adding 50 per cent. to bring this to electrical Board of Trade units, gave 1½ lb., as compared with Mr. Humphrey's 2 lb. Even with bituminous coal a Board of Trade unit could be generated with 1½ lb. of coal.

Mr. O. H. Mueller, of the Worthington Pump Company, said that, looking at the water end of the new gas pump, it would be seen that it had valves, and he thought that they would be the means of precluding the use of the pump for a large number of purposes, particularly as the valves were inaccessible. Inspection of the valves would necessitate employing the supply tank, and arranging a sluice valve in the pipe to the high level tank or air chamber. The size of such a sluice valve would have to be such as not to restrict the passage of the oscillating column of liquid. For pumps of comparatively small capacities sluice valves would be needed several feet in diameter. The operation of inspecting or replacing the suction valves would be extremely tiresome. In ordinary reciprocating pumps, single or double acting, the free area of the suction valves was equal to the capacity divided by the velocity allowed through the valves. This had to be multiplied by two, as the suction valves were only open half the time. The same velocity being allowed for the discharge valves as was customary, the total free area of all the valves was equal to four times the capacity divided by the velocity through the valves. In the new gas pump, which was operated by one four-cycle cylinder, the time allowed for the water to pass through the suction valves could not possibly be more than a quarter of the duration of a complete cycle, and possibly less. Therefore the valve area was at least equal to the total valve area of a reciprocating pump of the same capacity. With a duplex two-cycle arrangement, the area could be reduced to about one-half. But that only applied to very low heads, such as could be directly overcome by the motor cylinder without storing energy in an auxiliary air vessel.

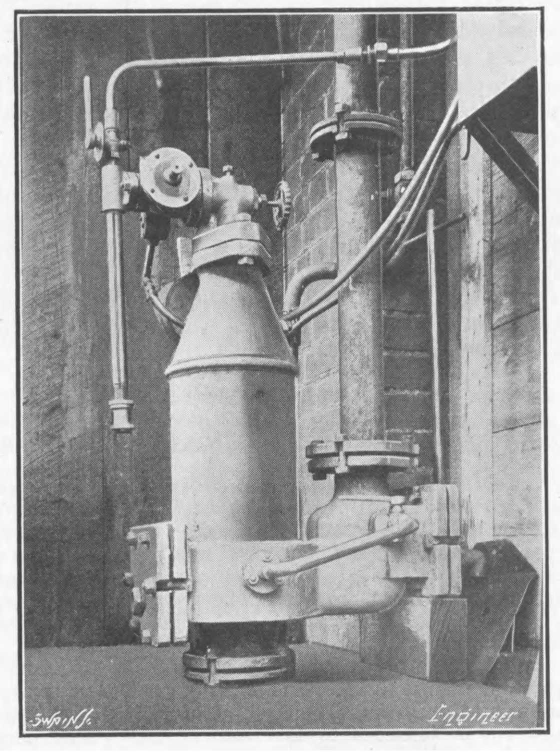


Fig. 3—JOY GAS PUMP

By reason of the expansion being carried below atmospheric pressure the mean effective pressure in the gas cylinder was a good deal less than in an ordinary gas engine, and he thought that any head above 60ft. would necessitate the use of an air vessel and check valve on the discharge pipe, as shown in Fig. 9 of the paper. The time allowed for the water to pass through the check valve—or, rather, a plurality of check valves—was only a fraction of the time allowed for it to pass through the suction valves, so that they would have to be much larger. While a reciprocating pump delivering 1000 gallons against 120ft. required half the valve area of another delivering 2000 gallons against a head of 60ft., a Humphrey pump for the first-mentioned condition required double the valve area, or four times as much as the reciprocating pump. That he considered was a great disadvantage. In order to convert the gas pump into a practical machine for pumping it would, in his opinion, have to be combined with a water motor and pump both of the reciprocating or rotary type. The principle would have to be adopted which the author had illustrated in Fig. 19 of his paper. Another thing which the speaker drew attention to was that the new pump requires a constant head on the suction side. He would like to ask in how many cases that was available. Such a condition was certainly not to be found on the banks of the Thames or on the banks of any other river, nor at the sea shore or with wells. Turning to the question of indicating the pump the speaker said that he would like to ask the author, whether in view of the slow motion of the water in the pump, it would not be possible to fix a gauge glass and to follow the motion of the water in the pump by the hand that pulls the indicator down, and to correct the card for the conical shape of the explosion chamber.

Captain Sankey called attention to Fig. 16 in the author's paper, where he gives the theoretical thermal efficiencies of the "air standard" of the Otto cycle and of the pump cycle, and also to Fig. 17, in which the practical thermal efficiencies had been obtained by multiplying the theoretical efficiencies by .71. The practical efficiencies thus calculated were correct for the Otto cycle, but had not been obtained with the pump cycle. Thus, taking the tests reported by Dr. Unwin, in which the compression was 44.7 lb. per square inch, it would be seen from Fig. 17 in the paper that the calculated thermal efficiency was 33 per cent., and if it was assumed that the friction losses were 10 per cent., that the gas producer had an efficiency of 80 per cent., and the calorific value of the coal was 14,400 then the coal consumption worked out to .75 lb. per pump horse-power, instead of 1.063 given in the tests. It followed that the practical thermal efficiency was only 23 per cent. It might therefore be assumed that in due course much more economical results would be obtained with the Humphrey pump. The speaker also referred to a hot air mercury pump, particulars of which had been sent to him by Professor Harold Dixon. In 1885, he said, the professor was making some experiments with gases, and left three gas tubes standing over night. The upper ends contained gas heated internally by a spiral wire carrying an electric current. Next morning he found the mercury in all the tubes throbbing up and down. The explanation was that the slightest disturbance produced a "pendulum" motion of the mercury, alternately compressing and expanding the gas in the top of the tube. On compression the gas would be slightly heated, and during expansion it would be cooled by the cold surface of the tube exposed by the mercury. The stroke of the "mercury" would thus be increased at each swing, and the limit would be reached when the friction of the mercury in the tube was balanced. The diagram —Fig. 4—illustrated the arrangement. Obviously if water were poured into the open leg when the mercury was at the bottom of its stroke, it would be pumped up, and, pointing to another diagram, which is reproduced in Fig. 5, the speaker said that by providing a tank, as shown, the apparatus could clearly be made to work as a pump.

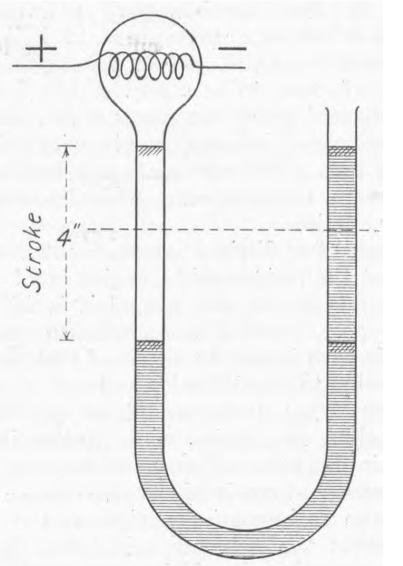


Fig. 4—DIXON'S EXPERIMENTAL APPARATUS

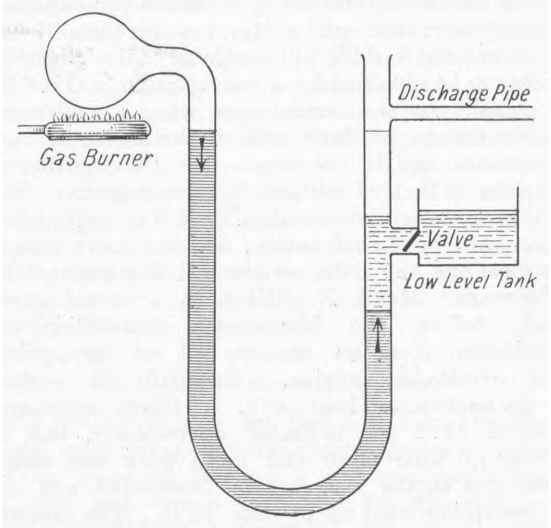


Fig. 5—MODEL PUMP

Mr. Henry Lea said that at the bottom of page 48 of the paper, the author gave the figure 1.063 lb. for the fuel consumption of his pump, per pump horse-power hour, when using anthracite. On page 50 there were three figures relating to the fuel consumption of steam engines. Two of these related to triple-expansion engines, and one to a compound engine. The figures were 1.66 lb. and 1.69 lb. of coal per pump horse-power hour for the triple-expansion engines, and 2 lb. for the compound engine. That which was most important, however, was the question of £ s. d. Assuming coal to be purchased for the steam engines at 10s. per ton, then multiplying that by 2 gave a figure which would serve the purpose of comparison for the compound engine. The figure was 20. Multiplying 1.66 by 10, gave 16.6 for one of the triple-expansion engines. Assuming anthracite used in the producer to cost 25s. per ton, the figure for comparison in that case would be 1.06 multiplied by 25, which equalled 26.5. Taking the cost of Mond gas at 2d. per 1000 cubic feet, and working it out, it would be found that by buying Mond gas the purchaser was not getting all the heat that was in the slack from which it was produced. He was paying as much for the heat obtained out of the Mond gas as he would have paid had he purchased the original slack at 35s. a ton. Multiplying the author's figure 1.063 by 35 it gave 37. They thus obtained in money values the relative cost of working under four different conditions.

For the Humphrey pump using Mond gas the figure was 37, and when using anthracite in the producer it was 26.5. The figure for the compound engine was 20, and that of the triple expansion engine 16.6. It did appear, therefore, that the Humphrey pump was more economical than any other form of pump, as the author had stated in his paper. Lastly, the speaker referred to the remarks of Dr. Hele-Shaw concerning the high consumption of injectors, and pointed out that it did not matter whether injectors used 400 lb. or 4000 lb. of steam per pump horse-power hour, for all the heat contained in the steam which worked them was returned to the boiler.

Mr. J. V. Robinson, of Richardson, Westgarth and Co., compared the weight of a 1600 horse-power gas engine with that of a 1600 horse-power pump. He said that an engine of that size having 39½in. bore and a 43.5in. stroke running at 100 revolutions per minute with a compression pressure of 120 lb., and using 500 lb. of rich mixture per minute would weigh from 130 to 150 tons with the fly-wheel. Assuming a Humphrey pump of that power to have four barrels 4ft. 9in. diameter and the stroke to be 20ft., the total length of the barrel would be 27ft. with the clearance volume. Also assuming that 1300 lb. of poor mixture were used per minute, the compression pressure to be 45 lb. per square inch and the explosion pressure 100 lb. per square inch, then, based on 1 lb. of mixture before compression occupying 12.5 cubic feet, after compression 5.7 cubic feet, and after expansion 22 cubic feet, the mean pressure was 17.5 lb. per square inch. The weight of water required would be 4570 lb. per pound of mixture, or 176.5 tons in all. To get a sufficient number of cycles the diameter of the pipes would have to be double the diameter of the combustion chamber, or 9ft. 6in. The length of the pipes, including the rising main, would be about 73ft. of 4ft. 9in. pipe, or 36.5ft. of 9ft. 6in. pipe, for each cylinder, or 36.5ft. of 13ft. 6in. diameter pipe for each pair of cylinders; in other words, 73ft. of 13ft. 6in. pipe in all, which would weigh about 206 tons. The cylinders would weigh approximately 50 tons, so that the total weight would be from 425 to 430 tons. Here Mr. Robinson remarked, in quite a matter-of-course manner but amid much laughter, that pipe work was a little less expensive than the machined parts which go to make up an engine, but his calculations showed what a weighty thing a 1600 horse-power Humphrey pump would be.

Mr. Bertram Blount dealt with the question of the effects which the gas is liable to have on the water. He did not think that there was much fear of the water taking up sulphur, nor did he anticipate that any trouble would be experienced with corrosion, nor did he think that drinking water would be appreciably contaminated.

Professor Spooner, who was the last speaker to take part in the discussion, confined his remarks to the question of applying the author's pump to jet propulsion. In view of its great simplicity and its high efficiency, he thought that it had latent possibilities before it in the direction of propelling ships. He noticed that a pump horse-power hour could be obtained for 1.06 lb. of coal, and assuming the jet to have an efficiency of 80 per cent. meant that an effective horse-power could be obtained with 1.3 lb. of coal. It was some years ago since the Thornycroft jet propulsion trials were carried out, but it would be remembered that the low efficiency of the pump was the greatest drawback. He thought that if the losses due to the pump could be got rid of a good deal more would have been heard about jet propulsion.

The author was then called upon to reply. In so doing he confined his remarks almost exclusively to what Mr. Henry Davey had said at the previous meeting, so that the reply was by no means complete, and we venture to suggest that the author was too hard on Mr. Davey, and that he would have done much better had he devoted some of the time at his disposal to the criticisms of other speakers. He said that he thought that Mr. Davey was hardly justified in stating that he—Mr. Humphrey—commenced his paper by endeavouring to establish a comparison between the economy of steam-worked pumps and gas-worked pumps as they existed. Had he made such an effort he would have quoted working results instead of merely making a passing reference to gas-driven pumps and instancing the case of the five pumps belonging to the South Staffordshire Mines Drainage Commissioners.

As regarded those pumps, he had been careful to ascertain that where the gas engines had been erected to replace steam engines, the change had resulted in the pumping being carried out at a reduced cost, and, secondly, that the plants were permanently erected and were intended for permanent working. The report of the South Staffordshire Mines Drainage Commissioners dealt with seven steam-driven pumps and four which were gas driven, and using Mond gas at 2d. per 1000 cubic feet. He had taken the trouble to analyse those costs, and he had found that the average cost per pump horse-power hour for the steam-driven pumps was .543d., and that of the gas-operated pumps .673d. If the fuel figures and the cost of delivering the fuel were alone taken as the basis, then the fuel cost for the steam plants was .248d. per pump horse-power hour, and for the gas plants .269d.

When it was remembered that the steam pumps were on the whole much larger than the gas pumps, the latter did not compare unfavourably with the former, especially when it was remembered that speed reduction gear had to be placed between the gas engine and pumps. He had quoted 18 lb. of steam per pump horse-power hour, but he had not done this before inquiring among large pump users. He was aware that, with high-pressure superheated steam used in large steam pumps working on high lifts, and in conjunction with a very good condenser, a pump horse-power had been obtained with even less than 12 lb. of steam. It was a marvellous result for a slow moving steam engine, but, after all, it was quite exceptional, and he still believed—and he found himself supported by other speakers—that 18 lb. of steam per pump horse-power hour was an excellent average working figure for a compound steam pump. Mr. Davey, after having stated that the pump which took 18 lb. of steam per pump horse-power hour was a disreputable example, had proceeded to make a calculation based on 20 lb. of steam per pump horse-power hour. Taking slack at 4s. 6d. per ton, he arrived at .096d. per pump horse-power hour, whilst he—Mr. Humphrey—had shown that with slack at 6s. 9d., the corresponding fuel cost for the internal combustion pump was below .06d., or less than half the more usual steam fuel figure of .13d.

The 4s. 6d. per ton for slack Mr. Davey stated to be the price paid by the South Staffordshire Mines Drainage Commissioners, who had five large Davey pumps in use. He had just shown the actual cost of fuel for the steam pumps to be .247d., instead of Mr. Davey's calculated figure of .096d.

Mr. Davey had said that making a mass of water provide fly-wheel effect was old. The combustion chamber, mushroom valve and iron pipes were also old. He had naturally made use of such things as he found at hand, and all that he claimed to have invented was a new pump, and not the materials or parts of which the pump was made.

Turning to the question of the pump being large, the speaker said that Mr. Davey had remarked that the pump appeared to be very bulky for its power, and he presumed that he was comparing the pump as such to steam pumps like those made by his firm. If it was a question of comparing the gas pump to a gas engine, then he was only too willing to admit that the apparatus was to be considered bulky, because when the gases were expanded down to atmospheric pressure, it was necessary to provide a chamber much greater in volume as compared with the cylinder of an Otto cycle engine. Also although a pump had been worked at 42 cycles per minute, the speed was slow as compared with a gas engine.

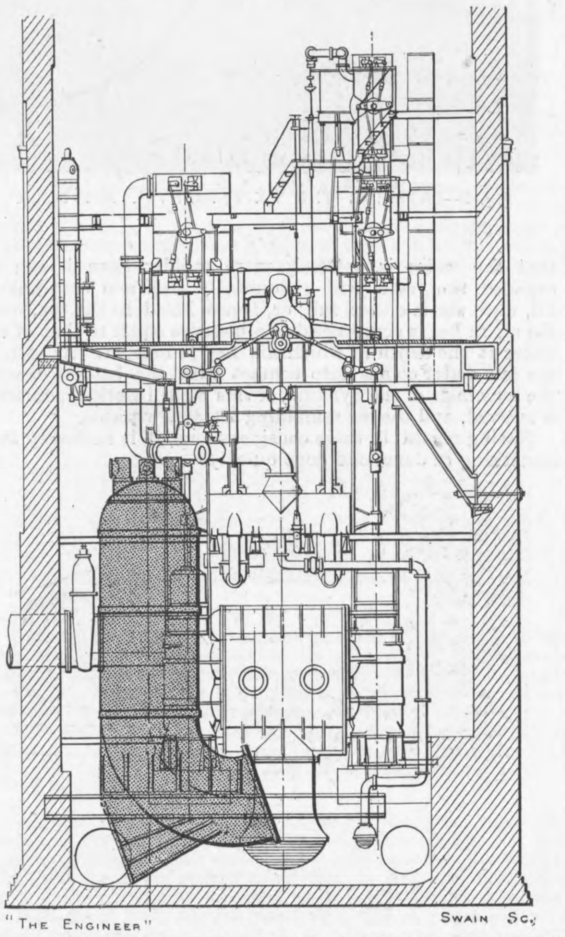


Fig. 6—WORTHINGTON & HUMPHREY PUMP CONTRASTED

But remembering that the pump in its simplest form was admittedly a low-lift pump, and comparing it to a reciprocating steam pump, then it was the steam pump which appeared enormously bulky compared with the gas pump.

He then said that Mr. Liddell Simpson had been kind enough to provide him with a drawing of one of the pumps mentioned by Professor Unwin in his report, namely, a triple-expansion high-duty Worthington pump having a large output. He had superimposed upon it the outline of a recently designed Humphrey gas pump delivering four times as much water as the steam pump. Here the diagram in question, which is shown in Fig. 6, was put upon the screen and the speaker gave the relative dimensions, the space occupied by the triple-expansion engine being 12,327 cubic feet and that occupied by the gas pump 2821 cubic feet. Taking four sets of Worthington engines to give the same water output as one Humphrey pump, these sets would occupy 17½ times the space occupied by the Humphrey pump.

The speaker then went on to make other comparisons of a similar kind, where the discharge pipe was included, these comparisons proving even more favourable from the point of view of space. Although Mr. Davey could not accede to his request and send him a drawing of his pump of greatest output, yet in a letter he had been referred to two illustrations in Mr. Davey's book on pumps, both showing deep well pumps, and therefore not really suited for comparison. Taking the one Mr. Davey seemed to like best, he had made a lantern slide of that part of the pump which was above ground—there was a lot more of it below. It lifted 1500 gallons per minute from a depth of 1500ft. When this drawing was thrown upon the screen an insignificant looking little pipe appeared in the margin. That, the speaker explained, was not the hooter to call the men to work, although it might be thought that it was. It was a Humphrey pump drawn to the same scale and delivering the same quantity of water. The comparison was not of his own choosing, and it was spoilt by the divergence of lift, but it was instructive as far as it went.

Coming to Mr. Davey's statement that if 10ft. or 12ft. is fixed as the maximum velocity of flow in the discharge pipe, the weight of water in the length of pipe between the two lower extremities of the two vertical limbs would have to be from three to four times the total weight of water from the bottom of the delivery limb of the tank, assuming the size of the pipe to be the same all the way through, the speaker said that the statement had no foundation either in fact or theory. He would assume the diameter of the discharge pipe, its length, and its rise all fixed. There remained two other controlling factors, namely, the kind of combustible mixture used, and the amount of combustible charge, both apparently ignored by Mr. Davey.

He would ask the members to imagine that an indicator card of the working stroke could be obtained and divided by vertical ordinates into a number of small parts, then theory required that for each part of the indicator card there would be an acceleration definitely related to that particular part. Of course, the acceleration became a deceleration after the expansion reached a point where the gaseous pressure equalled the pressure due to the static head of water. Those relations held whether the charge was large or small, since the expansion curves might, for the purpose, be supposed to follow the same law. What altered the amount of charge was the time base, and each element of acceleration acted for a longer period as the charge increased. It followed, therefore, that for any definite maximum velocity that might be fixed, there was some definite charge volume which met the conditions. In other words, if it was said that the velocity in the discharge pipe was not to exceed twelve or any other number of feet per second, then it was possible to find the charge volume which satisfied the conditions. On theoretical grounds there was no reason—always remembering the limitation of lift for the simple pump—why the delivery should not be wholly vertical. It was found in practice that there were other conditions which made it difficult to work with a pipe, the length of which was only equal to the height of lift; or, in other words, a vertical pipe only. With such a pipe the cycles per minute might become too rapid to allow the proper quantity of water to enter the pump at each cycle, and for that reason alone it had been found desirable to lengthen the pendulum, so to speak, as the lift increased, and so counterbalance the tendency of an increased lift to unduly quicken up the cycle. Mr. Davey, in choosing a 200ft. lift, necessarily referred to the high lift apparatus in which the gas was combined with an air vessel, and in that case he made his absurd and unfortunate statement that the pump requires 600ft. to 800ft. of pipe. He called it absurd, because excluding the rising main in which the flow was continuous, the pump only needed one-tenth of the length which Mr. Davey mentioned. Finally, the speaker mentioned that analyses of the water had been made to ascertain if there was an increase in the sulphur contents, but with negative results. He had a certificate from Dr. Hertz, of London, showing that there was no SO_2 in water pumped 100 times.

During a visit which Mr. William B. Bryan, Chief Engineer to the Metropolitan Water Board, paid to Dudley Port to inspect the pump at work, he was asked to arrange a test which should be conclusive as regards contamination of the water by pumping. He was kind enough to suggest that all the canal water in stock, tank, &c., should be emptied out and replaced by potable water from the South Staffordshire Waterworks Company's mains. The water then to be circulated by the pump a definite number of times, and samples taken before and after pumping, to be tested by a public analyst. Mr. Harry Silvester, public analyst for the County Boroughs of West Bromwich and Dudley, undertook the analyses, and the programme arranged was carried out, with the results shown below:—

Analyses of Water Circulated through Humphrey Pump.

Sample No. 1.—All canal water emptied from tanks, air vessels, &c., and flushed through. Plant refilled with water from the South Staffordshire waterworks main. Pump run for five minutes to thoroughly mix water, and then No. 1 sample taken.

Sample No. 2.—The pump was run at an average rate of discharge of 2212·5 gallons per minute for 3 hours 20 minutes. Thus, the total water, amounting to 21,000 gallons, was circulated through the pump 21 times.

Certificate from Mr. H. Silvester, B.Sc., F.I.C., Public Analyst, Birmingham.

I have analysed these samples and give you the figures obtained in the accompanying certificate.

The ammonias in the two samples were practically identical, whilst the rise in the oxygen consumed figure, even after 21 circulations, was only ·0008 grain per gallon.

I also made a direct test for sulphuric acid with a negative result.

From these results I am of the opinion that the water is not contaminated by tar or sulphurous acid when pumped by means of your pump.

As the particular sample of water was circulated 21 times, the results are strong evidence of the non-contamination of the water by the gas, when the water is only circulated once, which, I presume, would be the ordinary practice.

I am,
Yours faithfully,
(Signed) HARRY SILVESTER.

Certificate.

I hereby certify that I have analysed the samples of water received from Messrs. The Pump and Power Company, Limited, December 2nd, 1909, and that I find the following results in grains per gallon:—

Mark on Sample.	No. 1.	No. 2.
Free and saline ammonia	·0042	·0034
Albuminoid ammonia	·0064	·0056
Oxygen consumed in four hours at 80 deg. Fah.	·056	·062
Combined chlorine	1·26	1·33
Alkalinity in terms of grains per gallon of carbonate of lime	7·7	7·52

I made a direct test for sulphurous acid, but the result was negative.

(Signed) HARRY SILVESTER, B.Sc., F.I.C.

LIFE-SAVING DEVICES IN SUBMARINE BOATS.

We received a few days ago from Siebe, Gorman and Co., Limited, of Westminster Bridge road, S.E., a copy of a book entitled "A Diving Manual," which this firm has recently produced. This little book treats of submarine appliances and their uses, deep sea diving, &c., and it has been compiled and edited by Mr. R. H. Davis, the firm's managing director. It embodies a description of the latest deep sea practice adopted by the British Admiralty, and includes chapters on the physics and physiology of diving, and also an account of the diving dress and diving bell, as well as instructions for divers. The whole is delightfully got up and affords excellent reading, but there is one portion in particular which is of special interest nowadays when so much attention is being devoted to the question of saving the lives of men who may sink with a submarine when she founders. It would be impossible to deal separately with each of the various subjects discussed, but we feel sure that a somewhat extended reference to this portion of the book will be of value to our readers; the more so that we are, through the courtesy of Siebe, Gorman and Co., Limited, enabled to illustrate our remarks by means of some of the same engravings as are contained in the book.

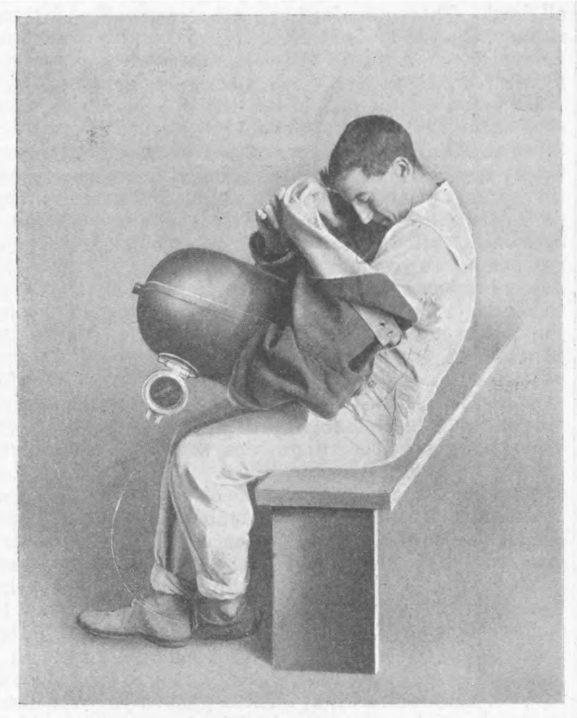


Fig. 1—PUTTING ON THE DRESS

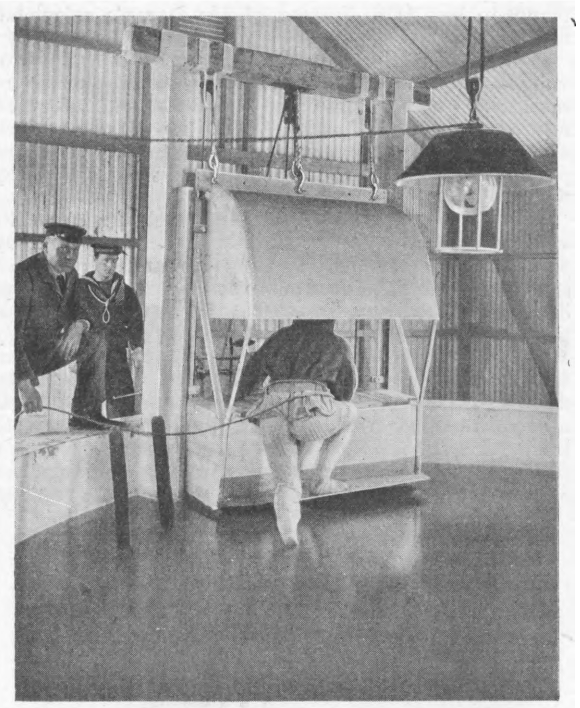


Fig. 2—ENTERING THE EXPERIMENTAL AIR DOCK

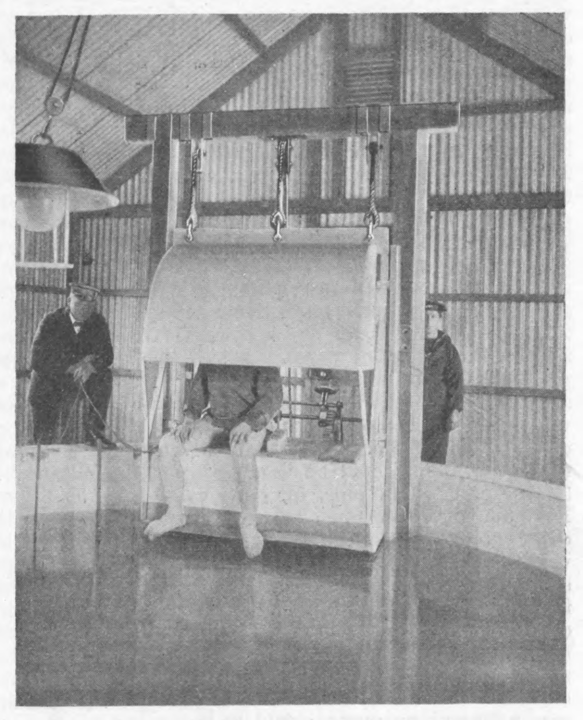


Fig. 3—IN AIR LOCK READY TO BE LOWERED

The problem of saving the lives of the crew of a submarine vessel is by no means easy of solution. Equipment and apparatus which is invaluable on shore is quite useless under water. As Messrs. Siebe, Gorman and Co. explain, it would be quite easy to construct a submarine boat, the crew of which would be safe under practically every conceivable set of circumstances, but such a vessel would be so hampered by her safety devices as to have little or no military efficiency, and since these craft are, at present, only built for fighting, this kind of boat need not enter into serious consideration. In studying the matter of rescue, the designers of the appliances to which we are about to refer have regarded it as essential that the salvage of the vessel and of the crew must be looked upon as entirely separate. Inevitable delays in the arrival of the salvage vessel, and in getting purchases on, conditions of tide, weather, &c., render it almost certain that a submarine cannot be raised in time to save life.

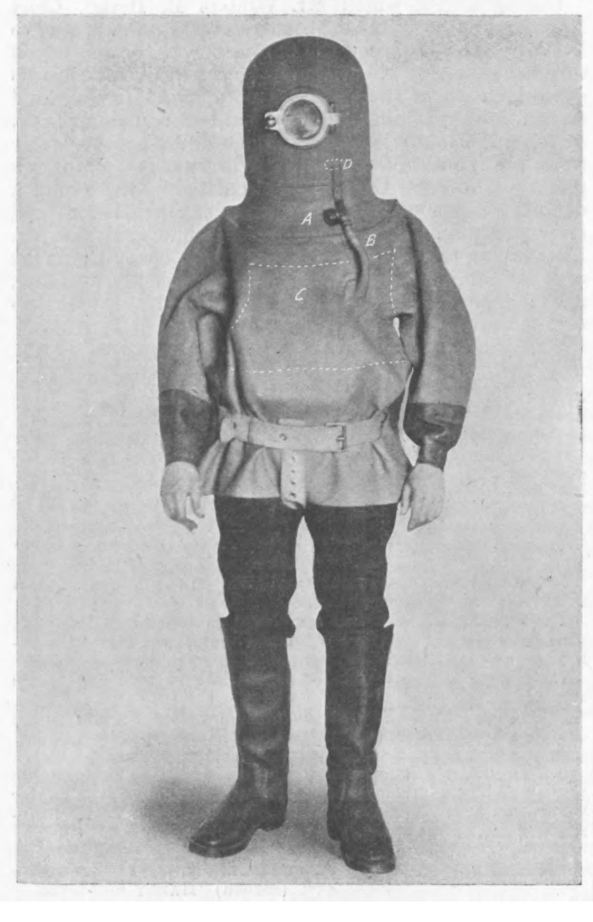


Fig. 4—MAN WEARING THE DRESS

It is taken for granted that an accident which will endanger the lives of the crew will result in the inrush of water in large quantities. A minor accident to the machinery would only result in an involuntary rise to the surface, owing to the reserve buoyancy of the boat, and any ordinary small leakage can be readily dealt with by the machinery at command. When, however, there is a collision, or when, by some other mischance, a hole is made in the hull, the water enters freely, and the effect will be the descent of the vessel to the bottom. This may not be very fast, but, assuming that the water is entering more rapidly than it can be expelled, the vessel will undoubtedly sink and continue to fill, until she is either full, or, if not holed in the top, until the air in her is compressed to a pressure equal to that of the water at the depth in which she has foundered. As soon as the salt water comes into contact with the battery or with the terminals of the dynamo, if this be still working, chlorine is evolved, and the air remaining inside is vitiated.

Having regard to these considerations, it is necessary that something be done, and done quickly

(*a*) To render the crew independent of poisonous gases,
(*b*) To preserve the crew from drowning in the boat, and
(*c*) To provide means of escape from the boat, and ascent to the surface.

The devices to bring these about at present known are:—

(1) Air locks for escape,
(2) Detachable chambers or life boats,
(3) Self-contained dress for escape.

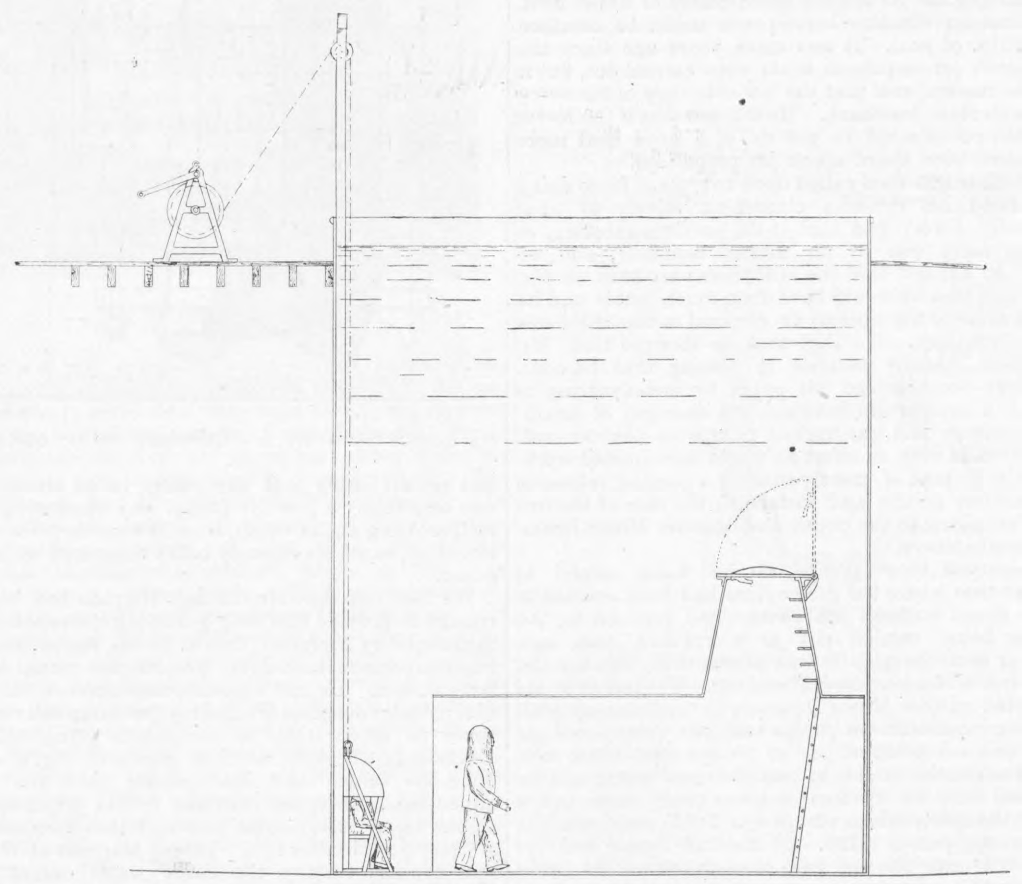


Fig. 5—EXPERIMENTAL TANK AND DUMMY SUBMARINE

Air locks alone are of little use, except in shallow water, but combined with (2) or (3) are essential in all methods of escape. The air lock may be a portion of the boat provided for the special purpose, or the general cavity of the boat may be used, in which case the pressure inside the vessel can be made equal to that of the water outside by simply allowing the water to enter, for it is manifestly impossible to open an aperture until the pressures at both sides of it are equal. The great objection to all forms of detachable chambers or life boats is their size, weight, and resistance, if made large enough to contain all the crew of a modern submarine, and as such a chamber would have to be carried as a superstructure, it would be in the likeliest position to be injured in case of collision. Moreover, what is further against any device of this kind is that the crew are expected in a moment of considerable excitement to undertake an entirely novel operation which there is no means of trying previously. Experience has shown that even plain drop safety weights fail at the critical moment. In fact, as Messrs. Siebe, Gorman remark, there are a great many loop holes for the unexpected in air locks or lifeboats carried in the hull—apart from their constant encumbrance.

It is then pointed out that a life-saving device to be efficient must be able to fulfil promptly the three conditions, *a*, *b* and *c*, previously referred to, and in order to meet them this firm has designed and patented a special form of diving helmet, which is quite self-contained and not dependent on any feature which is liable to get out of order. This apparatus is described and illustrated in the book, and has, we understand, been adopted, after exhaustive trials, by the British Admiralty. Its design and method of use will be understood by the aid of the accompanying engravings. The helmet—Fig. 4—which is made large enough to allow the head free movement, is sloped away to fit the shoulders, and is connected to a short jacket of strong waterproof material. In front of the jacket, inside, is a pocket containing a combined air purifier and oxygen generator, consisting of two small chambers formed in one case. These chambers are charged with a patented substance which, when in contact with the water vapour of the breath, gives off pure oxygen gas and forms a caustic alkali. The alkali in its turn takes up the carbonic acid gas of the respired air and forms an alkaline carbonate. In this way, as in various types of smoke helmet, the same air, purified and re-oxygenated, is used over and over again. The total weight of the whole outfit is 16 lb. Folded up for stowage it occupies a space of 12in. by 12in. by 15in. The dress can be put on without assistance in 30 seconds. When on it prevents a man from drowning, and in proof of this it may be said that it is now in everyday use under water with perfect success. Another important attribute is that it acts as a lifebuoy and actually raises its wearer to the surface. An additional device is also fitted to enable the wearer when he reaches the surface to inflate a flexible chamber which surrounds the jacket and thus to form a lifebelt. This provision is necessary, for the length of time the purifier will remain in action is limited, and when its efficacy is impaired the door in the helmet must be opened, which operation can be performed by the wearer—in order to admit fresh air. When this is done the helmet ceases to be buoyant. In Fig. 4 the buoyant chamber is shown at C; B is the pipe leading from the helmet, A a valve, and D the mouthpiece inside the helmet into which the wearer can blow. Other methods, such as the fitting of cork belts or chambers already filled with air, have been tried and abandoned, being found to be impracticable, owing to the necessity of employing heavy weights to keep the wearer down, and also by reason of the dangerous velocity with which he would rise to the surface on the removal of the weights.

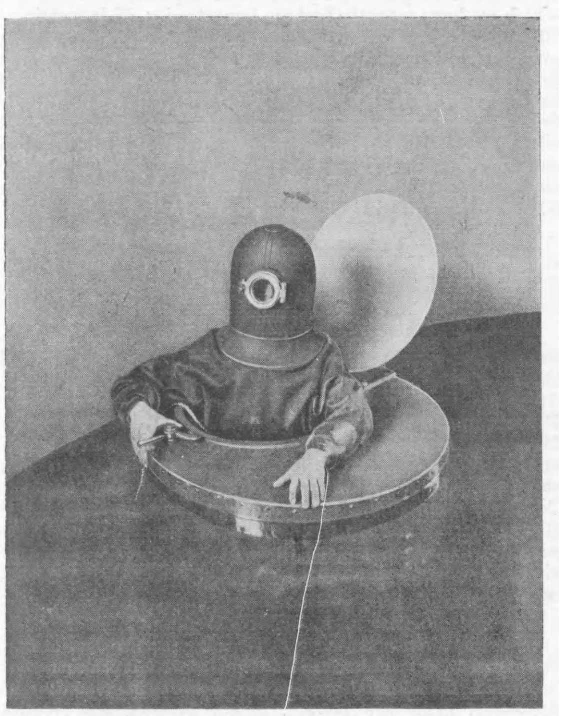


Fig. 6—EMERGING THROUGH HATCH OF CONNING TOWER

It is claimed, and with reason, that a great point in favour of the apparatus is that it can be exercised in. The man is made accustomed to put it on—see Fig. 1—and to work with it under water as a matter of ordinary routine. At Portsmouth the Admiralty have in use a huge water tank, at the bottom of which is erected a skeleton submarine boat. At the surface there is fitted an arrangement for lowering and raising the air lock—see Figs. 2 and 3. The men having first been trained to put on the dress quickly are set to practise getting into and out of the air lock. They are afterwards lowered in the air lock to the bottom of the tank—see Fig. 5—where they enter the submarine, and find their way to a ladder leading to the conning tower, the hatch of which they open—see Fig. 6. In the case of this engraving the water in the tank was partially lowered for the purpose of taking the photograph. They then either float to the surface or return to the starting point, the operations being repeated until the officer in charge considers the men proficient. These arrangements have been designed to represent as nearly as possible the same conditions as would obtain in a submarine boat that had been flooded.

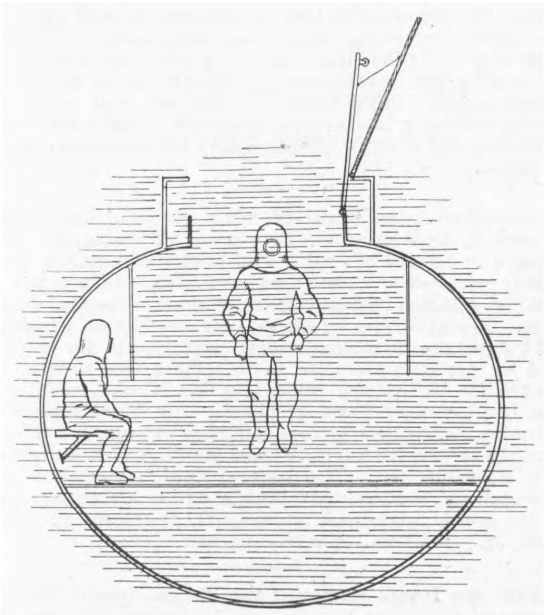


Fig. 7—FLOATING UP THROUGH TORPEDO HATCH

If, as has been explained above, the hole made in the submarine be at the top, the water will gradually displace the whole of the air. If, however, the hole is below the top, then the water will only enter until the air, which cannot escape, has been compressed until its pressure is equal to that of the water outside. In the latter case there is no difficulty in getting at and putting on the helmet dress, since there is air inside the hull. In the former case, however, unless some special provision were made, this would not be so, and, accordingly, bulkheads are arranged as shown in Fig. 7—so as to trap the air. The dresses are kept hanging up in readiness in the air pockets so formed. This does not in any way affect the habitability or efficiency of the vessel, and all the newer submarines in the British Navy are so fitted, whilst the older types are being converted.

It is claimed, further, that the apparatus makes an excellent shallow water diving dress, though in this case the man has to be weighted, and that it is also efficient as a smoke helmet. As a diving dress it can be used for about forty minutes at a maximum depth of 25ft. on one charge of the oxygen-producing compound. As a smoke helmet the densest and most sulphurous fumes can be encountered with immunity, and the man can do light work for about one hour or hard work for about forty minutes on one charge.

LETTERS TO THE EDITOR.

(*We do not hold ourselves responsible for the opinions of our correspondents.*)

THE GAS PUMP.

Sir,—Mr. Humphrey's mind appears very much disturbed because I said his pump should have a pipe of a capacity something like that which his actual pump has.

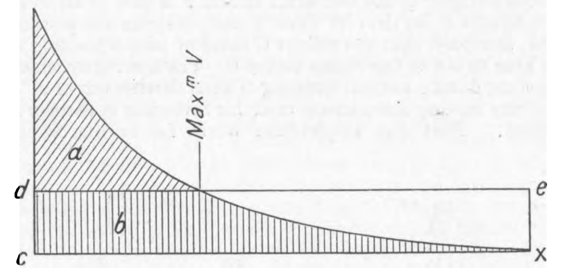
From Dr. Unwin's report of the pump I find that the pipe is 24in. diameter and 135ft. long. The lift is 33ft., so that the pipe is four times the length of the lift.

Mr. Humphrey, in his letter to you, says that he only requires a pipe of one-tenth the length. Then why in the name of common sense did he take the trouble to go out into the wilderness with a pipe 135ft. long, involving a return pipe of equal length when the tank into which the water was pumped was immediately by the side of the pump itself? Why did not the pump deliver direct into the tank? The reason is quite obvious. Without a pipe of similar capacity to that of the one used, there would not be kinetic energy enough in the water to enable the gases in the pump to be expanded from the initial to atmospheric pressure, with a reasonable amount of effective work. If the 24in. pipe had been reduced to a length of 33ft. the capacity of the pump would have been reduced to about one-fourth the power, the other conditions remaining the same.

Mr. Humphrey accuses me of propounding a theory to the effect that the length of the pipe must be three to four times the length of the vertical lift, where the maximum velocity of the water is limited to 10ft. per second, and omits to say that my statement was conditional on the pipe being the same size as the rising main. I propounded no theory that it must be so, but I know of a practical reason why it should be so. It should be so if you wish to get a reasonable quantity of water through a given size pipe at a given head.

If anyone were to tell me that a fly-wheel of a given weight and speed was as effective on a large gas engine as on a small one I should reply, "Tell that to the marines." The Humphrey pump is a pistonless gas engine in which the water in the pump pipe performs the function of a fly-wheel. The larger the capacity of the pipe the heavier the fly-wheel.

If we had an indicator diagram from the pump, it would be easy to discover what weight of fly-wheel was required for a given speed. We have no diagram from the Humphrey pump, but it is not difficult to imagine what it must be like if it has any analogy to a gas engine diagram. It would probably be like the following figure:—



The area *a* represents the energy taken up by the water in the pipe, and the area *b* the direct-pressure energy; the two areas together being equal to the work done, or the area of the rectangle *c*, *d*, *e*, *x*. The area *a* would probably be about four-tenths, and the area *b* six-tenths of the rectangle.

A 24in. pipe has a capacity of about 20 gallons, or 200 lb. of water per foot run. The energy of 200 lb. at 10ft. per second equals $\frac{W\,V^2}{64} = 300$ foot-pounds.

Example is better than theory. Take a 24in. pipe; pump displacement during the forward stroke, 250 gallons; 200ft. lift; and maximum velocity of the water in the pump pipe 10ft. per second. The total energy per stroke would then be 200ft. lift multiplied by 2500 lb. pump displacement, equal to 500,000 foot-pounds. Four-tenths of that energy is required to act as a fly-wheel, viz., 200,000 foot-pounds. The length of pump pipe required will then be $\frac{200{,}000}{300} = 666$ft.

If Mr. Humphrey is going to use a 24in. pipe only one-tenth the length, then the pump will only pump one-tenth the quantity, an absurdly small quantity for a 24in. main.

I stated that the pipe might be shortened by increasing its capacity. If Mr. Humphrey means that his shortened pipe of one-tenth the length shall have the capacity of the longer pipe, then his criticism of my statement is misleading.

The subject will be of more practical interest when Mr. Humphrey has other pumps than the one at Dudley—which has a pipe four times the length of the lift—to refer to. In the meantime I wish him every success. I have a great admiration for the Humphrey pump, and I would have said so at the meeting, and nothing else, but I was under the impression that the paper was submitted for criticism and discussion, and not for eulogy only.

Ewell, December 3rd. Henry Davey.

Sir,—I thank you for your courtesy in submitting Mr. Henry Davey's letter to me, as I am thus enabled to deal with it at once.

Mr. Davey, in opening the discussion on my paper, stated as a definite principle that, if the maximum velocity of the water in the pipe did not exceed 10ft. or 12ft. per second, the horizontal portion of the discharge pipe of my pump would have to be three or four times the vertical portion, assuming the same diameter of main throughout. I replied that the statement was inaccurate, and I now find that Mr. Davey abandons his position.

Again, I pointed out last Friday that as the simple form of Humphrey pump could only lift to 35ft. or 40ft. head, any calculation for a 200ft. lift must refer to the pump worked in conjunction with air vessels, in which case the length of the pipe was independent of the head, but Mr. Davey still ignores this fact.

Now let us turn to Mr. Davey's calculations. His arguments will not be affected if we change the number of gallons delivered per stroke, so we will substitute 75 gallons for his 250 gallons. Following through the calculation with everything else unchanged, the length of pipe works out to 200ft. Therefore, according to his formula, a pump should deliver 75 gallons per stroke to 200ft. through a 200ft. pipe, or, in other words, through a vertical pipe. The horse-power would be considerable, as the operation would be very rapid.

The *reductio ad absurdum* is reached by substituting 37.5 gallons per stroke, for then we find that, the maximum velocity still remaining 10ft. per second, a pump delivering this quantity per cycle to a height of 200ft. would only require 100ft. of pipe al told.

Mr. Davey asks a number of questions. I will reply as briefly as possible. The arrangements at Dudley Port had to be such that the pump could be tested at various heads. To arrange tanks for this would have been very expensive, while an air vessel was relatively cheap, and admitted of the head being changed instantly. Then as regards the 135ft. of pipe used with the pump tested by Dr. Unwin, this pump was at first run with 63ft. of pipe, but at the highest lift, and with the water valve area available, the longer pipe gave the best efficiency. For a given lift, charge volume, and diameter of pipe the horse-power increases as the length of pipe diminishes, so long as sufficient time is allowed for the water to enter the pump, and this is where Mr. Davey makes another mistake, as he states the contrary. The shorter pipe gives the greater number of cycles in unit time.

Genuine criticism is always welcome and helpful, eulogy is not wanted, but inaccurate statements must be corrected. Mr. Davey and I have since met, and I am sure the heartiness of handshake was genuine on both sides, so I trust the matter may now drop, as we are both too busy to indulge in paper warfare, and the space in your columns is too precious. H. A. Humphrey.

London, S.W.,
December 8th.

Sir,—Replying to Mr. Humphrey's letter in your issue of the 3rd, it would be superfluous to point out to him that it is not only usual, but advisable, in giving a guaranteed fuel consumption, to name a figure that one knows can be easily achieved, so as to allow for the unavoidable fluctuations in the quality of producer gas, and for the differences in the calorific values of different fuels. The margin of .11 between "water horse-power" and "brake horse-power" does not seem to me to err on the side of excessive caution. Personally, I am a believer in the "Humphrey" pump, and fully recognise that it may not yet have reached its highest efficiency in the tests which have been made, and it was only to advocate the claim—possibly temporary only—of the gas engine, that I wrote my last letter. I am pleased to include Mr. Humphrey among my personal friends, and it was for this reason, and with a wish to avoid any appearance of "trade controversy," that I wrote my letter in my private capacity.

The Wyelands, Buxton, S. Hastings Irwin.
7th December.

CENTRIFUGAL FORCE.

Sir,—I have read from week to week the various replies which your kind correspondents have given to my question, and this morning I have sat down and read them all over again. The effect of the whole correspondence on my mind is that centrifugal force presents a dilemma which no one has been able so far to solve.

It is interesting to note that not one of your correspondents has said that another correspondent is right. On the contrary, from the mass of words, so far as anything bearing on this point can be gathered, it appears to me that there is no formal agreement whatever, while there is a good deal of contradiction. It would help matters perhaps if, for example, Mr. Sayers would tell me whether he agrees with "Lundin," or if Mr. Dines would say whether he is in accord with "A. R." or with "L. R."

The dilemma has more horns than two. I will take two. First we are told that a revolving constrained body is continuously "accelerated" toward the centre round which it revolves. The popular definition of "accelerated" is "hastened." A falling body is accelerated by gravity, its velocity becoming continuously greater and greater. Turning to "Nuttall's Standard Dictionary," I find "accelerate, *v.t.* to hasten; to quicken the speed or rate of (L. *ad* to and *Celer* swift").

"Accelerated, *a*, quickened in motion, hastened in progress; *accelerated motion*, that which is continuously receiving fresh accession of velocity; *accelerated force*, the increased force which a body exerts in consequence of the acceleration of motion."

"*Acceleration of the moon*, her increase of mean motion compared with the diurnal motion of the earth."

Your correspondent "X." mentioned Clark Maxwell. In the little primer, "Matter and Motion," I find, "the word acceleration is here used to denote any change in the velocity, whether that change be an increase, a diminution, or a change of direction. . . . As the displacement of a system is defined to be the change of the configuration of the system, so the Total Acceleration of the system is defined to be change of the velocities of the system." This seems definite enough. Until we come to curvilinear motion, indeed, there is no other definition or meaning given to the word acceleration save hastening.

Secondly, it is a definite proposition—an axiom, indeed—that no change in direction or velocity of movement can be produced without the action of some external force; and it is further defined that the operation of a force through a distance means work.

What your correspondents have tried to do for my benefit is to reconcile these propositions with the explanations (?) of centrifugal force contained in text-books. In the first place, as a fact, the velocity of the stone is constant. There is no acceleration; consequently there is no work done. We are, however, told that the stone is continuously accelerated, and that it is the production of this acceleration that causes the radial pull. Here, then, we have a mass accelerated by a force, and yet no work is done. This seems to me to be a hopeless muddle of definitions. In order to get out of it we are told that for this particular case—so far I have been unable to find any other—a special meaning is given to the word acceleration. Precisely what this meaning is no one appears to know. According to Sir Oliver Lodge, as quoted by your correspondent X. it seem to be something which the stone is constantly receiving and never gets, which reads more like a "bull" than a scientific explanation of ascertained facts.

Nobody, of course, knows why there is a tangential effort. I am told that the first mathematician to investigate centrifugal force was the Marquis de l'Hopital. He seems to have been responsible for the statement that when a body is constrained to move in a circle it will make that circle as large as possible, because a large circle diverges less from a straight line than a small circle, and in any given advance of the body it is, therefore, less deflected.

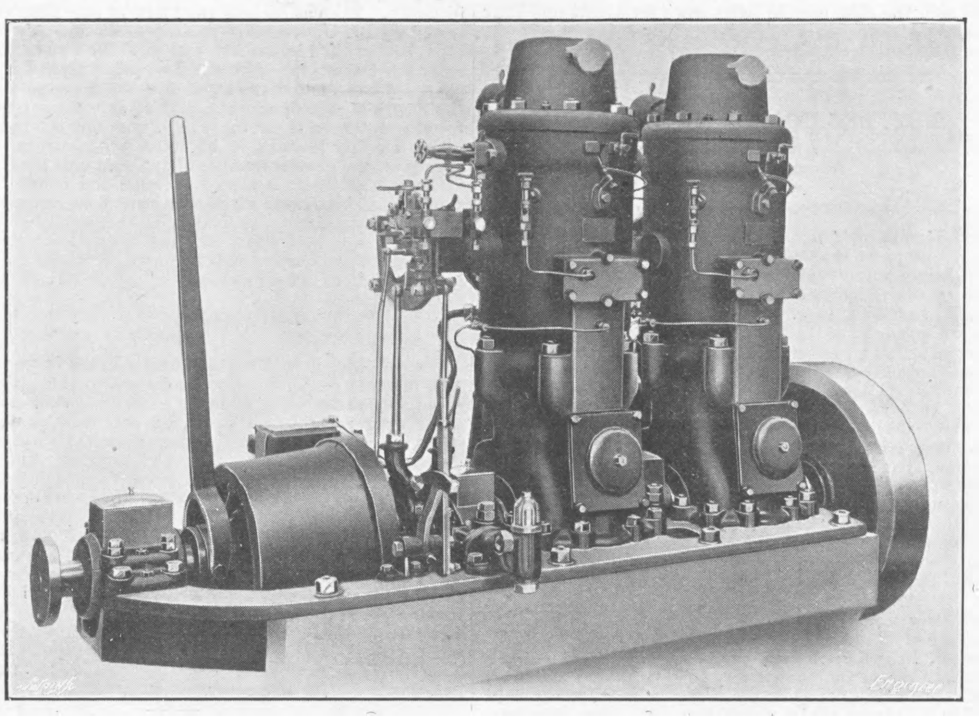
Incidentally, I may point out that the diagram given by "L. R." possesses the merit of originality. Nothing of the kind is, I am sure, to be found in text-books, according to which, while the stone is revolving, there is no force in operation but a tangential force. The line M F L has no existence. The diameter of the circle T P is quite arbitrary. Why not make it equal to that of the circle described by M?

The general result of an examination of the whole matter appears to me to be that the scientific men who write text-books have failed to find words to express their meaning, or to build up concepts on the virgin soil of the student mind—perhaps I may be excused this mixed metaphor. Examples of this crop up everywhere about the question. Thus, while the string pulls on the stone and the stone on the string, we are told that the result is a "stress" and that a stress does no work. If, now, the stone lies in a little carriage which runs without friction on a perfectly smooth level table, precisely the same pull will really accelerate the stone in the car and will do work upon it. In this case, then, a stress does work. Perhaps it is not a stress. Will any correspondent kindly say if not, why not, and what is the difference between a stress and a balanced force, and let us have a definition of an unbalanced force?

Might I suggest that some competent authority shall frame an accurate concept of what centrifugal action really is, and then select with care words which will involve no contradiction and will serve to transfer that concept to the mind of a student and

December 4th. Pater.

A REVERSIBLE MARINE OIL ENGINE



A NEW REVERSIBLE MARINE OIL ENGINE.

AT the invitation of James Pollock, Sons and Co., of 3, Lloyd's-avenue, E.C., we were recently invited to attend a demonstration which was organised to show the capabilities of the Bolinders direct reversible marine oil engine, fitted to a bluff-built fishing vessel of the Swedish type, 60ft. by 19ft. by 9ft. A short trip was made on the Thames, when the engine was reversed with great ease, and the general manipulation was equally satisfactory. The engine, which is shown above, is of the two-cycle type, delivering a power impulse for each revolution of the fly-wheel. The principle will be understood from the diagram—Fig. 1. On the upstroke of the piston a partial vacuum is created in the enclosed crank chamber, causing the charge of air to enter at the inlets B. When the piston is near the end of the stroke, an oil pump automatically injects the proper amount of oil through the nozzle F into the heated ball E. On starting, the latter is heated by means of a blow lamp, but when the engine has been running for a few minutes this is put out of action. The mixture of air and gas is fired, driving the piston downward, during which time the charge of air previously drawn into the crank-case is compressed. When the piston approaches the end of the down-stroke it uncovers the exhaust, the exhaust port G permitting the burnt charge to escape through the silencer. Immediately afterwards the transfer port H on the opposite side of the cylinder is uncovered by the piston, thereby allowing the charge of air compressed in the crank chamber to pass into the cylinder, where it is deflected upwards by the shape of the top of the piston, and caused to fill the cylinder, thereby expelling the remainder of the burnt charge. It will be seen that the engine is of very simple construction. The method of reversing the engine will be understood from the diagram—Fig. 2. A is an oil-fuel pump, having two pistons B C. The piston B is adapted to work during normal conditions when the engine is running in one direction, while the other C is used for reversing. Suppose the engine to be running in the direction of the arrow, then during the normal running of the engine the feeding mechanism appertaining to the pump piston B is in action. It is worked by means of the excentric D, which imparts to the lever E a rocking motion, by which the weight F is reciprocated on the arm H.

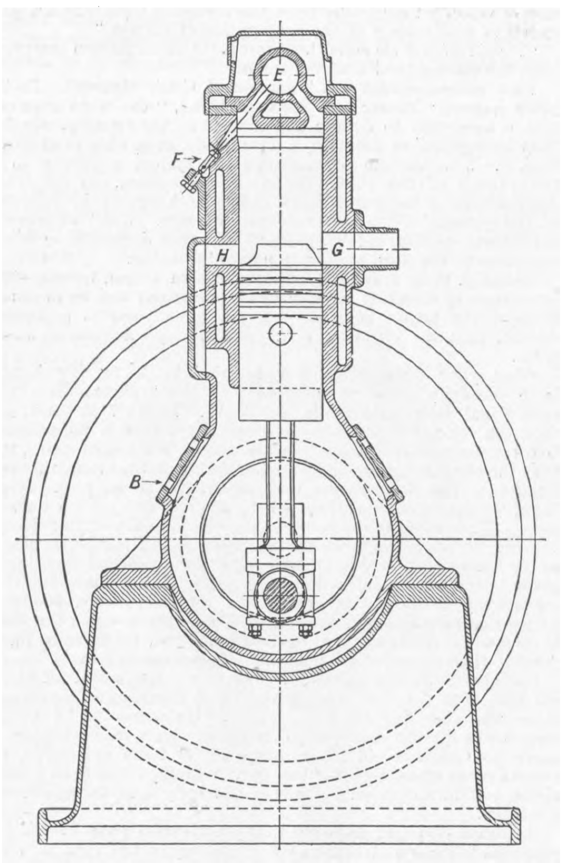


Fig. 1—VERTICAL CROSS SECTION OF THE ENGINE

The feeding mechanism for reversal is of the same construction, and acts in the same manner as that for normal running. The reversal of the direction of movement of the engine takes place in the following manner:—The lever G is thrown to the right, so that the left edge of the link K is thrown into engagement with the friction disc L, whereby the link and rod S are lifted. The arm H is lifted from the abutment O, and at the same time the arm P is moved from the position illustrated toward the abutment R. The result of the shifting of the two arms H and P is first of all to raise the weight F, so that its tooth T cannot strike the piston B, and, secondly, that the weight U takes up such a position as to be able to strike the pump piston C. The feeding mechanism working during normal running is thus thrown out of action, and the feeding mechanism used for reversing is thrown into action. That one mechanism works for normal running in either direction and the other for reversal will be evident on considering that the weights F and U in one and the same position of the engine take up opposite end positions. When the weight F is in the position in which it keeps the piston B pressed inwardly, the working piston of the engine is at that end of the cylinder next to the explosion chamber, whence it will be driven out by the explosion of the fuel just injected. When the piston has arrived at the other end of the cylinder, the main shaft has made half a revolution, and the weight U is thus in the position in which it will press the pump piston C inwardly, provided, of course, that the reversing handle has moved so as to reverse the engine. Assuming this to be the case, the pump piston C feeds fuel into the cylinder. The fuel consequently explodes before the working piston has reached its innermost position. The piston is thus stopped, driven backwards, and the engine begins to move in the opposite direction. After the lever G has been shifted towards the right and the engine has commenced to rotate in the opposite direction, the link K with the rod S are obviously moved downward. On account of this, the arms H and P are automatically shifted so that the weight F is again made operative instead of the weight U. The explosions therefore again take place at the normal time, so that the engine is continually driven in the direction obtained after reversal. If the engine is to be reversed again, the lever G is thrown to the left, so that the edge of the link K is again brought into engagement with the friction discs. At X and J there are two springs to keep the weights F and U in contact with the moving arms. As will be seen from our illustration, the engine fitted to the boat mentioned above has two cylinders. The diameter of the cylinders is 330 mm. and the stroke 340 mm. The speed is 325 revolutions per minute. The engine has several special features in addition to the reversing gear, one of these being that no separate compressor is used for compressing the air for starting purposes, one of the engine cylinders serving this purpose. The capacity of the engine, which we have recently had an opportunity of inspecting, is 80 horse-power, and it is capable of developing 20 per cent. overload. The engine has a pump for providing water circulation and also a bilge pump. Forced lubrication is used throughout, and all the principal bearings have a small pump driven from a common shaft. In this particular boat the whole of the control is carried out in the engine-room, but the firm is now constructing a 70ft. motor barge which is to be controlled from the deck. This is also to be fitted with an 80 horse-power engine of the same type.

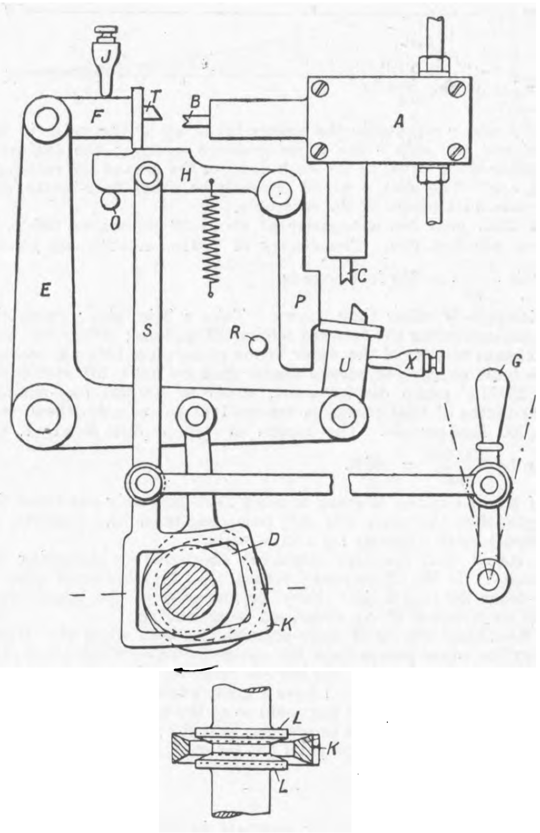


Fig. 2—REVERSING MECHANISM

SHIPBUILDING NOTES.

THE new work contracted for during the latter part of last month has gone mainly to the Clyde. In addition to the three large vessels for Messrs. H. and W. Nelson's South American trade which have been already noticed, Messrs. Russell are to build a cargo steamer for Glasgow owners. Messrs. Hamilton, of Port Glasgow, have contracted to build one, and Messrs. McMillan, of Dumbarton, two cargo steamers. It is also stated that Messrs. Barclay, Curle and Co. have secured the contract for a large steamer for the Blue Anchor line. On the other hand, Messrs. Denny Bros., who are usually fortunate in respect of their winter's provision of orders, are on short time, the men working an eight hours' day.

IT is stated that the Admiralty order for the two floating docks intended to accommodate the latest battleships of the improved Dreadnought class has now been placed. The successful firms are Messrs. Swan, Hunter and Wigham Richardson and Messrs. Cammell, Laird and Co. As our readers know, these are to be the largest docks of this kind yet built; the total lifting capacity is to be 32,000 tons.

WE regret to have to record the death of one who was well known in the shipbuilding world, Mr. W. J. Bone, managing director of the Tyne Iron Shipbuilding Company, Limited. Mr. Bone, who was in his sixty-seventh year, was trained in the service, and studied at the Royal School of Naval Architecture, and, as an old student of that school, he was generally seen at the biennial dinners of old students. He was for a long time a surveyor to Lloyd's Register, and was one of the original partners of the Tyne Iron Company.

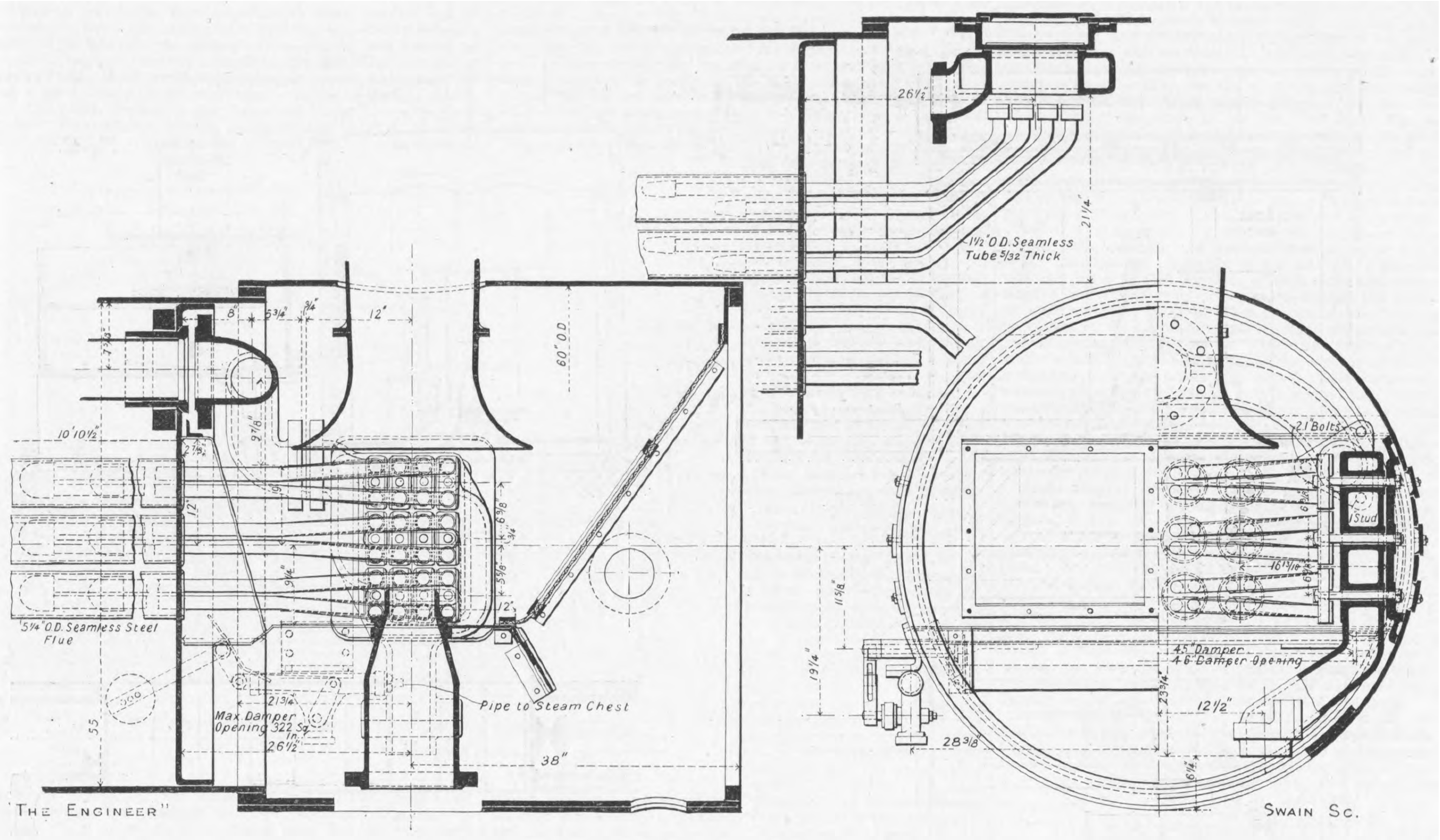
THE report of the United States Commission of Navigation contains some points of interest. Dealing with the annual period ending with June of this year, it is reported that the total commercial shipping of the United States has reached a total of 25,688 vessels, representing 7.4 million tons—a larger total than that credited to any other country except Great Britain. It is significant to note, however, that a very great proportion of the above tonnage is engaged in domestic trade only, and that only 887,000 tons are registered as being for oversea commerce. This total is less than that of the preceding year by 53,000 tons, and, in addition, it is stated that a goodly proportion even of this small tonnage is idle. The report shows that the depression, with which we are unhappily familiar, is not local, but practically of world-wide scope. At the same time, it is rather surprising to find so small a part of America's mercantile marine engaged in foreign trade. In the summer of this year there was a considerable activity in American shipbuilding, and a few vessels were then laid down in Atlantic coast yards for oversea freight purposes.

AS we have before remarked, the literature of naval architecture is, considering the importance of the subject, very meagre in respect of quantity at least. This fault is being slowly remedied, and some time ago Professor Biles published the first volume of his long promised work on naval architecture. Professor Biles, of course, addresses himself to readers who have already received some instruction in the subject, and we are glad, therefore, to welcome a new volume, intended for the average student, by Mr. Nicol, a member of the Institution of Naval Architects. Mr. Nicol appears to have the faculty for laborious collection of facts, and to have also the capacity to set forth these facts in a straightforward and clear manner. The book—"Ship Construction and Calculations"—covers very completely the elementary part of the subject, and should prove useful to officers, draughtsmen, &c., for whom it has been written.

FOR the Hoogli service of the Bengal-Nagpur Railway Company there was launched on November 28th from the yard of Wm. Denny and Brothers, Dumbarton, the train-ferry steamer Sir Trevredyn Wynne, 300ft. long, 50ft. breadth moulded, and 11ft. 6in. deep at sides. This vessel is to carry on her deck three heavily loaded goods trains, and at each end there is a set of three turntables worked by steam and controlled from the deck. Care has been taken to provide strength against racking as well as against longitudinal strains. The vessel is of the same design at each end, and all gear is duplicated, so that she may run either ahead or astern. The propelling machinery consists of two independent sets of paddle engines, which, together with the boilers, have been designed to come entirely underneath the main deck. The vessel has been built to the specification and instructions of Sir John Wolfe Barry, K.C.B. The train ferry service on the Hoogli, when started eight or nine years ago, was very strongly opposed. It has proved so successful that the port authority granted permission to duplicate it.

LOCOMOTIVE SUPERHEATER

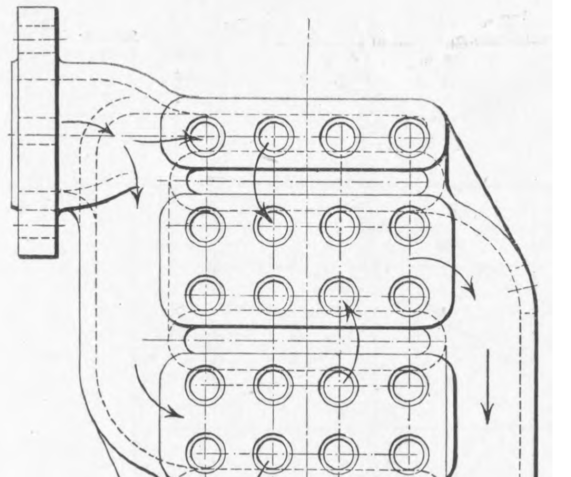
THE AMERICAN LOCOMOTIVE CO., SCHENECTADY, ENGINEERS



AN AMERICAN LOCOMOTIVE SUPERHEATER.

THE application of superheated steam to locomotives has for many years past received particular attention at the hands of American engineers, and in the example of an apparatus of this kind, which is herewith illustrated, there will be found several features of interest, since it may be taken as embodying the most recent ideas on this subject.

The engines to which this superheater has been fitted are two eight-wheeled passenger locomotives built by the American Locomotive Company for the Western Railway of Havana. A previous example of this form of superheater is to be found on a "Consolidation" locomotive recently built by the same company for the Wabash-Pittsburgh Terminal Railway. From the engraving, showing the smoke-box details, it will be seen that the superheater is of the return-tube type. On either side of the smoke-box barrel a cast iron header is bolted to a box-shaped casting. The interior of these headers is divided by walls into four distinct chambers—see end view—and of these, reckoning from the top, the first and third are in communication with the steam tee-pipe, while the second and fourth are connected to the steam passage of the cylinder, the connecting pipe being formed as part of the header, thereby avoiding unnecessary joints. Six rows of holes are formed on the inner face of the header, the first and fourth chambers having one row each, and the second and third, two. From these holes pipes are led, and being suitably bent, these enter the enlarged boiler tubes provided for their reception. Four tubes from the header are led into each boiler tube, and extend back to within 32in. of the fire-box tube plate, where they are connected vertically by return bends into pairs. It will thus be seen that steam supplied to the first and third chambers will leave the header by the first, fourth, and fifth rows of tubes, travel back towards the fire-box, and return to the header by the second, third, and sixth rows, which lead, as already stated, into the second and fourth chambers, and thence to the cylinder.



HEADER FOR SUPERHEATER

The peculiar method of securing the superheater tubes to the header is worthy of special note. For this purpose the ends of the tubes are upset, machined to a spherical form, and ground into their seats, which consist of the countersunk edges of the holes in the header. A gland extends across the ends of each connected pair of tubes, and a single bolt in each gland serves to pull the tubes tightly on to their seats. Provision is made for the passage of these bolts through the header by leaving an open space between the four chambers above mentioned. The bolts pierce the box-shaped casting attached to the side of the smoke-box, and are secured by nuts to which access is had through doors provided for that purpose in the smoke-box barrel plate.

It is claimed by the makers, who are also the patentees of the superheater, that this design allows complete freedom for expansion and contraction, and hence avoids the troubles incidental to leaking joints which are features of some other arrangements.

To control the admission of the hot gases to the large boiler tubes, a damper is provided at the smoke-box end. The arrangement of this damper is clearly shown in the engraving. A small steam cylinder in communication with the steam chest of the main cylinders is carried on the platform outside the smoke-box, and this cylinder operates the damper automatically, a balance weight being provided to give the return or closing motion. It will thus be seen that admission of steam to the cylinders also involves the opening of the damper, and brings the superheater into action, which at other times is inoperative.

We give below some numerical data dealing with the engines and superheater :—

Cylinders	18½in. by 24in.
Driving wheels	68in. diameter
Working pressure	165 lb.
Tractive effort	17,000 lb.
Grate area	17.8 square feet
Heating surface (tubes and fire-box)	1071 square feet
Heating surface (superheater)	158 square feet
Tubes :—	
135 charcoal iron	2in. by 12 I.W.G.
43 seamless steel	1½in. diameter
12 seamless steel	5¼in. diameter

THE REDUCING ALLOY SICAL.

A REDUCING alloy to which the name of Sical has been given has recently been put upon the market by the Société des Carbures Metalliques, the works of which are at Notre Dame de Briançon in France, whilst the London representative is Monsieur A. P. Champin, 47, Victoria-street, Westminster, S.W. This alloy consists principally of a mixture of silicon and aluminium with the addition of small quantities of other elements, such as titanium, calcium and manganese. It is claimed that it is suitable for all steel and iron metallurgical processes, and particularly so for cast and rail steels. It contains the ingredients mentioned in approximately the following proportions :—

	Per cent.
Silicon	50 to 55
Aluminium	22 to 29
Titanium	2 to 4
Calcium	1
Manganese	0.20
Carbon	0.20 to 0.30

Its introducers state that it can :—(1) Entirely take the place of ferro-silicon, which is now so universally used, even when added in smaller proportions than are usual with this substance; (2) turn white pig iron into grey pig iron when put without modification into the cupola; (3) absolutely prevent blow-holes or flaws during the manufacture of steel, its special effect being to disperse the gases in the metal by carrying them away together with the fluid scoriæ. And that, further, the metal obtained is harder and the melting operation less violent, while all the iron oxides are reduced on account of the greater affinity of silicon for oxygen. It is urged that ferro-silicon alone, only acts as it does by reason of the presence of silicon, which is combined with iron during its manufacture for the convenience of the operation, that the combined iron is a deadweight and is unremunerative, and that the substance reduces the temperature when tapping at the very moment when the maximum fluidity is important. It is further urged that aluminium, which acts upon steel more energetically than silicon, has, when used alone, the objections of being high in price and of being very volatile, thus showing a heavy proportional loss on melting.

On the other hand, it is stated that all the elements of the Sical alloy act at the same time, and that its peculiar qualities are due to the proportions of each element present. It is but slightly volatile, and it will not begin to volatilise till a temperature of 1350 deg. Cent., 2462 deg. Fah., is reached.

We have not had an opportunity of observing for ourselves the action of this alloy and are only able to add to the foregoing the following statements regarding its action and attributes which have been furnished to us by the makers. Its use with cast iron is advantageous as this material contracts strongly in cooling, and while hot has a tendency to absorb gases. Sical, being low in carbon, prevents flaws during cooling. It will find its most general application in Martin furnaces and small converters. The scoria which remains is a silicate of alumina and lime. It is readily fusible, and when floating after tapping removes the impurities and gases, if any are still present, and the steel obtained is homogeneous and tenacious. Steel and iron castings of all kinds can be perfectly made when it is used.

The following statement of the relative calorific value of Sical and other alloys has been handed to us by the makers :—

	Calories.
1 lb. of ferro-silicon 25 per cent. Si gives for its contents of Si	886
1 lb. of ferro-silicon 50 per cent. Si gives for its contents of Si	1773
1 lb. of silico-calcium 63 per cent. Si and 28 per cent. Ca gives for its contents of Si and Ca	2650
1 lb. of ferro-silicon 75 per cent. Si gives for its contents of Si	2650
1 lb. of Sical 55 per cent. Si and 25 per cent. Al gives for its contents of Si and Al	2900

1 lb. of pure carbon, it may be added, gives over 3500 calories.

THE use of T-rails is recommended for track construction in paved streets by the committee on permanent way matters of the American Street and Inter-urban Railway Engineering Association, except where the traffic is confined to the railway strip, or is so congested that the strip is continually used by vehicles. Under these conditions, which obtain only in the largest cities, the committee recommended a girder rail with a deep, roomy, self-cleaning groove.

THE INSTITUTION OF MECHANICAL ENGINEERS—AN INTERNAL COMBUSTION PUMP

(For description see page 617)

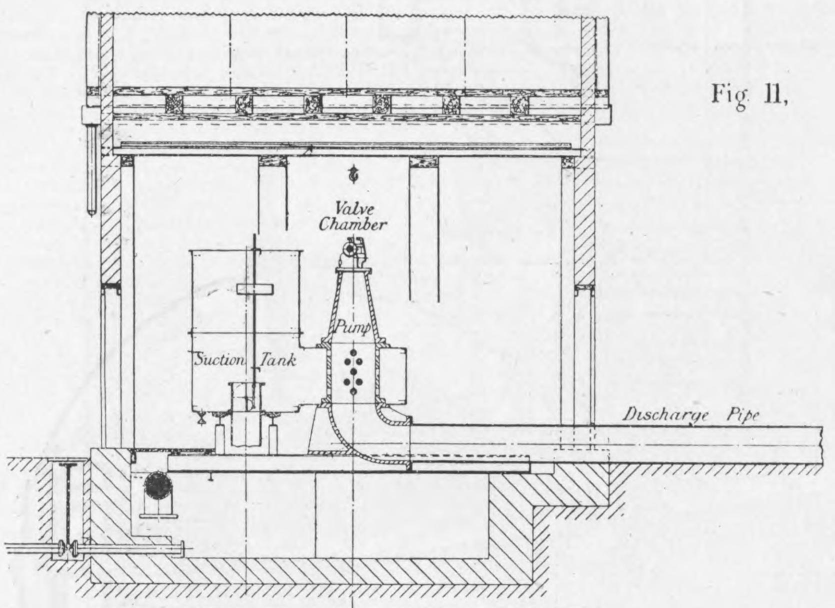


Fig 11.
Valve Chamber
Pump
Suction Tank
Discharge Pipe

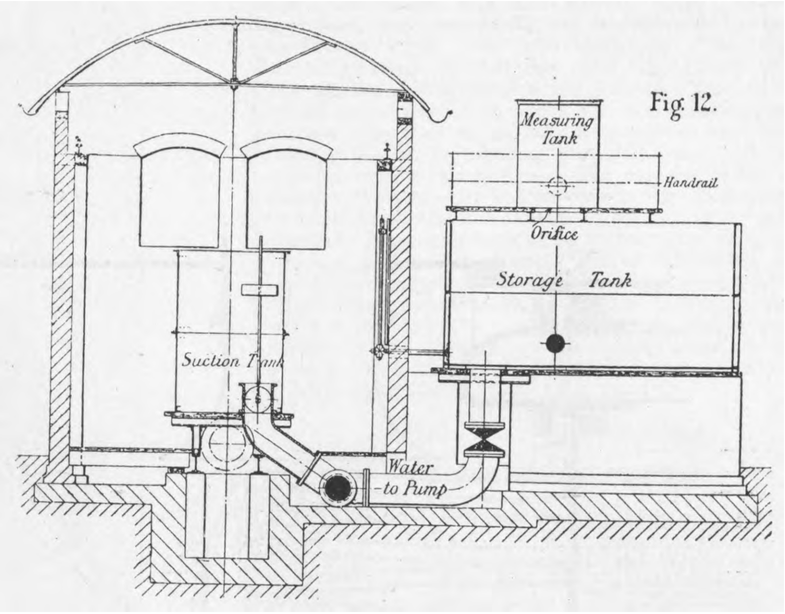
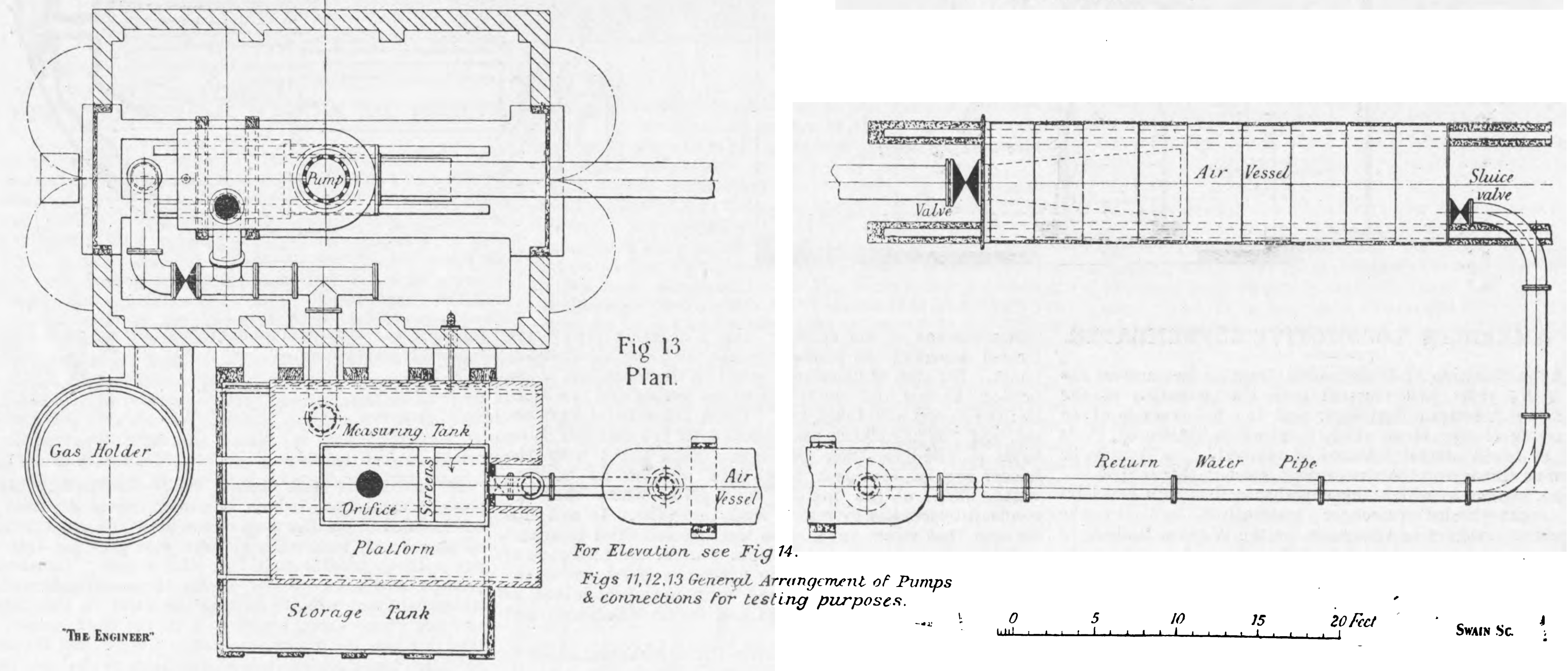


Fig 12.
Measuring Tank
Handrail
Orifice
Storage Tank
Suction Tank
Water to Pump


Pump
Fig 13
Plan.
Gas Holder
Measuring Tank
Orifice
Screens
Platform
Storage Tank
Air Vessel
Valve
Air Vessel
Sluice valve
Return Water Pipe
"The Engineer"
0 5 10 15 20 Feet
Swain Sc.

For Elevation see Fig 14.

Figs 11, 12, 13 General Arrangement of Pumps & connections for testing purposes.

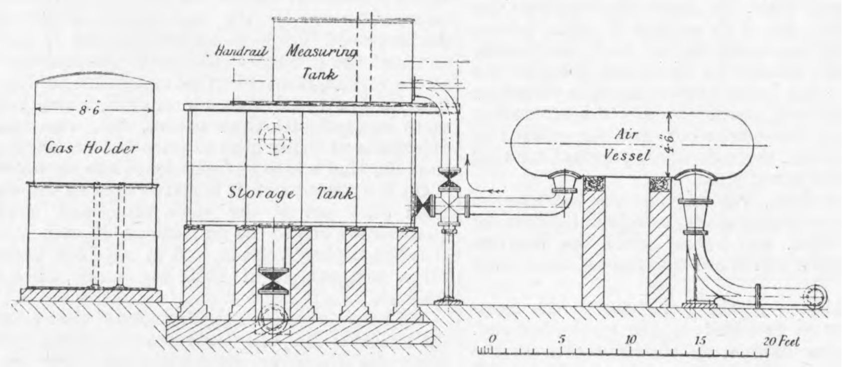

Handrail
Measuring Tank
8·6
Gas Holder
Storage Tank
Air Vessel
4·6
0 5 10 15 20 Feet

Fig. 14.—*Tanks for Testing.* (For plan see Fig. 13.)

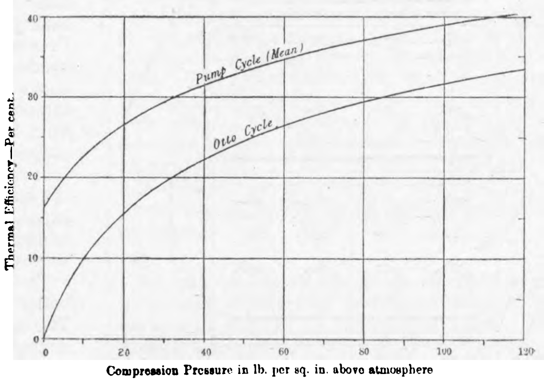


Fig. 17.—*Practical Efficiency Curve. 0·71 of Air Standard.*

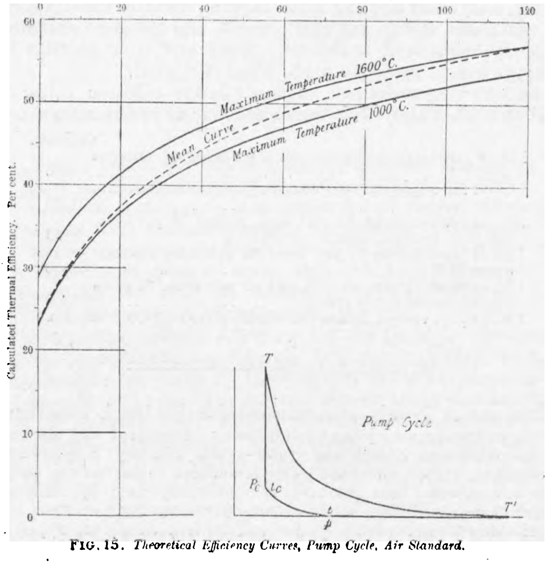


Fig. 15. *Theoretical Efficiency Curves, Pump Cycle, Air Standard.*

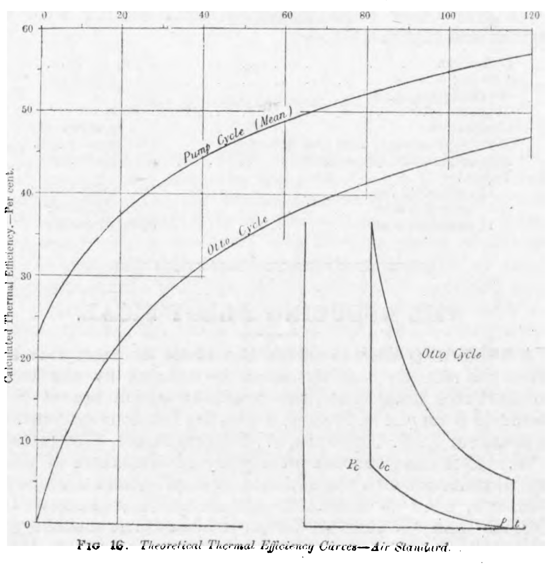


Fig 16. *Theoretical Thermal Efficiency Curves—Air Standard.*

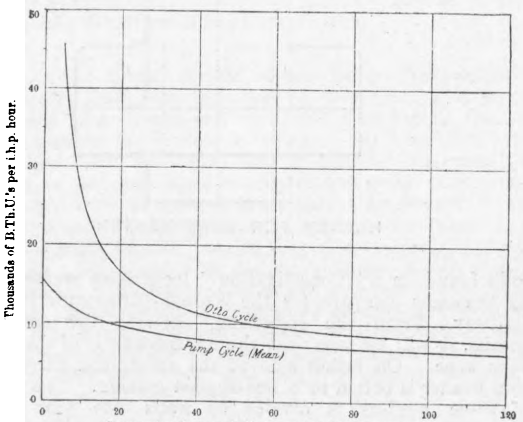


Fig. 18.—*British Thermal Units per i.h.p hour. Calculated from 0·71 of Air Standard.*

AN INTERNAL COMBUSTION PUMP, AND OTHER APPLICATIONS OF A NEW PRINCIPLE.*

By MR. HERBERT A. HUMPHREY, Member, of London.

(*Concluded from page* 587.)

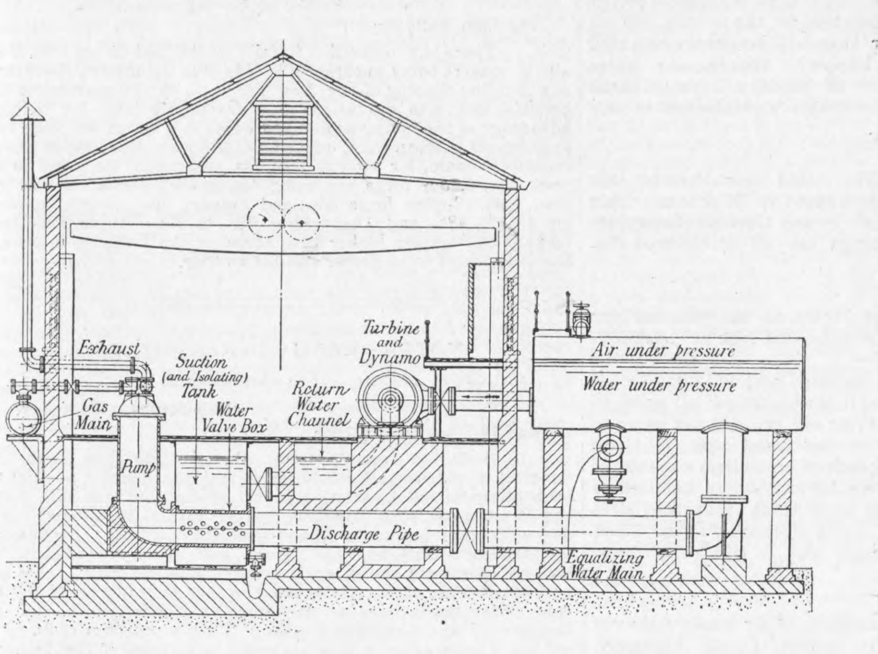


FIG. 19. *Diagram of suggested Central Electric Station, showing Hydraulic Coupling between the Gas Power and Electric Power.*

Efficiency tests.—The first experiments were carried out at Brimsdown, but in the early part of 1908 a testing station, specially designed to facilitate the testing of the pumps, was erected on ground belonging to the South Staffordshire Mond Gas Company at Dudley Port. Mond producer gas, electric current, compressed air, and a good supply of water, were all available at the site chosen, and the plant erected by the Pump and Power Company which controls the author's patents, is illustrated in Figs. 11 to 14 The building for containing the pump is fitted with an overhead crane for lifting off the cylinder cover of the pump and demonstrating how quickly the few working parts can be changed. The pump itself is shown, and the delivery main passes into an air vessel upon which any pressure can be put by means of compressed air. The outlet from the air vessel is connected to the measuring tank, which contains perforated baffle plates to stop eddy currents, and in the bottom of the tank is fixed a casting which receives any one of a number of accurately made sharp-edged orifices through which the water flows into the large water stock tank below. An accurately graduated gauge is fixed close to the orifice to show the height of the surface of the water above the sharp edge of the orifice, and when this height and the size of the orifice are known, the quantity of water passing through the measuring tank can be readily ascertained through the well-known formula:—

Gallons per second = $6.24\,k\,A\,\sqrt{2gH}$.

Where k = coefficient of contraction of orifice.
A = area of orifice in sq. ft.
H = head over orifice in feet.

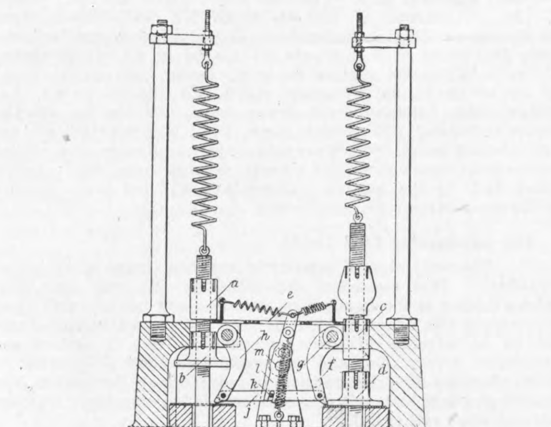


FIG. 20. *Top of Single Cyl. Pump used during Official Trials*

The stock tank is connected by an 18in. pipe to the suction tank of the pump, and thus the water is merely circulated over and over again. Between the air vessel and the measuring tank there is a valve, so that the flow is throttled at this point in order to maintain the required pressure in the air vessel, and pipe connections are brought from the air vessel and the suction tank respectively to the two sides of a U tube containing mercury, so that the actual lift of the water can be measured on a properly graduated scale.

The gas holder for measuring the gas was specially constructed for test purposes. A calorimeter for obtaining the heat value of the gas, and the usual appliances for analysing the gas and burnt products, are included in the equipment. Other testing appliances are referred to more fully in the Appendix.

Many tests of efficiency have been made with the plant described, and an official test of a four cycle Humphrey pump was carried ont by Dr. W. Cawthorne Unwin, F.R.S., and his assistant at Dudley Port on 21st and 22nd of September this year. A summary of Dr. Unwin's report is added as an Appendix and the results show that with a pump of only 16 pump horse-power the consumption of anthracite coal is 1.06 lb. per pump horse-power hour. This is about half the coal consumption of the highest class of steam pump, and it is also considerably less than with an ordinary gas engine driving any kind of pump on the same water lift. With slack costing 6s. 9d. per ton delivered into the Mond producers at Dudley Port, the actual cost of slack to yield the 83 cubic feet of gas mentioned in the report per pump horse-power hour is under 0.06d.

Experiments have shown that the pump works extremely well with petrol supplied through a carburetter, and gives about the same thermal efficiency as when working with Mond gas, but the water delivered from the pump is considerably increased. Water-gas has also been tried, with equal success, but so far neither ordinary town gas nor paraffin has been used. Probably ordinary paraffin, in conjunction with a separately heated carburetter, would form a useful working medium for isolated or contractors' pumping plants.

All the experiments so far have been confined to pumps in which an explosion takes place on ignition, but the author has designed a pump in which the combustion takes place at constant pressure.

Thermal efficiency.—It has already been mentioned that theoretically the pump cycle is superior to that of the Otto gas engine or of any other gas engine in which the volume of the expanded products is the same as the original charge volume. In Fig. 15 a curve is drawn showing the theoretical pump cycle efficiency, assuming that the maximum temperature reached on combustion is 1600 deg. Cent. Another curve is drawn assuming the maximum combustion temperature is 1000 deg. Cent. Using Mond gas and low-compression pressures, the second curve more nearly represents the true state of affairs, but as the compression pressure increases the combustion temperature is also increased, and the first curve is approached. Consequently, a curve, drawn as shown in dotted lines between these two curves, and passing from the lower to the higher of them, fairly represents the correct theoretical efficiencies when using producer gas.

This dotted curve has been transferred to Fig. 16, and plotted against it is the efficiency curve for the Otto cycle gas engine, assuming the working medium in both cases to be air. Mr. Dugald Clerk has shown that the possible efficiency which can be realised in commercial gas engines of fairly large size is about 71 per cent. of the air standard, and, assuming that this ratio also holds good for the pump cycle, we arrive at the two curves given in Fig. 17, in which the attainable efficiencies are compared. It will be noted that although the pump cycle curve is always above the Otto cycle curve, the efficiencies of the pump are greatly in excess of those of the Otto engine at low-compression pressures. This is much to the advantage of the pump, because it enables a good commercial efficiency to be obtained with relatively low working pressures.

In Fig. 18 the results of Fig. 17 are translated into British thermal units per indicated horse-power hour, so that with any working medium of a given calorific value it is possible to see how the gas consumption varies with different compression pressures.

Application for power purposes.—The curves just mentioned are specially interesting, because they lead one to recognise the possibility that, as the author's system comes to be developed in the future, internal combustion pumps may be substituted for gas engines in central electric power stations. If the water pumped is passed through an ordinary water turbine driving an electric generator, and the water is then returned to the pump to be used over and over again, we arrive at a gas-power electric system with the water forming a hydraulic coupling. Even now the combination of the author's pumps with water turbines gives far greater economy than that reached by any internal combustion turbine so far constructed. It is, of course, dangerous to prophesy, but there is no harm in looking so far ahead into future possibilities in order to see what a central station on the new lines might be like.

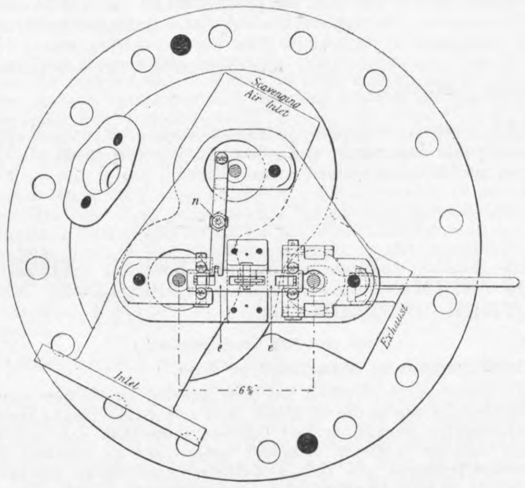


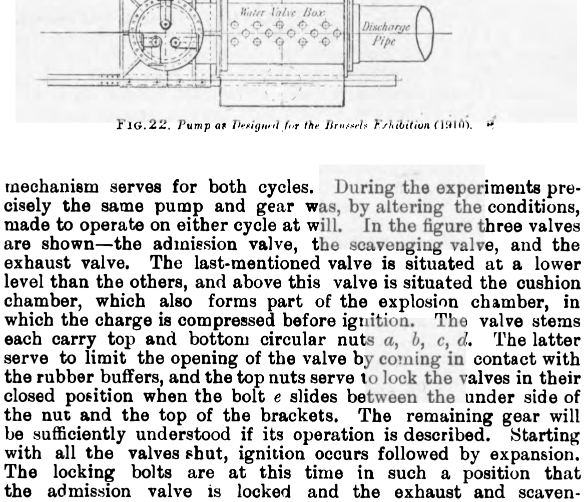
FIG. 21.—*Plan of Cylinder Top, Fig.* 20.

Fig. 19 shows, in diagrammatic form, a section of such a central station, so as to exhibit one unit of plant, the other units being arranged side by side. The pump discharges through the valve-box situated in the suction tank. This tank also serves as an isolating tank. The discharge pipe conveys the water into a large air vessel placed outside the building. This air vessel is connected with other similar air vessels by a common air pipe at the top, which maintains the air pressure the same in all the vessels, and a common water main at the bottom. The water is fed to the turbine by a pipe, and the turbine discharges into a longitudinal canal, which has a connection to each of the suction tanks. The turbine is direct coupled to the electric generator, and the current may be taken to the switchboard, which is conveniently placed overlooking the machinery. The necessary isolating valves are shown, and it will be noticed that the working parts of the pump, as also the turbine and generator, are so situated as to be supervised from a common platform. The gas main runs longitudinally outside the building.

The advantages of such an arrangement are fairly obvious, and arise chiefly from the simplicity of the working parts, the absence of noise and shock, and from the exceedingly low cost of upkeep. In gas engine stations using cheap producer gas or blast furnace gas the cost of lubricants and stores frequently exceeds the cost of the fuel, but in the present instance there is practically no lubrication required, and the author has worked one of his pumps for a week at a time with absolutely no lubrication whatever. Of course, one has to face the loss due to the conversion of the water power into mechanical energy, but the efficiency of a well-designed turbine is not less than 80 per cent. at full load, and there is no need to work any of the pumps at less than full load. The ease with which the pumps can be started and stopped from the switchboard gives the electrician complete control of his station and the ability to start up one or more pumps at a moment's notice. In fact, even this arrangement can be simplified, because the governing of the pumps can be so arranged that a steady pressure is kept on the air vessels irrespective of the demands, and a slight rise in this pressure may automatically cut out one pump and its attached dynamo after another, and re-start them again as the pressure falls. Based on the efficiencies so far obtained, a Board of Trade unit can be generated for 2lb. of anthracite coal, and with the large units of plants required in central stations this figure should be much reduced. Even if the fuel economy should not prove to be higher in such a station, yet its other advantages may more than compensate for this defect. One other aspect of this question might be mentioned, and that is, if the contour of the district is such as to permit the construction of a high-level reservoir of considerable capacity in proximity to the pump-house, water can be pumped into this reservoir and be drawn upon as required. This would enable the pumps to work steadily day and night on a 100 per cent. load factor, and would reduce the quantity of plant, in so far as the gas producers and pumps are concerned, to the minimum possible.

If the internal combustion pump proves in the future to be a successful competitor of the gas engine for power purposes, then it is probable that one of the most useful fields for its employment will be found in the propulsion of ships. Quite apart from the possibility of driving a turbine attached to a screw propeller, there is the much more efficient jet propeller, which is the most efficient of all propellers for ships if properly constructed and operated. What has been lacking so far has been a type of pump capable of delivering very large quantities of water at comparatively low heads, and it is just these conditions which suit the author's pumps in their simplest form. It would carry us too far to follow up this line, and one must be content with merely throwing out the suggestion, especially as the short time remaining must be devoted to the description of some details of the pump.

Pump details.—In all the diagrams except the first, the mechanism which controls the valves has been omitted, but in Figs. 20 and 21 some details are presented. These figures represent a recent design of valve chamber suitable for either a two-cycle or four-cycle pump, the curious fact being that exactly the same mechanism serves for both cycles. During the experiments precisely the same pump and gear was, by altering the conditions, made to operate on either cycle at will. In the figure three valves are shown—the admission valve, the scavenging valve, and the exhaust valve. The last-mentioned valve is situated at a lower level than the others, and above this valve is situated the cushion chamber, which also forms part of the explosion chamber, in which the charge is compressed before ignition. The valve stems each carry top and bottom circular nuts *a*, *b*, *c*, *d*. The latter serve to limit the opening of the valve by coming in contact with the rubber buffers, and the top nuts serve to lock the valves in their closed position when the bolt *e* slides between the under side of the nut and the top of the brackets. The remaining gear will be sufficiently understood if its operation is described. Starting with all the valves shut, ignition occurs followed by expansion. The locking bolts are at this time in such a position that the admission valve is locked and the exhaust and scavenging valves are free to open. The expansion is rapid, and as the point of atmospheric pressure is passed, suction causes the exhaust valve and the scavenging valves to open simultaneously. In the exhaust pipe there is a light non-return valve placed so that it is normally closed. This prevents the suction from drawing back exhaust products and causes a rush of air past the scavenging valve into the chamber, so that the top portion of the chamber is well swept out. The suction is soon over, and, the water column beginning to return, the scavenging valve shuts under the action of its spring, but the exhaust valve remains open while the products are discharged. When the water reaches the exhaust valve it shuts it by impact, and the cushion and cushion expansion stroke, followed by the suction stroke, results. It will, however, be seen that when the exhaust valve shuts, the enlarged portion of its lower nut, bearing against the curved lever *f*, which is hinged at *g*, forces this lever to the left. As another curved lever *h* is hinged to the first lever by means of the link *j* this other lever has also to partake of the motion and move to the left, thus setting it in position to be acted upon by the lower nut on the inlet valve. Link *j* carries a pin *k*, which engages against a lever *l*, hinged at *m* in such a manner that when link *j* moves to the left the top of lever *l* moves to the right. Two springs are shown attached to lever *l*, that on the left being stretched, and that on the right being closed, and as these two springs act upon the bolt *e* in the position shown, the effect is to urge the bolt to the right. This bolt cannot, however, move until the top nut *c* has risen to its full height, which occurs when the exhaust valve shuts. The movement of the bolt then takes place and locks the exhaust shut, at the same time releasing the admission valve. Consequently, when the cushion expansion stroke is followed by the charging stroke the suction opens the admission valve and a fresh charge is drawn in. The opening and shutting of the admission valve reverses the action of the gear, locks the admission, and unlocks the exhaust ready for the next cycle. It should be explained that the bolt which controls the scavenging valve is pivoted at *n*, Fig. 21, and has one end fastened to the bolt *e*, so that this end partakes of its motion. Whether the rise and fall of liquid which drives out the products



(Capacity 250,000 gallons per hour. Lift 35 feet.)

FIG. 22. *Pump as Designed for the Brussels Exhibition (1910).*

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* The Institution of Mechanical Engineers.

and takes in the fresh charge is due to an oscillation of liquid between the supply tank and the chamber, as in the two-cycle pump, or due to a reversal of flow in the discharge pipe, as in the four-cycle pump, makes no difference to this gear.

The only other working part is the water supply valve, which, of course, is purely automatic in its action. A single valve, as illustrated in the diagrams, would need to be too large and heavy to be practicable except for small sizes of pumps. Consequently the single valve is replaced by a number of valves. An arrangement which the author has found very effective is shown in Fig. 22, where a cylindrical valve box is pierced by a number of holes each fitted with a simple gun-metal valve held on its seat by a light spring. In Fig. 22 the valve-box is shown as placed immediately after the pump, and so virtually forms part of the discharge pipe. One very interesting fact should be noted in connection with the water valves. Each valve is normally held closed by a spring of such strength that it readily allows the valve to open when suction occurs. Now suppose that one or more of the water valves is fitted with an attachment which alters the compression of the spring so that the spring no longer brings the valve to its seat under normal conditions. The valve or valves thus fitted do not shut with the other valves, but water flowing through them causes them to shut under the action of the velocity. The result of such an arrangement is important, because it allows the pump to keep on working even if no explosion occurs. Thus, if a charge contains too much gas or air and fails to explode, it will expand again after compression and be exhausted, and a fresh charge drawn in, the pump continuing to work at the expense of a small quantity of energy representing the amount of water which falls from the high to the low level and escapes past the water valve mentioned. It is not usually desired that this should be a normal condition of affairs, but it is useful at any moment to be able, by moving a lever, to keep the pump running without explosions. By purposely exaggerating this action, and suitably altering the inlet and exhaust valve mechanism, the pump may be converted into an air compressor for compressing air by the energy of falling water.

In concluding this paper, the author wishes to express his indebtedness to those of his assistants who have taken an active share in the development of the pumps, and especially to Mr. W. J. Rusdell, who has taken the keenest interest in the experimental work, and who originated the suggestion that the cushion stroke, instead of being produced by an oscillation of the supply water, should be caused by a reverse flow in the discharge pipe, thus making the two-cycle into a four-cycle pump. Mr. Allen Nicholls, B.Sc., has had charge of the electrical ignition devices, and has succeeded in producing a sparking-plug which is absolutely reliable when washed by water at each stroke.

Northampton Polytechnic Institute.—The annual prize distribution and students' conversazione will be opened this evening at 6.30, and at 7.30 Sir John Wolfe Barry, K.C.B., will distribute the prizes and certificates. The conversazione for members and students will be continued on Saturday, the 11th inst., when the building will be thrown open to the whole of the members and students and their friends.

Institution of Electrical Engineers.—The Glasgow section of the Institution of Electrical Engineers held its eighth annual dinner in the Grosvenor Restaurant on December 1st, Mr. E. George Tidd presiding. Amongst those present were Dr. Gisbert Kapp, President of the Institution of Electrical Engineers, London, Dr. Robert Caird, Greenock, and Professor Archibald Barr, Glasgow University. In proposing "The Institution of Electrical Engineers" Dr. Barr referred to the progress it had made. It was only in 1871 that the Institution was formed and in 1888 that it assumed its present form and name. It had now over 6000 members. Dr. Kapp, in reply, said that the history of electrical engineering was largely made up of a race between this country and Germany and America. Sometimes one country was a litttle ahead and sometimes another, but in the long run this country was not found to be behind the others. He compared this competition to a race in which the horses were not always in the same position, and in which there was no winning post. There was, he said, no finality in electrical engineering, and that made the rivalry between the nations all the more interesting.

New High-pressure Fire Installation.—A test was recently carried out at the Royal Palace Hotel and Empress Rooms, Kensington, with a new fire protective installation which has lately been fitted up by Merryweather and Sons in connection with the Hydraulic Power Company's main. The main carries water at a pressure of 750 lb. to the square inch, and a special hydraulic hydrant is provided by means of which the pressure at the discharging nozzle is reduced to a pressure such as can readily be withstood by ordinary canvas hose. Ten of these hydrants are provided on the various floors of the building, each fitted with 120ft. of canvas hose and nozzle, enabling a fire to be promptly attacked from any point where it may break out. A jet was brought into play on the roof, which is over 100ft. from the ground, and it was found that the pressure was ample for fire-extinguishing purposes. At such a height as this the pressure from the ordinary water supply mains would be inadequate. A special feature of the hydrants is that they are each fitted with a relief valve, so that, in the event of the hose becoming kinked or twisted, this valve automatically operates and prevents a burst hose resulting.

Presentation of the Denny Gold Medal.—At the Institute of Marine Engineers on Monday evening, November 15th, the Denny Gold Medal was presented to Mr. Wm. P. Durtnall (Member), for his paper on "The Generation and Electrical Transmission of Power for Main Marine Propulsion and Speed Regulations," read in July, 1908. In making the presentation, Mr. J. T. Milton, Chairman of Council, said the paper Mr. Durtnall had given was a very valuable one, and several useful discussions had taken place upon it. It was a subject which was giving a great deal of thought to engineers, and the Council of the Institute considered the paper to be the best submitted during the session and well worthy of the award. Mr. Durtnall, in acknowledging the presentation, said he valued the Medal very highly, as he was a member of the electrical profession, which profession would, in his opinion, become more closely allied to marine engineering in the near future. He had pleasure in informing the members that the subject was being taken up in a practical way. A cargo boat would be fitted with this system of propulsion in about seven months' time, and he would be pleased to present the results of the trials of that vessel to the Institute as soon as they could be ascertained.

Japan-British Exhibition.—A Japan-British Exhibition is to be held next year at the White City at Shepherd's Bush, under the auspices of the Japanese Government. Its principal object is to give visitors complete information as to Japan's most important products, and her advance in various industries. In the Machinery Hall at the Exhibition the exhibits are to be purely British, and we understand that large spaces have already been allotted to Sir W. G. Armstrong, Whitworth and Co., and to Vickers Sons and Maxim, Limited, amongst other large firms. All the other portions of the Exhibition will be devoted to comparative exhibits of British and Japanese manufactures. As Count Mutsu, Councillor of the Japanese Legation in London, has publicly declared, an endeavour will be made to draw attention to some Japanese products which are, as yet, unfamiliar in this country, and, if possible, to give an impetus to Japanese exports to Great Britain, which are at present only a quarter of our exports to Japan, and only one-fifth of that country's exports to the United States. It is not intended to compete with our home industries, seeing that the principal items of export to Great Britain, such as various sorts of silk, rice, copper goods, &c., do not interfere with our own productions.

DOCKYARD NOTES.

The latest report of the German Thuringen class is as follows:—There are three ships of this class, Thuringen, Heligoland, and Ostfriesland; displacement, 22,000 tons; length, 489ft.; beam, 98ft.; draught, 27½ft.; speed, 20 knots; Schulz boilers, piston turbine engines; three screws; armament—twelve 12in. of 50 calibres, fourteen 6in., twenty 24-pounders, six 19.5in. torpedo tubes; armoured belt, 12in. These details are just as likely to be correct as any other details that have been published. They are also just as likely to be incorrect. Extremely little is known about these ships. In order to maintain secrecy all sorts of fancy wooden erections are built upon them; and it is impossible to say whether they will carry all their guns on the centre line, as originally designed, or whether they will be simply enlarged Nassaus. The probabilities, however, are in the latter direction, the main feature of all modern German naval designs being an extreme conservatism and absence of any originality.

The German destroyer G 171, fitted with Parsons turbines, built by Krupp, has made a speed of 39 knots. This is the record speed yet obtained by any German destroyer. The class to which G 171 belongs are all of 616 tons displacement.

It is officially announced that Argentina has ordered four destroyers in England, four in France, and four in Germany.

The old Italian battleships Duilio, Dandolo, Ruggiero di Lauria, and Andraea Doria, are, it is announced, all going to be turned into coal depôts. Four old cruisers are going to share the same fate, and it is calculated that by these arrangements there will be a squadron of colliers capable of carrying 50,000 tons of coal. So far as the old battleships are concerned, the saddest thing is to think that they were all Dreadnoughts in their era. Each of them was the "last word in naval construction." And this is what they have come to!

The four new Italian Dreadnoughts under construction or contemplated are provisionally named Dante Alghigeri, Leonardo da Vinci, Michael Angelo, and Cavour. These four should be completed in 1912, though it is extremely improbable that they will be. Four further Dreadnoughts, sisters to the above, are also contemplated for completion in 1914.

In addition, Italy is reported to have ordered from the firms of Ansaldo, Odero and Orlando, three cruisers destined to replace three of the Ligura class. It is rumoured that these ships will be sisters to the Pisa, and that they will have turbine machinery and Belleville boilers.

The German active naval *personnel* is being raised from 54,000 to 57,500 men.

A Chilian Naval Commission under Rear-Admiral Perez is at present touring French dockyards in connection with the expansion of the Chilian navy. It is expected that it will subsequently visit this country and tour our yards; also the German yards. It is unlikely, however, that any orders will be secured here, or, for that matter, in France either, owing to the German practice recently instituted of the Government arranging for a substantial rebate, with an eye to the fact that, in the event of war occurring as the vessels near completion, they may be purchased and used. The naval aspirations of South American Republics have put an entirely new aspect on naval construction.

It will be remembered that some time ago the Russians re-engined and re-boilered their gunboats of the Teretz class, six in number. It appears that all these gunboats have also been re-armed as follows:—Two 6in. 45-calibre, one 4.7in. 45-calibre, two 12-pounders, four 3-pounders, two 1-pounders, and one machine gun.

The French destroyer Voltigeur made her official full-power trials last week and obtained a mean speed of 31.3 knots, or 3.3 knots above contract speed.

THE IRON, COAL, AND GENERAL TRADES OF BIRMINGHAM, WOLVERHAMPTON, AND OTHER DISTRICTS.

(*From our own Correspondent.*)

Improvement in Manufactured Iron.

A reassuring effect has been exerted by the new return of the accountants to the Midland Iron and Steel Wages Board. The figures for September and October show that although the return does not indicate sufficient betterment to occasion any alteration in wages, yet that a definite improvement has taken place both in selling prices and in output compared with July and August. The new bi-monthly average selling price is £6 3s. 9.52d., or an increase upon the last return of 1s., whilst the sales made by the 17 selected firms totalled 37,322 tons, which was an advance of 5830 tons. The increased production affects all descriptions, embracing bars, angles, and tees, plates and sheets, and hoops, strip, and miscellaneous. The sales effected in the two months of September and October are as follows:—Bars, 23,995 tons; angles and tees, 775 tons; plates and sheets, 1596 tons; hoops, strip, and miscellaneous, 10,955 tons. The average price of bars, compared with the previous bi-monthly return—for July and August—was 1s. better, plates and sheets improved by 2s. 3d., and hoops were practically without alteration. An important characteristic of the new return is that angles and tees increased by as much as 4s. 2d. per ton in price. Evidently the makers have been getting some good terms lately from constructional engineers. The increased output is attributable to the trade improvement which was experienced at the beginning of September.

Good Shipments of Corrugated Sheets.

Almost at the same time as the foregoing favourable return, there come very satisfactory Board of Trade figures as to the exports of galvanised sheets. During the eleven months of this year the quantity exported was 441,455 tons, or an increase on the corresponding period of last year of 86,742 tons, whilst the value reached the excellent total of £5,850,869, which was an augmentation of £911,432. Most of the leading markets have been buying better than a year ago, the three chief increases being India, from 82,631 tons to 90,038 tons; the Argentine Republic, from 61,801 tons to 85,029 tons; and Australia, from 56,576 tons to 74,937 tons. With reference to the trade of the single month of November, the shipments amounted to 47,569 tons, or an increase of 11,119 tons, whilst the value was £569,079, or an improvement of £69,944. Heavy advances in quantity were shown by India (which nearly doubled its purchases), Australia, Canada, Chili, and some other markets. Altogether the new figures, both for the long and the short period, are very satisfactory. The general quotation this week continues £11 to £11 5s. for 24-wire gauge f.o.b. Liverpool.

Other Descriptions.

Gas strip is quoted £6 5s., and slit rail rods are £7. Marked bars remain at £8, with a fairly good demand, whilst unmarked sorts are £5 17s. 6d. to £6, with inquiry only moderate. Plain black sheets are rather improved at £7 2s. 6d. to £7 5s. for doubles.

Pig Iron Rallying.

There is a disposition to rally on the part of pig iron, the aim of makers being apparently to tide over the interval between now and the opening of the New Year with as few concessions as possible, and with quotations at a favourable level for taking advantage of the improved demand which it is hoped will then be experienced. Meanwhile, quotations, although less shaded than recently, remain, for prompt business, practically the same as a week ago, cinder forge pig being 45s. to 46s., part-mines 48s. to 49s., best all-mine forge 85s., and foundry 90s. Northamptons are 47s. to 48s., and Derbyshires 48s. to 49s. Quotations for forward delivery are higher than these. Coke keeps up in price, and is expected to be dearer still before long.

NOTES FROM LANCASHIRE.

(*From our own Correspondent.*)

Manchester, Thursday.

Bad Outlook in Pig Iron.

Although reports from other centres show signs of a revival in pig iron, it would seem that the demand is chiefly for continental and American account. Shipments from both East and West coast ports continue heavy, but in Manchester the demand is very slow and of a hand-to-mouth character. Foundries are very slack throughout the district, and with a continuance of the slow movement in the engineering trades generally, there is keen competition amongst merchants for the few orders being given out. This remark, however, only applies to delivery to the end of the year. For the opening months of 1910, a premium of 2s. 6d. per ton is being asked in most instances on account of the higher prices of fuel, which are expected to rule. We have no change, practically, to note in pig iron for the week. Forge iron is, if anything, in buyers' favour.

Finished Iron and Steel.

Great quietude prevails in most departments. It is noteworthy that foreign competition in billets on spot is practically nil, and prices are nominal for this class of steel.

Copper, Lead, and Tin.

Copper: Although raw copper is higher, there has been no further advance in manufactured stuff. In any case merchants say that an advance in this district would be useless, as inquiry is of a very restricted character. Lead: Sheets remain quietly steady. Tin: English ingots firmer, to 20s. per ton higher.

Quotations.

Lincolnshire No. 3 foundry, 55s.; Staffordshire, 53s.; Derbyshire, 55s.; Middlesbrough, open brands, 59s. 7d. to 59s. 10d. Scotch: Gartsherrie, 61s.; Glengarnock, 60s. to 60s. 6d.; Eglinton, 59s., delivered Manchester. West Coast hematite, 61s. to 61s. 6d.; East Coast ditto, 60s., both f.o.t. Delivered Preston: Gartsherrie, 60s.; Glengarnock, 59s. to 59s. 6d.; Eglinton, 58s. Delivered Heysham: Gartsherrie, 59s.; Glengarnock, 58s. to 58s. 6d.; Eglinton, 57s. Finished iron: Bars, £6 10s.; hoops, £7 12s. 6d.; sheets, £7 12s. 6d. to £7 17s. 6d. Steel: Bars, £6 2s. 6d. to £6 5s.; Lancashire hoops, £7 5s.; Staffordshire ditto, £6 17s. 6d. to £7; sheets, £7 17s. 6d. to £8; boiler-plates, £7 5s. to £7 7s. 6d.; plates for tank, girder, and bridge work, £6 5s. to £6 7s. 6d.; English billets, £4 12s. 6d. to £4 15s.; foreign ditto nominal; cold drawn steel, £9 10s. to £9 15s. Copper: Sheets, £72; tough ingot, £62; best selected, £62 per ton. Copper tubes, 8¾d.; brass tubes, 7⅛d.; condenser, 8⅛d.; rolled brass, 6½d.; brass wire, 6¾d.; brass turning rods, 6¾d.; yellow metal, 6⅛d. to 6⅜d. per lb. Sheet lead, £17 per ton. English tin ingots, £142 per ton.

The Lancashire Coal Trade.

The only sign of activity in the coal trade is in household fuel. This has been stimulated by the cold snap, but although some of the Lancashire collieries are behind with their deliveries in this department, it is now pretty certain that there will be no advance. Outside competition from Yorkshire and Derbyshire is very keen, and this would also tend to prevent it. In the shipping department there is more life at Partington, and some large boats have left the canal coal-laden recently. Furnace coal and slack rather dull.

Barrow-in-Furness, Thursday.

Hematites.

The demand for hematite pig iron is only moderate, and the business done during the week has been quiet and of small aggregate bulk, but there is nothing on the market which shows any real depression. True it is that more iron is being produced than is being sold and consumed, and equally true that stocks of metal are increasing in makers' yards, but this is not resulting either in any reduction of output or in any disposition to take a gloomy view of the situation. The crude iron trade depends very largely on the steel trade, as this represents the great feature of consumption, and at the moment steel makers are not taking such full deliveries of iron as usual. The consequence is that more metal is being thrown into the open market. Prices are a shade easier on the market, and mixed Bessemer numbers are quoted at 62s. net f.o.b., while warrant iron sellers are at 60s. 6d. net cash, and buyers 3d. less. Three months' deliveries are quoted at 62s. sellers, and 61s. 9d. buyers. Special hematites, for which there is a good steady demand, are at 64s. to 65s. Ferro manganese and spiegeleisen are in request, and business in charcoal iron and scrap iron is satisfactory. Iron ore quieter at 11s. 6d., 14s. and 18s. net at mines for ordinary medium and best sorts. Very little foreign ore is being imported.

Steel.

There is a quiet market for Bessemer classes of steel, and practically no market for mild steel. The plate mills at Barrow, which have been idle for twenty months, are yet at a standstill, and there is very little doing in merchant sorts.

Shipbuilding and Engineering.

It is generally understood that the order for the battleship cruiser required by the Admiralty will be placed with Vickers, Sons and Maxim. This firm is already very busy in all departments, and expects to be well employed for some time to come.

Shipping and Coal.

Business in shipping circles is much brisker than it has been. The exports of iron and steel from West Coast ports last week amounted to 18,881 tons—iron 7882 tons and steel 10,999 tons—as against 10,235 tons for the corresponding period of last year, an increase of 8646 tons. For the year to date the shipments aggregate at 585,038 tons, against 468,512 tons in the corresponding period of last year, an increase of 116,526 tons. Coal and coke are firmer, and prices show an improvement.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

The Coal Trade.

BUSINESS in the various departments is well maintained, and the alteration, if anything, is towards a better tone. The approach of the holiday season is causing considerably more to be done in domestic fuel, though steam coal is at present in what is usually the quiet season, pending the settlement of contracts for next year. Signs of improvement, however, are perceptible in the hard coal market, and the export trade, having regard to the time of the year, is very well maintained. Pits are working four to five days a week. Some complaint is heard of shortage of wagons, and consequent loss of time.

Railway Coal Contracts, &c.

The railway companies' contracts, for which inquiries have been received by the various coalowners, are yet in abeyance as regards the principal contracts. The coalowners have given their quotations at 9s. 3d. per ton, a price which represents an advance of 9d. per ton on last year's contracts. This rate has been explicitly declined by the railway companies. No further negotiations have yet been set on foot, as there are still arrears to deliver. In view of the hopeful feeling entertained that next year will bring better prices and more limited output, owing to the operation of the Eight Hours' Act, coalowners at present are in a position to stand out as to the future. It is reported that the Midland Company has been able to buy in West Yorkshire supplies of coal under contract from small collieries at an advance of 6d. per ton on last year's prices; but this is not regarded as a matter of great importance in South Yorkshire, from which the bulk of the supplies is drawn. Contracts for shipment are made in the early spring, and the advance is looked for then as well. Inquiries are coming forward as usual in the interval, but it is not likely that any arrangements will be made until the New Year. Since our recent reference to the Cunard and Elder Dempster Companies' purchases from a local colliery, we have not heard of other arrangements of any size in further contracts for coal for bunker purposes.

House Coal More Active.

As usual at this time of the year before Christmas, and partly because of colder weather, there is now rather a brisk demand for domestic fuel both on distant and local account. A good business is doing with the London and Southern markets, as well as for the Eastern Counties districts. The advance of 1s. per ton, which we mentioned as unofficially asked for, is being easily obtained. Current rates are as follows:—Best Barnsley, 12s. 6d. to 14s. per ton; secondary descriptions, 10s. 6d. to 11s. 6d. per ton. The West Yorkshire house coal trade keeps active.

Small Coal and Coke.

A good trade is still being done in the best qualities of small coals which are largely used in the Lancashire and Yorkshire mills. The quotation has not changed for a considerable time—4s. 6d. to 5s. 6d. per ton. Lower grades of slack are not quite so freely called for. The prices of furnace coke are well maintained, but just at present there is a slight weakening, owing to the local iron market not being of so hopeful a character as could be wished. There is, however, no reason for this, as all the iron made in the district is being absorbed. Quotations are maintained, viz.:—Best washed, 12s. 6d. to 13s. per ton; unwashed, 11s. 6d. to 12s. per ton.

Iron—Situation Unchanged.

A quiet tone continues to mark the pig iron market, and there is no likelihood of any change whatever this year. Ironmasters do not exhibit eagerness to press sales, as they are well sold forward, and they are convinced that more money will be obtained in the New Year. Deliveries, so far as this month has gone, have been slightly better than in November. The Lincolnshire Ironmasters' Association hold their usual fortnightly meeting on the 10th inst., but it is not anticipated here that any change in prices will be made. Quotations, all net, and delivered in Sheffield and Rotherham, are as follows:—West Coast hematites, 68s. to 70s. per ton; East Coast, 65s. to 67s. per ton. Lincolnshire: No. 3 foundry, 52s. 6d. per ton; No. 4 foundry, 51s. 6d. per ton; No. 4 forge, 51s. 6d. per ton; No. 5 forge, mottled, and white, 51s. 6d. per ton; basic, 52s. 6d. per ton. Derbyshire: No. 3 foundry, 52s. per ton; No. 4 forge, 50s. 6d. per ton.

Bars, Hoops, and Sheets.

Still no improvement to report in finished iron and allied trades. Bars, £6 10s. per ton; hoops, £7 10s. per ton; sheets, £8 10s. per ton.

The East End Works.

The heavy trades, as regards armour plates, projectiles, and war material, are finding a fair amount of work at the present time, but the earlier processes in the production of armour plates are for the most part now completed; the finishing stages are still being proceeded with, and will continue for a few weeks into the New Year. The new orders are being anxiously looked for. Several orders for projectiles, received a few weeks back, are also rapidly being completed, and, excepting in special lines, the large forging presses are becoming short of work. Railway material still continues very flat in demand, and no fresh orders of magnitude have come to hand for months back, either for home or foreign requirements. The hope was entertained that South America might come more largely into the market, and some small orders have been received for tires, axles, springs, &c. The Colonies are at present providing a fair amount of work. The sum total of all that is being received, however, is not sufficient to afford half employment for the capacity of the various establishments engaged in the manufacture of railway material. The home companies are ordering very sparingly. Marine material still in depressed condition.

Cutlery Exports—Increase in November.

The colonial and foreign trade in cutlery considerably advanced during November, the exports showing a value of £64,834, against £48,878 and £66,308 for the corresponding months of 1908 and 1907. The value for the eleven months of the year is £591,435, against £563,460 in 1908, and £710,859 in 1907. The principal market was Australia, with a value of £10,235, against £8582 in November of last year. Canada comes next with a value of £8989, against £6126. A feature of the month's trading is the improvement in South Africa, which had advanced to £7847 from £4007 in November of last year. The United States rank fourth with £7613, against £5870.

Government Requirements in Cutlery.

Tenders are out for the requirements of the Government departments in cutlery during 1910. The Admiralty ask for 45,000 table knives, 19,000 dessert knives, 1300 steels, and about 10 000 can openers. The War-office require 10,500 each of carving knives, forks, and butchers' steels.

NORTH OF ENGLAND.

(*From our own Correspondent.*)

Cleveland Iron.

THIS week a better state of business is to be reported in the Cleveland pig iron trade than was ruling last week, and, indeed, for two or three weeks previously, when the market was somewhat depressed, and prices moved downwards. A recovery is now apparent, the tone is becoming rather buoyant again, confidence seems to be returning, and quotations are being advanced, though it cannot as yet be said that the amount of buying is extensive, and it is held that it will not be until the general election is over. In any case, this is not the season when one can expect much upward movement, for the winter is the quietest time of the year, and people generally put off purchasing for spring delivery until February. Still, the outlook is promising for 1910, and the market is being strengthened by the reports concerning the Stock Exchanges and other metal markets, in addition to which there is the decided improvement in several branches of the finished iron and steel trades, which is not brought about by speculation, but by a genuine revival of trade. In view of these favourable features the unsatisfactory statistics—the rapidly increasing stock of pig iron in Connal's store and the very poor exports—fail to have a detrimental influence on the market. It used to be that when stocks went up prices dropped, but that no longer holds. Traders still expect that American demands will next year clear off most of the stock of Cleveland pig iron that is held, and probably this is one reason why the makers have not followed their usual policy of not accumulating stocks, but reducing their production when the demand for pig iron becomes small. So far the Americans have bought comparatively little Cleveland iron, but the revival in the United States appears to be more in steel than in ironfounding. It is for the latter that most of the Cleveland iron is sent. Hitherto the American furnaces have been able to supply all that the native ironfounders have required, but Cleveland iron can now be delivered at as low a figure as 70s. per ton at New York, Philadelphia, or Baltimore, and that should tempt the consumers in the States bordering on the Atlantic. The Rhodesia has sailed from the Tees this week with pig iron for the States, and the Dundonian has been chartered to carry 5000 tons from the Tees to Philadelphia at 5s. 6d. per ton, but the sale is said to have been made some considerable time ago. The quotations for Cleveland pig iron have moved upwards this week, makers asking 50s. 6d. per ton for prompt f.o.b. deliveries for No. 3 G.M.B., or 6d. more than a week ago, while No. 1 is at 52s. 9d.; No. 4 foundry at 49s.; No. 4 forge at 48s. 9d., and mottled and white at 48s. 3d.; but for delivery over the first quarter of 1910 fully 1s. per ton more is asked in each case. Another 3d. per ton was added to the prices on Wednesday, the market being considerably strengthened by the figures of the November Board of Trade returns, which furnish evidence of a general revival of trade.

Hematite Pig Iron.

Most traders speak well of the position and prospects of the East Coast hematite pig iron business. They are certainly encouraging, and it is not likely that prices will be lower. Makers maintain their quotation for mixed numbers for early delivery at 60s. per ton, which is the highest price of the year, and is 5s. 6d. above the minimum. Hematite pig iron producers are not troubled by the accumulation of stocks. They have little in their own hands, and there is none in Connal's public store, nor has there been any there since the spring of 1906. Not for fourteen years has there been any considerable quantity. Thus the hematite iron market, as far as regards quotations, is much steadier than the market for Cleveland iron. Since the upward movement set in, prices of hematite iron have not had a single set-back, and they have risen more than Cleveland iron. Makers are asking 62s. 6d. per ton for mixed numbers delivered during the next quarter, and 65s. up to the end of the year. Rubio ore is still nominal at 17s. 6d. per ton c.i.f. Middlesbrough, early delivery. Coke is very firm, and it is expected that higher prices will have to be paid for next year; indeed, sellers are asking more. The production even now is hardly equal to the requirements, and the latter are increasing. There are now 83 blast furnaces in operation in the North-East of England, of which 39 are producing hematite and other special kinds of pig iron, and 44 ordinary Cleveland iron.

Stock and Shipments of Pig Iron.

It must be acknowledged that the present statistical position of the pig iron trade in this district is not satisfactory. The stock continues to increase rapidly, and is now 233,000 tons more than it was at the commencement of the year. It is strange that the makers have not reduced their output, but latterly the idea has been that America would need considerable quantities of Cleveland iron, and this would deplete the stock in the public stores as quickly as it did two years ago. On Wednesday the stock in Connal's was 370,531 tons, the increase over the first week of the month being thus 7313 tons. The stock consisted of 337,273 tons of No. 3, 30,523 tons of other iron deliverable as standard, and 2735 tons not so deliverable. The pig iron exports from the Cleveland district this month are the worst this year, and are not likely to improve, for wintry weather is greatly curtailing deliveries to the Continent. The quantity shipped up to the 8th was 14,981 tons, compared with 20,004 tons last month, 18,946 tons in December, 1908, and 28,184 tons in December, 1907, all to the 8th.

Manufactured Iron and Steel.

The situation in the finished iron and steel industries has so far improved that advances in prices have been generally expected. Evidently the competition is still too keen to permit producers to raise their quotations. There are indications of good trade next year, and manufacturers do not want to put anything in the way of realising it by advancing their rates before the demand fully justifies it. The best business is done at present in shipbuilding materials, and there are also good orders for sheets (black and galvanised), wire, hoops, and rails, but the bar trade is very slack. Rail manufacturers are well off for orders, but nevertheless would like to have a better supply of contracts for the second quarter of the year. The best deliveries of rails this year have been to South America, and of that trade the United States manufacturers are determined to have a share. They have commissioned agents to visit South America, especially the Argentine, and get the orders regardless of price, but they must cut out other countries. German rail makers are likewise endeavouring to secure contracts from South America, where railways are being constructed at a rapid rate. From the Tees alone this year over 120,000 tons of steel, mostly rails, has been forwarded to Argentina, which is more than has been sent to any other country, not even excepting India.

Shipbuilders.

Business is steadily improving in the shipbuilding industry, and the outlook for the winter is very much better than the most sanguine had expected. Trade is evidently better for the shipowners, as the number of vessels laid up has not increased, and it was believed that with the closing of the Baltic our rivers would be crowded with idle shipping. Orders for new vessels are being booked at a very satisfactory rate. Messrs. William Gray and Co., West Hartlepool, have this week booked an order for a large cargo steamer, and Messrs. W. Pickersgill and Sons, Sunderland, one of 5800 tons for a Cardiff firm. The Dominion Coal and Iron Company, which recently ordered three colliers of between 7000 and 8000 tons each from Sunderland shipbuilders, is reported to have ordered two more from Tyneside builders. The British India Steam Navigation Company is in the market for a new passenger cargo steamer. Smith's Dock Company has now completed the removal of its shipbuilding business from North Shields to the Tees, where it will have twelve building berths, some of them for trawlers. It has orders for six steamers already on the books. The new dry docks which it opened this year on the Tees are regularly occupied by steamers needing repairs. At North Shields they will devote themselves to the repairing of vessels.

Coal and Coke.

Quite a change has lately come over the coal trade. The steam coal business is no longer depressed, but there is plenty of inquiry, and good orders are reported to have been placed on Australian and South American account, both for steam and gas coals. The improvement is leading to advances of prices, best steam having gone up to 11s. 6d. per ton, seconds to 9s. 6d., and smalls from 5s. 6d. to 7s., according to quality. Best Durham gas coals are up to 11s. 3d. per ton f.o.b., and bunkers have risen 6d. per ton this week, 9s. 9d. to 10s. 3d. per ton being quoted for delivery at Tyne Dock. The tendency in coke prices is upwards, and for Durham furnace coke 17s. 6d. per ton delivered only at Middlesbrough has to be paid. Considerably more is asked for forward, but consumers are not prepared to pay higher figures, for even now coke is relatively dearer than pig iron.

NOTES FROM SCOTLAND.

(*From our own Correspondent.*)

The General Trade Position.

THE position of trade generally has been gradually improving, and the state of employment is more satisfactory. The local poor authorities report a large decrease in the applications for relief compared with this time last year. A central labour exchange has been established in Glasgow by the Board of Trade, which has taken over as its nucleus the institution of that name started several years ago by the Town Council. Of course, it is to be greatly enlarged, and is to be the clearing-house exchange for all the other labour exchanges to be established in Scotland. The exchange is expected to be an advantage both to employers and workmen.

The Pig Iron Market.

The depression that characterised the warrant market last week has been succeeded by a considerable improvement this week in the amount of business done and also in prices. The lower rates touched last week afforded an opportunity to speculators to come in for a favourable turn, of which advantage has been taken, and a fair proportion of the business has been for future delivery. Cleveland warrants have sold since last report from 49s. 10½d. to 50s. 8d. cash, 50s. 2½d. to 51s. one month, and 50s. 11d. to 51s. 8d. three months. Transactions are also recorded at 50s. 2d. for delivery in nine days, 50s. 9½d. ten days, 50s. 7d. twenty-one and twenty-six days, 50s. 10d. and 50s. 11d. twenty-four days, 50s. 9d. for 21st January, and 51s. for 13th January. These transactions cover a considerable revival of speculative interest in warrants. There has been some inquiry for hematite, but scarcely any actual business reported.

Scotch Makers' Iron.

The demand for pig iron on the part of home consumers has been quiet, and there is not expected to be much improvement until the turn of the year. The inquiry for abroad has been moderate, and distributed over many countries, but the supplies required are generally individually small. Some of the makers' brands were reduced 6d. and 1s. per ton as a result of the depression in warrants last week, but the quotations this week are better maintained. Free at ship in Glasgow harbour, Monkland, No. 1, is quoted 57s.; No. 3, 55s.; Carnbroe, No. 1, 59s. 6d.; No. 3, 56s. 6d.; Clyde, No. 1, 62s.; No. 3, 57s.; Gartsherrie, Calder, and Langloan, Nos. 1, 62s. 6d.; Nos. 3, 57s. 6d.; Summerlee, No. 1, 63s. 6d.; No. 3, 58s. 6d.; Coltness, No. 1, 88s.; No. 3, 58s. 6d.; Eglinton, at Ardrossan or Troon, No. 1, 58s.; No. 3, 56s.; Glengarnock, at Ardrossan, No. 1, 64s.; No. 3, 59s.; Dalmellington, at Ayr, No. 1, 61s.; No. 3, 56s.; Shotts, at Leith, No. 1, 62s. 6d.; No. 3, 57s. 6d.; Carron, at Grangemouth, No. 1, 64s.; No. 3, 58s. per ton. There are 83 furnaces in blast in Scotland, compared with 84 last week, and 77 at this time last year.

Pig Iron Shipments.

The shipments of pig iron from Scottish ports in the past week amounted to 4944 tons, compared with 5442 in the corresponding week. To the United States 500 tons were despatched, Canada 50, South America 15, India 184, Australia 780, Italy 180, Germany 20, Holland 190, Spain and Portugal 135, other countries 832, the coastwise shipments being 1753 tons, against 4243 in the same period of last year. The arrivals at Grangemouth of pig iron from Cleveland and district were 9715 tons, being 3982 tons more than in the corresponding week of 1908.

Finished Iron and Steel.

During the last few days steelmakers have been receiving more orders for steel plates for shipbuilding purposes, and the extra work has provided steadier employment at several of the principal works. An increasing inquiry is also reported for boiler plates both for home use and export. On the other hand, the demand for structural steel seems to have fallen away to some extent, but the demand for thin sheets is still satisfactory. There is a good deal of idle time at some of the works, but it is hoped that the turn of the year may bring a more satisfactory state of employment. There is no improvement whatever in the malleable iron department.

The Coal Trade.

For several days this week Glasgow and the Clyde have been enveloped in thick fog, which caused great interruption to traffic both by rail and water. A scarcity of coal for shipment and home use has been the temporary result, and prices have gone higher. House coal for shipment is quoted at Glasgow harbour 9s. 6d. to 10s. 6d.; steam coal, 9s. 9d. to 10s. 3d.; and splint coal, 10s. 3d. to 11s. per ton. The output of the collieries is large, and when the fog clears away there ought to be full supplies for all requirements.

WALES AND ADJOINING COUNTIES.

(*From our own Correspondent.*)

Last Week's Coal Trade.

THE year will long be remembered in the annals of the coal trade for the continued evil influence of the weather. Last week was as bad as any experienced, and in addition to the injurious effect caused by delayed tonnage, several losses were sustained by Cardiff, and other shippers. One of these was that of a fine steamer laden with 3000 tons best steam consigned to Capetown. One of the consequences of delayed steamers was the large accumulation of stocks of coal. This at one time promised to result in a slump, but, fortunately, forward prices were stiff, and capital stems had been arranged up to Christmas, so the principal result was that in pressing cases buyers had a little more concession than usual, and the New Year does not promise badly as to existing contracts.

The White Star Line Contract.

This has been secured by Lewis's Merthyr Consolidated Collieries, and by Mann, George and Co. The price reported is private, but previous fixtures have been 15s. 1½d. to 15s. 3d., and in the second case 14s. 10½d.

Latest Prices, Cardiff.

Still limited tonnage coming in, and prices not so firm, but forward business is well maintained. With fairer weather conditions colliery owners believe quotations will improve. Best large steam, 16s. 3d. to 16s. 6d.; seconds, 15s. 6d. to 16s.; ordinaries, 14s. 6d. to 15s.; best drys, 16s. 3d. to 16s. 9d.; best washed nuts, 13s. 6d. to 14s. ; seconds, 12s. 6d. to 13s.; best washed peas, 12s. to 12s. 6d.; seconds, 10s. to 11s. 6d.; very best smalls, 8s. 6d. to 9s.; best ordinaries, 7s. 9d. to 8s.; cargo smalls, 6s. 6d. to 7s. 3d.; inferior sorts, 6s. to 6s. 6d.; very best Monmouthshire black vein, 15s. 3d. to 15s. 6d.; ordinary Western Valleys, 14s. 6d. to 14s. 9d.; best Eastern Valleys, 13s. 9d. to 14s.; seconds, 13s. to 13s. 3d. Bituminous coal: Best households, 17s. to 18s.; best ordinaries, 15s. to 16s.; No. 3 Rhondda, large, 17s. 3d. to 17s. 6d.; brush, 13s. 6d. to 13s. 9d.; smalls, 10s. to 10s. 6d.; No. 2 Rhondda, 12s. 9d. to 13s. 3d.; through, 9s. 6d. to 10s.; smalls, 7s. to 7s. 6d. Patent fuel, 15s. to 15s. 6d. Coke: Special foundry, 24s. to 27s. 6d.; foundry, 19s. to 20s.; furnace, 17s. to 17s. 6d.; pitwood, 20s. 6d. to 21s.

Newport, Mon., Coal.

No improvement for prompt coal. For forward bookings prices strong; smalls easy; pitwood advancing. Latest quotations:—Best black vein, 15s. to 15s. 3d.; Western Valleys, 14s. 3d. to 14s. 6d.; Eastern Valleys, 13s. 6d. to 13s. 9d.; other kinds, 12s. 6d. to 13s. 3d.; best smalls, 7s. to 7s. 3d.; seconds, 6s. 3d. to 6s. 9d.; inferiors, 5s. 9d. to 6s. 3d. Bituminous: Best house coal, 15s. to 15s. 6d.; seconds, 14s. to 14s. 6d. Patent fuel, 15s. to 15s. 3d. Coke: Foundry, 18s. to 19s.; furnace, 17s. to 17s. 6d. Pitwood, ex ship, 20s. to 20s. 6d.

Swansea Coal.

Little alteration shown, but a steady undertone. Demand for large coal good, machine-made coals firm, nuts and cobbles well maintained, beans scarce, rubbly culm firm, but duff weak. Latest:—Anthracite: Best malting, 23s to 24s. net; second malting, 21s. to 22s. net; big vein, 17s. 6d. to 19s., less 2½; red vein, large, 12s. to 13s., less 2½; machine-made cobbles, 23s. to 24s. net; Paris nuts, 25s. 6d. to 26s. net; French nuts, 26s. to 28s. net; German nuts, 25s. to 26s. net; beans, 18s. 6d. to 19s. 6d. net; machine-made large peas, 11s. to 12s. 6d. net; fine peas, 10s. 6d. to 11s. net; rubbly culm, 5s. 6d. to 5s. 9d., less 2½; duff, 2s. 6d. to 3s. net. Steam coal: Best large, 17s. to 18s.; seconds, 14s. 6d. to 15s.; bunkers, 9s. 6d. to 10s. 6d.; small, 7s. to 9s., all less 2½. Bituminous: No. 3 Rhondda, large, 18s. to 18s. 6d., less 2½; through, 14s. 9d. to 15s. 6d., less 2½; small, 10s. 3d. to 10s. 6d., less 2½. Patent fuel, 13s. to 13s. 6d., less 2½. Coal quotations all f.o.b., cash 30 days.

North's Navigation.

The settlement of the wages arrangements at these collieries appears to have been of a satisfactory character. The firemen have agreed to an advance equivalent to 5s. per week, the same to continue for five years.

Iron and Steel.

Dowlais continues to afford the most promising prospect in the district, though at Swansea a fair output of steel bars is taking place at Baldwin's. At Dowlais there was increased activity shown, and a more general briskness was apparent. Mills were busy, and the output of tin bar, billets, fish-plates, and colliery and heavy rails well up to the mark. It was to be noted, too, that while heavy rails were turned out for colonial orders, railway items were still insignificant. For the Colonies sleepers were again in request, and the accompaniment of rail cargoes from Newport continues to be large, quantities of coke showing that the works in India are active. The sleepers were despatched *viâ* Manchester and Liverpool, and gave a total of 2100 tons. Sheet iron is being sent largely to Bristol from Newport. Welsh slag is in demand, and cargoes are being despatched to Ghent and Antwerp. Of basic slag little, if any, remains in stock, but of blast furnace there is abundance in the vicinity of the large works, though an authority observes that the varied quality of the ores used has resulted in a lack of uniformity with the slag, and is thus unfavourable to the manufacture of the best cement. Experiment may be useful in amending this opinion. Latest prices Swansea were as follows:—Pig iron hematite mixed numbers, 60s. 6d. cash and month; Scotch, 56s. cash and month; Middlesbrough, 50s. 7d. cash, and 50s. 11d. month. Welsh hematite, 66s. to 67s. 6d. delivered. Steel bars: Siemens, £4 15s. to £4 16s; Bessemer, £4 12s. 6d. to £4 15s. Iron ore, 16s. 6d. to 17s., Cardiff and Newport, Mon.

Tin-plate.

Operations last week at the Swansea tin-plate works were as satisfactory as they have been at any time of the year. The quantities received during the week totalled over 100,000 boxes. The precise totals were 102,990 boxes, and the shipments, 91,529 boxes, would have been larger but for the stormy weather, which proved so detrimental to all industries. Stocks now consist of 88,190 boxes. Loading will very likely be busy for the Baltic and Mediterranean ports, and cargoes for America fully up to average. At Llanelly the tin-plate trade was reported good, but rather quiet, and makers expect a brisk demand in the New Year. Latest prices:—Ordinary tin-plates, Bessemer and Siemens, I.C. 20 × 14 × 112 sheets, 12s. 4½d. to 12s. 6d.; ternes, 22s.; C.A. roofing sheets, £8 10s. to £8 15s.; big sheets for galvanising, £8 10s.; finished black plates, £9 10s. to £9 15s.; galvanised sheets, 24 g., £11 per ton; wasters, usual reductions. Block tin, £144 5 cash, £146 three months. Other quotations, Swansea:—Copper, £59 cash and £60 2s. 6d. three months; lead, English, £13 7s. 6d.; Spanish, £12 17s. 6d.; spelter, £23; silver, $23\frac{11}{16}$d. per ounce.

Swansea Valley Industries.

Operations were briskly carried on at the copper and spelter works. The Mannesmann worked full time. Swansea Safety Fuse Company's plant well employed. Nickel's silver works maintain a good steady repute, and the leading foundries are all well placed for business.

Port Talbot.

There was a slight decrease in the port business last week. In the imports 2533 tons pig came in and 200 tons rails.

NOTES FROM GERMANY, FRANCE, BELGIUM, &c.

(*From our own Correspondent.*)

Rheinland-Westphalia.

The general condition of the market is firm and confident. Dealers have purchased heavily during the past few weeks; the mills and factories being well supplied with work for many weeks ahead, can await the further development of the market without feeling compelled to take in work at any price. Up to the present rates have shown considerable firmness. The sales of the Steel Convention during October of this year were 420,894 t., as compared with 438,904 t. in September, and as against 414,644 t. in October, 1908. This shows deliveries to have been 18,010 t. lower than in September of this year, and 6250 t. higher than in October, 1908. Of the deliveries in October of this year 133,775 t. were semi-finished steel, as compared with 136,487 t. in September, and as against 142,673 t. in October, 1908; railway material 158,112 t., as compared with 165,225 t. in September of this year, and as against 161,374 t. in October, 1908; sectional iron 129,007 t., as compared with 137,192 t. in September of this year, and 110,597 t. in October, 1908. Sales of the Wire Convention in October were nearly 32,000 t., more than one-third being for foreign consumption. At the end of last week the mills had orders on their books for 75,000 t.; prices for next year will be finally fixed at a meeting that is soon to take place.

List Quotations.

Official accounts from the Düsseldorf 'Change on November 25th stated current rates to be as follows:—Spathose iron ore, M. 10.90; roasted ditto, M. 15.50; Nassau red iron ore, 50 p. cent. contents, M. 11 50 p.t. at mines; spiegeleisen, 10 to 12 p. cent. grade, M. 60 to M. 63; white forge pig, Siegerland and Rhenish-Westphalian quality, M. 55 to M. 58; iron for steel making, M. 56 to M. 58; German Bessemer, M. 58 to M. 60; basic, free place of consumption, M. 49 to M. 52; Luxemburg forge pig, M 46 to M. 48; Luxemburg foundry pig No. 3, free Luxemburg, M. 51 to M. 52; German foundry pig No. 1, M. 59 to M. 61; No. 3, M. 58 to M. 60; German hematite, M. 63; bars, M. 100 to M. 104; in some cases, M. 108; heavy plates, M. 110 to M. 115; boiler plates, M. 120 to M. 125; sheets, M. 122 to M. 125; hoops in basic, M. 122 50 to M. 125; drawn wire in iron and steel, M. 127.50, all per ton at works.

The Silesian Iron Market.

Reports continue favourable as regards the business in iron and steel. According to the *Rhenish-Westphalian Gazette* the Silesian Union for Steel Castings has been prolonged till October 1st, 1910; from the 15th November of this year the Union has reduced the prices for some articles 7½ per cent. Though Westphalian competition is keen, employment is stated to be satisfactory at all the principal establishments.

No Change in Coal.

Concerning the trade in coal and coke, last week's accounts can only be repeated. In Silesia more life was felt in consequence of the cold weather, and the sugar mills have also bought freely. For coke an increase in demand could be felt, both for engine and house fuel. Quotations are the same as before, M. 11 to M. 12 p.t. being quoted for gas coal, producer coal fetching M. 13.25; steam coal stands at M. 10 to M. 12.35, and coal for coke making at M. 11 to M. 12 p.t.; dry sorts of coal fetch M. 9.50 to M. 10.50, and anthracite No. 2, M. 21 to M. 24; foundry coke stands at M. 17 to M. 19 p.t., while blast furnace coke can be bought at M. 14 50 to 16.50 p.t. For briquettes M. 10.50 to M. 13 75 p.t. is given.

Austria-Hungary.

Only small purchases have been made in iron and steel, and as the Railway Ministry has postponed a vast amount of work for various reasons, the outlook is not bright as regards employment. The tone of the market is somewhat weak in consequence of the slackening off in various branches, and makers often find it difficult to maintain prices. A regular and good demand exists for all sorts of fuel, and more firmness has been perceived of late. Steam and gas coal are best inquired for; Bohemian brown coal sells freely.

The Belgian Iron Market.

There is not much to relate of the iron and steel business. Pig iron remains somewhat quiet, and makers cannot realise more than 67f. p.t. for basic, while foundry pig moves between 61f. and 68f. p.t. Consumption increases steadily. While the output in pig iron rose 335,000 t., import increased from 339,063 t. to 392,959 t. Stocks are small in all sorts of pig iron. There is no extensive business being done in bars, but current rates are well maintained; for home consumption a rise of 5f. p.t. to dealers has been resolved upon. Plate makers give rather good accounts, exports being particularly good, and figures are higher than last year. For girders the export price of £5 4s. is only nominal, and in rails only a poor trade was done. Both engine and house coal are reported in rising demand. For briquettes also some fair inquiries have come in from abroad, but this has not had any influence on prices. Exports in pit coal rose to 4,255,919 t. during the first ten months of this year, as compared with 3,913,048 t. in the same period last year. Imports rose from 4,446,593 t. to 4,794 710 t. Accordingly, import was 538,791 t. higher than export. From Germany 2,734,831 t. were imported to Belgium, as compared with 2,360,651 t. last year. In coke 842,460 t. were exported and 254,502 t. imported, 218,302 t. coke coming from Germany.

AMERICAN NOTES

(*From our own Correspondent.*)

New York, December 1st.

An unexpected weakening developed in pig iron from southern furnaces because of the throwing on the market in the central west of large quantities of Alabama iron. It is improbable that this action will have a permanent effect upon the market. Legitimate demand still in abeyance will probably absorb all available iron. Furnace output will be materially increased by next spring. Eastern railroads have about completed their requirements for steel rails, but western systems are still in the market. The Havana Central will buy 1200 tons of rails this week. The American Car and Foundry Company and the Standard Steel Car Company have each booked an order for 1000 coal cars from the Reading Railroad. In the nail industry activity prevails for both cut and wire nails, wire nails, of course, taking the precedence. The factories are accumulating stock. The Pennsylvania Railroad will largely add to its shop repairing facilities at Terre Haute, Indiana.

Billets are arriving at Atlantic ports from abroad, but as yet no orders have gone from Pittsburg, though the possibilities of such a course are still contemplated. The actual situation regarding the supply of crude steel in the west is not known. Some speculative influences have been quietly operating for months past, but these influences will not accomplish their intended purpose. Productive capacity is being expanded with all possible speed. The policy of maintaining prices at a dead level year in and year out, as has been successfully done in steel rails, will be applied as far as is possible to do so in all other mill products of wide consumption. Purely speculative efforts will be discouraged and crushed out. Mills everywhere are adding to their capacity, so that there will be no occasion for the annoying ups and downs in prices which have characterised the American iron and steel industry. In the copper market prices remain about stationary. The larger consumers are not in the market at present. The only thing worth noting is some speculative buying to protect the market. The talk of a giant copper merger is still the absorbing subject in mining and financial circles. The decision of the United States Circuit Court in declaring the Standard Oil Company an illegal corporation is deterring those who have in hand the formation of the great copper combination. That there will be some sort of a combination may be granted. The case will go to the Supreme Court for final adjudication.

LAUNCHES AND TRIAL TRIPS.

Risby, steel screw steamer; built by the Laxevaags Engineering and Shipbuilding Company, of Bergen; dimensions, 259ft. 6in. by 35ft. by 16ft. 10in.; to carry 1775 tons; engines, triple-expansion, 16in., 25½in. by 3in., pressure 175 lb.; constructed by the builders; trial trip, November 2nd.

Natalia, steel screw steamer; built by Swan, Hunter and Wigham Richardson, Limited; to the order of the Linea de Vapores Serra, of Bilbao, Spain; dimensions, 290ft. by 42ft. beam; to carry 2250 tons; engines, triple-expansion; constructed by the builders; trial trip, November 6th.

Bassam, steel screw steamer; built by Irvine's Shipbuilding and Dry Docks Company, Limited; to the order of Elder, Dempster and Co.; dimensions, 355ft. by 46ft. by 25ft. 3in.; engines, triple-expansion, 25in., 40in., 67in. by 4in. stroke, pressure 180 lb.; constructed by Richardsons, Westgarth and Co.; trial trip, November 13th.

Gladys, steel screw steamer; built by the Goole Shipbuilding and Repairing Company, Limited; to the order of The Borneo Company, London; dimensions, 160ft. long; engines, compound, constructed by Richardsons, Westgarth and Co., Limited; launch, November 13th.

Cloutsham, steel screw steamer; built by W. Doxford and Sons, Limited; dimensions 378ft. by 51ft. by 30¼ft.; to carry 8000 tons; launch, November 16th.

Steam launch Hall; built by Edward Finch and Co., Limited; to the order of the Corporation of Bridgewater; dimensions, 62ft. by 14ft. by 6ft.; constructed by W. and F. Wills; launch, November 16th.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

Messrs. Blake and Scott, of 41, Old Queen-street, Westminster, S.W., inform us that they have been appointed the representatives in London of Wm. Arnott and Co., of Coatbridge, for bridge and steel construction work.

Mr. D. R. Mayhew has resigned his position as branch manager to Willans and Robinson, Limited, in order to take up the position of general manager to Michael Pal and Co., Engineers, Westminster.

The Midland Institute of Mining, Civil, and Mechanical Engineers.—A general meeting of the members of the Institute will be held at the Arcade Hall, Barnsley, on Wednesday, December 15th, at 3.30 p.m. There will be a council meeting at 3 p.m. The following papers will be read:—"Automatic Protection Switchgear for Colliery Work," by Mr. E. B. Wedmore. "An Improved Instrument for Recording the Working of Winding and Other Engines," by Mr. A. Victor Kochs. The following papers will also be open for discussion:—"Recovery of Power from Exhaust Steam," by Mr. W. M. Sanderson. "Electricity in Coal Mines," by Mr. Robert Nelson.

The Institution of Civil Engineers: Students' Meetings.—At the Students' Meeting held at the Institution on Friday, the 3rd December, 1909, at 8 p.m., Col. R. E. B. Crompton, C.B., M. Inst. C.E., in the chair, Mr. George Ingram, Stud. Inst. C.E., read a paper on "The Design of Generating Stations." The author, having discussed at length the conditions influencing the choice of plant, went on to describe a suggested arrangement of plant for a shipyard, and for a large high-tension alternating-current station suitable for a bulk supply scheme. The author concluded by showing a number of lantern slides of various generating stations. An interesting discussion followed, in which the following gentlemen took part:—Messrs. C. J. Guttmann, E. Timothy, E. H. Spence, W. G. Fairweather, G. Lees, N. Smith, W. H. Pirrie, T. H. Williams, F. F. Arroya y Caso, H. G. Butchart, and W. D. Pile.

Contracts.—Ed. Bennis and Co. have recently received orders for seventy stokers and furnaces of various types, twenty-nine of which are the firm's high duty smokeless, smutless, and gritless, coking stokers.—The contract for laying water mains and building a pumping station and covered storage reservoir for the Pewsey Urban District Council has been awarded to Geo. Pollard and Co., Taunton.—A. and J. Main and Co., Limited, have just completed the final shipment from their Glasgow works of two important contracts for South America. One comprises about two-thirds of the steel-framed shedding, covering an area of 60,000 square metres, to be used in the housing of the coming Exhibition at Buenos Aires. The other being the complete roofs to cover in the filter beds of the city of Buenos Aires water supply, amounting to about 7½ acres area. This latter contract is being erected complete at destination by A. and J. Main and Co., Limited. This firm is also responsible for the erection in India of the whole of the steel buildings for the new rolling mills of the Tata Iron and Steel Company, housing the first iron and steel plant now being laid down in India for the production on a large scale of iron and steel from native ore.

The Institution of Electrical Engineers.—The members of this Institution held their annual dinner on Wednesday, December 8th, in the Hotel Cecil, London. Dr. Gisbert Kapp, the President of the Institution, occupied the chair, and two hundred and fifty gentlemen were present. Sir William H. White, K.C.B., F.R.S., proposed the toast of the Institution, and, in reply, Dr. Kapp made some interesting remarks on the present position of electrical enterprise in this country. He entered a strong protest against a growing habit of deploring British backwardness in adopting and developing electrical methods of working, and added that a recurrence to an expression of this belief must have the effect of discouraging our manufacturers and others from adopting the means advocated. It was not true, he continued, that foreign nations now held the lead in the electrical industry. While we had, perhaps, been backward in adopting some of the methods and inventions of the Continent, there were many discoveries and new processes which owed their inception to the genius and industry of British electricians, and at no time in the history of electrical science had there been greater activity in this country than at present. Prof. Sylvanus P. Thompson, F.R.S., in the absence through illness of Lord Justice Fletcher Moulton, spoke on the subject of science and industries, and, in reply, Sir Joseph Larmor, F.R.S., and Mr. J. A. F. Aspinall acknowledged the toast on behalf of the scientific and industrial worlds respectively. Among others present were the Rt. Hon. Lord Strathcona, Sir John Gavey, C.B., and Mr. C. E. Spagnoletti.

Royal Institution.—A general monthly meeting of the members of the Royal Institution was held on Monday afternoon—the 6th instant—Sir J. Crichton Browne, Treasurer and Vice-president, in the chair. Mr. J. H. Batty, Mr. T. Gibson Bowles, Mr. C. Broadbent, Captain F. S. Rose, Dr. H. Spitta, Mr. J. B. R. Swan, and Mr. J. S. Wilson were elected members. Geh. Reg. Professor Dr. Otto N. Witt, President of the Chemical Society of Berlin, and Professor George E. Hale, Director of the Mount Wilson Solar Observatory of the Carnegie Institution, Washington, were elected honorary members. The following are the lecture arrangements at the Royal Institution before Easter:—Mr. W. Duddell, a Christmas course of six illustrated lectures on "Modern Electricity, adapted to a Juvenile Auditory": (1) "First Principles;" (2) "Electrical Instruments;" (3) "Röntgen Rays;" (4) "The Generation of Electricity;" (5) "Electric Oscillations;" (6) "Electric Lighting." Professor W. A. Herdman, three lectures on "The Cultivation of the Sea;" Rev. C. H. W. Johns, two lectures on "Assyriology;" Professor F. W. Mott, Fullerian Professor of Physiology, R.I., six lectures on "The Emotions and their Expression;" Major Martin Hume two lectures on "Europe's Debt to Mediæval Spain;" Professor Silvanus P. Thompson, three lectures on "Illumination, Natural and Artificial;" Mr. A. J. Finberg, two lectures on "Turner;" Dr. H. Walford Davies, three lectures on "Music in Relation to other Arts;" Professor Sir J. J. Thomson, Professor of Natural Philosophy, R.I., six lectures on "Electric Waves and the Electro-magnetic Theory of Light." The Friday evening meetings will commence on January 21st, when Professor Sir James Dewar will deliver a discourse on "Light Reactions at Low Temperatures." Succeeding discourses will probably be given by the Rev. Canon Beeching, Professor W. Bateson, Mr. C. E. S. Phillips, Professor H. H. Turner, the Rt. Hon. Lord Rayleigh, Dr. Charles Chree, Dr. H. Brereton Baker, Professor Sir J. J. Thomson, and other gentlemen.

BRITISH PATENT SPECIFICATIONS.

When an invention is communicated from abroad the name and address of the Communicator is printed in italics.

When the abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent-office Sale Branch, 25, Southampton-buildings, Chancery-lane, London, W.C., at 8d. each.

The first date given is the date of application; the second date at the end of the abridgment is the date of the advertisement of the acceptance of the complete specification.

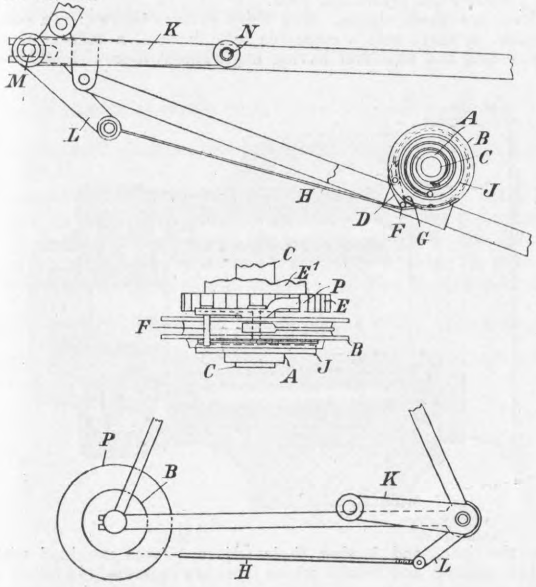
Any person may on any of the grounds mentioned in the Acts, within two months of the date given at the end of the abridgment, give notice at the Patent-office of opposition to the grant of a Patent.

INTERNAL-COMBUSTION ENGINES.

27,667. December 19th, 1908.—Improvements in or connected with Starting Devices for Internal Combustion Engines of Motor Bicycles, Alfred Angas Scott, of Mornington Works, Grosvenor-road, Bradford.

This invention has for its object improvements in starting devices for internal combustion engines of motor bicycles whereby the engine can be started by the rider when on his seat. As shown in the upper engraving, the boss A of the pulley B is mounted on the same shaft C as the two-speed gear, while the pawl D is arranged to engage with the teeth of a ratchet E fixed to a portion E^1 connected to the high gear chain wheel. This pawl D is mounted on the side of the pulley, and has a projection F on its backward extension projecting out therefrom at right angles and through a cut G in the groove of the pulley into the groove itself in such a way that when the flexible connection is wound round the pulley by means of the helical spring J it engages with the projection F and normally keeps the tooth of the pawl out of engagement with the ratchet. The flexible connection, which is of stranded wire or chain, is connected to a bell crank lever, the arms K and L of which are at about 45 degrees to one another, mounted on the rear wheel spindle M. The free arm K of the bell crank lever is provided with a crank or pedal N, so as to be capable of being engaged and pressed down by the foot of the rider. The pedal is normally kept in its raised position by the helical spring J of the pulley. As will be seen, the above arrangement is particularly applicable to machines with clutches enabling the engine to run free, or with variable gears with a position enabling the engine to run free. In the cases, as in the lower engraving, in which the free engine clutches P are arranged on the back wheel intermediate to the belt pulley or sprocket wheel and the driving wheel, the starting pulley may be arranged at the back and the starting lever in the position generally occupied by the pedals if such are not used.—*November 27th*, 1909.

N º 27,667.

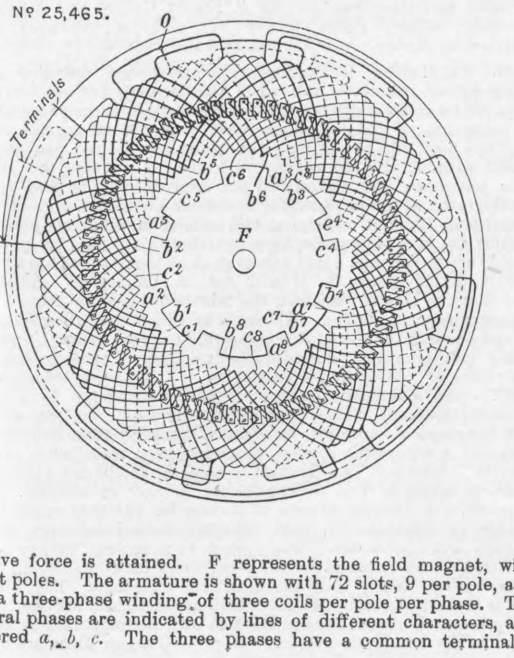


DYNAMOS AND MOTORS.

25,465. November 25th, 1908.—Improvements in and relating to Alternating-current Dynamo Electric Machines, the British Thomson-Houston Company, of 83, Cannon-street, E.C.

This invention relates to alternating-current dynamo electric machines, and its object is to provide a novel and simple form of armature winding whereby a true sine wave of induced electromotive force is attained. F represents the field magnet, with eight poles. The armature is shown with 72 slots, 9 per pole, and has a three-phase winding of three coils per pole per phase. The several phases are indicated by lines of different characters, and lettered a, b, c. The three phases have a common terminal 0. The three phases are then connected in Y, so that between each pair of terminals the third harmonic and its overtones are eliminated. Each coil spans seven slots, or, in other words, has a pitch of $\frac{7}{9}$. Since this is approximately equal to $\frac{4}{5}$, the fifth harmonic is substantially eliminated in each coil. While the total number of coils of each phase is 24, that is, three per pole, the coils of each phase are not grouped in the usual manner. The groups of coils at the several poles differ in the number of coils per group. For instance, considering the phase shown in heavy full lines, to which reference letters b are applied, exponents being used to denote the different groups, it will be seen that starting at group b^1 and proceeding in a clockwise direction around the armature the number of coils in the groups are as follows:—b^1, 3 coils; b^2, 4 coils; b^5, 3 coils; b^6, 2 coils; b^3, 3 coils; b^4, 4 coils; b^7, 3 coils; and b^8, 2 coils; that is, groups b^2 and b^4 each have one coil in excess, while groups b^6 and b^8 have a deficit of one coil each. The result of this grouping of coils is to displace half the coils of the phase from the other half. For instance, considering groups b^1 and b^5, it will be seen that the coils in these two groups instead of being displaced by 18 slots—that is, twice the pole pitch—are displaced from each other by 19 slots. In other words, the two groups of coils are offset from each other by a slot—that is, by $\frac{1}{9}$ of the pole pitch. Similarly, groups b^2, b^3 and b^4 are offset from groups b^6, b^7 and b^8 respectively by one slot. In other words, half the coils of the phase are offset from the remaining coils of the phase $\frac{1}{9}$ the pole pitch, and this offset, as has heretofore been explained, results in the substantial elimination of both the seventh and the eleventh harmonics. The theory of the winding is fully described.—*November 17th*, 1909.

Nº 25,465.



19,012. November 11th, 1909.—Improvements in the Rotors of Dynamo Electric Machines for Reducing Noise, Siemens Brothers Dynamo Works, Limited, of Caxton House, Tothill-street, Westminster.

Referring to the upper engravings, the salient poles are denoted by P, the magnetic yoke by K, and the spokes by K^1. The yoke K projects sidewise to some extent on either side beyond the poles P, and according to the invention discs S are screwed to the sides of K. The outer diameters of the discs S are nearly or exactly equal to the outer diameters of the poles P, and the latter are consequently nearly or completely enclosed in a ring-shaped canal. A moderate movement of air around the pole or rotor windings is desirable for cooling purposes, but usually when the discs are fitted there will be a sufficient movement for this purpose owing to the production of weak eddy currents of air due to air friction against the inner cylindrical stator surface. When, however, a sufficient movement of the air for cooling purposes is not obtained in the above manner distance pieces may be fitted between the yoke K and the discs in order that a limited quantity of air may flow into the ring-shaped canal through the spaces between the yoke and the discs. The foregoing arrangement with distance pieces is illustrated in the lower engravings, which are similarly lettered. In the former figures projections or distance pieces V are fixed between K and S, and a limited quantity of air flows through the narrow ducts M so produced in a radial direction into the ring-shaped canal. This air circulates in the ring-shaped canal and cools the windings of the poles P sufficiently without producing any undue noise.—*November 17th*, 1909.

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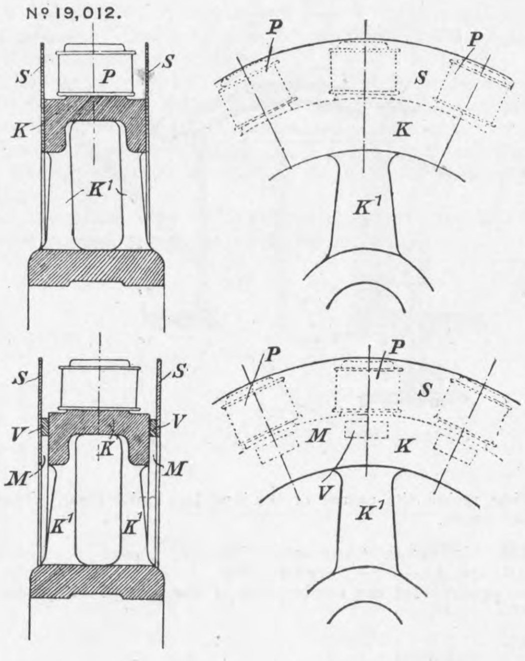

14,391. June 19th, 1909.—Improvements in Dynamos or Electrical Motors, John Halifax Garty, of 51, Bishop-street, Anderston, Glasgow, Scotland.

The object of this invention is to simplify and cheapen the construction of dynamos and motors. The magnetic field and yoke parts are constructed of a series of stamped metal plates provided with one or more pairs of poles, with suitable holes to receive bolts supporting the end plates, which are of stamped metal and the requisite key-ways to take the bars constituting the feet. The yoke and magnetic field portion A, which is composed of a series of stamped metal plates of square section outside, is provided with one or more pair of poles. Holes F are formed for the reception of the bolts G, the bolts have fitted thereon the tubular distance pieces H for bracing together the end plates I, I which carry the bearings J, J for the spindle of the dynamo or motor—not shown. Suitable shields K envelope the bearings, as seen. The stamped metal plates composing the yoke and magnetic field A are provided with the dovetail key-ways L, M designed for the bars N, O which constitute feet for enabling the dynamo or motor to be bolted down to the place required.—*November 17th*, 1909.

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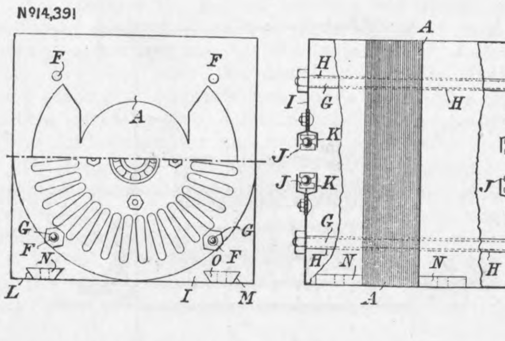
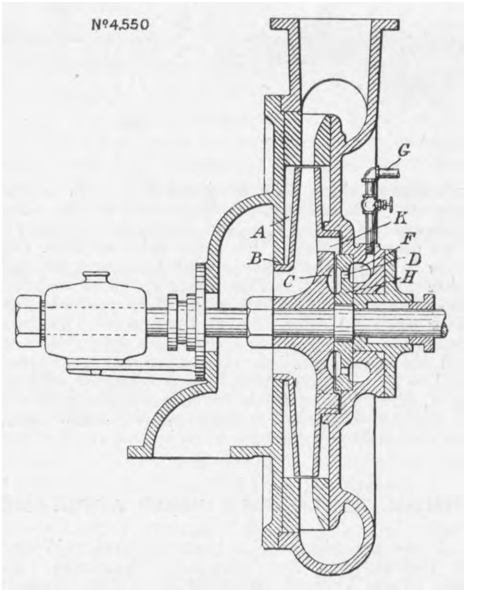


PUMPING AND BLOWING MACHINERY.

4550. November 11th, 1909.—Improvements in Balancing Devices for Centrifugal Pumps and the like, *Henry R. Worthington, No. 115, Broadway, New York.*

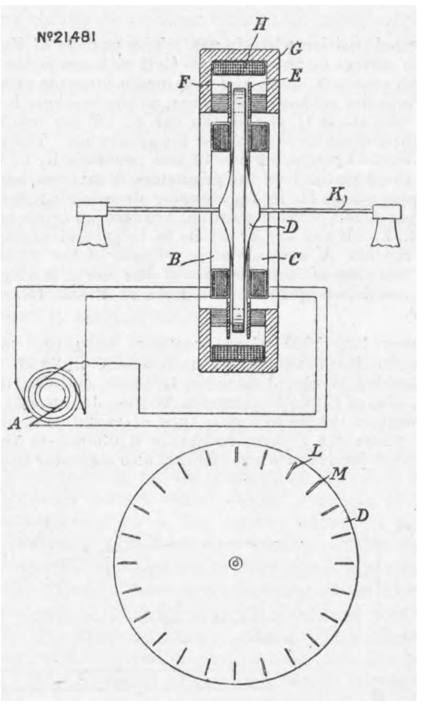
The chambers A extend from the outer edge of the impeller inward to the running joints which are formed between shoulders on the impeller, and on the casing. Instead of making these chambers A of the same radial dimensions as usual, the chamber on one side, and preferably the front or suction side of the impeller, is made of greater radial dimensions than that on the other side of the impeller, so that a larger surface on the impeller is exposed to the pressure in the chamber A on the suction side of the impeller, thus securing a constant excess of pressure tending to move the impeller to the right in the drawings. At the back of the impeller is a balancing chamber C which connects through passages D with a circular chamber F in the casing, into which liquid under the desired pressure is introduced through pipe G, controlled by a cock by which the normal pressure on the rear side of the impeller opposed to the constant excess of pressure on the other side may be regulated as desired. In the construction shown, the chamber C is enclosed by the bearing surfaces on the back of the impeller and the thrust bearing ring H, and the space outside the bearing surfaces is connected with the impeller by passages K through the impeller. The liquid from pipe G thus passes between the bearing surfaces to the impeller and forms a liquid anti-friction bearing. The circular chamber F is not essential, but any suitable connection constructed to supply liquid to chamber C and the liquid bearing may be used.—*November 17th*, 1909.



TELEGRAPHS AND TELEPHONES.

21,481. October 10th, 1908.—Improvements in Driving Shafts Electrically at High Speeds, *Reginald Aubrey Fessenden, of Brant Rock, State of Massachusetts, United States of America.*

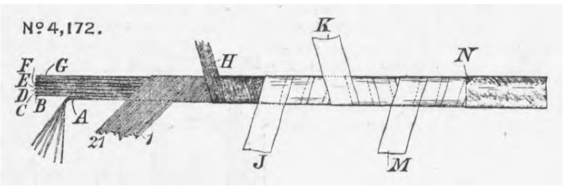
The upper engraving shows the method as applied to the driving of a high-frequency alternator. Here A is a two-phase dynamo having a frequency of 500 cycles per second; B, C is the field of the motor; D is the armature of the motor and may consist of a single disc of phosphor bronze or nickel steel. A side elevation of this disc is shown in the lower engraving. E, F are the armatures of the high-frequency machine to be driven; G is the field circuit, and H the magnetising coil for the field circuit of the high-frequency machine; K is a shaft on which the motor armature or rotor is mounted. The disc D is slotted around its circumference, and the slots L, M are filled with pieces of thin sheet iron in order to complete the magnetic circuit of the high-frequency alternator. By means of this apparatus a rotative speed of 30,000 per minute can be maintained, with a minimum of frictional loss and of vibration.—*November 17th*, 1909.



TRANSMISSION OF POWER.

4172. February 20th, 1909.—Improvements in Insulated Wire Cables, British Insulated and Helsby Cables, Limited, Milton-road, Edge-lane, Liverpool, and William Aitken, of the same address, and Charles Randall Sproule, of the British Insulated and Helsby Cables, Limited, Helsby.

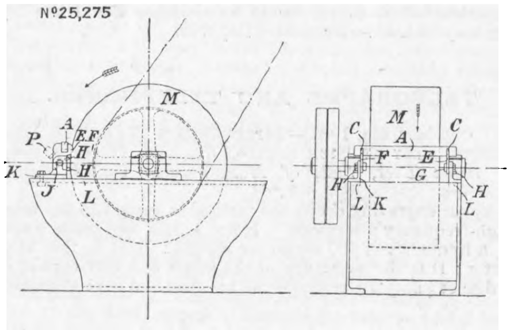
This invention relates to the construction of insulated wire cables, and primarily to those used for telephone switchboard construction work. In the form of cable generally used for this purpose three wires are twisted together for each circuit, and twenty-one such triple wires are laid up round a cardboard core or centre. The cardboard core is required to give a rigid base on which to lay up the wires, which are afterwards pressed flat, and kept flat by this cardboard centre. The objections to this method of construction are: (*a*) That the signalling wire is laid up with the speaking circuit, and inductive disturbances are liable to be set up in the latter; (*b*) the cardboard centre absorbs and retains moisture readily, and although this may be removed when the cable is manufactured, the moisture is re-absorbed when the cable is cut up into lengths for forming into multiple jack ends; (*c*) the cable is bulky. The present invention overcomes the objections specified in the following manner:—The twenty-one pairs are laid up in seven cables of three pairs, as shown at A to G. Each set of three pairs are stranded together with a suitable lay. The seven small cores are laid side by side, and during the process of manufacture are passed through a thin metal flattened tube, which acts as a former to keep these cables in a flat formation, and takes the strain from the lay-up of the wires which are to be wrapped round the seven cores, and this former therefore prevents the seven cores being displaced from the flat formation. The twenty-one single wires for the signalling circuits are arranged twenty-one wide, and are lapped round the seven cores with a suitable lay, as shown at 1 to 21. The cable thus formed is lapped with a cotton covering H, paraffin paper J, lead foil K, another lapping of paraffin paper M, and then braided N in any of the well-known manners.—*November 17th*, 1909.


Nº4,172.

MACHINE TOOLS AND SHOP APPLIANCES.

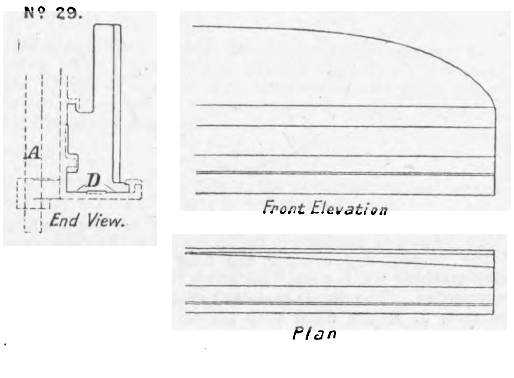
25,275. November 24th, 1908.—Improvements in Tool Rests for Grindstones and Abrading Machines, Manasseh Luney, Farm Cottage, Whitehouse, Antrim, Ireland, and James Charles Hamilton, Sunnyside, Whitehouse, Antrim, Ireland.

This invention relates to an improved tool rest for grindstones and abrading machines, of the kind which automatically alters its position in relation to the abrading surface, if by accident the tool or article to be ground gets between the tool rest and the abrading surface of the grindstone or abrading machine. The invention essentially consists of a bar, A, on which the tool or article to be ground is rested, the bottom side of which is notched at the two studs C, C, and fitted into complimentary notches in the top of the two brackets E, F, which are free to swivel on two studs G, G, and stopped by projections H, which retain the brackets E, F and bar A in a normal position when in use. The portion of the brackets E, F which swivel on the two studs G, G is made in the form of a slot J, with one end open, and thus make a simple arrangement, and facilitate the purpose of cleaning, as the brackets E, F can be lifted off the studs G, G and the bar A, off the brackets E, F, without unscrewing any portion of the apparatus. The studs G, G are fixed in the upright portion of the pedestals K, K, which are bolted to the framing L of the grindstone M or abrading machine, and the projections H, H, for stopping or retaining the brackets E, F and bar A in a normal position, are cast on or screwed to the brackets E, F. If the tool or article to be ground accidently gets between the bar A and abrading surface of the grindstone or abrading machine M, the distance of the bar A is automatically increased, as shown by the dotted lines at P and H¹.—*November 17th*, 1909.


Nº25,275

29. January 1st, 1909.—Improvements relating to Radial Drilling Machines, Loudon Brothers, Limited, of Clyde Engineering Works, Johnstone, Renfrew, and Charles Francis Rush, also of Clyde Engineering Works, Johnstone, Renfrew.

This invention relates to a new type of radial arm for drilling machines, whereby a greater resistance is offered to the upward vertical thrust produced when drilling, also a greater resistance to the torsional strain which takes place in an ordinary machine. These results are obtained by making the bearing faces on the under side of the radial arm to extend the full width across it, and thus offer a greater resistance against the upward vertical thrust, due to this thrust being distributed over a larger area than is usually the case. From the engraving it will be clearly seen that the vertical upward forces acting on this radial arm due to feeding the revolving spindle A into the material being operated upon will be distributed over the whole face D, and so over the whole width of arm, thus offering a greater resistance to vertical upward thrust and torsional strain.—*November 17th*, 1909.

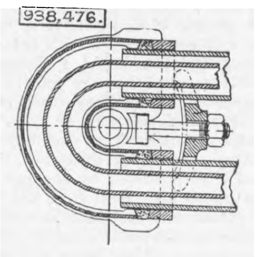

Nº 29.
End View.
Front Elevation
Plan

SELECTED AMERICAN PATENTS

(*From the United States Patent-office Official Gazette.*)

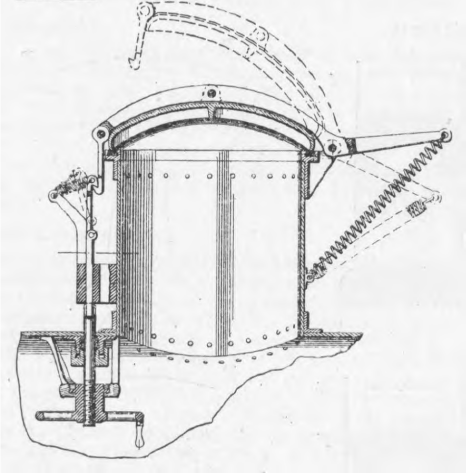
938,476. Condenser, *C. J. A. Gottlieb, Aarhus, Denmark.—Filed May 28th*, 1908.

This patent is for the construction of what may be termed headers. Their construction will be best understood from the drawing. There are two claims. The second runs "in heat-exchanging apparatus, the combination with an outer and an inner tube, of a divided curved connector forming a prolongation of the outer tube and provided with a shoulder on each of the divided parts, a pair of packing rings encircling the two outer tube ends, a packing joint between the two-part curved connector and the packing rings, a bolt engaging with the shoulder on the divided curved connector, and means co-operating with said bolt for tightening the joint between the rings and the divided curved connector."


938,476.

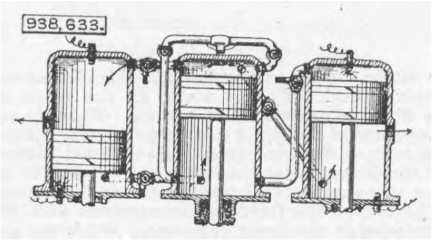
938,593. Water-tight Hatch or Manhole Cover, *M. A. Laubeuf, Paris, France.—Filed June 23rd*, 1909.

This invention applies to torpedoes and submarines. The drawing makes the nature of the invention quite clear. There are ten claims.


938,593.

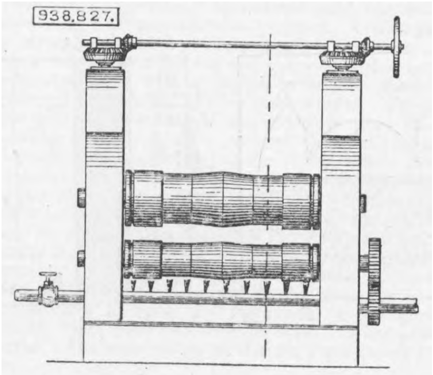
938,633. Internal Combustion Engine, *Gustav V. Benson, Chicago, Ill.—Filed July 14th*, 1909.

This patent is for the combination of one central compression cylinder with two explosion cylinders. The compression or "pumping" cylinder is double-acting. There are four rather long claims.


938,633.

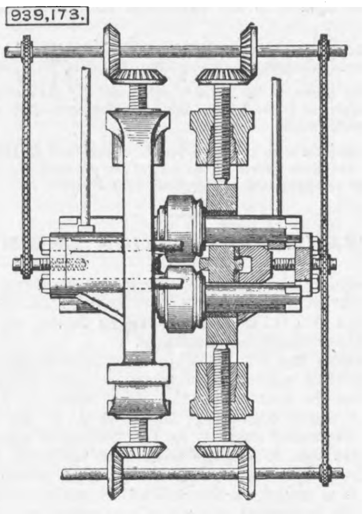
938,827. Steel Car Axle and Method of Making the same, *Andrew C. Cunningham, Norfolk, Va.—Filed December 17th*, 1908.

The invention claimed is a method of producing car axles of great hardness, toughness, ductility, and strength, which consists in first heating a billet or bloom of steel of the necessary size; secondly, forming said bloom into a billet of elliptical or flattened cross section by rolling the same longitudinally; and thirdly, working and shaping said billet by cross or transverse rolling throughout its length under gradually increasing pressure. There are four claims.


938,827.

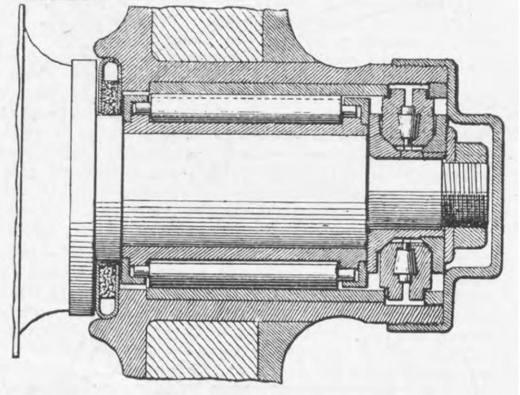
939,173. Universal Rolling Mill, *H. Sack, Düsseldorf, Germany; A. Sack, Administratrix of said H. Sack, deceased.—Filed November 30th*, 1908.

This is one of several patents taken by Herr Sack for improvements in rolling mills. This one is for a universal mill for rolling I-bars with outwardly diverging flanges, comprising a pair of housings having guideways, a pair of horizontal rolls journaled in bearings in said guideways, a pair of vertical rolls, each having a convex face, a pair of chocks carrying said vertical rolls, horizontal guideways for said chocks, and inter-connected means for simultaneously forcing both the horizontal and the vertical rolls toward the roll pass, and thereby accurately maintaining the desired form of pass. There is only one claim.


939,173.

939,269. Thrust Bearing, *A. T. Killian, Buffalo, N.Y., assignor, by direct and mesne assignments, to National Anti-friction Roller Bearing Company, Buffalo, N.Y., a Corporation of New York.—Filed March 5th*, 1909.

There are three claims. The third runs as follows:—In combination, a shaft and a rotatable hub thereon, a pair of rings surrounding the axle and having engagement therewith and also with the hub, and having their adjacent faces provided with annular grooves and tracks whose faces are oppositely bevelled, a series of radially arranged thrust-receiving rollers, and a series o radially arranged spacing rollers smaller in diameter than the thrust rollers and having reduced end extensions running on said tracks, for the purpose set forth.


939,269.

Machinery Exhibition in Manchester.—An exhibition of machinery is to be held next year in the new City Exhibition Hall at Manchester. Preparations for this exhibition are, we understand, in a forward state. The hall is fitted up especially for exhibitions of this character, the main gangways being paved with wood blocks, and being sufficiently strong to permit the safe passage along them of a 10-ton traction engine. Moreover, arrangements will be made for lifting heavy weights into position and for supplying power, water, &c. Particulars of the exhibition may be obtained from Mr. W. Cawood, 16, John Dalton-street, Manchester.

North of England Institute of Mining and Mechanical Engineers.—A general meeting of the members of the North of England Institute of Mining and Mechanical Engineers will be held in the Wood Memorial Hall, Newcastle-upon-Tyne, at two o'clock, on Saturday, December 11th. The following paper will be open for discussion:—"Automatic Cage Tub-stops," by Mr. T. Campbell Futers, and the following papers will be read or taken as read:—"Some Results of Experiments made to Test the Effect of Sprayers upon the Moisture of Main Roads at Brandon Colliery," by Mr. T. L. Elwen; "Sinking the John Shaft at Hamsterley Colliery through Sand and Gravel by means of Under-hanging Tubbing," by Mr. John Cummings; "Electric Shot-firing," by Mr. James Douglas; and "A Natal Colliery Explosion, and Underground Fires in Fiery Mines," by Mr. Wm. Taylor Heslop. A new reinforced concrete mine prop will be exhibited and described by Mr. F. Elford Gulley, and a patent self-oiling colliery guide sheave will also be exhibited and described by Messrs. Jno. Alf. Jackson and Son.

The Telephone Operator.—The telephone operator had hardly sprung into existence when the necessity for her services began to be contested by inventors, who within three years after the invention of the telephone itself proposed to provide each telephone user with means for establishing any desired connection himself without the aid of any operator. For years the automatic telephone was considered an improbability by the great majority even of the most skilful telephone engineers, and at the present time it is not unusual to find articles in telephone journals in which the idea of the telephone operator being done away with is held up to ridicule. But events such as those which have been recently taking place in Munich are in themselves sufficient proof that the idea of banishing the telephone operator from local exchanges at any rate, viz., exchanges in which the subscribers in one and the same city are inter-connected is by no means Utopian. During last month a considerable number of the telephone subscribers of Schwabing, a suburb of Munich, were transferred from the old manually-operated telephone exchange to a new automatic system. This system is, in the main, the one which bears the name of Strowger, who is one of the inventors who have developed a successful system which has been installed in many towns in America. The Munich automatic telephone exchange system is arranged for a capacity of 100,000 subscribers, and comprises five distinct groups of automatic switches called line switches or pre-selectors, first selectors, second selectors, third selectors and connectors. The system is a central battery one, *i e*, there are no batteries in the subscribers' instruments, all the battery power being centralised in the exchange. The whole town is to be ultimately provided with an automatic service, and the systems of other towns in Bavaria will, perhaps, also be converted to the automatic system. Several German firms are now developing automatic telephone systems.

NOTES ON THE DESIGN OF SHAFTS, WITH SPECIAL REFERENCE TO HIGH-SPEED ELECTRIC GENERATORS.

By H. H. JEFFCOTT.

No. V.* *(conclusion)*

28. If the load on a shaft consists of discs (of external and internal radii a_1 and a_2), we may examine the rotational strains in them. At any point distant r from the centre of the disc the radial strain due to rotation may be shown to be

$$\lambda \cdot \left\{(3 - 2\sigma)(a^2_1 + a^2_2) - \frac{3 - 2\sigma}{1 - 2\sigma} \cdot \frac{a^2_1 a^2_2}{r^2} - 3r^2\right\},$$

and the tangential strain is

$$\lambda \cdot \left\{(3 - 2\sigma)(a_1^2 + a_2^2) + \frac{3 - 2\sigma}{1 - 2\sigma} \cdot \frac{a^2_1 a^2_2}{r^2} - r^2\right\},$$

The greatest strain is tangential and has the value

$$2\lambda(1 - \sigma)\left\{a^2_2 + \frac{3 - 2\sigma}{1 - 2\sigma} \cdot a^2_1\right\}.$$

The discs should be strong enough to withstand this strain. In particular, the discs of which an armature is built must be able to withstand this strain, in addition, of course, to the strains due to gravity, and the magnetic pull exerted on the iron by the field pole system. This last may be reckoned as $B^2_g A \times 8.942 \times 10^{-8}$ lb. weight directed to each pole, and spread nearly uniformly over that part of the armature surface under each pole; A is the air gap area in square centimetres, and B_g is the gap density in lines per square centimetre.

In the case of the shaft, which is continuous up to the axis, the rotational strains are:—

$$\text{Radial strain} = \lambda\left\{(3 - 2\sigma)a_1^2 - 3r^2\right\};$$

$$\text{Tangential strain} = \lambda\left\{(3 - 2\sigma)a_1^2 - r^2\right\}.$$

The greatest strain is tangential and of magnitude $\lambda(3-2\sigma)a_1^2$.

Comparing this with the solution for the disc load, in which we make the internal radius a_2 indefinitely small, we find that the greatest tangential strain in the latter case—in which the shaft has a small flaw along its axis—is greater than that when there is no flaw in the proportion $\frac{2(1-\sigma)}{1-2\sigma}$. In other words, if the shaft have a small flaw along its axis, the greatest rotational strain is about three times what it would be in a sound shaft.

Further, if there is a flaw near the circumference, the greatest torsional strain may be twice that for a sound shaft. (Love, "Elasticity," vol. I., chap. VI.)

Again, a sudden application of a load may produce strains twice as great as the same load gradually applied would give; and a sudden reversal of load may produce strains three times as great as those due to the same load steadily applied.

There are also strains due to centrifugal and magnetic forces if the shaft is thrown into vibration, as well as strains due to torsional oscillation.

29. The proper factor of safety to allow in any given case will depend upon the relative magnitudes of flexural, torsional, and rotational strains.

If rotational strain greatly predominates a factor of safety of 3 will be required to provide against flaws (near the axis). If torsional strain predominates the factor of safety need only be 2. If flexural strain greatly predominates the factor of safety may be reduced to nearly one, so far as flaws are concerned.

Further, we are concerned with the nature of application of the various loads. For each load suddenly applied a factor of safety of 2 must be allowed on the corresponding strain, and for sudden reversal of load the corresponding strain should have a factor of safety of 3.

In the case of flexure of the rotating shaft under gravity the load is alternating, and a factor must be allowed on the ordinary breaking stress, say 3. The possibility of increased torsional load due to short circuit in the case of a dynamo should also be provided for by a factor of safety of at least 3.

It is to be remembered that if the load is not perfectly balanced the out of balance loads give rise to flexural strains.

Thus, in general, the total factor of safety demanded from the consideration of possibility of flaws, and nature of application of load depends on the relative magnitudes of the flexural, torsional, and rotational strains.

We may separate the following cases:—

Flexure alone—Factor of safety (for alternating load 3) = 3.

Torsion alone—Factor of safety (for flaw 2, for sudden reversal 3, for short circuit 3 or more) = 6 say.

Rotation alone—Factor of safety (for flaw 3, for sudden application of load 2) = 6.

If we multiply by a margin of 2, we find that a factor of safety of 6 to 12, depending on the nature of the load, will be sufficient. These figures are in accordance with common practice. As the elastic limit is about one-half of the ultimate strength, we see that the values of the factor of safety just given ensure that the working stress does not exceed the elastic limit.

30. As an example of the determination of whirling speed and factor of safety, we take the case of a 500-kilowatt continuous current turbo generator, 2 poles, 500 volts, 2400 revolutions per minute. Shaft diameter $5\frac{3}{4}$in. Distance between bearing centres 89in. $E = 39 \times 10^6$ lb. per square inch. $I = \frac{1}{4}\pi a_1^4 = 53.7$in. units. $g = 386$in. per second per second. G, the magnetic unbalanced load = 28,000in. lb. units. The value of ω^2 is first obtained by neglecting G, and then the value of $\frac{G}{\omega^2}$ is sufficiently known for a second approximation. See sections 14, 15.

Omitting G in a first approximation, we find $\Sigma q m \Psi - \Sigma q' m \frac{k^2}{l^2}\theta$ is ·3882. Also $3{\cdot}75\frac{EI}{l^3} = 11{,}400$; $\therefore \omega^2 = \frac{11{,}400}{.3882} = 29{,}300$. Hence $\frac{G}{\omega^2} = 1$ (nearly) for a second approximation. Adding the corresponding term to $\Sigma q m \Psi$ we obtain a value for ω^2 which gives $\frac{G}{\omega^2} = 1.14$ for a third approximation.

Thus finally we obtain $\omega^2(.4523 - .0082) = 11{,}400$; $\therefore \omega^2 = 25{,}750$; $\therefore \omega = 160.5$; $N = 1525$ revolutions per minute. Had we omitted G we would have obtained 1630 revolutions per minute.

The actual whirling speed was 1480 revolutions per minute when the machine was run, vibration occurring from about 1450 to 1520 revolutions per minute.

Using the second formula (section 14) in the same way we find $\omega^2 = 25{,}400$, $\omega = 159$, $N = 1515$ revolutions per minute.

If the whole load be imagined split up into, say, five pieces spaced along the shaft we may take

$m = \dots 1{\cdot}30 \dots 4{\cdot}19 \dots 1{\cdot}31 \dots 1{\cdot}33 \dots 1{\cdot}78$
$t = \dots {\cdot}135 \dots {\cdot}291 \dots {\cdot}45 \dots {\cdot}528 \dots {\cdot}865$

Load.	Weight, lb.	Mass.	Square of radius of gyration about transverse axis (inch-units).	Position, inches from end.	Value of t.	Value of ψ.	Value of θ.	Value of q	Value of q^1.	$q m \psi$.	$q^1 m \frac{k^2}{l^2}\theta$.
Shaft	650	1.69	2.06	—	—	.0386	.3812	1	1	.0650	.000168
Commutator and rings	882	1.15	15.2	12	.135	.013	.61	1.1	1.15	.0165	.001550
		1.15	15.2	42	.472	.077	.01	1	2.8	.08 6	.000018
Cover, copper, and casting	393	1.02	40.3	49	.55	.076	.021	1	2.8	.0775	.000087
Core and teeth, copper, and separators	1057	2.74	29.0	63	.709	.048	.29	1.02	1.25	.1342	.002750
Cover, copper, and casting	393	1.02	40.3	77	.865	.013	.61	1.1	1.15	.0146	.003640
$\frac{G}{\omega^2}$	—	1.14	—	63	.709	.048	—	1.02	—	.0559	—
										.4523	.008213

and hence by sections 10, 11 we find $\omega^2 = 26{,}000$, $\omega = 161$, $N = 1540$ revolutions per minute.

If we require the second whirling speed roughly we may imagine the load divided into two parts: mass 4·385 at $t = {\cdot}20$, and mass 4.385 at $t = .64$. Then by section 17 we find $\omega^2 = 29{,}350$ or $321{,}000$; $\therefore \omega = 171$ or 566; $N = 1630$ or 5400. These have still to be corrected for magnetic pull G. We find then $N = 1525$ or 5390. Thus G exerts a much smaller effect on the second than on the first whirling speed, since indeed $\frac{G}{\omega^2}$ is then smaller.

If we require the second whirling speed with greater, accuracy we should take a distribution of load more nearly approximating to the actual, and follow section 17; or, take the load as actually distributed and assume a displacement curve coinciding with the actual curve at two suitable points. (See sections 13, 16.) And so on, for higher whirling speeds.

To determine the factor of safety (section 27) on greatest strain theory:—Normal speed 2400 revolutions per minute, $\therefore \omega = 252$; H = twisting couple = 17,600 inch lbs.; $\lambda = 1.21 \times 10^{-7}$; $\tau = 1.026 \times 10^{-5}$. For X let us take that load at the centre of the shaft that will give the same maximum bending moment as the maximum bending moment for the actual distribution; $\frac{1}{2} X \times 44{\cdot}5 = 47{,}500$; $\therefore X = 2140$ lb., $\mu = 1.12 \times 10^{-8}$. Hence $S' = 8.122 \times 10^{-5}$; $S'' = 8.022 \times 10^{-5}$; $S''' = 6.4 \times 10^{-5}$. Taking $T_o = 135{,}000$ lb. per square inch, we find $\Phi' = 41.6$; $\Phi'' = 42.1$; $\Phi''' = 52.9$. The shaft is more than amply strong, stiffness rather than strength being here the dominating factor.

It will be noticed too that the rotational stresses are small compared with the total stresses.

COMPOUND ENGINES.

By R. M. DEELEY, M. Inst. C E.

The increasing use that is being made of compound locomotives, especially on the continent of Europe, cannot fail to make thoughtful railway engineers ask themselves how it is that they are so unpopular in England. The problem is a complex one, and can only be answered by the consideration of quite a number of circumstances. As I have had some considerable experience in the design and working of both simple and compound locomotives, I venture to put on record some facts which may be of interest.

In this country Mr. Webb and Mr. Worsdell were the first to experiment on a large scale. Their engines did and are now doing useful work on some of our lines. It is true that most, if not all, of Mr. Webb's engines have been broken up during recent years. There seems no doubt but that they were too small to work our modern trains, and that they frequently failed to start without assistance. Mr. Malcolm, however, has a number of compounds of the Worsdell-von Borries type at work in Ireland, and he considers them good and economical engines.

Although the feeling in England among railway men always has been, and still seems to be, strongly against compounding, when Mr. S. W. Johnson discussed the question with me, and stated that he contemplated building such an engine I strongly advised him to do so, more especially as the late Mr. W. M. Smith had designed a three-cylinder arrangement which promised to start away well with a heavy train under all conditions of load and gradient. There was quite a number of circumstances which led me to support the proposition.

The introduction of the corridor, dining, and sleeping coaches has largely increased the weight of the train to be hauled; for owing to the great restriction in seating space the corridors, lavatories, &c., entails, the weight of train per passenger has been much increased. These heavy trains frequently required more than one engine to draw them, a most expensive method of working, for two drivers and two firemen were then required. The weight of the engines alone was a large proportion of the train, and the consumption of fuel by the two engines was consequently very heavy. To increase the size of the cylinders and boiler very much meant heavy stresses on the connecting-rod bearings and other parts. Large bearings and heavy parts are not particularly objectionable on stationary engines, but on locomotives, owing to the flexibility of frames, wheels, &c., necessary to allow the locomotive to run round curves, wide bearings are very apt to run hot owing to the cross strains set up. The use of three cylinders and cranks enabled the crank and connecting-rods to be relieved of considerable strains, whilst the compounding promised to relieve the boilers very considerably.

The first five compounds built on Mr. W. M. Smith's plan, and now numbered 1000 to 1004, have two outside low-pressure cylinders and one high-pressure inside cylinder. With the first engine a large number of experiments was made to ascertain the best diameters of cylinder, the necessary end clearances to prevent undue compression, and the best ratio of cut-off and release of the high-pressure and low-pressure valves. The five engines were then completed. The two outside low-pressure cylinders have their cranks at right angles, and the crank of the high-pressure cylinder is on a line intermediate between the two outside cranks. As soon as steam is admitted to the high-pressure steam chest some of it passes through a reducing valve to the low-pressure steam chest, which then works as a simple engine under about 60 lb. of steam. To prevent excessive differences of pressure on the high-pressure piston when starting, a valve is fitted at each end of the high-pressure cylinder, so that should the pressure in the intermediate steam chest become greater than that in the high-pressure cylinder, the steam can pass it and balance the piston. Unless these valves are fitted I find that the locomotive will not start in certain positions.

These five engines worked so satisfactorily that I built forty others, to the drawings published in The Engineer of March 9th and 23rd, 1906, for the fast heavy passenger service on the Midland Railway. They were, however, modified and simplified in some respects. Mr. Smith's high-pressure cylinder equalising valves were retained; but instead of passing steam through a reducing valve to the low-pressure steam chest when starting, it was admitted through a port in the jockey valve on the main regulator valve. The first movement of the regulator handle moves the jockey valve into such a position that steam is admitted to the high-pressure steam chest, and also by a separate port through an auxiliary small steam pipe to the low-pressure steam chest. The engine then starts away with full boiler pressure in the low-pressure cylinders. As the speed of the locomotive increases with the regulator valves in this position, the pressure in the steam chest decreases, owing to the small diameter of the auxiliary steam pipe, and the stresses on the parts then decrease. Experience shows that the working parts do not suffer in any way from this high pressure, for it is only momentary. With the regulator in the starting position, the locomotive, being short of steam, can only travel slowly. On further movement of the main regulator, the small port admitting steam to the low-pressure steam chest direct is closed, and the large ports in the main valve admit a full bore of steam to the high-pressure cylinder. Four-cylinder balanced compounds can be built on this system also.

To enable the regulator valves to be easily worked, the jockey valve and main valves are actuated by separate links. With this arrangement the jockey valve opens first, and on closing the regulator shuts last, thus always balancing the large valve. Owing to the position of the cranks actuating the links, the leverage on the main valve is also greatest when the pressure on the face is greatest. Even with large valves and high pressures this design of regulator is easily moved by hand. With this form of compound no special instructions are required by the driver. The locomotive is manipulated exactly as is a simple engine, and it never fails to start easily, even with very heavy trains on severe gradients.

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* No. IV. appeared December 3rd.

The results of the fuel tests I am about to give were obtained with a number of the 1000 class compounds as compared with the 700 class simple engines. Both classes have Belpaire boilers. The leading particulars are as in Table I. The first five compounds carry 200 lb. The higher pressure put in the later engines was to give a reserve of steam on heavy banks, rather than to secure increased economy in fuel.

Table I.

Type of engine.	Pressure per sq. in.	Grate area, sq. ft.	Total heating surface sq. ft.	Wheels.	Cylinders, dia.
Compounds..	220	28·4	1473	7ft. 0in.	(1) H P. 19in. × 26in. (2) L.P. 21in. × 26in.
Simple ...	180	25	1528	6ft. 9in.	$19\frac{1}{2}$in. × 26in.

It will be noticed that the compounds have slightly less heating surface but larger grate areas than the simple engines. More heating surface would have resulted in greater economy in fuel; but the main object was to produce a locomotive of moderate weight with a maximum hauling capacity on gradients of 1 in 100, and capable of running at high speeds. That this result has been obtained is apparent, when it is stated that the allowed load in any weather for the 700 class engine on limited expresses is 180 tons, whilst for the compound it is 210 tons. This greater capacity for hauling heavy loads is partly due to the extra grate area and partly to the nature of the draught produced by the blast pipe of the compound engine, for more steam can be obtained from a given boiler on a compound engine than can be obtained from it on a simple engine. Indeed, drivers of compounds will, if not checked, take such heavy loads without an assisting engine that the fire-boxes are apt to suffer unduly. With regard to the question of the mileage obtained with the compounds and simples during similar intervals, including those at work and under repair, the compounds give over 20 per cent. better results than the simples.

To sum up as regards traffic working, the compounds take heavier loads, work a greater mileage, and have less frequently to be assisted than the simple engines. They are, however, more expensive to build and repair than the simple engine, but are more economical in fuel.

The coal consumption results here given were for trips made by engines as worked by drivers in ordinary running, no inspectors or others being on the foot-plates. The period chosen for making these tests was when trains were comparatively light, and no assisted trains have been taken into account. When the heavy summer traffic is being worked, the simple engines are largely assisted, and a proper comparison on a wide basis is not then possible. The following table gives the result of these workings:—

Table II.

Type of engine.	Average weight of train.	Train miles.	Gross ton-miles.	Lbs. coal per mile.	Lbs. coal per ton-mile.
Compounds ...	289	16,599	4,802,248	37·5	·129
Simples	281	10,582	2,975,668	39·2	·139

It will be seen that the compound engines took rather heavier loads than the simple engines, and on the ton-mile basis the economy of the compound as regards coal is $7\frac{3}{4}$ per cent. better than the simple. To this must be added the saving resulting from the much less double heading required. The greater duty which can be obtained by the compound, as regards weight of train hauled, is due to the fact that the blast pipe orifice can be made small enough to give a fierce draught without checking the engine as regards speed. With a larger blast pipe orifice I have found that they will work the lighter trains even more economically. Some of them are now fitted with a variable blast pipe, and much better all-round results have been obtained, as regards fuel consumption, with its assistance; $7\frac{3}{4}$ per cent. may not seem a large saving to effect, but when the great cost of coal to a railway company is considered, it is really a very considerable economy to secure in addition to obtaining a light engine of great hauling power.

The coal burned is that consumed by the engine in lighting up, shunting, working to and from the train, and standing during intervals between workings. Tests with two engines, both in very good condition, give an economy in favour of the compound of about 14 per cent. The difference between individual tests and the all-round results is due, I think, partly to the fact that the high-pressure engines lose more water through tube and stay leakage, on the average, than do the lighter pressed simple engines. And again, drivers of powerful engines keep time better up the banks, and do not run so fast on down grades and on the flat. For test runs, also, there is no shunting, &c., and the saving during running is a percentage of a smaller total coal consumption.

I have no hesitation in saying that the compound engine does better work than the simple engine from the point of view of working traffic, and that the economy in fuel obtained more than pays for the additional cost. By increasing the heating surface of the boiler and, therefore, the weight of the engine, greater economy of fuel could have been obtained, but such a plan was not admissible.

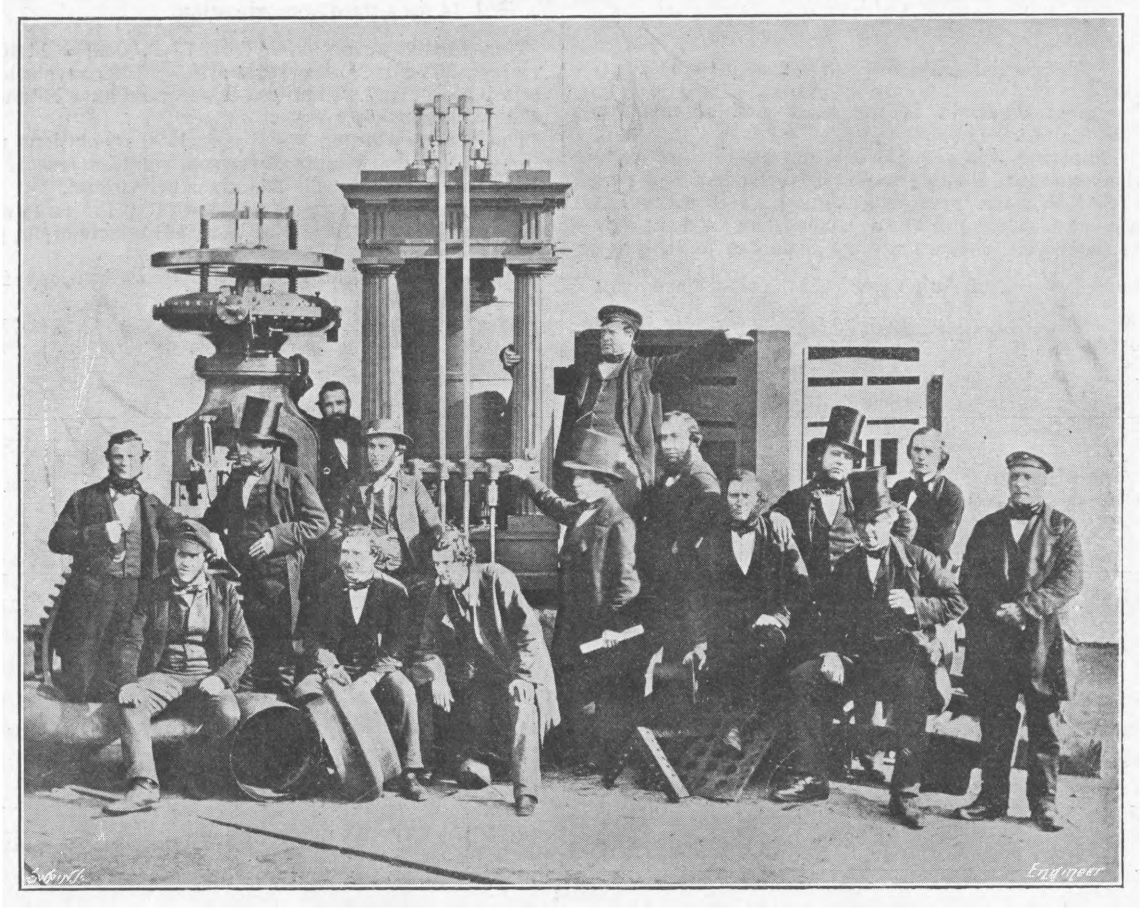
SOME RECOLLECTIONS OF SOHO FOUNDRY, ITS MEN AND METHODS.

By CHARLES H. WALL, M.I. Mech. E.

There is often some misunderstanding as to Soho Foundry and Soho Works. Soho Foundry was the engineering works founded and carried on by Mathew Boulton and James Watt. Soho Works was the large factory originated by Mathew Boulton in connection with his own private business, with which Watt had no connection. These notes refer to Soho Foundry.

The early photographic portrait group—Fig. 1—was taken about 1860 to 1862, some years before I was engaged there. The names of the worthies who appear in it are given beneath it. Mr. Brown was at that time managing director, and was known as a thoroughly good business man. He left Soho about 1873 or 1874. At that time a Mr. Hamilton was general manager. He invented the side pockets used in Lancashire boiler flues. He was followed by a Mr. Sanders, who invented a railway brake, which was tried by the Midland Railway at Derby, the first being made at Soho. He was known among the men by the title of "the Shah," on account, I suppose, of that potentate's visit to this country about that time. Mr. Darlington then succeeded as manager, having previously held the position of cashier, and he held the general managership till the closing of the works.

Mr. Carmichael, works manager, came to Soho from Portsmouth Dockyard in 1850. To him was deputed the duty of taking down and re-erecting at South Kensington Museum, Watt's "Lap engine" from Soho Works. This old beam engine was the first rotative engine ever put to work a factory. Of Mr. Carmichael's abilities as a mechanic I shall have to speak again when referring to special machines. He left Soho Foundry about the year 1863 to join Mr. Barrows, of Banbury, at Cherwell Works, afterwards Barrows and Stewarts. (Mr. Barrows married a grand-daughter of William Murdock.) Mr. Carmichael died in 1868. The manager before him was Mr. Buckle, who left Soho in 1850, to take the position of bullion master at the Royal Mint.



Mr. CARMICHAEL, *Works Manager.*
Mr. DAVID ANDERSON, *Second Assistant Works Manager.*
Mr. LEWIS, *Foreman Patternmaker.*
Mr. WALTON, *Foreman Coppersmith.*
Mr. FORBES, *Third Assistant Works Manager.*
Mr. BROWN, *Managing Partner.*
Mr. FRANK SHAW, *Foreman Foundryman.*
Mr. GARLAND, *Chief Draughtsman.*
Mr. MICKLEJOHN, *Shipping Clerk.*
Mr. HAZELDENE, *Assistant Office Manager.*
Mr. HARDY, *Foreman Boilermaker.*
Mr. MOLLINEUX, *Foreman Blacksmith.*
Mr JOLLY, *Assistant Draughtsman.*
Mr. WILLIAMS, *Gate-keeper.*

Fig. 1—STAFF OF THE SOHO WORKS IN 1860

Mr. David Anderson also came to Soho from Portsmouth Dockyard about 1854. At first Mr. Carmichael's assistant, he succeeded him as works manager, and held the position till his retirement in 1883. It was under Mr. Anderson that I made my own first acquaintance with Soho Foundry.

Mr. Forbes was another assistant of Mr. Carmichael's, and became chief of the out-door staff, and was principally engaged in the erection of mints and engine and machinery abroad. He retired before Soho Foundry was finally closed, and died a few months ago.

Mr. Garland was chief draughtsman, and was responsible for the designing and estimating department. He left in the early seventies.

With regard to the other names, Mr. Hazledene afterwards went to the London office, and I believe he was in charge there at the time the foundry closed in 1894. All these foremen were sound practical men who understood their business; and at that time a large amount of freedom and responsibility in matter of detail was given to the heads of departments. They always came to the works in top-hats, which no doubt demanded respect from the workmen.

An interesting feature in connection with this photograph is that each man's department can be recognised by his having something in his hand representing his work, or from his standing by a piece of work for which he has been responsible. Thus Mr. Carmichael holds a two-foot rule; Mr. Garland a roll of drawings; Walton, the coppersmith ("Old Copper"), holds the well-known expansion joint; Hardy, the boilermakers' foreman, is behind a tube plate; Lewis, the pattern foreman, is by a toothed wheel; and Shaw, the foundry foreman is in front of a bed-plate. The face between the coining press and the cylinder nozzle I am not able to identify. Of the possessors of the fourteen names given, all but two have joined the majority. They are Lewis, who I believe is still in London, and Mr. Anderson, who is living at Handsworth, and to whom I am indebted for the names of those in the photograph, having compared it with a group he has which was taken at about the same time, but with one or two more officials in it. With several of them I was acquainted when I first went to Soho.

Through the kindness of Mr. W. H. Dugard, M.I. Mech. E., I am enabled to add several photographs which I believe you have not published before. One—Fig. 1—is interesting as illustrating the Boulton coining press in the mint at Soho Foundry. About the year 1860 an order was received at Soho Foundry for twelve of these presses for the Calcutta Mint. A Mr. Harvey, engineer to the Calcutta Mint, conceived the idea of driving them by means of compressed air in a cylinder which was a segment of a circle, the piston of which was attached to the end of a radial arm which rotated the screw of the press. This press is illustrated in the group—Fig. 1. Harvey paid Mr. Carmichael £50 to design the press in accordance with his idea. A Colonel Smith came to Soho to inspect it on behalf of the purchasers, but its manner of working was so spasmodic that he condemned the lot, and James Watt and Co. were paid £500 each for altering the presses back to the old design. The presses shown in the photograph of the Soho Mint were of this original Boulton design. A trumpet-shaped rotating piece extended to the floor above the presses, its top part being parallel and free to rotate in a cast-iron bearing fixed to the floor. The bottom of this piece was formed with claws which dropped over a circular casting having fly-arms upon it, into which was fitted the screw of the press, the flange of the trumpet piece being further held down by bolts to this circular casting. Thus the circular casting and trumpet piece rotated, and rose and fell with the screw: The trumpet piece was hollow, and a lever was keyed to its upper end. This lever was worked by a vertical piston and cylinder of 20in. stroke placed outside the wall of the room in which the presses were situated, the piston and lever being connected by a bell-crank and rods. This motion performed the working stroke of the press. A loose connection was made by means of a rod passing through the hollow trumpet to a beam or lever poised on a centre, and having a rod connected to the piston of a second vertical vacuum cylinder placed by the side of the first. This second cylinder (of 12in. stroke) performed the duty of raising the screw and top die attached to it. The valve gear consisted of one valve only to each cylinder, actuated by the motion of the press. A constant vacuum was maintained in the cylinders on one side of the piston, the valves admitting air on the other side, or placing the pistons in equilibrium

HISTORICAL RELICS OF SOHO WORKS

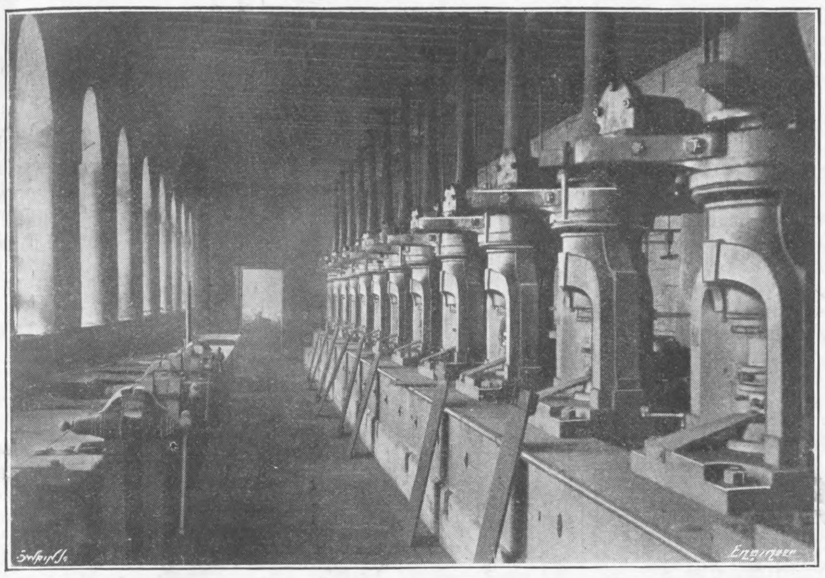


Fig. 2—BOULTON'S COINING PRESSES

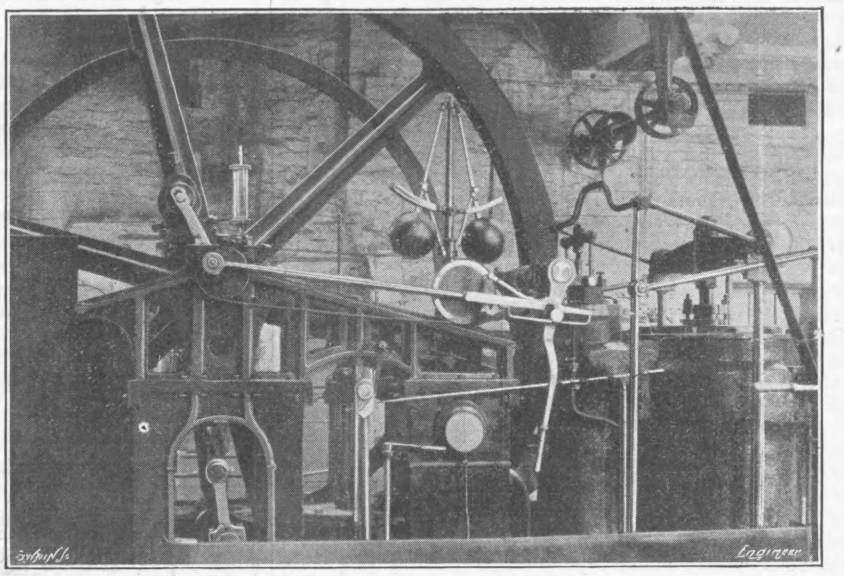


Fig. 3—SIDE LEVER ENGINES

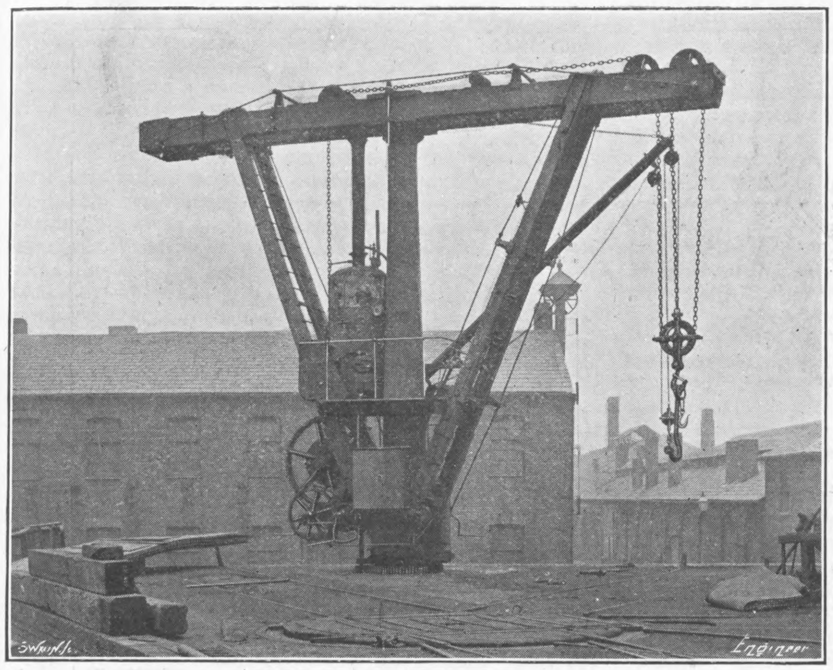


Fig. 4—MURDOCK'S 20-TON CRANE

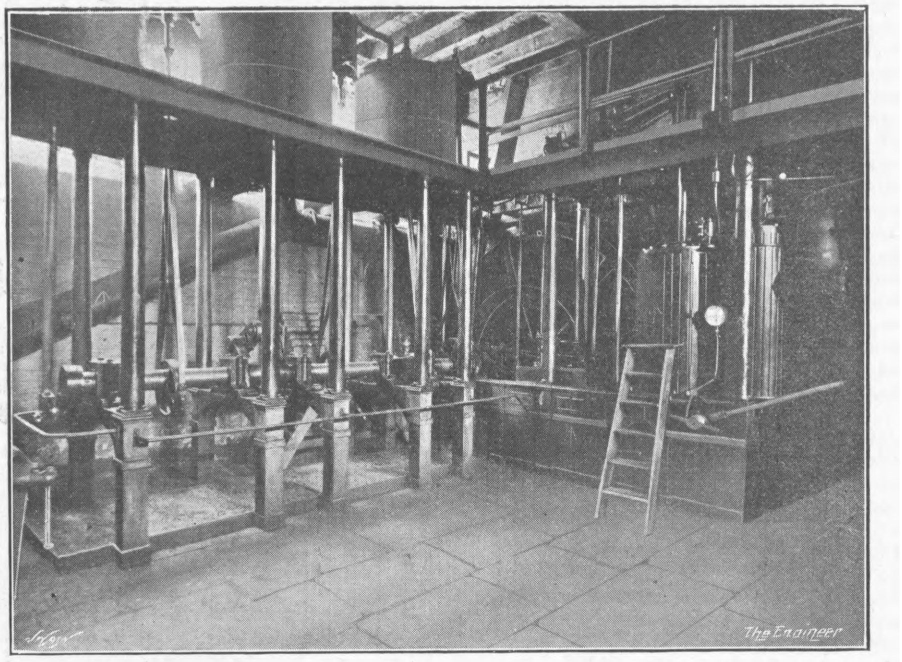


Fig. 5—MURDOCK'S BLOWING TUBS

as required. The presses struck 120 to 130 blows a minute. All that was needed to start them was to open the valve of the cylinder actuating the working stroke; after that the machine looked after itself. The horizontal cylinder, shown in the photograph attached to the press housing, contained a buffer spring fitted with a contact block of wood. This coming in contact with the fly arm checked the blow of the press and was adjustable. If the blow was too heavy the coin was damaged, if too light it was a waster. The shears and laying-on gear were worked automatically by means of a rod off the top lever. To the original workmen this method of driving these presses by vacuum appeared so mysterious that they named the vacuum tube the "Spirit pipe," and by this name it was always known. I should like here to state that three generations of men named Jerome worked in this mint from Watt's day to the eighties without a break.

MACHINE TOOLS AT SOHO FOUNDRY.

In respect to the tool illustrated in The Engineer of September 10th last, and described as a boring machine, I would like to say that this was a tapping machine, and was principally used for tapping large nuts up to 6in. diameter. The long taps used can be seen in the illustration at the back. The boring of cylinders was performed in another machine described later. The lathe—Fig. 3, page 260—with a worm gear drive has a further interest in the fact that the worm wheel was a mortice wheel. This is the only case I remember of a worm wheel with wood teeth. The light planing machine—Fig. 7, page 261—had, besides the usual table, another with a rotary motion upon which piston rings were turned.

Slotting machine.—This machine, having a stroke adjustable up to 3ft. 6in., had a travelling head driven by bevel gear from the top, the stroke being regulated by tappets and a belt reversing gear. The cutting head travelling vertically, after the manner of a side-planer, and the frame carrying it, was fitted solidly to the wall. There was a circular table underneath with two feed motions, and a gap in the wall enabled wheels up to about 30ft. diameter to be machined. Next to this slotting machine was a boring machine, which was chiefly used for boring the gudgeon holes of engine beams. There was a radial drilling machine here which was also designed by Mr. Carmichael, and another was built later. All these machines were attached to the wall similarly to the slotter.

Boring machines.—At one end of the boring mill proper was erected a square high brick tower, some time in the sixties, the walls being built very thick for strength; attached to the walls inside were cast iron plates fitted with angle plates and adjustable screw dogs; these were fixed up the wall sufficiently high to set up the longest cylinder ever made at Soho (the largest I saw bored under this mill was 108in. diameter by 12ft. stroke, which, if my memory served me right, was for Vauxhall Waterworks, London), in the top of the tower a crane was fixed for unloading the cylinders off the wagon which brought them by rail from the foundry. The crane also withdrew the boring bar, the foundation plate at the bottom being fitted with the boring bar step in the centre, this bottom plate was fitted with cramping bolts to set and fix the cylinder central to the bar. The bar was driven vertically from the bottom by gearing, and was held in position by a cross bar at the top. The cylinders were bored by a disc fitted with a number of tools, feed motion being supplied by a screw star driven from the top, the screw lying in a groove longitudinally to the bar running through a metal nut fixed to the disc, which was made a working fit, and also was the means of driving the disc. The other boring machines, of which there were several, were all horizontal, and driven practically the same way as the vertical one, most of them in the original form in which Watt left them, except for an alteration here and there to the method of driving them. There were the remains of an old sofa in this mill, on which it was said James Watt often sat when discussing matters over with the workmen; the floor of the mill was laid in white stone slabs, and in Watt's time was kept in trim order.

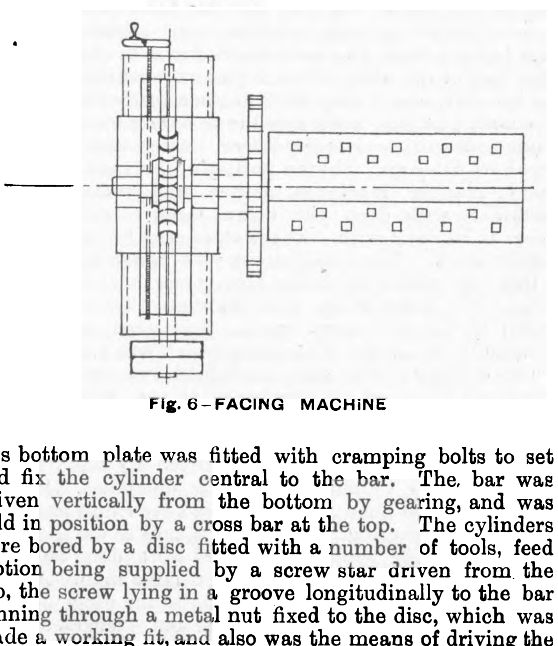


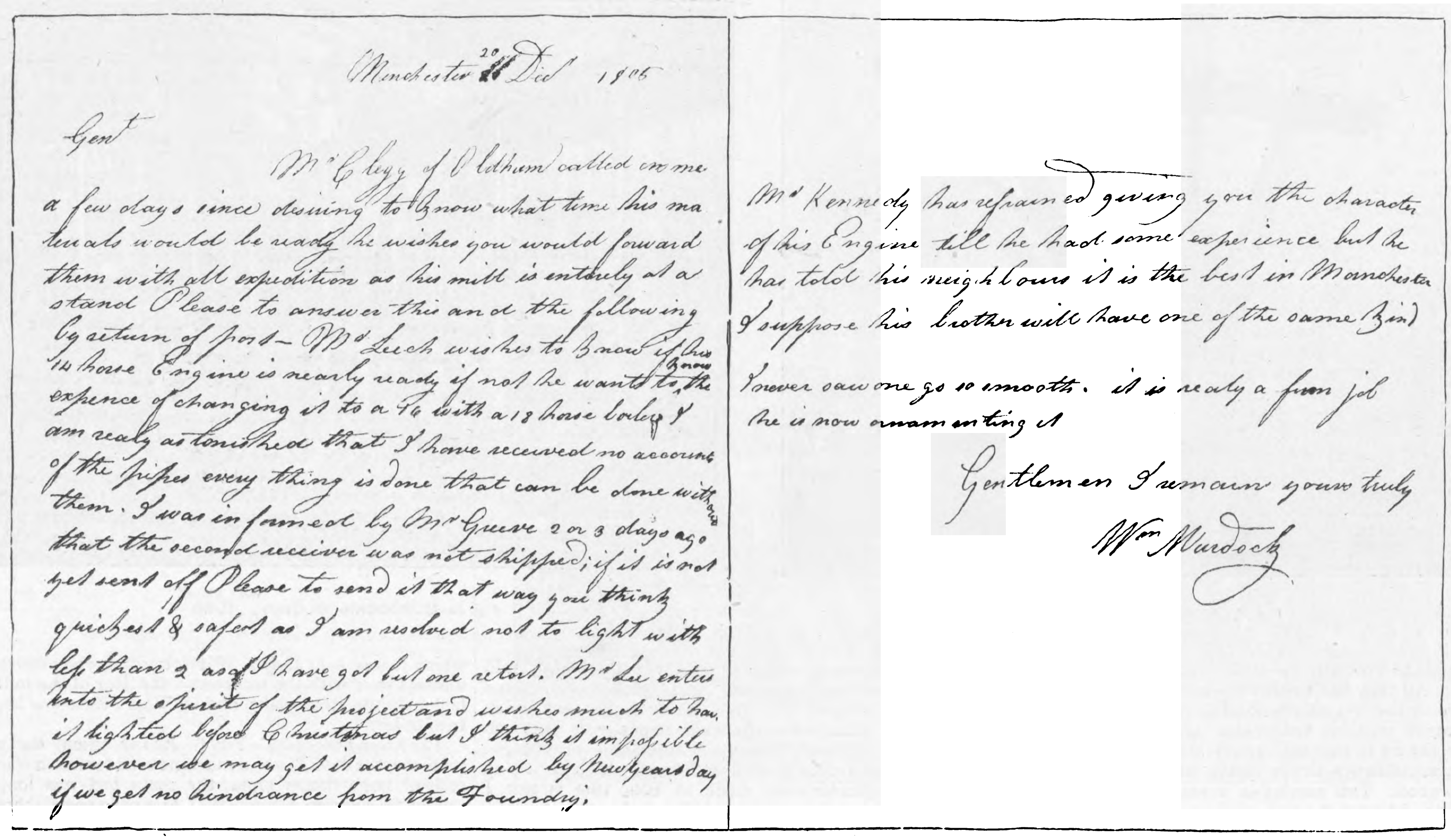
Fig. 6—FACING MACHINE

The facing machine—Fig. 6—known among the workmen as "the devil," was a machine used for machining the ends of large flange pipes, the main bed was long and somewhat narrow, fitted with V blocks to carry the pipes. At the end, at right angles, was the facing tool; this was a disc fitted with a number of tools in grades from roughing to finishing. It was driven by belt with a fast and loose pulley on the end of a shaft at right angles, carrying a worm in a frame which was free to move through the worm sliding on a feather on the shaft. This frame carried a worm wheel attached to a shaft in two bearings, on the one end of which was fixed the disc with the cutting tools. This frame worked on slides, the feed being actuated through a star and screw, somewhat similar to the slide rest of an old-fashioned lathe. This end casting was rectangular in shape, and, of course, stood at right angles to the bed; other work besides facing pipes was accomplished. Mr. Carmichael designed this machine in the fifties; the work was carried out by Mr. Harper, his assistant. The chief points embodied in this machine have of recent years been brought out as new.

Magneto cleaning machine.—This was used for cleaning the brass and copper borings. The machine consisted of a shaft fitted with permanent horseshoe magnets in the shape of a screw which worked inside a rectangular box driven by belt power. At one end was a hopper into which the borings were fed, the action being that the screw carried the material along and delivered it at the other end; the iron was collected from the magnets as they revolved by means of brushes. This machine was made at Soho somewhere about 1850.

Slot drilling machine.—This was another example of the genius of Soho. It was used for drilling cottar holes in piston rods, connecting rods, and all other places where cottars were required. The operation consisted in the drills starting together at the opposite sides; they were fed automatically, one being thrown out in advance of the other, which was run until the hole was finished, this action being necessary to avoid the drills coming in contact with each other. This machine started somewhere about the sixties.

Wall planing machine.—This was another example of Mr. Carmichael's mechanical engineering. He designed this machine in the early fifties, the work being carried out by Mr. Harper, his assistant, and it worked right to the end of Soho foundry's career in 1894. The framing for carrying the tool box was fixed to the side of the wall. The tool box being driven by a screw with fast and loose and reversing pulleys on the end; this tool box had also a vertical movement, the whole of the box working on square slides with the screw in the centre horizontally. There were very large tables bolted to foundations in the floor with the usual fixing holes of T slot type into which the bolts were inserted to hold down the work by means of straps, &c. This machine was used chiefly for planing fly-wheel sections, marine engine standards, cylinder bases, &c. The tool box was double-acting, swivelling on a pin so as to bring the two tools into position automatically. The action of the machine was as follows:—When taking a cut, the main screw carried the slide with the tool box along the face of the work, arriving at the end of the stroke, the machine was reversed by means of a long rod running parallel with the main screw, attached to which were tappets, which could be altered to suit the stroke. These came in contact with a tappet fixed on the work, the result being that the belt was shifted over by a lever which had a weight on it. The moment the lever passed the vertical centre the weight fell over against a stop, thus reversing the motion. The return stroke being completed, the tappets came in contact again, thus reversing again for the next cut. The vertical feed to the tool was obtained by a star-feed motion from the bottom in contact with a tappet. This machine had at full stroke a travel of 15ft. Another machine of similar type with about 25ft. stroke was built later. There was another planing machine, screw driven, with a reversing tool box for cutting both ways. This was a very old one, probably built by Whitworth.



Manchester ~~17~~ 20 Decr 1806

Gent

Mr Clegg of Oldham called on me
a few days since desiring to know what time his ma
terials would be ready he wishes you would forward
them with all expedition as his mill is entirely at a
stand Please to answer this and the following
by return of post— Mr Leech wishes to know if this
14 horse Engine is nearly ready if not he wants to know the
expence of changing it to a 16 with a 18 horse boiler I
am realy astonished that I have received no account
of the pipes every thing is done that can be done without
them. I was informed by Mr Greeve 2 or 3 days ago
that the second receiver was not shipped; if it is not
yet sent off Please to send it that way you think
quickest & safest as I am resolved not to light with
less than 2 as I have got but one retort. Mr Lee enters
into the spirit of the project and wishes much to have
it lighted before Christmas but I think it impossible
however we may get it accomplished by New years day
if we get no hindrance from the Foundry;

Mr Kennedy has refrained giving you the character
of his Engine till he had some experience but he
has told his neighbours it is the best in Manchester
I suppose his brother will have one of the same kind

I never saw one go so smooth. it is realy a fine job
he is now ornamenting it

Gentlemen I remain yours truly

Wm Murdock

"The Engineer"

Fig. 7—AUTOGRAPH LETTER BY WILLIAM MURDOCK

Blowing tubs (Fig. 5).—These were designed by William Murdock and erected by him; you will notice there are three tubs driven by a beam engine in series, each tub being driven by its own crank shaft, the shafts being connected together by means of drag link, the valves were worked by excentrics and rods mechanically. The collecting pipes originally conveyed the air to a large rectangular tank under the ground level in the boiler shop, this formed a reservoir on which was a safety valve loaded to the required pressure. From this tank each hearth in the boiler shop and smiths' shop adjoining was supplied with blast. Mr. Carmichael during his time had this reservoir shut off, the hearths were then supplied direct. This engine and tubs worked right up to the close of the works in 1895.

Fig. 4 is from a photograph of 20-ton hand crane with auxiliary side crane for light weights. This crane was another of Murdock's designs, the framing originally, including the centre post, being all of oak. Somewhere in the late seventies the management at Soho thinking the centre post was decayed and unsafe, instructed Mr. Harris, the foreman patternmaker, to cut it out; after doing so it was found the oak was practically as sound as the day it was put in by Murdock; the present centre pillar was then constructed in wrought iron boiler plating as shown, the crane continuing its usefulness as before. The boiler and engine were added for steam power somewhere about 1880 90. The building immediately behind the crane with the workmen's time bell on the end was called the "Magazine." It was here that all the detail parts were packed and got ready for despatch. The building to the right was the smiths' shop, at the far end of which was the boiler shop; whilst at the end nearest to the crane was the office of the general manager, the last to occupy this being Mr. Darlington, who has recently died. The main entrance to the works was between this office and the gate-keeper's time office, through which passed all the foremen, and a little further away the workmen passed through at the other end, the intermediate space being occupied by the general offices, whilst over the top was the drawing-offices. To the left of the magazine is the high square tower of the boring mill.

Fig. 3 is from a photograph of a side lever marine engine of Napier's type, but made by James Watt and Co. This engine was used for driving what was called the 14 horse-power shop, with its lathes and planing machines, &c. The framing of this engine was malleable iron. The parallel motion was added during my connection with Soho, being carried out by a Mr. Judge. The engine had for probably forty or fifty years, or more, previously to this, worked without it, and so far as I could see worked equally as well. The old D slide of this engine had a balance weight attached to a lever for balancing the weight of the valve. This was taken off about 1875, a circular valve and muzzle of the Rooke type being substituted. This valve was balanced by the steam being admitted to the centre, the top portion being larger in diameter than the bottom, the steam acting on this difference of area compensating the weight of the valve.

SOHO METHODS.

A few notes on the methods adopted at Soho Foundry in the construction and erection of engines, &c., may be interesting. The machining, fitting, and erecting shops were known as the boring mill, the 6 horse-power shop, the 14 horse-power, and the big shop where the engines and machines were finally assembled and erected. Castings, such as cylinders, pump barrels, &c., were delivered from the foundry first to the boring mill, where they were bored to the sizes given on the drawings. All the small castings and forgings were distributed chiefly to the bottom machines bay of the 14 horse-power shop. Various lathes, planing, slotting, and other machines, after being turned, &c., were handed over to fitters in the other bay of the shop, a bench going the whole length on the one side, where they were finished ready for erection. In addition to this work small rock boring machines and coining presses were erected here. All pistons and rings were here fitted up. The top portion of this shop had some heavy planing machines, lathes, and radial drilling machines, with deep pits below them to enable large pieces to be dealt with. These were used for some of the heavier work. There was also a vice bench on one side of this bay where all boiler taps, brass cocks, indicator cocks, and brass work were finished. This shop was driven by the side lever engine, illustrated, which was situated in the centre of the shop which was L shaped.

The 6 horse-power shop contained two or three big lathes and the large nut tapping machines—illustrated in your issue of September 10th—these were in one bay, the shape of this shop being like the letter T. The top end portion, to the right, was occupied by hand lathes and small nut tapping and facing machines. It was here that all the Soho apprentices had their first practical lesson in engineering. They were taught to use the hand turning tool, and some of the hand work done on those lathes would shame a more modern lathe man. As the boys progressed they were moved on to the other departments. Cylinder studs, bright nuts and washers, and all kinds of lever handles were the production of this part of the shop. The foreman over the boys in my time was named Stokes, and a lively time he often had with them. He was an ingenious workman; the brass screwed ferrules made in his shop, and used for screwing down the tapes on the ends of the surface condenser tubes, were plain, with a slot across one end into which a T spanner fitted for screwing them tight home. The tubes often worked through out of position, especially as the tapes deteriorated. Stokes conceived the idea of cutting these slots on the angle, the deepest side being on the outside. The high side was forced inwards by a flat surface tool; this formed a projection to the inside diameter, which made it impossible for the tube to work out of its place. At this time the other part of the shop was used for erecting pump barrels and small engines by a man named Thompson, who used to come in a tall hat and worked in a white apron, as also did a man named Tranter. These were both old men, and the two last workmen who ever came to Soho thus attired.

The big shop.—This shop was somewhere about 300ft. long by 60ft. to 70ft. wide. It had three overhead hand-power travellers, two of 20 tons, the other about 10 tons. There were also jib cranes fixed to the side walls for the use of fitters when erecting small work. At one end of this shop was a very large and powerful lathe with thirty-six different speeds; it would swing anything up to 45ft. in diameter. I have seen 35ft. fly-wheels weighing as many and more tons turned on the rim by this lathe.

The wall planing machines referred to previously were fixed on one side of this shop, whilst on the other was the powerful slotting machine and radial drilling machine also mentioned before. This machine had head room of 14ft. to 16ft. above ground level, in addition to a pit; the machine known as the "devil" worked up at the other end on the same side of the shop. For large fly-wheels requiring boring only, provision was made in the centre of this shop with foundation carrying a centre for the boring bar. The wheels were levelled up on plates true to this centre, a portable boring machine being fixed over the top, and bored in the usual way, the machine being driven by belt from the shafting. This same centre was used for large spur wheels which had machine-cut teeth, a milling machine being fixed and driven for this purpose in a similar manner. Wheels up to 60ft. diameter were cut here. Deep square pits existed in the floor, and were covered over by planks when not required. They were used for the erection of vertical standard engines. A large marking-off plate was used; this had a jib crane with rack on the jib for moving the load in or out radially.

At one corner of the big shop was a gauge and tap stores connected by a door with a counter. A little old man named Simms was in charge. There were frames on the wall, triangular in shape, fitted with racks carrying finely tempered steel bars about $\frac{3}{8}$in. to $\frac{1}{2}$in. square, with centre punch points in lengths from 3in. up to 6ft., rising by $\frac{1}{8}$in. up to 3ft., afterwards by $\frac{1}{4}$in. and $\frac{1}{2}$in. These were used as standard lengths, as no man was allowed at Soho to measure lengths when working to a drawing with his rule. As an illustration, suppose a man had a beam to mark off, his drawing would give length from centre gudgeon to connecting-rod gudgeon centre so much, centres between parallel links, and so on. He applied at the gauge stores for these lengths. Simms had a long steel bar fitted on the bench with one head fixed, the other being a sliding head held by a screw, another screw giving a micrometer adjustment. He took the steel gauge or gauges of suitable length to make up the length required, set the sliding head to them, then adjusted his milling screw to suit, took a bar of iron—and according to length so was the strength from a $\frac{1}{4}$in. square up to $\frac{3}{4}$in. square or more—the ends of which were bevelled and filed flat until they passed the gauges with a touch, the length previously being stamped on them. Iron centres were driven in the rough holes cast in the beam, the centre of the main gudgeon marked, the length gauges laid on, and the centre of the other holes marked from the gauge. The gauges were afterwards returned to the stores, and, if necessary, filed away for future reference.

An erector going out to erect a pumping engine had all his centres supplied to him with gauges of this type, and, if very long ones, these were made in two or three lengths properly marked to come together for the particular length they represented. All radius curves on bearings and necks of shafts were turned to gauge supplied from the stores.

Main crank shaft bearing brasses were all turned short to the length of neck on the crank shaft; this varied $\frac{1}{32}$in.-$\frac{1}{16}$in. up to $\frac{1}{8}$in. in larger shafts. There were the usual male and female ring gauges for turners to work to; and limit gauges to be used with regard to shrinking of cranks on to the shafts. The method used was a simple and clean one. In shrinking a crank on to a shaft, the shaft was levelled up near to an iron bath containing lead, under which was a fire, the crank was adjusted in a crane to see that the keyway was in line and the crank level; the latter was immersed in the lead bath, and, as soon as the limit gauge passed, the crank was taken by the crane and pushed over the shaft end, a temporary gauge key inserted, and the whole left to cool down.

In marking holes off for drilling on the various parts of work thin zinc sheets were used with the pitch and size of the holes cut through; these were carefully marked as to which side of templet came next to the casting. I never knew a failure of work coming together from this system, as it was all worked from either the vertical or horizontal centre lines. All bearing brasses were cast with a clearance on the sides, the actual contact surface for the shaft to rest on being 120 deg.; this clearance extended longitudinally to each end of bearing within, say, 1in. to 2in., according to size. The object was to have a cool running bearing. Another feature of the Soho plummer blocks was they were all bored circular, the bottom brass could be twisted out of its bearing by just easing up the weight, the top bearing having a rectangular snug on it over which the gland cap fitted, the brasses butting together at the centre, it was impossible for them to move when screwed down.

In the construction of engine beams the two flitches were first bolted together through the distance pieces, the beam then erected upright or "work-ways" on wood packing, that they might obtain their normal condition. In this position straight edges and lines were fixed from which levelling points were marked horizontally and vertically by chipping a square about 1in. or so to suit small cube steel levelling pieces, which were 1in., $\frac{7}{8}$in., and $\frac{3}{4}$in. on the sides; this done the beam was turned on to its side, levelled up, the gudgeon centres and size of holes marked off. The beam was then removed on to a long bed-plate levelled up to the points marked as above, and properly secured, the holes were bored one after the other by being moved along on the bed-plate; this boring machine being specially designed and made at Soho for the purpose; the holes were thus all parallel to each other.

In writing these notes I am indebted for assistance, which has readily been given me by some of the old workmen still living, and with whom I was associated during my time at Soho, viz.:—Mr. David Anderson, works manager; Mr. Thomas Jerome, who had charge of the Mint, as did his father and grandfather before him, his grandfather having worked in the original Mint of James Watt as already mentioned; Abel Hall, Arthur Bradley, erectors in the big shop; T. Wheeler, Tom Beasley and W. Hackett, all planing machine hands; and Edward Jones a lathe hand. These men all bear names connected with Soho for many years, their fathers having worked there before them.

Some controversy having taken place as to the correct spelling of William Murdock's name, we are enabled to give herewith a facsimile reproduction of a letter sent by him from Manchester to Boulton and Watt, at Soho, Birmingham, and dated December 20th, 1805. For the loan of this letter we are indebted to the courtesy of Mr. R. H. Kirton, of the Cornwall Works (Tangyes, Limited), Birmingham. It will be observed that this letter definitely sets at rest the question of whether the name should end in an "h" or a "k." An examination of it will show a final "h" in the name "Leech," in the sixth line of the first page, and a final "k" in the word "think," at the end of the thirteenth line. A comparison with these two letters with the final letter of the signature leaves no room for doubt that the latter is a "k," and that the correct spelling of the name is "Murdock," and not "Murdoch," as some people have urged.

LITERATURE.

Recent Cotton Mill Construction and Engineering. Third Edition. By the late Joseph Nasmith and Frank Nasmith. Manchester: John Heywood, Limited. Price 6s.

The first edition of this book was in great part a reproduction of an article which appeared in the *Textile Recorder* for May, 1894. As no other publication dealing with the subject in the same way exists it is not surprising that the sale has already exhausted two editions. The third edition has been largely re-written, and new chapters have been added, so that the book may be regarded as an up-to-date standard work on a subject which has seen considerable developments in recent years. Practically every phase of cotton mill engineering is dealt with, separate chapters on constructional details, fire-proof construction, reinforced concrete, fire-extinguishing appliances, lighting, heating, power plants, gearing, rope and belt driving, &c., being included. The sections of the book dealing with construction will be found particularly useful to architects and others in designing factories and workshops according to the best modern methods, and those who are still unconvinced of the suitability of reinforced concrete for this class of buildings will find information concerning its application to mill buildings on the Continent and in the United States, which show how far removed this method is from the experimental stage. With regard to cost the authors state that small buildings of reinforced concrete show very little saving over the older types, but as the amount of structural work increases so does the comparative cost of reinforced work decrease, other considerations being equal. In modern cotton mill design one of the most conspicuous features is the large window area aimed at. In this respect ferro-concrete appears to possess advantages hitherto unattainable.

The chapter on heating, ventilating, and humidity, is of special interest at the present time on account of the official steps which are being taken to remedy the condition of the workers in the steaming sheds. The various systems of humidifying the air are all described, and the reader will be able to obtain some idea of the difficulties which have to be overcome in obtaining the necessary uniformity of humidity to give good results under varying climatic conditions. There are two distinct methods of humidifying the air supplied to mills; namely, first, the production of a spray by the action of a jet of air or water under pressure against an emerging stream of water; and, secondly, the charging of the air with moisture prior to injecting it into the room. In this section, on page 117, the editor has allowed an obvious error to escape his notice with regard to temperatures and pressures of steam used. The chapter on steam boilers contains much useful information collated from reliable sources. The chapter on steam engines comprises descriptions and illustrations of the most approved forms of engine now in use. Electric driving is treated at some length in Chapter XVII., and after quoting tables on the subject by reliable authorities, the author comes to the conclusion "that there is not any considerable advantage to be gained at the present time from electricity as a motive power for mills." The chapter on gas and oil engines is chiefly devoted to descriptions of the Körting gas engine which has been adopted to drive a mill at Stalybridge, and of the Diesel oil engine. The latter is illustrated driving a cotton mill in Bombay, and is capable of developing 400 brake horse-power. Other sections of the book deal with gearing, rope and belt driving. The illustrations, with a few exceptions, are satisfactory, but the format of the page is rather too small to admit of clearness of detail in some cases.

Drapers' Company Research Memoirs: On a Practical Theory of Elliptic and Pseudo-elliptic Arches, with special reference to the Ideal Masonry Arch. By Karl Pearson, F.R.S., W. D. Reynolds, B.Sc., and W. F. Stanton, B Sc. London: Dulau and Co.

The theoretical treatment of masonry arches being based largely on assumptions has hitherto been admittedly defective. In the present treatise, which forms No VI. of the Technical Series issued by the Department of Applied Mathematics of University College, London, the authors have made a serious attempt to place the theory on a sound scientific basis, and to clear up several of the obscurities associated with it.

The treatment given to the subject by the authors is, of course, essentially mathematical, and without reproducing a large proportion of the algebraical work it would be impossible for us to describe in a satisfactory fashion the various considerations dealt with. We can, however, briefly indicate some of the more important results arrived at, leaving the reader to the original work as far as the method of arriving at them is concerned.

Under ideal conditions the centre line of a masonry arch rib, designed for a particular span, rise, and system of loading, should coincide with the line of resultant pressure between the voussoirs. Taking this as a guide, it is well known that an arch should be made in the form of a parabola or of a catenary, according as the loading is distributed uniformly over the horizontal span or over the rib itself. It is less well known, perhaps, that in cases where the arch has to support vertical loads extending uniformly from the rib to a horizontal level coincident with the directrix, the catenary is again the correct curve to employ, and of this statement a proof will be found in the book. The catenary is a difficult curve to construct, and hitherto in practice the parabola has been substituted for it in a large majority of the cases where theory demands its use. On this point the authors of the present work have something to say. General expressions for the catenary, parabola, circle, and ellipse, with reference to the end of the vertical diameter as origin, are obtained, and are shown in the form of explicit equations of y in terms of x. Taking the parameter in the case of the catenary as c, that of the parabola as $2c$, the radius of the circle as c, and the semi-axes of the ellipse as $\sqrt{3}c$ and $3c$, it is shown that the ellipse affords the nearest approximation to the catenary. In a particular case which the authors work out, where the ratio of rise to span is $\frac{1}{5}$, it is shown that on most drawings of arches the discrepancies involved by the substitution are within the limits of draughtsmanship. From these considerations it is concluded that for the fairly flat arches of modern practice designed to carry a uniform load per foot run of the rib, or per foot of vertical height from the rib to a certain definite level above the central line at the crown, the elliptic arch is the proper form to employ. The usual substitution of the parabola for the catenary is not justified, we are informed, unless the ratio of rise to span is less than $\frac{1}{10}$.

It will be at once seen that the vertical loading of the elliptic arch is fixed by a certain definite height. Taking the span as l and the rise as r, this height is given by $c = l^2/8r + \frac{1}{6}r$. But the authors point out that there are many cases in which the actual rise given to the arch is of little account, so that c and l being settled *a priori* we may choose r to suit the above relation. An interesting example of a problem of this class is worked out and illustrated in the treatise.

The writers next consider the case of an arch loaded with a uniform rib load—or the equivalent vertical load—and a uniformly distributed platform load. A curve half way between the catenary and the parabola is the natural result, although the equations to it and the integration involved in arriving at them are complicated. To this curve the authors give the name "compound catenary," and proceeding to analyse it, and comparing it with the equation to the ellipse, show that this curve is even better approximated to by an ellipse than is the simple catenary. Thus the elliptic arch is again the ideal form, when the loading consists of a uniform rib and platform load. An example of the fundamental work in connection with the design of an arch of this class is gone through and illustrated.

The majority of arches cannot, however, be placed under one or other of the above classes. In addition to the rib, vertical, and platform loadings of the foregoing arches, we have also to consider the weight due to the backing and the ballast. To investigate the ideal form for an arch of this type the backing is given a form expressible algebraically, and the authors have provided an equation which, by a suitable choice of constants, can be made to suit a variety of commonly-adopted shapes.

After much laborious work, the resultant equation to the ideal form for the arch is obtained, and is shown to be of the form $y = a x^2 + b x^4 + c x^6 +$ &c. From the investigation and results of the previous cases it might be surmised that an equivalent elliptic arch could be found for this case also. When a comparison, however, is made between the above equation and that of the ellipse expressed in a similar form, it is seen that this is not so, and the authors show algebraically and graphically that an elliptic arch can be substituted justifiably for the ideal form only in those cases where the ratio of rise to span is very small—smaller, in fact, than is met with in practice.

If we assume that the above equation is convergent, a point apparently tacitly assumed by the writers, then we can obtain an approximation to the ideal form for any arch by using as many of its terms as we like. Thus, regarding x^6 and higher powers of x as negligible, it is fairly easy to plot the curve under any given conditions of loading. The determination of the constants involved is a trifle laborious, and in the case of the two-term equation, a cubic equation has to be solved. To secure a higher approximation, the third term is included, and to determine the constants in this case a quintic equation must be solved. In both cases the authors employ Newton's method for the solution of the equations, and they have plotted the resultant curves. An inspection of these, and in particular of the last, shows that the centre line of the arch so determined and the true line of pressure agree very closely. The curves of these arches found, as explained above, from the equations given, and by retaining or neglecting the sixth term is, of course, neither an ellipse, catenary or parabola, and to it the authors have applied the name "pseudo ellipse."

The methods of design indicated in the book are novel, and are clearly in the direction of an advance upon the present haphazard style, which, after all, depends not on the actual stresses in the arch, but on those which would be called into play just as the arch was on the point of collapse. Graphical methods are, however, always sought after wherever possible, and we doubt if designers will be readily induced to undertake the mathematical work involved in this treatment of the subject. At the same time some valuable information could be gained by the designer if the new method were compared as to its results with the old, and if only as a check on the latter, it would repay any time given to mastering it.

Annuaire pour l'an 1910. Publié par le Bureau des Longitudes. Avec des Notices Scientifiques. Prix net, 1f. 50c.

(By the Late Prof. Bauerman.*)*

With the advent of the New Year this well-known Annual appears in its accustomed form for the ensuing year. Following the arrangements adopted at the beginning of the century, the notices, apart from the main astronomical series, are confined to physical, chemical, and similar data, the geographical, statistical, actuarial, and similar matters being reserved for the alternate years. The supplemental notices include an account of the International Committee for the execution of the Photographic Map of the Heavens, held in Paris under the presidentship of M. Bailland, and an article on the tidal deformation and the elasticity of the earth's crust, in which this very complicated subject is treated in a somewhat popular manner by M. Sallemand. Of greater interest, however, from the bibliographical point of view, is the third supplement, which contains a complete classified list of the scientific notices that have appeared in the "Annuaire" since its first publication 115 years ago. This is further enhanced by an alphabetical index, so that all the famous papers may be easily identified.

BOOKS RECEIVED.

Cape Colony To-day. Second edition. Issued by the Cape Government Railway Department. Capetown: Townshend: Taylor and Snashall, printers.

Wireless Telegraphy and Wireless Telephony. By H. E. Kennelly. Second edition. London: T. Fisher Unwin, Adelphi-terrace, W.C. Price 4s. net.

The Guide to South Africa, 1909-10. By A. S. and G. G. Brown. Seventeenth edition. London: Sampson Low, Marston and Co., Limited. Price 2s. 6d.

The "Timber Trades Journal" List of Shipping Marks on Timber. 1909 edition. London: William Rider and Sons, 164, Aldersgate-street, E.C. Price 7s. 6d. net in cloth, 9s. net in leather.

Applied Mechanics, Vols. I., II., III., IV. Professor Jamieson. Seventh edition. London: Charles Griffin and Co., Limited, Exeter-street, Strand, W.C. Price, Vol. I., 6s.; II., III. and IV., 5s. each.

The Dynamo: Its Theory, Design and Manufacture. Two volumes. By C. C. Hawkins and F. Wallis. Fifth edition. London: Whittaker and Co., 2, White Hart-street, Paternoster-square, E.C. Price £1 1s. two volumes.

LOCOMOTIVE PROPORTIONS AND POWER.

By G. James Wells, Wh. Sc., Assoc. M. Inst. C.E., M.I. Mech. E.

No. I.

There is an immense amount of interest bestowed upon railway matters to-day, and possibly the locomotive obtains the largest share. This is not surprising, for it is the part that looms large in the eye of the travelling public, and with the technical man it is usually scanned most closely. According as the train arrives at its destination early or late so is the judgment passed upon its capacity as well as upon that of its designer. It is a very difficult thing to say offhand which type of locomotive is the better able to deal with the duty allotted to it, and the object of this discussion is to arrive at some basis upon which the matter may be examined and some idea of the power of the machine to do its work fairly arrived at.

Table I.

Type.	Cylinders, diameter × stroke.	Driving wheels, diameter.	Cylinder volume per mile.	Total heating surface.	Grate area.	Cylinder volume divided by		Steam space in cub. ft.	Water-line area in sq. ft.	Cylinder vol. divided by water-line area.	Water-line area divided by grate area.	Steam space divided by cylinder volume.	Boiler pressure, lb. per sq. in.	Total tractive force.	Calculated weight on driving wheels.	Actual weight on driving wheels.	$\frac{\text{Act. weight}}{\text{Cal. weight}}$	Engine No. or name of class.
						Heating surface	Grate area.											
	in.	ft. in.	cub. ft.	sq. ft.	sq. ft.									lb.	tons.	tons.		
2-4-0...	17 × 24	6 6	3260	1363	16·4	2·39	199	—	—	—	—	—	140	9,337	20·75	23·4	1·127	2204
2-4-0...	18 × 24	6 0	3960	1469	19·01	2·69	208	—	—	—	—	—	160	12,960	28·00	28·8	1·028	3225
4-4-0...	20 × 26	7 0	4561	1561	20·8	2·92	219	—	—	—	—	—	160	14,926	33·17	31·5	0·950	"Gooch"
4-4-0...	18 × 26	6 8½	3838	951*	18·32	—	209	—	—	—	—	—	180	14,130	31·39	32·7	1·041	"Badminton"
4-4-0...	18 × 26	6 8½	3838	1520	23·65	2·52	162	—	—	—	—	—	180	14,130	31·39	33·5	1·067	"Atbara"
4-4-0...	18 × 26	6 8½	3838	1818	20·56	2·11	187	76·2	79·81	48·08	3·882	0·01986	200	15,700	34·89	34·0	0·9745	"Cities"
4-4-0...	18 × 30	6 8½	4428	1818	20·56	2·43	215	76·2	79·81	48·08	3·882	0·01986	200	19,320	42·93	34·3	0·799	"Counties"
4-4-2...	18 × 30	6 8½	4428	2143	27	2·07	164	97·7	102¼	43·31	3·772	0·02207	225	20,370	45·28	39·0	0·861	"Atlantics"
4-6-0...	18 × 30	6 8½	4428	2143	27	2·07	164	97·7	102¼	43·31	3·772	0·02207	225	20,370	45·28	51·2	1·201	"Albions"

* Serve tubes.

Table II.

Type.	Cylinders, diameter × stroke.	Driving wheels, diameter.	Cylinder volume per mile.	Total heating surface.	Grate area.	Cylinder volume divided by		Steam space.	Water-line area.	Cylinder vol. divided by water-line area.	Water-line area divided by grate area.	Steam space divided by cylinder volume.	Boiler pressure, lb. per sq. in.	Total tractive force.	Calculated weight on driving wheels.	Actual weight on driving wheels.	$\frac{\text{Act. weight}}{\text{Cal. weight}}$	Engine No. or name of class.
						Heating surface	Grate area.											
	in.	ft. in.	cub. ft.	sq. ft.	sq. ft.			cub. ft.	sq. ft.					lb.	tons.	tons.		
0-4-2	17½ × 24	5 6	4083	916	16·25	4·46	251	—	—	—	—	—	140	11,690	25·98	26·8	1·031	"Stirling" 561
2-4-0	17½ × 26	6 6	3744	929	16·25	4·03	230	—	—	—	—	—	140	10,720	23·82	27·5	1·154	,, 869
4-4-0	17½ × 26	6 7½	3672	1124	17·8	3·26	206	—	—	—	—	—	170	12,770	28·38	27·9	0·983	"Ivatt" 400
2-4-0	17½ × 26	6 7½	3672	1124	17·8	3·26	206	—	—	—	—	—	170	12,770	28·38	28·6	1·008	,, 1061
4-4-2	19 × 24	6 7½	3996	1442	26·75	2·77	149	—	—	—	—	—	175	14,310	31·79	31·0	0·975	,, 990
4-4-0	17½ × 26	6 7½	3672	1250	20·8	2·94	176	—	—	—	—	—	170	12,770	28·38	31·0	1·092	,, 1321
4-4-2	18¾ × 24	6 7½	3890	2500	30·9	1·56	126	66·03	92·11	42·23	2·981	0·01697	175	13,930	30·95	36·0	1·163	,, 251

The power of single-expansion engines—no matter for what purpose it is designed—is proportional to the volume swept out by the pistons in unit time. The greater this volume the greater will be the power that may be developed; thus the first factor to be assessed is the capacity of the cylinders provided. The size of the driving wheels must be allowed for, and this has been effected by calculating the volume swept out per mile without slipping.

The power developed will also in part depend upon the mean pressure maintained in the cylinders, and is a difficult matter to predict. Generally it depends upon the boiler pressure, cut-off, and speed at which the engine is running. With a fixed cut-off and steady boiler pressure the mean pressure falls as the speed increases; but whilst this is generally known, it is not easy, except by knowledge derived from experiment, to estimate its amount. It is usual in estimating the tractive effort of a locomotive to assume that the pressure in the cylinders will be from 75 per cent. to 90 per cent. of the boiler pressure, according to the individual judgment, and in the following comparisons 75 per cent. is the value that has been assumed, the figure adopted by Mr. S. W. Johnson in his presidential address, 1898.

The ultimate limit of the power is the capacity of the boiler provided, and the measure of this will be the area of grate, and in a lesser degree the area of the heating surface. The weight of coal consumed per square foot of grate will depend upon the draught, and in this respect probably all boilers will stand upon an equal footing. Of course, there is the increasing difficulty of firing as the area increases, so that probably the efficiency will be somewhat lower for the largest grates as compared with the medium dimensions. The true value of the heating surface will depend upon its position, a few square feet in the fire-box being very much more valuable than many square feet at the smoke-box ends of the tubes. Further, there is the arrangement of the tubes to consider, for there is good reason to believe that closely packed small tubes, although a ready means of obtaining area, will choke both the circulation of the water and the draught by increasing the resistance of the tubes to the passage of the flue gases. Consequently, when comparing the heating surface allowed in locomotives of different designs, anomalous results may be obtained; and therefore the safest measure of the boiler capacity is the grate area. In the comparisons made in the tables both the heating surface is given and grate area, but the latter should be looked upon as of the first importance. The ratios of the cylinder volume and heating surface and grate areas are given as the most suitable factor for the estimation of the boiler capacity.

The adhesion weight provided is the final factor of importance in the estimation of the ability of a locomotive to perform its duties in all weathers, for unless there is sufficient weight provided to prevent slipping, large cylinders and boilers will not avail. The amount of adhesion per ton of the weight on the driving wheels is a quantity that depends upon the state of the weather, and somewhat upon the size of the wheels. In average weather, and for wheels about 7ft. diameter, 450 lb. per ton may be safely reckoned upon, and for wheels of 5ft. diameter the figure is about 350 lb. In bad weather the amount is much reduced, whereas in good weather it may be much greater.

No attempt has been made to combine these factors into one comprehensive factor, which should give the power of a locomotive at a glance, as the task is at the moment scarcely feasible, but a consideration of the factors for different designs will enable one to form a fair opinion of the way that each may be expected to perform under given conditions.

Some typical cases have been taken from British practice, and the several factors calculated to illustrate the manner in which this comparison may be effected, and incidentally examples will be given of the manner in which these factors will enable the preliminaries for a new design to be easily and quickly laid down.

Table III.

Type.	Cylinders, diameter × stroke.	Diameter of driving wheels.	Cylinder volume per mile.	Total heating surface.	Grate area.	Cylinder volume per mile divided by		Boiler pressure, lb. per sq. in.	Tractive force.	Calculated weight on driving wheels.	Actual weight on driving wheels.	$\frac{\text{Act. weight}}{\text{Cal. weight}}$	Name or number of class.
						Heating surface.	Grate area.						
	in.	ft. in.	cub. ft.	sq. ft.	sq. ft.				lb.	tons.	tons.		
2-4-0	17 × 24	6 6	3260	1088	17	2·99	192	140	9,337	20·75	24·06	1·159	No. 800
4-4-0	17½ × 26	6 6	3744	1223	17·5	3·06	214	140	10,718	23·84	26·08	1·130	,, 1315
4-4-0	18 × 26	6 9	3815	1142	17·5	3·34	218	140	10,920	24·27	27·35	1·127	,, 1532
4-4-0	18 × 26	7 0	3678	1260	17·5	2·92	210	160	12,034	26·69	28·10	1·053	,, 1757
4-4-0	19 × 26	7 0	4099	1122	17·5	3·65	234	140	11,730	26·08	28·00	1·074	,, 1668
4-4-0	19 × 26	7 0	4099	1205	19·5	3·40	210	160	13,409	29·79	29·92	1·044	,, 150
4-4-0	19½ × 26	6 9	4315	1519	25·0	2·841	173	180	16,470	36·62	34·10	0·931	,, 2607
4-4-0	19½ × 26	6 9	4315	1455	25·0	2·96	173	200	18,310	40·68	35·5	0·873	,, 863
4-4-0	19 × 26	6 6½	4385	1557	28·4	2·82	154	220	19,730	43·85	38·75	0·884	,, 990

The first column indicates the type on the now generally understood wheel plan; followed by columns in which the total heating surface and grate area are given. From this data the cylinder capacity is calculated and entered in column 4. The formula used is:—

$$\frac{d^2 \times \pi}{144 \times 4} \times 2 \times \frac{S}{12} \times N \times \frac{5280}{D \times \pi} = V;$$

where d = diameter of cylinders in inches,
S = stroke ,, ,,
N = number of cylinders,
D = diameter of the driving wheels in feet,
V = total displacement of all pistons per mile in cubic feet.

The two succeeding columns give the total heating surface and the grate area provided, each in square feet; from these the ratios-cylinder capacity ÷ heating surface, and cylinder capacity ÷ grate area, are tabulated. It is obvious that the steam produced will be proportional to the amount of coal consumed, and this will be measured by the area of the grate, whilst the demands for steam will be proportional to the cylinder volume per unit distance. In Table I. this grate factor is 199, and in Table III. 192—each in the first line. An examination of the cylinder capacity shows that the cylinder capacities of each are equal, but the latter engine would stand more forcing than the former, and to that extent is the more powerful. The meaning of these numbers is—for each mile 192 cubic feet will be swept out by the pistons for each square foot of grate area. The second factor is given and has a similar meaning, but not so much importance can be assigned to it for the reasons already given, but it should assist us in forming some idea of the relative amounts allowed in various cases.

The five succeeding columns give data relating to the actual capacity of the boilers, and have been obtained from the paper by Mr. G. J. Churchward.* The amount of spray that will be formed as the steam bubbles rise and burst at the surface must in some degree depend upon the amount of area provided, and for this reason the water-line area has been quoted. The ratios—Water line area ÷ grate area has been calculated, also cylinder capacity ÷ water-line area, for each of these are in a way a measure of the probability of priming. The steam space has been quoted, for the lesson was taught in the early days of torpedo boat work that there was a minimum ratio of steam space and cylinder capacity that must not be overlooked, unless trouble was desired each time the rate of working was disturbed, and it is quite possible that a similar limit in locomotive practice exists. On this point it is interesting to note that Swindon allows 3.9 and 3.8 square feet of water-line area per square foot of grate, whilst at Doncaster this figure is 3 (see Tables I and II.). But in this connection it must be remembered that Swindon engines have no steam dome or perforated internal pipe, taking their steam supply into the open end of the pipe direct; whilst the Doncaster-built engine has a steam dome as usual. Does this mean that to obtain dry steam with a dome the requisite water-line surface may be smaller? The Swindon boiler is of the Belpaire type, and so may account for the larger surface, and consequently these figures may not have the significance suggested; any way, the amount of data available is not sufficient to permit any conclusions.

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* See Proceedings Mechanical Engineers, London, p. 165, vol ii., 1906; and The Engineer, pp. 189, 204, 205, 288, vol. ci., January-June, 1906.

The last group of columns relate to the adhesion weight. The total tractive force has been calculated from the formula—

$$\frac{d^2 \times s}{2 \times D} \times N \times 0.75 \times P = T;$$

where d, s, and N have the same significance as before, and

P equals the boiler pressure.
T equals tractive effort.

The proportion taken—75 per cent. of the boiler pressure—is lower than is sometimes used, but it is the figure taken by Mr. S. W. Johnson in his presidential address to the Institute of Mechanical Engineers, 1898, and for the purposes of comparison is all that is required in this discussion. The following column is obtained by assuming that the average value of the friction between the drivers and the rails is 450 lb. The calculated load on the drivers in tons is equal to T ÷ 450 = W tons, say. The ratio, actual load on the drivers in tons ÷ W, is the factor showing the comparative abilities to haul a load in bad weather. It is asserted that the driving wheels are continually slipping more or less in all weathers, and there can be no doubt but that there is some value of this factor when this imperceptible slipping will rapidly increase. Some guide to this critical value may be obtained from a consideration of the penultimate column of Table III. It will be seen that the values in successive designs seem to diminish, but are afterwards followed by an increase. This table shows the values used by the Midland Company's designers. The first design quoted is No. 800, where the value is 1.159, and this diminishes slowly down to 0.873 in the case of No. 868; but in the next design, No. 990, it has increased again to 0.884. On the Great Western the "Atlantics" are being altered to six-wheeled coupled type, because they are not so reliable with heavy fast trains as the "Albions" have proved themselves to be. The factor for the "Atlantics" is 0.861, slightly lower than the Midland minimum noticed above, so that it would seem that the value for reliable work should not be less than about 0.9. When it is much less inconsistent running is to be expected.

During recent years a remarkable development of locomotive powers has been provided by the locomotive department of the Great Western Company to meet the increasing demands of the traffic. For many years the single-wheel type was exclusively employed for all the best trains, and the work done was of a very high character, many very fine records standing to the credit of the single-wheel engines employed. There were several types of coupled engines employed on various sections of the company's system doing good work within their capacities, but in the Table I., data referring to the modern types only have been used, whilst the single-wheeled designs are dealt with in a later table.

An examination of this table is very instructive. First notice the very rapid increase of the cylinder capacity provided in the first three designs representing an augmentation of 40 per cent., whilst the proportion of the boilers was reduced 9 per cent., as measured by the grate area factor. Hence, if the "Gooch" engines were put to work, trains of equal average speed and proportionately loaded, the boilers would have to supply more steam than the earlier types per unit of fuel consumed; otherwise they would run themselves out of breath. It is, of course, possible that Mr. Dean's intention in this design was to make more efficient use of the steam in the big cylinders, and so obtain an increase of economy in running; but it is generally understood that these engines have proved to be very sluggish runners, but capable of dealing with heavy trains at moderate speeds. The 3225 class have done much excellent work with the expresses between Shrewsbury and Bristol, and in the new type following the "Gooches" it would appear that a return was made to the proportions of 3225. In the new "Badmintons" the allowance of fire grate area is the same, and the cylinder capacity was reduced 16 per cent. as compared with the "Gooches," and nearly 4 per cent. less than the 3225 class. In the "Gooch" the adhesion factor was reduced to 0.950, but in the new "Badminton" it was increased again to 1.041; it is evident, therefore, that the "Badminton" was a much more powerful engine than the "Gooch," although its total tractive force on paper is less, because it had greater boiler power and a greater adhesion factor, enabling it to make better use of its cylinder capacity than was possible for the "Gooch" type; hence it would prove to be a more reliable type for use in all weathers, and in practice this was realised, for it at once proved its capacity for work, as many noteworthy achievements were immediately placed to its credit.

The "Atbara" type soon followed, and was a further development; the cylinder volume remained the same, but the boiler capacity was again increased beyond any of the preceding types, and the amount of adhesion allowed was greater. These engines proved their worth immediately, so that they were speedily multiplied; the "Badmintons," although performing so admirably, were outclassed and became obsolete. The next variant onwards was the type known as the "Cities," in which the chief variation made was an increase of the boiler pressure and of the total heating surface allowed, but this was accompanied by a decrease in the grate area and of the adhesion factor, the latter falling to only a little more than in the "Gooch." This class has proved to be very satisfactory in actual work, and is still being multiplied, the later engines being known as the "Flower" type.

The next type in the order of development was the "Counties," and in these engines the cylinder capacity is increased nearly to the same size as that of the "Gooch," and were placed outside the frames; the boiler was the same as that supplied to the "Cities," and is in consequence a retrogression; the adhesion factor is also much less; in fact, it is almost as low as in some single-wheeled types. These engines have, however, done some excellent work, but have not been multiplied on the same scale as the "Cities." The "Counties" were succeeded by the "Atlantics," which are similar to the "Counties" as regards cylinder capacity, but have larger boilers, which are on the same liberal scale as with the "Atbaras." The weight on the drivers was increased, but the value of the factor was still relatively low, and this latter defect has apparently led to their reconstruction as the "Albions," which are six-wheeled coupled, and in this form they have proved to be most successful in every way, and are being multiplied rapidly.

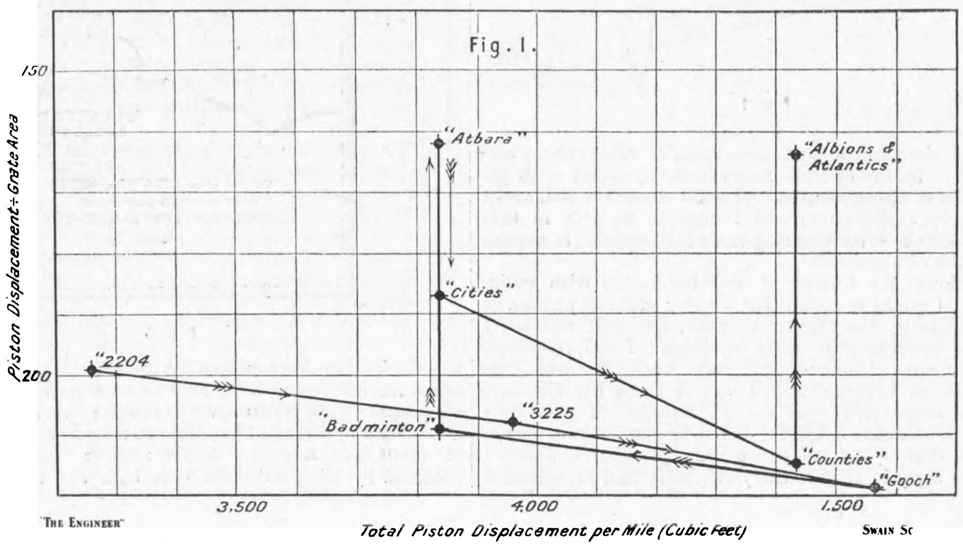

Fig. 1—EVOLUTION OF G.W.R. LOCOMOTIVES

Briefly, the lines along which Messrs. Dean and Churchward appear to have moved may be summed up thus:—

First, a reduction of the ratios:—

$$\frac{\text{Cylinder volumes}}{\text{Grate area}} \text{ and } \frac{\text{Tractive effort}}{\text{Adhesive weight}}.$$

Secondly, a return to greater values of these ratios. Thus the "Gooch," the "Counties" and the "Atlantics" each mark the "low-water levels" of the ratios and 2204, the "Atbaras," the "Cities" and the six-coupled types are the several succeeding high levels reached. It is interesting to note that the cylinder capacities of the six-coupled is still less than that of the "Gooch," although it is quite obvious that the latter class could not do the work of the former. The curves, Figs. 1 and 2, illustrate the movement during the evolution of the latest type of engine. In Fig. 1 the ratio of the grate area factor is shown, and Fig. 2 the adhesion factor, both being plotted on a basis of cylinder displacement, and the progress is shown by the arrow lines in each case.[*]

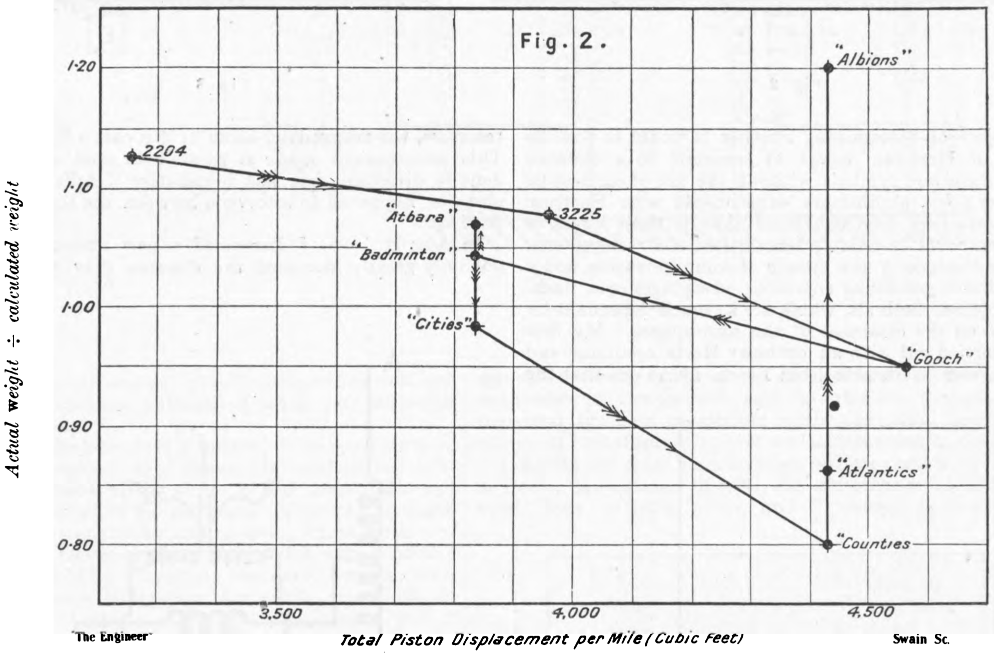

Fig 2—EVOLUTION OF G.W.R. LOCOMOTIVES

This table has been discussed at length in order to show how the tables are constructed and what information may be obtained from them, also for the reason that the engines of the Great Western Company have probably in recent years been doing work better than many of its contemporaries, and for that reason alone are well worth the attention that has been given them.

A point worth notice when estimating the probable adhesion factor suitable for any given case is the character of the road over which the engine will have to work, which must have full consideration, as in some cases a lower value may give quite satisfactory results in actual practice. At starting and at low speeds the engine may be working with little or no expansion, and yet the boiler be quite able to supply all the steam required, but as the speed increases the engine must be notched up; thus, although the engine revolutions are greater, the amount of steam required will be but little different from that at the lower rate—*i.e.*, the engine may work at constant power, although running at varying speeds. Thus a small cylinder capacity may, with a suitable boiler, use steam all through the stroke when starting a load, and give a nominally high tractive effort, and so accelerate a load quickly, and afterwards when speed is attained an earlier cut-off will give plenty of power to keep the train up to speed. Further, this engine would be able to run with a later cut-off when climbing a bank, and so maintain its average speed more easily than an engine having nominally greater tractive effort, due to a greater cylinder capacity only. Further, as an engine gathers speed the mean pressure in the cylinders fall when the cut-off is maintained at the same point,[*] consequently the tractive effort at the draw-bars is also a constantly decreasing quantity with increasing speed, so that there are reasons why an engine, such as the "Atbaras," should be much better than the "Badmintons," solely from the more adequate boiler power that this class possesses, and the consequent ability to run fast with a later cut-off. Another example is the Great Northern Atlantic No. 251, which appear to be capable of doing quite as good work as many engines with much larger cylinder capacity, and the secret is the large grate area factor. From a consideration of these points one would expect the "Cities" to maintain a higher speed up the banks than the "Atbaras." Also if the "Counties" were set to work the same trains as the "Cities" they would perform satisfactorily, but if they were pressed by heavy loads, or bad weather, then in all probability they would run out of breath by reason of their smaller adhesive weight, which would allow slipping to occur, and so prevent them taking full advantage of their superior cylinder capacity. This was probably the reason why they have given rise first to the Atlantic type, in which the same engine receives a larger boiler, so getting a better steam supply, only to find that they must have more adhesion to prevent slipping, so that the six-coupled engine was the necessary result.

In her speed trials recently, the North Dakota, the latest Dreadnought for the United States Navy, which is fitted with Parsons turbine engines, succeeded in attaining a speed of 22¼ knots.

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[*] "3225" appears to be wrongly plotted in Fig. 2.—Ed. The E.

[*] See Dalby, Proc. Inst. C.E., p. 329, vol. clxiv.

MARCONI WIRELESS TELEGRAPHY.*

By Mr. G. Marconi.

THE discoveries connected with the propagation of electric waves over long distances, and the practical applications of telegraphy through space, which have gained for me the supreme honour of sharing the Nobel prize for Physics, have been to a great extent the result of one another.

The application of electric waves to the purposes of wireless telegraphic communication between distant parts of the earth, and the experiments which I have been fortunate enough to be able to carry out on a larger scale than is attainable in ordinary laboratories, have made it possible to investigate phenomena and note results often novel and unexpected. In my opinion many facts connected with the transmission of electric waves over great distances still await a satisfactory explanation, and I hope to be able in this lecture to refer to some observations which appear to require the attention of physicists.

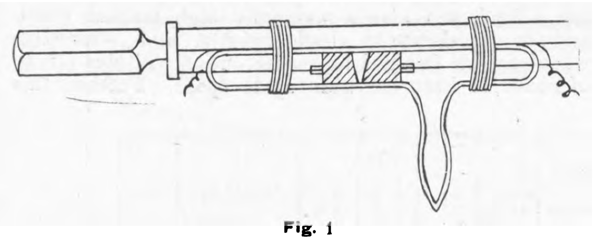

Fig. 1

In sketching the history of my association with radio-telegraphy, I might mention that I never studied physics or electrotechnics in the regular manner, although as a boy I was deeply interested in these subjects. I did, however, attend one course of lectures on Physics under the late Professor Rosa, at Livorno, and I was, I think I might say, fairly well acquainted with the publications of that time dealing with scientific subjects, including the works of Hertz, Branly and Righi. At my home near Bologna, in Italy, I commenced early in 1895 to carry out tests and experiments with the object of determining whether it would be possible by means of Hertzian waves to transmit to a distance telegraphic signs and symbols without the aid of connecting wires. After a few preliminary experiments with Hertzian waves I became very soon convinced that if these waves or similar waves could be reliably transmitted and received over considerable distances a new system of communication would ecobme available possessing enormous advantages over flashlights and optical methods, which are so much dependent for their success on the clearness of the atmosphere. My first tests were carried out with an ordinary Hertz oscillator and a Branly coherer as detector, but I soon found out that the Branly coherer was far too erratic and unreliable for practical work.

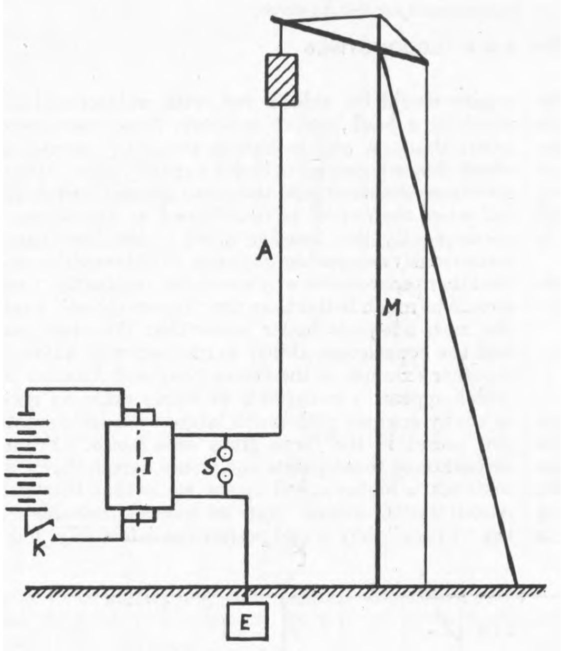

Fig. 2

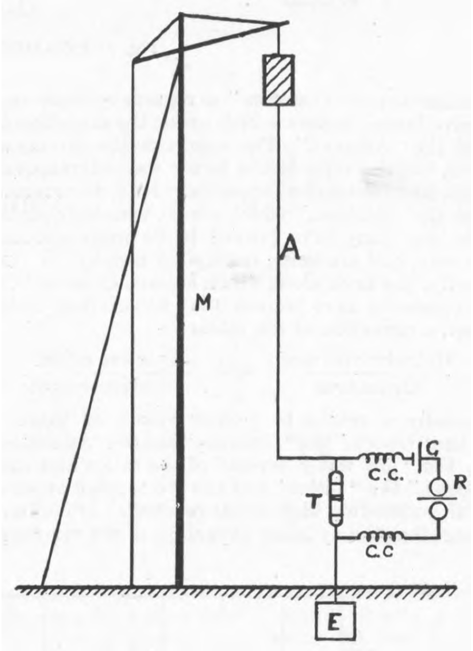

Fig. 3

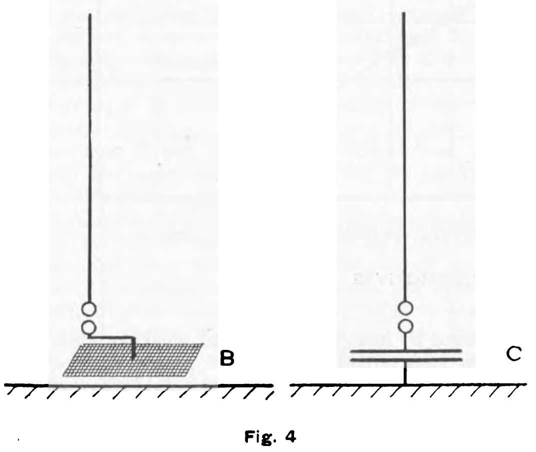

Fig. 4

After some experiments I found that a coherer, constructed as shown in Fig. 1, and consisting of nickel and silver filings placed in a small gap between two silver plugs in a tube, was remarkably sensitive and reliable. This improvement, together with the inclusion of the coherer in a circuit tuned to the wave-length of the transmitted radiation, allowed me gradually to extend up to about a mile the distance at which I could affect the receiver.

Another, now well-known, arrangement which I adopted was to place the coherer in a circuit containing a voltaic cell and a sensitive telegraph relay actuating another circuit, which worked a tapper or trembler and a recording instrument. By means of a Morse telegraphic key placed in one of the circuits of the oscillator or transmitter, it was possible to emit long or short successions of electric waves, which would affect the receiver at a distance and accurately reproduce the telegraphic signs transmitted through space by the oscillator. With such apparatus I was able to telegraph up to a distance of about half a mile. Some further improvements were obtained by using reflectors with both the transmitters and receivers, the transmitter being in this case a Righi oscillator. This arrangement made it possible to send signals in one definite direction, but was inoperative if hills or any large obstacle happened to intervene between the transmitter and receiver.

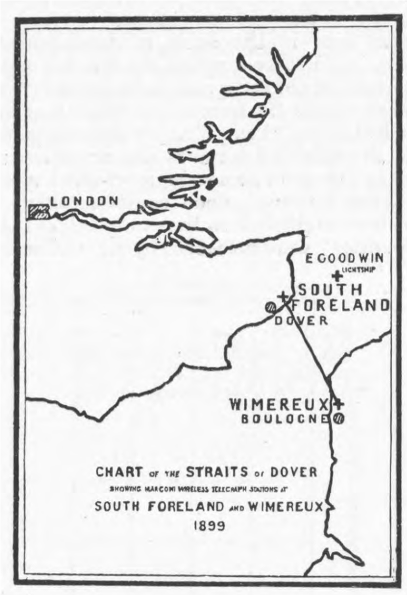
LONDON
E GOODWIN
LIGHTSHIP
SOUTH FORELAND
DOVER
WIMEREUX
BOULOGNE
CHART OF THE STRAITS OF DOVER
SHOWING MARCONI WIRELESS TELEGRAPH STATIONS AT
SOUTH FORELAND AND WIMEREUX
1899

Fig. 5

In August, 1895, I discovered a new arrangement which not only greatly increased the distance over which I could communicate, but also seemed to make the transmission independent from the effects of intervening obstacles. This arrangement consisted in connecting one terminal of the Hertzian oscillator, or spark producer, to earth, and the other terminal to a wire or capacity area placed at a height above the ground, and in also connecting at the receiving end one terminal of the coherer to earth and the other to an elevated conductor.—Figs. 2 and 3. I then began to examine the relation between the distance at which the transmitter could affect the receiver, and the elevation of the capacity areas above the earth, and I very soon definitely ascertained that the higher the wires or capacity areas the greater the distance over which it was possible to telegraph.

Thus I found that when using cubes of tin about 30 cms. side as elevated conductors or capacities, placed at the top of poles 2 m. high, I could receive signals at 30 m. distance, and when placed on poles 4 m. high at 100 m., and at 8 m. high at 400 m. With larger cubes 100 cms. side, fixed at a height of 8 m., signals could be transmitted 2400 m. all round.[1] These experiments were continued in England, where, in September, 1896, a distance of $1\frac{3}{4}$ miles was obtained in tests carried out for the British Government at Salisbury. The distance of communication was extended to four miles in March, 1897, and in May of the same year to nine miles. Tape messages obtained during these tests, signed by the British Government officers who were present, are exhibited. In all these experiments a very small amount of electrical power was used, the high-tension current being produced by an ordinary Rhumkoff coil. The results obtained attracted a good deal of public attention at the time, such distances of communication being considered remarkable.

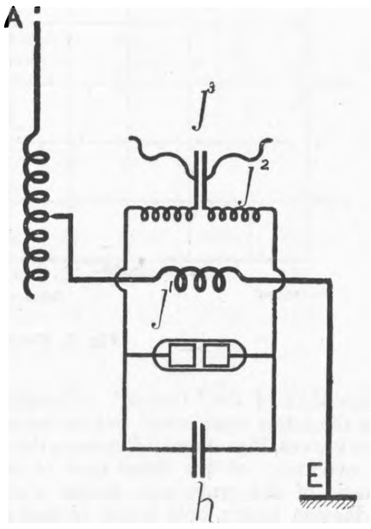

Fig. 6

As I have explained, the main feature in my system consisted in the use of elevated capacity areas, or vertical wires, attached to one pole of the high-frequency oscillators and receivers, the other pole of which was earthed. The practical value of this innovation was not understood by many physicists for quite a considerable period, and the results which I obtained were by many erroneously considered simply due to efficiency in details of construction of the receiver, and to the employment of a large amount of energy. Others did not overlook the fact that a radical change had been introduced by making these elevated capacities and the earth form part of the high-frequency oscillators and receivers. Professor Ascoli, of Rome, gave a very interesting theory of the mode of operation of my transmitters and receivers in the *Elettricista* (Rome) issue of August, 1897, in which he correctly attributed the results obtained to the use of elevated wires or antennas. Professor A. Slaby, of Charlottenburg, after witnessing my tests in England in 1897, came to somewhat similar conclusions.[2]

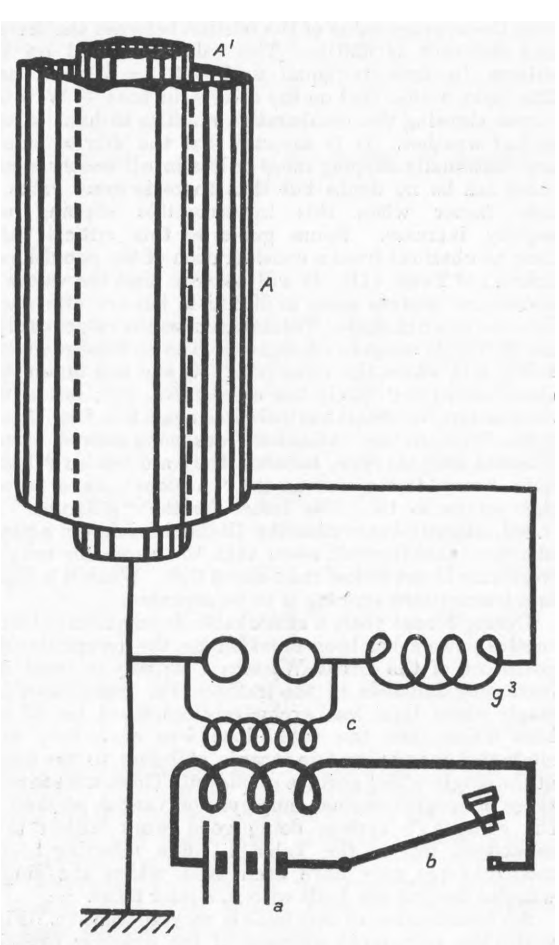

Fig. 7

Many technical writers have stated that an elevated capacity at the top of the vertical wire is unnecessary. This is true if the length or height of the wire is made sufficiently great, but as this height may be much smaller for a given distance if a capacity area is used, it is more economical to use such capacities, which now usually consist of a number of wires spreading out from the top of the vertical conductor.

The necessity or utility of the earth connection has been sometimes questioned, but in my opinion no practical system of wireless telegraphy exists where the instruments are not connected to earth. By "connecting to earth" I do not necessarily mean an ordinary metallic connection as used for ordinary wire telegraphs. The earth wire may have a condenser in series with it, or it may be connected to what is really equivalent, a capacity area placed close to the surface of the ground—Fig. 4. It is now perfectly well known that a condenser, if large enough, does not prevent the passage of high-frequency oscillations, and therefore in these cases the earth is for all practical purposes connected to the antennæ. After numerous tests and demonstrations in Italy and in England over distances varying up to 40 miles, communication was established for the first time across the English Channel between England and France in March, 1899.[3] (Fig. 5.)

From the beginning of 1898 I had practically abandoned the system of connection shown in Fig. 2, and instead of joining the coherer or detector directly to the aerial and earth, I connected it between the ends of the secondary of a suitable oscillation transformer containing a condenser and tuned to the period of the electrical waves received. The primary of this oscillation transformer was connected to the elevated wire and to earth—Fig. 6. This arrangement allowed of a certain degree of syntony, as by varying the period of oscillation of the transmitting antennæ it was possible to send messages to a tuned receiver without interfering with others differently syntonised.[4]

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* Address delivered in Stockholm on 11th December by Mr. Marconi on the occasion of the awarding of his share of the Nobel prize.

[1] See "Journal" of the Institution of Electrical Engineers, London, 1899. Vol. XXVIII., page 278.

[2] See A. Slaby, "Die Funkentelegraphie," Berlin, 1897, Verlag von Bronhard Simion; also A. Slaby, "The New Telegraphy," the *Century Magazine*, April, 1898, Vol. LV., page 867.

[3] See *Journal* of the Institution of Electrical Engineers, 1899, London, Vol. XXVIII., p. 291.

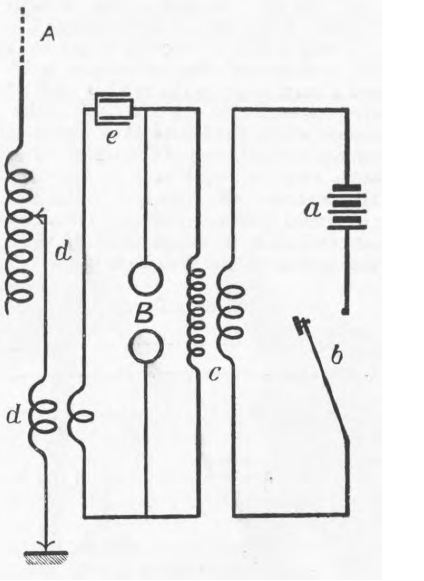

Fig. 8

As it is now well known, a transmitter consisting of a vertical wire discharging through a spark gap is not a persistent oscillator the radiation it produces is strongly damped. Its electrical capacity is comparatively so small and its capability of radiating energy so large that its oscillations decrease or die off with great rapidity. In this case receivers or resonators of a considerably different period or pitch are likely effected by it. Early in 1899 I was able to improve the resonance effects obtainable by increasing the capacity of the elevated wires by placing adjacently to them earthed conductors, and inserting in series with the aerials suitable inductance coils[5]. By these means the energy storing capacity of the aerial was increased, whilst its capability to radiate was decreased, with the result that the energy set in motion by the discharge formed a train or succession of feebly damped oscillations. A modification of this arrangement, by which excellent results were obtained, is shown in Fig. 7.

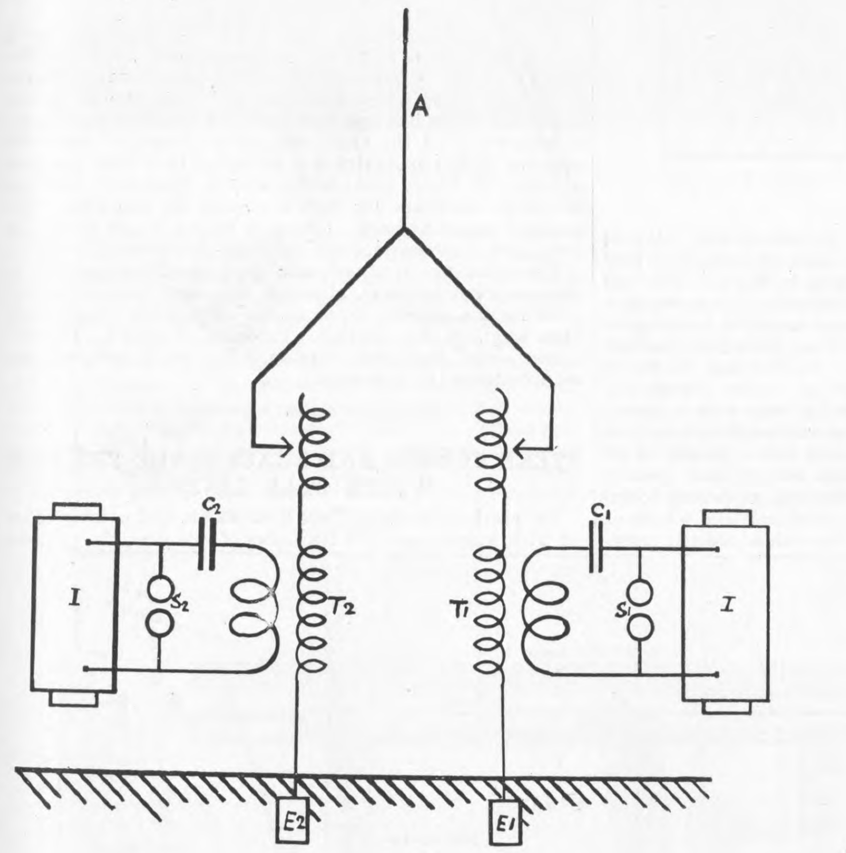

Fig. 9

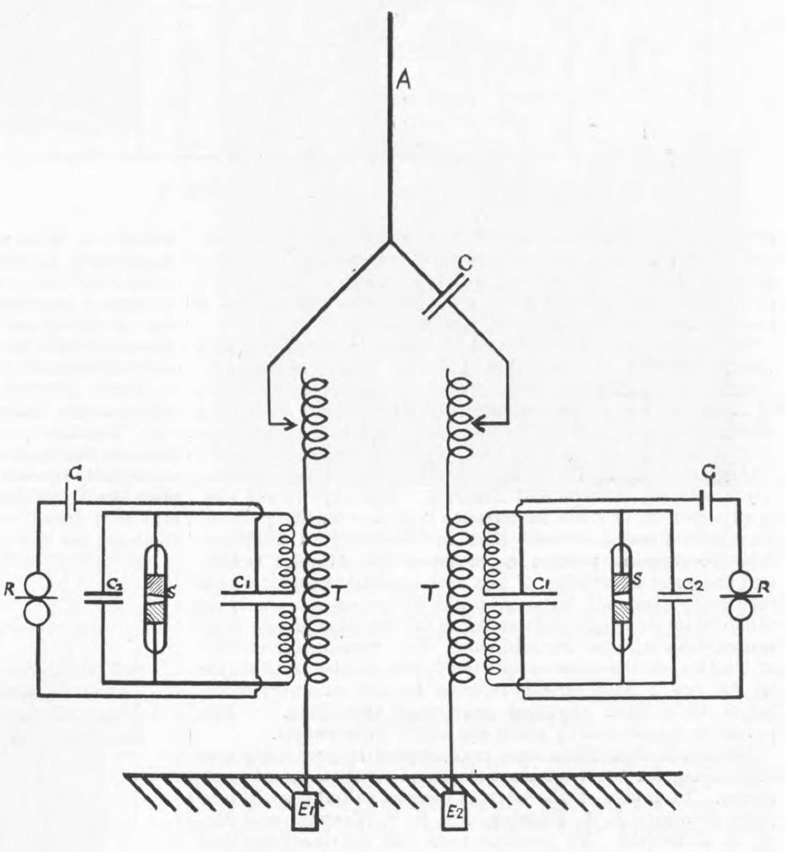

Fig. 10

In 1900 I constructed and patented transmitters which consisted of the usual kind of elevated capacity area and earth connection, but these were inductively coupled to an oscillation circuit containing a condenser, an inductance and a spark gap, the conditions which I found essential for efficiency being that the periods of electrical oscillation of the elevated wire or conductor should be in time or resonance with that of the condenser circuit—Fig. 8[6]. The circuits, consisting of the oscillating circuit and radiating circuit, were more or less closely "coupled" by varying the distance between them. By the adjustment of the inductance inserted in the elevated conductor and by the variation of the capacity of the condenser circuit the two circuits were brought into resonance, a condition which, as I have said, I found essential in order to obtain efficient radiation.

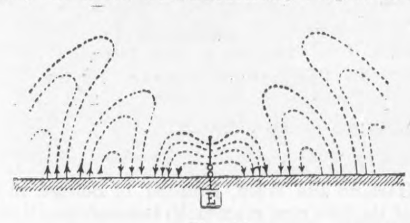

Fig. 11

Part of my work regarding the utilisation of condenser circuits in association with the radiating antennæ was carried out simultaneously to that of Professor Braun, without, however, either of us knowing at the time anything of the contemporary work of the other.

A syntonic receiver has already been shown in Fig. 6, and consists also of a vertical conductor or aerial, connected to earth through the primary of an oscillation transformer, the secondary circuit of which included a condenser and a detector, it being necessary that the circuit containing the aerial and the circuit containing the detector should be in electrical resonance with each other, and also in tune with the periodicity of the electric waves transmitted from the sending station. It is also possible to couple to one sending conductor several differently tuned transmitters, and to a receiving wire a number of corresponding receivers, as is shown in Figs. 9 and 10, each individual receiver responding only to the radiations of the transmitter with which it is in resonance.

At the time (twelve years ago) when communication was first established by means of radiotelegraphy between England and France, much discussion and speculation took place as to whether or not wireless telegraphy would be practicable for much longer distances than those then covered, and a somewhat general opinion prevailed that the curvature of the earth would be an insurmountable obstacle to long-distance transmission, in the same way as it was, and is, an obstacle to signalling over considerable distances by means of light flashes. Difficulties were also anticipated as to the possibility of being able to control the large amount of energy which it appeared would be necessary to cover long distances. What often happens in pioneer work repeated itself in the case of radiotelegraphy—the anticipated obstacles or difficulties were either purely imaginary or else easily surmountable, but in their place unexpected barriers manifested themselves, and recent work has been mainly directed to the solution of problems presented by difficulties which were certainly neither expected nor anticipated when long distances were first attempted.

With regard to the presumed obstacle of the curvature of the earth, I am of opinion that those who anticipated difficulties in consequence of the shape of our planet had not taken sufficient account of the particular effect of the earth connection to both transmitter and receiver, which earth connection introduced effects of conduction which were generally at that time overlooked. Physicists seemed to consider for a long time that wireless telegraphy was solely dependent on the effects of free Hertzian radiation through space, and it was years before the probable effect of the conductivity of the earth between the stations was satisfactorily considered or discussed.

Lord Rayleigh, in referring to Transatlantic telegraphy, stated, in May, 1903: "The remarkable success of Marconi in signalling across the Atlantic suggests a more decided bending or diffraction of the waves round the protuberant earth than had been expected, and it imparts a great interest to the theoretical problem."[7]

Professor J. A. Fleming, in his book on "The Principles of Electric Wave Telegraphy,"[8] gives diagrams showing what is now believed to be the diagrammatic representation of the detachment of semi-loops of electric strain from a simple vertical wire—Fig. 11. As will be seen, these waves do not propagate in the same manner as free radiation from a classical Hertzian oscillator, but glide along the surface of the earth. Professor Fleming further states in the above-quoted work:—"The view we here take is that the ends of the semi-loops of electric force, which terminate perpendicularly on the earth, cannot move along unless there are movements of electrons in the earth corresponding to the wave-motions above it. From the point of view of the electronic theory of electricity, every line of electric force in the ether must be either a closed line or its ends must terminate on electrons of opposite sign. If the end of a line of strain abuts on the earth and move, there must be atom-to-atom exchange of electrons, or movements of electrons in it. We have many reasons for concluding that the substances we call conductors are those in which free movements of electrons can take place. Hence the movements of the semi-loops of electric force outwards from an earthed oscillator or Marconi Aërial is hindered by bad conductivity on the surface of the earth and facilitated over the surface of a fairly good electrolyte, such as sea water."

Professor[9] Zenneck has carefully examined the effect of earthed transmitting and receiving aërials, and has endeavoured to show mathematically that when the lines of electrical force, constituting a wave front, pass along a surface of low specific inductive capacity, such as the earth, they become inclined forward, their lower ends being retarded by the resistance of the conductor to which they are attached. It therefore seems well established that wireless telegraphy, as practised at the present day, is dependent for its conductivity of the earth, and that the difference in operation over long distances on the conductivity between the surface of the sea and land is sufficient to explain the increased distance obtainable with the same amount of energy in communicating over sea as compared to over land.

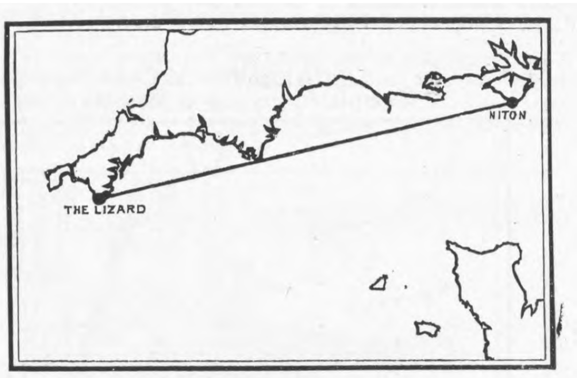

Fig. 12

I carried out some tests between a shore station and a ship at Poole, in England, in 1902, for the purpose of obtaining some data on this point, and I noticed that at equal distances a perceptible diminution in the energy of the received waves always occurred when the ship was in such a position as to allow a low split of sand about 1 kilom. broad to intervene between it and the land station. I therefore

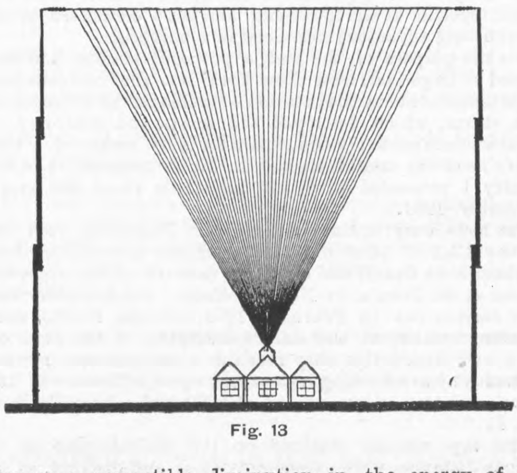
Fig. 13

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[4] British Patent No. 12326 of June 1st, 1898; also No. 6982 of April 1st, 1899.

[5] See "Etat Actuel et Progres de la Telegraphie sans Fil" by A. Blondel and G. Ferrie, read at the Congres International d'Electricite, Paris, 1900; also "Journal" of the Society of Arts, 1901, Vol. XLIX, page 509.

[6] See British Patent No. 7777 of 26th of April, 1900; also "Journal" of the Society of Arts, Vol. XLIX., May 17th, 1901, page 510-511.

[7] See "Proceedings" of the Royal Society, Vol. 72, May 28th, 1903

[8] See page 348 (published by Longmans, Green and Co., London. 1906.)

[9] See J. Zenneck. "Annalen der Physik.," 23, 5, p. 846, September 1908. "Physikal Zeitschrift," No. 2, p. 50; No. 17, p. 553.

believe that there was some foundation for the statement so often criticised which I made in my first English patent of June 2nd, 1896, to the effect that when transmitting through the earth or water I connected one end of the transmitter and one end of the receiver to earth.

In January, 1901, some successful experiments were carried out between two points on the South Coast of England 186 miles apart, *i.e.*, St. Catherine's Point, Isle of Wight, and the Lizard, in Cornwall.[10]—Fig. 12. The total height of these stations above sea level did not exceed 100 m., whereas to clear the curvature of earth a height of more than 1600 m. at each end would have been necessary. The results obtained from these tests, which at the time constituted a record distance, seemed to indicate that electric waves produced in the manner I had adopted would most probably be able to make their way round the curvature of the earth, and that therefore even at greater distances, such as those dividing America from Europe, the factor of the earth's curvature would not constitute an insurmountable barrier to the extension of telegraphy through space.

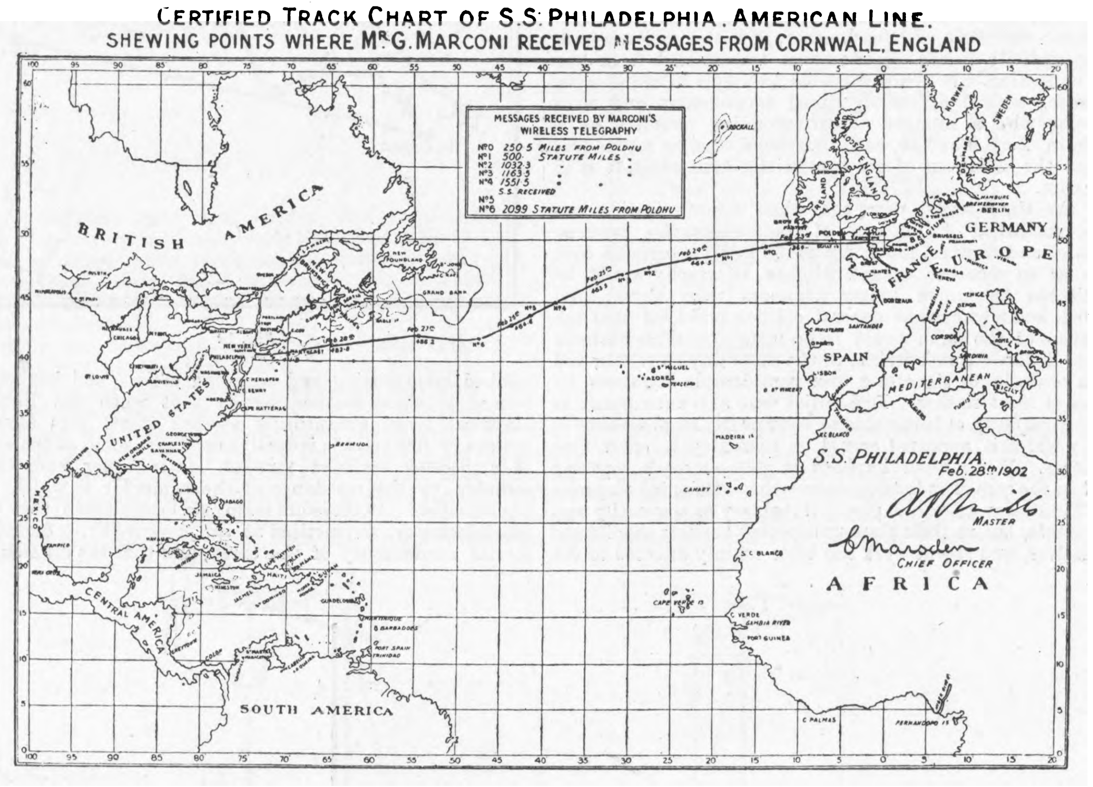
CERTIFIED TRACK CHART OF S.S. PHILADELPHIA. AMERICAN LINE.
SHEWING POINTS WHERE MR G. MARCONI RECEIVED MESSAGES FROM CORNWALL, ENGLAND
MESSAGES RECEIVED BY MARCONI'S WIRELESS TELEGRAPHY
Nº0 250.5 MILES FROM POLDHU
Nº1 500 STATUTE MILES
Nº2 1032.3
Nº3 1163.5
Nº4 1551.5
S.S. RECEIVED
Nº5
Nº6 2099 STATUTE MILES FROM POLDHU
BRITISH AMERICA
UNITED STATES
CENTRAL AMERICA
SOUTH AMERICA
GERMANY
EUROPE
FRANCE
SPAIN
MEDITERRANEAN
AFRICA
S.S. PHILADELPHIA.
Feb. 28th 1902
MASTER
C Marsden
CHIEF OFFICER

Fig. 14

The belief that the curvature of the earth would not stop the propagation of the waves, and the success obtained by syntonic methods in preventing mutual interference, led me in 1900 to decide to attempt the experiment of testing whether or not it would be possible to detect electric waves over a distance of 4000 kiloms., which, if successful, would immediately prove the possibility of telegraphing without wires between Europe and America. The experiment was, in my opinion, of great importance from a scientific point of view, and I was convinced that the discovery of the possibility to transmit electric waves across the Atlantic Ocean, and the exact knowledge of the real conditions under which telegraphy over such distances could be carried out, would do much to improve our understanding of the phenomena connected with wireless transmission. The transmitter erected at Poldhu, on the coast of Cornwall, was similar in principle to the one I have already referred to, but on a very much larger scale than anything previously attempted.[11] The power of the generating plant was about 25 kilowatts.

Numerous difficulties were encountered in producing and controlling for the first time electrical oscillations of such power. In much of the work I obtained valuable assistance from Professor J. A. Fleming, Mr. R. N. Vyvyan, and Mr. W. S. Entwistle. My previous tests had convinced me that when endeavouring to extend the distance of communication, it was not merely sufficient to augment the power of the electrical energy of the sender, but that it was also necessary to increase the area or height of the transmitting and receiving elevated conductors. As it would have been too expensive to employ vertical wires of great height, I decided to increase their number and capacity, which seemed likely to make possible the efficient utilisation of large amounts of energy. The arrangement of transmitting antennæ which was used at Poldhu is shown in Fig. 13, and consisted of a fan-like arrangement of wires supported by an insulated stay between masts only 48 m. high and 60 m. apart. These wires converged together at the lower end, and were connected to the transmitting apparatus contained in a building.

For the purpose of the test, a powerful station had been erected at Cape Cod, near New York, but the completion of the arrangements at that station were delayed in consequence of a storm, which destroyed the masts and antennæs. I therefore decided to try the experiments by means of a temporary receiving station erected in Newfoundland, to which country I proceeded with two assistants about the end of November, 1901.

The tests were commenced early in December, 1901, and on the 12th of that month the signals transmitted from England were clearly and distinctly received at the temporary station at St. John's, in Newfoundland. Confirmatory tests were carried out in February, 1902, between Poldhu and a receiving station on the s.s. Philadelphia, of the American Line. On board this ship readable messages were received by means of a recording instrument up to a distance of 1551 miles, and test letters as far as 2099 miles from Poldhu—Fig. 14.

The tape records obtained on the Philadelphia at the various distances were exceedingly clear and distinct, as can be seen by the specimens exhibited.

These results, although achieved with imperfect apparatus, were sufficient to convince me and my co-workers that by means of permanent stations and the employment of sufficient power it would be possible to transmit messages across the Atlantic Ocean in the same way as they were sent over much shorter distances. The tests could not be continued in Newfoundland owing to the hostility of a cable company, which claimed all rights for telegraphy, whether wireless or otherwise, in that Colony.

(*To be continued.*)

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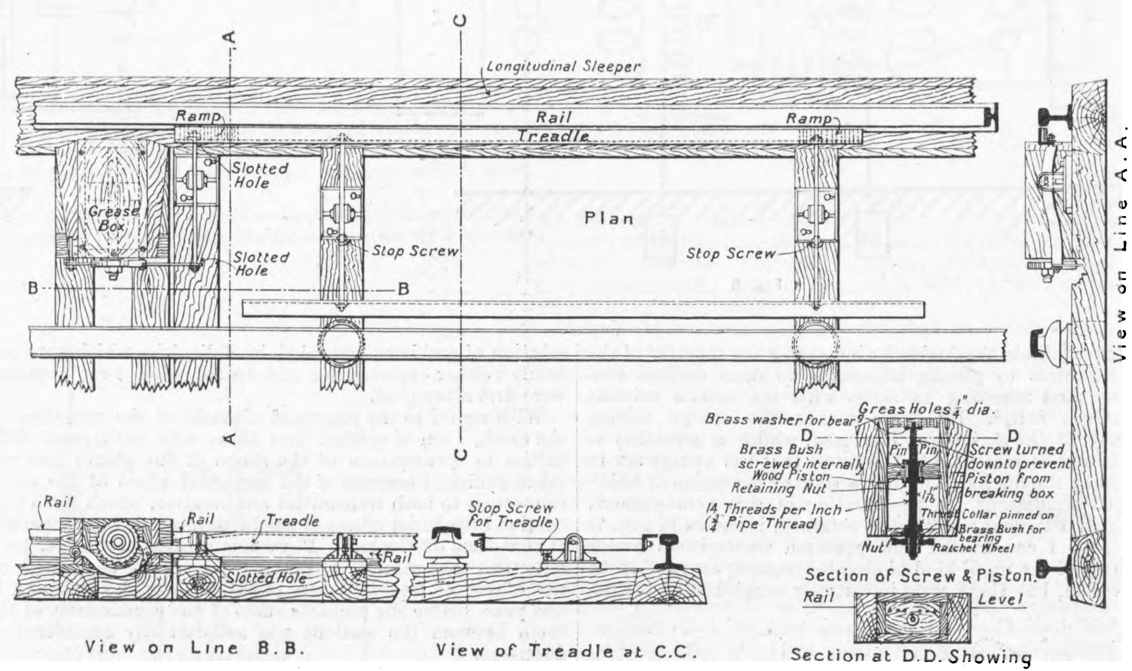
[10] See "Journal" of the Society of Arts, London, Vol. XLIX., page 512, 1901.

[11] Royal Institution of Great Britain, Lecture by G. Marconi, June 13th, 1902.

THE LUBRICATION OF CHECK-RAILS.

SINCE the introduction of electrical traction on railways the wear of check-rails has been a matter of considerable concern to those responsible for the permanent way. It will be generally known that a check rail is an additional rail provided inside the inner rail on a curve, as in Fig. 2. This will be seen in elevation in the middle illustration, from which it will be appreciated that the check-rail assists in keeping the wheel on the outer side of the curve from mounting the rail and becoming derailed. It may be remarked that the Board of Trade requirements specify that all curves, where the radius is ten chains or less, are to be provided with a check-rail. Naturally, therefore, there must be considerable friction between the wheels and check-rails, and this is greater on an electrically operated than on a steam-worked road, because with the latter the locomotive is the only propelling force, and as it draws the train past the check-rail the wheels of the train are disposed to "give." But with an electric train, on the multiple-unit system, each motor grinds its way through, which leads to considerable wear of both check-rail and wheel.



"THE ENGINEER" SWAIN SC.

Fig. 1—NEACHELL'S APPARATUS FOR LUBRICATING CHECK RAILS

A remedy for this has, however, been found, and it is one that is equally applicable to steam and electric roads. It has been designed by Mr. E. J. Neachell, the general manager and engineer of the Liverpool Overhead Railway, on which line we recently inspected the apparatus. This line has always been electrically operated, and the troubles arising from check-rails have been particularly manifest there, as the railway has fourteen miles of track, of which one-sixth is on curves, and there is a five minutes' service on each road.

The apparatus will be understood on reference to Fig. 1. Fixed in the "four-foot," near the commencement of a curve, is a grease-box containing graphite or some other lubricant. In this box is a piston, driven forward by a screw actuated by a ratchet wheel. The ratchet wheel is turned by means of a pawl raised, through a series of levers, on the depression of a treadle by the side of the line. The treadle is carried by two or more levers fixed to the sleepers in the "four-foot," and is balanced by another treadle connected to the levers on the opposite end. The levers, not being centrally pivoted, cause the treadle nearer the rail to be normally raised and, being fixed close to the rail, it is depressed by the flange of the wheel of passing vehicles. The treadle may be balanced in other ways, but in the manner illustrated the distribution of weight and of stress is better equalised. As, then, the bar is depressed, the connecting levers and pawl are moved and a turn given to the ratchet wheel, and so the piston is driven forward. At the other end of the grease-box are holes through which the lubricant is forced out on to the inner vertical face of the flange of the wheel. The wheels are thus lubricated, also the check-rails as the wheels pass by them. In the centre of the four-foot is the third rail conveying the electrical power. This is, of course, no part of the apparatus, and each is independent of the other. By arranging the length of the treadle it is possible to actuate the piston for every wheel or every bogie, or only once for each train.

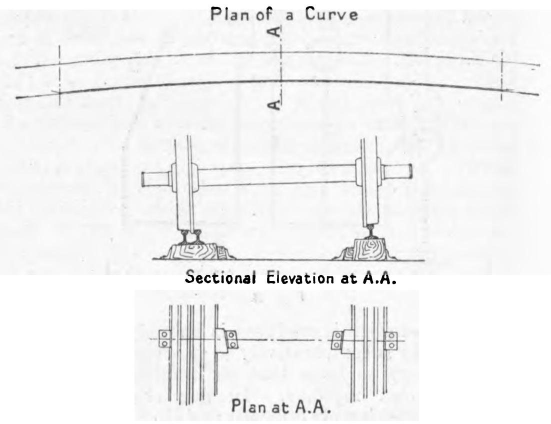


Fig. 2—ARRANGEMENT OF CHECK RAIL

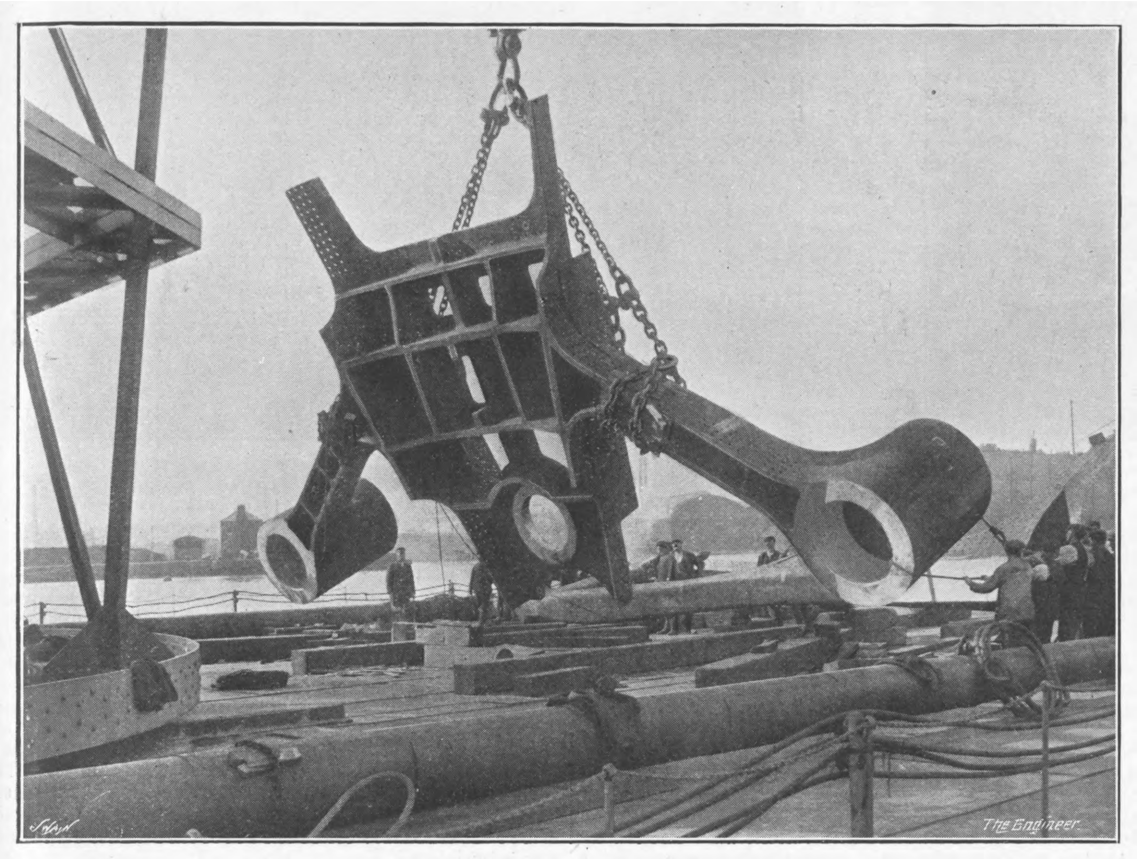
On the overhead railway there is a grease-box at the north end of the line and another at James-street Station. The latter is on the up-line, and we noticed grease on the opposite down-line, which showed that it had been carried to the south end of the line and back again—a distance of six miles—lubricating all the check-rails in the distance. Since the adoption of this apparatus it is estimated that there has been a saving of 50 per cent. in the wear of check-rails, and it is no longer necessary for men to go over the line every night to apply grease by hand. There is also a longer life in the tires, and, necessarily, some reduction in operating power.

The apparatus is, as we have said, equally applicable to steam-worked railways, although the need there is not so great for the reasons given above. The patent rights have been acquired by Graphite Products, Limited, 218-220, Queen's-road, Battersea, London, S.W., which company also manufactures the apparatus.

STERN FRAMES AND BRACKETS OF THE NEW WHITE STAR LINERS.

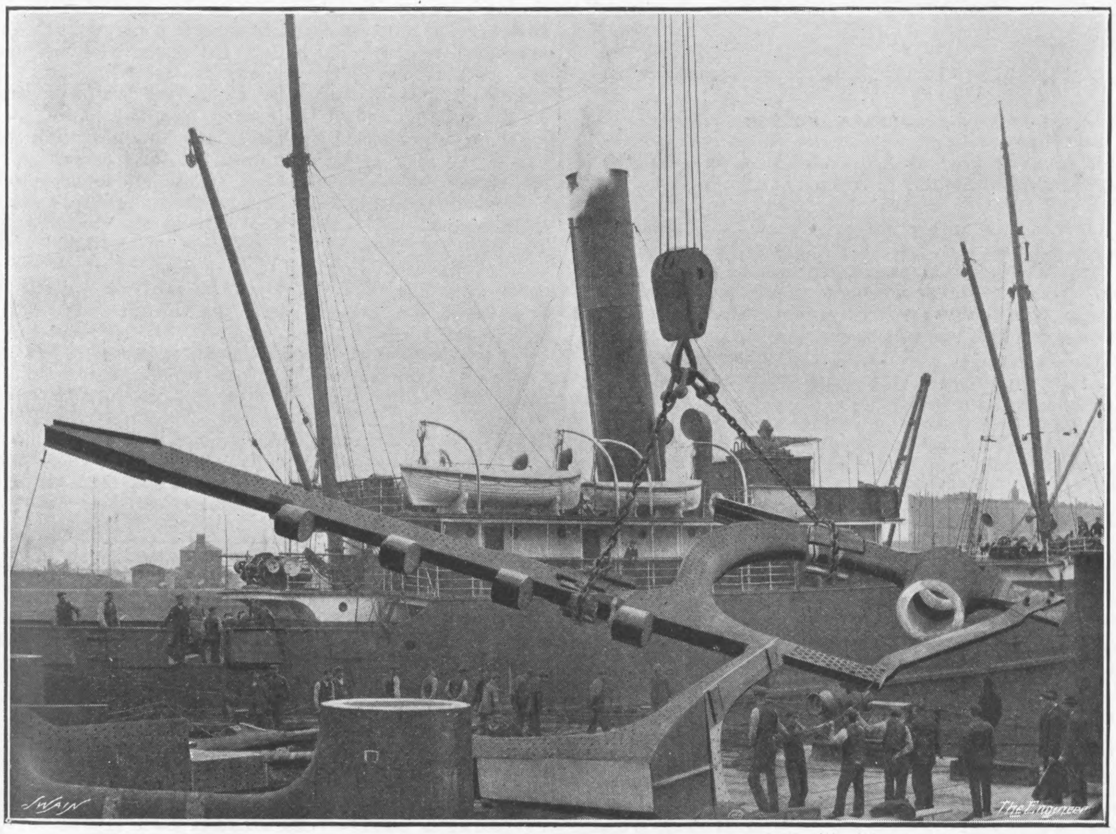
IN previous issues of THE ENGINEER, and notably those of 27th August and 3rd December of this year, the progress made by Harland and Wolff, Limited, of Belfast, in the construction of the two new mammoth steamships, Olympic and Titanic which they have on order for the New York services of the White Star Line, has been described and illustrated. As is now well known, these vessels will eclipse the new Cunarders in point of size, but their speed will not be so great. For both these new additions to the fleet of the White Star Line, the Darlington Forge Company was entrusted with the manufacture of the cast steel stern frames, brackets, and rudders, and these various pieces are far and away the largest and heaviest marine castings ever produced. The stern frame, rudder, and brackets of the Lusitania and of the Mauretania—which were also supplied by the Darlington Forge Company, and were described and illustrated in THE ENGINEER of September 29th, 1905—had a weight of about 220 tons. The total weight of the stern frame, rudder, and brackets in each of the new White Star steamships will be approximately 289 tons, made up as follows:—Stern frame 70 tons, after boss arms 74 tons, forward boss arms 45 tons, and rudder 100 tons. The stern frame is of special quality mild cast steel, and is of hollow or "dished" section, constructed in two pieces 63ft. and 37ft. 4in. in length respectively. The scarphs have been so arranged that in the event of any damage occurring to the post it can be removed with a minimum of trouble and without disturbing the riveting in any large portion of the shell plating of the vessel.

Great attention has been paid to the design of the scarphs, the forward one being of somewhat novel construction, owing to the "dishing" of the post in its vicinity. They were riveted up with rivets of the best Lowmoor iron, and as these were naturally long and extra heavy, special apparatus in the shape of rams had to be employed in this operation.



BOSS ARMS OF OLYMPIC BEING WEIGHED

The boss arms are in two pairs, placed one about 20ft. forward of the other, and they are of exceptional dimensions and special design. They will extend right across the vessel, with the object of forming a very strong girder and of obviating vibration or panting at this part of the ship. These boss arms are of the finest special quality mild cast steel, and each pair is in two pieces, bolted together with strong flanges at the centre line of the vessel. The after one is connected to a 2in. solid steel bulkhead, whilst the forward one is connected to very stout and broad web frames down the vessel's sides. It will therefore be evident that in addition to their special function of carrying the shafts and propellers, these frames will increase materially the strength of the structure at the after part of the vessel.



UPPER PORTION OF STERN FRAME OF OLYMPIC

In casting the main piece of stern frame, about 95 tons of molten metal were required, and as now finished its weight is 70 tons. The making of the mould in which the stern frame was cast represented two months' work, and the completion of the finished castings five months more—seven months in all. The rudder frame is in five massive castings, bolted together with a forged rudder head, 24in. in diameter, and the stock is of hydraulic-pressed steel.

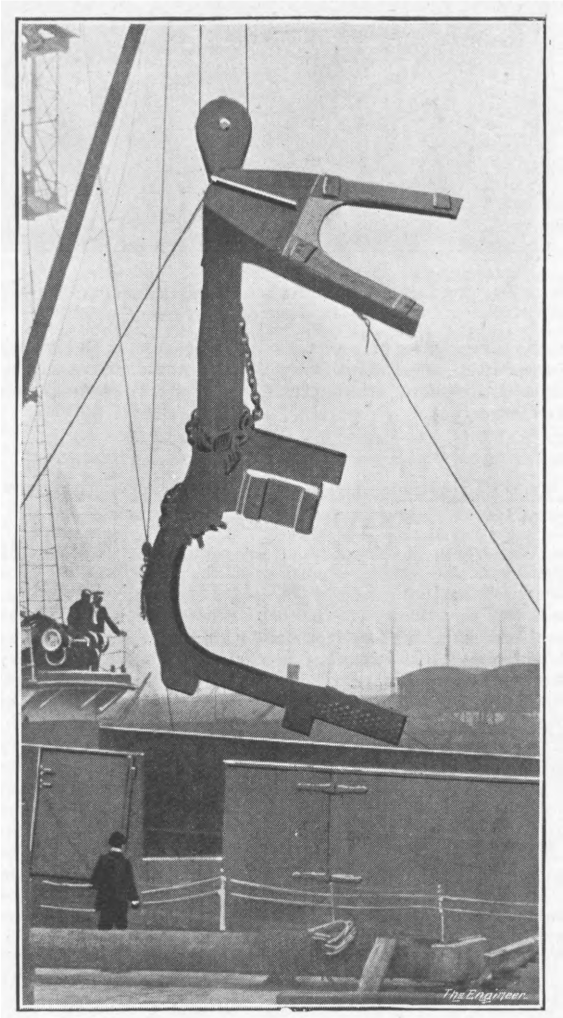
On page 636 we are enabled to show views of the forward and aft brackets of the Titanic, and on this page are reproduced three views of stern frames and boss arms of the Olympic. The three photographs from which these engravings were made were taken on August 10th last.

Owing to their enormous weights and exceptional overall dimensions, a series of elaborate railway arrangements had to be adopted, in order to permit of the safe passage of these castings between the Darlington Forge Company's works and the shear legs at the North-Eastern Railway Company's Union Dock at West Hartlepool.

As previously mentioned, the stern frames were, for the purposes of transport, manufactured in two portions, the upper part having a length of 63ft., with the tail-piece 56ft. 0½in. in length, the total weight being about 39½ tons. This casting was loaded upon a 50-ton trolley wagon having a length over buffers of 51ft. 7¼in., a bogie wheel base of 5ft., and bogie centres distanced 38ft. 6in. apart. The "well" of the wagon, 25ft. in length, was built up with timber baulks and the load secured by chains and shackles, whilst heavy steel ingots formed counter-balancing weights. The total overhang, on the off or abutment side, was 2ft. 9in., and the tail-piece was slewed round so as better to distribute the load on the wagon, the overhang, measuring from the centre of the wagon, being 16ft. 3in., and the total height of the load above rail level 9ft. 6in. The lower part of the stern frame of the Titanic has a length of 37ft. 4in., the length of the gudgeon being 16ft., and the palm 9ft. wide and 11ft. deep. When loaded upon the 40-ton trolley wagon the overhang amounted to 11ft. 10in. The after boss arms frame was constructed in two parts, and loaded upon 40-ton and 50-ton wagons respectively, These castings have each a total length of 22ft., whilst the boss is 6ft. 3½in. deep and 5ft. 2¼in. diameter. The "wells" of the wagons were built up with heavy timbers, and eight-ton steel ingots served as counter-balancing weights. In these instances, although the castings were loaded at an angle, the overhang from the wagon side was 15ft. and 2ft. 6in. on the "off" side. The forward boss arms were also in two parts, of a total weight of about 45 tons. They have a length of 22ft. $3\frac{9}{16}$in., and the boss is 3ft. 6½in. deep and 6ft. 2in. diameter. They were loaded similarly to the after boss arms.

It was only possible to transport these castings during the lull of traffic on a Sunday, and then only by a temporary re-arrangement of the existing goods train services on the route between Darlington and West Hartlepool, and by observing a speed for the "stern-frame" specials never exceeding five miles per hour.

The great weight and size of the various castings for one of these new White Star steamships put out of question their erection preparatory to leaving the Darlington Forge Company's works, and therefore it is not possible to include illustrations of the stern frame, brackets, and rudder complete, but the accompanying engravings afford a good idea of the design and dimensions of the various pieces.



LOWER PORTION OF STERN FRAME OF OLYMPIC

DOCKYARD NOTES.

ACCORDING to the French newspapers, which very often nowadays know more about these things than we do over here, the Blanche will carry ten 4in. guns and the Newcastle two 6in. and four 4in. The latter statement, however, strikes us as doubtful.

THE maximum speed reached by the German cruiser Blucher on her trials was 25.33. This is a great deal in excess of what she was designed for.

A UNITED STATES Congressman by the name of Roberts is heading an agitation against the two 25,000-ton battleships which it is proposed to build. He wishes to see constructed instead one monster 30,000-ton battleship, carrying twelve 14in. guns, which he declares would be more than equal to the two 25,000-ton ships. In a certain sense this is perhaps so. On the other hand, the 30,000-ton ship could only be in one place at once! Incidentally, also, there is probably no dock that would be able to take it if built. It might furthermore be advanced that one ship of 40,000 tons would be superior to two of 30,000, and so on *ad infinitum*.

THE first of the new Spanish battleships has been laid down at Ferrol; she will be named Espana.

THE new Greek warship now turns out to be the cruiser which was building in Italy on chance of sale. She will be named Averof. The armament consists of four 10in. and eight 8in. guns. She is in every respect a sister to the Italian Pisa.

THE reported breakdown of the St. Vincent on her trials was a very small affair, and merely amounted to a mishap to one of the auxiliary pumping engines, and even that of a minor nature.

A GOOD many interesting stories are going round as to the armament of H.M.S. Lion, including the report that Admiral Sir John Fisher had designed the arrangement of guns! For this, so far as we can ascertain, there is absolutely no truth whatever. The present trend of British naval architecture is towards having all guns on the centre line, but the invention, or rather the resuscitation of this idea comes from America.

RADIO-TELEGRAPHIC APPARATUS AT THE ARMSTRONG COLLEGE

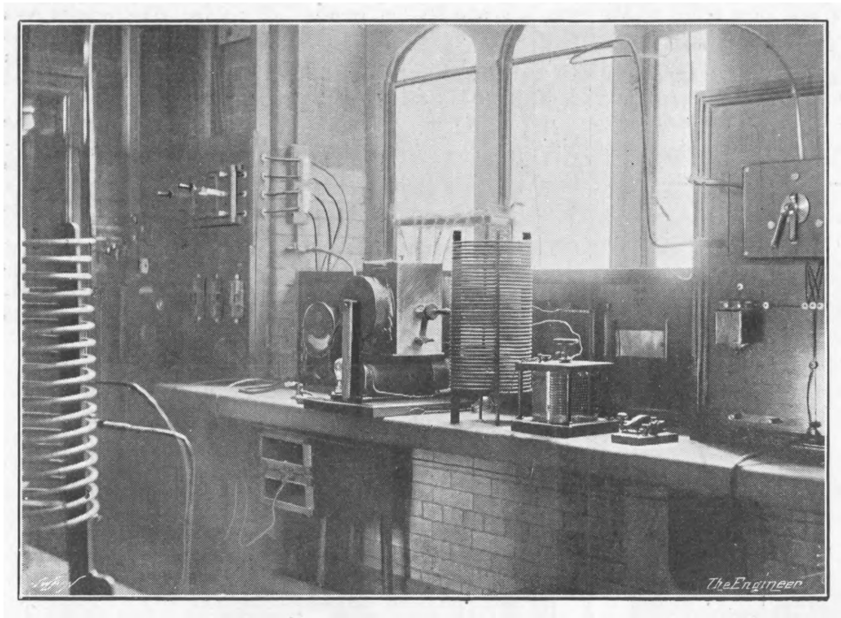


Fig. 1—POULSEN ARC SENDER

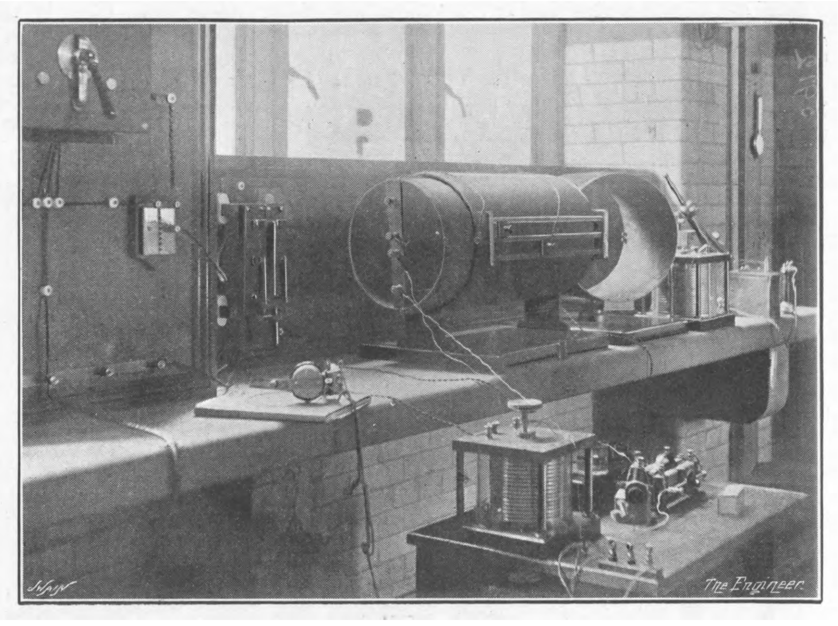


Fig. 2—THE RECEIVING SIDE

In the early sixties this arrangement appeared in the British Navy, in the turret ships Royal Sovereign and Prince Albert. There is, therefore, nothing left for anybody to invent in this direction to-day.

THE ARMSTRONG COLLEGE RADIO-TELEGRAPHIC STATION.

In the course of his presidential address at the opening meeting of the present session of the Newcastle-on-Tyne section of the Institution of Electrical Engineers, which was held on the 22nd of October, Professor Henry Stroud described the radio-telegraphic station in the Physical Department of the Armstrong College, which has recently been licensed by the Postmaster-General for experimental purposes. The towers of the College permitted the use of a very simple method of erecting the antenna. In its construction about 1500ft. of wire cable are used; the cable is seven-stranded, and is made up of No. 20 S.W.G. bare silicium bronze wire. A double cable of this wire, about 170ft. long between the insulators, is stretched between the Sir Lowthian Bell tower (130ft. high) and the Jubilee Exhibition tower (80ft. high). The double cable is insulated at each end by three porcelain insulators of special construction so as to prevent the ends of the wire falling in case of the breakage of the insulators. Two sets of cables of the same wire are attached to the 170ft. of insulated double cable, and lead to the room where the signals are sent and received—one set consists of five cables suitably spaced towards the higher tower end, the other set comprises three cables suitably spaced towards the lower tower end. The King's Hall necessitated this division into two sets; but it is arranged, by separately insulating the two sets, that the antenna can be used as a "loop" antenna, or all the eight cables can be joined at their lower ends, thus forming a "fan" antenna, but of unsymmetrical type. The connections between the insulated antenna and the experimental room are made through two leading-in tubes of porcelain above one window. Each porcelain tube, which is filled with paraffin, has a brass tube, furnished with terminals at the ends, along its axis. The lower ends of the two sets of the antenna cables are joined to the outer terminals on these brass tubes, the inner terminals being normally joined together, and connected to the switch in the centre of the wall of the room. The antenna is thus in the normal connection a "fan" antenna. The centre switch enables the antenna to be joined to (1) the spark sender, (2) the Poulsen arc sender, (3) the earth, (4) the receiving side. The earthing wire, used for sending and receiving, is a thick cable proceeding through the floor out to an extended lead roof over a corridor.

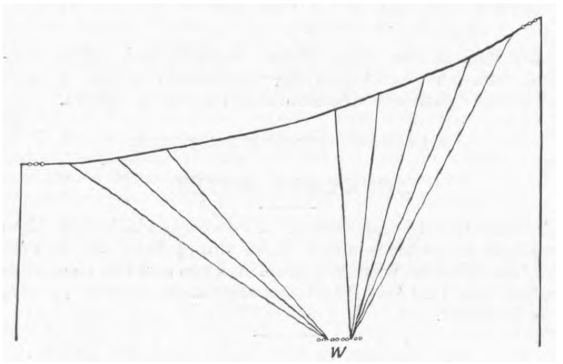


Fig. 3—THE ANTENNA

The spark sender consists of an 18in. Apps' induction coil, which can be excited from the city alternating supply—100 volts—through a resistance, or, using a mercury or other break, by means of storage cells up to 100 volts. The sending circuit includes a battery of large Leyden jars arranged in parallel and series. This condenser discharges through an inductance consisting of a few turns of a helix of stout copper tubing and various types of spark gap. The capacity and inductance are adjusted for a wave length of 600 m. At present the coupling with the antenna circuit is direct, as it is usually in the Braun sender. Such a number of turns of the helix is included in the antenna circuit as to produce the correct wave length.

The Poulsen arc generator is of an experimental type, having a separately excited magnetic field which can be varied over a wide range. The arc is struck between the usual copper and carbon electrodes inside a closed chamber with marble sides, with means for admitting hydrogen, coal gas, &c. A suitable atmosphere can also be provided by means of a spirit dropper, which allows alcohol to drop on to the copper electrode, or into the arc near the copper. The arc is fed from the city direct-current 240 or 480-volt mains through regulating resistances, air cored choking coils being introduced to prevent the oscillations passing to the supply mains. Under normal working conditions one terminal of the arc is connected to earth through a large capacity—block condenser—the other terminal being connected through a similar condenser to an inductance and capacity which are connected to the antenna. The capacity, which is in parallel with the inductance, is an oil condenser, and both it and the inductance can be changed to give various wave lengths up to 1500 m. The sending key is arranged to short-circuit either an extra capacity or an extra inductance in the antenna circuit, so as to produce the variations in wave lengths by means of which signalling is effected on the Poulsen system.

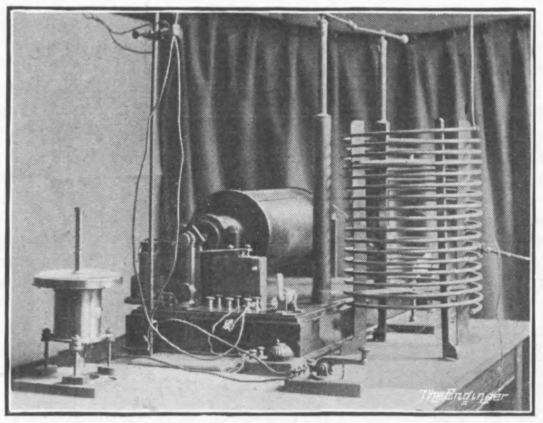


Fig. 4—SPARK SENDER

For the receiving circuit, a primary coil, wound with No. 14 wire over an ebonite cylinder (12in. diameter), is arranged with its axis horizontal. Spring contacts connect the turns of the coil in use to the antenna and to earth, a variable condenser being arranged in parallel with the coil. By means of a double-pole change-over switch, the variable condenser can in a moment be changed from the above connection and put in series with the coil between the coil and earth. In this way the wave length can be adjusted between wide limits from the lowest wave length used in wireless telegraphy of about 300 m. up to the highest used by Marconi of nearly 4000 m. Inductively coupled with this coil is another coil, sliding within it, also wound on an ebonite cylinder but of slightly smaller diameter. To this secondary, which can be closely or loosely coupled to the primary by sliding it in or out along guides, are connected the various detectors, electrolytic, thermoelectric, &c. Near one end of the primary coil is arranged another secondary wound on an ebonite cylinder (13in. diameter), with a finely stranded conductor consisting of 21 strands of No. 35 silk-covered wire. This secondary is intended for use as the receiving circuit for the undamped Poulsen waves. Variable condensers are joined to the turns of this secondary coil, and adjustment of the wave length is made by means of contacts on the secondary and the variable capacity. By means of a Poulsen "tikker" the energy, accumulated by resonance, intermittently charges a condenser across which is the receiving telephone. The coupling between the tuned primary and secondary of the Poulsen receiver is varied by the rotation about a vertical axis of the secondary before one end of the primary coil, whose axis is horizontal.

The diagram reproduced in Fig. 3 shows the wire arrangements for the fan-shaped antenna. The vertical lines at the sides indicate the positions of the two high College towers. A double cable of bare wire is stretched across between the towers (80ft. and 130ft. high). The insulators at each end are indicated by the small circles. Bare wires in two sets converge from the double cable to the experimental room (marked W) in the physical department. The two sets of wires can be connected together at their lower ends, thus forming the fan antenna. Fig. 4 illustrates the spark sender in the centre of the experimental room. The large induction coil is seen, together with the helix of copper tube. The Leyden jars are beneath the table, the spark gap is behind the helix. The sending key is in front. In Fig. 1 is shown the Poulsen arc sender. Behind the left end of the table are the supply switches for the arc and electro-magnet, to the right of which is the Poulsen arc (experimental type) with the helix and variable condenser for the oscillation circuit. To the extreme right is the antenna-connecting switch. The antenna-connecting wires come through tubes above one window. The helix to the extreme left belongs to the spark sender. Fig. 2 shows the receiving side. The antenna-connecting switch is at the top left-hand corner. In the position shown the central terminal, joined to the antenna, is connected by the switch to the bottom stud, which is joined to earth by means of the wire passing over the edge of the table. The stud to the left connects to the Poulsen arc sender, one at the top—shown in Fig. 1—to the spark sender, and that to the right to the receiving side. The ordinary receiving coils are seen on the table with a tuning condenser on a small table in front, on which are the detectors. The receiving telephone is lying on the wall table. On the extreme right are the Poulsen receiving arrangements.

We understand that communications have passed very successfully between the Cullercoats wireless station and the Armstrong College, and, moreover, that messages have been received over a very wide range. The Armstrong College wireless station is under the direction of Professor Stroud and of Mr. Morris-Airey, who have had the benefit of the technical advice of Mr. A. Sörensen, the engineer and manager of the Cullercoats radio-telegraphic station.

TURBINE *v.* PISTON ENGINES IN WARSHIPS.

The two most recent additions to the United States navy, the Dreadnoughts Delaware and North Dakota, have recently carried out important steam trials, with the results set forth in the accompanying table, which has been sent to us as official. We have commented at some length on these figures in our leader pages. The Delaware has reciprocating and the North Dakota turbine engines.

Delaware.

Water per indicated horse-power per hour, main engines only	12 knots, 15·48 lb.	19 knots, 12·7 lb.	21 knots speed, 12·9 lb. water
Water per indicated horse-power per hour, all purposes	12·24 knots, 21·03 lb.	19·225 knots, 14·52 lb.	21·563 knots speed, 14·8 lb. water
Total water per hour, all purposes	12·24 knots, 83,463 lb.	19·225 knots, 250,549 lb.	21·563 knots speed, 422,931 lb. water
Total water per hour for main engines only	12 knots, 55,000 lb.	19 knots, 205,000 lb.	21 knots speed, 312,000 lb. water

North Dakota.

Water per shaft horse-power per hour, main turbines only	12 knots, 20·6 lb.	19 knots, 14·25 lb.	21 knots speed, 13·8 lb. water
Water per shaft horse-power per hour, main turbines and engines' auxiliaries...	12·1 knots, 23·94 lb.	19·245 knots, 15·92 lb.	21·64 knots speed, 14·408 lb. water
Total water per hour, main turbines and engines' auxiliaries	12·066 knots, 90,984 lb.	19·245 knots, 266,761·1 lb.	21·64 knots speed, 450,965 lb. water
Total water per hour for main turbines only	12 knots, 76,000 lb.	19 knots, 23,800 lb.	21 knots speed, 349,000 lb. water

RAILWAY MATTERS.

Materials for the electric tramways in Dairen are being obtained from various countries, the rails and cars coming from the United Kingdom. The total length of the system will be 13 miles.

The Adelaide correspondent of *The Standard* cables that the South Australian Parliament has sanctioned the construction of 300 miles of railway line, which will open up over 3,000,000 acres of magnificent arable land.

The Board of Trade have recently confirmed the undermentioned Order made by the Light Railway Commissioners:—Mid Suffolk Light Railway (Amendment) Order, 1909, amending the Mid Suffolk Light Railway Orders of 1900, of 1903, and of 1905.

A return recently issued shows that in no less than five instances where local authorities or companies sought parliamentary consent to tramway schemes, while the general schemes were sanctioned, the clauses seeking powers to adopt the trackless trolley system were struck out.

According to the *Railway News*, the London and North-Western Company's projected new loop line at Coventry is estimated to cost under £200,000, and not £2,000,0 0, as had been rumoured. This line is intended to afford connection with the Nuneaton branch railway, serving various collieries, and also with the main line to London.

The Philadelphia Rapid Transit Company reports that on certain of its lines in that city since the introduction of "pay-within" street cars, the number of accidents to persons has decreased 74 per cent. This remarkable change is attributed to the arrangement of closed doors and steps, making it impossible for passengers to get on or off when the cars are moving.

Important developments are discussed in connection with railway enterprise in Japan. The Canadian Trade Commissioner at Yokohama states, in a recent report, that a sum of about £4,000,000 is to be appropriated in the next Japanese Budget for the erection of a central railway station at Tokio, for laying two more tracks between Tokio and Yokohama, and for replacing the rails over a large part of the railway system by heavier ones. The Commissioner remarks that it will be impossible to obtain any order in connection with the above-mentioned work except through a representative on the spot.

There are over 400 miles of railway now in operation in Guatemala, and various extensions are in prospect. One of these contemplates the building of a line from Zacapa on the Northern Railroad, about 100 miles from the sea, to Santa Ana, on the north-western frontier of Salvador, where it will connect with the British railway already built, and thereby with the capital of Salvador. Much of the coffee now grown in that Republic will thus find an outlet to the Atlantic of which it has long been in need, and it is highly probable that the bulk of the import trade to Salvador will also be conducted along this route.

The first sod of the Ichang Chengtu section of the Hankau-Szechuan Railway was cut on December 13th. The occasion gave rise to a demonstration of patriotic Chinese feeling. This section of the line was allotted by Prince Ching to British construction in the event of foreign capital being required. The British, French, German, and American financial groups interested have not yet come to an agreement with regard to the financing of the line. The Chinese provincial authorities and gentry now refuse to allow the foreign construction of this section, and have raised funds with a view to building the line themselves.

The gross receipts of Russian railways in 1908, exclusive of the Grand Duchy of Finland, amounted to R. 789,406,338—£83,314,645—as compared with R 796,459,036—£84,058,995—in the preceding year, showing a decrease of no less than R. 7,052,698 · £744,350. The diminution in the earnings is attributable almost wholly to a failure of the harvest, in consequence of which a smaller quantity of grain was carried out of the country by rail. In 1908 only 285,328,500 pouds—4,599,274 tons—of grain of all kinds were despatched by the railways, while the quantity of this commodity so transported in the previous year amounted to 302,198,250 pouds—4,871,836 tons—or a decrease of 16,869,750 pouds—272,562 tons.

The formal opening and linking-up of the British and Congolese sections of the Cape to Cairo Railway took place on Saturday, December 11th. The section of the Rhodesia-Katanga Railway, covering 131 miles from Broken Hill to the border, opened on December 11th, was commenced on July 1st. At present eight miles have been built on the Belgian section, which extends 160 miles from the border to the Star of the Congo, the greatest mine in Katanga. Thence it will be continued to Kambowe, and ultimately it will doubtless be connected with Bunguella, but it is understood this portion of the line will not be completed for several years. Pending that development, oversea traffic with the newly-opened territory will pass through Beira.

On November 1st, the United Railways and Electric Company, of Baltimore, Md., put into use a system of oiling the motor bearings of all revenue cars on a mileage basis. Motors are oiled at the division car houses on instructions from the office of the superintendent of shops, where all records of mileage are computed. Mail, express, maintenance of way, and special parlour cars are not included in the plan, nor are snow-ploughs and sweepers. The system is not intended to supplant the previous practice of having car-house foremen follow closely the mileage of the cars in their charge, but it is believed it will relieve those divisions where the work of computing the mileage daily has proved too great a task, and will result in better economy and efficiency of lubrication on the whole system.

We hear that the Kirkcaldy and Dysart Town Council have now agreed on terms for the extension of the Kirkcaldy tramways to Dysart. By the agreement the Kirkcaldy Corporation undertakes to construct a single-line tramway with three or four passing places along Dysart-road from the junction with their existing tramways to a point in Normand-road, about 80ft. east of the centre of the East Port, Dysart, and on the completion of the construction of the tramway to run a suitable service of cars between Junction-road, Kirkcaldy, and the Dysart terminus. The Kirkcaldy Corporation will maintain a portion of the road in connection with the tramway track, and the Dysart Corporation will in return pay to Kirkcaldy £150 annually for ten years. A Provisional Order has been applied for, and it is proposed to proceed with the extension early next year.

On the 31st December, 1908, the Assam-Bengal Railway Company had 86 locomotive engines out of 95 fitted with the vacuum automatic brake; also the whole of its coaching stock, namely, 266 vehicles braked and 7 vehicles piped. A fair proportion of the goods stock was also fitted, namely, 560 vehicles were braked, 131 vehicles piped, and 1637 vehicles were not fitted. The ruling gradient between Chittagong and Badarpur Junction, forming the Southern Section, is 1 in 150; and on the Hill Section—Badapur-Lumding—1 in 60. On the Gauhati-Tinsukia Northern Section the gradient is 1 in 100, and it is still easier on the Noakhali, Chandpur, and Silchar branches, namely, 1 in 200, 1 in 300, and 1 in 150 respectively. During next year the company intends to make the following additions to its rolling stock:—Ten third-class bogie carriages, 6 passenger brake vans, 4 horse-boxes, and 50 high-sided goods wagons. It is also proposed to fit 200 more iron covered goods wagons with the vacuum automatic brake.

NOTES AND MEMORANDA.

The production of mercury at the Almaden mines, Spain, was 1,017,023 kilos., or 29,472 flasks in 1908. At Micares it was 50,685 kilos.

Various experimenters have recently endeavoured to determine the exact distribution of the magnetic lines of flux in the air-gaps of dynamos by means of testing coils. The author of a paper read in America points out that these methods give only approximate values, because the testing coils must have certain dimensions, and therefore give only the mean of the fluxes within the space covered. The author shows how to apply a correction to change the curve which is experimentally plotted into a curve which represents more correctly the exact distribution of the flux.

Dr. H. S. Hele Shaw recently delivered a lecture to the members of the Edinburgh Philosophical Institution in the U.F. Assembly Hall on "Aerial Navigation." With the assistance of a series of lime-light views, he described the evolution of aerial navigation, and compared the balloons with the heavier-than-air machine. He remarked on the effects of the aerial currents on navigation, and said that he did not think a passenger dirrigible balloon would be a success, owing to the cost of upkeep and the small number of passengers it would be able to carry. The three essentials of airships were power, stability, and the power of direct movement through the air.

In a patent recently issued to Dr. C. P. Steinmetz, a description is given of a machine having interpoles without winding which operates sparklessly. The armature of the machine is of the closed-coil type provided with both a commutator and collector rings. The arrangement for operation is such that the m.m.f. of the current entering by way of the collector rings is greater than that leaving by way of the commutator, and the excess m.m.f. serves for exciting the interpoles to the extent required for sparkless operation. This result is obtained when the machine receives all of its power over the collector rings, and delivers only a part over the commutator, the remainder being utilised mechanically at the pulley.

As a result of the experiment made by the Sydney City Council in street lighting with metal-filament lamps, in place of the existing arc lamps, the electrical engineer has come to the conclusion that while there may be better illumination of the side walks, it would be impossible, without adding greatly to the cost of lighting, to get the brilliant effect necessary in the main thoroughfares of the city by means of incandescent electric lamps. For these places he thinks the existing type of open arc lamps should be exchanged for flame arcs at a cost of £3000, and in future extensions of the lighting system streets that are too narrow and too crooked to get the full benefit of the light from arc lamps should be illuminated by metal-filament lamps.

By microphotographic methods, the vibrations in an incandescent filament, due to the expansion and contraction caused by the passage of an alternate current, have been recorded. An arc lamp was used as the source of light for photographic purposes, and if the arc is fed from the same alternator as the incandescent filament, the vibrations are seen from the plate to synchronise with the rise and fall of the alternating pressure With a 100 candle-power osram lamp, supplied with alternate current at 50 alternations, a slight humming noise was perceptible even at a distance of three yards, but this is not usually noticeable in a lamp mounted in a vacuum. The experimenter considers that this may be a cause contributing to the shorter life of a metallic filament on alternate current.

A new method of bonding new concrete to old was described by Mr. Frank Barber, of Toronto, in a recent article in the *Canadian Engineer*. This consists in placing bags of cracked ice on the last surfaces of concrete placed at night, thus reducing the temperature of the concrete, and, consequently, retarding its time of setting, so that on the next morning the surface is still plastic, and the concrete then placed will set in one mass with the old. The invention of this scheme is credited to Mr O L. Hicks. when he was contractor for a reinforced-concrete truss bridge in Ontario. As all of the members in these trusses were of relatively small cross section, the ice bags were easily placed in position, at the end of a day's work, and it is stated that the method worked very successfully. To what extent it could be applied to heavier work is not as yet known.

A consideration of the mechanical principles involved in valve construction, and the duty required lead to the conclusion, says an American contemporary, that electrically operated stop valves offer many advantages, as compared with the hand-operated type. They can be operated from any point, often permit a simpler layout of piping, and, in time of accident, make it possible to shut off a valve that might otherwise be inaccessible on account of fire, escape of steam, &c. The stopping and starting of large units upon short notice is expedited by motor-driven valves for the large exhaust piping, and when installed between the boilers and steam header, or the header and the engine, and between sections of the leader, they enable any break in the piping to be isolated at once, or any other trouble checked by closing switches which may be situated a safe distance away from the piping.

A paper dealing with "Research on Metallic Filament Lamps," by Mr. F. H. Reakes Lavender, was recently presented at a meeting of the Birmingham Institution of Electrical Engineers. The research was undertaken in order to investigate the conditions of working as regards voltage, and efficiency and percentage drop in candle-power, giving the most economical life in the case of metallic filament glow lamps, and to determine as far as possible the cost of illumination with this source of light. The author stated that the useful life of a lamp, and the drop in candle-power which it was advisable to allow for a given voltage, depended on the cost of current and the price of the lamp. The cheaper the current, the longer the life, and the greater the admissible drop. Taking the current at 5d. per unit as an average price, and the lamp run at rated voltage, then it paid in the case of the Tantallum class of lamp to throw it away as soon as the candle-power had fallen to 3 per cent. below its original value. This result appeared startling at first, considering the large initial cost of the lamp. However, by the time that point was reached the lamp had been burning for 1500 hours at the best possible efficiency, so that the cost of the lamp per candle-hour had become small.

In a paper on "The Mechanics of Dust," read before the Society of Engineers by Mr. C. H. W. Biggs, the author says "one of the most interesting investigations, and one open to every student, is that of the effect of minute air currents upon dust particles. Imagine for a moment dust particles having very large surface compared with their mass. Fortunately, the student can on occasion easily see such particles, and watch their evolutions, in a room where otherwise it is almost, if not quite, impossible to detect air currents by other means. Smoke consists of small particles of matter, and is in daily use to detect minute currents of air both in drains and in rooms. There is an excellent way to investigate and to follow the motion even of individual particles. Dr. Travis, in his experimental work on seeing colloidal matter, makes great use of the ultra-microscope. You can get something of this effect in rooms where a window faces a bright sun. Darken the room, leaving only a hole—preferably circular—through which to get a beam of bright sunshine. Thus we get a cone of brilliant light through the room. In this cone you can see dust particles playing all manner of antics, some falling, some rising, some going in one direction, some in another, the direction of the small masses being the direction of the resultant of the forces acting."

MISCELLANEA.

The Belgian Consul in Central America reports that vigorous efforts are at present being made to introduce modern methods and machinery into the agricultural industry in that Republic.

A Moscow Consul recently reported: "Electrical engineers have chances to exploit their ability in the Baku district, as electrical power is being instituted in the immense oil fields of that district. Oil well supplies, such as casing, drilling tools, rig and engineering machinery, and irrigation outfits are in demand."

On Tuesday last, the Chinese Minister in Paris took formal possession of the standards of weights and measures which the Chinese Government ordered last spring from the International Office of Weights and Measures in the French capital, for the purpose of introducing the metric system in China, in conformity with the law promulgated in 1908.

In an American Consular report it is stated that a company in British Columbia is working an electric process for the distillation of turpentine from mill refuse, tree stumps, &c. Six or eight gallons are obtained from a cord of wood, and the product is said to be chemically pure. The cost of erecting a mill is estimated at £300 "per cord to be treated." The by-products find a ready sale.

The French Deputies were presented a few days ago with specimens of the new aluminium coinage with which it is proposed to replace the bronze coins in France. The 10 centimes piece is described as "something between a counter and a trouser button," and is said to be even less attractive in appearance than a nickel coin, and to be "ugly and unhandy." The "sou" is much the same, but, of course, rather smaller, and it is expected that both, if they are adopted, will cause considerable confusion.

It is announced by the Cunard Company that commencing with the New Year, and during the remainder of the winter season, their vessels from New York will steam direct to Fishguard, omitting the call at Queenstown. Since the starting of the quicker service from New York to this country, *via* Fishguard, more than 2000 passengers have made use of the facilities provided, and they have, without exception, expressed themselves in terms of appreciation of the advantages derived and the saving of time effected.

A consular report dealing with the trade of the consular district of St. Petersburg states that it is gratifying to see that the import of machinery from the United Kingdom increases year by year. The high figure for 1908 has never been reached before, and shows an additional quantity of over 100,000 poods compared with 1907. Germany also benefited by the increased demand, but the percentage of its share in the general import of machinery during the year under review was considerably less than that of the United Kingdom, viz., 21.2 per cent. against 72.8 per cent.

The Council of the Sheffield Chamber of Commerce met at the Cutlers' Hall on Monday last. Mr. James Boyd Adams, of the Labour Exchanges Department of the Board of Trade, conferred with the Council as to the founding of the new Government Labour Exchange in Sheffield. He explained what it is hoped to do with the Exchange, and his views were listened to sympathetically. It was felt that the employers of Sheffield ought to do their best to give the scheme a good start in the city. Premises are to be taken in Suffolk-road as the headquarters of the Labour Exchange in Sheffield.

In his presidential address to the Chartered Institute of Patent Agents, Mr. O. Imray dealt with the results of section 27 of the Patents and Designs Act, 1907. It had been reported, he said, that in one year's working eleven patents had been revoked by consent, and four after a contest. Only one patent had been revoked at the instance of a British manufacturer anxious to manufacture the patented article. The section had, however, resulted in the introduction into this country of several industries by foreigners owning British patents. He suggested that the Act should be altered so that manufacture in one country of the Patents Union should protect a patentee from the revocation of his patent in all countries of the Union.

The central station on the moors in East Friesland, states the *Electrical Review*, was opened for public supply on November 15th. Peat is used as fuel, and it is calculated that the quantity available is sufficient to raise steam for a period of 100 years. The cost of establishment has amounted to £150,000, the plant is capable of dealing with a demand for 5,000,000 kilowatt-hours per annum, and the distributing network extends over 150 miles. Various contracts for supply to local authorities have been concluded, but the dockyard at Wilhelmshaven is not connected with the mains, as the erection of two plants for dock and lock works was projected before the station was built, and has already been carried partly into effect. On the other hand, the station affords a supply to the harbour works at Emden. It is expected that the contemplated tramways at Wilhelmshaven and Rustringen will be operated from the moorland station.

A conference to discuss the needs of technical education in Burma was held at Rangoon early in November. Mr. J. G. Covernton, Director of Public Instruction, in opening the discussion, presented a brief sketch of what had been done in the past in the way of technical education. He divided the work of technical instruction into two main groups:—(1) Those connected with scientific professions, especially engineering; (2) those connected with ordinary country and home life. He proposed that a central technical school for industrial education in the vernacular should eventually be opened at Insein in connection with the engineering school, and related to all the selected vernacular schools for technical education which may hereafter be established, and that pupils who showed special aptitude for technical training should be drafted to this central school. The instruction should be in the vernacular, and its aim be to provide for a general technical training for hand and eye. For trained pupils who might hope to be skilled artisans in various crafts and industries there should, the director said, be local industrial schools.

According to a contemporary, some interesting tests have recently been carried out by Messrs. Kirkaldy and Son for H.M. Office of Works on some reinforced concrete columns in connection with the new General Post-office. The columns were twelve in number, and measured 9in. square by 6ft. in length, and were tested under thrust. The concrete used was composed of one yard screened Thames ballast, crushed to pass ¾in. mesh, half yard Thames sand, and 6 cwt. Portland cement, all machine mixed fairly dry. The age of the columns was from two and a-half to three months. The reinforcement consisted of four 1in. steel bars spaced 5in. centres, and tied by $\frac{3}{16}$in. wire links at intervals varying in the different specimens, except in two columns, the tying of which was accomplished by the use of expanded metal of 1½in. mesh and ⅛in. by ⅛in. strand, the slits running longitudinally. Two exactly similar columns of each type were tested, in order to secure trustworthy results. The ends of the columns were trued up before testing, and the depression was measured after each increment of load of 20,000 lb. Failure occurred in all the columns in the same way, namely, by crushing at a point from 1ft. to 2ft. from the upper end, the concrete cracking away and exposing the reinforcement. The ultimate load varied from 85.2 to 107.5 tons, according to the distance apart of the binding ties, the highest results being obtained when the wires were 6½in. apart throughout the greater part of the length, and 3in. apart near the ends. The two columns with expanded metal binding failed at 73.1 and 76 tons, owing to spreading of the mesh.

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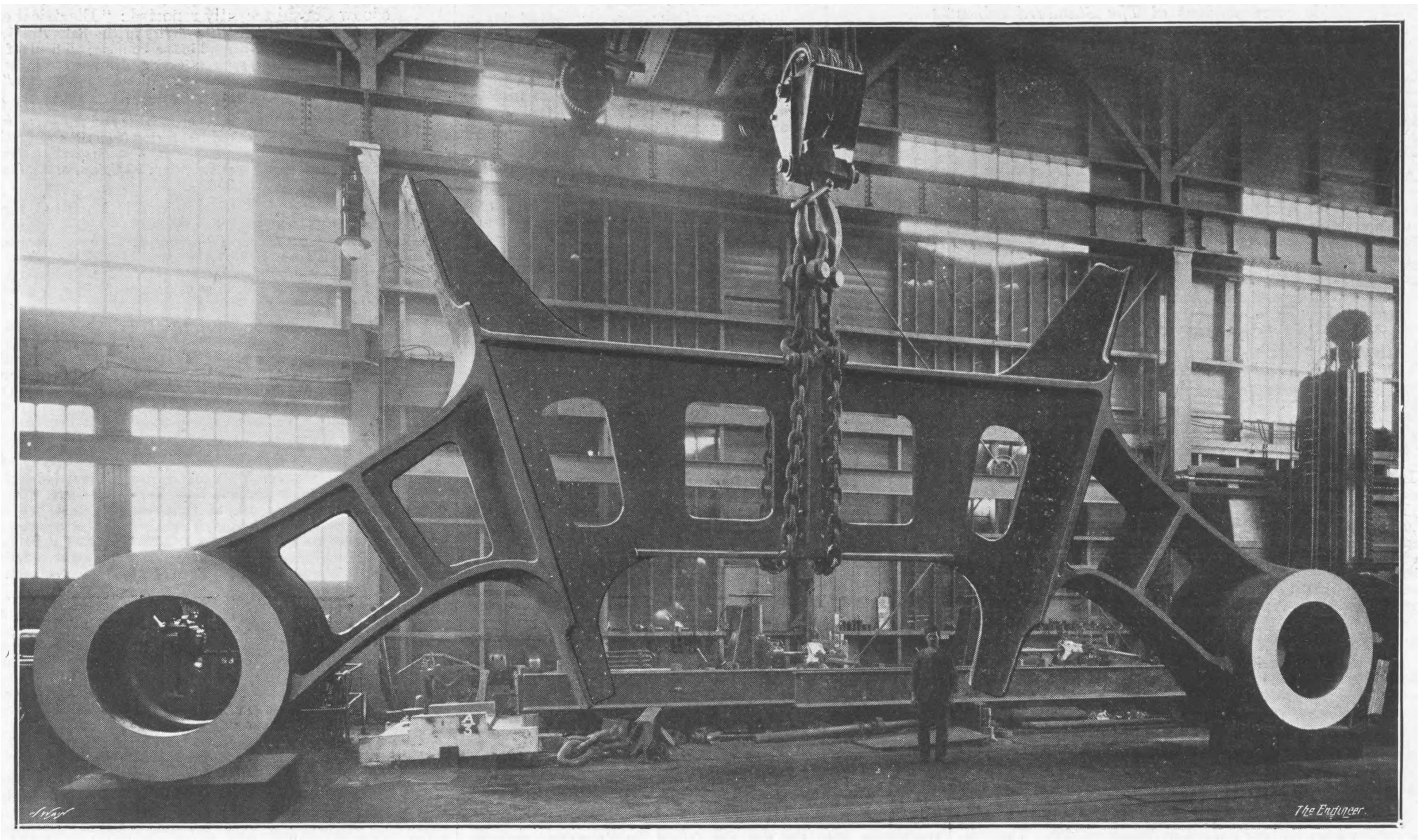
THE DARLINGTON FORGE COMPANY, LIMITED, DARLINGTON, ENGINEERS

(For description see page 633)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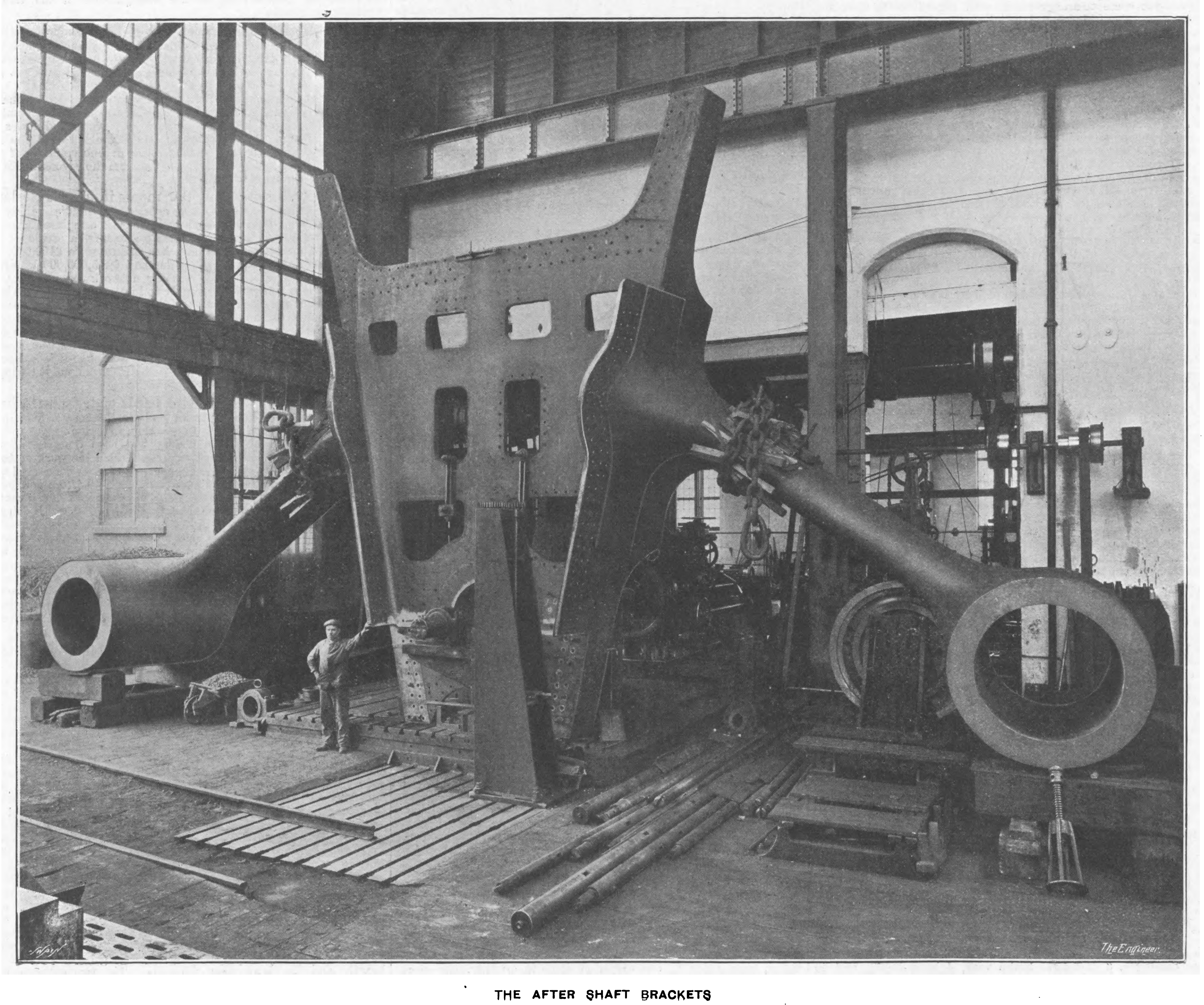
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Letters relating to Advertisements and the Publishing Department of the Paper are to be addressed to the Publisher, Mr. Sydney White; all other Letters to be addressed to the Editor of THE ENGINEER.

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PUBLISHER'S NOTICES.

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⁂ *Next week* THE ENGINEER *will be published on* THURSDAY, *instead of* FRIDAY. *New Advertisements should reach the Office not later than Five o'clock on* WEDNESDAY *evening; alterations to Standing Advertisements before One o'clock on* TUESDAY *afternoon.*

H.M.S. VANGUARD.

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TO CORRESPONDENTS.

☛ *In order to avoid trouble and confusion we find it necessary to inform correspondents that letters of inquiry addressed to the public, and intended for insertion in this column, must in all cases be accompanied by a large envelope legibly directed by the writer to himself, and stamped, in order that answers received by us may be forwarded to their destination. No notice can be taken of communications which do not comply with these instructions.*

☛ *All letters intended for insertion in* THE ENGINEER, *or containing questions, should be accompanied by the name and address of the writer not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

☛ *We cannot undertake to return drawings or manuscripts; we must, therefore, request correspondents to keep copies.*

INQUIRIES.

COATING IRON OR STEEL WITH LEAD.

SIR,—Can any of your readers tell me of any process for covering cast iron or steel with lead, so that the articles so formed are acid proof, and can be used in acid solutions? C. W.

December 14th.

MEETINGS NEXT WEEK.

ROYAL SOCIETY OF ARTS.—Monday, December 20th, at 8 p.m., at John-street, Adelphi, London, W.C. Cantor Lecture: "Aeronautics," by Charles Cyril Turner.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND.—Tuesday, December 21st, at 8 p.m., in the Lecture Hall of the Institution, Elmbank-crescent, Glasgow. General meeting. Paper, "Concrete Pile Foundations, with Particular Reference to the 'Simplex' Method of Constructing Same," by Mr. Alexander Melville.

THE INSTITUTION OF CIVIL ENGINEERS.—Tuesday, December 21st, at 8 p.m., at Great George-street, Westminster, S.W. Ordinary meeting. Discussion, "Railway Signalling in India," by Charles William Hodson, C.S.I., M. Inst. C.E. Paper, "The Design of Rolling Stock for Smooth Rail Working on Heavy Gradients," by Frederick William Bach, M. Inst. C.E.

THE INSTITUTION OF MECHANICAL ENGINEERS.—This evening, Friday, December 17th, at 8 p.m., in the Institution House, Storey's Gate, St. James's Park, Westminster, S.W. Ordinary general meeting. Papers: "Mild Steel Tubes in Compression and under Combined Stress," by Mr. William Mason. "Compound Stress Experiments," by Mr. C. A. M. Smith, B.Sc.

THE ENGINEER.

DECEMBER 17, 1909.

Compound Locomotives on the Midland Railway

IT is not easy to overestimate the value of Mr. Deeley's contribution to the literature of the locomotive, which will be found on another page. It will be remembered that we recently called attention to the fact that only those in authority in the locomotive department of British railways were familiar with the hidden life of the engines which work the traffic of our greater lines of inter-communication. Mr. Deeley was for years intimately acquainted with the working of the Midland Railway, of which he has been chief mechanical engineer for a considerable period. He is full of minute information. He understands exactly what he is writing about; and he gives quite freely his experience of the compound locomotive as tried on the Midland Railway. It will be seen that he begins by admitting that the compound system has been tried and failed, and is unpopular in this country. He attributes this to want of power to deal with heavy trains; but he does not say in what respect power was lacking, save in capacity to start such trains. Seeing that the "John Hick" class of Webb compounds had two 15in. high-pressure and one 30in. low-pressure cylinders, all 24in. stroke, with 6ft. 3in. wheels, we have, on paper at all events, a very powerful engine. The Midland compounds are quite different in type. Mr. Deeley has so fully explained their peculiarities that it would be superfluous to describe them here, particularly as they were illustrated in our pages in March, 1906. We have the Webb system reversed. But the most important fact is that Mr. Smith got rid of all the complicated forms of reducing valves, and took high-pressure steam direct into the low-pressure cylinders for the purpose of starting his trains. The low-pressure cylinders are 21in. diameter, with an area of 346 square inches. The pressure in the boiler is 220 lb., and when starting it is certain that the cylinder pressure will be at least 200 lb. Now 200 × 346 = 69,200 lb., or a little over 30 tons. A very heavy stress which, however, we gather, is borne with equanimity by the machinery. The steam goes direct from the boiler through a pipe only 2in. in diameter; but a pipe ½in. in diameter would suffice, while the piston was not moving, or moving very slowly, to give a cylinder pressure identical with that in the boiler. Leaving out the effect of the steam in the high-pressure cylinder for the moment, because of the relief valves, which we gather place the piston in equilibrium, we have by the usual formula a draw-bar pull of 126 lb. per pound of average pressure in the cylinder, and 126 × 200 = 25,200 lb., or in round numbers, 11 tons, which is about twice as much as the adhesion would suffice to utilise. It is clear, therefore, that the Midland compounds must be competent to start with ease the heaviest train that they can be called upon to pull, and so one defect of the compound system is absent.

The special value of Mr. Deeley's article will become manifest if we compare it with one written by "A Fireman," and published in our impression for August 20th. It will be seen that the experience of "A Fireman" shows a saving in coal consumption of over 20 per cent. No doubt the figures he gave are quite accurate, but they apply only to certain trains, loads, and speeds. Mr. Deeley, with the whole group of forty-five compounds before him, gives the saving in coal as not more than 7½ per cent. It is quite useless to argue that if this or that had been done with the engines better work would have been accomplished. Here we have the results of an experiment carried out on a great scale by a man who firmly believes in the compound system, and wishes it to be a success. Yet the utmost he can claim is little when compared with the assertions made on the Continent. A small difference in the quality of the coal, in the ability of the drivers and firemen, in the cleanliness of the boilers might easily account for more than this percentage. Unfortunately, too, the differences between the compound and the simple engines are in many respects radical; so great, indeed, that it is impossible to make a simple comparison based on compound *v.* simple alone. The comparison lies between two types radically diverse on points of an extreme importance—an importance which is seldom rated at its real value. Mr. Deeley explains that a great advantage is gained by sub-dividing the work among three cylinders instead of two. Compensation is much simplified, and the turning moments are equalised. We would direct particular attention to what Mr. Deeley says concerning the heating of long bearings under the heavy stress of large pistons and high pressures. Let us suppose for a moment that the engine was of the non-compound three-cylinder type—first patented by Stephenson, if we are not mistaken—is it not certain that it would possess many of the advantages claimed—and properly claimed—for the Midland compounds? Compounding is an addition, a something thrown in, and no doubt useful and worth having. But we must not shut our eyes to the fact that in many ways a three-cylinder locomotive will, in any case, be better than one with two cylinders when great power is demanded to draw such trains as are now run at very high speeds over long non-stop distances. Three 16in. cylinders are no doubt better than two 19½in. as regards stresses and compensation and balancing and equalisation of turning moments.

Again, it is only too easy to undervalue the good gifts which high pressure confers on the locomotive superintendent. Two hundred and twenty pounds is an heroic pressure. "The higher pressure put in the later engines was," says Mr. Deeley, "to give a reserve of steam on heavy banks, rather than to secure economy." The first thing to be secured is that the engines shall keep time; after that try for economy. It is clear that at every step Mr. Deeley has aimed at turning out an engine which will meet the greatest demands that a traffic manager can make on it; and it is quite open to those who do not believe in compounding to say that he has done this in spite of the fact that his is a compound locomotive. The high pressure which he uses could, of course, be used in normal engines just as well.

We have said before now in this journal that, so long as the grate and fire-box are big enough, there will be plenty of steam. Nothing will compensate for lack of capacity to burn coal. Mr. Deeley is of the same opinion, because he uses an enormous grate, with an area of 28.4 square feet, as against that of the simple engine with an area of 25 square feet. The simple engines, too, carry only 180 lb., or 40 lb. less than the compounds, so that they have none of that reserve to help them up banks which Mr. Deeley has conferred on the compounds. The loads are, moreover, the same within eight tons. It is probable, however, that their boilers are rather more economical, as the ratio of grate to heating surface is 1 to 61, while in the compound boiler it is 1 to 50.

Mr. Deeley makes a very remarkable statement concerning draught, namely, that a blast pipe, presumably smaller than that fitted to the simple engine, may be used. One of the stock objections to the compound engine is that the back pressure acts on a very large area of piston, and that therefore small blast pipes are quite inimical at once to high speeds and economy of fuel. In the absence of further information in the shape of diagrams it is, however, impossible to discuss this question with profit. No matter what may be the opinion held concerning compounding, it seems to be certain that Mr. Deeley has put in to service a large number of extremely efficient as well as economical engines which represent in several ways a new departure in locomotive practice.

A Copper Trade Combination.

THE air has been charged with so many rumours during the past two or three months in relation to a suggested combination or trust in the United States copper industry that it is not without interest to hear of something definite in the shape of a scheme that possesses the element of probability at the present time. We refer to the reported conclusion of an agreement between influential parties to restrict the production of copper. It is a coincidence that as far back as last June the statistical report issued by the Frankfort Metall Gesellschaft, in referring to the upward tendency which seemed to prevail in the copper market at the time, stated that where price speculation was not concerned, the rise was due to the expectation of the introduction of a limitation in the output. The report added that interested circles only anticipated a lasting improvement in the conditions as a result of a considerable curtailment of the production over a long period. At the time the question was receiving attention in the United States, where the copper owning interests complain of over-production, increasing stocks, and low prices for the metal. Since then individual mines have deemed it advisable to reduce the output of copper, and others, whilst maintaining the quantity of ore mined, have only had a portion of it smelted, leaving the remainder to accumulate as stock. The Calumet and Hecla mines, it is understood, are working at a restriction of 14 per cent., and the limitation in the case of the Phelps-Dodge undertaking also amounts to several per cent. But these individual efforts are entirely eclipsed by the agreement which is now announced as having been concluded between a number of the large interests, headed by the Amalgamated Copper Company, the Cole-Ryan group, the American Smelting and Refining Company—the Guggenheim enterprise—and the mines controlled by the American Metal Company. These undertakings, which rumour has previously credited with the intention of amalgamating, with a total capital of £100,000,000, have agreed to limit the output by 10 per cent. until further notice, and as they represent about 70 per cent. of the total American output of copper the magnitude of the scheme will be apparent.

The understanding between the large interests has been arranged on a basis which is growing in favour in the United States, and which is believed to be the controlling element in the working of the International Rail Syndicate. This is what is termed a "gentlemen's agreement," each party to which undertakes the obligation to observe the rules or arrangements decided upon without entering into written agreements. The system apparently owes its origin to the desire to avoid any contravention of the laws in the individual Federal States. At any rate, the important copper interests concerned expect that the reduction in the production will cause consumers to abandon their reserve and buy more largely, and thus result in an improvement in the situation of the market and of prices. The former do not propose, it is said, to raise prices unduly, but merely to obtain a suitable profit, whatever that may mean. The price of copper, which now amounts to from 13 to 13½ cents per pound, is, for instance, to be brought up to 15 cents, an augmentation which would be equivalent to an advance of from £7 to £9 6s. per ton. It remains to be seen whether this object will be accomplished by the promoters, and if so, whether they would be satisfied with securing such a price. If the interests represented by the scheme are able to force up the price in this manner it may be expected that the other copper producers will follow their example, both in the United States and in other producing countries, if, indeed, the movement should not be simultaneous and due to co-operation. A great deal depends, however, upon the question as to whether it will be possible to adhere to the arranged restriction in the production. A limitation is possible in the case of the low-cost mines, but where the prime costs are comparatively high the question is exceedingly difficult; and it has to be remembered that the Amalgamated Copper Company, which reduced the output two years ago in order to meet the fall in prices, was compelled to resume normal working, as the cost of production was too great when limiting the out-put.

It is therefore probable that the cost of production will play a not unimportant part in determining whether it will be possible to maintain the ten per cent. limitation that has been decided upon by the principal groups, apart from the restrictions of individual producers, such as the Calumet and Hecla, which are not included in the agreement. On the other hand, any inflation of prices would permit of the re-opening of mines which are not now worked owing to being unremunerative at the present price of copper; but the influence which these could bring to bear upon the situation would be inconsiderable, even if they were allowed to exercise it. It is calculated that the cost of production ranges from as low as 8½ cents per lb. to as high as 12½ cents per lb., as compared with the selling price of from 13 to 13½ cents. If, then, it were possible to raise the quotation to 15 cents, it might still be carried further, but the history of such artificial movements does not afford pleasant reading. Since 1886 the world's production has increased four-fold, and two great attempts have been made to control it. In 1887 the Secretan group, which is said to have been supported by the Rothschilds, succeeded in regulating from 80 to 85 per cent. of the world's output. The price was forced up from 12⅛ cents in 1886 to 17¾ cents in the first year of the copper ring, and to 19¾ cents in the following year; but the scheme collapsed, and the corner eventually liquidated its enormous stocks at from 10 to 12 cents per lb. A little more than ten years ago the Rockefeller group attempted a similar operation, which, although also successful for a time, finally fell asunder, with copper only costing 11 cents for several years. The South African War, the Russo-Japanese War, and the San Francisco disaster again produced a fresh rise to 17 to 18 cents. and the former president of the Amalgamated Copper Company then expressed the opinion that it was not to be expected that the quotation would ever fall below 17 cents. Yet so great are the possible fluctuations in the metal that three months after this statement was made the price declined to 12 cents per lb. It is possible, even probable, that a higher price than at present will prevail in the near future. Those who are engineering the American scheme, which is said to be merely a preliminary of a copper trust on the Steel Trust lines, will, however, have to bear in mind the possibility, not only of consumers continuing to curtail their purchases, but also of recourse being made to other metals, particularly aluminium, in the case of an attempt to secure inflated prices; for that matter the producers of aluminium are only awaiting an opportunity to flood the market with that metal.

Turbines in the United States Navy.

IT is impossible to over-estimate the naval importance of an experiment which has been very recently carried out by the United States Government. It is a matter of almost common knowledge that the efficiency of a warship depends largely on her range of action. In other words, how far she can go without having to refill her bunkers. This depends on certain factors, which are all variables. Thus, let us suppose that the consumption of fuel varies as the square of the speed. Then doubling the speed augments the consumption per hour or per day fourfold; but for any given distance the consumption is only doubled because the number of days or hours of steaming is halved. In practice, of course, for the higher velocities the consumption per hour augments in a much more rapid ratio. But the augmentation is not a fixed quantity. Every ship has a different rate. Again, we have the consumption of fuel varying with the power, because some powers are more economical than others. The general result may be summed up in a few words. For every ship there is a speed at which she can steam further per ton of coal burned than she can steam at any other speed. What this speed may be can only be determined by direct experiment. It is clear, however, that, particularly in the case of warships, the higher the velocity the better. So much premised, we may proceed to the experiment.

Two of the most recent additions to the United States navy are two Dreadnoughts. These are the Delaware and the North Dakota. It is claimed for them that they are the most powerful warships afloat. They are in all respects but their machinery sisters. Each can fire a broadside from ten 12in. and seven rapid-fire 5in. guns. Their displacement is about 21,500 tons, and their nominal or contract speed 21 knots, a velocity which has been considerably exceeded by both ships. The North Dakota was built and engined by the Fore River Shipbuilding Company, and is propelled by Curtis turbines, developing on the high-speed trials 31,400 shaft horse-power, which drove her at 22.25 knots. The Delaware was built and engined by the Newport News Shipbuilding Company. She has reciprocating engines, and on her trial attained a speed of 21.563 knots with 28,578 indicated horse-power. Now, in this country the results of what are virtually competitive trials are kept secret from everyone but foreign officers. But a more liberal policy prevails in the United States, and facts are given to the world. Not only were trials made to settle speeds and powers, but also incidentally to fix the range of action of the two great ships. A keen controversy is going on between the two shipbuilding companies to settle this point. On page 634 will be found a table containing the official figures, and we are told that the United States Bureau of Steam Engineering estimate that the North Dakota can steam about 5000 knots, and the Delaware 6000 knots, without quite emptying their bunkers—figures which do not appear to be justified by those in the table.

We now proceed to examine the facts in a little more detail; and, first, as to the consumption of fuel. Taking the main engines only, we find that at 12 knots, 19 knots and 21 knots, the Delaware required 15.48 lb., 12.7 lb., and 12.9 lb. of feed water per horse per hour. The North Dakota, at the same speed, required per shaft horse-power 20.6 lb., 14.25 lb. and 13.8 lb. Even after we have made an allowance for the difference between shaft and indicated horse-power, we find that the Curtis turbine is not so economical as the piston engine, and as was to be expected, this is particularly manifest for the lower powers. Every steam engine, whether it is a piston engine or a turbine, has a certain speed which is more economical than any other speed. In the Delaware the difference between best and worst is only 2.58 lb.; in the North Dakota it is 6.8 lb., or nearly three times as much. The Delaware, during a full-speed four hours' trial run on the 23rd of October, made 21.563 knots with 28,578 indicated horse-power and a coal consumption of 24 English tons per hour. The figures for the North Dakota have not reached us, but we deduce them from the published water consumption. At 21.64 knots she burned 28 tons per hour; taking the fraction of a knot higher speed into account, it may be said that the consumption —which is in American tons of 2000 lb.—was about the same for both ships. This is assuming that the boilers evaporated 8 lb. of water per pound of coal, which is the stated evaporation. Applying the same rule to the Delaware, we find that the consumption was 26½ tons per hour. We may take it that at these high velocities there was no substantial difference between the ships.

Turning now to the lower speeds, we find, calculating in the same way, that at 12.24 knots the Delaware burned 5.26 tons per hour, and the North Dakota, at 12.06 knots, 5.6 tons. The builders of the Delaware give the consumption as 4.3 tons per hour at 12 knots. The Fore River Company do not give any figures. If the builders of the Delaware are right then the boilers must evaporate more than 8 lb. per pound of coal. The Delaware made, we are told, 21 knots with 23,600 horse-power, 19 knots with 14,560, and 12 knots with 3520 indicated horse-power. It will be seen from the table on page 634 that at all these speeds the total weight of steam used by the North Dakota, including all auxiliaries, was in excess of that required by the Delaware. The data are, however, incomplete, in that nothing has been said—officially at all events—about the comparative efficiency of the propellers in the two ships. The probability, nay, the certainty, is that the propellers of the Delaware are more efficient than those of the North Dakota. But it is not necessary to go far into this question. We have only a certain number of facts to go upon, and these show that so far as range of activity is concerned, the turbine is, other things being equal, inferior to the piston engine. The highest average speed attained by the Delaware was 21.563 knots, and that, as we have said, was got with 28,600 indicated horse-power. The highest speed obtained with the sister ship was 21.64 knots—a scarcely appreciable difference, while the shaft power was 31,400, a difference of not less than 9 per cent. If we deduct 10 per cent. from the indicated horse-power of the Delaware engines we have 25,740 as the shaft horse-power, or but 82 per cent. of that of the North Dakota. These figures, inconclusive as they are, go to show that the propellers of the turbine ship must be much less efficient than those of the Delaware. This handicaps the turbine. But the turbine and the propeller are inseparable. They work together, and the naval architect must deal with them as a whole. The result of the experiment seems to be so far adverse to the turbine. But the end is not yet. The last word has not been said concerning either turbines or propellers.

The New French Dreadnoughts.

THE provisional plans for the new French Dreadnoughts show that these vessels, although differing in minor details, in main principles closely resemble British designs, such as the Brazilian Dreadnoughts. So far as the big guns are concerned, the arrangement of the Minas Geraes is followed exactly. The only novelty is connected with the secondary armament. It consists of eighteen 5.5 guns, arranged in six quite novel three-gun casemates on the main deck. This arrangement suggests that all three guns might be put out of action by a single lucky shot. On the other hand, it allows of considerably more protection than can be given to a battery spread right along the main deck. Even as regards the liability of a lucky shot putting all three guns out of action, it may also be argued that the disposition of the secondary artillery leaves vast spaces, which may be hit without result, and by the mere law of chances it is these vacant spaces which are more likely to be hit than the casemates, so that quite a good case can be made out for the French idea. The new French ships will have three funnels and a couple of light masts; but about these there is nothing characteristically French. Indeed, the new French Dreadnoughts mark the abandonment of what, for want of a better name, may be called characteristic French design, and adhere very closely indeed to the latest British practice as evolved by our British private yards. Whatever may be said about French design, there remains the indisputable fact that not so many years ago, the only recipe for building a satisfactory warship was to capture a French ship and imitate her as closely as possible! Even in more modern times, despite many failures in French design, it should never be forgotten that the French were the only nation to ignore the low free-board battleship, and that it is to them that we owe the guns of high command which are now a feature in naval design all over the world. That the French should abandon their characteristic systems in favour of a design that is distinctly the evolution of our private yards at Elswick and Barrow is a compliment to British naval architecture, the full force of which is hardly to be appreciated at first sight.

OBITUARY.

DR. LUDWIG MOND.

THE death occurred early last Saturday morning in London of Dr. Ludwig Mond, the distinguished scientist and industrial chemist.

Dr. Mond was born in 1839 at Cassel, in Germany, and there he was educated until he began his career in chemistry by a course of study in that subject at Marburg and Heidelberg. His earliest application of the knowledge thus acquired was made, before he had reached the age of twenty-three, to an improvement in the Leblanc soda process. Several of the leading chemical manufacturers in this country became interested in his improvement—which consisted of a method for the recovery of the sulphur contained in the tank liquor remaining over from the final stages of the Leblanc method—and in 1862 he came to England, when his attention was directed to the carrying out of his ideas on a commercial scale. In 1864 he returned to Germany, where he remained for the following three years, having established chemical works for the production of soda at Utrecht. Thereafter he became permanently settled in England, where his subsequent discoveries were all made and set on a commercial basis.

The manufacture of sodium carbonate constitutes the main portion of the alkali industry, and in view of Dr. Mond's close association with the subject we may, perhaps, briefly indicate the developments which have taken place in the methods used for its production. In the Leblanc process common salt is acted upon by sulphuric acid to produce sodium sulphate and hydrochloric acid. The acid is taken off as a by-product, and the sulphate known as salt cake is mixed with limestone and coal dust and roasted. As a result, a mass of "black ash" is produced, containing crude sodium carbonate, with sulphide and oxide of lime, and other substances are present as impurities. This "black ash" is lixiviated with water, and on the tank liquor thereby produced being allowed to settle and concentrate soda crystals are deposited. It was with this process that the late Dr. Mond was identified in his earlier years, until Solvay introduced his ammonia-soda method, when, seeing its advantages over the older one, he and Sir John Brunner commenced working it in this country in 1873 under licence from the inventor. In the Solvay process a solution of brine is saturated with ammonia gas, the liquid being afterwards charged with carbon dioxide. The result is the formation of bicarbonate of soda and ammonium chloride. The first of these is converted into the carbonate by calcination, during which process carbon dioxide is driven off, and this is used for carbonating a fresh supply of brine. At first the success of the method commercially was doubtful, owing to the expense of the ammonia used as a reagent, but Dr. Mond soon introduced a method whereby its recovery from the last stages in the process could be effected, and thus permit of its being used repeatedly. Some years after he was enabled still better to compete with the Leblanc process by discovering a means for converting the chloride of calcium, hitherto a waste product of the reactions involved, into bleaching powder.

It is, of course, as the inventor of Mond gas that Dr. Mond will be chiefly remembered by engineers. For many years he had experimented on the production of cheap producer gas, and in 1893 his first producer was put into continuous working. His ideas in this direction are now well known to engineers, and need no description. We may add that, like all his other inventions, his method of producing gas shows a genius for taking advantage of all waste products and utilising them either to render the parent process more efficient or as a basis of operation in some new manufacture.

Among his other discoveries we have room only to mention that of the metallic carbonyls. In 1890, while experimenting on the utilisation of the hydrogen derived from the gas producer, he noticed that carbon monoxide had the power of combining with certain metals, giving rise to compounds some of which have remarkable properties. With the ability which he throughout his life displayed for adapting his scientific discoveries to commercial enterprise, he directed his attention towards the production of nickel from its ores. In the method introduced by him, and carried out on a large scale to-day at Swansea, carbon monoxide is passed over heated nickel oxide, so that the metal is first reduced and then caused to combine to form nickel carbonyl, $Ni\,(C\,O)_4$. When condensed this compound is a colourless volatile substance from which metallic nickel can be produced by heating it to 43 deg. Cent., carbon monoxide being evolved, which can be again used for the carbonyl stage. The chief advantage of this method lies in the fact that the metal is obtained free from the cobalt with which nickel ore is nearly always associated.

Dr. Mond was a Fellow of the Royal Society, and held honorary degrees from four universities—Padua, Oxford, Heidelberg, and Victoria. In 1889 he was president of the Society of Chemical Industry, and in 1896 of the Chemical Section of the British Association.

SIR ALFRED JONES.

On Monday night, at his house in Liverpool, Sir Alfred Jones, the head of the Elder Dempster Steamship Company, died in his sixty-fourth year. Sir Alfred was born at Llanelly, Carmarthenshire, and after receiving a sound, but plain education, entered, as a clerk, into the employment of the firm of which he ultimately acquired the chief control. About thirty years ago, through, it is said, his own intensity of purpose and ability, he bought out the original proprietors of the business, and assumed as his partner the late Mr. W. J. Davey. Since then the company has been developed by the enterprise and courage of Sir Alfred. As an instance of the manner in which he overcame obstacles, it is said that to popularise the banana, with the sea transport of which his steamships were chiefly engaged, he distributed freely a large quantity of the fruit to a number of costermongers in Liverpool, and instructed them to sell it at whatever price they could obtain in the streets.

His energies were not confined to the West Indies. The Canary Islands and the West Coast of Africa were benefited by his ability and industry, and the inhabitants of the former at least had cause to regard him as a benefactor to their race.

Outside his particular occupation his interests were varied and his activity great. He was the founder of the Liverpool School of Tropical Medicine in connection with the University of that city. For this service to science he received an honorary fellowship from Oxford University. The inception of the British Cotton-growing Association is also largely due to his initiative. As President of the Liverpool Chamber of Commerce, as Consul for the Congo Free State in Liverpool, and as Chairman of the Bank of British West Africa, his interests were varied and numerous. For his many services to the West African Colonies and to Jamaica, he was created in 1901 a Knight Commander of St. Michael and St. George.

EDWARD TANGYE.

As we briefly announced in our last issue, Mr. Edward Tangye—fourth son of Joseph and Ann Tangye, and brother of George Tangye, Heathfield Hall, Handsworth—died on Thursday of last week. Mr. Tangye was born at Illogan, Cornwall, on April 27th, 1832, and he was one of the five brothers Tangye, who among them founded and carried on the now celebrated Cornwall Works. In the early days he took an active part in the mechanical department of the rapidly-developing business, but after a few years, was compelled by a breakdown in health to recognise that he must give up the work which his strong bent for engineering made congenial to him, and retire.

He had, when young, devoted much attention to improved methods of horticulture, and had become an expert in fruit growing, hence it was not difficult for him again to turn his attention to this subject. He therefore returned to Cornwall and took up what doubtless he intended to be a more restful mode of life. But, as might have been anticipated, he found himself altogether unable to relinquish the fascination of mechanical invention, and soon was engaged in a study of the methods of manufacturing blasting fuse, a subject which had long before occupied the attention of his brothers James and Joseph. In this he achieved a marked success, and having designed and constructed automatic machinery of a novel type, he was soon engaged in the manufacture of an improved quality of fuse. This machinery, in its latest developments, is now used in the modern fuse factories of the Nobel Company.

Mr. Tangye, a few years ago, removed from his Cornish home to Knowle, where at Manor House, he resumed his horticultural work. Being a skilled pomologist he gave his special attention to the culture of apples of the higher qualities in which he was remarkably successful. Mr. Tangye leaves a widow and family of sons and daughters.

DIRIGIBLES AND AEROPLANES FOR THE FRENCH ARMY.

AMONG the questions which are likely to receive special attention during the forthcoming debate upon the army estimates in the Chamber of Deputies is the preparedness of France in the matter of dirigibles and aeroplanes. This has been impressed upon the public by the report of M. Capazza, the well-known aeronaut, who has recently visited Germany to find out what was being done in the construction of motor balloons. He ascertained that while France has been carrying out trials and experiments, and hesitating as to the types of machines most likely to render good service for military purposes, her neighbour has already created a formidable aerial fleet. At the present moment Germany possesses no fewer than twelve dirigible balloons—that is to say, six Zeppelin, three Parseval, and three Gross—while there are about fifteen dirigibles owned privately, and available for military use in case of need. The organisation of this fleet has been completed by the erection of huge sheds at different strategical points, which are each capable of containing six dirigibles, and Government has purchased considerable quantities of hydrogen gas, stored in cylinders ready to be despatched at a moment's notice to any part of the territory. The balloon corps is also being thoroughly trained to manage these airships in all kinds of weather. It is stated that the cost of creating this fleet has been close upon £100,000. In France, on the other hand, the only dirigible at present in service is the Ville de Paris, which has already depreciated in military value, and will be withdrawn as soon as it can be replaced, to be used for the training of pilots.

As the result of the public agitation aroused by this report, the Minister of War has been obliged, apparently against his own private convictions, to give more prominence to dirigibles in the army estimates. Because, however, Germany has lost no time in creating a fleet of motor balloons it does not follow that these are of greater value than flying machines for military purposes. She has built dirigibles because they are the best to be had at the moment, and the progress of aeroplane construction in Germany has been so much slower than in France that, as things go at present, it will apparently be a long time before that country will be able to rely upon flying machines as distinct from dirigible balloons. In a word, Germany is doing the best she can with the material already at hand without stopping to question whether the aeroplane will not eventually render still greater services. The French military authorities appear to have far less confidence in the motor balloon, the experience during the manœuvres, and the catastrophe to the République, having shown that its value for scouting purposes is distinctly restricted. It has been found that in order to be perfectly safe the balloon must fly at a height of about 5000ft., and from that altitude, except in the clearest weather, it is difficult to make accurate observations owing to the slight mist which almost invariably envelops the dirigible. Again, it is argued that if the balloon were pitted against the aeroplane it would have little or no chance, owing to the extreme mobility of the flying machine, which could attack the dirigible in any way it pleased. This, however, is by no means the opinion of French experts generally. M. Painlevé, of the Institute, who has been giving a great deal of attention to aviation, believes that it will take a generation to produce a sufficient number of aeroplane pilots to allow of this type of machine being used on any large scale. The aeroplane, too, will have to be greatly improved before it can be sufficiently reliable, and it is impossible to foresee whether the evolution of war machines will take place at an early date or will proceed slowly. It is therefore undesirable to place too much faith upon the immediate utility of the aeroplane to the exclusion of the dirigible.

The Minister of War is now endeavouring to satisfy public opinion by hastening forward the creation of a fleet of dirigible balloons, at the same time that he is carrying out preliminary arrangements for establishing an aeroplane corps. It is intended to render these two services entirely distinct, the dirigibles being confined to the Army Balloon Corps, while the aeroplanes will be placed in the hands of the Artillery. So far as the dirigibles are concerned, it has been decided to fit them all with two engines, which may be run together or separately, and the high-speed metal propellers of the type which proved fatal to the République will be replaced by low-speed wood propellers, while special arrangements will be made to avoid any possibility of explosion through the contact of gas with the exhaust. Two dirigibles, the Liberté and the Colonel Renard, are being modified in this way, and two others will be completed in the first half of 1910, so that in the course of a few months France will have at least four dirigibles capable of travelling at a rate of 30 miles an hour, and of rising to an altitude of between 6000ft. and 7000ft. without the use of sand ballast. It may be expected that, as the result of the forthcoming debate, the Chamber will vote funds to enable the Minister to purchase other dirigibles, while the fleet will probably be augmented by the funds raised by public subscription during the past few months. Meanwhile, Government has already completed a shed at Verdun, and others are in course of construction on the eastern frontier.

So far as concerns aeroplanes, the Government have decided upon taking an active part in the development of

VERTICAL COMPOUND CORLISS STEAM ENGINE

HICK, HARGREAVES AND CO., LIMITED, BOLTON, ENGINEERS

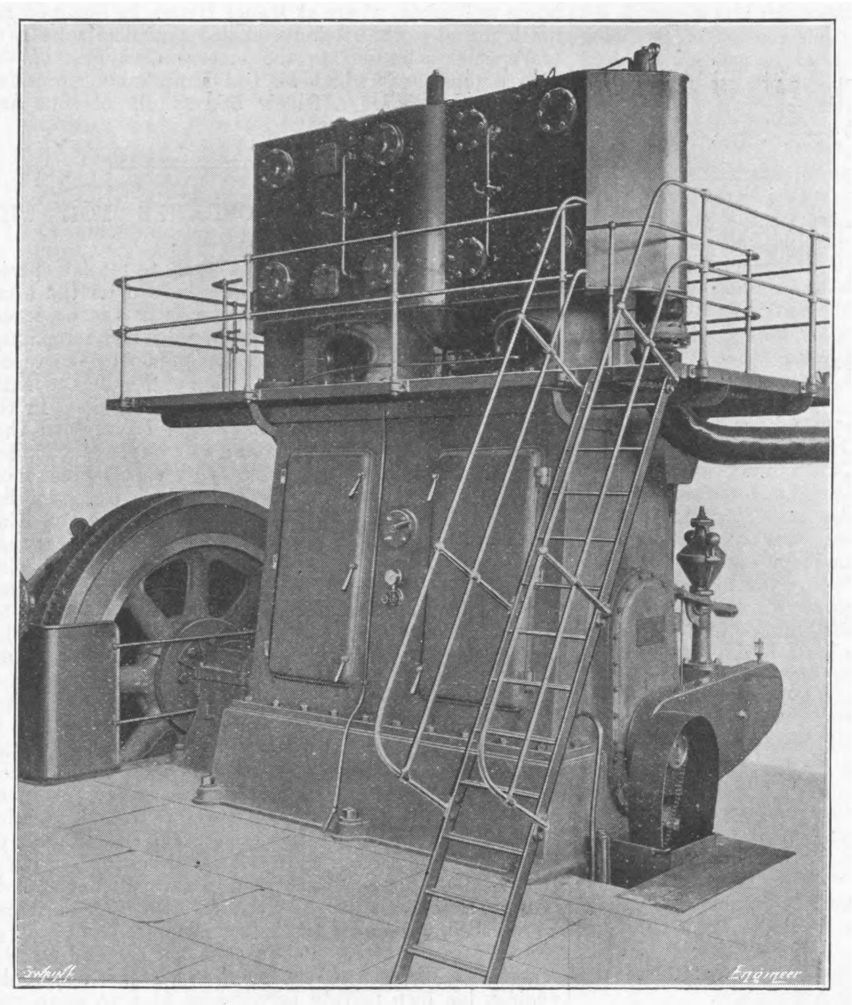


Fig. 1

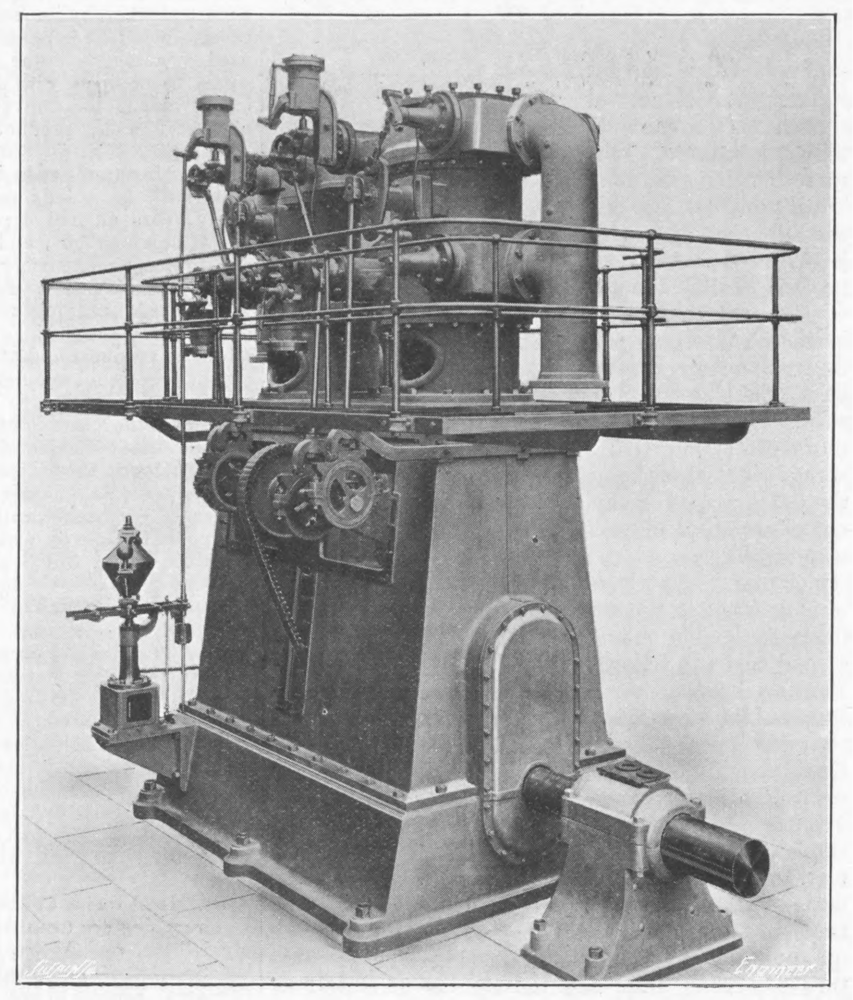


Fig. 2

these machines, for which purpose they have decided upon creating a laboratory between Nice and Marseilles, workshops for the construction of aeroplanes at Vincennes, and a school for the training of pilots on the aerodrome of Croix-d'Huns, near Bordeaux. The Minister of War has not yet fixed upon the type of aeroplane to be constructed by the Artillery, but he has purchased machines from different makers, with which trials are to be carried out, and it is upon the result of these trials that will depend the system of aeroplane which will be put under construction at the Vincennes works. While the military authorities are taking a practical interest in the design and construction of aeroplanes, the problem is one which appeals with special interest to French engineers and scientists, who are devoting considerable time to mechanical flight. Men of means have been coming forward with funds for the creation of laboratories, and it is characteristic that the first professor of aviation has recently been appointed at the Sorbonne, in the person of M. Marchais, Professor of General Physics at the University of Bordeaux. While, therefore, France will probably try to keep up with Germany in the creation of a fleet of dirigible balloons, she is likely to do more than hold her own when the aeroplane is sufficiently developed for military purposes.

A NEW PARTITION SLAB.

A FEW days ago we were invited to inspect the process of manufacture and the adaptability for building purposes of the "Muribloc" concrete slabs, which have recently been put upon the market by the firm of Muribloc Partition Slabs, Limited, of Prince's Wharf, Bridgend-road, Wandsworth, S W. Special machinery has been designed for the manufacture of these slabs, by means of which the clinker used in their construction is crushed, mixed with cement, forced into the mould, compressed, and the finished product ejected ready for storage in the extensive maturing sheds which have been erected at the works. The principal advantages claimed for the slabs are low price, economy in fixing, strength, durability, fire-resisting, and sound-proof qualities. The slabs are made in three thicknesses, viz., 2¼in., 3¼in., and 4¼in. The face dimensions are 27in. by 15in. The method of compressing the material consists of piercing holes almost completely through the slabs by means of a number of rods, which enter at one of the edges, whilst the mixture is enclosed in a definite space. The holes so formed are claimed to give the slabs exceptionally good sound-proofing qualities. Two of the edges are formed concave and two convex, thus enabling adjacent slabs to fit one within the other, the joints being made by means of cement. At the firm's works a small building has been erected with these slabs for the purpose of demonstrating the adaptability of the system and various methods of finishing. The system is claimed to be suitable for any buildings requiring partitions, or for the construction of estate walls, garages, bungalows, and other similar buildings. The system of coring above referred to, in addition to making the slabs sound-proof, also has the effect of making them light. It is claimed, in fact, that these are the lightest and cheapest fireproof slabs on the market. Another advantage claimed for the Muribloc slabs is that screws and nails may be driven into them with safety. We are informed that only clean clinker and the best Portland cement are used in the manufacture.

VERTICAL COMPOUND CORLISS ENGINE.

ALTHOUGH Corliss valves have hitherto only been used with comparatively slow running engines, it would seem that they can be made adaptable to engines running at medium speeds. The firm of Hick, Hargeaves and Co., Limited, Bolton, is now driving the machine tools in a portion of its Soho Ironworks electrically, the necessary power being provided by a novel design of a vertical Corliss engine coupled direct to a 400-kilowatt British Westinghouse direct-current generator. We are enabled to give illustrations of this engine, Fig. 4 representing a sectional elevation and end view, and Figs. 1, 2, and 3 different views of the engine and its valve gear. From these illustrations it will be observed that, with the exception of certain novel features, the design is somewhat on the lines of an enclosed high-speed engine. The engine has two cylinders, the high-pressure cylinder being 17in. diameter and the low-pressure 30in., the stroke of each being 24in. At a speed of 150 revolutions per minute, and with superheated steam at 180 lb. pressure per square inch, the engine is capable of giving off 600 indicated horse-power as a full economical load.

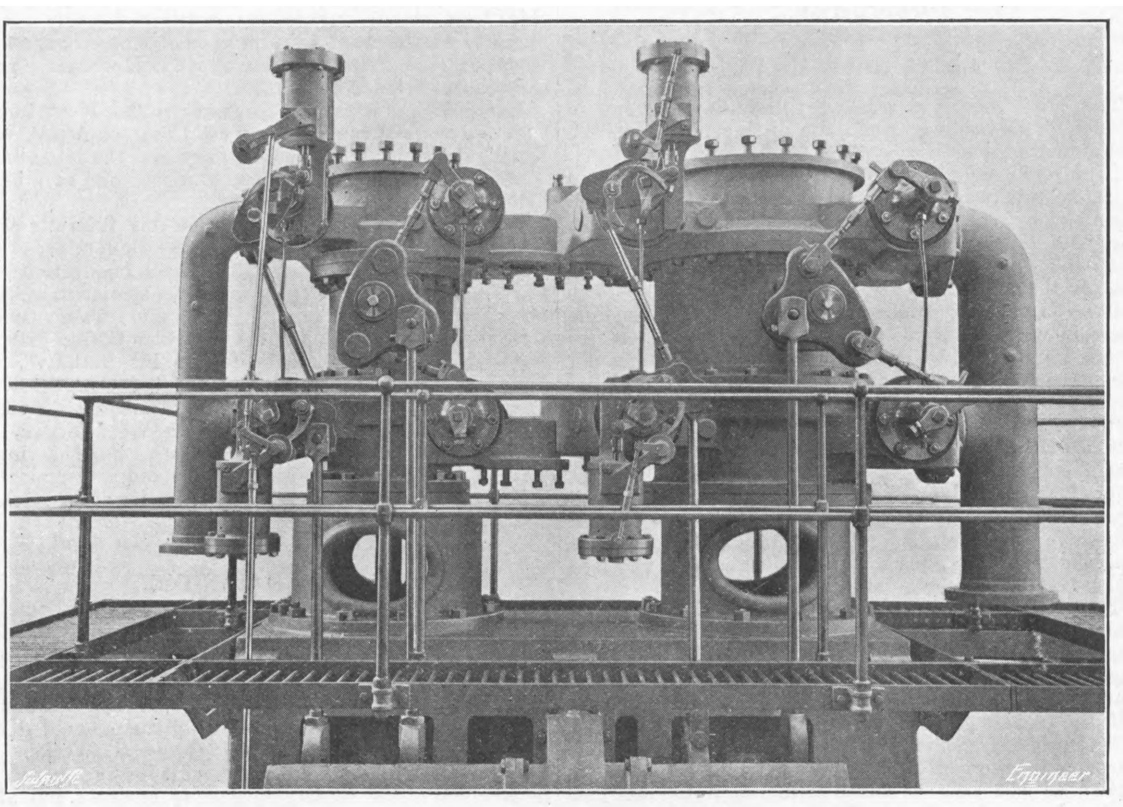


Fig. 3—THE CORLISS VALVE GEAR

As will be seen, the engine is built up in six essential parts—a base plate, roomy oil-tight crank chamber, two cylinders, and two open neck pieces between the cylinders and crank chamber. Bolted on to the outside of the crank chamber is a lay shaft, which is driven from the crank shaft by means of a Renold silent chain, the speed being the same for each shaft. The lay shaft is provided to operate the Corliss gear by means of four excentrics, two for each cylinder. The valves and valve gear are of this firm's usual standard pattern, the moving parts being made as light as possible, but to allow the rotary motion of the lay shaft to be converted into a vertical reciprocating movement on the wrist plate a ball-and-socket joint is provided on the top end of the excentric rod. This arrangement enables the crank shaft to be kept quite free of excentrics and simplifies the valve driving mechanism throughout.

The lubrication is forced throughout, the used oil from the base plate flowing into a tank, in which it is strained before being pumped back to the engine by valveless oscillating pumps, which are driven by a chain from the crank shaft. These pumps deliver oil under pressure into the main bearings, whence it is conducted to the crank pins and afterwards to the crosshead pins and slippers. The lubrication system is clearly shown in Fig. 4. A further application of the pitch chain is afforded by the governor. This is of Hick, Hargeaves and Co.'s sensitive type, and is driven from the

VERTICAL COMPOUND CORLISS STEAM ENGINE

HICK HARGREAVES AND CO., LIMITED, BOLTON, ENGINEERS

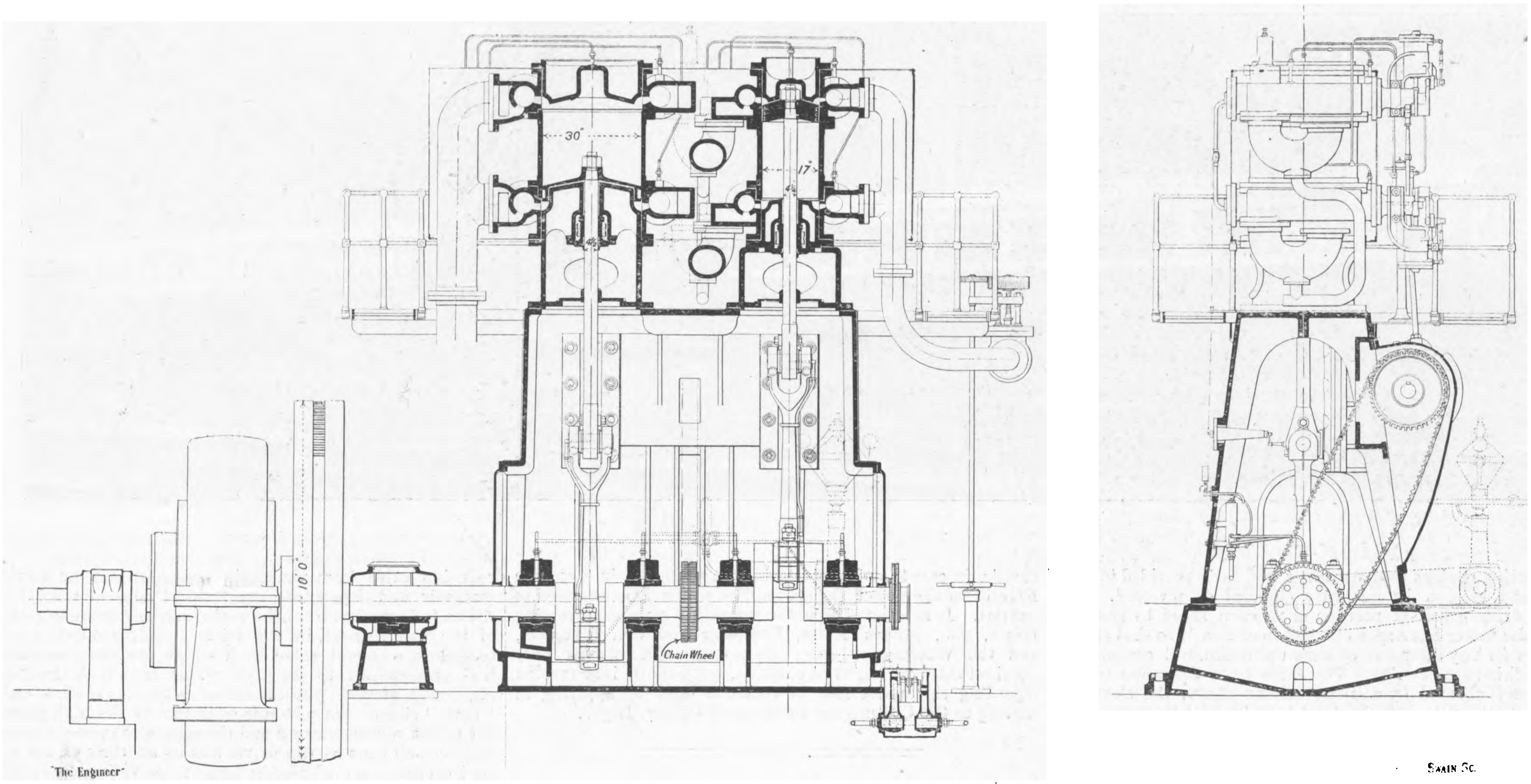


Fig. 4 -SECTIONS SHOWING THE OILING ARRANGEMENTS

crank shaft by a chain which is enclosed in an oil-tight casing, secured at one end of the engine.

The makers consider that this type of engine offers a useful compromise between the ordinary slow-speed, long-stroke engine with direct coupled generator, and the quick-revolution engine of the Willans, Bellis, or other pattern, also with direct-coupled generator. The advantages claimed are that, whilst on the one hand these engines do not call for so large or expensive a generator as the slow-speed type, they are, on the other hand, more economical in steam consumption than the high-speed engines with piston valves, particularly after the latter have been in operation for some time. The engine, in short, appears to combine in a large measure the best features of both the slow-speed and high revolution types without many of their respective disadvantages.

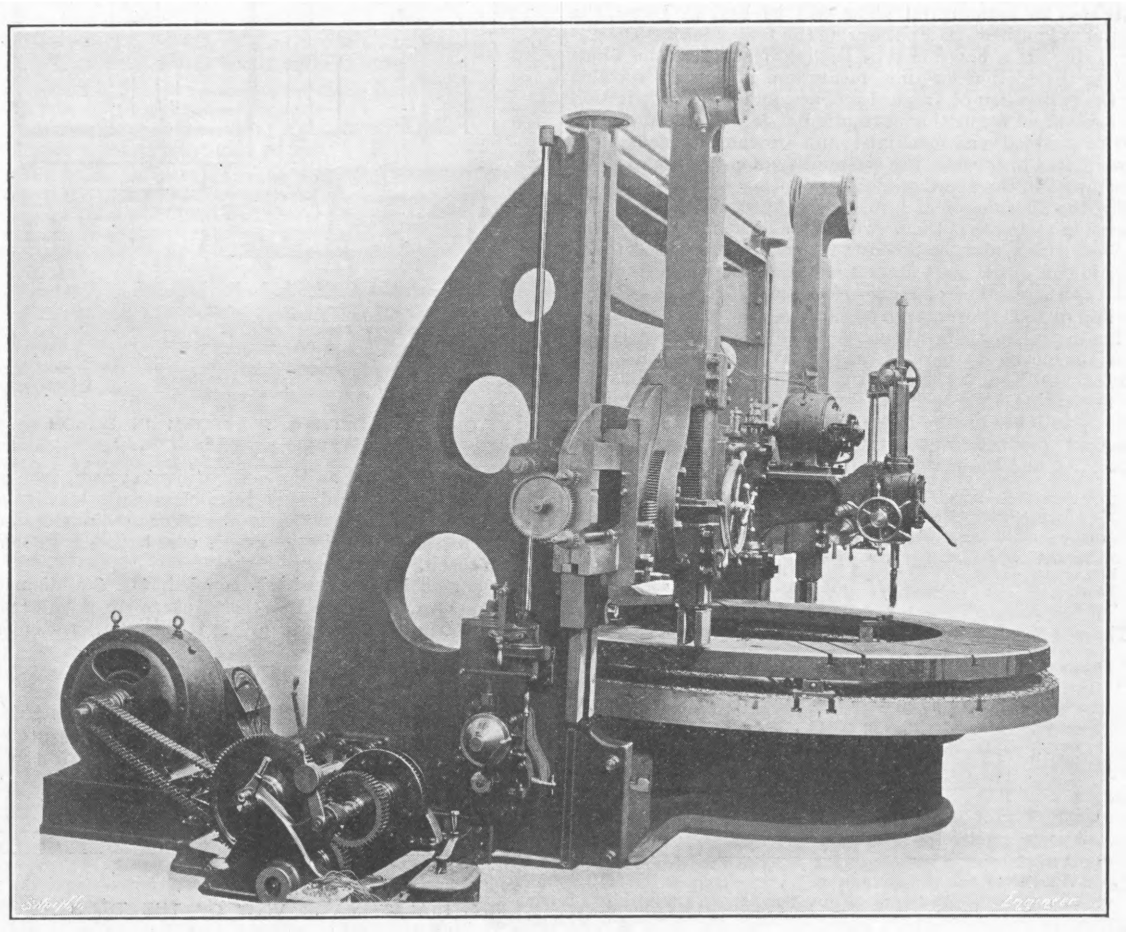
NEW STEAMSHIPS FOR THE GRAND TRUNK PACIFIC RAILWAY COMPANY.

THERE was launched on Monday afternoon, December 13th, from the Wallsend shipyard of C. S. Swan, Hunter and Wigham Richardson, Limited, the twin-screw passenger steamer Prince Rupert, the first of two steamships which are being built to the order of the Grand Trunk Pacific Railway Company of Canada, and which will start early next summer a new service between Prince Rupert, the western terminus of the Grand Trunk Pacific Railway, and Vancouver, Victoria, and afterwards to Seattle or Tacoma. This route is some 750 miles in length. The Prince Rupert, along with a similar vessel, the Prince George, which, it is expected, will be launched at Wallsend early in the new year, has been designed by Swan, Hunter and Wigham Richardson, Limited, to meet special conditions, and is being built under the superintendence of Mr. T. L. Newman, of Victoria, British Columbia, the consulting naval architect for the Canadian Government and the Grand Trunk Pacific Railway Company.

The Prince Rupert has a smart appearance, having a straight stem and cruiser stern, which latter has been adopted in order to obtain the best lines to give a high speed. There will be two pole masts and three funnels. The length over all will be 320ft., the breadth 42ft. 2in., and the depth to the main deck 18ft. The ships are being built to the highest class under the British Corporation survey, and they will also comply with the Board of Trade regulations for passenger steamers. The gross tonnage of each vessel is 2850. The engines and boilers, with Howden's forced draught, are being constructed by the Wallsend Slipway and Engineering Company, Limited. The former consist of two sets of triple-expansion engines, balanced on the Yarrow, Schlick and Tweedy system, and are designed to give a speed on service of about 18 knots. On the shelter and shade decks of the Prince Rupert there will be accommodation in state-rooms of two berths each for about 220 first-class passengers. There will also be a few sets of state-rooms *en suite* placed on the shelter-deck amidships. Second-class passengers will be carried on the main deck forward. When occasion arises, about 1500 excursionists will also be accommodated. A feature of the first-class accommodation will be two spacious corridors running fore and aft, one on each side of the engine casing, and to enhance the general appearance, light will be given from several domes in a long roof, which will also have a clerestory. The dining saloon on the main deck is placed at the extreme after end of the vessel, and immediately forward of the dining saloon will be the stewards' pantries and the kitchens.

The Prince Rupert will be provided with a wireless telegraphy installation, refrigerating machinery for ship's stores and dairy produce, electric light, and steam heating throughout. The rudder is of the balanced type wholly below the water-line, and will be actuated by a telemotor steering gear.

Subsequently to the naming ceremony, a large party of invited guests were entertained in the mould loft of the Wallsend shipyard, and, responding to one of the toasts, Mr. F. B. Girdlestone, the general manager of the Bristol, Avonmouth, and Portishead Docks, made the announcement that, in the course of a short time, they would, by the co-operation of the Great Western Railway Company and the Grand Trunk Railway Company of Canada, have a service of high-speed steamships from the Avonmouth Docks, and thus open up a new and direct, and, indeed, the shortest route between London and Montreal. By the opening in February next of its new line affording direct connection to Avonmouth, the Great Western Railway Company would be able to cover the distance between Avonmouth and London in 1¾ hours. The new passenger and mail station alongside the outer wharf at Avonmouth was, he added, now nearing completion.



BORING AND TURNING MILL WITH DRILLING ATTACHMENT

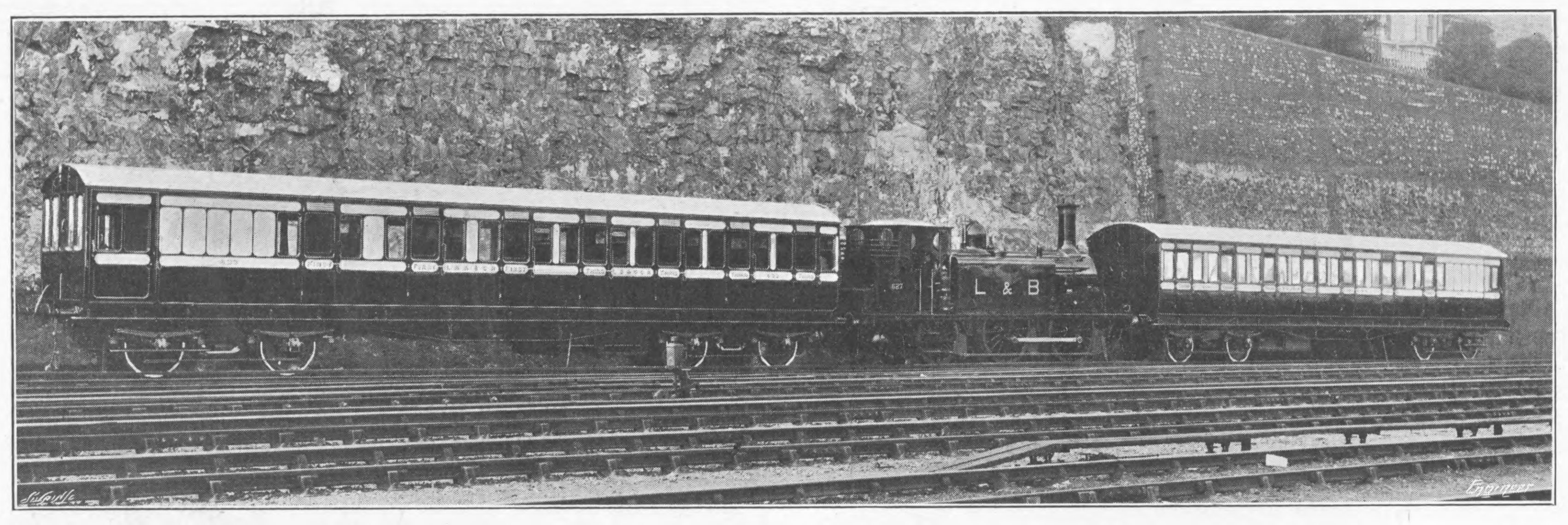
THE INSTITUTION OF MECHANICAL ENGINEERS: GRADUATES' ASSOCIATION.—The third general meeting of the session was held at the Institution, Storey's-gate, S W., on Monday, December 13th, at 8 p.m., chairman, Captain Riall-Sankey, R.E. (retired). A paper entitled "Planning and Equipment of Turbo-Generating Stations," was read by Mr. Thomas Walmsley, graduate. The discussion was opened by Mr. P. Petrie, and the following took part:—Messrs. E. Timothy, H. C. Hodgson, A. J. Bremner, M. G. Duncan, S. A. Smith, A. C. Cartwright, and E. Seddon. Captain Sankey also made several interesting remarks.

BORING AND TURNING MILL WITH DRILLING ATTACHMENT.

THE electrically driven boring and turning mill, of which we give an illustration below, has been specially adapted by the makers, George Richards and Co., Limited, Broadheath, Manchester, for dealing with circular steel doors and frames for bank safes. It will take work up to 14ft. diameter, and is fitted with the radial drilling attachment shown. The height admitted under the tool holders is 72in., and under the cross slide 82in., while the down feed is 48in. The cross slide has long guides giving a large bearing surface on the uprights, and bolts pass through these into the trough of the uprights, enabling the cross slide to be bolted firmly in position. The square slides which carry the tool bars are guided only by the lower member of the cross rail, ensuring greater accuracy and rapidity of the tool bars. These slides have a rapid movement along the cross slide by means of a rack, pinion, and ratchet handle. The swivel slides can be moved to an angle of 45 deg. on each side of the centre line for turning internal or external tapers. The tool bars are balanced by a spring balance arrangement, which does away with weights and chains and does not interfere with the manipulation of the machine by the operator. At each end of the cross slide a spring-slipping device is provided to prevent breakage to gears in case the two saddles collide. A positive

MOTOR TRAIN ON THE EPSOM DOWNS BRANCH, L.B. AND S.C.R.

MR. D. EARLE MARSH, M. INST. C.E., BRIGHTON, ENGINEER



feed motion enables twelve rates of feed to be provided to each bar, and these can be instantly changed or reversed. The motor drive gives six positive changes of speed by gearing, while the motor has a speed reduction of 2 to 1, so that speeds suitable for any diameter of work up to the full capacity of the machine are possible. The drive from the motor to the machine is effected by a silent driving chain, the elevating motion to the cross slide is also driven from the same motor through gearing and a vertical shaft.

Fitted to the cross slide is a radial drilling attachment which, by means of a ratchet handle, can be moved to any position. The drill has a 3ft. radius, so that by the combined horizontal and radial movements and rotary motion of the table holes can be drilled in any position. The spindle is 2in. diameter, has 15in. self-acting and hand down feed, and is bored for a No. 4 Morse taper shank. This drill is driven by means of a variable-speed motor directly connected, and has back gearing and reversing motion, enabling tapping to be done up to 1½in. holes. To enable the peripheries of the circular steel safe doors to have their multiple taper joints carefully ground, an electrical grinding attachment is used in the tool holder of the mill for grinding these after turning.

LAGOS AGRICULTURAL SHOW, 1910.

WE are asked by the Crown Agents for the Colonies to state that an agricultural show will be held in Lagos, the capital of Southern Nigeria, during the first week in December, 1910. It is hoped that a leading feature of the Show will be the section for implements and machinery suitable for the cultivation of tropical produce, and for its preparation for export and for local consumption. Medals and diplomas will be awarded, and machinists and implement makers are now invited to consider the desirability of preparing exhibits to compete in the above section.

For the information of firms not connected with Nigeria, it may be stated that the port of Lagos is the most important in West Africa, and the Colony and Protectorate of Southern Nigeria one of the most progressive, the total trade—imports and exports together—having risen from under four millions sterling in 1900 to over seven millions in 1908. The population of Southern Nigeria is about seven millions. Lagos is the terminus on the seaboard of the railway which is being constructed to Kano in Northern Nigeria, and the line was in September last open for public traffic for 307 miles, viz., up to Jebba on the Niger River. The following are the principal products which figure in the Southern Nigeria export list, and the quantities and values shipped in 1908 :—

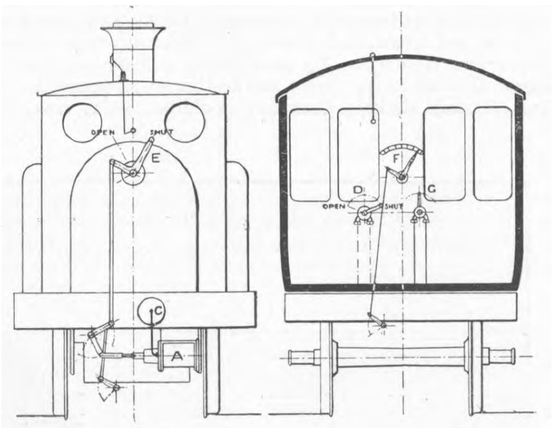
		£
Palm oil	18,300,000 galls.	1,155,000
Palm kernels	136,500 tons	1,424,000
Rubber..	1,222,000 lb.	98,000
Mahogany	—	77,000
Lint cotton..	2,300,000 lb.	53,000
Maize	15,500 tons	52,000
Cocoa	3,060,000 lb.	50,000

There is also a small export trade in fibre and coffee. In addition to the above, cassava is largely cultivated for local consumption, also yams, and, to a minor extent kola nuts, ground nuts, sugar cane, tobacco, peppers, indigo, &c. The following are some of the fruits grown :—Oranges, bananas, plantains, limes, pineapples, mangoes, pawpaws.

Exhibits of any simple implements or machines suitable for working the above products are cordially invited, but for the guidance of prospective exhibitors it should be noted that there are at present no draught animals working on the plantations and farms. Inquiries in Europe may, during during the rest of this year, and January and February, 1910, be addressed to Mr. R. E. Dennett, Provincial Forestry Officer for Southern Nigeria, care of the Crown Agents, Whitehall-gardens, London, S.W., and subsequently to the Commercial Intelligence Officer, Lagos, who will be glad to furnish exhibitors with a list of the local European merchants, in case they desire to establish an agency in Southern Nigeria for the sale of the specialities which it is proposed to exhibit. It is believed that the steamship companies serving Lagos, viz., Messrs. Elder, Dempster and Co., Liverpool, and the Woermann Linie, Hamburg, will charge only nominal rates of freight on exhibits, but definite information regarding this point may be obtained later by applying in writing to the Commercial Intelligence Officer, Lagos.

MOTOR RAILWAY SERVICE, LONDON, BRIGHTON AND SOUTH COAST RAILWAY.

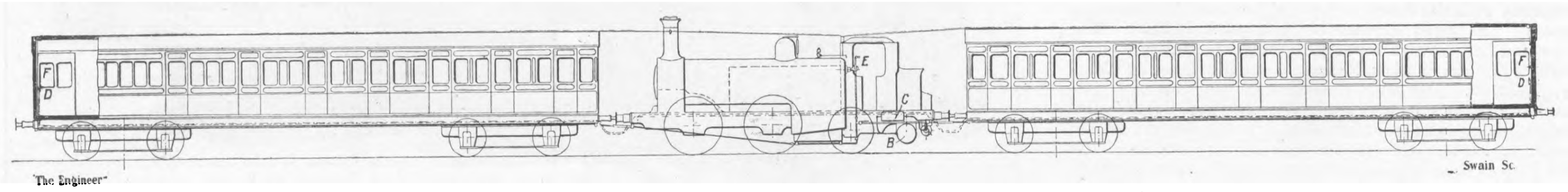
THE London, Brighton and South Coast Railway has recently instituted a somewhat novel motor train service on its Epsom Downs branch. The train is made up of an engine and two bogie coaches, placed one at each end of the engine, and it is illustrated in the accompanying engravings. The coaches are arranged on the compartment system, each containing three first and four third-class with luggage and driver's compartments. The total seating accommodation is for 128 passengers, and the length over buffers is 57ft. 7in. in each coach.



Actuating Cylinder . . . . . . A
Main Air Reservoir . . . . . . B
Auxiliary Do C
Regulator Air Valve . . . . . . D
Regulator Handle-steam . . . . . . E
Do Indicator . . . . . . F
Westinghouse Brake Valve . . . . . . G
Air Pipe Between Main & Auxiliary Reservoirs & to Cylinder . . Thus ————
Air Pipe from Main Reservoir to Drivers Regulator Valve . . . . Do —·—·—
Air Pipe from Drivers Regulator Valve to Cylinder . . . . Do - - - - - -

CAB AND DRIVING PLATFORM IN COACH

The engine has four wheels coupled, 5ft. 6in. diameter, cylinders 17in. diameter by 24in. stroke, with a boiler pressure of 150lb. per square inch. It is 32ft. 3in. over buffers, so that the extreme length of the train is 147ft. 5in. The train is equipped with the Westinghouse brake, blocks being applied to every wheel of the cars and engine.



DIAGRAMMATIC VIEW OF THE TRAIN

Advantage is taken of the air pressure necessary for the working of the brake to operate the regulator handle on the engine, which is worked from the end of either coach without in any way interfering with the action of the brake. A double-acting cylinder is attached transversely under the engine frame, its piston-rod linked to a lever on a short shaft; another lever on this shaft is connected to the regulator handle by a rod passing up through the footplate. The upper end of this rod is provided with a French pin, so that the regulator handle may readily be disconnected from the gear and worked by hand. In the cylinder an air-tight piston has a constant pressure of air on it, holding the regulator closed, the air effecting this passing first through a reducing valve from the main reservoir into an auxiliary reservoir, and thence into the "shut" end of the cylinder. Air at full pressure from the main reservoir is led to each end of the train, where, in the driver's compartment, it is controlled by a special valve with which the driver admits the high-pressure air to the pipes which lead it to the "opening" side of the piston. The reduced pressure on the "shut" side of the piston is overcome by the high pressure, the piston moved forward and the regulator opened gradually during such time as the driver admits air through his valve. On his closing the admission port of his valve, the regulator remains held in any desired position by the pressure on both sides of the piston. By releasing the air through the exhaust port of his valve, the pressure on the "shut" side of the piston closes the regulator. Should pipes or joints fail, or the coaches break away from the engine, the same result is obtained, as the reduced pressure is always in the "shut" end of the cylinder and the reservoir feeding it. An indicator on a sector worked through universal joints from the shaft reproduces exactly in each cab the position of the regulator handle on the engine.

To prevent interference with the apparatus in the cab at one end of the train while the driver is at the other, one handle only is provided for the two driver's regulator valves, and one for the two Westinghouse brake valves. The handle in each case is only removable from the valve it is being used for when the latter is in neutral position, and is transferred by the driver when he changes from one end of the motor train to the other. A whistle, blown by air pressure, is provided at each end of the train, and the engine whistle is also at the driver's command. We are indebted to Mr. D. Earle Marsh, the chief locomotive superintendent of the line, who designed the train, for the foregoing information and illustrations.

EXAMINATION OF MARINE ENGINEERS.

THE following instructions to examiners and notice to candidates as to qualifications for a second-class certificate of competency as engineer of vessels propelled by oil engines, available for home trade passenger ships only, have just been issued by the Marine Department of the Board of Trade. On and after January 1st, 1910, candidates may be examined for the above certificates, the qualifications for which are as follows :—

(1) A candidate for a second-class certificate must be at least 21 years of age.

(2) He must prove :—(*a*) Four years' experience at the making or repairing of machinery, of which at least six months must be at the making or repairing of oil engines, or (*b*) Three and a-half years' experience in charge of engines and boilers at sea or an equivalent suitable experience on shore; and in addition to either (*a*) or (*b*), (*c*) Six months' experience with oil engines at sea. Note.—Alternative service to the above may be considered, but it is essential that the candidate should have experience with oil engines, and have spent at least six months at sea in the engine-room of a sea-going vessel.

(3) He must write a legible hand, and have a good knowledge of arithmetic up to and including vulgar and decimal fractions and square root. He must also understand the application of these and other rules to problems relating to spring and lever-loaded relief valves, and be able to solve questions about the relative speeds of a vessel at different revolutions, the capacity of oil tanks, &c.

(4) He must be able to give a clear explanation of the principle on which an oil engine works, and to show by means of illustrative sketches and otherwise that he understands the construction of those in general use.

(5) He must be able to describe the chief causes which may make the engine difficult to start, and to explain how he would proceed to remedy any defects.

(6) He must be able to show that he understands the mechanism of the starting and reversing arrangement, and is competent to deal with defects which may lead to failure in the prompt handling or reversing of the engine.

(7) He must have sufficient mechanical ability to be able to over-

haul the engine, to adjust the working parts, and to put the engine together again in good working condition.

(8) He must be able to give satisfactory answers to the elementary questions numbered 305 to 310 inclusive in the Regulations issued by the Board of Trade relating to the examination of engineers in the Mercantile Marine.

(9) He must be able to prove—by actual trial if practicable—that he is competent to manipulate an oil engine when under way by starting, running the engine, stopping, reversing or slowing down.

(10) He must understand what is meant by the flash point, and have a knowledge of the explosive properties of the oil generally used in oil engines when exposed in the open air, and the danger of exposing any vapour from the oil to a light, or of allowing any leak from the oil tanks, particularly into the vessel's bilges.

(11) He must understand the action of wire gauze diaphragms when placed in pipes and connections to oil tanks, &c., for the purpose of preventing the explosion or ignition of oil vapour therein.

(12) He must be able to take the necessary precautions to guard against the escape of inflammable vapour from the vaporiser when the engines are stopped.

(13) He must be able to explain the principle and construction of a dynamo and the construction and arrangement of primary and secondary batteries and induction coils, so far as is necessary for the efficient management of an oil engine.

These Regulations are to be considered as part of the Regulations relating to the Examination of Engineers in the Mercantile Marine (1908), issued by the Board of Trade, and the provisions of the latter will, so far as the nature of the case admits, and except where these Regulations specifically provide otherwise, apply to the examination of candidates for certificates of competency as engineer of vessels propelled by oil engines.

A NEW ELECTRICAL TOWER CRANE.

THE tower crane illustrated in the accompanying engravings was designed and constructed by George Anderson and Co. (1905), Limited, Carnoustie, Scotland, and is at present engaged on the building operations in connection with the extensions at the British Museum.

As will be seen from Fig. 2, the tower is composed of three sections, the divisions being made at the platform carrying the electric motors and their gearing, and at the platform supporting the sole-plates from which the two jibs of the crane spring. As a whole, the tower may be regarded as built up from four corner towers having each a rectangular cross section of 4ft. by 3ft. at their base, and of 18in. square at their highest point. Each of these corner towers has a height of 98ft. 6in., and is built up of four angles braced together diagonally and across by flat bars and gusset plates, similar bracing being employed to connect up the four elements into the main tower. Half-way up each of the three sections into which the main tower is divided a diaphragm composed of stout angles and plates is introduced with a view to giving increased rigidity towards resisting torsional forces.

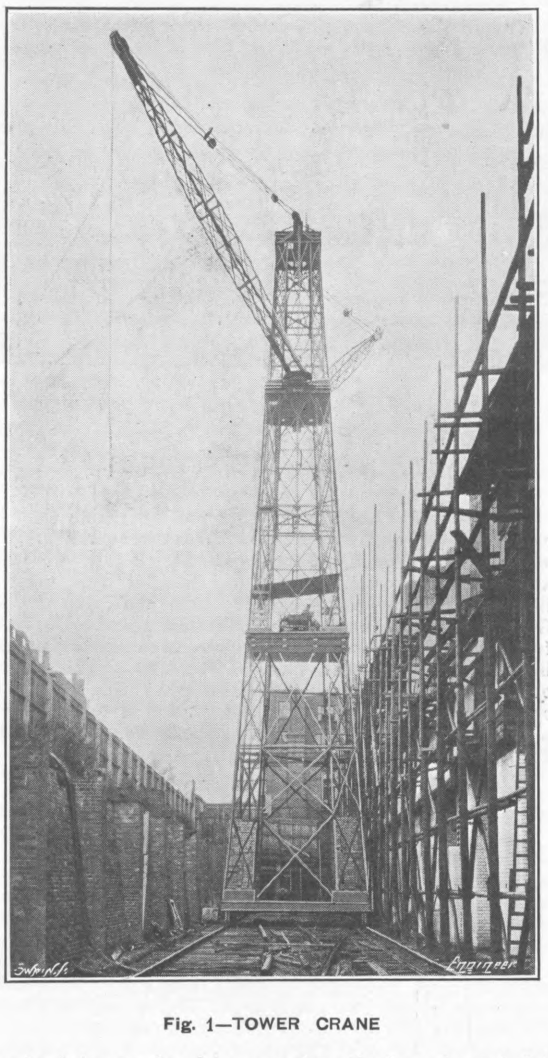


Fig. 1—TOWER CRANE

At the base of the tower where the section is 21ft. by 19ft. 6in., the structure is carried on a six-wheeled carriage composed of rolled steel joists, angles, and plates. A 10 horse-power motor is mounted on this carriage and transmits power to the wheels through cut steel spur and worm gearing for travelling purposes. At the top of the first section, at a height of 39ft. from the ground, the double set of gearing in connection with the jibs is carried on a floor composed of steel plates, channels and angle irons. The gearing required for hoisting, slewing and jibbing is driven for each jib by a separate motor of 20 horse-power, and all the movements ,including travelling, are controlled from the motor floor At the top of the second section and 75ft. from the ground a floor is provided, and is carried on joists, channels and angles. The sockets, sole-plates and slewing gearing for the jibs are situated on opposite sides of this floor. Steel plates roof in the upper extremity of the tower, which has a rectangular section 6ft. 6in. square, and from the ends of a cross beam carried at this point steel links and pulleys support the jibs and provide the necessary means for radiating them. Each jib is of lattice steel-work construction, and is 45ft. in length. Provision is made for swinging either jib through an arc of 180 deg. A series of steel ladders is disposed in the interior of the tower, and gives facilities for reaching any of the three platforms.

With regard to the performance of the crane the following figures have been supplied to us by the makers:—At the maximum radius of each jib, 40ft., a load of 3 tons can be raised at a rate of 85ft. per minute, while at a 17ft. radius the crane can deal with a weight of 8 tons, the hoisting speed in this case being 36ft. per minute. The jibs can be used simultaneously, and when this is done each can deal with a 3-ton load at any radius up to the 40ft. limit. Forty-five seconds are taken to bring the jibs from their maximum radius to their minimum, while to slew them through their greatest arc of 180 deg. 30 seconds are required. A travelling speed of 50ft. per minute is arranged for. During the working of the crane 12 tons of ballast are distributed on the travelling carriage, placed, as will be seen from the engraving, Fig. 1, in lots of 3 tons in each of the four corner towers.

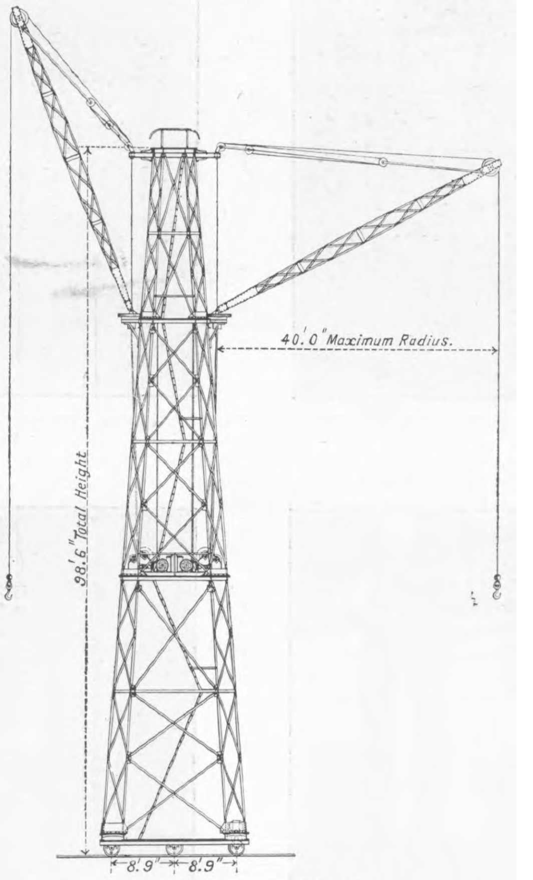


Fig. 2—ELEVATION OF CRANE

LETTERS TO THE EDITOR.

(*We do not hold ourselves responsible for the opinions of our correspondents.*)

CENTRIFUGAL FORCE.

SIR,—"Pater" quotes Clark Maxwell's definition of accleration: "Any change in velocity, whether that change be an increase, a diminution, or a change of direction," and immediately afterwards writes, "There is no other definition or meaning given to the word acceleration save hastening," although he has just quoted two other definitions.

"Pater" is really questioning Newton's first law of motion:—"Every body continues in a state of rest, or of uniform motion in a straight line, unless compelled to change that state by the action of some external force." The velocity of the stone, "Pater" says, is constant; but it is not constant in a straight line. Therefore some external force is acting on it, or the above-quoted law is not true. It is quite clear by experiment that there is an external force acting on it, viz., the constraint of the string. The tensile stress, or stretch, of the string is the reaction to the inertia of the stone. Properly valued in direction and amount, it is the sole and sufficient cause of the change of direction, or acceleration, suffered by the stone. The angular velocity of the stone is constant, for there is no angular acceleration acting on it. Its rectilinear velocity is constantly changing, in accordance with Newton's second law:—"Rate of change of momentum is proportional to the impressed force, and takes place in the direction in which that force acts," for there is a force of constantly changing direction acting on it.

Why that force does no work on the stone is answered by the fact that it accelerates positively and negatively—or accelerates and decelerates—equally and evenly. Since the accelerating force is derived from the reaction to the stone's inertia under constraint it cannot increase the kinetic energy of the stone. Similarly, a bullet reflected from a target has its direction altered, and is therefore accelerated, but it will certainly not have its kinetic energy increased. It will be hastened in its new direction, slowed in its original one, both effects being due to a reaction force derived from its own inertia.

"Pater" instances gravity as an accelerating force. Gravity acts on a pendulum bob, accelerates it all the time in a constant direction, but does no work on it, and does not hasten it.

Your correspondent appears to have all "the law and the prophets" of mechanics at his elbow by his quotations. It is hardly likely that where they have failed to enlighten—as in the quotation with which I commence—your correspondence columns will succeed. "Pater" will find Glazebrook's "Laws and Properties of Matter" very clear on the laws of motion, the lines of reasoning and observation which have led to their acceptance and their use in calculation. He will find Chapter XXVII. and the latter part of Chapter XXVI. of Perry's "Applied Mechanics" clear up his particular difficulties with centrifugal force, so far as his difficulties are the usual difficulties of the student. He will certainly be pleased with the sentence in paragraph 481, containing a quotation from Erasmus.

But I suspect that his real difficulties are of a different kind. The questions he wants science to answer are of the class commencing with a "Why?" whereas, so far, scientific research has only managed to answer, somewhat imperfectly, a few questions commencing "How?" If he wants to get some answers to the latter sort of question for himself, he will find in Professor Perry's book aforesaid an instrument described for measuring centrifugal force. He may get some instruction from the observation of simpler devices. For example, a weight whirled at the end of an india-rubber cord, or a spiral spring, at different speeds, the elongation being noted, and the elastic string calibrated by known weights, will not only demonstrate the existence of centrifugal force, but measure it, and co-relate it with the weight, radius, and angular velocity of the mass. Allowing for errors of observation, and the disturbing influences of gravity, friction, &c., he will find his results agree with the accepted formula, which is the matter of practical importance.

If I am right as to "Pater's" real difficulties, perhaps the best advice is carefully to read Karl Pearson's "Grammar of Science."

London, December 13th. HENRY M. SAYERS.

THE DRIVER OF THE "ROCKET."

SIR,—In the obituary notice of Mr. Edward Entwistle, which appears at page 573 of your issue of the 3rd instant, you express considerable doubt as to his claim to have driven the "Rocket" on the occasion of the opening of the Liverpool and Manchester Railway on September 15th, 1830. I first became acquainted with Mr. Entwistle's name in that connection from a paragraph in the *Evening News* of April 10th last, but I did not pay much attention to it, as I regarded it as one of those stories of remarkable survivals which reach us every now and then from the New World.

Mr. Entwistle was born on March 15th, 1815, so that he would be only fifteen and a-half years of age on the day of the opening of the railway, and, according to his account, Stephenson engaged him just two days before that momentous occasion to drive the "Rocket," the engine which gained the prize at the Rainhill competition in October of the previous year. This story is ludicrous, and as you say, "doubts have been expressed as to the probability of a careful man like George Stephenson selecting a youth for such an important task." Those who favour Mr. Entwistle's claim should remember that Stephenson had no less than eight locomotives on the line at the time, the names of which are well known, and that all these engines had been "repeatedly tried, and with success, several weeks before"—*Mechanics' Magazine*, September 25th, 1830, page 65. Is it at all likely that Stephenson would displace the regular driver of the "Rocket," and put an inexperienced boy on the foot-plate? It is reasonable to suppose that Stephenson had at his disposal at the time a pick of drivers, and that even had the supply fallen short he would have appointed a fireman, not an absolute novice.

I have consulted four newspapers of the day to see whether the name of the driver is given in the report of the inquest which was held upon Mr. Huskisson, but he is referred to only as "the engineer." The unfortunate accident created a great sensation throughout the country, and the appearance in the witness-box of a boy under sixteen would certainly have provoked comment.

I am, however, in a position entirely to disprove Mr. Entwistle's claim. The name of the driver of the "Rocket" on September 15th, 1830, was White. My authority for this is the report of the opening of the line in the *Morning Herald*, quoted at page 66 of the *Mechanics' Magazine*, cited above. R. B. P.

London, December 15th.

HUMPHREY'S PUMP.

SIR,—In your issue of December 10th, 1909, at the top of the first column on page 611 you make me say that my figures of comparative fuel costs taken from Mr. Humphrey's paper show "that the Humphrey pump was more economical than any other form of pump, as the author had stated in his paper." My figures, which you correctly give, prove the exact opposite, and were offered for Mr. Humphrey's criticism. They were as follows:—

Humphrey—Mond	37	Relative fuel costs.
Humphrey—anthracite	26.5	
Compound steam engine pump	20	
Triple-expansion ,,	16.6	

Birmingham, December 14th. HENRY LEA

[The fact that "not" had dropped out was no doubt noticed by our readers.—ED. THE E.]

SIR,—I regret that I made an error in my calculations regarding the length of pipe required for the Humphrey pump to which I referred at the recent meeting of the Institution of Mechanical Engineers, and reported on page 611 of your last issue; 73ft. of 4ft. 9in. diameter pipe is, of course, equivalent to 18.25ft. of 9ft. 6in. pipe, so that for one pair of cylinders there would be required 36.5ft. of 9ft. 6in. pipe, and not 13ft. 6in. as stated previously.

I shall be glad if you will kindly insert this correction.

London, December 10th. J. F. ROBINSON.

THE NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.—The annual dinner of the North-East Coast Institution of Engineers and Shipbuilders was held at the Armstrong College, Newcastle-on-Tyne, on Friday, December 10th. In submitting the toast of "The North-East Coast Institution of Engineers and Shipbuilders," the Duke of Northumberland recalled the opening address of their first president, Mr. William Boyd, in which appeared the remark: "I imagine no shipbuilder or naval architect among us will contend that the best type of vessel is already designed, and that the ship of to-day is incapable of improvement." Looking back over those twenty-five years he (the Duke) could not help thinking that was a very pregnant remark. As a child he heard of a vessel called the Great Eastern, which was not altogether a success, and people said that nobody would be foolish enough to build so big a vessel as that again; yet time had gone on, and they had seen the Mauretania built beyond the proportions of the Great Eastern. Again, their first president said that attention required to be paid to the employment of higher working pressures of steam in steamships. Mr. Summers Hunter, in responding, said that to keep their position in the manufacturing world they must continually aim at being in front. Although possessing no politics, there were matters of Imperial moment that greatly concerned their Institution. For instance, they had heard a good deal about the "All-Red" route for their shipping, and that, they hoped, would eventually be accomplished, but along with the "All-Red" route, if not in front of it, should be what he called the "All-White" route, or the white ensign of the British Navy, to protect the "All-Red" shipping route, and also to show that there was an Imperial, as well as a commercial connection between every part of the British Empire. The "White" route required more ships, more men, and greater efficiency. They greatly valued the man behind the gun, but there was a man behind him, down in the engine-room, for whom they claimed more recognition. The solution of the status of the naval engineer was only to be found in the complete fusion of the executive and engineer branches and in the engineers having control in their own department with identical titles and uniform. Sir Hugh Bell, in submitting the toast of "The Trade and Commerce of the North-East Coast," said that he had calculated that it took just about £200 or £250 to put a man to work in the industry in which he was engaged. For every £200 they had invested, one man directly employed by them was obtaining a livelihood, bringing up a family, providing citizens for the State in future, and discharging all the duties of a patriotic member of the community. For that the capitalist received at the very outside 10 per cent., very often much nearer 5 per cent.; £10 per year, therefore, was about what any captain of industry might receive for such a man. What did the man receive? The amount of wages paid to him and those in connection with him was very nearly £150. This consideration had an important bearing upon industrial matters at the present juncture. Lord Joicey, with whose name the toast was coupled, in responding, said that with reference to the Coal Mines Eight Hours Act he was glad to tell them that in Northumberland and Durham they were likely to come to some arrangement to carry on their business under this Act without having any serious stoppages.

REPAIRING A FRACTURED ROLL MILL HOUSING

THERMIT, LIMITED, LONDON, ENGINEERS

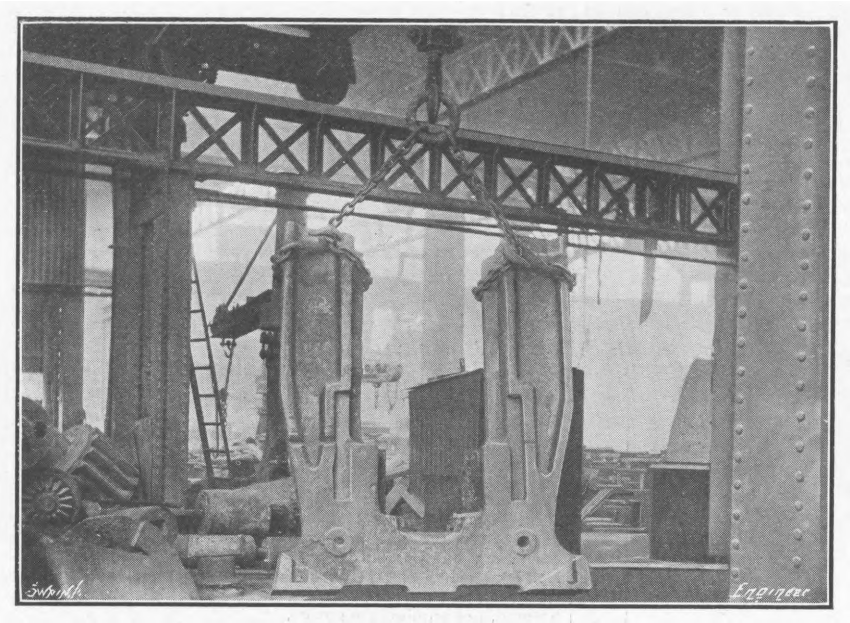


Fig. 1—THE FRACTURED HOUSING

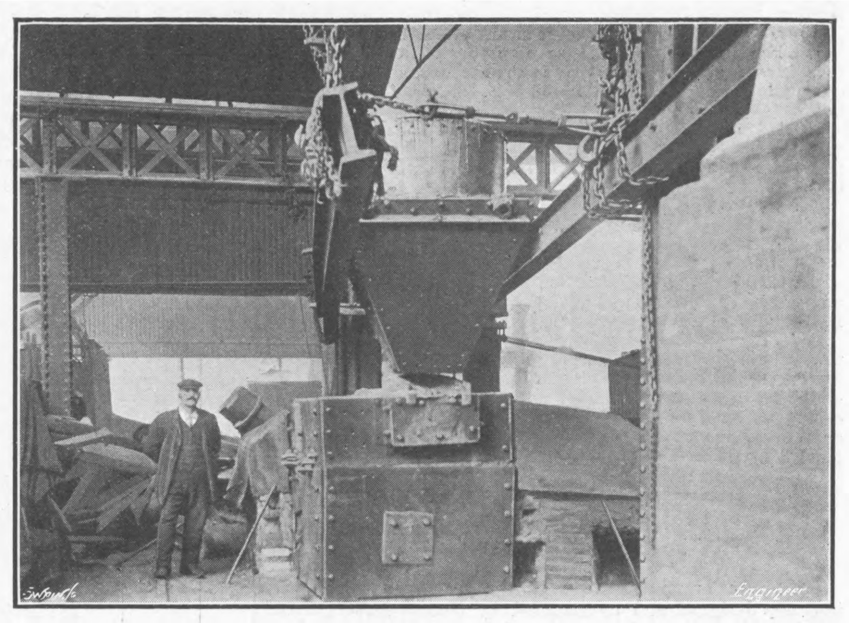


Fig. 2 CRUCIBLE AND MOULD IN POSITION

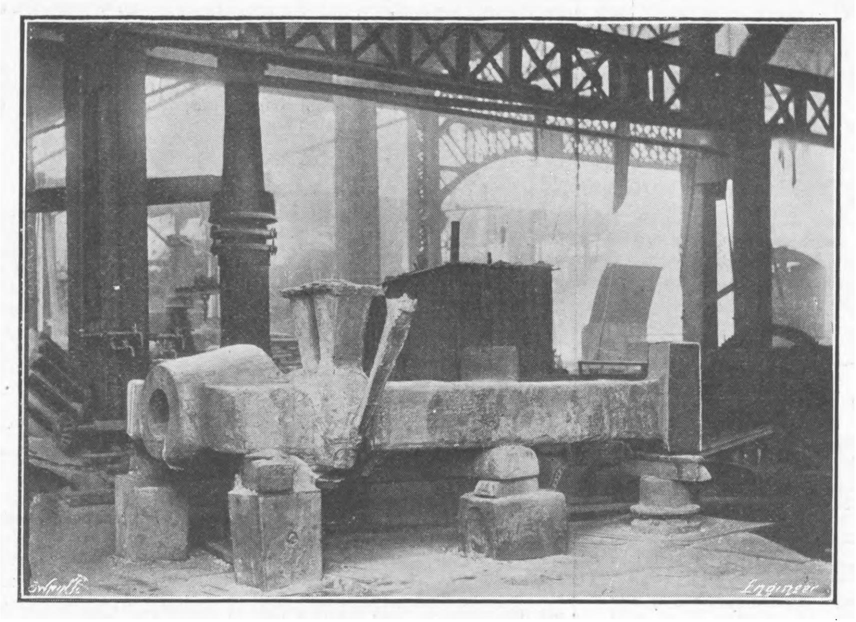


Fig. 3—ONE WELD WITH RUNNER AND RISERS ADHERING

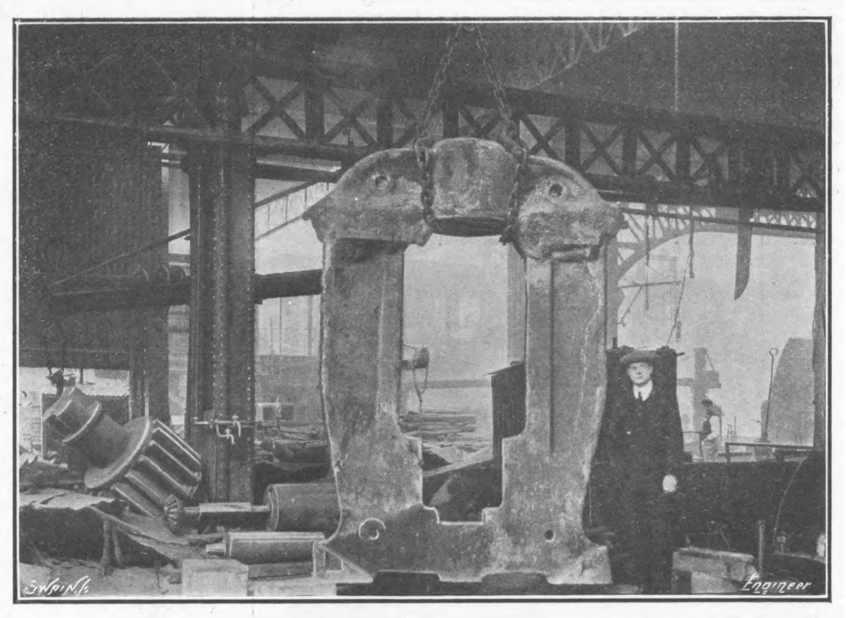


Fig 4—THE REPAIRED HOUSING

REPAIRING A ROLL MILL HOUSING.

AN interesting repair has recently been carried out on a broken roll mill housing by means of the Thermit process. The housing was a steel casting which was broken through each side near the top, as seen in Fig. 1. Sections of the broken part and of the Thermit band welded on are given in the accompanying sketches, Figs. 5 and 6.

To effect the repair two welds were necessary, one on each limb. The broken part was secured in position, allowing for a 2in. space between the fractured ends. A wax pattern was formed round one of the breaks, the mould box fitted, and the mould, which was made from a mixture of two-thirds silica sand and one-third fireclay, was made in the usual way on the casting. The parts were preheated by means of two petrol and compressed air torches, which also dried the mould in position and melted out the wax, leaving space for the Thermit steel.

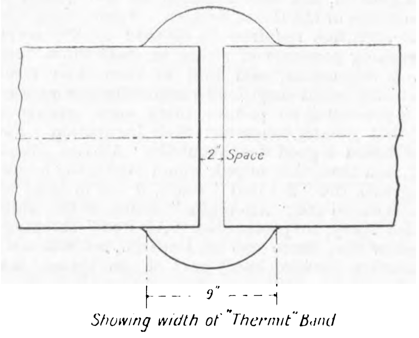


Fig. 5—LONGITUDINAL SECTION AT WELD

The crucible was placed in position, the compound ignited and tapped as soon as the reaction was over. After the weld had cooled sufficiently the mould was removed and the second weld made in the same way. The fractured ends were drawn together while the weld was solidifying to relieve it of contraction stresses. The welds were subsequently annealed for 48 hours. For each weld 18½ cwt. of Thermit compound were used, together with the necessary additions. The weight of the broken casting was about 15 tons.

The repair was carried out by Messrs. Thermit, Limited, of 27, Martin's-lane, Cannon-street, E.C., for a firm of engineers in the Black Country at the end of last month, and occupied ten days from start to finish. The repaired casting appears, so we understand, to have been perfectly satisfactory, and is now again in use. The engravings which, by the courtesy of Thermit, Limited, we give above, speak for themselves and require no explanation.

For those of our readers who are unfamiliar with the Thermit process, we may say that it depends for its action on the affinity of aluminium for oxygen—or, in other words, on the reducing properties of the metal. In practice, a composition made up of a mixture of finely granulated aluminium and the oxides of metals is employed. When steel is to be welded the oxide of iron is employed. This mixture is ignited by means of a special ignition powder, and the combustion when once started spreads through the whole mass, a great heat being evolved, steel being easily melted as well as other refractory metals.

We may add that we are informed by Thermit, Limited, that the British Corporation for the Survey and Registry of Shipping, of Glasgow, has recently sanctioned this process for repairs to fractured stern-posts, lower portions of rudder frames, and other damages of a similar character.

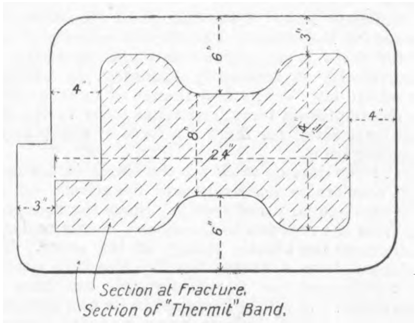
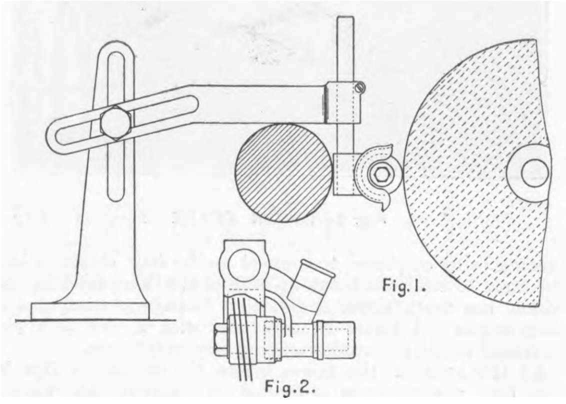


Fig. 6—CROSS SECTION AT WELD

IN the heating and domestic engineering trade disputes have been caused within the last few years in some districts by the action of the plumbers in claiming a monopoly of pipe fitting and fixing work in all metals, whether lead or not, to the exclusion of any other trade. The engineers have all along been willing to submit the matter to arbitration, and a step in this direction has now been taken in connection with a dispute on the New Masonic Hall, Leicester, where the plumbers, in pursuance of their claims, withdrew from their own work. Lead work is not in dispute, as it is not touched by the engineers. After protracted delay the plumbers agreed to the appointment of an arbitrator, who has decided that no claim has been established giving to plumbers the exclusive right to fit and fix all pipes and fittings in hard metals used in connection with ventilation, heating, warming, laundry, cooking, and general hot and cold water domestic or other supplies or services. This award upholds the claim of the heat and domestic engineers to do the work in question, and establishes that all lead work be considered plumbers' work, but that a neutral line be taken as regards all iron, brass, copper, or other metalwork, which may be executed by engineers or plumbers.

DRESSING GRINDSTONES.

THE extensive use of grinding in the machine shop has called into being a number of devices whereby the grinding wheel may be dressed and trued from time to time as occasion arises. In the example of this class of tool herewith illustrated the makers, Messrs. Brunton and Trier, of Great George-street, Westminster, claim to have evolved a design free from certain objections to be found in others, and possessing several virtues of its own. Two forms of this tool are obtainable. In one the instrument is held during the dressing operations by hand against the wheel, and is provided with a hook to catch on the tool rest of the stone. In the other design herewith illustrated, the tool is held securely by an adjustable arm, so that the wheels of grinding lathes and such-like machines can be trued with great accuracy.

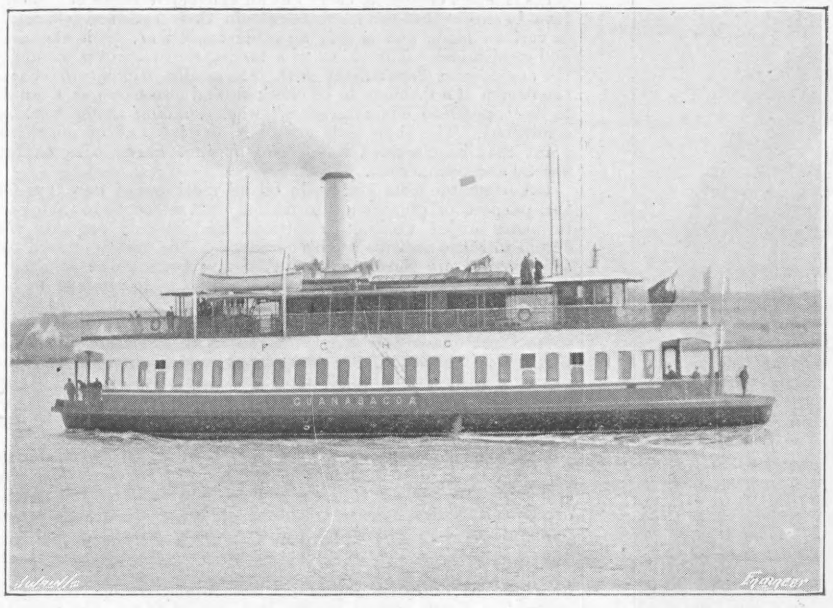


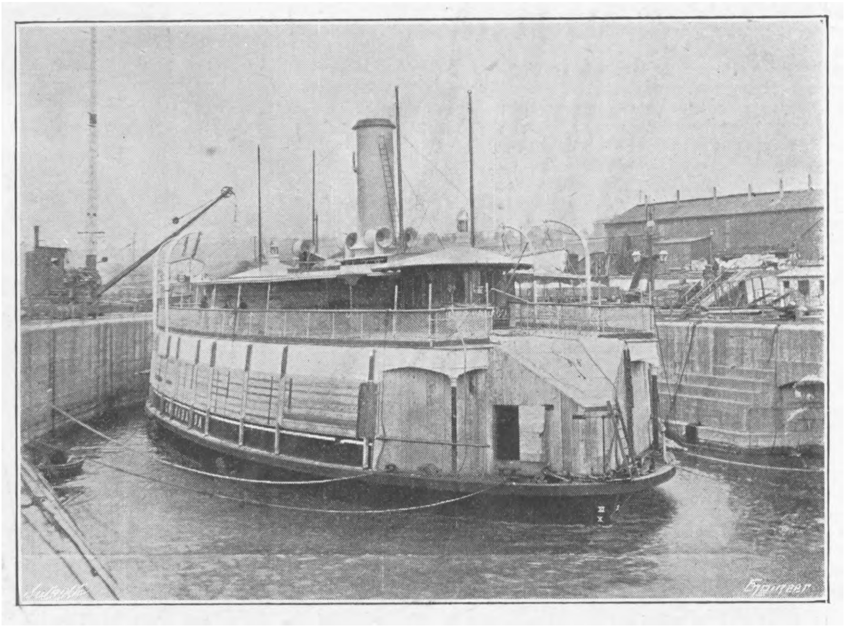
GRINDSTONE DRESSING DEVICE

The form of cutter used will be seen from Fig. 2. A spindle running in a dust-proof bearing carries several discs lying at an angle with the axis of the spindle. These discs are made of specially hardened thin sheet steel and are arranged so that their edges lie on a true cylinder whose axis is coincident with that of the spindle. When the cutter is brought into contact with the emery wheel the oblique setting of the discs causes them to move across the edge of the wheel and thus, by their wedge-like action, they cut down any inequalities or roughness. In Fig. 1 the cutter is shown applied to the wheel of a machine adapted for grinding between centres. The supporting arms are so arranged that the thrust of the wheel on the cutter is taken up by the work in the lathe.

THE FERRY STEAMER GUANABACOA

CAMMELL, LAIRD AND CO., LIMITED, BIRKENHEAD, BUILDERS





THE FERRY STEAMER GUANABACOA.

THERE has recently left the works of Cammell, Laird and Co., Limited, Birkenhead, a double-ended ferry steamer, 140ft. long, 38ft. moulded, 55ft. extreme beam, and 14ft. 3in. moulded depth, the first of her type built in England. The whole of the work, which was completed in the short time of four months from the date of the order, has been designed and supervised by James Pollock, Sons and Co., Limited, of 3, Lloyd's-avenue, London, E.C.

The vessel has two propellers, one at each end. On the official trial which was recently carried out a speed of 11¼ knots, ¾ of a knot over the guaranteed speed, was obtained. The weather was anything but favourable, and as a very strong breeze was blowing at the time, this speed was considered to be an excellent achievement. The vessel is fitted at either end with a Pollock's patented stern frame, which is designed to reduce the friction and to enable the boat to be fitted with a larger propeller than is possible with the ordinary frame. The manœuvring qualities were on the trial found to be good, the vessel turning round a complete circle, in a radius about twice her own length.

The steering arrangements are elaborate, and the following methods can be used from either pilot-house on the promenade deck:—Steering by means of (1) two rudders by steam power, (2) the after rudder by steam power, (3) the two rudders by hand power, and (4) the after rudder by hand power. There are eight distinct and separate arrangements for locking the rudder which is not in use.

The engines, which are of the inverted compound surface-condensing marine type, were built by the contractors, and have cylinders 19½in. and 42in. by 27in. stroke. They indicate 940 horse-power when running at 148 revolutions per minute. They are arranged to drive one propeller at each end through one line of shafting running the entire length of the vessel. The handling gear for the main engines is arranged on a wrought steel quadrant in the engine-house on the main deck.

The docking and handling arrangements consist of a non-reply system of telegraph from each pilot-house leading to one indicator in the engine-house, special transmitters or indicators in each pilot-house, so arranged that the handles are moved in the direction the vessel is intended to travel, and a complete set of jingle and docking bell signals and gongs.

Each pilot-house is fitted with an indicator, so that the captain can ascertain the direction in which the main engines are running, and also the revolutions per minute they are making. A similar arrangement is also fitted in the engine-house for the use of the engineers.

The aft end of the engine-house facing the engine-room is practically all glass, so as to give the engineer in charge of the levers a view of the engine-room and the main engines. The floor is laid with small black and white tiles. A switchboard controlling all the electric lights in the ship is also fitted in the engine-house. The condenser is independent, and is connected to a centrifugal pump and a vertical direct-acting air pump, which maintained a vacuum of 27in. throughout the official trials. The feed pump is of the vertical simplex type, with an automatic control arrangement. Besides these pumps the equipment includes a vertical auxiliary duplex feed pump, which can also be used for general services. A large fire and salvage pump is also fitted.

The Guanabacoa is fitted with a complete electric light arrangement. The wiring is carried out on the two-wire system. The lights throughout the ship are grouped in sections, and each section is controlled by a switch on each deck, these again are controlled by the switches on the main switchboard in the engine-house. Two dynamos are provided, a smaller one is installed for economical reasons and for use when only a few lights are required. The navigation lights are in twin sets, and are controlled by special switches in the pilot-house. They are so arranged that when one set is put on the other set is put out. There is a small pilot light to notify the pilot if the right lights are on or not.

The boilers are of the Babcock and Wilcox water-tube type, two in number. They blow off through a silent blow-off valve at 225 lb. per square inch. This pressure is reduced through a reducing valve to 150 lb. per square inch, under which pressure the engines are designed to work, and steam can be used direct through a by-pass should the boiler pressure be low. All the auxiliary machinery works at full boiler pressure.

The main saloons are arranged on either side of the main deck, the entrance being through double doors opening outwards at either end of the vessel, and from the upper deck by means of a double staircase. The floors are covered with interlocking rubber tiles. Special windows at the side of the vessel, each 5ft. by 2ft. 6in., extend the whole length of the saloons. Seats are fitted all round the saloons. Cartways for the accommodation of vehicular traffic run between the saloons and the engine casings. Collapsible gates are fitted at each end of the main deck in place of the ordinary bulwark gates. The upper deck, which extends the whole length and width of the vessel, has accommodation for about 1000 passengers.

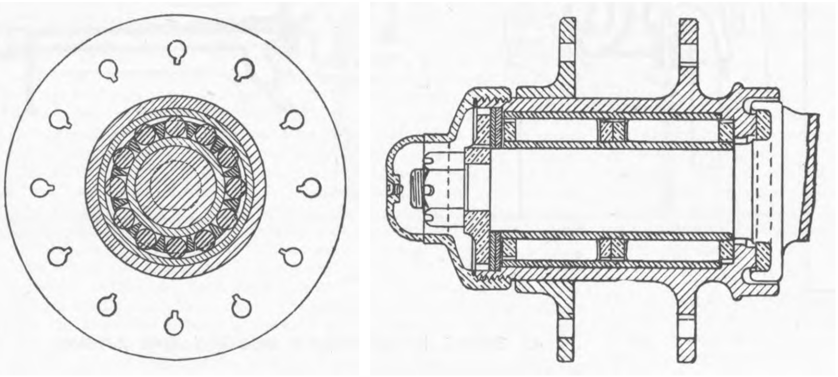
The pilot-houses, which are of teak, have curved plate-glass in front. The floors are covered with interlocking rubber tiles as used in the saloons. All the windows are arranged to lower, and are fitted with plate-glass.

The sun deck, which is 7ft. 6in. above the promenade deck, is of pine covered with canvas and painted green, on which are fitted the side-light screens and the lifeboats, which are of steel; they are arranged to lower overboard by hollow steel davits.

We are enabled to give two views of this vessel. One of these shows her undergoing her official trials and the other gives a view of her as she appeared in dock at Liverpool, boarded up preparatory to making her journey to Cuba, where she is to be employed.

ROLLER BEARINGS FOR ROAD MOTORS.

THE rapid deterioration of the bearings and axles of motor omnibuses is largely due to the excessive friction and the severe stresses called into play by the uneven nature of the surface of the streets and roads over which the vehicles have to pass. Sudden starting and stopping likewise subject the bearings to stresses of a similar nature, and in many cases the wear and tear so caused is a fruitful source of trouble and repairs. To avoid these, and consequently to decrease the cost of maintenance, the Empire Roller Bearings Company, of Westminster, has recently designed and constructed the form of axle arm roller bearings illustrated in the accompanying engraving. These bearings consist of two steel sleeves, the inner forming a bush for the axle journal and the outer a liner for the wheel hub, between which two sleeves hardened cylindrical steel rollers are disposed. The rollers, of which there are two sets in each hub, are prevented from twisting by the patented gun-metal cages which also separate each roller from its neighbours. End collars and nuts of the usual pattern are employed to secure the wheel to the axle, and in appearance the outside view of the bearings is quite similar to that of the ordinary type. The sleeves and rollers are made from a special quality of steel, hardened and ground to a true fit. The design of these bearings is the result of a long experience of, and experiments with, a similar class of goods as applied to railway and tramway rolling stock. We are informed that recent trials with them have shown a considerable saving in petrol consumption, while the small amount of lubricating oil required and the ease with which the vehicles were started, run, and stopped were other marked features of the tests.



ROLLER BEARINGS FOR MOTOR OMNIBUSES

MANCHESTER ASSOCIATION OF ENGINEERS.

ON Saturday last, Mr. J. S. Peck read a paper before the members of the above society on the "Distribution and Application of Electric Power." Mr. J. H. Stubbs, the President, occupied the chair. The author first described in a general way the different systems of generation and distribution. By means of simple analogous diagrams the operations of the various types of electrical apparatus were described in terms easily understood by mechanical engineers. Then, after dealing with general principles, Mr. Peck proceeded to describe some of the most recent types of electrical apparatus, including turbo generators, transformers of various types, rotary converters, current controllers and starting mechanism.

He conveyed as clear a meaning as could be desired in the course of a short paper of the term "power factor," applied to alternating-current work. He said that with direct current the power was equal to the pressure multiplied by the current, just as in hydraulics the power equals the head multiplied by the volume flowing. Where the current was alternating, however, the power was calculated by multiplying the pressure by the current, and by a term called the power factor. The reason for this was that under certain conditions work was done in the circuit during a part of the cycle, and was returned during another part of the cycle, so that the resultant energy supplied over the complete cycle was represented only by the frictional losses. In an electrical circuit power = volts × effective current; but the effective current = total current × $\cos \phi$, where $\cos \phi$ was the angle between current and voltage. But $\cos \phi$ = power factor of the circuit. Therefore the power = watts = electromotive force × current × $\cos \phi = E \times C \times$ power factor.

He remarked that the only really important change made in direct-current motors in recent years was the addition of commutating poles on shunt motors where these are required to give a wider range of speed variation. Before this feature was introduced most manufacturers hesitated to guarantee more than a 2/1 speed variation, whereas a speed range of from 4 to 6 to 1 could now be guaranteed. The use of commutating poles was also coming into favour for large motors and generators even where no speed variation was required, as their use permitted certain economies in the design of the machine. The function of the commutating pole was to give good commutation under severe working conditions.

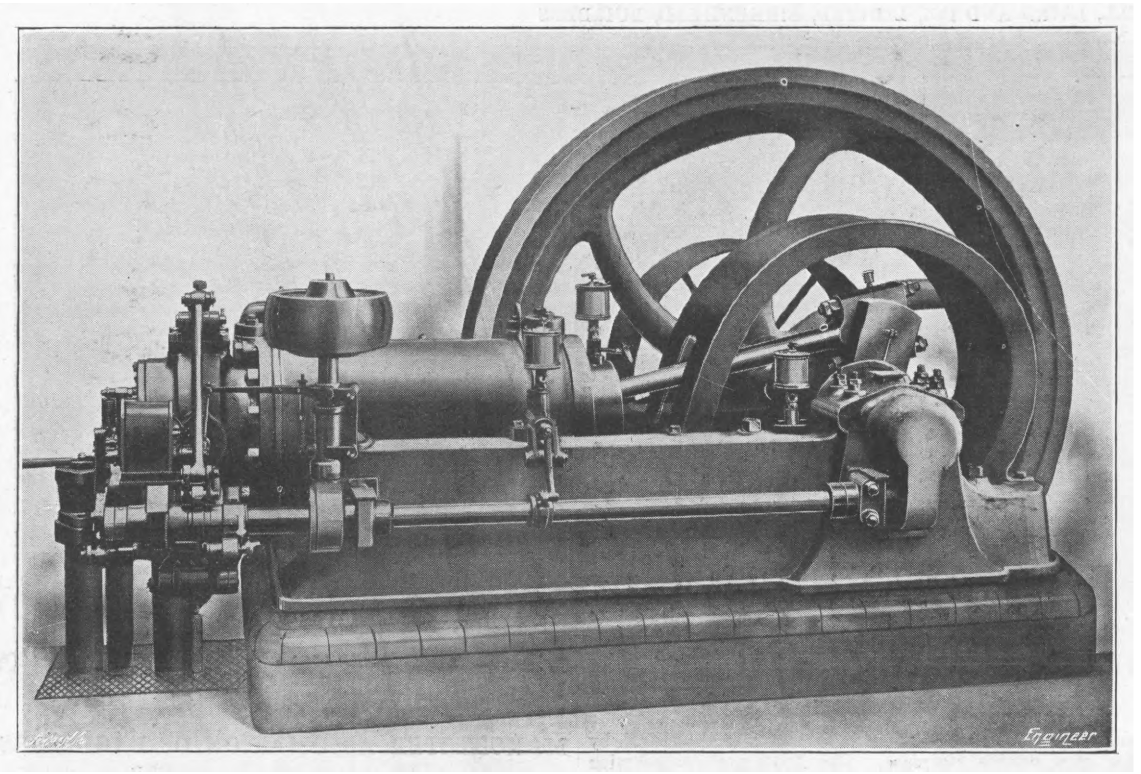
With regard to the synchronous and induction motors the author said that these were constant-speed machines, since the synchronous must run in exact step with its generator, and the induction machine runs at a speed very slightly below synchronism. Except for variable speed working they were, however, successful and efficient machines and had a number of points of superiority over the direct-current motor.

As the paper was not of a controversial character, the discussion which followed was scarcely germane to the subject and chiefly limited to questions of cost of generation of electric energy. In this connection Mr. Creek spoke of the splendid opening which flour mills presented for the use of electric power, as they were run without a break from Monday morning to Saturday night. He said, however, that unless power could be obtained at 0.4 penny per unit, electricity could not compete with steam power in this class of work. Mr. Watson, who followed, said that current could be obtained from power supply stations at even a smaller figure than 0.4 penny. Mr. Cook said that current could not be generated profitably for so small a sum, and spoke of the frictional losses in an electrically-driven cotton mill that he was associated with, due to the lightness of the shafting necessitating pedestals spaced 6ft. apart. Mr. Gass and the President also took part in the discussion.

NEW distant signals with white boards, and electric lights near them, both intended to help the engineman pick up the signals, have, we hear, been placed between Brussels and Antwerp, and are reported to have reduced largely the over-running of signals.

45 BRAKE HORSE-POWER SUCTION GAS ENGINE

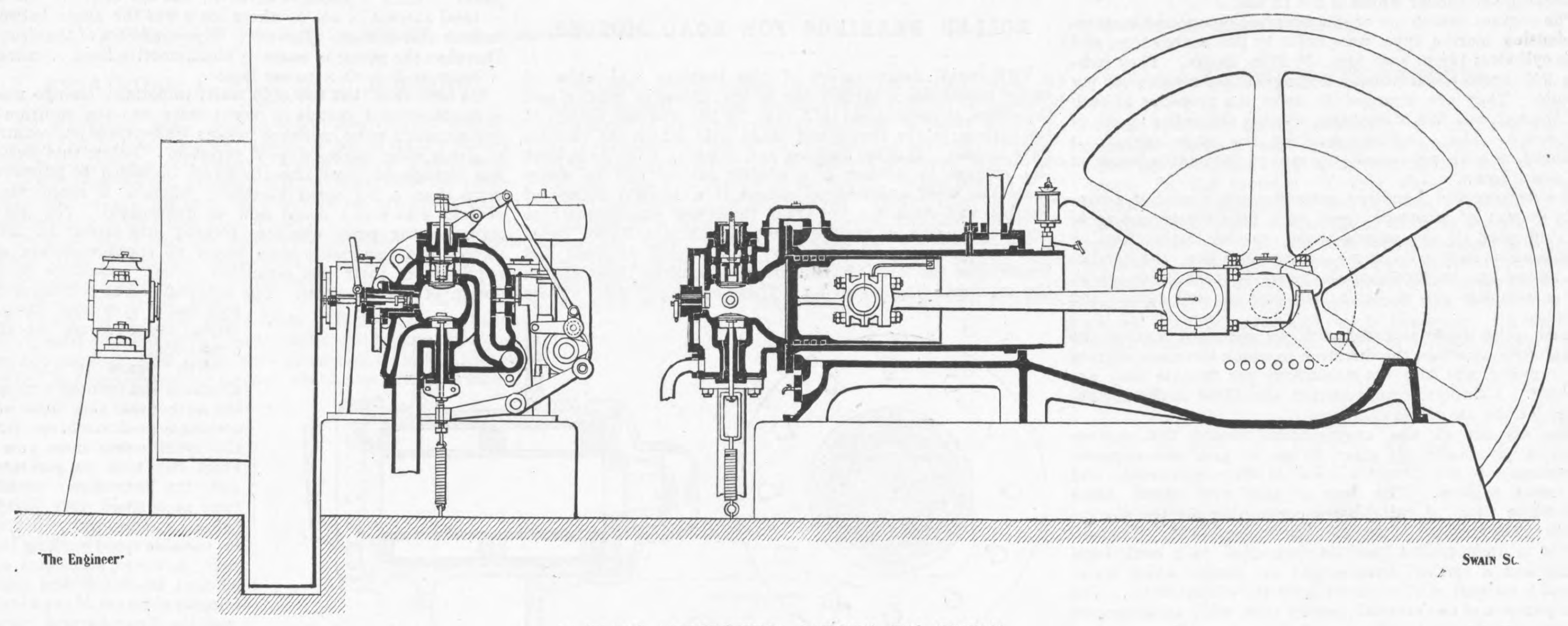
CAPEL AND CO., LONDON, ENGINEERS



SUCTION GAS ENGINE.

THE larger gas engines designed and manufactured by Messrs. Capel and Co., of 168, Dalston-lane, London, have recently been considerably altered in many of their more important details in order to make them on a par with the best British and foreign design in this class of machinery.

The accompanying engraving shows one of the firm's latest engines, and many of the new features embodied are clearly illustrated. Instead of allowing the cylinder to overhang the bed-plate, it will be seen that the latter is now a large single casting supporting the cylinder, with which the water jacket is cast in one for its whole length. A very good arrangement has been adopted with regard to the liner. This is now so made that the joint between the combustion chamber and water space is dispensed with. The liner is held between the main casting and the breech end by means of a flat flange, and as the other end is quite free to move, it is claimed that no distortion can take place due to expansion. In many engines the joint between the cylinder and breech end has often given trouble, and the elimination of this possible source of mischief is pointed out as a good feature of the engine under consideration. Nothing need be said of the piston, which follows the usual practice, except that it is made particularly long in order to permit of a maximum wearing surface. The crank shaft and connecting-rod are cut from the solid, and are not bent or welded in any way. On the fly-wheel side the crankshaft is extended, and is supported by a third bearing, the pedestal of which, however, is not in any way connected with the bed-plate of the engine. On the other end of the crank shaft is keyed the timing gear for the half-speed shaft, the latter being supported at three places by ring oiled bearings.



45 BRAKE HORSE-POWER SUCTION GAS ENGINE

The breech end is a special feature of the Capel engine. It carries the valve and ignition gears, and also forms the combustion chamber. At the back of it there is a cover which enables the whole of the water space to be examined and easily cleaned. The valves are arranged in renewable bushes or sleeves, and are opposite to each other. The gas valve is situated above the air valve, and is on the air valve spindle, so that both valves operated together. The air valve opens about one-sixteenth in advance of the gas valve, so that with low lifts—that is, when the engine is running light—the gas valve may not open at all, or, at all events, only occasionally. This arrangement practically constitutes a hit-and-miss device at lower powers, and at higher powers there is a throttle governor. The latter is of the centrifugal type, and is given a large range of speed, which can be adjusted whilst the engine is running. The governing is accomplished by varying the lift of the inlet valve, thus reducing the compression as the load decreases. It is claimed by the makers that this method gives the best results.

Ignition is by magneto, and two sparking plugs are fitted into the cylinder, one at either side. The timing gear is variable, and this also allows a comparatively large range of speed to be obtained. Another feature of the Capel engine is the elaborate precaution taken to ensure efficient lubrication. The cylinder is oiled by a force pump driven by a cam from the cam shaft, the oil being forced on to the piston rings. The gudgeon pin is lubricated separately from the cylinder by means of a wipe contact and tube, a method which is undoubtedly better than relying upon the cylinder oil to find its way to this vital part. The crank pin is oiled by a centrifugal ring fixed to the crank web, the oil being carried to the centre of the pin and then thrown out from the inside of the crank brass. Oiling rings, dipping into oil troughs situated under the bearings, are adopted for lubricating the main and crank shaft bearings.

The engine, of which we give an illustration, develops 45 brake horse-power when working on suction gas. On town gas the same engine develops 60 brake horse-power. The former figure is the nominal working load, but a maximum of 52 brake horse-power has been obtained on suction gas. The diameter of the cylinder is 13½in. and stroke 21in., and the above powers were developed at a working speed of 200 revolutions per minute. The engines are well finished, and the care bestowed upon the castings and the general workmanship in construction is particularly noticeable.

THE French Chamber of Commerce, in its annual report just issued, points out that although in view of the general depression the trade between France and the United Kingdom may be considered as fairly satisfactory, nevertheless, there has been a falling-off in the exports from France with regard to a considerable number of articles during the last ten years. The decline is attributed to negligence and carelessness on the part of the French producer in packing and preparing consignments.

SHOP TESTING OF DIRECT AND ALTERNATING-CURRENT MACHINERY.*

By J. W. ROGERS.

IT will be generally admitted that the position occupied by the testing department of an electrical works is an important one, as on it depends the quality and satisfactory performance of the plant turned out. In all modern electrical manufacturing concerns it is the custom to carry out an exhaustive series of "shop" tests to ensure that the machines attain their specified efficiency at various loads and satisfy all other conditions, both electrical and mechanical. The object of a testing department is to supply the engineering department with information which will enable the design of a machine to be checked, and also serve as a guide to its "operating characteristics" when running under working conditions. The shop tests generally carried out on electrical plant may be classified under two distinct heads, viz., experimental and commercial.

Experimental tests are made on all machines of new type for the purpose of obtaining information with reference to their performance under working conditions, and also to compare the actual with the anticipated performance. The tests required for this purpose are those of (1) insulation; (2) rating and efficiency. As is well known, the rating of a machine is determined by (*a*) heating; (*b*) drop in voltage or speed, depending on the machine being a generator or motor; (*c*) commutation; a knowledge of these three quantities being obtained from temperature, regulation and commutation tests respectively, under various conditions of loads. As regards the efficiency this may be obtained (1) from the relation between input and output; (2) by calculation of the copper, iron, friction and windage losses, as determined by the resistance, and iron loss and friction tests respectively.

It is the custom to record the results of the experimental tests carried out on new machines in the form of curves, which are systematically filed for future reference, and then in the subsequent testing of duplicate machines of the same design a few observations only are taken for comparison with these curves, and, if they agree, the machine is passed as up to standard.

Commercial tests are made chiefly to locate faults in manufacture due to defective material, bad workmanship, or faulty assembling. Any defect in the iron circuit of a machine would show up in the saturation and temperature tests in the form of (*a*) excessive iron loss at normal excitation, and (*b*) excessive temperature rise of the iron circuit. Generally speaking, the commercial tests for machines of moderate output are (1) iron loss, saturation, and friction, (2) temperature run at full load, (3) insulation, (4) overload and commutation test.

As already stated, it is generally found that all defects in manufacture are shown up in the temperature test, so that the most important shop tests are those for efficiency and temperature. The time taken by a machine to reach its maximum temperature depends upon its output and design, and as it is impossible to obtain a knowledge of the real efficiency until the $C^2 R$ losses reach a constant value, the data from which the efficiency is calculated should always be taken at the conclusion of a temperature test.

As it is impossible to give more than a general outline of the tests carried out by manufacturers in the space at the author's disposal, it will be sufficient to briefly describe the methods of making the various tests and the information to be derived therefrom, dealing first with direct-current machines.

Iron loss, friction and saturation tests of shunt and compound generators and motors.—These tests are most conveniently made by driving the machine to be tested as a generator by belting it to a shunt motor, and measuring the motor input when driving the machine at its rated speed at different voltages. Under these conditions, the total input to the driving motor includes the losses in the motor armature and field + iron loss, brush and bearing friction, and windage in the driven machine. The $C^2 R$ loss in the motor armature will vary with the excitation of the machine on test, but the $C^2 R$ loss in the motor field may be held constant by heating the field before commencing the test, and keeping the terminal voltage constant. The frictional losses may be considered constant if the speed is held constant throughout the test.

The iron loss and friction test consists in taking readings of the motor input under the following conditions:—(1) No excitation on generator; (2) varying exciting current; (3) no excitation on generator with its brushes raised; (4) belt off, motor running at the normal speed of the machine on test. As a check on the correct position of the brushes, it is the custom to measure the motor input when driving the generator excited to give the normal voltage, but with its brushes raised, and if this reading is subtracted from that representing the motor input when driving generator with same excitation and brushes down, the value of brush friction so obtained should correspond with that found with no excitation on generator. If the values of brush friction do not correspond closely, this proves that currents have been circulating in the armature due to the brushes having been wrongly set. The iron loss in watts for any particular value of exciting current or terminal voltage on the generator is given by:—

Motor input (gen. excited) – motor input (gen. unexcited).

Similarly the friction loss is:—

Motor input (gen. unexcited) – motor input (generator disconnected).

As the same readings are required, a saturation test is generally made in connection with the iron loss test. From the results of these tests, an iron loss curve is plotted having watts lost as abscissæ and volts as ordinates, and a saturation curve having field ampères or ampère turns as abscissæ and volts as ordinates.

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* Rugby Engineering Society.

Iron loss, friction, and saturation tests of series motors.—As the series motor is not a constant speed machine, and the iron loss varies with a change in the speed, it is not advisable to employ the same method as that already described, as it would necessitate a number of tests being made at different speeds. A more satisfactory method consists in running the machine as a motor at different speeds and measuring the input which will represent the energy required to overcome the iron loss, friction and windage for any particular value of speed and field current. Having found the combined losses at different speeds, it is necessary to obtain the friction loss at the same speeds, and from these two sets of readings the iron loss at different speeds may be easily calculated. As the speed of a series motor is very high when run light, it is necessary to shunt the armature by a low resistance, so that the field will carry the larger current and thus reduce the speed which may be varied by altering the shunt resistance. The friction and windage losses may be obtained by running the machine at a low voltage with no shunt across the armature, the voltage being gradually increased to get the same range of speeds as when the combined losses were measured. As the field strength under these conditions will be very small, the iron loss may be neglected, therefore the motor input will be a measure of the friction loss at each speed. From the results of these tests, curves are plotted having iron loss and friction, friction, and main ampères as ordinates, and speed as abscissæ.

Regulation and efficiency tests of generators.—As is well known, the regulation of a generator may be defined as the maximum variation of voltage or current which occurs between "no load" and "full load" under normal working conditions, expressed as a percentage of the normal voltage. Generators may be loaded directly on a rack, or water resistance in the case of machines of moderate output, but it is more economical to employ loading back methods when two similar machines are available. Although the Hopkinson test is too well known to need description here, it may be mentioned that when two compound machines are tested in this manner, the machine which is intended to generate the lower voltage and operate as a motor should have its series windings reversed, if the windings are connected to give a constant voltage when the machine is working as a generator under normal conditions.

The readings taken for a regulation test are:—(1) No load reading, with field rheostat adjusted to give normal volts at no load; (2) full load reading, the diverter, if any, to the series winding in the case of compound machines being adjusted, if necessary, to give the normal voltage, without altering the shunt field rheostat. When taking intermediate readings between no load and full load, all adjustments should remain as when No. 2 reading was taken. The data obtained from this test enables regulation curves to be plotted, having values of terminal volts and shunt field ampères as ordinates, and load ampères abscissæ, the efficiency being worked up from these curves in the following manner, taking the case of a compound generator as an example. The values of terminal volts and shunt field ampères, corresponding to any particular value of external ampères are first read off the regulation curves, the various losses being then calculated separately for that particular load.

The total losses = C^2R losses in armature, series and shunt fields + C^2R loss in brushes + brush friction, bearing friction and windage + iron loss. The C^2R loss in the brushes is given by total ampères × volts drop in brushes, this drop in the case of carbon brushes being taken from a standard curve showing the volts drop at various values of ampères per square inch of brush section for that particular quality of carbon used for the machine on test, the current density in the brushes being calculated from

$$\frac{\text{Total ampères}}{\text{Total brush area}}.$$

It is the custom with some manufacturers to debit the engine with the friction and windages losses in the case of engine type generators, but they are always taken into account in belt-driven machines. The various losses having been separated in the manner described above, the percentage efficiency is given by

$$\frac{\text{Watts output}}{\text{Watts input}} \times 100 = \frac{\text{Terminal volts} \times \text{external ampères} \times 100}{\text{Output} + \text{total losses}}.$$

Regulation and efficiency test of motors.—The regulation of a motor represents the change in speed between no load and full load, a regulation test being made by (1) belting the motor to a generator run on water resistance load; (2) loading back on a similar machine; (3) loading on a brake, this being the most direct method of determining the speed regulation of a motor, which, however, can only be carried out on machines of moderate output. The regulation test on a motor is similar to that on a generator, the only difference being that in the case of a motor the speed will be the variable quantity, instead of the terminal voltage as with a generator. The connections for a loading back test are also similar to those required for generators, but when compound motors are tested the series windings should be so connected that their effect is the same in each machine. The readings taken are those of shunt field ampères, armature ampères, speed and terminal voltage, and these results, when plotted with field ampères and speed as ordinates and armature ampères as abscissæ, will represent the regulation speed curve for different loads on the motor under test.

The regulation test of a series motor is made by belting it to a similar machine which is loaded as a generator on a water resistance. The test is started with about 50 per cent. overload, which is gradually reduced, the readings taken being those of terminal volts, field volts, main ampères and speed of the machine on test. As the characteristic of a series motor is such that its speed at any particular load decreases with an increase in the temperature, it is necessary to correct the speeds obtained from the regulation test for a certain standard temperature, which is usually 75 deg. Cent. for enclosed, and 50 deg. Cent. for open-type motors. This correction in speed must be taken into account in working up the efficiency, and may be obtained in the following manner:—The armature and field resistances are first taken at a known temperature, their values at the standard temperature being then calculated. The speed corrected for the standard temperature will then be given by:—

$$\text{Speed from curve} \times \frac{\text{Term. volts} - \text{total drop at standard temp.}}{\text{Term. volts} - \text{total drop at temp. of test}}.$$

The efficiency of motors may be obtained from (1) losses worked up in connection with data taken from the regulation curve, (2) directly from a brake test. When the efficiency is worked up from the losses the values of speed and field ampères corresponding to any particular value of load ampères are read off the regulation curves, the various losses being then calculated in the usual manner. In the case of series motors, the efficiency is worked up from the losses in a similar manner, but the iron, friction, and windage losses must be read off the curves for the corrected values of speed, instead of terminal volts as with shunt and compound machines.

Temperature tests.—The duration of a temperature run and the rise in temperature allowed varies slightly with different makers, but it is the custom to run a machine until the temperature of its various parts becomes stationary. Surface temperatures are taken with mercury thermometers, their readings being checked by calculating the mean temperature rise from the increase in the resistance of the windings. As the resistance of a copper conductor increases by ·428 per cent. per degree C. rise in temperature, the mean temperature rise of the windings is given by—

$$\frac{\text{Hot Resistance} - \text{Cold Resistance}}{\text{Cold Resistance} \times {\cdot}00428}.$$

Insulation test.—As the insulation of a machine is more liable to break down when hot, this is always made at the conclusion of a temperature run. It consists in applying a high alternating current voltage between the armature and field windings and the frame of a machine. In the case of low voltage machines the testing pressure is generally double the working voltage, but, as the factor of safety of a low voltage winding is higher than that of a high voltage winding, the ratio of the testing to the working voltage should be less for high voltage machines to prevent the possibility of damaging the insulation of the windings. The capacity of the testing transformer used for making dielectric tests is a point which requires due consideration, as it is governed by conditions affecting the testing circuit as well as the apparatus to be tested, and this question may be considered as follows:—In virtue of its static capacity, the apparatus to be tested may be considered as a condenser, the charging current of which may be represented by $C = 2\pi \times 10^{-6} \times V \times N \times K$ (assuming a sine wave of E.M.F. applied to its terminals), where C = current in ampères, V = terminal voltage, N = frequency, and K = capacity in microfarads. It follows, therefore, that the charging current taken by the apparatus to be tested is proportional to its static capacity, and varies directly as the frequency and testing voltage.

The apparent output of the testing transformer would be proportional to the square of the voltage, and may be calculated from the formula given above when the static capacity of the apparatus to be tested is known. The C^2R losses in the insulation are generally very small compared with the charging current, and may, in the majority of cases, be neglected. The dielectric loss has, however, an appreciable effect on the output of the testing transformer when the testing pressure approaches the disruptive strength of the insulation, and as this loss varies directly with the frequency, it should be taken into account when calculating the capacity of a testing transformer to be used for disruptive tests. The frequency of the testing circuit also governs the size of the transformer for a given output, which varies inversely as the frequency. It follows from the above remarks that (1) for a given output the lower the frequency the larger will be the transformer required; (2) for a dielectric test under given conditions the higher the frequency of the testing circuit the larger the capacity of the testing transformer.

An important test coming under the heading of experimental testing which may be mentioned is that known as a distribution or field-form test. It is sometimes made on machines built to a new design for the purpose of determining: (1) the character and strength of the field; (2) the maximum difference of potential between commutator segments; (3) the variation in field strength, and whether it can be improved by altering any constructional details. The machine to be tested is first run light as a separately excited generator, to obtain a potential curve representing the field form with no current in the armature. It is then run on full-load as a generator or motor, as the case may be, at its rated output and speed, to determine the full effect of armature reaction under normal working conditions. The results of a distribution test may be shown graphically by making the horizontal scale represent the distance between the positive and negative brushes, and the vertical scale the volts generated at each point, and a comparison of curves so obtained will plainly show the effect of armature reaction on the field.

Having considered the shop tests it is usual to carry out on direct-current machines, reference will now be made to the testing of alternating current plant.

Alternating-current generators.—The experimental tests carried out on alternators are those for (1) Iron loss saturation and friction; (2) regulation and efficiency; (3) short circuit. As the first test has already been described in connection with the testing of direct-current machines, it will not be considered here. The regulation of an alternator may be defined as the percentage rise in voltage which takes place when full non-inductive load is thrown off, the speed and field current being held constant. The test consists in running the machine at its rated output and speed, with the current in phase with the terminal voltage, a regulation curve showing a varying field charge with a constant terminal voltage. A full-load test can only be made on machines of small output unless two similar machines are available, in which case loading back methods may be employed. A loading back test is made by coupling the alternator shafts together, and also to a direct-current motor of sufficient capacity to supply the power lost in both machines. The efficiency of motor being known, the power supplied may be easily calculated. The two alternator armatures are short-circuited on each other through an ammeter in each phase, the load current being made to circulate between them by weakening the field of one machine, thus causing it to act as a motor and help to drive the other as a generator. The P.F. of the load may be varied by altering the connections between the two armatures, so that there is a phase difference between their E.M.F.'s, and when the relative position of the two armatures is such that their E.M.F.'s are in direct opposition, the power factor will be approximately unity. The efficiency is worked up from the losses in the same manner as with a direct-current generator, the only difference being in the method of calculating the C^2R loss in the armatures of two and three-phase machines.

Short-circuit test.—This is made chiefly to determine the self-induction of the armature, and also the effect of armature impedance in reducing its terminal voltage when the machine is run at constant speed with various values of exciting current. A series of readings is taken connecting the armature current with the exciting current, and from the results of this test a short-circuit characteristic curve may be plotted, which is generally found to be a straight line. The connection between the short-circuit test and the regulation of an alternator may be considered as follows:—When it is impossible to run a machine at full load, its regulation may be calculated from the data given by the open-circuit and short-circuit characteristics, in the following manner. The volts drop due to the armature resistance are calculated for a given load, and added to the terminal voltage on open circuit. The exciting current corresponding to this total voltage is then read off the no-load saturation curve, and its value added vectorially to the value of field current required to give the same load when the armature is short-circuited. The voltage corresponding to this resultant field current is then read off the open-circuit saturation curve, and the difference between this voltage and the terminal voltage expressed as a percentage will represent the regulation of the alternator at that particular load. Perhaps an example of this method of determining the regulation, which is used to great extent in American practice, may be of interest, and the following data refers to a 150-kilowatt three-phase alternator. The total armature resistance of this machine at standard temperature = $.024^{w}$; total ampères = 340; C.R. drop in armature = $.024 \times 340 = 8.2$ volts.

∴ The sum of the terminal volts and C.R. drop = $440 + 8.2 = 448.2$ volts.

The exciting current required to give this voltage, as taken from the saturation curve = 42.5 ampères also, the field current required to give 340 ampères on short-circuit = 15 ampères as taken from short-circuit curve. The vector sum of these two values of exciting current = $\sqrt{42.5^2 + 15^2} = 45$ ampères, and the volts corresponding to this resultant field current was shown by the open-circuit saturation curve to have a value = 470 volts.

∴ The regulation at full load with a constant field current =

$$\frac{470 - 440}{440} \times 100 = 6.8 \text{ per cent.}$$

Commercial tests.—As regards the commercial testing of alternators, the tests generally made are those of:—(1) Polarity, (2) temperature, (3) insulation. With machines of moderate output, the temperature test consists in running the machine on full load, but in the case of large machines it is the custom to run them on open circuit with the field current required to give the normal voltage at full load, this test being followed by a run on short-circuit with the field adjusted to circulate the full load current in the armature.

Induction motors.—The tests generally made on induction motors to determine the iron loss, saturation, efficiency, &c., are those of (1) resistance, (2) saturation, running light, (2) torque locked saturation and impedance, (3) power and slip, and these may be considered separately as follows:—

Saturation tests.—These are made for the purpose of checking the design of the magnetic circuit. The motor is first run light at various voltages, commencing with a voltage about 25 per cent. above the normal, the readings taken being those of ampères per phase, terminal volts and real watts. From the result of this test curves are plotted having total ampères and watts as ordinates and terminal volts as abscissæ. The ampères curve may be compared to the saturation curve of a direct-current machine, and from it the magnetising or no-load current taken by the motor at different voltages may be obtained. Strictly speaking, the magnetising current is slightly less than no-load current, as a certain part of the latter is spent in overcoming the loss due to hystereses and eddy currents. The primary current taken by an induction motor is the resultant of two components, viz: (1) an energy component which is in phase with the terminal voltage and does useful work; (2) an inductive component, which represents the wattless part of the current, lagging 90 deg. behind the terminal voltage. The apparent input to the motor

$$= \sqrt{\text{energy component}^2 + \text{inductive component}^2},$$

∴ the inductive component

$$= \sqrt{\text{apparent input}^2 - \text{energy component}^2}$$

That is to say, the true magnetising current

$$= \sqrt{\text{total current}^2 - \text{energy current}^2};\ \text{where energy current} = \frac{\text{Real watts}}{\text{Terminal volts}}.$$

The watts curve represents the iron loss and friction at different terminal volts.

The information to be derived from the curves of locked saturation enables the inductive component of the volts, and also the effect of magnetic leakage to be calculated. A knowledge of the starting torque of the motor at different voltages is also obtained from this test, which is made by fixing a brake arm to the shaft, and connecting the motor to the supply circuit in a similar manner to that required for a running saturation test, the torque being measured by means of a scales or spring balance. The motor is supplied with a low voltage, which is gradually increased to its normal value—if the capacity of the generating plant and the design of the motor permits—the readings taken being those of terminal volts, ampères per phase, real watts, and torque. The results of this test may be shown in the form of curves having kilowatts, total ampères, and pounds torque as ordinates and terminal volts as abscissæ. A test sometimes made at the conclusion of the locked saturation is that known as the pulling out or maximum torque test, the voltage at which it is desirable to make it depending upon the output and characteristics of the motor. The resistance of the rotor circuit also has an important bearing on this point, owing to the fact that the pulling out torque is very much greater than the starting torque when the resistance of the rotor circuit is low. It follows, therefore, that the current taken by a large motor to give its pulling out torque at normal voltage is liable to reach an enormous value, and for this reason it is advisable to take the pulling out torque at a voltage considerably below the normal. This test is made by adjusting the voltage to its required value, which must be held constant. The brake is then tightened and balance adjusted on the scales until the motor slows down rapidly without increasing the torque. The actual pulling out point is reached when the motor begins to slow down, at which instant readings of the terminal volts and scales are taken. In connection with the locked saturation test, it is the custom to take two sets of readings of terminal volts, ampères per phase, and true watts, corresponding to the different positions of the rotor with respect to the stator, which give the maximum and minimum values of stator current, the terminal voltage being first adjusted to give the normal full-load current in that winding, and then held constant.

Power and slip curves.—These consist of a series of curves representing the complete performance of a motor. They may be obtained either (1) directly from a brake test in the case of small machines, or (2) by calculation from the losses. The motor is run at various values of torque, representing different loads, its full-load torque being calculated from the output and speed at that point. A complete set of readings covering about 25 per cent. overload is taken at each point, consisting of terminal volts, ampères per phase, true watts, torque, motor and generator speeds. When the power curves are to be worked up from the losses a speed curve is also required, and may be obtained by belting the motor to a generator of sufficient output to give it a 25 per cent. overload, the readings taken being those of motor and generator speeds, terminal volts, and ampères per phase, from which a curve is plotted, having total ampères as abscissæ and speed as ordinates. When a slip indicator is not available, the slip may be calculated from the motor and generator speeds by means of the formula—

$$\%\ \text{slip} = \frac{\text{generator speed} - \text{motor speed}}{\text{generator speed}} \times 100.$$

This completes the series of shop tests from which are obtained the data required to work out the true performance of an induction motor.

Synchronous motors.—The experimental tests made on these machines are those of (1) resistance, (2) open and short-circuit characteristics, (3) iron loss, saturation, and friction, (4) efficiency, (5) regulation and V curves. These tests are practically the same as those carried out on alternators, and are conducted in a similar manner, with the exception of those for regulation and V-curves, which may be considered as follows:—As is well known, a synchronous motor may be made to operate at various power factors by altering its field strength, and when the excitation is such that the impressed voltage

$$= \sqrt{(\text{C.E.M.F.}^2 + \text{C.R. drop}^2 + \text{reactive drop}^2)},$$

the armature current will be exactly in phase with it, and the power factor will be practically unity, the current input to the motor being then a minimum. Any further alteration in the exciting current will then give rise to a leading or lagging current, which will cause the current input for any particular load to increase. It follows, therefore, that every load has its corresponding value of excitation which enables the motor to operate with the smallest armature current. This variation of the armature current with the excitation is one of the most important characteristics of a synchronous motor, and the curve representing such variation is, owing to its shape, known as a V curve. The data for these curves are obtained by running the motor on "no load," "half load" and "full load" at different exciting currents, and taking readings of armature and field ampères.

A reference to the curves so obtained will show that the armature current varies to a greater extent, and that the angle of the V is more acute at "no load" than is the case when a motor is loaded, the variation in armature current for any particular value of excitation decreasing as the load increases. There is consequently a wider variation in the power factor for different values of the exciting current when a motor is running light than when loaded. The regulation curve of a synchronous motor shows the relation between the excitation and the armature current at unity power factor. This test is made by belting the machine to a direct-current generator of sufficient output to give it a 25 per cent. overload, and adjusting its excitation so as to obtain unity power factor at all loads. The wave forms of the motor and the supply circuit should be similar, and the terminal voltage and frequency held constant during the test, the readings taken being those of armature and field ampères. The efficiency is worked up from the data given by the regulation curve so obtained in the same manner as with an alternator.

Rotary converters.—The experimental test carried out on converters are those of:—(1) Iron loss, saturation, and friction; (2) short circuit; (3) efficiency and compounding; (4) commutation.

Iron loss, saturation, and friction.—This test is made in the same manner as with an alternator, but when taking the saturation it is necessary to measure both the alternating and direct-current voltages so that there will be two separate saturation curves from which the average value of the voltage ratio may be calculated by reading off the curves the values of A.C. and D.C. volts for the same value of exciting current.

Short circuit.—This test is made on the direct-current side for the purpose of testing the commutation in a weak field; it also serves as a temperature test in the case of large converters. It is made by belting the machine to a shunt motor and short-circuiting the armature through an ammeter. The converter is then run up to its normal speed with its field separately excited, the excitation being gradually increased until the armature current reaches its full-load value. The readings taken are those of field and armature ampères, which, when plotted, will represent the short-circuit characteristic on the direct-current side of the converter. A short-circuit test on the A.C. side is carried out in a similar manner, the readings taken being those of armature and field ampères, and kilowatts, the short-circuit characteristic being represented by curves having armature ampères as abscissæ, and field ampères and kilowatts as ordinates.

Compounding and efficiency.—A compounding test, which is really a form of regulation test, is made to show the relation between the kilowatts output and the terminal voltage on the direct-current side, and the most satisfactory method of making this test is to run the machine with a constant field strength, so that the generator voltage will increase with the load current. The efficiency of a converter may be obtained (1) directly from a full-load test; (2) by calculation from the losses. The first method consists in running the machine on full load at unity power factor, and measuring the A.C. input and D.C. output, the efficiency being the ratio of these two quantities. When the efficiency is worked up from the losses, these are calculated for different outputs on the direct-current side, the efficiency being given by—

$$\frac{\text{Output}}{\text{Output} + \text{losses}}.$$

The copper loss in a converter armature is calculated for values of equivalent currents, and not the load current, as is the case with a direct-current generator.

The commercial tests made on converters are those of—(1) Polarity; (2) synchronising; (3) temperature; (4) insulation.

Synchronising.—The object of this test is to obtain data showing the conditions under which a converter may be synchronised with the line when started up from its A C. side. Before starting the test the brushes on the D.C. side should be set on the neutral position, and the voltage and current required to start the starting motor should be taken with the shunt field of the converter open, so that the friction loss may be calculated. When the exact moment of synchronism is reached as indicated by the synchronising arrangement used for this test, readings are taken of the shunt-field current, D.C. voltage, and terminal voltage on the starting motor, this data serving as a guide to the operation of synchronising the converter.

Temperature and insulation tests.—A temperature run on full load is only possible with machines of moderate output, and in the case of large machines they are run short-circuited on the D.C. side with the field separately excited to give the full-load armature current. This test is followed by running the machine self-excited on open circuit, the exciting current being about 25 per cent. above its normal value. The insulation test for converters generally consists in applying an alternating voltage equal to double the working voltage between the armature, field windings, and the frame of a machine.

Motor generator sets.—It is the custom to carry out the usual experimental and commercial tests on each machine separately when the set is the first built to a new design, the combination being then run on full load either directly or by loading back when two similar sets are available. In conclusion, the author has attempted to give a general description of the tests it is customary to carry out in modern testing shops, and although the subject treated will be familiar ground to many members of this Society, it will, it is hoped, be at least of interest to some.

THE INSTITUTION OF CIVIL ENGINEERS.

MARINE PROPULSION BY ELECTRIC MOTORS.

At the ordinary meeting on Tuesday, the 7th December, Mr. James Charles Inglis, President, in the chair, the paper read was "Marine Propulsion by Electric Motors," by H. A. Mavor, M. Inst. C.E. The following is an abstract of the paper:—A comparative study of the methods of applying power on land to the propulsion of vehicles and other purposes, and of the methods adopted at sea, shows that, while the problems have much in common, there are differences in methods and in experimental results which have mutually interacted from time to time between land and sea practice, tending towards assimilation, with a gradual improvement in the economic results in both cases.

At first sight it would appear that on a ship the direct connection between the power generator and the propeller renders unnecessary the use of any intermediate transmission device, and so long as reciprocating steam engines were the best attainable power generators it was possible to correlate the speeds of generator and propeller so as to gain the best efficiency of each. The steam turbine and the non-reversible internal combustion engine introduce a new set of conditions. On land the turbine holds the field for the largest powers, and because its speed of revolution is unsuited to ordinary mechanical direct application of power for industrial purposes, its evolution has been directly associated with electrical transmission. These turbines are many of them of the same order of magnitude as the turbines used on shipboard, and therefore a comparison of economy in the two conditions is inevitable.

Before the introduction of electric transmission the marine engineer had the more complete scientific data, and consequently the marine engine held the blue ribbon of economy which now belongs to the turbo-electric generator. Among the reasons for the higher efficiency of the land turbines are:—That the engineer on land is freer than is the marine engineer to adopt a suitable speed of revolution; that the land turbine runs at approximately constant speed for all loads, and can therefore be run on the governor, rendering easier the application of superheat and augmented vacuum; that on land it is possible to subdivide the power-units to meet the conditions of varying load, and thus maintain at the smaller loads an efficiency not materially different from the efficiency at the full load of the system; that at sea change of power is directly associated with change of speed, and the whole of the power-units must always be in motion while the ship is in motion. The same engine has to run the ship at 10 knots and at 20 knots, although the power varies very widely between those limits. Also the high economy on land of power-production associated with electric transmission is largely due to the possibility of exact measurement of power under all conditions of load, giving a complete knowlege of the effect of all changes in the apparatus or in the methods of working it.

The proposition here made is to provide an electric equipment intermediate between the prime mover and the propeller, extending the limits of practical economy in each by modifying the restrictions which the prime mover and propeller impose upon one another, and providing that the prime mover may operate at or near the constant speed required for the attainment of maximum efficiency and full power, and that the power expended in driving machinery not required for work is reduced to a minimum or entirely eliminated. At full power all the elements of the generating plant are in full operation and the whole power resources can be concentrated on driving the ship. When full power is not required the generating plant may be shut down in sections. To accomplish these ends special motors have been designed, which give the necessary changes of speed and direction and permit of the advantageous combination or elimination of the power generators. These motors involve no new electrical principle, but simply mechanical adaptation of well-known electric designs. Alternating current alone is available for the purpose in question, and normal motors have therefore a fixed speed of rotation which is a simple multiple of the generator speed.

Two methods of speed change are proposed each associated with a new form of motor. The principle of operation of the "Spinner" motor is that an ordinary normal motor driving the propeller at a fixed speed, with the shaft and propeller directly connected, is so arranged as to be rotatable as a whole about the propeller-shaft axis. This rotation is accomplished by a second motor concentrically arranged outside the first, so that the main motor system may be rotated in either direction—again at a fixed speed which is a simple multiple of the generator speed—and the speed of rotation of the propeller-shaft and of the propeller in the water is the algebraic sum of the rotation of the main motor and of the rotation imposed upon it by the auxiliary motor. As both motors are reversible it will be seen that in each direction there are three speeds:—(1) The speed of the main motor system—the middle speed; (2) the speed of the main motor system minus the speed of the auxiliary motor system—the low speed; (3) the speed of the main motor system plus the speed of the auxiliary motor system—the full speed. The combination may be designed for any three-speed ratios, such as 1, 2, 3; 2, 3, 4, &c. Any intermediate speeds required are attainable by adjustment to the turbine or engine governor, which can be operated economically through a range down to about 75 per cent. of full speed. The same method is applicable to non-reversible internal-combustion engines.

The "Multiple" motor is an ordinary squirrel-cage induction motor in all respects, except that its stator is wound with two or more independent electric circuits each associated with a separate source of supply of energy. For example, the motor may be fed from two sources of supply at 25 and 50 periods respectively, the motor windings being for 46 and 92 poles. At full power and speed both windings are in operation under their most advantageous conditions; each of these windings results in a synchronous speed of 66 revolutions per minute. When the 25-period current is supplied to the 92-pole winding the speed is 33 revolutions per minute. Either of these motors permits of one or more generators being used together in the same mechanical system without electrical connections or synchronising devices.

The author then goes on to discuss the application of electric propulsion to certain definite types of ship, and also gives diagrams illustrating the saving in space obtained. The examples worked out are as follows:—(1) In a cargo vessel of 840 shaft horse-power the normal reciprocating engine equipment with a single screw would weigh 570 tons for engines, boiler, and fuel. The electrical equipment, consisting of three oil engines, three motors, and three propellers, would weigh only 270 tons, including fuel. Further, with coal at 20s. per ton and oil at 40s. per ton, the saving in fuel cost on a total of £17 would be £5 6s. per day at full power. (2) In a similar cargo vessel gas engines might be used. Taking an equipment of 770 shaft horse-power, and using three gas engines and one multiple motor, the respective weights of the normal and proposed equipments would be 446 tons and 229 tons. The consumption of fuel shows an equally favourable comparison. (3) A third cargo vessel, but of 1030 shaft horse-power, is worked out for the purpose of illustrating the application of steam turbines to the multiple motor. One plant drives the ship under normal conditions; extra power is supplied by a small turbo-generator, and is used to keep up the ship's speed in heavy or contrary weather. (4) On a passenger vessel of, say, 16,200 shaft horse-power, the electrical equipment permits of a sub-division of the plant, so that at ship speeds lower than the maximum only part may be run, and that at full power. The advantage is gained without loss in full power economy, and without additional complication.

PASS LIST (*Interim*), OCTOBER EXAMINATIONS, 1909.

Studentship (69).—C. J. Allen, A. C. E. Anthony, J. T. Aslin, A. J. B. Atkinson, W. Barrington, J. H. Berry, E. Black, E. A. Black, F. T. Blythe, C. W. Boyle, R. W. Brims, J. Brooks, T. E. Brydon, A. M. S. Burn, F. J. Burns, P. F. Campbell, W. H. A. Chester, G. A. Clark, F. H. Colebrook, W. R. Cooper, A. S Culham, J. T. Currie, B. N. Dutta, E. J. E. Everett, K B. Findlay, L. E. Garbutt, G. Glanville, T. C. Gray, T. R. Hancock, A. C. Harland, B. A. E. Heilig, F. E. Henson, W. A. Hine, C. R. Hollingsworth, H. S. Hornby, H. Y. Hsu, G. G. Jackson, G. F. C. Jonas, E. C. Last, C. V. M. Lewis, A. McColgan, D. R. Mackie, J. A. Manners-Smith, F. W. Meyer, L. W. Nott, F. E. Oakes, A. C. V. Orrell, C. R. Otto, G. N. Parker, W. E Parker, R. D. Patterson, K. N. Pearson, C. A. Phillips, H. A. Rhodes, H. W. Richards, L. E. Sawyer, R. A. Shiell, W. L. Siddle, P. B. Smith, R. F. Speir, E. L. Stainbank, G. K. Sutherland, T. J. Taplin, jun., J. C L. Train, R. B. Walker, L. G. Walters, E. C. Whelan, J. H. Wiles, F. S. Wilkinson.

Associate Membership: Candidates Examined in London (195): *Whole Examination* (99).—M. K. Ahmed, C. V. Albrecht, W. G. Anglesea, H. F. Anns, W. K. Bartley, E. L. Bascombe, B. H. Bayliss, J. Beer, C. S. Berry, H. H. Bird, E. H. Bond, N. E. Brooks, A. E. Brounger, A. G. Brown, P. C. Burnett, E. L. W. Byrne, S. J. N. Carrington, S. F. R. Carter, R. A. M. Cecil, A. Cooper, H. W. B. Cotterill, J. F. Craig, H. B. Dart, E. A. H. Daw, C. E. Dickinson, H. M. Dunkerley, H. M. Edmunds, G. E. Edson, E. A. Evans, R. Foster-Palmer, D. W. Gollan, C. Gorman, K. D. D. Grazebrook, L. W. K. Greiff, A. E. Griffiths, K. B. Griffith-Williams, W. E. R. Gurney, H. L. Guy, A. D. Harrison, A. J. Hart, C. E. Harvey, J. L Hodgson, S. J. Hunter, A. G. Ingham, W. Jaggar, D. Kennedy, W. H. Kirby, A. S. Knox, J. S. Laing, R. W. Landon, B. R. Leapingwell, W. S. Lloyd, G. O. Lockwood, A. N. Lucey, T. S. Malik, R. H. May, W. E. W. Millington, A. S. F. Mody, W. H. Morgan, N. Murray, R. Nelson, P. G. Norman, S. J. Norton, W. J. Norton, E. A. Oliver, J. A. Orrell, H. B. Parrott, A. S. Parsons, J. K. Partridge, V. N. ff. Powell, R. C. Pratt, H. Raj, G. E. Rhodes, E. M. Rice, L. H. Richards, H. Robbins, F. Round, G. K. Rouquette, U. S. Row, T. R Sewell, C. D. Sheldon, M. Sinclair, A. Slater, C. Smith, S. W. Smith, H. H. M. Spink, E. S. Stanford, A. F. V. Stephenson, A. C. B. Taylor, J. A. Taylor, L. G. Tessier, H. Thackeray, A. W. Thomas, J. T. V. Twest, M. Wilks, P. D. Wilson, T. W. Wishlade, M. Wynne-Jones, S. Yates.

Section B of Part II. (48): *Previously passed in Part I. and Section A of Part II.*—H. A. Alexander, F. A. Atkinson, G. R. Atkinson, R. G. Bartholomew, G. S. Baxter, M. N. Bowmer, J. S. Bullough, V. C. D. B. Carpenter, H. F. Coales, G. Cooper, H. A. Cox, G. K. Dalal, H. Dyson, P. N. Fawcett, D. Furness, J. R. Gill, T. C. F. Greenway, J. S. Guthrie, A. G. Haigh, S. St. G. Harvey, F. Horspool, W. P. Hulton, S. J. Kirby, K. M. Kirkhope, R. C. Y. Kirkpatrick, T. F. Linnell, R. W. Lister, F. T. Murray, W. W. Newman, L. F. W. Nolan, E. G. Parker, P. I. Payne, C. A. Pollock, J. W. Revell, R. W. Richardson, B. R. Saberwal, J. H. Samuel-Yates, J. G. Scoular, J. Scruby, P. K. Shinde, C. V. Stephens, H. Taylor, J. C. Telford, G. G. Terrell, P. Trump, R. A. Wallace, E. G. Woodward, A. Young.

Part I. and Section A of Part II. (48):—E. S. R. Adams, J. G. Ambrose, E. J. Attenborough, C. G. H. Bellamy, A. W. Brayshay, J. Broadhead, H. P. Clarke, C. A. Dickinson, P. C. D. Douglass, B. P. Ellis, J. Ferguson, D. C. Fletcher, H. F. Fox, A. Gidley, C. Glenday, R. W. Ham, H. Hamer, W. Houghton, T. H. Leader, G. M. Lembcke, A. E. Loach, W. G. McFadyen, D. N. Macpherson, A. S. Marr, I. Meerza, E. A. Mills, J. R. Moreton, E. Morgan, J. Mulcahy, P. F. Murphy, L. Napier, A. L. Ohlson, A. G. B. Palmer, C. St. L. Perfect, V. C. Peycke, A. C. Pratt, H. D. Roberts, S. D. Shroff, S. Simaika, J. M. Simpson, E. L. Sladen, J. R. Smith, N. Smith, V. F. Stephens, A. C. Thomson, F. D. Tunnicliffe, B. N. Weekes, A. E. Wheatley.

AUSTRALIAN NOTES.

(*From our own Correspondent.*)

Queensland Railways.

From the report of the Queensland Railway Commissioner for the year ended June 30th last, the following information is obtained:—During the year 138½ miles of new line have been opened for traffic, and a further 376 miles are under construction, which are expected to be opened in the course of a few months. As in some of the other Australian States, there is a strong cry for the duplication of the existing lines to cope with the ever-increasing traffic, and it is intended to ask Parliament for a vote of £100,000 to be spent next year in providing duplications for these railways. The revenue shows satisfactory increases in all branches over the previous year, as under:—

	£	
Coaching traffic	55,721	increase
Minerals traffic	2,969	,,
Agricultural produce	8,124	,,
Wool	23,016	,,
General merchandise	20,408	,,
Live stock	42,000	,,

Working expenses show an increase of £173,362, the principal increase being £71,946 on maintenance of way and works. It involves the cost of relaying. A number of composite lavatory coaches have been added to the branch lines, and fitted with electric light. Fifteen carriages of special design are now in course of construction in the railway workshops, and are intended for the Sydney mail trains.

Results of working, compared with the corresponding period of the previous year, are as follows:—

		Year ended June, 1909.	Year ended June, 1908.
Capital cost of construction	£	23,396,322	22,575 603
Length of line, miles		3,497½	3,350
Average miles open for the year		3,444	3,230
Goods earnings	£	2.103,119	1,950,881
Working expenses	£	1,227 098	1,053,736
Net earnings	£	876,021	8 7,145
Working expenses to gross revenue, per cent.		58.35	54.01
Train miles		7,391,332	6,557,723
Tonnage carried (exclusive of live stock), tons		2,483,413	2,423,529
Locomotives, number		428	368
Carriages, number		493	474
Goods stock, number		8,581	8,093
Brake vans, number		131	120

South Australian Railways.

The best indication of the prosperity or decline of the business of a country is the comparative results of the railways. This is exemplified in the case of the South Australian railways—the report of the Commissioner for the year ended June 30th last having now been published. In consequence of the prolonged strike at Broken Hill and the suspension of operations at the mines, the total receipts of the Barrier traffic showed a decrease of £198,653. The decrease in minerals carried, compared with the previous year, was 180,583 tons. There was a gratifying increase in the tonnage of wheat carried, and the consequent result was an increase in the receipts under this item of £25,353, and in live stock showing an increase of £20,188. An average distance of 123.42 miles was run for all the goods and live stock, as compared with 120.73 miles for the previous year. On June 12th last Mr. A. G. Pendleton, C.M.G., retired from the position of Railway Commissioner, after being connected with the railways of that State for thirty-two years, during the first eighteen years of which he occupied the position of General Traffic Manager, and the last fourteen years as Railways Commissioner. The position of Railways Commissioner has been filled by Mr. A. B. Moncrieff, who was formerly the Chief Engineer to those railways.

		Year ended June 30th, 1908.	Year ended June 30th, 1909.
Miles open at close of year, 3ft. 6in. gauge		1,280	1,289¾
,, ,, 5ft. 3in. gauge		599¼	599¼
Average miles open for the year		1,860½	1,881½
Capital cost on miles open	£	13,909,635	14,157,245
Average cost per mile open	£	7,402	7,498
Gross earnings	£	1,741,259	1,639,259
Working expenses	£	969,530	940,828
Net earnings	£	771,729	698,431
Working expenses to gross earnings, per cent.		55.68	57.39
Net earnings to capital cost, per cent.		5.57	4.93
Passenger journeys, number		12,839,428	13,854,588
Goods and live stock, tons		2,255,996	2,165,619
Train miles		5,010,121	4,925,356
Gross earnings per train mile		6s. 11.41d.	6s. 7.88d.
Working expenses per train mile		3s. 10.44d.	3s. 9.84d.
Gross earnings per average mile open	£	936	871
Working expenses per average mile open	£	521	500
Locomotives, number		331	337
Coaching vehicles, number		443	465
Goods and live stock vehicles, number		6,226	6,384
Ton-miles (goods and live stock)		272,373,487	267,271,137
Average miles per ton		120.73	123.42
Average earnings per ton per mile	d.	1.04	0.95

North-East Coast Institution of Engineers and Shipbuilders.—The third general meeting of the session will be held in the Lecture Theatre of the Literary and Philosophical Society, Westgate-road, Newcastle-upon-Tyne, this evening, at 7.30 p.m. Members of Council will meet in the Institution Rooms, Bolbec Hall, at 7.15 p.m. The discussion on Mr. D. Myles's paper on "Notes on Marine Boiler Design, Construction and Economy," will be resumed. There will be a discussion on Mr. T. O. Handy's paper on "Some Notes on the Erection of the Baikal Railway Ferry Steamers," and a paper on "The Remarkable Failure of a Consignment of Steel Ship Plates," by Mr. W. J. B. Wilson, will be read.

Steam Turbines for Marine Work.—A paper was recently read before the Liverpool Engineering Society by Mr. C. J. Blackburn, entitled "The Working of Parsons Steam Turbines on Fast Channel Steamers," from which it appears that the total number of mercantile steamers running with Parsons turbines is sixty-nine, with a total horse-power of 606,000, and of these twenty-three were Channel steamers, aggregating 193,000 horse-power. The total number of war vessels built and under construction is 194, representing a total horse-power of 2,700,000. The total number of all vessels built and under construction at the present time with these turbines is about 275, representing about 3¼ million horse-power. With regard to manœuvring power, Mr. Blackburn said he had carefully timed the Ben-my-Chree when leaving the pier at Douglas, Isle of Man, and the average length of time occupied in leaving the end of the pier, bringing the vessel to a state of rest, and getting a headway on her was usually four minutes, but the manœuvre had been done in two and a-quarter minutes. For a vessel 375ft. long, 46ft. beam, and with a displacement of 3350 tons, the author considers this a very satisfactory performance.

THE IRON, COAL, AND GENERAL TRADES OF BIRMINGHAM, WOLVERHAMPTON, AND OTHER DISTRICTS.

(*From our own Correspondent.*)

A Busy Trade.

THE only branch of the finished iron trade in which there is a steady activity of demand, and in which sellers seem to be masters of the price position, is that engaged in galvanised iron. Local producers of this material keep fully employed, with good prospects of a continuance of present very gratifying conditions in 1910. Good shipments are being made, and most of the Midland makers have as much work on hand as they can cope with for the time being. Values are steady at £11 to £11 5s. f.o b. Liverpool for 24 w.g. material. There is rather less irregularity, too, than recently in the black sheet iron trade, which supplies the raw material for the galvanisers, but it has to be recorded that the developments of the past few years, which have resulted in the establishing of large new competitive works in South Wales, Monmouthshire, and the North of England, have weakened the position of the South Staffordshire local makers fundamentally. Quotations locally rule on the basis of £7 to £7 2s. 6d. for sheets of 20 w.g., £7 2s. 6d. to £7 5s. for 24 w.g., and £7 15s. to £7 17s. 6d. for 27 and 28 w.g.

The Bar Iron Trade.

Little that is satisfactory can be reported about the bar iron trade. The Staffordshire marked bar business rules steady alike as to demand and price, values being well sustained on the basis of £8 for best sorts and £7 for second-grade sorts, with £8 12s. 6d. as the quotation for the L.W.R.O. brand of iron. Respecting second and third-class irons, however, known respectively as "unmarked" and common bars, the report is the reverse of prosperous. According to the accounts brought to 'Change this (Thursday) afternoon, in Birmingham values are still on the down grade, and there seems nothing to stop them. The prices of "unmarked" or merchant iron are falling almost continually—the outcome of a famine in demand, and common bar quotations are being forced down by continued Belgian importations.

Unremunerative Prices.

Prices are now at an almost unremunerative level. Indeed, one firm of common bar makers distinctly asserted to-day that they had booked orders at 5s. per ton loss purely to keep the ironworkers employed. Unmarked bars were easily obtainable at £5 16s. 3d. to £5 17s. 6d., delivered Birmingham, and hurdle and bolt iron for early delivery was said to have been done at as low as £5 12s. 6d. per ton. Even for delivery over the first quarter of 1910 only a small advance on this figure can be got, and sales are spoken of over next April at £5 15s. per ton—truly an exceedingly lean figure.

Steel Trade Improving.

Steel billets and sections are undoubtedly developing a stronger market position. Present requirements show little variation. It is unquestionable as regards forward buying that sellers are putting the brake on very firmly. Contracts have been made up to March at current rates, but beyond that neither raw nor finished steel producers are disposed to commit themselves. This uncompromising attitude has a hardening effect upon the market, though quotations can hardly be said to be quotably influenced. Current prices are:—Bessemer sheet bars, £4 15s.; Siemens sheet bars, £4 17s. 6d.; angles, £5 17s. 6d. to £6; girder plates, £6 to £6 2s. 6d.; boiler plates, £7 5s.; joists, £5 15s. to £6; mild bars, £6 7s. 6d. to £6 17s. 6d.

Raw Iron Values.

The rather better state of the raw iron market reported last week, as it affects forward business for delivery into, say, the second quarter of 1910, is preserved. Coke continues firm, which is the main occasion of the strength in pig iron, and dearer fuel is generally looked for next year, alike coke and coal. Pig iron makers are, therefore, a little cautious, and prices are also assisted by the knowledge that some blast furnaces both in the Staffordshire district and in the Midland raw iron centres are being blown out. Quotations are:—Forge pig iron: Staffordshire common, 45s. to 46s.; part-mine, 48s. to 49s; best all-mine forge, 85s.; foundry, 90s.; cold blast, 115s.; Northamptonshire, 47s. to 48s.; Derbyshire, 48s. to 49s.; North Staffordshire forge, 50s. to 51s. 6d.; best, 58s. to 59s.

NOTES FROM LANCASHIRE.

(*From our own Correspondent.*)

MANCHESTER, Thursday.

Better Inquiry for Pig Iron.

THERE was a shade better feeling in pig iron on our Exchange on Tuesday. There was certainly more inquiry for delivery over next year, but the position is very uncertain, makers not being inclined to commit themselves, while buyers, on the other hand, are not disposed to make purchases beyond the month of March. Demand on shipping account both to Germany and the United States has also had a tendency to stiffen the market, especially for Middlesbrough brands. There are, however, re-sale lots of Lincolnshire on the market, which are offering at fully 1s. 6d. per ton under makers' list prices. Hematite is steady, and the tendency is decidedly upward in character.

Finished Iron and Steel.

Spot business is slow. Billets, however, continue scarce, and practically there are no foreign lots being offered.

Copper, Lead, Tin.

Copper: Sheets were reduced 20s. per ton, but tough ingot was dearer. Lead: Sheets slightly higher. Tin: English ingots firmer.

Quotations.

Lincolnshire No. 3 foundry, 54s. 6d.; Staffordshire, 53s.; Derbyshire, 55s.; Middlesbrough, open brands, 59s. 7d. to 59s. 10d. Scotch: Gartsherrie, 61s; Glengarnock, 60s.; Eglinton, 59s. 6d., delivered Manchester. West Coast hematite, 61s. to 61s. 6d.; East Coast ditto, 60s. 6d., both f.o.t. Delivered Heysham: Gartsherrie, 59s.; Glengarnock, 58s.; Eglinton, 57s. 6d. Delivered Preston: Gartsherrie, 60s.; Glengarnock, 59s.; Eglinton, 58s. 6d. Finished iron: Bars, £6 10s.; hoops, £7 12s. 6d.; sheets, £7 12s. 6d. to £7 17s. 6d. Steel: Bars, £6 2s. 6d. to £6 5s.; Lancashire hoops, £7 5s.; Staffordshire ditto, £6 17s. 6d. to £7; sheets, £7 17s. 6d. to £8; boiler plates, £7 5s. to £7 7s. 6d.; plates for tank, girder, and bridge work, £6 5s. to £6 7s. 6d.; English billets, £4 12s. 6d. to £4 15s.; foreign ditto, nominal; cold drawn steel, £9 5s. to £9 10s. Copper: Sheets, £73; tough ingot, £63 10s.; best selected, £63 10s. Copper tubes, $8\frac{3}{4}$d.; brass tubes, $7\frac{1}{8}$d.; condenser. $8\frac{1}{8}$d.; rolled brass, $6\frac{1}{2}$d.; brass wire, $6\frac{3}{4}$d.; brass turning rods, $6\frac{3}{4}$d.; yellow metal, $6\frac{1}{8}$d. to $6\frac{3}{8}$d. per lb. Sheet lead, £17 per ton. English tin ingots, £146 10s. to £147 per ton.

The Lancashire Coal Trade.

The attendance on our local Coal Exchange was about an average one, but business generally was disappointing. Although the weather created a "spurt" in house coal, this has fallen away again, and for the time of the year the demand is much below the average. Slack and furnace coal is rather in buyers' favour, and inquiry is slow. On the other hand, shipping and bunkering coal is fairly good, although low prices have to be accepted to induce business.

BARROW-IN-FURNESS, Thursday.

Hematites.

There is a rather better demand for hematite iron this week, and it is evident there will soon be a turn in the market for the better. The inquiry at the moment is mainly for forward delivery in the early months of next year, and makers are also doing some prompt trade. They are producing a considerable tonnage of iron, practically all of which is going into delivery. There are twenty-nine furnaces in blast. The difficulty between the Distington Ironworks and their men has been amicably settled, and the men have resumed work, while the two furnaces which were damped down have been restarted. Prices are steadier, and mixed Bessemer numbers are now at 62s. 6d. net f.o.b., while warrant iron sellers are at 61s. net cash, buyers 6d. less. The trade doing in special hematite iron is very satisfactory, and it is recognised when trade improves there will be a marked improvement in the demand for the higher-graded qualities of metal, which it is found can be produced to almost any specification according to the requirements of the consumers. This class of iron is selling at about 65s. per ton. Charcoal iron is also in large demand, and arrangements have been made by the accumulation of a large amount of charcoal from the neighbouring district to keep the only furnace in England producing charcoal iron in blast for a long time to come. Ferro-manganese is in good request, and good deliveries are being made alike to home and foreign consumers. Spiegeleisen is in steady demand not only on home but on foreign account. Sales of scrap iron are being made in large parcels, and there is a good demand for the best sorts of metal. Iron ore is in rather fuller request, and prices this week are at 12s., 14s. 6d. and 18s. per ton net at mines. Sales are mostly of the better quality. The imports of foreign ore are smaller than they have been, but good supplies for forward delivery in the New Year have already been purchased.

Steel.

The demand for steel rails has improved of late, and makers are generally engaged on light sections. There are only two of the three mills in this district at work at present, and this position is likely to be continued for a few weeks yet, although orders are to hand which would justify a full output. Prices rule at about £5 5s. per ton net f.o.b. The demand for merchant steel is quiet, but a good trade has lately been done in hoops and in strips for the armouring of electric cables. A poor report is given of the shipbuilding material trade, but this is expected to improve with a revival in shipbuilding.

Shipbuilding and Engineering,

Much better hopes are being formed as to the future of the shipbuilding trade, and the prospect is that before long the firm of Vickers, Sons and Maxim will be very busy on large contracts for the home Government, and possibly for foreign governments as well.

Shipping and Coal.

The exports of iron and steel from West Coast ports last week were 6690 tons—iron 1694 tons and steel 4996 tons—as against 11,858 tons for the corresponding week of last year—a decrease of 5168 tons. For the year to date the shipments aggregate 591,728 tons, against 480,370 tons for the corresponding period of last year—an increase of 111,358 tons. Coal steady.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

Steam Coal Firmer.

A STRONGER tone pervades the hard coal market, owing in part to the good demand for shipment, and extra supplies ordered to tide over the approaching holidays. The return of coal business with Hull exhibits a heavy advance on the month and on the year so far. Since the report was issued, the export trade from Hull has continued to keep up well, the weight for the first week in December showing a total of 61,350 tons, as compared with 39,635 tons for the corresponding week of last year. Rotterdam was the largest customer in that week, taking 8848 tons, Rouen coming next with 5215 tons.

Railway Coal Contracts.

No further progress has been made in the settlement of the locomotive fuel contracts with the railway companies. The offer of the coalowners was at 9s. 3d. per ton, which is an advance of 9d. per ton on last year's rates. The companies for the present are receiving deliveries under running contracts, which are somewhat in arrears.

House Coal—A Steady Business.

The demand for domestic fuel keeps fairly brisk, merchants at local depôts reporting rather more active trade. There are practically no stocks in hand. The weight being forwarded to London and the South, as well as to the Eastern Counties' markets, is fully up to the normal amount. Consumers' requirements generally are stimulated by the approaching holidays. The weather has again taken a milder turn, diminishing the prospect of any further advance this year. Quotations are not changed, best Barnsley making 12s. 6d. to 14s. per ton, and secondary descriptions from 10s. 6d. to 11s. 6d. per ton. In the coalfield generally from four to five days a week are being worked.

Small Coal and Coke.

The short time being worked in the Lancashire cotton trade has not appreciably affected the demand for the South Yorkshire coal used in these mills, as well as in the Yorkshire textile trades. All orders for coal now being received are more or less urgent, as is usual at this season of the year. This remark applies to every quality of coal. The higher qualities of slacks have been in active demand for a considerable time, and there is now more doing in the secondary sorts. The grades of South Yorkshire smalls used in the cotton and woollen industries continue firm at from 4s. 6d. to 5s. 6d. per ton. Furnace coke is at present rather firmer than when last reported, more inquiries coming forward. Quotations continue as before:—Best washed, 12s. 6d. to 13s. per ton; unwashed, 11s. 6d. to 12s. per ton.

The Iron Market: Hematite Firmer.

Hematites, both West and East Coast, are firmer in tone than for some weeks past. No material business is being done, but the hopeful feeling entertained for the New Year is making producers stand out for better prices for forward delivery; while, on the other hand, consumers having only scant order books are not eager to purchase beyond present requirements. The Lincolnshire Ironmasters' Association held their customary meeting last Friday, and, as we anticipated, made no alteration in prices. Derbyshire irons are also unchanged. Quotations:—Hematites: West Coast, 68s. to 70s. per ton; East Coast, 65s. to 67s. per ton. Lincolnshire: No. 3 foundry, 52s. 6d. per ton; No. 4 foundry, 51s. 6d. per ton; No. 4 forge, 51s. 6d. per ton; No. 5 forge, mottled and white, 51s. 6d. per ton; basic, 52s. 6d. per ton. Derbyshire: No. 3 foundry, 52s. per ton; No. 4 forge 50s. 6d. per ton. All quotations net, and for delivery in Sheffield and Rotherham.

Bars, Hoops, and Sheets.

The South Yorkshire Bar Iron Association, at their recent monthly meeting, made no change in the quotation. The depression in the bar iron business continues as marked as ever. Bars, £6 10s. per ton; hoops, £7 10s. per ton; sheets, £8 10s. per ton.

Swedish Iron.

Satisfaction is expressed in this district at the termination of the strike in Sweden. This strike, however, has not been entirely unanimous for some time past, supplies of iron having been obtainable for pressing requirements all along. Still, in view of the hopeful feeling of improved trade, many orders given by Sheffield firms to Swedish makers will now have attention, and better work is expected in several local firms engaged specially in this branch of the iron trade.

Sheffield and the French Tariff.

The Council of the Sheffield Chamber of Commerce met on Monday. The present position of affairs with regard to the French tariff was reported to the Council, and it was pointed out that the unsatisfactory proposal to classify steel in accordance with its chemical contents has been carried through the Chamber of Deputies. It was further pointed out that the duty on steels containing more than a small percentage of tungsten or chromium is raised from 15f. to 50f. per 100 kilos. This duty is regarded by the Council as likely seriously to injure the trade from Sheffield to France, if not entirely, to arrest the trade in the higher-grade steels. The duty on engineers' tools is raised from 22f. to 150f. per 100 kilos., and this duty the Chamber regarded as being prohibitive to nearly every article in this class. The matter was referred again to the Tariff Committee.

NORTH OF ENGLAND.

(*From our own Correspondent.*)

Cleveland Pig Iron.

AN improvement in tone and actual business can be reported this week in the Cleveland pig iron market, and the rather depressed feeling which was apparent last week has given place to one of cheerfulness. Holders of iron are less keen to sell, and consumers have during the last few days bought rather more freely than hitherto this month. The reduction of the Bank rate has to some extent relieved the strain on the operators in warrants, and there is not that pressure to clear out which was noticeable last week, especially as almost everyone is again taking a more sanguine view of the prospects for next year. Well-known business men publicly predict that trade will next year show a considerable improvement on that of the current year, though they do not expect it will be more than fair; and as for prices they are not likely to be materially above those now ruling. As soon as the elections are out of the way it is believed a brisker market all round will be reported. Speculators are thus inclined to hold on, and that the fluctuations of late have been within such narrow limits would indicate that the bulk of the warrant iron now lodged in Connal's public stores is in strong hands. London houses are known to hold a good deal of the warrant iron, and they are as firm in regard to prices as the makers themselves. Business this week in No. 3 Cleveland G.M.B. pig iron for prompt f.o.b. delivery has been mostly done at 50s. 3d.; while for No. 1 the rate has been 52s. 6d.; No. 4 foundry, 48s. 9d.; No. 4 forge, 48s. 6d.; and mottled and white, 48s. per ton. For delivery over the first quarter of 1910 fully 1s. per ton more than the prompt prices have to be paid, and the premium over prompt figures for the second quarter is 1s. 6d. per ton.

Hematite Pig Iron.

The position of East Coast hematite pig iron makers continues good, and prospects are encouraging now that the revival in the shipbuilding industry is so strong. The cheap lots of hematite iron that have lately been offering by second hands have either been sold or taken off the market; at any rate, they are not in evidence now, and the market is stronger in consequence. Mixed numbers are not at present to be had under 60s. per ton for prompt delivery, and consumers are more ready to buy. Some fair orders were given out by Sheffield consumers a fortnight ago, and this week several well-known Sheffield manufacturers have been in this district. American consumers have also considerable quantities of East Coast hematite pig iron coming due to them. The quotation for mixed numbers of hematite for delivery over next quarter is firm at 62s. 6d., and for the second quarter at 65s., and certainly higher prices have become necessary, seeing how rapidly the cost of materials is increasing. For some time the nominal quotation of Rubio ore delivered c.i.f. Middlesbrough has been 17s. 6d. per ton for prompt delivery, but this week it has risen to 18s. 6d. per ton, and 18s. 3d. has been paid, while 19s. $4\frac{1}{2}$d. has been paid for 20,000 tons delivered at Stockton over the first half of the year, which is equal to 19s. 3d. Middlesbrough. A marked advance was generally expected, taking into account the heavy demand for Rubio ore that is reported, not only from this district, but also from Germany and the United States. Coke is also rising in price; the sellers are holding off for 17s. 6d. per ton for early deliveries of furnace coke delivered equal to Middlesbrough, and it is thus as dear as foundry coke, yet some of the manufacturers affirm that they can do better by selling the coal as coal instead of converting it into coke. There is no doubt that coke is relatively dearer than Cleveland pig iron at the present time, so that cheaper rates for the latter can hardly be expected.

Manufactured Iron and Steel.

The prospects of business in the steel trade are very favourable; the leading firms are fairly well supplied with orders, and the output is on a larger scale than it has been at any time since 1907. The best demand is for rails, plates, angles, sheets—both black and galvanised—and hoops, but it appears difficult to keep the bar mills in regular operation. It has been expected that the manufacturers would before this have advanced the quotations for plates, angles, and sheets, but as yet they have not seen their way to make any such change. There can be no doubt that the situation is more satisfactory, and consumers must expect soon to be called upon to pay more for their requirements. Iron and steel ship plates are strong at £6, steel ship angles at £5 7s. 6d., iron ship angles at £7, steel bars at £6, iron bars at £7, steel hoops at £6 5s., steel strip at £6 2s. 6d., steel sheets—singles—at £7 5s., steel joists £5 15s. to £6 5s, all less $2\frac{1}{2}$ per cent. f.o.t. Heavy steel rails are quoted at £5 5s. net f.o.b. The Darlington Forge Company, Limited, Darlington, have this week despatched to Messrs. Harland and Wolff, Belfast, the stern frame, rudder, and brackets for the new White Star liner Titanic. They weighed 280 tons, or 60 tons more than those for the Mauretania and Lusitania, which were also constructed at the same works. The consignment had to be sent by rail from Darlington to West Hartlepool on Sunday, when there was no other traffic, and then it was forwarded by sea.

Shipbuilding and Engineering.

Improvement is reported in the engineering industry, but it may be said that most establishments are turning out a good deal less than they were last year, and the output will be a good deal less than it was in the record year 1907. The co-partnery scheme established in connection with Irvine's Shipbuilding and Dry Dock Company, Limited, West Hartlepool, at the suggestion of Sir Christopher Furness, has been attended with very satisfactory results. The employé shareholders are informed that they are from every point of view very satisfactory. At the two yards nine steamers have been launched, and orders for six more steamers are on hand. Under the new conditions of employment operations at the shipyards have proceeded with comfort to all concerned. The financial results are highly satisfactory, and enable the directors to make a distribution on the agreed basis of the scheme, viz., the guaranteed 4 per cent. to the employé shareholders; the fixed 5 per cent. to the ordinary shareholders, with a bonus of 5 per cent. to both classes of shareholders. Thus the employé shareholders will get 9 per cent. per annum, and the ordinary shareholders 10 per cent. per annum. The report suggests that the scheme, which has been nine months in operation, should now be put upon a permanent basis as a preliminary to tendering for other important work.

Coal and Coke.

There is considerable improvement in the coal trade, and consumers are buying more freely, now that it is recognised that the application of the Mines Eight Hours Act on January 1st will not be attended by any trouble. The employers' and the men's representatives have made arrangements as to how the pits shall be worked, and it is practically decided that the three-shift system shall be introduced. For prompt delivery best Northumberland steam coal is at 11s. 6d. per ton f.o.b., but 11s. will be taken for January delivery. More demand is reported for gas and bunker coals, the best qualities of the former realising 11s. to 11s. 3d. per ton f.o.b., and bunkers range from 9s. 9d. to 10s. 3d. per ton f.o.b. Tyne Dock. Furnace coke is strong at 17s. 6d. per ton delivered at the Middlesbrough furnaces, and the demand for it is fully equal to the present production.

NOTES FROM SCOTLAND.

(*From our own Correspondent.*)

The General Business Outlook.

THE impression appears to be gaining ground that trade is really improving. Christmas holidays and the unsettling tendency of the approaching general election may postpone the further development of business for a time, but the indications of expansion in various directions are so manifest that belief in the coming better time is everywhere in evidence. Shipbuilders have received a considerable accession of new orders within the last two or three weeks, and inquiries seem to point to additional business of this description being soon available. A decided revival has been gradually taking place in the freight market. The United States have recently taken up a large amount of British tonnage on time charter for Transatlantic, West Indian, and River Plate trades This is an immediate relief to the freight market, and the business in other directions has expanded in such a way as to promise not merely the maintenance of present rates of freight, but a probable advance in various sections of the market. It is confidently anticipated, from orders already fixed and inquiries received, that we shall do an extensive trade in iron and steel goods with Canada in the coming year. Important developments are also expected in South Africa and the Australian Colonies, which are expected materially to assist business at home. These are a few of the subjects now engaging attention, and leading to the hopeful state of feeling that prevails.

The Iron Market.

There has been some weakness in the warrant market since last report, and the business done has been materially less than last week. The near approach of the holidays is believed to be adversely affecting speculative dealing at the moment. Business has been done in Cleveland warrants from 50s. 7d. to 50s. 1d. cash, 51s. to 50s. 3½d. one month, and 51s. 7d. to 51s. three months. Sales have also been made at 50s. 5d. for delivery in twenty-one days, 50s. 9d. twenty-six days, and 51s. 9d. for February 28th. The demand for hematite warrants has not issued in any substantial extension of the business that took place last week.

Scotch Makers' Iron.

The business in Scotch iron for delivery during the remainder of the year has been of small consequence, but merchants and makers are reported to have entered into good contracts over the early months of next year, these including very considerable shipments to Canada. The inquiries for special brands on English account have also been encouraging. Prices of Scotch iron have been well maintained, notwithstanding the depression in warrants. Free at ship in Glasgow harbour, Monkland, No. 1, is quoted 57s.; No. 3, 55s.; Carnbroe, No. 1, 59s. 6d.; No. 3, 56s. 6d.; Clyde, No. 1, 62s.; No. 3, 57s.; Gartsherrie, and Calder, Nos. 1, 62s. 6d.; Nos. 3, 57s. 6d.; Summerlee, No. 1, 63s.; No. 3, 58s.; Langloan, No. 1, 64s.; No. 3, 59s.; Coltness, No. 1, 85s.; No 3, 58s.; Eglinton, at Ardrossan or Troon, No. 1, 58s.; No. 3, 56s.; Glengarnock, at Ardrossan, No. 1, 64s.; No. 3, 59s.; Dalmellington, at Ayr, No. 1, 61s.; No. 3, 56s.; Shotts, at Leith, No. 1, 62s. 6d.; No. 3, 57s; Carron, at Grangemouth, No. 1, 64s.; No. 3, 58s. per ton. Since last report two additional furnaces have been put on ordinary iron, while one has been withdrawn from hematite. There are now 84 furnaces in operation in Scotland, compared with 83 last week, and 77 at this time last year, and of the total 42 are producing hematite, 37 ordinary, and 5 basic iron.

The Hematite Trade.

The arrivals of hematite ore in the Clyde in the course of the week numbered thirteen cargoes, and the harbour authorities and railway companies are now giving fair despatch from the vessels to the iron and steel works. So far as can be ascertained, the current output of hematite pig iron is considerably larger than the rate of consumption. One furnace less is now employed on this class of iron than a week ago. The market demand for hematite is poor, but steady deliveries are being made to local consumers under existing contracts. Merchants quote Scotch hematite 63s. per ton for delivery at the West of Scotland steel works.

Pig Iron Shipments.

The shipments of pig iron from Scottish ports in the past week were small, amounting to only 3859 tons, compared with 6589 in the corresponding week of last year. To the United States only 30 tons were despatched, and nothing was sent to either Canada, South America, Italy, Holland, or Russia. India took 25 tons, Australia 280, France 10, Germany 120, Belgium 50, other countries 230, the coastwise shipments being 3094 tons, against 2562 in the corresponding week. The arrivals at Grangemouth of pig iron from Cleveland and district amounted to 9473 tons, compared with 10,771 in the corresponding week of 1908.

Finished Iron and Steel.

The malleable iron trade remains depressed, with works partly idle, and quotations for export are exceptionally low. In the steel trade the inquiry for structural material for export is poor. A good shipping business is being done in thin sheets. The home demand for steel has not turned out so well as was expected, and it now appears likely that few additional orders will be available until after the holidays. The inquiry for boiler plates for shipment as well as for home use is fairly active.

The Coal Trade.

There has been a good business in shipping coal since last report, and the recent advances in prices are so far maintained. At Glasgow Harbour ell coal is quoted for shipment 10s. 6d. to 10s. 9d., steam coal 10s. to 10s. 6d., and splint 10s. 9d. to 11s. per ton. House coal for home use is firm, and in active request owing to cold weather. The question of the rate of wages to be paid the colliers has been this week submitted to arbitration at meetings in Edinburgh under the chairmanship of Lord Balfour of Burleigh, and an adjournment took place in order that evidence might be produced as to the prices obtained by the coalmasters. Both parties are pledged to abide by his lordship's decision, so that no serious trouble is apprehended.

WALES AND ADJOINING COUNTIES.

(*From our own Correspondent.*)

Last Week's Coal Trade.

STORMY weather again affected tonnage arrivals, but fortunately there was no great loss of shipping, as reported last week. The chief result was to hamper business seriously, and to some extent affect quotations. On the whole, there was not much change in prices, but a few of the leading coalowners were much inclined to advance quotations for January shipment, showing that in their opinion the New Year will bring about an improvement. One satisfactory piece of news discussed on 'Change was the placing of Admiralty orders confirming the opinion of a leading coalowner that they were certain to be received. "Welsh coal was indispensable."

The Admiralty Orders.

Only the old coalowners remember the excitement at Cardiff when, chiefly through the efforts of Messrs. Fothergill and Vivian, a share of the orders was secured for Cardiff. Now the trade has grown so enormously that their non arrival this year, though regrettable, was not looked upon as a calamity. They came to hand on Tuesday, but, as usual, quantities and prices were kept as secret as possible; but it is understood that practically the whole of their requirements, totalling from 1¼ to 1½ million tons, have been placed. Next week I hope to obtain some definite facts. One authority states that for best steam prices range up to 16s. 3d.; another, usually well informed, states that the figures are for best 15s. 6d. to 16s. net, and for second-class down to 14s. 9d. Cardiff colliery owners have received the bulk, though the placing covers a wide area. Latest:—A very good undertone. It is said on 'Change that one result of the better outlook is that some agents have withdrawn quotations they had given for next year. Best steam coal, 16s. 3d. to 16s. 6d.; seconds, 15s. 6d. to 16s.; ordinaries, 14s. 6d. to 15s.; best drys, 16s. 3d. to 16s. 9d.; ordinary drys, 14s. 6d. to 15s.; best washed nuts, 13s. to 13s. 6d.; seconds, 12s. 6d. to 13s.; best washed peas, 12s. to 12s. 6d.; seconds, 10s. to 11s. 6d.; very best smalls, 8s. 9d. to 9s. 3d.; best ordinaries, 7s. 9d. to 8s 3d.; cargo smalls, 6s. 9d. to 7s. 6d.; inferiors, 6s. to 6s. 6d.; very best Monmouthshire black vein, 15s. 3d. to 15s. 6d.; ordinary Western Valleys, 14s. 6d. to 14s. 9d.; best Eastern Valleys, 13s. 9d. to 14s.; seconds, 13s. to 13s. 3d. Bituminous: Very best households, 17s. to 18s.; best ordinaries, 15s. to 16s.; No. 3 Rhondda, 17s. 3d. to 17s. 6d.; brush, 13s. 6d. to 13s. 9d.; smalls, 10s. to 10s. 6d.; No. 2 Rhondda, 13s. to 13s. 3d.; through, 9s. 6d. to 10s.; smalls, 7s. to 7s. 6d. Patent fuel, 15s. to 15s. 6d. Coke: Special foundry, 24s. to 27s. 6d.; foundry, 19s. to 20s.; furnace, 17s. to 17s. 6d.; pitwood, 19s. 3d. to 19s. 9d.

Newport, Mon., Coal.

With the arrival of long-delayed tonnage, merchants have now for several days been busy in reducing stocks. General tone steady. Not so much fresh business as expected. Fair business done up to holidays. Latest:—Best black vein, large, 15s. to 15s. 3d.; Western Valleys, 14s. 3d. to 14s. 6d.; Eastern Valleys, 13s. 6d. to 13s. 9d.; other sorts, 12s. 6d. to 13s. 3d.; best smalls, 7s. to 7s. 3d.; seconds, 6s. 3d. to 6s. 9d.; inferiors, 5s. 9d. to 6s. 3d. Bituminous coal: Best house, 15s. to 15s. 6d.; seconds, 14s. to 14s. 6d. Patent fuel, 15s. to 15s. 3d. Coke: Foundry, 18s. to 19s.; furnace, 17s. to 17s. 6d. Pitwood, 19s. 6d. to 20s.

Swansea Coal.

Anthracite steady; good undertone. Brisk demand for Swansea Valley and other brands. Last prices well maintained. Machine coals firm; rubbly culm strong demand; scarce. Latest: Best malting, 23s to 24s. net; seconds, 21s. to 22s. net; big vein, large, 17s. 6d. to 19s., less 2½; red vein, 12s. 6d. to 13s. 6d., less 2½; machine-made cobbles, 23s. to 24s. net; Paris nuts, 25s. 6d. to 26s. net; French nuts, 26s. to 28s. net; German nuts, 25s. to 26s. net; beans, 18s. 6d. to 19s. 6d. net; machine-made large peas, 11s. to 12s. 6d. net; fine peas, 10s. 6d. to 11s. net; rubbly culm, 5s. 6d. to 6s., less 2½; duff, 2s. 6d. to 3s. net. Steam coal: Best large, 17s. to 18s.; seconds, 14s. 6d. to 15s.; bunkers, 9s. 6d. to 10s. 6d.; small, 7s. to 9s., all less 2½. Bituminous coal: No. 3 Rhondda, 18s. to 18s. 6d.; through, 14s. 9d. to 15s. 6d.; small, 10s. 3d. to 10s. 6d. Patent fuel, 13s. to 13s. 6d., all less 2½. Coal quotations all f.o.b., net cash 30 days.

Port Talbot.

This port had a fairly good week, though, like others on the seaboard, it suffered from the long-continued tempestuous weather. The imports included a large quantity of pig iron and copper ore, and in coastwise exports a large total of slag. In all, the total shipments were over 40,000 tons.

Iron and Steel.

Latest prices in pig iron and steel bar at Swansea:—Pig iron: Hematite, mixed numbers, 60s. 6d. cash and month; Middlesbrough, 50s. cash, 50s. 6d. month; Scotch, 50s. 3d. cash and month; Welsh hematite, 66s. to 67s. 6d. delivered; East Coast hematite, 64s. to 65s. c.i.f. Steel bars: Siemens, £4 15s. to £4 17s. 6d.; Bessemer, £4 15s. Iron ore, 16s. 6d. to 17s., Newport and Cardiff.

Tin-plate.

The quantity of tin-plates received from works last week totalled 104,137 boxes, shipments 77,973 boxes, and stocks now remaining at Swansea total 114,334 boxes. It is evident that Welsh plates are in growing favour in the East, for the shipments to that quarter last week, it was stated before the Trust, was the largest yet despatched. Market continues firm, and prices have advanced correspondingly to the improvement taking place in tin. It is reported in the Swansea district that a large quantity of bookings have been made for the first months of the New Year by the leading oil companies. The demand from the Pacific Coast, and from American buyers, is said to have been large, and in some quarters quite unexpected. Latest prices: Ordinary Bessemer and Siemens tin-plates, 12s. 6d. to 12s. 7½d.; ternes, 22s. to 22s. 3d.; wasters, usual terms. C A. roofing sheets, £8 10s. to £8 15s.; big sheets for galvanising, £8 10s. per ton; finished black plates £9 10s. to £9 15s.; galvanised sheets, M. G., £11 to £11 5s. per ton; block tin, £148 12s. 6d. Other quotations, Metal Exchange, Swansea: Copper, £60 5s. cash to £61 5s. three months; lead, English, £13 12s. 6d.; Spanish, £13 2s. 6d.; spelter, £23 1s. 3d.; silver 2$\frac{3}{16}$ per oz.

The Swansea New Dock and Harbour Trade.

But for the downpour, the new dock business, satisfactory as it was, would have been larger. At the Harbour Trust meeting last week the Chairman reported an increase on last month of 57,000 tons. Among the items of increase pig iron figured as 10,000 tons. In the exports coal, coke, and patent fuel were 26,000 tons; tin plates and galvanised sheets, 8000 tons over corresponding month.

AMERICAN NOTES

(*From our own Correspondent.*)

NEW YORK, December 8th.

QUITE a number of manufacturers of finished iron and steel products are being offered more business for winter and spring delivery than they are able or willing to take. Some of the demand is due to the apprehension of buyers that a further advance in prices may be made in January. There will be very little ground for such an advance, because most manufacturers who have to buy pig iron and crude steel are assured that prices will remain where they are. Besides, it is generally understood that the active preparations in progress for increased production in raw and semi-finished material will constitute an ample protection against speculative values. The largest buyers of material at the present time are shipbuilders and bridge builders. The shipbuilders began some three weeks ago to order liberally, and they are still being heard from on account of the new ship work that is coming to hand. Outside of these two sources the demand has fallen off this week, and the larger interests do not anticipate a revival of the buying movement until after the holidays. The only exception to the anticipated quiet is found among the buyers of sheets and tin-plates. Sheet steel and wire also are under fair inquiry, but as the sheet steel companies are far over-sold the new business that is offered is not promptly accepted. The greatest demand has been for blue annealed sheets. The lake ore season closes this week. All of the furnaces depending on that source of supply are well provided for for the winter. Steel plate is far over-sold to steel car makers, and new business is in sight which will extend the engagements of the plate mills far into spring.

Four new furnaces will be in blast by February on the Ohio River, ten miles below Pittsburgh, which is the site of the new mill to be erected by Jones and Laughlins. The mill will be an aggregation of mills for the manufacture of rods, wire, nails, tin-plate, rails and structural material. Advices from all steel centres in the south are of a highly encouraging nature. Some rumours are afloat regarding very large investments of capital in Alabama. Copper has fallen in price slightly. The exports for the week ending December 2nd were 5862 tons. Exports last Friday, 1700 tons. The outlook for copper is said to be satisfactory to the copper interests, but in view of the large European holdings the volume of future exports is uncertain. Tin is quiet and prices irregular. Lead is selling steadily at unchanged prices.

LAUNCHES AND TRIAL TRIPS.

PIKEPOOL, steel screw steamer; built by Ropner and Sons, Limited; dimensions, 358ft. 6in. by 50ft. 10in. by 25ft. 6in.; engines, triple-expansion, pressure 180 lb.; constructed by Blair and Co.; launch, November 26th.

RENARD, torpedo boat destroyer; built by Cammell, Laird and Co.; to the order of the Admiralty; dimensions, 266ft. by 28ft. by 16ft. 7½in.; launch, November 30th.

NETHER PARK, steel screw steamer; built by the Northumberland Shipbuilding Company, Limited; to the order of John Greenlees and Co., of Glasgow; dimensions, 395ft. by 49ft. 9in. by 29ft.; to carry 7300 tons; engines, triple-expansion, 24½in., 40in., 68in. by 48in. stroke, pressure 180 lb.; constructed by the North-Eastern Marine Engineering Company; trial trip, recently.

POSTE IRO, steel screw steamer; built by Sir W. G. Armstrong, Whitworth and Co.; to the order of Pile and Co., of London; dimensions, 285ft. by 43ft. 6in. by 17ft. 6in.; engines, triple-expansion, 15in., 25in., 41in. by 27in. stroke; constructed by Richardsons, Westgarth and Co.; trial trip, recently.

CITY OF COLOMBO, steel screw steamer; built by Swan, Hunter and Wigham Richardson, Limited; to the order of the Ellerman Lines, Limited; dimensions, 437ft. 9in. by 54ft. by 33ft. 7in.; to carry 9880 tons; engines, triple-expansion, 25½in., 43½in., 75in. by 51in. stroke; constructed by the Wallsend Slipway and Engineering Company, Limited; trial trip, December 1st.

LIVORNO, steel screw steamer; built by Earle's Shipbuilding and Engineering Company, Limited; to the order of T. Wilson, Sons and Co., Limited; dimensions, 300ft. by 42ft. 6in. by 20ft.; launch, December 2nd.

BOVERTON, steel screw steamer; built by the Tyne Iron Shipbuilding Company; to the order of Evan Thomas Radcliffe and Co., of Cardiff; dimensions, 341ft. by 48ft. by 24ft. 4½in.; engines, 24in., 40in., 65in. by 42in. stroke, pressure 180 lb.; constructed by the North-Eastern Marine Engineering Company, Limited; launch, December 7th.

ROCHESTER CITY, steel screw steamer; built by Sir Raylton Dixon and Co., Limited; to the order of Mr. W. A. Watson, of Sunderland; dimensions, 240ft. by 35ft. 3in. by 17ft. 6in.; engines, triple-expansion, 17½in., 29in., 47in. by 33in. stroke; pressure 180 lb.; constructed by the North-Eastern Marine Engineering Company; launch, December 9th.

CONSTANTINE, steel screw steamer; built by the Blyth Shipbuilding and Dry Docks, Limited; to the order of J. Ridley, Son and Tulley, of Newcastle-on-Tyne; dimensions, 245ft. by 36ft. 9in. beam; engines, triple-expansion, 19in., 31in., 51in. by 36in. stroke, pressure 180 lb.; constructed by the North-Eastern Marine Engineering Company; trial trip, recently.

PRINCE RUPERT, twin-screw passenger steamer; built by Swan, Hunter and Wigham Richardson; to the order of the Grand Trunk Pacific Railway Company of Canada; dimensions, 320ft. by 42ft. 2in. by 18ft.; engines, triple-expansion; constructed by the Wallsend Slipway and Engineering Company, Limited; launch, December 13th.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

Mr. W. NOBLE TWELVETREES, M.I. Mech. E., A.M.I.E.E., &c., whose address until recently was 91, Louisville Road, Tooting, S.W., has removed to 195, Bedford-hill, S.W.

THE Adnil Electric Company, Limited, of Adnil Buildings, Artillery-lane, London, E.C., informs us that it has appointed Mr. James Turnbull, of 3, New-street, Birmingham, its agent for the whole of the Birmingham district, including the counties of Warwickshire, Worcestershire, Shropshire, and Staffordshire.

THE A.E.G. (Allgemeine Elektricitäts Gesellschaft) of Berlin has disposed of its English installation, engineering, and consumers' business to a new firm called A.E.G. Electric Company, Limited, with offices at 121, 123, and 125, Charing Cross-road, London; Cardiff, Glasgow, Manchester, Newcastle-on-Tyne, and Sheffield.

CONTRACTS.—Boulton and Paul, Limited, of Norwich, have secured the contract for the supply of twelve bungalows for use during the construction of the Benguella Railway extension, West Coast of Africa.—Among the recent orders obtained by Applebys Limited are those for a 100-ton overhead traveller for Yorkshire, a 60-ton overhead traveller for Spain, a 30-ton overhead traveller for Spain, five 65ft. portable Temperley transporters for coaling purposes, two 60ft. portable Temperley transporters for Brazil, and a Temperley fixed transporter for Yorkshire.

NOTES FROM GERMANY, FRANCE, BELGIUM, &c.

(*From our own Correspondent.*)

Rheinland-Westphalia.

No change worth speaking of has taken place on the iron market since last week; in a few instances only have prices been raised, and there is more confidence generally. The Steel Convention has resolved to reduce export bounties for semi-finished steel to M. 10 p.t. for the second quarter in 1910; for the first quarter the former bounty of M. 15 p.t. will continue. The Heavy Plate Convention, at a meeting in Cologne on the 26th November, was prolonged till April 1910. This Convention has also been extended so as to include plates for shipbuilding. The Union of Rhenish-Westphalian Hoop Mills has resolved to maintain the prices now ruling, viz , M. 127.50 to M. 132.50 p t., free Cologne or Dortmund, for the next few weeks. At a meeting on the 9th inst. the Bar Convention was prolonged for another year; prices for the second quarter in 1910 have been fixed at M. 106 p.t. free Neumkirchen, and M. 110 p.t. free Oberhausen. The Prussian Railway Administration has placed orders for 492 locomotives, worth over 30 million marks, with various North and West German works for delivery from April 1st to September 30th, 1910. On the Düsseldorf 'Change on the 3rd inst. prices were further raised as follows:—Basic from M. 49 to M. 52 and M. 54 p.t.; Luxemburg forge pig from M. 47 to M. 49 p.t.; German foundry pig No. 3 from M. 58 and M. 60 to M. 59 and M 61; Luxemburg foundry pig from M. 51 and M. 52 to M. 52 and M. 53 p.t.; hoops from M. 125 and M. 130 to M. 127.50 and M. 132.50 p.t.; sheets from M. 125 and M. 130 to M. 127 and M. 131 p.t.

Improvement in Coal.

Demand and inquiry have been increasing on the Rhenish-Westphalian coal market, and the accounts given of the Silesian coal trade are likewise satisfactory.

Austria-Hungary.

Weakness has been the characteristic feature of the iron and steel market during the last few weeks. October was disappointingly quiet, and the business in November has been even more limited, so that the returns for the last quarter of this year will be unfavourable. In bars and in rails a falling off against previous months will be felt, and though dealers have been inclined to purchase more freely now, on account of the new tariff that will come into force on the 1st of January, the general business in iron and steel remains very limited. Want of wagons in the Ostrau-Karwin district has become quite a calamity, for the demand of late has been extremely active, so that the pits, in a number of instances, have been unable to supply requirements within the time stipulated for. Brown coal is in strong request in the Bohemian district, and a rise in demand is anticipated.

Increasing Activity in France.

During the last two months employment in the various branches of the iron industry has steadily improved, and rates have been slowly moving upwards. Employment in the crude iron business is strong, and the manufactured iron industry will be well engaged all through next year in consequence of the extensive orders given out by the French Railway Administration. Up to the present 2280 wagons are known to have been ordered, Diétrich in Luneville and the Société Franco-Belge being the chief producers. Large purchases of marine requirements are also to be made; there is talk of seven armoured cruisers of 22 000 tons each to be delivered within three to four years. In the Haute-Marne and in the Loire district employment on the finished iron market has been so strong that prices have been advanced 5f. p.t. for hoops and plates, and bars in iron and steel will probably also meet with a similar advance. In the north girders have been very well inquired for, the Paris market proving a good customer. Pipe foundries and wire mills are satisfactorily employed; the rise of 10f. p.t. for wire speaks well for the condition of this branch of business. In the Meurthe-et-Moselle Departement the basis quotation for bars rose from 165f. to 170f. p.t. The works in the Champagne quote 180f. p.t. for merchant iron No. 2 and for common sorts of steel bars, while best sorts fetch 185f. p.t., sheets standing at 200f. to 220f. p.t.

The Belgian Iron Trade.

In bars a slight falling off in demand was felt all through last week, but until now producers have been able to maintain the prices formerly quoted. The terms of delivery are comparatively long, and the mills do not care to commit themselves beyond the 1st of January. For home consumption the price of 135f. to 145f. p.t. is maintained. Heavy plates are neglected, while sheets and medium sorts move on satisfactorily. Girders are inclined to move upwards, although this is the dull season for these articles. A good deal of firmness has been shown in rails; only in exceptional cases have they gone down below £5 4s. f.o.b. Antwerp. So far as prices are concerned, firmness has increased on the pig iron market. For the first two quarters rates have been fixed at 63f. p.t. for forge pig, 67f. to 68f. for basic, and 68f. p.t. for foundry pig, free place of consumption. This is exactly what was quoted in April and May, before foreign competition caused prices to fluctuate. Scrap iron is extremely depressed. Semi-finished steel has moved from 80f. to 82f. in consequence of a lively demand from abroad. Orders come in rather slowly at the construction shops, as, even at reduced prices, contracts are difficult to obtain.

Smart Work.—A smart piece of engineering work has recently been performed by Bull's Metal and Melloid Company, Limited, Yoker. The Allan liner Grampian recently required a new bronze blade, but only four days could be allowed to complete the work. The pattern was received by the firm on a Tuesday at 3 p.m., and by 3 a.m. on the following Saturday the heavy blade was completed ready for the boss. The work naturally included the moulding of the blade, drying the mould, pouring, cooling, detaching the dead-head, removing 3½ cwt. of metal in turning, facing, drilling and stopping out centre, as well as finishing of edges and dressing the surfaces. Six hours were lost by small accidents and stoppages. It is believed that this repair easily breaks all records of the same kind. In order to execute repairs to bronze propellers in the most expeditious and careful manner, the company has fitted a furnace sufficiently large to give room for the whole propeller blade up to the flange or boss. The blade under repair is slowly brought up to a red heat in this furnace, and thereafter straightened and formed to correct shape and pitch by squeezing, wedging, or screwing, without hammering.

Lectures on Aeronautics at the Imperial College.—Arrangements have been made by the Governors of the Imperial College of Science and Technology for a series of short courses of lectures on problems connected with the general subject of aeronautics and for the award of scholarships to qualified students desirous of undertaking research work in scientific problems connected with aeronautics. The first of three courses will begin about the middle of January next, in which Sir George Greenhill, formerly Professor of Mathematics in the Ordnance College, Woolwich, will treat of "The Dynamics of an Aeroplane." In the early part of February, Mr. H. R. A. Mallock will begin to deal with "Fluid Resistance," and after Easter Colonel H. C. L. Holden, head of the Royal Gun and Carriage Factories at Woolwich, will take up the subject of "Light Petrol Motors for Aerial Work." The research Scholarships are to be tenable for one year at the Imperial College, and in suitable cases provision may be made for part of the work to be undertaken at the National Physical Laboratory. Scholars will be entitled to free admission to the College, and to a maintenance allowance varying with the circumstances of the individual.

BRITISH PATENT SPECIFICATIONS.

When an invention is communicated from abroad the name and address of the Communicator is printed in italics.

When the abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent-office Sale Branch, 25, Southampton-buildings, Chancery-lane, London, W.C., at 8d. each.

The first date given is the date of application; the second date at the end of the abridgment is the date of the advertisement of the acceptance of the complete specification.

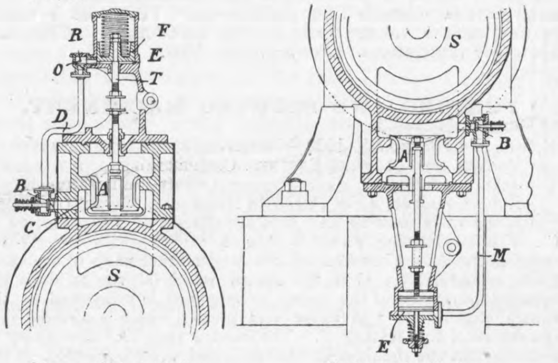
Any person may on any of the grounds mentioned in the Acts, within two months of the date given at the end of the abridgment, give notice at the Patent-office of opposition to the grant of a Patent.

STEAM ENGINES.

6971. March 23rd, 1909.—Improvements in or connected with Drop Valve Reversing Engines, William Thomas Bell, of the firm of Robey and Co., Limited, Globe Works, Lincoln, and Arthur John Wood Graham, of the same address.

This invention relates to automatic release over-pressure valves fitted to drop valve reversing engines, to provide for a quick release in case of the steam pressure becoming excessive in the steam cylinders. For the purpose of the invention as fitted to the steam inlet valve A, in addition to the usual relief valves, another valve B is fitted to the steam space C of the cylinder, *i.e.*, that portion of the steam which is in communication with the piston. This additional valve B is fitted with a spring of sufficient strength to resist the ordinary working pressure of the cylinder. Should, however, this pressure suddenly increase, due to all the inlet and outlet valves being closed at the time, this valve B will open and the steam will then pass up a pipe D into the cylinder E, which will force up the spring-controlled piston F which is connected to the steam valve A through a spindle T. This operation will instantly release the excessive pressure in the cylinder S, and so avoid any damage being done to the engine. Also, in order that the cylinder E above referred to may be used in the usual way to cushion the steam valve on its seat, a non-return valve O is fitted which has also fitted the usual screw adjustment at R for regulating the air cushion. When this automatic release over-pressure valve is fitted to the exhaust valve A—see right-hand engraving—the arrangement is substantially the same as for the steam inlet valve, except that the steam from the additional valve B passes down a pipe M instead of up, and enters at the opposite end of the cylinder E to force the piston F inwards, and so raise the exhaust valve A, to which it is connected by a spindle.—*November 24th*, 1909.

Nº6971



Steam Inlet Valve Exhaust Valve.

12,644. December 2nd, 1908.—Improvements in and relating to Steam Engines, *Johann Stumpf, of 33, Kurfürstendamm, Berlin.*

This invention relates to engines in which the exhaust takes place through ports in the centre of the cylinder which are covered and uncovered by the piston at the end of its stroke. The object of the invention is to provide means by which the high compression pressure may be relieved during starting. During starting the cocks B are opened. When the steam is passed through one of the main steam valves, C for instance, the high-pressure steam passes into the cylinder and also through the pipe D to the casing E. The valve F is in consequence pressed to the left, so that the left-hand exhaust port G is uncovered and the steam from the left-hand end of the cylinder may not only exhaust through the ports P in the cylinder, which are controlled by the piston, but also through the auxiliary exhaust passage G to the casing E and thence to the auxiliary exhaust outlet H. This state of affairs continues until the compression pressure on the left-hand side of the piston K is greater than the steam pressure on the right-hand side of the piston. Since the compression pressure is not allowed to rise very quickly owing to the exhaust passage O being open, this auxiliary pressure will continue for a very considerable part of the stroke from right to left and thereby only a very low compression will be attained, such as is sufficient to meet the requirements during starting or at low loads. In the form illustrated, where the exhaust passage O does not open into the extreme end of the cylinder, but only in the region of the inlet end, the piston K in its stroke, as can be seen at the right-hand side of the figure, covers the auxiliary exhaust passage which is thereby automatically cut out, so that sufficient compression is secured to ensure proper cushioning, and also to ensure that the valve F is operated by inlet steam before the passage O is uncovered at the inlet end by the piston. In this way it is impossible that live steam can escape through the auxiliary exhaust passage O.—*November 24th*, 1909.

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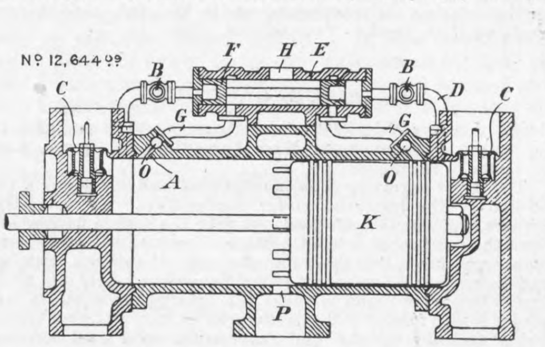
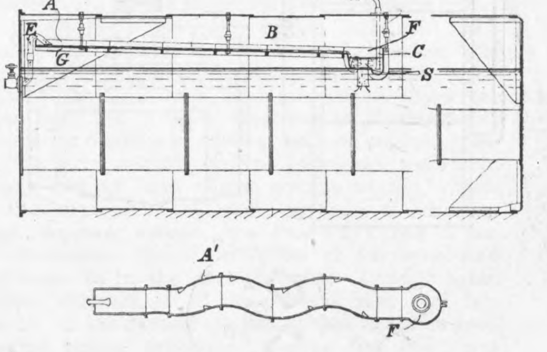


STEAM GENERATORS.

2647. February 4th, 1909.—Improvements in and relating to Internal Feed-water Heaters for Steam Boilers, Frederick Cockayne, of Commercial Bank Chambers, Albert-street, Derby; John Cockayne, of 3, Orford-street, Longport; and Charles Edward Medcalf, of Clarence Chambers, 39, Corporation-street, Birmingham.

A number of horizontal cast iron trays A having undulated sides A^1 are disposed in the steam space B of the boiler G, the trays being made of various widths and depths as circumstances may require to suit different forms and sizes of boilers. The trays A may be bolted together by flanged ends, so as to form a long tortuous channel which terminates in a large bowl-shaped vessel or pan F, in which a pipe C and valve D are arranged for the purpose of blowing out any collected deposit of lime, salts, mud, and the like that may accumulate therein. An inlet pipe E is arranged provided with the usual fittings. The feed-water, which may be previously heated by exhaust steam, waste heat, or flue gases, or other heating arrangement, is delivered on to the inlet end G of the internal heater A, over which it travels slowly, making frequent changes of direction through the curved path of the trays, which causes the water to be churned from the sides to the centre and thus breaks it up so that every portion is brought into direct contact with the steam, so that by the time it reaches the settling bowl B and overflows through tube S into the body of the boiler the water has been heated up to the full temperature of the steam. To assist in the churning action, angle pieces may be disposed on the inner side of the heater to thereby direct the water towards the centre.—*November 24th*, 1909.

Nº2,647



INTERNAL COMBUSTION ENGINES.

21,401. April 13th, 1909.—An Improved Vaporiser for Internal Combustion Engines, Georges Willes Stallard, of 88, Bramhall Moor-lane, Hazel-grove, Stockport, formerly of Horton-crescent, Rugby.

This invention has relation to that type of vaporiser in which heavy mineral oil is passed through a heated chamber containing incandescent material in order to decompose the more complex hydrocarbons composing the oil passing therethrough, the present invention comprising an improved combination of elements forming a more simple and effective apparatus than hitherto. A single chambered hot vessel A is used, which may be heated by an internal coke fire raised to incandescence by natural or forced draught, at starting, and by the engine suction when running. The chamber is provided with a charging door B at the top and ash removing door C at the lower part. The oil is delivered through the inlet nozzle D on to the heated coke, thereby forming a fixed gas, which mingles with the carbon monoxide gas produced by the induced air current passing in at the pipe E and downwardly through the fire to the induction pipe F, in which pipe a mixing valve, not shown, is situated in order to admit the air required to form an explosive mixture, a throttle valve G being arranged at the upper part of the hot vessel A to regulate the air passing thereto; the quantity of air admitted to the hot chamber being small, the amount of coke consumed is correspondingly small, only sufficient air being supplied to retain the fuel and chamber A at the correct temperature to gasify or vaporise the oil, thus enabling the vaporiser to be more economically worked than the usual type of suction gas producer and to be of small dimensions for a given horse-power. A suitable scrubber may be disposed between the vaporiser and mixing valve to remove tarry matter. The air and oil supply may, if desired, be hand or governor controlled and the chamber lined with refractory material. The oil is preferably supplied by means of a pump of any suitable type.—*November 24th*, 1909.

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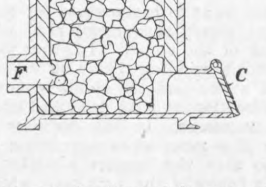
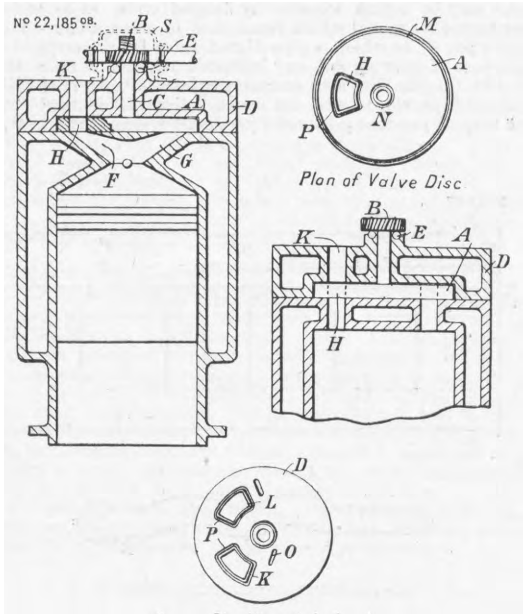


22,185. April 25th, 1909.—Improvements in and relating to the Valves of Internal Combustion Engines, William Cochrane, 26, Charges-street, Mayfair, London, W.

This invention relates to rotary disc valves of internal combustion engines. The valve consists of a simple disc A adapted to be rotated by skew gearing B mounted on a shaft C attached to the centre of the disc A; the shaft C extends through the water-jacketed detachable cylinder end D, and is fitted with ball or roller bearings E adapted to take the thrust on the valve spindle bearing from the skew gearing. The end of the cylinder is coned, and has two ports F G, inlet and outlet respectively, adapted to register alternately with a port H in the disc valve A. The coned formation of the cylinder end permits a water jacket being arranged under the disc valve, and the detachable cylinder cover being also water jacketed or air cooled, the disc valve will thus be properly cooled on both sides. The cylinder cover also has an inlet port K and an outlet port L; the ports K, L, H may be of any preferred shape, but they are preferably of the shape shown. For lubricating purposes and to prevent grinding and leakage of the charge during compression, the disc valve has inner and outer grooves M N, to which oil is supplied from the opening *o* in the cylinder cover. The ports are also grooved as shown at P. The shaft C is driven by any usual 2 to 1 gearing through skew gear, preferably covered in by a light casing S filled with lubricant.—*November 24th*, 1909.

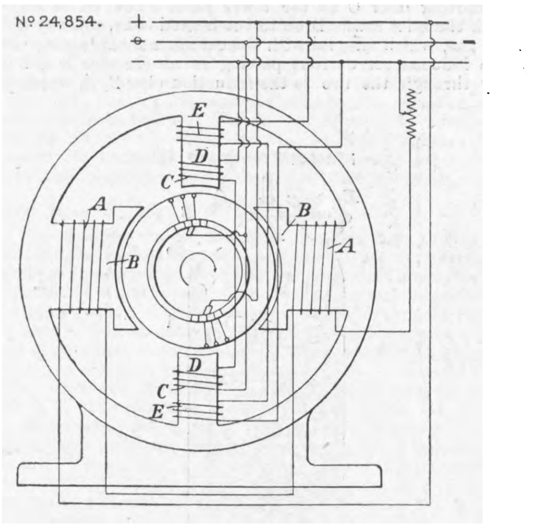


Reverse Plan View of the face in the Cylinder End against which the Valve Plate rotates

DYNAMOS AND MOTORS.

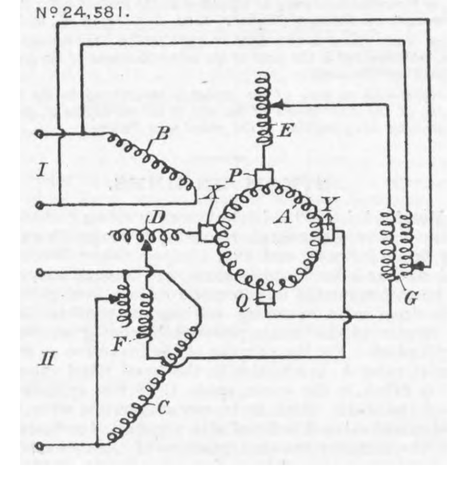
24,854. November 18th, 1908.—Improvements in and relating to Dynamo Electric Machines, The British Thomson-Houston Company, Limited, of 83, Cannon-street, London, E.C., and Frank Percy Whitaker, of 237, Clifton-road, Rugby.

The object of this invention is to provide an improved split-pole rotary converter adapted to run at unity power factor or approximately unity power factor at all loads from no-load to maximum working load at constant potential or over-compounded without employing reactances or boosters. A dynamo-electric machine is employed, having a shunt winding A on the main poles B, and a series winding C on the auxiliary poles D, for the purposes of producing the commutating field, and for changing the ratio between the alternating-current and direct-current volts. The main pole and the auxiliary poles are so arranged that at no-load the required ratio is obtained between the alternating-current and the direct-current volts, and at full load its ratio is changed by means of the auxiliary pole, so as to compensate for the drop in the line, transformers, and rotary converters, and, when necessary, the over-compounding of the rotary. In order to increase the range of ratio, a differential winding E may be wound on the auxiliary poles D, so that at no-load the shunt winding produces a flux in the reverse direction to that produced by the series winding C as the load increases. In the ordinary type of split-pole rotary converter it is usual when converting from alternating to direct-current to give the brushes a slight forward lead, and commutate in the fringe of the main pole, which is approximately of constant strength. Since the flux density under the auxiliary pole increases approximately proportionately to the load on the machine, the machine in this case is run towards the auxiliary pole in the direction of the arrow, and thus use the latter as a commutating pole, in addition to varying the ratio between the input and output volts. The essential feature consists in varying the voltage ratio, and the provision of a commutating field of a density which increases with the load by arranging that at full load the greater portion of the flux from the auxiliary poles must enter the armature on that side of the axis of commutation nearest the main pole of similar polarity.—*November 24th*, 1909.



24,581. November 16th, 1909.—Improved Means for Regulating Polyphase Electric Commutator Machines, *Allmänna Svenska Elektriska Aktiebolaget, of Westeras, Sweden, and Jens Larsen La Cour, also of Westeras, Sweden.*

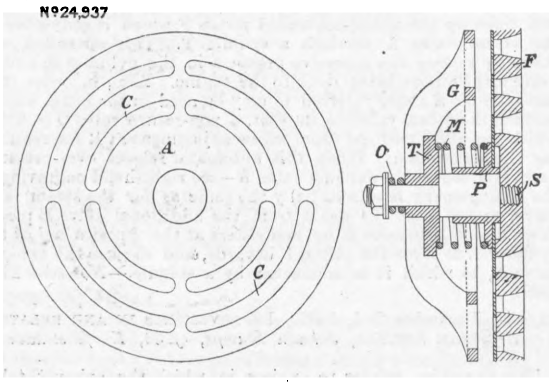
This invention relates to improved means for regulating polyphase commutator machines of the induction type in contradistinction to machines of the conduction type. A is the armature winding, and B and C the main windings. These windings are in the usual manner mounted on the stator with an angular difference of 90 electrical degrees, and are disposed in slots at the inner surface of the stator core. D and E are adjustable auxiliary windings which correspond to the main winding B and C respectively, and also are disposed in slots arranged at the inner surface of the stator core. The armature winding A is, by means of brushes X and Y, connected in series to the adjustable auxiliary winding D, while the corresponding main winding B is directly connected to the first phase I of the network. In analogous manner, the armature winding A is in direction at right angles to the brushes X Y, connected in series by brushes P Q to the adjustable auxiliary winding E, while the corresponding main winding C is directly connected to the second phase I I of the network. In the armature circuits are further connected the secondary windings F and G respectively of transformers, the primaries of which are connected to the phases I I and I respectively of the network. By means of the winding F, a magnetising current, the phase of which agrees to that of phase I I of the network, is induced in the armature winding in the direction X–Y, and, in analogous manner, a magnetising current, the phase of which agrees to that of phase I of the network, is induced in the armature winding, by means of the winding G, for magnetising the armature core in the direction P–Q. When the motor runs the currents induced by means of the windings F and G causes the power factor to be high, so that the motor takes up only small wattless currents from the network. The speed is varied by altering the voltage ratio of the transformers. There are five other illustrations.—*November 24th*, 1909.



PUMPING AND BLOWING MACHINERY.

24,937. February 17th, 1909.—Improvements in or relating to Valves for Blowing Engines, Compressors, and the like, John Scarisbrick Walker, Thomas Ascroft Walker, and Edwin Robert Walker, all of Pagefield Ironworks, Wigan, Lancaster.

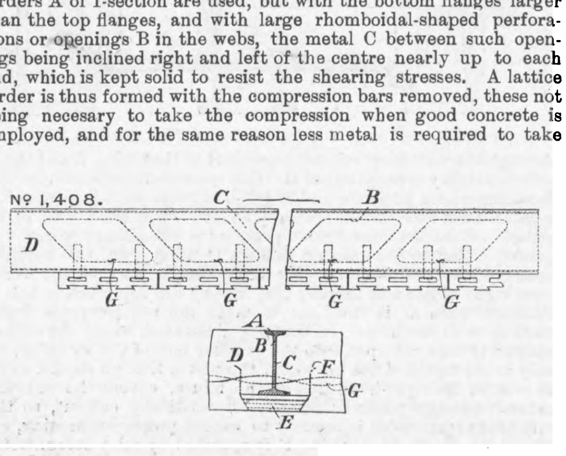
A is the valve plate formed with arc-shaped slots as indicated at C; F is the seating which is formed with a series of grid-like openings which are covered by the imperforate parts of the valve plate as indicated; G is the guard which serves to limit the opening movement of the valve. The guard is supported on the central stud having a threaded end piece S which is screwed into the centre of the seating F. The centre part T of the guard G rests against the shoulder of the enlarged middle portion of the stud and is held up from the rear by a compression spring O and a nut, the position of which can be adjusted in order to vary the spring pressure. The valve plate A is open at the centre and a sliding hub P is provided so as to work over the stud and to be guided thereby. The hub has an enlarged disc-like portion against which a spiral spring M bears, the other end of the spring being supported against the centre part of the guard G. The inner end of the hub P projects through the central hole in the valve plate A and fits closely therein, so that the hub does not require to be actually fixed to the valve plate. It will be seen that with this construction the valve will be accurately guided during its movements, whilst the hub can be readily replaced if required.—*November 24th*, 1909.



MISCELLANEOUS.

1408. January 20th, 1909.—Improvements in Steel and Concrete Construction, Mark Fawcett, of 50, Queen Anne's-gate, Westminster.

The upper engraving shows an elevation and the lower a cross-section of the improved girder construction. For this purpose girders A of I-section are used, but with the bottom flanges larger than the top flanges, and with large rhomboidal-shaped perforations or openings B in the webs, the metal C between such openings being inclined right and left of the centre nearly up to each end, which is kept solid to resist the shearing stresses. A lattice girder is thus formed with the compression bars removed, these not being necesary to take the compression when good concrete is employed, and for the same reason less metal is required to take the longitudinal compression, as this is obtained from the concrete itself. These girders are placed at varying distances apart to suit the spans and loads, and, centering having been placed below or suspended from above, the concrete D is filled in, and allowed to extend 1½in. to 2in. below the girders and come level or above the top. This concrete D, passing through the large rhomboidal-shaped perforations or openings B in the web, becomes, when set, one monolithic mass, in which the girders are imbedded. To allow for the expansion of the girder, tiles E can be used under the bottom flanges of the girders, which tiles can be utilised as a packing for fixing the centering. The use of such tiles E also prevents discoloration of the ceiling such as occurs when concrete is in close contact with the bottom flange of the girders. These tiles E can be held in position by forming them with bevelled edges as shown, around which the concrete sets. In addition, pieces of hoop iron F can be employed, passing through the slots e^1 of the tile, the ends of which are bent outwards, and extend into the concrete itself, on which they become imbedded. The bottom flanges of the girders resist the tensional stresses, and the concrete, assisted by the small top flanges of the girders, resists the compressional stresses, and any tendency to expand in the direction of the length of the girders is resisted by the web metal C holding against the concrete in the rhomboidal-shaped perforations B. Expansion in the opposite direction—that is, at right angles to the girders—is resisted by placing twisted metal strips or bars G in the rhomboidal-shaped perforations, which become imbedded in the concrete. Such bars also serve to reinforce the concrete transversely between girder and girder.—*November 24th*, 1909.

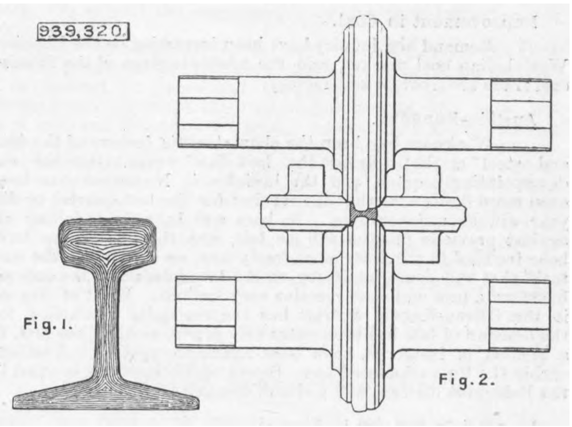


SELECTED AMERICAN PATENTS

(*From the United States Patent-office Official Gazette.*)

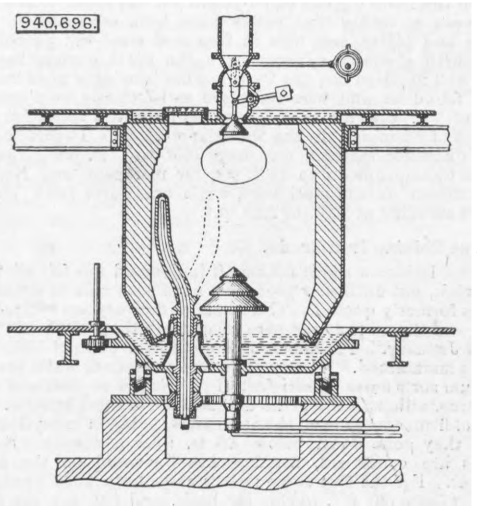
939,320. Method of Manufacturing Rails, *N. Rendleman, Knoxville, Pa., assignor to Jones and Laughlin Steel Company, Pittsburg, Pa., a Corporation of Pennsylvania.—Filed September 29th*, 1908.

This patent is one of two for a method of improving the quality of rail tables. The first is for a rail having the strata formed in the head and flange during reduction, disposed in planes substantially at right angles to the direction in which load is applied to the rail, as shown in Fig. 1. The second is for the rolling mill, Fig. 2, which submits the rail to horizontal pressure, as shown. There is one claim to the first patent, three to the second.



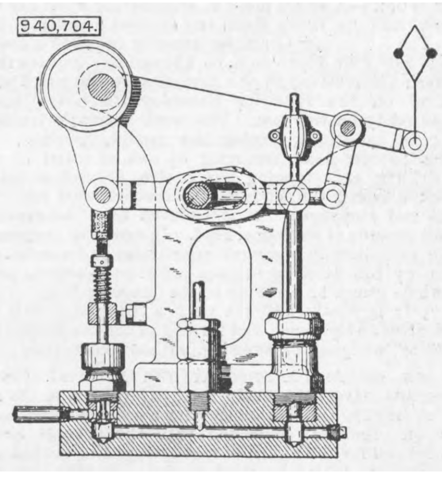
940,696. Gas Producer, *R. B. Kernohan, Pittsburg, Pa.—Filed April 13th*, 1909.

The main feature of this invention is the use of a rotative stirrer or poker which can be caused to rotate inside the charge. There are seven claims.



940,704. Pump, *N. McCarty, Indianapolis, Ind., assignor to Atlas Engine Works, Indianapolis, Ind., a Corporation of Indiana.—Filed June 14th*, 1909.

The drawing is self explanatory. The patent is for an arrangement by which the stroke of the pump is varied by a governor which shifts the fulcrum, as shown. There are six claims.



A New Method of Preserving Wood.—With reference to the paragraph under the above heading in our last issue, we desire to correct an error in line 14. Among the advantages claimed for cresol-calcium is its non-inflammability, and not, of course, its inflammability, as was by error misprinted in the paragraph above mentioned.

THE ENGLISH UNIVERSITIES AND ENGINEERS.

(*By a London Professor.*)

Sir William White, from the presidential chair of the Institute of Metals, recently rebuked those people who constantly belittle this country and its achievements in Applied Science. His words were chiefly directed to the writers and owners of the halfpenny papers. During the last decade we have heard a great deal about the wonderful equipment of the American technical colleges. It may surprise some readers to learn what is being done in England. We have not been altogether listless or asleep. Many of us would have gladly welcomed a heartier response to certain appeals for more money for the engineering departments of our Universities. We may hope that many public-spirited men in this country will take as much interest in higher technical education as is done elsewhere. But it is only fair to add that during the last decade large sums have been obtained from generous donors—many of them men who are well known to readers of this journal as "captains of industry."

For the purposes of our survey of what has been done for University education for engineers during the last four or five years in this country, we will consider first London and then the provinces. It may be well, however, to state that ten years ago the only engineering course leading to a degree in this country was that of the Victoria University. Now the youth in the remotest village of Yorkshire, Cumberland, or Cornwall, may burn the midnight oil at home in preparation for graduation as a B.Sc. (Engineering) in the London University. Birmingham, Durham, Liverpool, Manchester, Leeds, Sheffield, and Bristol now possesses Universities empowered to give the capable engineering student a degree in his own branch of applied science. Engineering is duly recognised as a subject worthy to be accepted in the curricula of those ancient seats of learning at Oxford and Cambridge. These facts of themselves must surely satisfy the croakers that the status of the engineering profession has improved during the last few years. Let it be understood at once that these degrees are by no means intended to be professional certificates; they are not to be interpreted as meaning that the graduate is a capable engineer. It is fully recognised by the University authorities that experience only can do that. But the degree does prove that the student has attained a certain knowledge, and it usually means that he has been through a definite College course. He has given serious study to the fundamental principles of engineering science. The degree also shows that courses of instruction have been given to the student in the laboratory, and some general designing and college drawing-office practice accomplished. If the degree needed defending, that could be done in a sentence. It offers the student a reward for industry, it stimulates him to do his best, and it provides a method of ensuring discipline.

Dangers of degrees.—It may be suggested by thoughtful onlookers that there is a danger in multiplying the facilities for obtaining University degrees in engineering. "After all," they may say, "there must be competition among the various Universities, and each one will endeavour to show a long roll of graduates. There will be a temptation to lower the standard of the degree." Or again, it may be reasonably urged, that it is impossible for the busy man to differentiate between an engineering degree obtained in London, Birmingham or Bristol. It is also conceivable that a man possessing a degree may be a mere "bookish" person, who has not the remotest instinct of proportion and the ways of human nature, so essential to an engineer. All these things may be true, but is only fair to examine the replies which can be given. With regard to the vexed question of the standard of the degrees, it must be remembered that each degree is rewarded on the recommendation of examiners, some of whom are attached to the Institution at which the student has attended, while others are "external" and are attached to other Universities. It is reasonable to suppose that, as these "external" examiners are appointed for not more than three years, the standard at all of the Universities is about the same. If any place lowered the standard the result would be to its own detriment, and that fact is fully recognised. Although it may be difficult for the busy man to distinguish between the various degrees, he can feel satisfied that they all mean about the same general standard, except, possibly, Oxford and Cambridge. These Universities must be considered apart from the more modern places. As for the "bookish" graduate, that is the weakness of any examination system. It is not pretended by the advocates of University education for engineers that the existing system is a perfect one. It does seem to be the best possible under the complex circumstances. It makes it compulsory for a man to have a certain knowledge of theory; he must have the practice as well. That is not a problem to be solved by the University, although every encouragement is to be given to perfecting arrangements, so that graduates may obtain experience immediately after passing their examinations. In some places the "sandwich system" works well. The ideal arrangement is probably the old Admiralty system whereby a student obtained, on an average, about three hours' theory and six hours' practice a day. Such a system is only possible with the resources of a Government department.

Colleges and polytechnics.—The London University is similar in some respects to those in the provinces, but quite different in one feature. The University of the metropolis offers two ways of obtaining an engineering degree. One system was designed for the youths in the London colleges, the other for those who cannot attend colleges. The two sets of students are known as "internal" and "external." To obtain an "internal" degree a student must matriculate, spend at least three years after matriculation in a London college under the supervision of "recognised teachers," and take a course of study approved by the University. A student may attend evening classes and rank as "internal" under the above conditions. He must pass an intermediate examination in mathematics, physics or chemistry, and mechanical drawing, after which he may proceed to study for the final. In that examination he has a fairly wide choice of subjects. He must select three out of the following four, viz.:—(1) Strength of Materials; (2) Theory of Structures; (3) Theory of Machines; and (4) Electrical Technology. He must satisfy the examiners in the three subjects selected. This is called Group A. A further set of subjects—Group B—contains (5) Hydraulics; (6) Surveying; (7) Theory of Heat Engines; (8) Design of Electrical Machinery and Apparatus; (9) Generation, Transmission, and Distribution of Electrical Energy; (10) Mathematics; (11) Advanced Theory of Machines and Structures.* In order to obtain a "pass" degree it is necessary to select and satisfy the examiners in two out of these last seven subjects. To obtain an honours degree three of the Group B subjects must be taken successfully in the examination. If a man selects three subjects in Group B, and fails in one, he obtains a pass degree. These regulations hold both for external and internal students, although separate papers are set for the two examinations. The "internal" student obtains certain marks for his course work, *i.e.*, he submits the designs and notes of laboratory experiments which he has done while studying for the degree. The "external" student does certain designs during the course of the examination (such as a girder, a boiler, a water turbine, &c.), according to the subjects taken. Questions concerning laboratory work are set in the examination; it is a great pity that the "external" student does not necessarily have actual experience in laboratory work. He may study in Timbuctoo, but he is examined in London.

Internal students may attend certain of the chief centres of engineering instruction in the metropolis. University College, King's College, the Imperial College of Science and Technology, and the East London College, are officially known as "Schools of the University." Students who attend these schools are qualified to sit for University examinations, provided only that they have been credited with the requisite number of hours attendance. There are also "Institutions having recognised teachers." Those which provide for engineering are Battersea Polytechnic, the Northampton Polytechnic Institute, the South-Western Polytechnic Institute, the Technical College, Finsbury, the Northern Polytechnic Institute, and the Woolwich Polytechnic. In these latter institutions, students must attend certain courses under teachers "recognised by the University" as sufficiently qualified for the purpose.

In the matter of equipment, the schools of the University are better off than the other institutions, although some of the latter places have excellent apparatus. It may be said at once that there is no single institution in the metropolis which has such equipment as the University of Birmingham.

It is probable that the Imperial College will soon be able to provide the students with apparatus and equipment worthy of the metropolis. But at present London lags behind. University and King's Colleges have great traditions. The former has an especially strong school of civil engineering, and the electrical department, under the distinguished Professor Fleming, has made a world-wide reputation for research work. In the mechanical engineering department, Professor Cormack is engaged upon research work in connection with worm gearing. Sir Alexander Kennedy created traditions whilst he held the chair of engineering at University College. The engineering laboratory was the first of its kind in this country.

Strength of materials equipment.—Throughout the country the University Colleges have laboratories equipped somewhat on the following lines. For strength of materials a 50 or 100 tons machine is used for tension, compression, and bending tests. In most cases there is apparatus for shear or rivet tests. Usually a smaller machine for testing wires is installed. Impact testing machines are fairly general. Experiments on the deflection of beams (to find E) and the torsion of wires (to find C) are invariably arranged. A separate torsion machine is also usually provided. One or two forms of extensometer are used—the telescopic form of instrument seems to be most popular. Useful research work is being done in this subject of materials. In the metropolis several papers have recently been published. Professor Unwin's classical work for the Standards Committee can hardly be reckoned as University research work, although it was conducted at the Imperial College. Several papers on combined stress have been published from the East London College. The work has attracted considerable attention by reason of the ingenious sphingometer used for measuring strains, and the unexpected results showing excentric loading, obtained with it. An electrically controlled testing machine is used at the Northampton Institute, Clerkenwell, and the results of certain torsion tests have recently been published. The tests were conducted in a painstaking fashion, and further data will be awaited with interest.

Experiments with heat engines.—The equipment of the heat engine laboratories in most of the colleges in London and the provinces is after the following general arrangements. Two boilers—locomotive, water-tube or cylindrical—are usually installed. Superheaters are sometimes fitted. Professor Watkinson at Liverpool has one especially designed so that researches may be conducted. A compound steam engine, a single-cylinder steam engine, and a steam turbine are seen in most places. Steam calorimeters, various types of indicators, measuring tanks, &c., are provided, so that complete steam consumption tests may be made. Steam engine research work is not very evident just at present, although several efforts have been made to obtain decisive data. Professor Weighton's work at Newcastle on condensers is well known. Professor D. S. Capper, two or three years ago, presented to the Institution of Mechanical Engineers some results of his researches on valve leakage made at King's College. Other attempts have been made to solve certain steam engine problems. The difficulty is that each engine is a law unto itself. The internal combustion engine, on the other hand, is a popular subject for investigation. In most of the Colleges there are one or two gas engines, and frequently a suction gas producer. Petrol engines are also met with. At Cambridge Professor Hopkinson, at Birmingham Professor F. W. Burstall, at the Imperial College Professor Calendar, and at Finsbury Professor Coker, have all published researches upon matters relating to internal combustion engines. The usual type of laboratory work for the student is a series of tests, under various conditions, upon each engine installed. The engines are either coupled to dynamos or to brakes. The tests are usually thermal and mechanical efficiency tests. It is good practice for the student. Practically every institution (with the possible exception of Birmingham) in this country, requires to develop its heat engine equipment. It is perhaps hardly fair to enumerate individual institutions, but for heat engine equipment the visitor obtains the impression that the University of Birmingham, with its power station, is a long way ahead of the other Universities. The Universities of Liverpool and Sheffield seem to be the next in order. London again lags behind, although all of the colleges have very fair equipment. If the earnest student wishes to obtain good heat engine testing experience he can find the plant necessary in all the London Colleges; there is, however, little opportunity for research work.

Experimental hydraulics is a subject that is comparatively new, but it has come to stay. Here, again, Birmingham is right ahead of any other University. The two concrete channels, 200ft. long, and the 6in. pipe lines, &c., are magnificent. Finsbury College has a very fine hydraulic laboratory. The Leeds University has recently built one, and the Liverpool University will shortly do great things. In this connection it is worth noting that the latter University has recently appointed a Professor of Naval Architecture, and there is a great deal in common between naval architecture and hydraulics. At Sheffield University there is some useful plant, but the space is small. London, again, lags behind—Finsbury is the one place worth mentioning in connection with this subject. Experimental work in hydraulics is essential if the elements of the turbine and pump design are to be grasped. The various colleges are severely handicapped, and in almost every case money is required for hydraulic apparatus. The Imperial College recently obtained £4000 for a new laboratory for this subject. The other London Colleges want more funds for similar equipment.

The elements of civil engineering are taught, but the attempt to give advanced courses to any students except graduates is not to be encouraged. Structural design is dealt with chiefly in the drawing-office. Surveying field work is carried out. In some cases a summer camp for surveying work is arranged, and is usually a success.

Electrical engineers are well provided for at the colleges, and more money seems to have been spent on equipment for this branch of engineering during the last ten years than any other. Birmingham, Leeds, the Imperial College, Liverpool, King's, and University Colleges are well provided with experimental apparatus. The usual equipment is a large laboratory for electrical machines such as A.C. and D.C. motors, rotaries, and transformers. A photometric room is provided for lamp tests. A junior laboratory is equipped with galvanometric, hysteresis, and other bench tests. Invariably a departmental drawing-office is used for design purposes. A great deal of so-called research work has been turned out in this branch of engineering during the last three or four years. Some of it has been really physical research, whilst some has been merely routine testing. The colleges which seem to have turned out good original work in London are University, King's, and East London, and in the provinces a brilliant Birmingham graduate working at Liverpool has made a reputation. Many of the Universities have done electro-chemical researches, but that is not suitable for discussion here. It may be well, however, to point out that there seems to be far more opportunity for original work in electrical work than any other branch of engineering.

Metallurgical and mining work is done at the Imperial and King's College, London, and the Universities of Sheffield, Birmingham, Leeds, and Durham. At Sheffield and Birmingham the equipment is on a very large scale, and could hardly be improved. It is doubtful whether other University Colleges should attempt to provide instruction in these subjects. Possibly it would be wise to have a lecturer in metallurgy and a small laboratory for microscopic work in the mechanical engineering department.

So much for the general outlines of the equipment. It is appreciated that statistics are dangerous, but it may be of interest to mention that in London there are, at the schools of the University, about 500 day students in engineering, most of whom have passed the matriculation. There are probably about 150 other engineering students of the same type in the Polytechnics, day and evening. In addition, these institutions have large numbers of Board of Education students, but they represent work done in the provinces by the technical schools which is not being considered in this article. The Universities of Birmingham, Liverpool, Leeds, Sheffield, Manchester, Durham, and Bristol, have together about 500 students. There are, therefore, in England at present from 1000 to 1200 students seriously studying and taking a course which leads to a University degree. It is a surprisingly high figure, but at Cornell, there are 1700 engineering students. It is curious that the proportion of engineering students at the University, to the population, is very much greater in the United States than in this country. The American youth seems to be determined to obtain a University education. Their fees are lower than in this country.

We have it on reliable authority that the engineering equipment at the University of Birmingham is second to none in the world. It is certainly an example to the

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* It is worth observing that a student is not obliged to take an electrical subject under either heading. Rather anomalous in view of the present position of electricity. Some test of his knowledge in that subject should be required.—Ed. The Engineer.

London Colleges. The metropolis presents a complex problem. There is at present a Royal Commission taking evidence on University Education in London, and the subject of applied science work will be considered carefully. For the medical profession there are various training places in London, and it is reasonable to suppose that several colleges are needed in which engineers can be trained. These places are in existence, but they want better equipment. London should be able to offer to the British subject the best education for any profession in the world. It leads in law and arts. In London there are all of the most prominent experts in engineering. London is enormously wealthy. Several patriotic men have given large sums for the development of applied science at Birmingham, Manchester and Liverpool. £100,000 is badly needed for applied science equipment by each of the schools of the London University. The City Companies and Guilds have assisted to their everlasting credit. They have done a great deal to keep burning the flame of research. More might be done by the private citizens.

This article began with the mention of the name of Sir William White. It is fitting to close it by paying a tribute to his unselfish and tremendous efforts on behalf of University education for engineers. Every engineer may not fully know of it or appreciate it at present; but a future generation will understand more fully, because the benefit will then be reaped.

LOCOMOTIVE PROPORTIONS AND POWER.

By G. JAMES WELLS, Wh. Sc., Assoc. M. Inst. C.E., M.I. Mech. E

No. II.*

ANOTHER instructive set of figures is that shown in Table II. (*ante*), relating to the coupled engines of the Great Northern Company, and an examination of it gives identically the same lessons as those disclosed by the Great Western practice. There is, however, one interesting difference to be noted, viz., Mr. Ivatt has never apparently gone backwards in the values of his ratios, which indicates that he appreciated the controlling factors and recognised the limits. In his 4-4-0 types he maintained Mr. Stirling's engine, but improved the grate factor from 230 first to 206, and finally to 176; whilst in his first design, the well-known 990, the factor was reduced to 149, and this engine was reproduced with slightly smaller cylinders and a yet larger boiler, in which the factor equals 126, equal to the most liberal proportions of any locomotive boiler extant. Put in other words, Mr. Ivatt's engine has twice the grate area and nearly three times the heating surface that his predecessor deemed necessary, truly a revolution in locomotive practice. Going steadily forward, Mr. Ivatt has reached his present position *viâ* one type (990) only, a magnificent record.

TABLE IV.

Type.	Cylinders, diameter × stroke.	Driving wheels, diameter.	Cylinder volume per mile.	Total heating surface.	Grate area.	Cylinder volume divided by		Boiler pressure, lb. per sq. in.	Total tractive force.	Calculated weight on driving wheels.	Actual weight on driving wheels	$\frac{\text{Act. weight}}{\text{Cal. weight}}$	
						Heating surface.	Grate area.						
	in.	ft. in	cu. ft	q. ft	sq ft.				lb.	tons.	tons.		
2-2-2	16 × 24	7 1	2651	1241	14·62	2·14	228	120	6,506	14·45	—	—	Gooch, No. 157
2-2-2	17 × 24	7 1	2990	1203	16·77	2·49	178	140	8,567	19·04	14·00	0·735	Armstrong, No. 378
2-2-2	18 × 24	7 1	3355	1214	19·30	2·76	174	140	9,607	21·35	15·50	0·726	Dean No. 158
2-2-2	18 × 24	7 1	3355	1328	21·0	2·53	167	150	10,390	22·88	16·00	0·699	,, 158
2-2-2	20 × 24	7 8½	3806	1445	20·8	2·64	183	160	13,550	30·11	19·00	0·631	,, 3021
4-2-2	19 × 24	7 8½	3436	1561	20·8	2·21	165	160	12,240	27·19	18·00	0·662	,, 3051
4-2-2	18 × 24	8 0	2970	1769	21·7	1·68	137	115	6,986	15·52	12·3	0·792	Gooch-Dean broad gauge
4-2-2	18 × 24	8 0	2970	2085	21·7	1·42	137	140	8,505	18·90	16·0	0·846	,, latest ,,

TABLE V.

Type.	Cylinders, diameter × stroke.	Driving wheels, diameter.	Cylinder volume per mile.	Total heating surface.	Grate area.	Cylinder volume divided by		Boiler pressure, lb. per sq. in.	Total tractive force.	Calculated weight on driving wheels.	Actual weight on driving wheels.	$\frac{\text{Act. weight}}{\text{Cal. weight}}$	
						Heating surface.	Grate area.						
	in.	ft. in.	cu. ft.	-q. ft.	sq. ft.				lb.	tons.	tons.		
4-2-2	18 × 28	8 1½	3412	1045	17·75	3·26	192	140	9,770	21·71	15·00	0·691	"Stirling" No. 1
4-2-2	18 × 28	8 1½	3412	1045	17·75	3·26	192	160	11,160	24·82	17·00	0·685	,, 771
2-2-2	18 × 26	7 7½	3376	1045	17·75	3·23	190	160	11,050	24·56	17·40	0·708	,, 876
4-2-2	19½ × 28	8 1½	4004	1032	20·0	3·88	200	175	14,330	31·84	19·20	0·603	,, 1003
4-2-2	19½ × 28	8 1½	4004	1032	20·0	3·88	200	175	14,330	31·84	18·00	0·5653	,, 1003
4-2-2	18 × 28	8 1½	3412	1210	23	2·82	148	175	12,220	27·14	18·00	0·663	"I att" 7.6
4-2-2	18 × 26	7 7½	3376	1269	23	2·66	147	175	11,740	26·08	17·75	0·680	,, 266
4-2-2	19 × 26	7 7½	3762	1269	23	2·96	164	175	13,400	29·77	18·00	0·605	,, 267

TABLE VI.

Type.	Cylinders.	Diameter of driving wheels.	Cylinder capacity per mile.	Total heating surface.	Grate area.	Cylinder capacity ÷ heating surface.	Cylinder capacity ÷ grate area.	Engine No.	
	in.	ft. in.	cub. ft.	sq. ft.	sq. ft.				
4-2-2 ...	18 × 28	8 1½	3412	1045	17·75	3·26	192	776	Mr. Stirling's original design
2-4-0 ...	17½ × 26	6 6	3744	929	16·25	4·03	230	869	,, ,, ,,
2-4-0 ...	17½ × 26	6 6	3744	1148	19·5	3·26	192	869	Calculated on the same basis as Mr. Stirling's 776
4-4-0 ..	17½ × 26	6 7½	3672	1124	17·8	3·26	206	400	Mr. Ivatt's original design
2-4-0 ...	17½ × 26	6 7½	3672	1124	17·8	3·26	206	1061	,, rebuild of Stirling's
4-4-0 ...	17½ × 26	6 7½	3672	1250	20·8	2·94	176	1321	,, latest design

Some interesting examples are given in Table III. (*ante*), which are taken from the practice of the Midland Company's Locomotive Department. Mr. Johnston's practice was always to use comparatively small boilers for his engines, and this is borne out by the figures in the table. The first engine, No. 800, is the well-known Kirtley engine, which has done much remarkable work, and the values of the factors are in accordance with this result. Mr. Johnston in his first engine reduced both factors, and in the next type, 1562, these values were still further reduced. In his next engine, the Princess Beatrice, the boiler factor is increased, but is still smaller than that of Mr. Kirtley's No. 800, but the adhesion weight is again less. The engine 1668 belongs to a small class of five in which the cylinder capacity was largely increased, but the then standard boiler employed, so that this engine marked a very great reduction of the boiler factor, so much so that they were subsequently rebuilt to the Princess Beatrice dimensions, the cylinder capacity being reduced and the heating surface being increased. The cylinder capacity of the original 1668 reappears next in the 150 class, but this time the boiler factor is retained at the apparently irreducible minimum for the Midland Company's system of 210, a value which agrees with that disclosed in the other tables. In the next type of engine, 2607, Mr. Johnston used a value for the grate area factor greater than that of 800 for the first time, and these engines were so successful that the same type of boiler has since been fitted to all the older engines that were worth the expense of rebuilding.

TABLE VII.

Type.	Cylinders.	Diameter of driving wheels.	Cylinder capacity per mile in cubic feet.	Total heating surface.	Grate area.	Cylinder capacity ÷ heating surface.	Cylinder capacity ÷ grate area.	Engine No.
4-2-2	19 × 24	7 8½	3436	1561	20·8	2·21	165	"3051." Mr. Dean's design
4-4-0	20 × 26	7 0	4561	1561	20·8	2·92	219	"Gooch." ,, ,,
4-4-0	20 × 26	7 0	4561	2064	27·6	2·21	165	Gooch on same scale as No. "3051"
4-4-2	18 × 30	6 8½	4428	2143	27·0	2·07	164	Mr. Churchward's "Atlantics"

In the succeeding 863 class an increased steam pressure was given, the boiler having the same capacity, but the adhesion factor reaches its lowest value. In Mr. Deeley's latest type 990, the boiler is on a greatly increased scale, and the adhesion factor is increased, but is still apparently very low.

An examination of Tables IV. and V. shows that the development of the single-wheeled engines has proceeded along the same lines as the coupled engines, both as regards adhesion and grate area factors. Table IV. relates to Great Western engines, whilst Table V. refers to Great Northern practice. It is curious to note that the designers of single-wheeled engines have been uniformly of the opinion that they required a more liberal allowance of boiler power than coupled engines, as the grate area factor for contemporary engines is always smaller. It will be remembered that Mr. Stirling said that his single-wheelers always beat his coupled engines when set to work the same class of traffic; but he did not point out that the latter had relatively much less boiler power. Taking as a basis engine No. 771, then the heating surface of No. 869 would have been 1148 square feet and the grate area 19.5 square feet. Mr. Ivatt, in his 400 class, which was a rebuild of 869 so far as regards the engine power, realised these proportions and the excellence of these engines illustrates the value of these factors in proportioning a new type. Table VI. illustrates clearly how if Mr. Stirling had used these factors, and recognising the good work done by his big singles, had taken them as the basis, might have anticipated Mr. Ivatt's engines which are to-day doing work that the big singles could not possibly do.

Similarly, Mr. Dean's "Gooch" was given a smaller boiler than his contemporary singles, and Table VII. illustrates how, if the "Gooch" had been treated as liberally as the Achilles single, the "Atlantics" of Mr. Churchward would have resulted. It seems clear, therefore, that the practice which obtained upon both the Great Western and Great Northern systems of giving the singles the most exacting work to do and restricting the less arduous trains to the coupled engines had resulted in allowing the singles the larger boilers, apparently without disclosing the handicap this was to the coupled engine when put to do the same work as the single-wheeled type.

Four cylinder engines are being multiplied, and in Table VIII. some examples are given. The first example given is the engine to which Mr. Manson fitted four cylinders, but retained the then standard boiler, thus increasing the cylinder capacity without altering the boiler, so that the grate area factor was virtually reduced. It still remains the only example of its class on the Glasgow and South-Western, so that it may be presumed that the results obtained were not good enough to warrant its repetition; and, judged from the knowledge obtained from the discussion of the preceding tables, this might be anticipated. In the then standard engine the grate area factor is 217.5—and it is seen from the practice exhibited in Tables I., II., and III. that 210 appears to be the limiting value—so that increasing the cylinder capacity 7 per cent., and thus giving the grate area factor a value of 232, was making worse the poverty-stricken condition of the standard engine; it is therefore necessary to see how the engine could run with such a small boiler.

It has been stated that the lap on the valves was increased to prevent the engine running itself out of *breath*. The next example is Mr. Webb's Iron Duke, in which the grate area factor was 227, and therefore foredoomed to failure. The following is Mr. Ivatt's 271, which, with the same cylinder capacity as Mr. Manson's No. 11, has been provided with a grate no less than one-third greater area, a somewhat startling comparison. Mr. Drummond has been building four-cylinder engines, and his successive stages are interesting. The last example is fitted with a superheater, hence the factor in this case cannot be directly compared with the other examples, except Mr. Churchward's Great Bear. From a comparison of the Drummond 335 and the Great Bear it would appear that the Great Western people do not attach so much value to the superheater as Mr. Drummond.

The data employed in the calculations of the foregoing tables have been obtained from the pages of THE

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* No. I. appeared December 17th.

ENGINEER, *Engineering*, *Railway Engineer*, &c., and whilst it is impossible to vouch for exact accuracy, there is reason to believe that they may be taken as being substantially correct, and the figures obtained from them may be used for the purpose of comparison between the given designs, also the principal dimensions may be determined for a new type to give some predetermined duty.

The adhesion weight varies with the type of engine, and from an examination of the tables the value of the factor for single-wheeled engines should be about 0.70; for the four-coupled type it should be 1.00, and for the six-coupled type it should be about 1.20.

The value of the grate area factor is somewhat more difficult to assess, but remembering that it is a bad policy to force a boiler, probably its value should be about 150—that is, 1 square foot of grate area is required for each 150 cubic feet of piston displacement per mile, and the heating surface should be about 2.25.

Example (*i.*).—A single-wheeled express engine is required to give a tractive effort of 12,000 lb. with a boiler pressure of 180 lb.

Calculated weight on the wheel $= 12{,}000 \div 450 = 26.6$ tons, and the factor is 0.7, therefore the weight on the drivers must be $= 26.6 \times 0.7 = 18.7$ tons, say 18 tons; with heavy rails perhaps 18.5 tons would be allowed.

Tractive force required per pound of steam

$$= 12{,}000 \div (0.75 \times 180) = 89 \text{ lb.}$$

TABLE VIII.

Type.	Cylinders, diameter × stroke.	Driving wheels.	Cylinder volume per mile.	Total heating surface.	Grate area.	Cylinder volume divided by		Steam space.	Water-line area.	Cyl. volume divided by water-line area.	Water-line area divided by grate area.	Steam space divided by cylinder volume.	Boiler pressure, lb. per sq. in.	Total tractive force.	Calculated weight on driving wheels.	Actual weight on driving wheels.	$\frac{\text{Act. weight}}{\text{Cal. weight}}$	
						Heating surface.	Grate area.											
	in.	ft. in.	cub. ft.	sq. ft.	sq. ft.			cub. ft.	sq ft.					lb.	tons.	tons.		
4-4-0	14½ × 26 12½ × 24	6 9½	4172	1205	18	3·46	232	—	—	—	—	—	165	14,090	31·3	31·7	1·013	G. & S.W. No. 11
4-4-0	15 × 24	7 1	4660	1409	20·5	2·63	227	—	—	—	—	—	175	16,670	37·05	34·0	0·918	L. & N.W. "Iron Duke"
4-4-2	15 × 20	6 7½	4151	1303	24·5	3·181	169	—	—	—	—	—	175	14,860	33·01	32·0	0·969	G.N.R. No. 271
4-4-0	15 × 26	6 7	5431	1701	27·4	3·19	198	—	—	—	—	—	175	19,438	43·20	37·7	0·873	L. & S.W. No. 720
4-4-0	14 × 26	6 7	4730	1701	27·4	2·78	137	—	—	—	—	—	175	16,933	37·63	37·7	1·002	,, ,,
4-6-0	16 × 24	6 0	6251	2727	31·5	2·29	199	—	—	—	—	—	175	22,400	49·76	51·5	1·035	,, No. 330
4-4-2	14¼ × 26	6 8½	4810	2143	27·1	2·24	177	97·7	102·25	43·31	3·772	0·02207	225	22,130	49·18	39·6	0·805	G.W.R. No. 40
4-6-0	14¼ × 26	6 8½	4810	2143	27·1	2·24	177	97·7	102·25	43·31	3·772	0·02207	225	22,130	49·18	58·8	1·196	,, No. 4001
4-6-0	16½ × 26	6 0	7211	2727 s	31·5	2·64	229	—	—	—	—	—	175	25,800	57·33	52·5	0·916	L.S.W.R. No. 335
4-6-2	15 × 26	6 8½	5330	3400 s	41·8	1·57	127	—	—	—	—	—	225	24,540	54·54	60·0	1·100	G.W.R. "Great Bear"

s = these have superheaters.

Undoubtedly a large driving wheel is an advantage, so assume a diameter of 7ft. 7½in. when tires are new, and try a stroke of 26in., then

$$89 = (\text{cylinder diameter}^2 \times 26) \div 91.5;$$

or

$$\text{diameter of cylinder} = \sqrt{(89 \times 91.5) \div 26} = 17.7\text{in.}$$

Since the nearest even figure is 18, the cylinders would be 18in. × 26in.

The cylinder capacity per mile is

= (volume displaced by both pistons per revolution) × (revolutions per mile)

$$= \left(\frac{18^2 \times \pi}{144 \times 4} \times \frac{2 \times 26}{12} \times 2\right) \times \left(\frac{5280 \times 12}{91.5 \times \pi}\right) = 3376 \text{ cu. ft.};$$

hence the total heating surface will be

$$= \frac{3376}{2.25} = 1500 \text{ sq. ft.} \quad . \quad . \quad . \quad . \quad . \quad (3)$$

And the grate area must be

$$= \frac{3376}{150} = 22.5 \text{ sq. ft.} \quad . \quad . \quad . \quad . \quad . \quad (4)$$

	Cylinders.	Diameter of driving wheels.	Cylinder capacity.	Heating surface.	Grate area.	Load on driving wheels.	Steam pressure.	Grate area factor.	Adhesion factor.
	in.	ft. in.	cub. ft.	sq. ft.	sq. ft.	tons.	lb.		
Proposed engine	18 × 26	7 7½	3376	1500	22·5	18	180	150	0·68
Mr. Ivatt's No. 266*	18 × 26	7 7½	3376	1269	23·0	17¾	175	147	0·68
Mr. Dean's No. 3051 ...	19 × 24	7 8½	3436	1561	20·8	18	160	165	0·66

It is evident that these dimensions agree very favourably with current practice, and may be relied upon as a sound basis for a new design.

Example (*ii.*).—Next suppose a coupled engine (4–4–0) be required to give a tractive effort of 16,000 lb., the steam pressure to be 180 lb., the stroke to be 26in., and driving wheels 6ft. 9in. dia.

$$\text{Weight on driving wheels} = \frac{16{,}000}{450} \times 1.00 =$$

36·0 tons; that is, 18 tons per axle; the "Precursors" have 38 tons and the Midland Company's 990 has 38·7 tons, so 36 tons is assumed to be a suitable load.

The tractive force per pound of steam

$$= \frac{16{,}000}{0.75 \times 180} = 118.5 \text{ lb.};$$

hence, diameter of cylinder will be

$$= \sqrt{\frac{118.5 \times 80}{26}} = 19.09\text{in., say 19in.}$$

The cylinder volume per mile is

$$= \left(\frac{19}{12}\right)^2 \times \frac{\pi}{4} \times \frac{26}{12} \times 2 \times 2 \times \frac{5280}{6.75 \times \pi} = 4250 \text{ cu. ft.}$$

Hence the heating surface must be $4250 \div 2.25 = 1889$ sq. ft., and the grate area $= 4250 \div 150 = 28.33$ sq. ft.

	Cylinders.	Driving wheels.	Cylinder capacity.	Heating surface.	Grate area.	Steam pressure.	Tractive effort.	Calculated weight on drivers.	Actual load.	$\frac{\text{Act. load}}{\text{Cal. load}}$	$\frac{\text{Cyl. capacity}}{\text{Grate area}}$
	in.	ft. in.	cub. ft.	sq. ft.	sq. ft.		lb.	tons.	tons.		
Proposed engine...	19 × 26	6 9	4250	1889	28·33	180	16,000	36·0	36	1·000	150
N.W. "Precursor"	19 × 26	6 9	4250	2010	22·40	175	15,220	33·8	38	1·124	190
G.W. "Cities"	18 × 26	6 8½	3838	1818	20·56	200	15,700	34·9	34	0·974	187
M.R. No. 2607	19½ × 26	6 9	4315	1519	25·00	180	16,470	36·6	34	0·931	173

The comparison shows that the proposed engine has somewhat more generous boiler proportions than the examples selected, but the only outside dimension is the grate area proposed, and this is on the right side, as recent practice tend towards larger areas.

Example (*iii.*).—Lastly, assume that 20,000 lb. tractive effort is required with 200 lb. steam pressure, 6ft. 9in. driving wheels, and a 26in. stroke. Then the calculated load on driving wheels $= 20{,}000 \div 450 = 44{\cdot}44$ tons, so the engine must have six wheels coupled, and with a load of 17 tons per axle a total load of 51 tons will be a suitable adhesion load.

The tractive effort per pound of steam pressure $= \frac{20{,}000}{0.75 \times 200} = 133\frac{1}{3}$ lb.; hence the diameter of the cylinder will be

$$= \sqrt{\frac{133\frac{1}{3} \times 81}{26}} = 20.4\text{in.; say 20in.}$$

The cylinder volume per mile

$$= \left(\frac{20}{12}\right) \times \frac{\pi}{4} \times \frac{26}{12} \times 4 \times \frac{5280}{6.75 \times \pi} = 4709 \text{ cu. ft.}$$

Hence the heating surface $= 4709 \div 2{\cdot}25 = 2090$ sq. ft., and the grate area required is $4709 \div 150 = 31{\cdot}4$ sq. ft.

	Cylinders.	Driving wheels, diameter.	Cylinder capacity.	Heating surface.	Grate area.	Steam pressure.	Tractive force.	Calculated weight on drivers.	Actual load on drivers.	$\frac{\text{Act. load}}{\text{Cal. load}}$	$\frac{\text{Cyl. capacity}}{\text{Grate area.}}$
	in.										
Proposed engine...	20 × 26	6 9	4709	2090	31·4	200	19,260	42·80	51	1·19	150
N.E. No. 2111	20 × 26	6 8	4769	1769	23·0	200	19,500	43·33	51·9	1·20	208
G.W. "Albions"	18 × 30	6 8½	4428	2143	27·0	225	20,370	45·28	54·2	1·20	164

A closer approximation could be obtained by a modification of the factors if it were thought necessary. The exact value of the grate area factor, however, will depend upon other conditions local to each system, such as the character of the fuel supplied, the loads to be hauled, speed to be maintained, and the gradients also would have to be allowed for, and this is the reason for some of the variations between the practice of our chief companies.

The case of compound locomotives has been deferred, as their number and relative importance, so far as British practice is concerned, is at present second to the simple locomotive; but the same system of comparison can be extended to them, and will probably lead to similar results as obtained in the foregoing discussion.

The choice of examples depended upon the possession of the data relating to a series of consecutive designs, and doubtless the work of other locomotive designers would repay equally a detailed analysis.

ARMOURED CONCRETE TRUSSES.

WHILE armoured concrete has been used very extensively in the United States for bridge girders and in buildings, and even in viaducts, it has been used only to a limited extent for trusses. One of the few cases in which concrete truss spans have been employed is the Broadway bridge over the Cumberland River at Nashville. The river itself is crossed by three steel truss through spans—one of 320ft. and two of 178ft.—but the approaches consist of armoured concrete viaducts, with two concrete deck truss spans of 97½ft. and 91½ft. The panel length is 14ft. 11in. The horizontal bottom boom is 36in. wide and 18in. deep, while the curved upper boom varies from 36in. by 42in. at the end panels to 36in. by 38in. at the middle panel, where the depth is 16ft. between centres of booms. The truss posts are rounded off at top and bottom to form curved connections with the booms, and in line with them are upper posts, which rest on the upper boom and support the concrete floor of the bridge. It is to be noted that there are no diagonal members in the trusses. The section of the upper boom and the area of steel in the lower boom were arrived at by assuming the trusses fully loaded, with dead and live load and impact allowance, all applied at the panel points. The height between centres of booms was so made as to keep a constant tension in the lower boom. The upper boom was calculated also under the excentric loading as an equilibrated arch rib hinged at the ends, and under this assumption (due to the large dead load) the stresses on extreme fibres of the concrete are well within the crushing strength of concrete. The bridge is designed to carry a double line of electric tramway, with 40-ton motor cars and 30-ton trail cars.

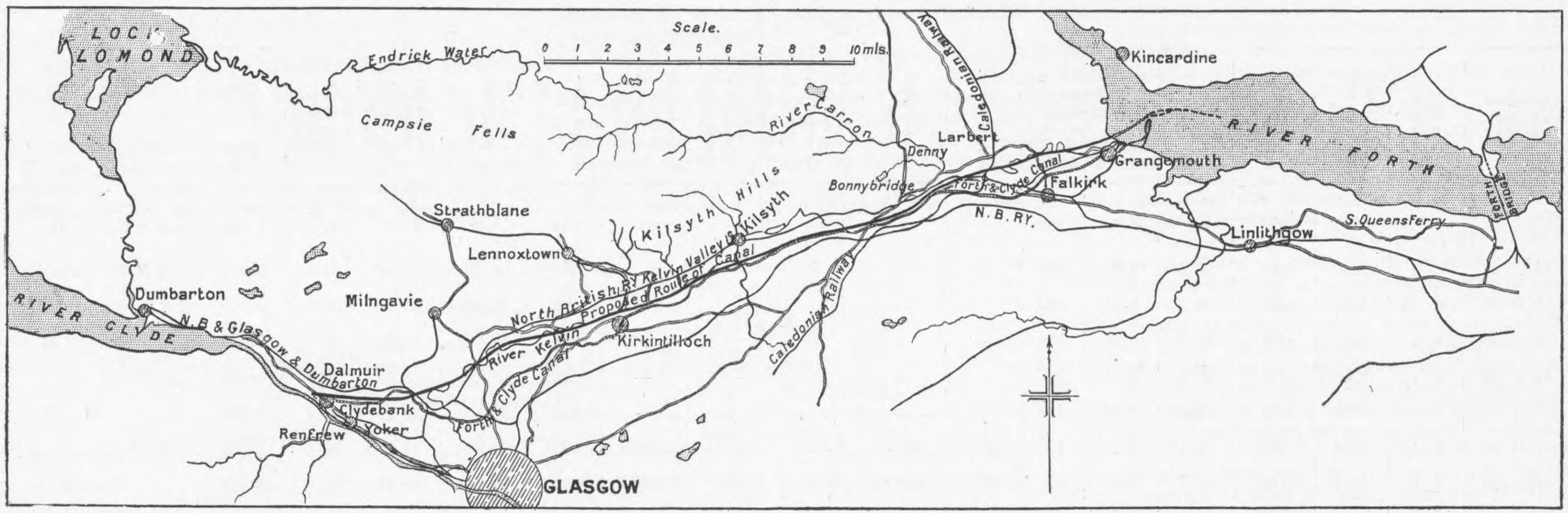
THE ROYAL COMMISSION ON CANALS AND WATERWAYS.

No. XVI.*

FORTH AND CLYDE SHIP CANAL SCHEMES.

THE Royal Commission on Canals and Waterways concluded the taking of evidence by devoting the last two days of the public sittings to the consideration of proposals for the construction of a ship canal between the Forth and the Clyde. In this—the last of our series of articles summarising the evidence—we propose to deal with the question of the proposed Forth and Clyde Ship Canal, a subject which was considered by the Commission in 1907, when a number of witnesses were heard, and again, as we have already stated, at the two final sittings in April of this year.

Two distinct proposals for the construction of a ship canal have been made, each with one or two variants in detail. The first is commonly known as the direct route, and dates from over half a century ago, when proposals were made for the construction of a ship canal of some sort between the Forth near Grangemouth and the Clyde below Glasgow. This scheme was revised and enlarged in 1890, when a preliminary survey of the route was made by Messes. Crouch and Hogg, of Glasgow. After a further period of quiesence, the proposals were revived in 1903, when Mr. W. T. Douglass, of Westminster, made a survey, and prepared a scheme for a canal to follow much the same route as that originally proposed, but embodying considerable modifications in details. Both Mr. Hogg and Mr. Douglas appeared as witnesses before the Commission, the latter putting forward a revised scheme for a canal of greater dimensions than has ever before been proposed for the direct route.



"THE ENGINEER" SWAIN SC.

Fig. 1—PROPOSED FORTH AND CLYDE CANAL—DIRECT ROUTE

The second proposal is that concerned with the Loch Lomond route suggested, we believe, in the first instance by Smeaton who made a survey in 1764. Smeaton's proposals were for a canal of very moderate dimensions, in fact, hardly more than a barge canal. About 1889 Mr. D. A. Stevenson, of Edinburgh, made another survey of the Loch Lomond route, and prepared the scheme which in a somewhat modified form has been submitted by him to the Royal Commission and supported by the evidence of Sir John Jackson and others.

At the present time there exist two canals connecting the east coast of Scotland with the west, viz., the Forth and Clyde barge canal from Grangemouth to Bowling, in the Clyde, opened in 1790, and now owned by the Caledonian Railway Company, and the other from Inverness to Fort William, known as the Caledonian Canal, which was constructed at National expense and is controlled by Government commissioners. We have described both these canals in earlier articles on this subject.† The Caledonian Canal is capable of passing vessels 160ft. long, 38ft. beam, and drawing 14ft.; while the Forth and Clyde Canal can take only barges of moderate dimensions.

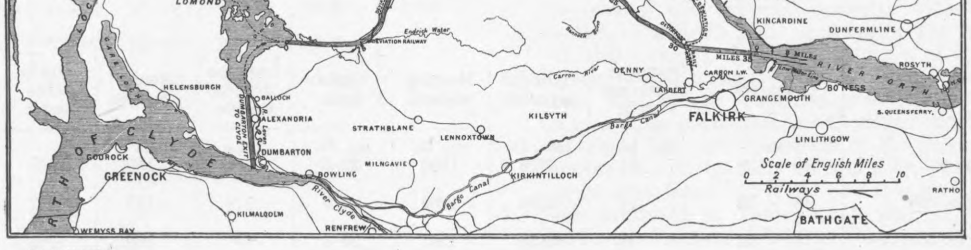
The construction of the Rosyth naval base in the Firth of Forth has given renewed life to the proposals for a ship canal across Scotland, and the principal arguments in favour of its construction are now based, not on the commercial advantage, which undoubtedly would be considerable, but upon the strategic advantage of such a waterway in time of war. In recent times the problem of the maintenance of sea power has shifted its base from the English Channel and the Straits of Dover to the North Sea, and the growing strength of the German navy is an ever increasing argument in favour of the provision of rapid means of communication for battleships between the North Sea and the West Coast. It seems obvious that the strategic value of a ship canal would be so great as to justify the expenditure of a considerable sum to secure a waterway of sufficient dimensions to meet the needs of the Navy. The canal would form a link between the naval base in the Firth of Forth and the shipbuilding and engineering yards on the Clyde, which in time of war must be of vast benefit to the fleet. The advantage of rapidly moving a powerful squadron from one sea to the other in case of necessity without having recourse to the long and possibly impeded voyage through the Pentland Firth or the Straits of Dover is one which cannot be gainsaid. The saving in distance alone would be about 500 miles. The canal would also, in time of war, double the mobility of our fleet, giving us a power of concentration in the Atlantic or North Sea which would be denied to our opponents. The present intentions of the Government with regard to Rosyth include the building of one large graving dock in addition to the large entrance lock, which will be available as a dry dock, but it cannot be argued that this provision—no doubt sufficient for overhaul and repairs in peace times—will be an adequate provision for the needs of a fleet in the event of a naval war in the North Sea. On the other hand the canal would put the great shipbuilding and repairing facilities of the Clyde and other West Coast ports into immediate connection with the North Sea base. An objection, which has been raised on strategic grounds, to the construction of the canal applies equally to the provision of a naval base at Rosyth, and that is the possible destruction of the Forth Bridge in time of war, but this argument has no strong evidence to support it; the great depth and width of the channel at the Forth Bridge make the possibility of serious obstruction very remote, and at all events the argument has not been considered of sufficient importance by the naval authorities to prevent the construction of the Rosyth works.

From the commercial standpoint it must be admitted at the outset that there is little prospect of a canal large enough to accommodate modern battleships, paying a return upon the great outlay involved. Mr. Stevenson has put before the Commissioners a statement of estimated traffic which is certainly optimistic both as regards the volume and the rate of dues which would be levied on ships using the waterway. So far as we have been able to ascertain, few authorities other than Mr. Stevenson go to the length of anticipating a revenue sufficient to pay a moderate interest on the capital necessary to build the canal. It is significant that the Commissioners have been unable to obtain any evidence from the Corporation of Glasgow to the effect that financial support from the local authorities concerned would be forthcoming in the event of the construction of the canal, and, as a matter of fact, the Glasgow Chamber of Commerce has recently adopted a resolution setting forth the opinion that the scheme cannot be regarded as financially sound from a commercial point of view.

Taking the longer of the canal routes proposed—that by way of Loch Lomond—the mileage saved by vessels using the cana on voyages from North Sea ports to the West Coast and America is shown in the accompanying table:—

	Distance saved in nautical miles.
Aberdeen to Glasgow	320
Leith to Glasgow	485
Tyne to Glasgow	386
London to Glasgow	253
Hamburg to Glasgow	312
Baltic to Glasgow	242
Forth to Liverpool...	400
Forth to Belfast	377
Forth to New York	175
Rotterdam to Glasgow	290
Amsterdam to Glasgow...	377

By the "direct" route the savings in distances are somewhat greater.



"THE ENGINEER"

Fig. 2—PROPOSED FORTH AND CLYDE SHIP CANAL—LOCH LOMOND ROUTE

The estimates of probable traffic, so far as they were put before the Commissioners by Mr. Stevenson, may be summarised as follows:—The witness bases his calculations on the Board of Trade shipping returns for 1907. He estimates that nearly 4½ millions registered tons of foreign-going shipping would find it advantageous to use the canal, as well as over 6½ millions of tons of coasting traffic, or one-eighteenth part of the total of such traffic. Adding these figures together, he estimates that the total traffic of the canal will be 11,181,636 tons annually, yielding an average toll of 1s. 6d. per ton, or an income of £833,622. Deducting the cost of maintenance, which he puts at £60,000, he obtains a net revenue of £778,622, which would pay about 3¾ per cent. on 20 millions of capital expenditure. To say the least, Mr. Stevenson's figures are optimistic, and the suggested toll of 1s. 6d. per registered ton is out of all proportion to the rates charged on the Suez and Kiel Canals.

So far, we have dealt with aspects of the question which are to a great extent common to both of the proposed schemes. We now propose to refer to the details, taking first of all the Grangemouth-Yoker or direct route.

The scheme put before the Commissioners in 1907 by Mr. Hogg provides for a canal from Grangemouth to Yoker, in the Clyde, a distance of about 30 miles. The waterway would be 100ft. in width and 26ft. deep, with a summit level of 95ft. above mean sea level, and twelve locks in all, six on each side of the divide. Mr. Hogg estimated the cost of this canal at £7,000,000. The dimensions of the locks proposed are: Length 600ft., width 65ft.

The scheme prepared by Mr. Douglass in 1904 provided for a canal following much the same route as in Mr. Hogg's proposal, commencing a little to the north of Grangemouth and following the north bank of the river Carron as far as Carronshore, where the river would be crossed for the first time. The route passes near the Carron Ironworks and to the south of Larbert, near which town the Caledonian Railway from Larbert and the Denny branch of the same railway would cross, to Bonnybridge. From Bonnybridge the line is generally parallel to the old Forth and Clyde Canal, passing the Bankier Distillery and to the south of Kilsyth to Kirkintilloch. Thence it follows the valley of the Kelvin to Garscube Bridge. To the west of the bridge the Forth and Clyde Canal is crossed. Leaving the Old Canal the line passes over country having a steep declivity towards the Clyde and terminates in the new dock of the Clyde Trustees between Yoker and Clydebank; the total length to this point from low water at Grangemouth being about 29 miles 4½ furlongs. The whole of the existing railways, other than the two lines at Yoker, viz., the Glasgow, Yoker and Clydebank Railway and the Lanarkshire and Dumbartonshire Railway, would be carried over the canal by high-level bridges giving a clear headway of not less than 75ft. for the passage of ships. The construction of these bridges would entail considerable railway deviations and alterations in alignment. The railways at Yoker are at such levels that there it would be impracticable to carry them over the canal except by means of a swing bridge, but a short diversion would enable both lines to be dealt with by one swing span. The road bridges and road deviations necessitated by the construction of the canal offer no insuperable difficulties.

The excavation throughout would be in alluvial deposits and boulder clay, except in the neighbourhood of Kilsyth, where an outcrop of basalt would have to be cut through. Mr. Douglass estimates the total volume of the excavation necessary at nearly 66,000,000 cubic yards. The scheme provides for a waterway 30ft. deep and 130ft. in width at bottom, with locks 700ft. long, 80ft. wide, and 30ft. deep. The canal would have six sets of locks on either side, in addition to tidal regulating locks at the terminals. In addition to the large locks, there would be a smaller lock at each lift for vessels of moderate size, and the large locks would have intermediate gates. The summit level of nearly 19 miles would be 110ft. above Ordnance Datum. The question of water supply is one which closely affects any proposal for the construction of a high-level canal between the Forth and the Clyde; the supply to be obtained from the small streams in the neighbourhood of the canal summit is insufficient for the working of the canal, and Mr. Douglass proposes to draw an additional supply from the watersheds of the Endrick and Carron to the north of the Kilsyth Hills. The depth at low water in the Forth at Grangemouth is considerably less than the 30ft. intended in the canal, and to provide access to the locks from the deep water of the firth, training walls would have to be constructed at Grangemouth and an entrance channel dredged between them. Mr. Douglass' estimate of cost for the scheme sketched above is 10 millions sterling. His later proposal for a waterway on a larger scale which was put before the Royal Commission is estimated to cost 14 millions. In its revised form the scheme provided for a canal 140ft. in width at bottom, 35ft. deep, with only six sets of locks, three on either side, in addition to tidal locks at the terminals. The summit level proposed by this scheme is 95ft. above Ordnance Datum, or 85ft. above high water in the Forth, so that the lift from high-water level to the summit would be effected by means of three locks. The large locks are 1000ft. long, 110ft. wide, with 40ft. depth over sills. The minimum headway under bridges is put at 120ft. Mr. Douglass also proposes an alternative outlet for the canal into the Clyde. This question of the Clyde connection is the most difficult problem which would be met with in the course of construction of the work. Clydebank, Yoker, and the neighbourhood are so much built over, and land is so valuable, that the selection of a suitable route presents great difficulties. As the termination of the canal in the Clyde Trustees' Dock at Yoker, may be considered open to objection, Mr. Douglass suggested a deviation from the original proposal from the 27½ mile point, following the existing Forth and Clyde barge canal to 30 miles, passing to the south of the Kilbowie factory. At 30 miles the canal would cross the main Dumbarton-Glasgow road, and the line of the Lanarkshire and Dumbartonshire Railway, both of which would be diverted for the purpose. Thence the canal would enter the Clyde near Dalmuir light, nearly 30½ miles from the commencement. This revised scheme for a canal by the direct route has been prepared in view of the probable demands of the Admiralty, in the event of its construction. A depth of 35ft. would be required in order that damaged battleships drawing more than the normal might be passed through. With a view to a still greater depth being available if required, the locks would be constructed with 40ft. of water over sills. The estimate for this scheme is £14,000,000, including over five millions sterling for the excavation of 81 millions of cubic yards of material.

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* No. XV. appeared November 12th.

† THE ENGINEER, July 31st, 1908.

The witness also prepared an estimate of the cost of constructing a sea-level canal between the Forth and Clyde, following the same route as the high-level canal. The sea level construction entails an enormous increase in the volume of excavation—about 174 millions of cubic yards additional—but at the same time the expenditure on locks and water supply is reduced, and in some respects the difficulties of railway crossings are simplified. The dimensions of the waterway would be the same as in the fourteen millions scheme, but the minimum headway under bridges is increased to 130ft. The only locks would be regulating, or tidal locks, at Grangemouth and on the Clyde. The minimum water level throughout would be 7ft. above Ordnance Datum, or about the level of high water of neap tides in the Firth of Forth. The maximum depth of cutting would be between the thirteenth and fourteenth mile, where the land rises to 200ft. above Ordnance Datum. The cost of this scheme is put at a total of twenty-three millions sterling.

In all the estimates of cost of constructing a canal by this route, including that of Mr. Hogg, no provision has been made for the deepening of the Clyde from Yoker or Dalmuir to the sea. The present minimum depth at low water of spring tides is about 23ft., and the spring rise at Glasgow being about 11ft., the existing depth at high water is 34ft. It is, however, proposed still further to deepen the canal until 30ft. is available at low water, and it is reasonable to suppose that this depth would be provided by the Clyde Trustees in the event of a ship canal being constructed.

The advantages of the direct route over the Loch Lomond route are, first of all, the saving in distance. The first is less than 30 miles from Grangemouth to Yoker, while the second involves 40 miles of cutting, in addition to the deepening of the Forth from Grangemouth to the canal entrance, and the total length of the navigation between the Forth and the mouth of Loch Long is 68½ miles. The distance from Grangemouth to the mouth of Loch Long by the direct route is about 48 miles, and to Dumbarton 38 miles. The cutting for the direct canal would be principally in soft material; on the other hand, the Loch Lomond scheme entails a vast quantity of rock cutting. Again, the direct route possesses the important advantage of passing through a manufacturing district and a valuable coalfield, thus bringing a number of large ironworks and collieries into direct communication with the sea. On the other hand, the difficulties connected with the Clyde junction at or below Yoker are considerable; an adequate water supply for a high-level canal entails a large additional expenditure, and some of the land to be acquired is of high value. Objections have also been made to the high-level scheme on the score of locks, but in any case terminal locks will be necessary, and the disadvantages connected with a moderate number of locks are probably exaggerated. The *pros* and *cons* of a lock canal compared with a sea level canal have been fully thrashed out in connection with the Panama Canal, with the result that the objections to their use in that waterway have not been considered of sufficient moment to justify the additional cost involved by sea level construction. In any case, the time involved in passing the additional locks on the high-level route cannot equal the delay occasioned by the extra mileage of the Loch Lomond route. Still another objection levelled against the direct route is the navigation of the Clyde between Yoker and Dumbarton. The river is in places not more than 400ft. wide, and the fear has been expressed that the traffic in the waterway might become congested. This is a point of considerable moment, and one upon which there is much diversity of opinion.

We now come to the details of the Loch Lomond scheme as put before the Commissioners in its revised form, which differs materially from the scheme outlined to them in 1907. The latter was estimated to cost seventeen millions, while the revised scheme is expected to cost about twenty millions. In order to avoid the necessity of swing bridges to carry several of the lines of railway over the canal the later scheme provides for constructing the eastern entrance to the canal in the Firth of Forth, a little to the north of Grangemouth, instead of at Alloa. By leaving the Forth 4½ miles below Alloa the Caledonian Railway can be carried over the canal at a point north of Larbert by a fixed bridge giving 120ft. headway. Thence the route proceeds by Stirling and Balfron station, where another high-level bridge would carry the railway over the canal, to Loch Lomond. From Loch Lomond to the sea there are two alternative routes proposed, one at the south end of the Loch from Balloch to the Clyde at Dumbarton, and the other further north, giving an exit from Loch Lomond into Loch Long by way of Tarbert. At a point 10 miles east of Loch Lomond the line passes through a hilly district, the level being 260ft. over sea level, falling gradually to the level of Loch Lomond, 22ft. above mean sea, which is proposed to be the level of the canal water surface throughout. The canal, which, as we have stated, is estimated to cost a little over twenty millions, would have a depth of 36ft.; but if a depth of 31ft. is considered sufficient, Mr. Stevenson reduces his estimate by two millions. He proposes a bottom width of 100ft., with eight passing places in 37½ miles. If the engineer's estimate of probable traffic is ever realised, there is little doubt that the passing places will have to be considerably increased in number or the canal much widened throughout. The entrance to the canal at both ends would be by means of locks, two lifts at each end. The total distance from the Firth of Clyde at the mouth of Loch Long is 68½ statute miles. Of this distance 28½ miles is made up of Loch Lomond and Loch Long, so that the actual canal cutting would be 40 miles, in addition to nearly four miles of dredging in the Firth of Forth. The length of the route *viâ* Balloch and Dumbarton is 7½ miles less than the Tarbert-Loch Long route; but, on the other hand, the canal cutting between Balloch and Dumbarton is three to four miles longer, and the river between Dumbarton and the mouth of Loch Long is crowded with traffic. On the whole, Mr. Stevenson prefers the Loch Long route. The routes of the two rival schemes are shown in the plans—Figs. 1 and 2.

INSTITUTION OF MECHANICAL ENGINEERS.

Two papers were read and discussed at last Friday's meeting of the Institution of Mechanical Engineers, the titles being "Mild Steel Tubes in Compression and under Combined Stress" and "Compound Stress Experiments." The former was read by Mr. W. Mason, of the University of Liverpool, and the latter by Professor C. A. M. Smith, of the East London College. An abstract of Mr. Mason's paper is given on page 671. At the opening of the meeting Mr. J. A. F. Aspinall, who occupied the chair, announced that Professor Unwin and Mr. Robert Matthews had been appointed to fill the vacancies on the Council caused by the retirement of Mr. George Whale and Mr. J. F. Robinson, which take place at the end of the year. It was also announced at the close of the discussion that the next annual summer meeting would take place in conjunction with the American Society of Mechanical Engineers. The discussion was an exceptionally short one, which was due to the fact that after the papers had been read little more than half an hour remained before the time arrived for the meeting to be brought to a close.

Mr. J. J. Guest, of Birmingham, who was the first speaker, said that he did not consider that the authors had explained the general aim they had in view with sufficient fulness. The reason why he expressed that opinion was that after reading a paper on similar work he found that many of his audience had failed to catch the general drift of the paper. If a specimen were put in an ordinary testing machine and pulled it would break at so many pounds per square inch. A tension member in a bridge could be directly compared with the result of that test. In the case of a piece of mild steel in an unstayed boiler there was a hoop stress round the boiler and a longitudinal stress also. The material was therefore subjected to tension in two directions at right angles. Ordinary experiments in a testing machine gave no clue as to whether the second tension affected the capacity of the material to withstand the first tension. The questions which the experimenters were endeavouring to solve were: Could the effect of the tension on the resistance of the material be ascertained, and would the second stress lower the capacity of resistance of the material? They were the questions which the experimenters were endeavouring to answer.

In the case of the crank shaft to which Professor Smith referred, and to the solution of which problem his research was specifically directed, the second stress was of the opposite nature to the first; that was to say, if one was a tension stress the other would be a compressive stress, and *vice versâ*. The experiments which he, the speaker, had carried out, had convinced him that for ductile mild steel the shearing stress was the governing factor. Professor Smith and Mr. Mason had extended the research to the unexplored region. He would first deal with Mr. Mason's experiments. He wished to criticise Figs. 15 and 16 in Mr. Mason's paper, as he did not think that they represented matters quite fairly. Mr. Guest then proceeded to draw on the blackboard the diagram shown in Fig. 1. Mr. Mason, he said, had tested the material in axial tension, and had found it to give a certain point A. He had also carried out experiments corresponding to the boiler plate, and had subjected the test pieces to equal tension, both longitudinally and laterally, obtaining the point B, the yield point for combined axial and hoop tension. If tension were put on the material up to a point C, then tension in a perpendicular direction could be put upon the material up to the amount A B before the material yielded. With the amount C D the material would not yield. The new tension in a direction at right angles to the first would not affect the capacity of the material to withstand the first. In dealing with combined tension and compression stresses, Mr. Mason had put the material in pure compression and obtained a point at E showing the yield point. Then he had taken a certain tension, combined with an equal amount of compression, finding that he could only apply little more than half the previous stresses obtaining at the point F. The stress in the material in that case was a pure shear stress. The second stress then did have a great effect upon the capacity of the material to resist the first stress. If he had put on stresses equivalent to three-quarters tension and one compression, &c., he would have obtained nearly a straight line E A, but that line had been fully obtained by Professor Smith in an entirely different way. To get the point H, Mr. Mason had applied a compression O E in one direction, and an equal compression E H in a direction perpendicular to it. That was the opposite to the case of double tension—the point B. If the material yielded at K, and it were loaded up to E, it would be possible to go on loading it with a perpendicular compression almost up to an amount E H before the material yielded. Mr. Mason's research had located points B, A, F, E, H, but the speaker did not think that he should have duplicated the diagram by reflexion in the line B H. That might suggest that the material had had further tests applied to it, for the point K would correspond to compression in a direction perpendicular to the compression represented by B E—one would be hoop and the other lengthways compression—and similarly for the points A and L.

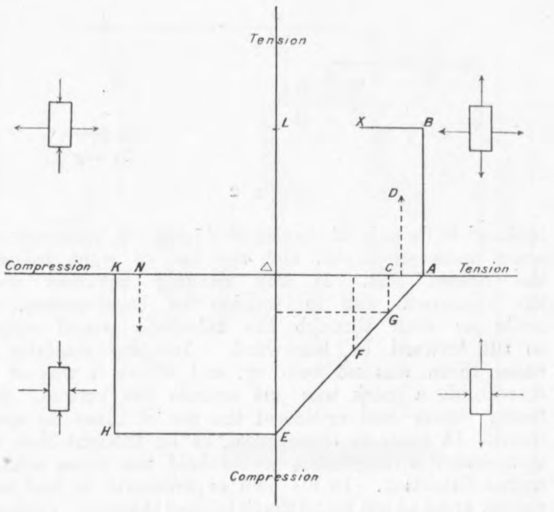

Fig. 1

Professor Smith among others had criticised the use of tubes, but he, Mr. Guest, believed that they were suitable for some experiments. He fully recognised the great importancee of using solid specimens for certain experiments, but he considered that reliable and useful results could be obtained from tubes. His own research obtained a series of points running from A up to B and along B X towards the point L, and also from A towards F. That he considered the easiest part of the curve to obtain. The two extensions of the investigation were both exceedingly difficult pieces of work. Mr. Mason's achievement was to obtain the point H, whilst Professor Smith had covered by a number of points the line A E, which for the materials dealt with completely settled the vexed question of the crank shaft, and the portion of which from F to E was extremely difficult to determine. It appeared that the whole problem of compound stresses in mild steel had been fairly solved, although Mr. Mason should have filled in the line E H as completely as the figure had been filled in from E to A and B. It was fortunate that Professor Smith and Mr. Mason had attacked the problem from quite different standpoints. It would be noticed that the points of Mr. Mason's stress strain curve did not come so exactly on the mean curve as Professor Smith's points. That could be accounted for partly by the instability of the material under Mr. Mason's experiment—secondary flexure troubles—and partly because Professor Smith had aimed at a much higher precision in his observations, taking into account also the stress distribution, which he actually measured. He had no doubt that the axis of stress and that of the specimen were never really coincident, but in his own experiments he had done his best to make them so. The testing machine was not a precision tool, but a weighing machine, and too much should not be expected from it.

Professor Smith had continued some of his—the speaker's—tests in relation to the amount of bending, and had stated that he—Mr. Guest—had not obtained a pure torque. The stops taking the lower bars, however, had been carefully set up in the various experiments, and almost the same arrangement of bicycle pulleys as Professor Smith used were employed. He did not think there was very much bending, and as a matter of fact, in his own experiments that had been guarded against. Drawing a sketch similar to that shown in Fig. 2, Mr. Guest went on to explain that the arrangement employed consisted of two mirrors mounted on the specimen, and inclined to its axis at angles of 45 deg. A telescope and scale were employed, and the line of sight followed the dotted line. If any bending occurred when the specimen was in tension or compression, the scale as seen through the telescope would appear to tilt forward or backward. In the majority of cases there was no bending, and where it was at all discernible a mark was put against the results. Professor Smith had criticised the use of tubes as specimens. In reply to those remarks he thought that the split collet arrangement would hold the tubes without undue distortion. In his own experiments he had used solder, and had not found that it injured the tube. Professor Smith had also stated that the material was not isotropic, but in his own experiments the tubes had been carefully selected, and their density precluded the existence of the defects known to occur in tube or wire-drawing. They were round, and of uniform thickness, and in no case were they seven-thousands of an inch out, as Mr. Mason's had been, but were less than one-thousandth out. The material from which the tubes were constructed were checked for isotropism by the method of applying the stresses, the material being first made to yield under stresses P_1 and P_2—as shown in Fig. 3—and then a test made with the values of P_1 and P_2 interchanged. Also tests could be applied producing stresses such as P_1 and P_2 in Fig. 4, and other tests in which the sides of the element could have a different position as indicated by the broken lines. The difficulty of making accurate measurements of the specimens subjected to loads was overcome by weighing the tubes in air and in water, from which the volume and density were calculated. If there were flaws the density would be low. The tension tests were always found to give a high yield-point stress, which was also against the existence of flaws.

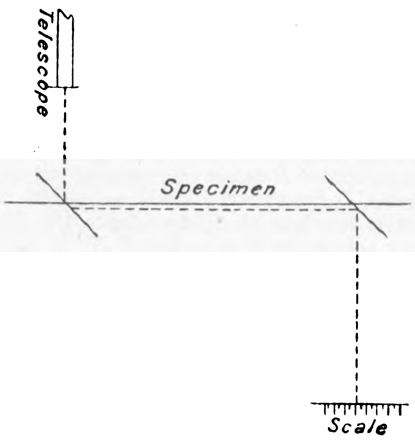

Fig. 2

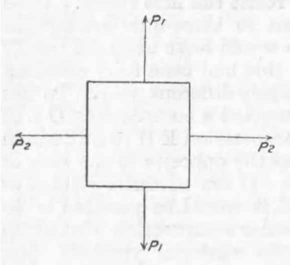

Fig. 3

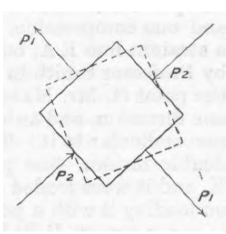

Fig. 4

The chief point raised by Professor Smith was that tubes when loaded in compression might fail by reason of secondary flexure. Mr. Mason had experienced some trouble of that kind, but tests in which it occurred had, of course, to be rejected. In dealing with the last objection raised by Professor Smith with regard to the use of tubes, namely, that engineers did not seem to have confidence in tests carried out upon them, the speaker said that engineers knew the chances there were of getting flaws in cheaply made tubes, and so might be suspicious even of tests made on good tubes. Finally, in congratulating the authors on the work they had done, Mr. Guest said that probably both gentlemen had many serious drawbacks in the course of their experiments. That was more than probable in Professor Smith's case, for he dealt with refinements of measurement to a degree of $\frac{1}{100,000}$ of an inch on specimens under very high stresses. All engineers knew what patience, skill, and labour, measurements involving such an advance of precision meant. The audience listening to a paper and looking at a point on a curve probably did not fully realise that it took 70 observations or thereabouts to get it, and that possibly three or four months were occupied in getting the apparatus to work well. Although this extremely difficult work on mild steel was completed for stresses in two dimensions, he thought that it would be of scientific interest to have the results of some experiments on similar material under stresses in three dimensions. Practically yielding occurred at the surface of a body, the third stress being zero, or nearly so. It had long been known that cast iron gives way under tension only. It would, he thought, be of great interest to know what caused elastic failure in other materials used in engineering work. Was there an abrupt change or some continuous general law?

The next and last speaker was Mr. J. P. E. C. Stromeyer, who remarked that it would have been an advantage if Mr. Mason had given the hoop tension. That, he thought, would have made the paper more interesting, for it would have completed the curve. As he pointed out when he took part in the discussion of Mr. Izod's paper, every material has a characteristic of its own. Turning to Prof. Smith's paper, the speaker said that it seemed to him from the last four readings in the table on page 15 that the author inferred that so long as the ratio of maximum stress to mean stress did not exceed a certain value the material would not fail. If this were so the material could be stressed up to an infinite value without failure, provided that this ratio were not exceeded. At this point Professor Smith remarked that the speaker was drawing an erroneous conclusion, for the stresses on the third plane had to be borne in mind. Referring to Mr. Smith's sphingometer, the speaker said that it was his view, so far back as 1880, that several instruments should be employed to get the elastic limit. He had always used at least two instruments. In his tests in connection with Blackfriars Bridge he used four instruments, two at the top and two at the bottom. There was one objection to Mr. Smith's instrument, and that was that the coiled metal strip was not made of the same material as the metal undergoing test. He thought that the difference in the coefficients of expansion would have an effect upon the accuracy of the instrument. Both papers, he thought, gave insufficient details pertaining to the results. Mr. Mason gave twenty curves, whilst Mr. Smith only gave two, and Mr. Mason had omitted thirty-three curves that he should have included.

Professor Smith writes that as he had no opportunity to reply to the discussion on Friday night, he would like us to publish a few notes in order to make clear some points which evidently confused Mr. Guest. He states that as he was only permitted about twenty minutes to read his paper, he refrained from going over the ground already covered by his other papers, references to which were given. His object was to prove definitely the case of the crank shaft. Mr. Guest, he goes on to say, made experiments on tubes which suggested that mild steel does not fail in the manner as was until then supposed. Lord Kelvin, on the other hand, with evidence which Mr. Guest's experiments did not refute, previously made a statement which really meant that the shear stress theory of elastic limit was not correct. The experiments made at the East London College, it is pointed out, proved not that the shear stress theory was approximately correct, but that it was, for the S.S. mild steel used, correct to within very narrow limits. Mr. Guest's approximate results obtained with tubes were confirmed, and the tests made on specimens under combined compression and torsion proved the shear stress theory for mild steel. Our correspondent informs us that he made rough experiments with tubes, and abandoned them for accurate work.

The tubes used by Mr. Guest, he states, were made in America, and Mr. Guest acknowledged that the English made tubes contained blemishes such as to give rise to variations of .007in. in thickness, but the American tubes were quite free from such defects. Professor Smith is of opinion that tubes are probably satisfactory for quite approximate results, say to within 10 per cent., but he aimed at as great an accuracy as possible in order to test Navier's theory, for which approximate results would be of little value. He considers that, taking into account the labour involved in any work on compound stress, it is worth while aiming at great accuracy. The tests on the S.S. specimens, we are informed, gave experimental results, which almost coincided with the shear stress curve. All the published tests on tubes, we are told, contained certain results which had to be discarded, which fact alone, it is considered, showed how the material varied. The elastic breakdown of a tube in compression, it is maintained, cannot be located with any certainty because of secondary flexure. Professor Smith draws attention to the fact that Mr. Guest's work did not include compression tests, so essential for the case of the crank shaft. There are, he considers, certain cases of compound stress of academic, but no immediate practical interest which could be approximately solved if tubes were used; these, however, Professor Smith has not attempted to attack. Lastly, our correspondent expresses the opinion that the value of Mr. Guest's pioneer work cannot be over-estimated.

MARCONI WIRELESS TELEGRAPHY.*

By Mr. G. Marconi.

No. II.*

A RESULT of scientific interest which I first noticed during the tests on s.s. Philadelphia, and which is a most important factor in long-distance radio-telegraphy, was the very marked and detrimental effect of daylight on the propagation of electric waves at great distances; the range by night being usually more than double that attainable during daytime.[1] I do not think that this effect has yet been satisfactorily investigated or explained. At the time I carried out the tests I was of opinion that it might be due to the loss of energy at the transmitter, caused by the dis-electrification of the highly-charged transmitting elevated conductor under the influence of sunlight.

I am now inclined to believe that the absorption of electric waves during the daytime is due to the ionization of the gaseous molecules of the air affected by ultra-violet light, and as the ultra-violet rays, which emanate from the sun, are largely absorbed in the upper atmosphere of the earth, it is probable that the proportion of the earth's atmosphere which is facing the sun will contain more ions or electrons than that portion which is in darkness, and therefore, as Sir J. J. Thomson has shown[2], this illuminated and ionised air will absorb some of the energy of the electric waves. Apparently, the length of wave and altitude of electrical oscillations have much to do with this interesting phenomenon, long waves and small amplitudes being subject to the effect of daylight to a much lesser degree than short waves and large amplitudes. According to Professor Fleming, the daylight effect should be more marked on long waves, but this has not been my experience. Indeed, in some very recent experiments, in which waves about 8000 m. long were used, the energy received by day was usually greater than at night. The fact remains, however, that for comparatively short waves, such as are used for ship communication, clear sunlight and blue skies, though transparent to light, act as a kind of fog to these waves. Hence, the weather conditions prevailing in England, and perhaps in this country (Sweden), are usually suitable for wireless telegraphy.

During the year 1902 I carried out some further tests between the station at Poldhu and a receiving installation erected on the Italian cruiser Carlo Alberto, kindly placed at my disposal by H.M. the King of Italy[3]—Fig. 15. During these experiments the interesting fact was observed that even when using waves as short as 1000ft., intervening ranges of mountains, such as the Alps or Pyrenees, did not, during the night time, bring about any considerable reduction in the distance over which it was possible to communicate. During daytime, unless much longer waves and more power were used, intervening mountains greatly reduced the apparent range of the transmitter. Messages and press despatches of considerable length were received from Poldhu at the positions marked on the map, which map is a copy on a reduced scale of the one accompanying the official report of the experiments—Fig. 16.

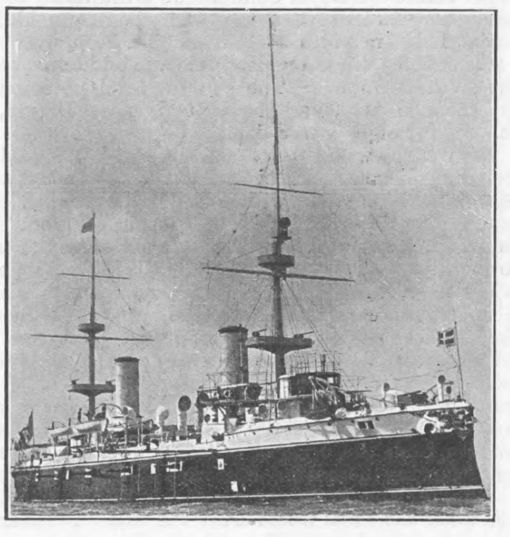

Fig. 15

With the active encouragement and financial assistance of the Canadian Government, a high-power station was constructed at Glace Bay, Nova Scotia, in order that I should be able to continue my long-distance tests with a view to establishing radio-telegraphic communication on a commercial basis between England and America.[4] On December 16th, 1902, the first official messages were exchanged at night across the Atlantic, between the stations at Poldhu and Glace Bay—Figs. 17 and 18. Further tests were shortly afterwards carried out with another long distance station at Cape Cod in the United States of America, and under favourable circumstances it was found possible to transmit messages to Poldhu, 3000 miles away, with an expenditure of electrical energy of only about 10 kilowatts.

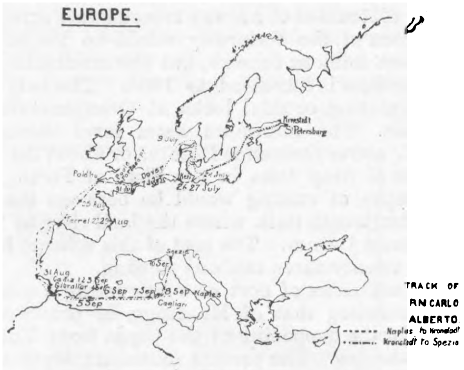

Fig. 16

In the spring of 1903 the transmission of Press messages by radio-telegraphy from America to Europe was attempted, and for a time the London *Times* published, during the latter part of March and the early part of April of that year, news messages from its New York correspondent sent across the Atlantic without the aid of cables. A breakdown in the insulation of the apparatus at Glace Bay made it necessary, however, to suspend the service, and unfortunately further accidents made the transmission of messages uncertain and unreliable. As a result of the data and experience gained by these and other tests which I carried out for the British Government, between England and Gibraltar, I was able to erect a new station at Clifden in Ireland, and enlarge the one at Glace Bay in Canada, so as to enable me to initiate, in October, 1907, communication for commercial purposes across the Atlantic between England and Canada. Although the stations at Clifden and Glace Bay had to be put into operation before they were altogether complete, nevertheless communication across the Atlantic by radio-telegraphy never suffered any serious interruption during nearly two years until, in consequence of a fire at Glace Bay this autumn, it has had to be suspended for three or four months. This suspension has not, however, been altogether an unmitigated evil, as it has given me the opportunity of installing more efficient and up-to-date machinery.

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* No. I. appeared December 17th.

[1] See Proceedings of the Royal Society, Vol. LXX., "A Note on the Effect of Daylight upon the Propagation of Electromagnetic Impulses." G. Marconi, June 12th, 1902.

[2] See *Philosophical Magazine*, August, 1902, Ser. 6, Vol. IV., p. 253. J. J. Thomson, "On some Consequences, &c."

[3] See "Revista Marittima," Rome, October, 1902.

[4] See paper read before the Royal Institution of Great Britain by G. Marconi, March 3rd, 1905.

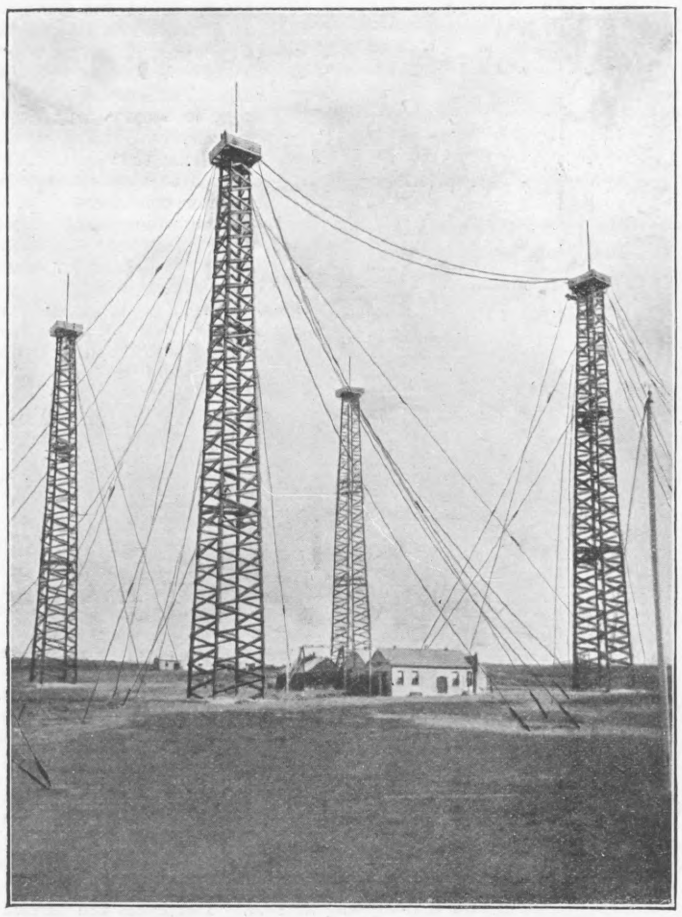
Fig. 17

The arrangements of elevated conductors or aerials which I have tried during my long-distance tests are shown in Figs. 19, 20, and 21.[5] The aerial, shown in Fig. 21, consisted of a nearly vertical portion in the middle, 220ft. high, supported by four towers, and attached at the top to nearly horizontal wires, 200 in number and each 1000ft. long, extending radially all round, and supported at a height of 180ft. from the ground by an inner circle of 8, and an outer circle of 16, masts. The natural period of oscillation of this aerial system gave a wave length of 12,000ft. Experiments were made with this arrangement in 1905, and with a wave length of 12,000ft., signals, although very weak, could be received across the Atlantic by day as well as by night. The system of aerial I finally adopted for the long distance stations in England and Canada is shown in Fig. 22. This arrangement not only makes it possible efficiently to radiate and receive waves of any desired length, but it also tends to confine the main portion of the radiation to a given direction. The limitation of transmission to one direction is not very sharply defined, but the results obtained with this type of aerial are nevertheless exceedingly useful.

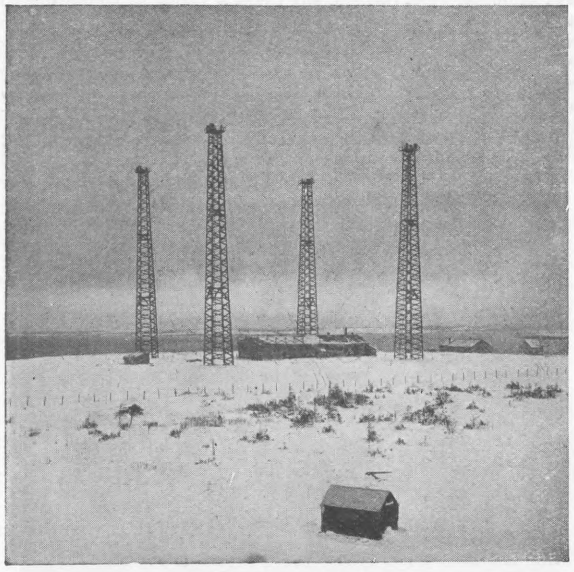
Fig. 18

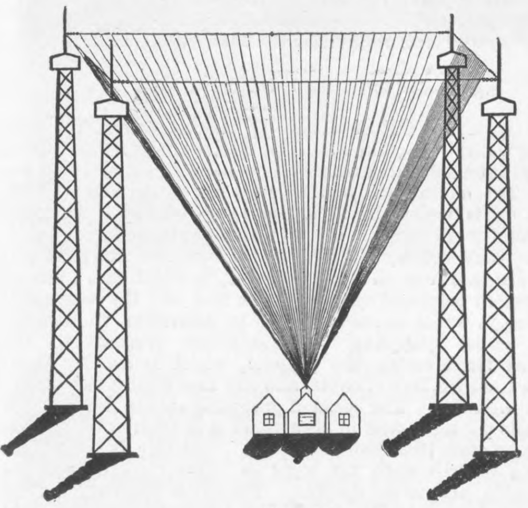
Fig. 19

Many suggestions respecting methods for limiting the direction of radiation have been made by various workers, notably by Professor F. Braun, Professor Artom, and Messrs. Bellini and Tosi. In a paper read before the Royal Society in London in March, 1906[6], I showed how it was possible by means of horizontal aerials to confine the emitted radiations mainly to the direction of their vertical plane, pointing away from their earthed end. In a similar manner it is possible to locate the bearing or direction of a sending station. The transmitting circuits at the long distance stations are arranged in accordance with a comparatively recent system for producing continuous or slightly damped oscillations, which I referred to in a lecture before the Royal Institution of Great Britain on March 13th, 1908. An insulated metal disc A— Fig. 23—is caused to rotate at a high rate of speed by means of an electric motor or steam turbine. Adjacent to this disc, which I will call the middle disc, are placed two other discs C′ and C″, which may be called polar discs, and which are also revolved. These polar discs have their peripheries very close to the surface or edges of the middle disc. The two polar discs are connected by rubbing contacts to the outer ends of two condensers K, joined in series, and these condensers are also connected through suitable brushes to the terminals of a generator, which should be a high-tension continuous current generator. On the middle disc a suitable brush or rubbing contact is provided, and between this contact and the middle point of the two condensers an oscillating circuit is inserted, consisting of a condenser E in series with an inductance, which last is inductively connected with the radiating antennæ. The apparatus works probably in the following manner:—The generator charges the double condenser, making the potential of the discs, say, C′ positive and C″ negative. The potential, if high enough will cause a discharge to pass across one of the gaps, say, between C′ and A. This charges the condenser E through the inductance F, and starts oscillations in the circuit. The charge of F in swinging back will jump from A to C″, the potential of which is of opposite sign to A, the dielectric strength between C′ and A having meanwhile been restored by the rapid motion of the disc, driving away the ionised air. The condenser E therefore discharges and recharges alternatively in reverse directions, the same process going on so long as energy is supplied to the condensers K by the generator H. It is clear that the discharges between C′ and C″ and A are never simultaneous, as otherwise the centre electrode would not be alternatively positive and negative.

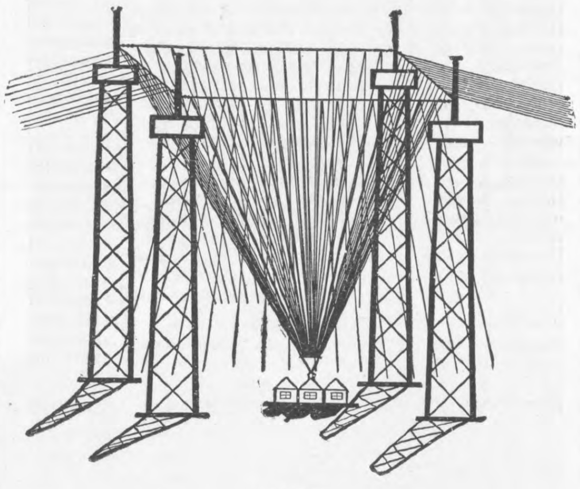
Fig. 20

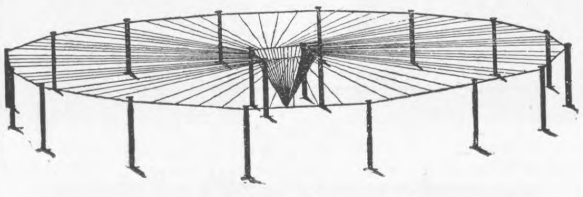
Fig. 21

The best results have, however, been obtained by an arrangement, as shown in Fig. 24, in which the active surface of the middle disc is not smooth, but consists of a number of regularly spaced copper knobs or pegs, at the ends of which the discharges take place at regular intervals. In this way it is possible to cause the groups of oscillations radiated to reproduce a high and clear musical note in a receiver, and thereby it is easier to differentiate between the signals emanating from the sending station and noises caused by atmospheric electrical discharges. By this method very efficient resonance can be also obtained in appropriately designed receivers.

With regard to the receivers employed, important changes have taken place. By far the larger portion of electric wave telegraphy was, until a few years ago, conducted by means of some form or other of coherer, or variable contact either requiring tapping or self-restoring. At the present day, however, I may say that in all the stations controlled by my company my magnetic receiver is almost exclusively employed —Fig. 25[7]. This receiver is based on the decrease of magnetic hysterises which occur in iron when under certain conditions this metal is subjected to the effects of electrical waves of high frequency. It has recently been found possible to increase the sensitiveness of these receivers, and to employ them in connection with a high-speed relay, so as to record messages at great speed.

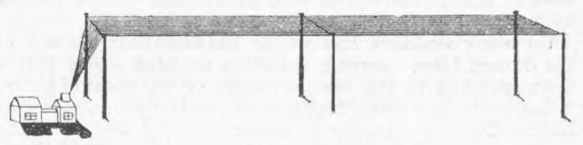
Fig. 22

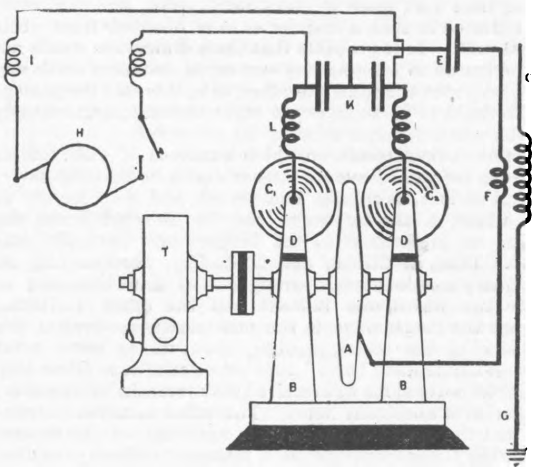

Fig. 23

A remarkable fact, not generally known, in regard to transmitters is that none of the arrangements employing condensers exceed in efficiency the plain elevated aerial or vertical wire discharging to earth through a spark gap, as used in my first experiments—Figs. 2 and 3 (*ante*). I have recently been able to confirm the statement made by Professor Fleming in his book, "The Principles of Electric Wave Telegraphy," 1906, page 555, that with a power of 8 watts in the aerial it is possible to communicate to distances of over 100 miles. I have also found that by this method it is possible to send signals 2000 miles across the Atlantic with a smaller expenditure of energy than by any other method known to myself.

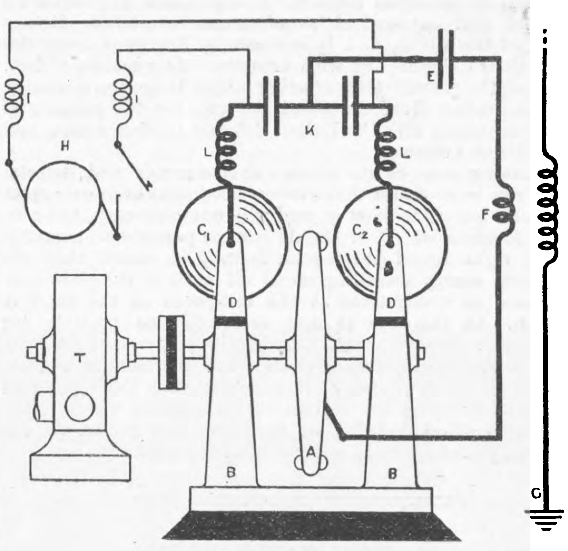

Fig. 24

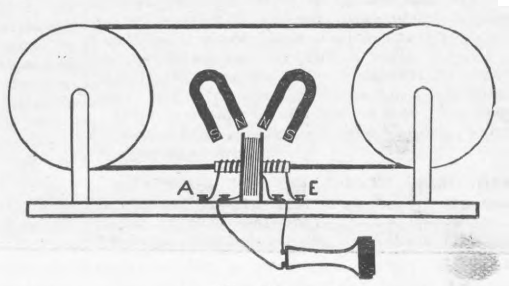

Fig. 25

The only drawback to this arrangement is that unless very large aerials are used, the amount of energy which can be efficiently employed is limited by the potential, beyond which brush discharges and the resistances of the spark gap begin to have a deleterious effect. By means of spark gaps in compressed air and the addition of inductance coils placed between the aerial and earth, the system can be made to radiate very pure and slightly damped waves, eminently suitable for sharp tuning. In regard to the general working of wireless telegraphy, the widespread application of the system and the multiplicity of the stations have greatly facilitated the observation of facts not easily explainable. Thus it has been observed that an ordinary ship station utilising about half a kilowatt of electrical energy, the normal range of which is not greater than 200 miles, will occasionally transmit messages across a distance of over 1200 miles. It often occurs that a ship fails to communicate with a nearby station, but can correspond with perfect ease with a distant one.

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[5] See also lecture before the Royal Institution of Great Britain by G. Marconi, March 13th, 1908.

[6] "On Methods whe eby the Radiation of Electric Waves may be Mainly Confined, &c." "Proceedings" of the Royal Society, A Vol., 77, 1906.

[7] "Proceedings" of the Royal Society. "Note on a Magnetic Detector of Electric Waves." G. Marconi, Vol. LXX., 1902, page 341.

On many occasions last winter the steamship Caronia, of the Cunard Line, carrying a station utilising about half a kilowatt, when in the Mediterranean off the coast of Sicily, failed to obtain communication with the Italian stations, but had no difficulty whatsoever in transmitting and receiving messages to and from the coasts of England and Holland, although these latter stations were considerably more than 1000 miles away and a large part of the Continent of Europe and the Alps lay between them and the ship.

Although high power stations are now used for communicating across the Atlantic, and messages can be sent by day as well as by night, there still exist short periods of daily occurrence during which transmission from England to America, or *vice versâ*, is difficult. Thus, in the morning and evening, when, in consequence of the difference in longitude, daylight or darkness extends only part of the way across the ocean, the received signals are weak, and sometimes cease altogether. It would almost appear as if electric waves, in passing from dark space to illuminated space, and *vice versâ*, were reflected in such a manner as to be diverted from their normal path. It is probable that these difficulties would not be experienced in telegraphing over equal distances north and south, on about the same meridian, as in this case the passage from daylight to darkness would occur almost simultaneously over the whole distance between the two points.

Another curious result, on which hundreds of observations continued for years leave no further doubt, is that regularly, for short periods, at sunrise and sunset, and occasionally at other times, a shorter wave can be detected across the Atlantic in preference to the longer wave normally employed. Thus, at Clifden and Glace Bay, when sending on an ordinary coupled circuit arranged so as simultaneously to radiate two waves, one 12,500ft. and the other 14,700ft., although the longer wave is the one usually received at the other side of the ocean, regularly about three hours after sunset at Clifden and three hours before sunrise at Glace Bay the shorter wave alone was received with remarkable strength, for a period of about one hour. This effect occurred so regularly that the operators tuned their receivers to the shorter wave at the times mentioned as a matter of ordinary routine.

With regard to the utility of wireless telegraphy, there is no doubt that its use has become a necessity for the safety of shipping, all the principal liners and warships being already equipped, its extension to less important ships being only a matter of time, in view of the assistance it has provided in cases of danger. Its application is also increasing as a means of communicating between outlying islands, and also for the ordinary purposes of telegraphic communication between villages and towns, especially in the Colonies and in newly developed countries. However great may be the importance of wireless telegraphy to ships and shipping, I believe it is destined to an equal position of importance in furnishing efficient and economical communication between distant parts of the world, and in connecting European countries with their Colonies and with America. As a matter of fact, I am at the present time erecting a very large power station for the Italian Government at Coltano, for the purpose of communicating with the Italian Colonies in East Africa, and with South America.

Whatever may be its present shortcomings and defects, there can be no doubt that wireless telegraphy even over great distances has come to stay, and will not only stay, but continue to advance. If it should become possible to transmit waves right round the world, it may be found that the electrical energy travelling round all parts of the globe may be made to concentrate at the antipodes of the sending station. In this way it may some day be possible for messages to be sent to such distant lands by means of a very small amount of electrical energy, and therefore at a correspondingly small expense. But I am leaving the regions of fact, and entering the regions of speculation, which, however, with the knowledge we have gradually gained on the subject, promise results both useful and instructive.

A NEW CABLE SHIP.

A NEW twin-screw cable-repairing steamer named Telconia, built by Swan, Hunter and Wigham Richardson, Limited, of Walker and Wallsend-on-Tyne, has recently been completed to the order of the Telegraph Construction and Maintenance Company, Limited. The principal dimensions of the Telconia are:—Length over all, 223ft.; breadth, 30ft. 9in.; and depth moulded, 21ft. 6in. At Lloyd's low draught she has a total deadweight capacity of 1000 tons. She is provided with triple expansion engines and two single-ended boilers with forced draught, and when indicating 1050 horse-power her speed is 12 knots. On page 664 is given a picture of the vessel when on trials off Tynemouth. The hull, engines, and boilers were built at the Neptune Works of Swan, Hunter and Wigham Richardson, Limited, but the cable machinery and appliances were designed and manufactured by the Telegraph Construction and Maintenance Company, Limited, whilst the general arrangement of the ship in all its details was carried out in accordance with the designs of Mr. F. R. Lucas, the managing director of the owning company.

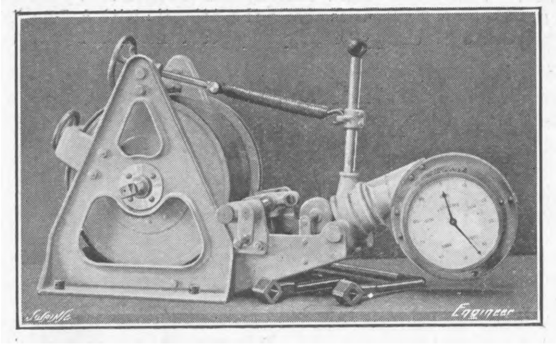


Fig. 1—LUCAS AUTOMATIC SOUNDING MACHINE

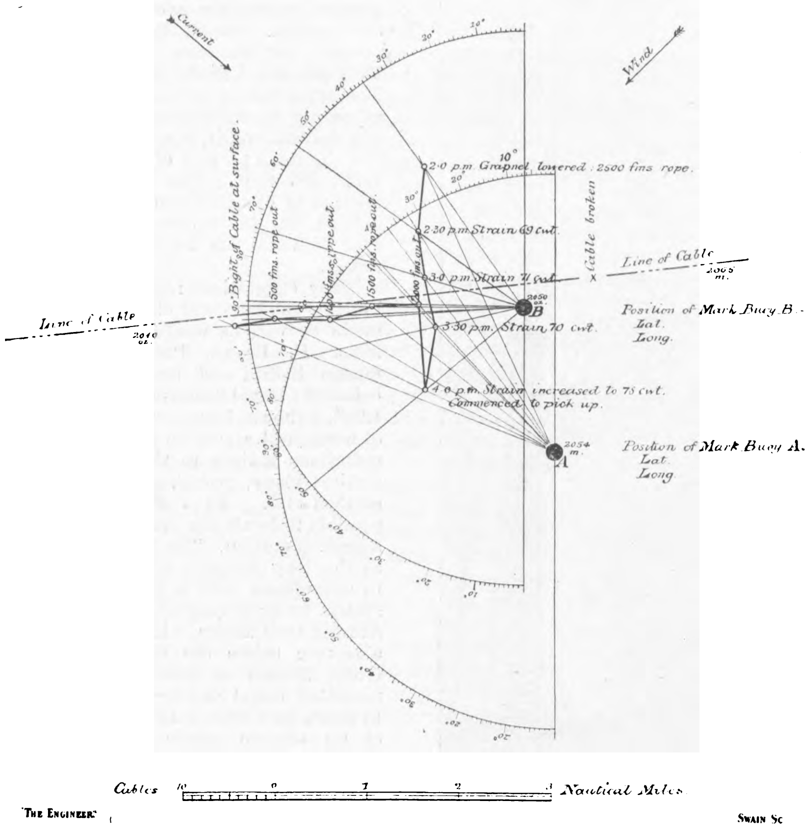


Fig. 2—GRAPPLING CHART

One special feature of the Telconia is that the crew are quartered aft, and the whole of the space forward of the bridge is set aside for cable work. The captain's cabin is on the bridge deck, and the officers' cabins and the saloon are situated amidships. The sailors and firemen are provided with quarters in the after 'tween decks, while the petty officers—including boatswain, carpenter, foremen cable hands, and quartermasters—find comfortable accommodation in the after deck-house.

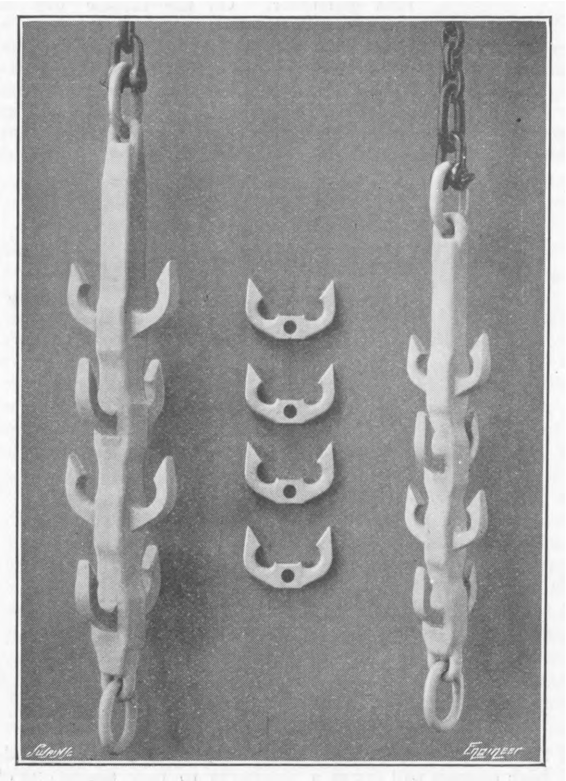


Fig. 3—CENTIPEDE GRAPNEL

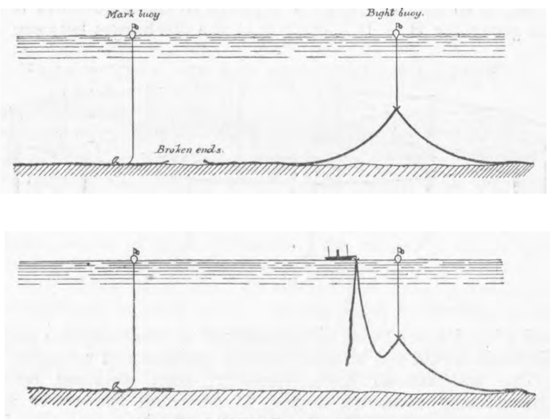


Fig. 4—BUOYING A CABLE

The duplex picking-up machinery occupies the centre of the space in the forward 'tween decks. The gear is controlled from the upper deck, from which place the attendant has the whole of the cable operations under his observation. Three views on page 664 show the picking-up machinery and the inboard and outboard side of one of the picking-up machines, both the latter views having been taken in the works of the Telegraph Construction and Maintenance Company, Limited, prior to the erection on board the ship. The electrical testing-room is situated under the bridge amidships, and from this apartment the electrician is enabled to view the whole of the cable operations. The bow sheaves, which are constructed of cast steel, are wide and flat in the tread, and thus permit of an ordinary centipede grapnel being hove right inboard. At the sides of the 'tween decks there are placed grapnels, coils of rope, and all the other tools most generally used in cable work. The buoys are stored in the forehold immediately under derricks, by means of which latter they are lifted into the fore-rigging in the required positions for launching. The grapnel ropes, buoy moorings, and chains are also conveniently placed so as to be readily led on to the gear for paying-out purposes. There is a total coiling space in the two cable tanks of about 8000 cubic feet. The upper deck is constructed of steel, sheathed with Oregon pine, and has the usual camber of about 6in., whilst the main deck is flat and forms a good bed for bolting down the picking-up machinery, besides providing lofty 'tween decks. The main deck is constructed of steel covered throughout with Lito-silo, which provides a warm and non-slipping surface. The boats are carried in Welins' patent davits.

Some brief outline of the *modus operandi* pursued in repairing submarine cables, for which the vessel has been specially designed, may not be without interest to readers of this journal. First, the electrician determines, by means of careful electrical measurements taken from the shore, the position of the fault in the cable. The ship then proceeds to the spot and places a mark-buoy as nearly in the position as can be estimated, and, whilst waiting to verify it by astronomical observations, she takes a series of soundings so as to determine accurately the depth and nature of the bottom in the neighbourhood of the buoy, where the grappling work will have to be done. The soundings are taken with a wire sounding machine. The wire is on a cast steel drum, and as it is paid out passes over a measuring wheel, the revolutions of which record on a dial the number of fathoms out. A spring brake, which is capable of stopping the reel instantly, is kept out of action by the tension of the wire during the run out, but when the sinker strikes the bottom the loss of tension allows the brake to spring back and stop the reel. The depth can then be read off on the dial (Fig. 1). The wire is wound in by a small engine or by a messenger from the steam winch. On obtaining the latitude and longitude by observation, it may be found that the mark buoy is some distance from the line of cable, in which case a second buoy would be placed exactly on the line, and the bearings of both buoys would be used in order to determine the courses made whilst grappling. The ship now proceeds to the position for lowering the grapnel, which is usually about a mile from the line of cable, and she then steams very slowly across the cable. The speed of grappling should never exceed one mile per hour, and in deep water it is often advantageous not to go more than half this speed. The ship is sometimes allowed to drift with the wind or current when these are favourable, and across the line. The whole operation may be seen by reference to Fig. 2, which is a reproduction of a real chart.

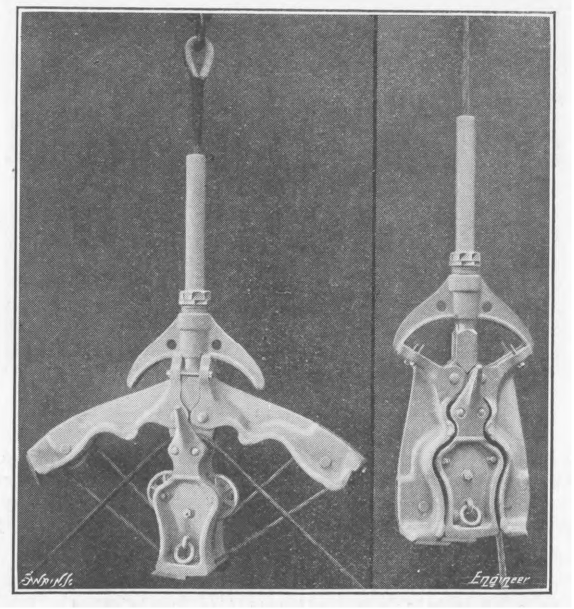


Fig. 5—CUTTING AND HOLDING GRAPNEL

After the cable has been hooked and raised to the surface, it is cut, and the ends taken on board the repairing ship. Electrical tests are then taken to ascertain towards which shore the fault lies and how far from the ship it is. As soon as this is known, a chain is attached to the good end, and it is left hung up to a buoy, whilst the ship proceeds to pick up the cable towards the fault, cutting and testing it from time to time in order to see whether the fault has come on board. As soon as this proves to be the case, new cable, which has been stored in one of the cable tanks on board the ship, is spliced on to the end of the cable which is being picked up. This is then paid out over the bow sheave in the direction of the buoy. This operation completed, the end of the cable hung up is taken on board and the two ends spliced together, and the bight carefully lowered to the bottom.

Several types of grapnels are used, according to the varied conditions of the bottom, but perhaps the one most frequently used is the centipede grapnel. This grapnel is made in two sizes—the larger about 2 cwt. and the smaller $1\frac{1}{4}$ cwt.—and it has the advantage of being of strong construction and not easily broken on rough ground. It hooks the cable securely, and if a prong does get broken through hooking a rock, the damaged prong is easily replaced—see Fig. 3. The grapnels are regularly kept very clean, and painted grey, as a speck of tar on the grapnel occasionally affords the most important evidence, and, in fact, may be the only proof that an old cable has been touched.

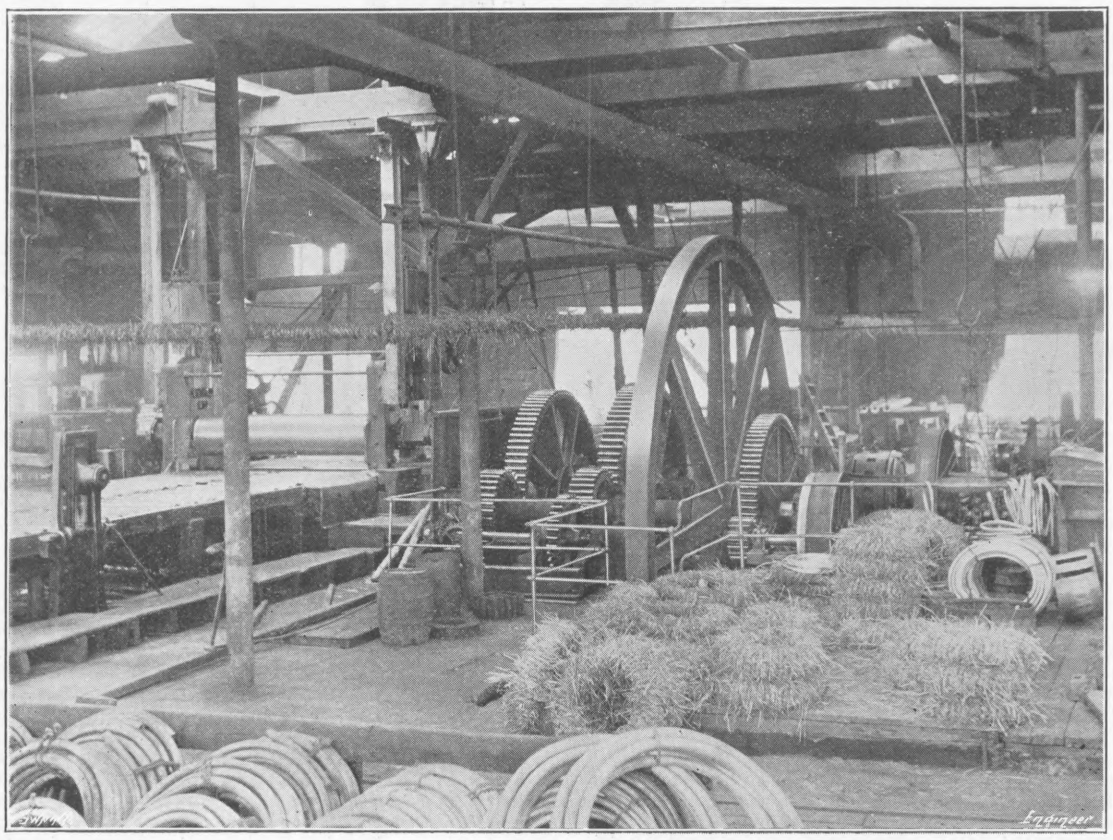


Fig. 1—THE LEAD MILL

In the lifting of an old cable which is in a very weak condition, it sometimes becomes necessary to hang it half way up on to a bight buoy, and then to hook the cable a second time between this buoy and the broken end, so that the cable may be lifted to the surface without putting the whole weight of it on one grapnel—Fig. 4. It is, however, more usual to utilise the Lucas cutting and holding grapnel, which is designed to hook the bight of a cable, to cut and drop one end, and to grip and raise the other end to the surface. It is dragged over the bottom with the folding arms in the position shown in the left-hand view in Fig. 5. When the cable has been hooked, the bight is raised until it becomes tight; the strain then breaks the bolts which keep the arms extended, and the tension on the wire ropes causes the arms to fold down on to the shank, consequently gripping the cable on one side and cutting off the other. The right-hand view in Fig. 5 shows the grapnel when the bolts have been broken, the folding arms gripping one end of the cable in the serpentine-shaped space between them and the shank, the knives having closed together and cut away the part of the cable not required. The builders of the Telconia have had considerable experience in the construction of cable-laying and repairing steamers, and amongst the vessels which they have built during recent years are the Colonia and Cambria, both for the Telegraph Construction and Maintenance Company, Limited.

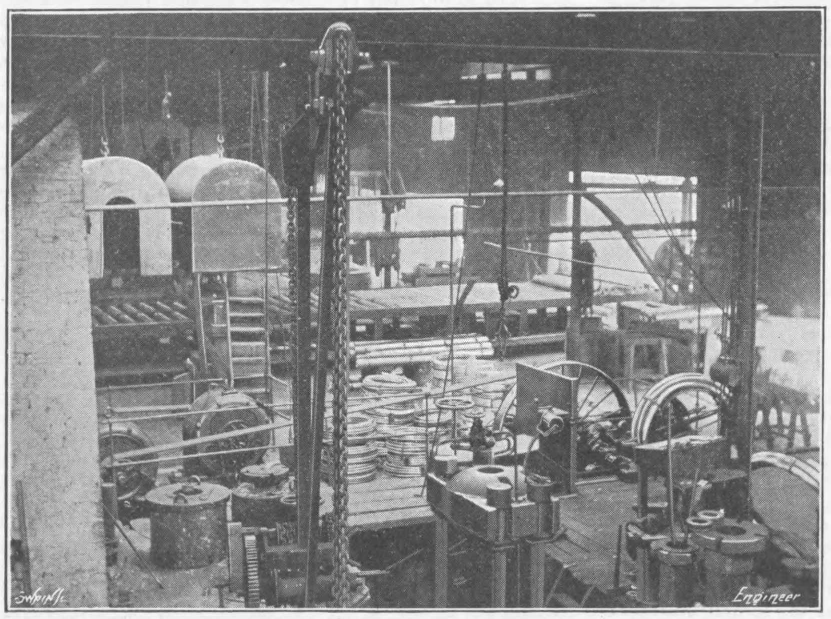


Fig. 2—THE PIPE PRESS SHOP

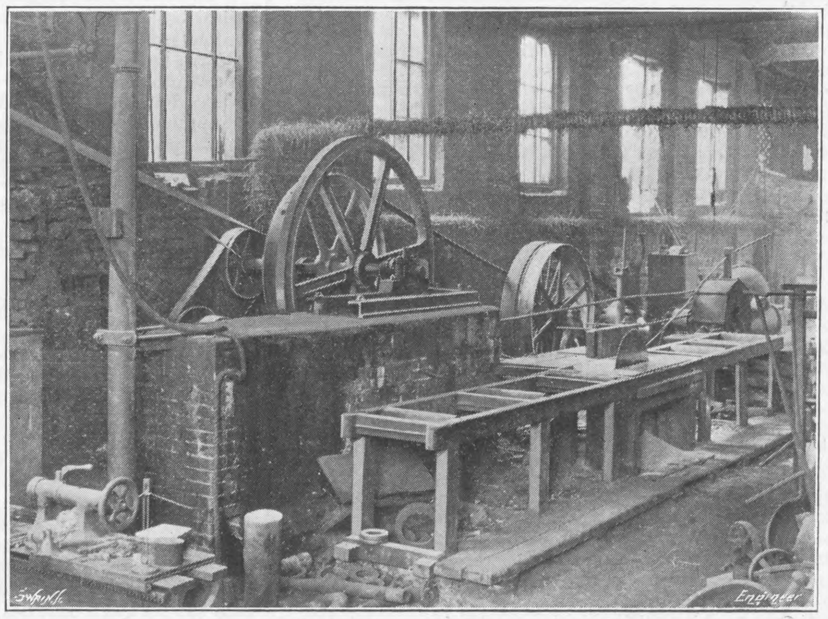


Fig. 3—ELECTRICALLY DRIVEN SAW AND FAN

THE ELECTRICAL DRIVING OF A LEAD WORKS.

ABOUT a year and a-half ago the firm of Foster, Blackett, and Wilson, which, during the fifty years it has been established at Hebburn-on-Tyne, has contributed very largely to the prominent position which Tyneside holds in lead manufacture, became convinced of the advantages of the electric drive, and decided to equip electrically the whole of its works, taking a supply of current from the Northern Counties Electric Supply Company. The result of the last year's running has, we understand, in every way justified the decision. The work of conversion was entrusted to Chas. Martin and Co., Newcastle-on-Tyne, the wiring to Warren, Beattie and Co., of Middlesbrough, and the manufacture of the complete equipment of motors, auto-starters, and controllers to the British Westinghouse Electric and Manufacturing Company, Limited.

The firm devotes itself entirely to the manufacture of lead products, and does not smelt its own lead. It obtains its chief supply of raw material in the form of pig lead from Spain, the ore having been melted on the spot. At one time these pigs used to contain from 20 oz. to 80 oz. of silver per ton, which was separated out by the Pattinson process at the works. Now-a-days, however, the silver is extracted in Spain; but this process is still very largely used for refining the lead where great purity is a necessity, as is the case with sheet lead for use in chemical works and for making white lead. Messrs. Foster, Blackett and Wilson are among the few firms which refine exclusively by this process, and they make a speciality of "chemical" lead.

The raw materials, *i.e.*, lead pigs, oak bark, &c., are brought to the works by water and hauled in trucks by a single-drum haulage at the top of an incline running from the company's private jetty on the Tyne. The haulage-way is some 200 yards long, and has an average gradient of 1 in 10 up the bank. Red lead, white lead, and refined lead are also conveyed by this path, and turntables are placed at intervals from which branch roads lead into the various departments of the works for sea shipment. The maximum load of each truck when full is $6\frac{1}{2}$ tons, and the full load haulage speed is 7 miles per hour. The gear was formerly driven by a vertical double-acting steam engine, with its cylinder below the crank shaft. On conversion, the crank shaft of the engine was taken out and a gear wheel and countershaft put in, by means of which it is now driven by a 60 horse-power motor operated by a drum controller. One of the main objects in carrying out the conversion was to avoid delays, so that existing gear was used as much as possible. The capital outlay, therefore, was kept down, and is, we are informed, very low for this class of work. The whole of the conversion was carried out without a shut down or causing any serious hitch in the operation, the longest interval occurring in connection with the haulage gear, which was carried out during the Christmas holidays.

In the separating house the lead pigs are refined and the pure lead run into a mould about 8ft. square, in which a mass of metal, weighing about eight tons, is formed. This metal slab is lifted by a jib crane and swung over to the bed of the lead mill. This crane was formerly operated by a two-cylinder double-acting steam engine, the crank shaft and cylinders of which were taken out, a countershaft and gear wheel put in, and the drive effected by a 10 horse-power motor, operated by a drum controller. The lead mill, which is shown in Fig. 1. has rolls about 20in. in diameter and 8ft. 3in. long, the bottom one being positively driven and the top one running loose, but giving pressure. A series of six live rolls, standing slightly above the bed of the mill on either side of the main rolls, facilitates the passing of the billets through the mill, and beyond this there are dead rolls for easing the work, the bed being 120ft. long. The fly-wheel, which was retained for equalising the load on the motor, weighs seven tons, and has a diameter of 19ft., in contrast to which the motor is almost lost sight of.

This mill was originally driven by a two-cylinder horizontal engine, of about 200 indicated horse-power and 4ft. 5in. stroke, working at 60 lb. steam pressure. Upon conversion the crank was replaced by a gear wheel, and the countershaft carrying the pinion engaging this wheel is now belt-driven by a 90 horse-power slip-ring motor. The original reversing gear, comprising two pinions keyed on to the fly-wheel shaft, one of which engaged directly on to a loose gear wheel on the roll shaft, the other gearing on to an idler, which in its turn engaged with another loose gear wheel on the roll shaft, has been retained. By means of a four-jaw double-headed clutch, sliding on a feather key on the roll shaft, either one of the loose gear wheels is engaged with the shaft, and these revolving in opposite directions reverse the motion of the mill. A pair of rolling cutters at each side of the bed is used for trimming the edges of the sheets when necessary, and also as a guillotine for cutting the sheets into length. Both of these are operated from the gearing of the mill. The largest sheets rolled are 8ft. wide by 45ft. long, and up to 1in. thick, while sheets as thin as $\frac{1}{24}$th of an inch can be rolled.

It has been found, we gather, that the installation of the electric drive has resulted in a much larger output of the mill, owing to the steadier drive. A three-ton jib crane is used for loading the finished lead from the mill bed, and this has been converted to electrical working, and equipped with a 10 horse-power motor for lifting, the motor and controller being mounted on a bracket swinging with the crane. The crane cannot make a complete turn, so collector rings are unnecessary, and, as in the above-mentioned crane, slewing is done by hand.

Adjacent to the lead mill are two similar pipe presses, one of which is shown in Fig. 2, each machine consisting of an hydraulic press which forces the solid lead out of a steel container through a die, a steel core being bedded in the container, the size of the core settling the inside diameter of the pipe. Pipes can be made varying from $\frac{3}{16}$in. to 9in. inside diameter, a maximum hydraulic pressure of $3\frac{1}{2}$ tons per square inch being exerted on an 18in. diameter ram. The fly-wheel of the three-throw plunger pump, which was steam driven, was replaced by a 6ft. diameter pulley belt driven by a 30 horse-power slip-ring motor. A great improvement has been found in the class of pipe turned out, especially in the case of tinned lead pipes, owing to the even turning moment of the motor, in addition to which a quiet drive is now obtained.

At the other end of this house there is a group of machinery consisting of a lathe for general work, a set of flue paddles, a circular saw, and a cupola blast fan, shown in Fig. 3. The cupola is used for melting down to pigs all the lead residues and slags which are formed during the various processes of manufacture, and which cannot otherwise be reduced. Any lead dust escaping with the fumes from the cupola is caught by the water sprayed up by the flue paddles, and settles in a tank. This group was formerly driven by an old type horizontal single-acting steam engine, and on conversion the piston and connecting-rod were removed, the fly-wheel retained, and the machinery driven by a 20 horse-power motor.

This firm also makes white lead on a very large scale, and the department for the production of this material is one of the most interesting of its class in this country. Metallic lead is converted into white lead by the old Dutch process, and the white lead is then separated out by roller tubs consisting of two copper corrugated rollers and a perforated screen, the metallic or "blue" lead being used over again. The white lead is finely ground by four sets of three pairs of grinding stones in series. After leaving these stones and being washed by dollies it settles in settling tubs, and is finally dried and packed.

For loading and unloading the stacks five overhead electrically driven jib cranes are used, provided with switches for throwing the motors on and off the mains. The crane travel is obtained by means of an ingenious jockey pulley rope drive. Parts of the old gear have again been used, and the hoisting, slewing, and traversing are carried out by friction clutches from the ground. This is a great improvement on the old arrangement, in which nine cranes were used, driving through an endless rope drive by a 50 horse-power gas engine running on town gas. The convenience, economy, and simplicity of the electric drive has here been probably most strikingly demonstrated.

The two white lead grinding equipments were driven by two steam engines, one being of 120 brake horse-power, and the other an old beam engine with a 5ft. stroke and 20ft. fly-wheel running at twenty-six revolutions per minute. These are now replaced by 50 horse-power motors driving the existing shafting through a belt and a 10 to 1 gear reduction. From this shafting the grinding mills and hoists for lifting the lead from the ground to the roller tubs are operated. The greater portion of the white lead is sold in the form of white paint, and for the production of this two large Torrance mixing machines are used, driven by a 60 horse-power motor geared to the old shafting, which also works a 1-ton hoist, raising the dry white lead to the machine hoppers, an oil pump, and a dust extractor fan.

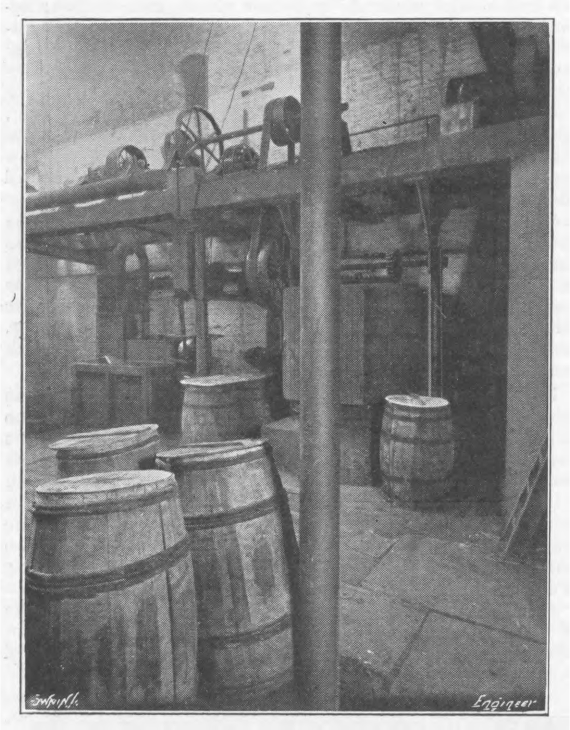


Fig. 4—MIXING HOUSE AND RED LEAD MILL

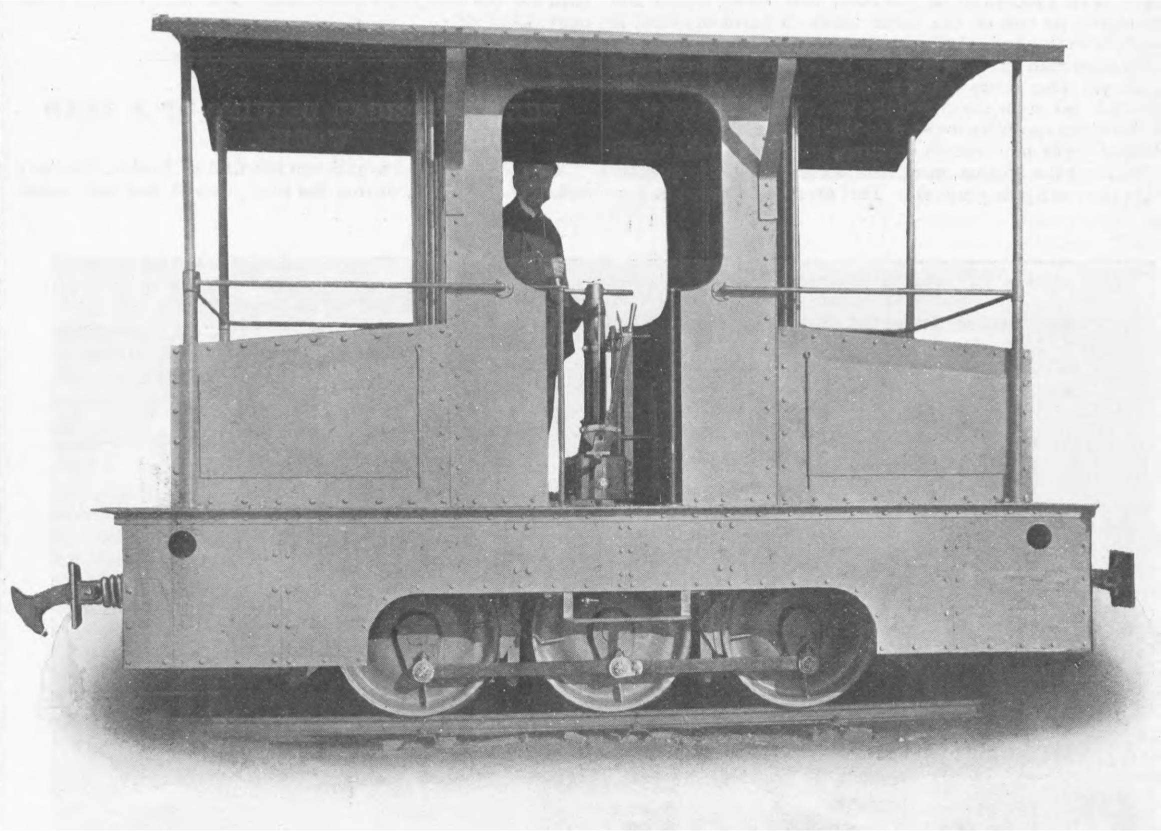
In the manufacture of red lead, metallic lead is heated and oxidised in large drossing ovens called "waste furnaces," and in the presence of free air is converted into litharge PbO. This is then put through grinding stones and a levigating plant, the lighter lithage being washed over into settling tanks, while the heavier metallic impurities sink, and are collected and sent back to the "waste furnaces." The lithage is taken from the settling tanks and placed in a second series of ovens, called "colouring furnaces," where it is again oxidised, taking up more oxygen and becoming red lead (Pb_2O_3). After cooling this is ground through another set of stones and finally taken out and dried. The whole of this grinding plant is driven by a 50 horse-power motor, geared to the original shafting, and on account of the great overloads which may occur, owing to improper use, a large-faced ammeter with a danger line indicating the overload point is placed in the front of the operator. Originally this plant was driven from the beam engine which drove one of the white-lead grinders.

Adjacent to this mill is a dust extractor fan, a mixing, and a sifting machine driven by a 10 horse-power motor, which is shown in Fig. 4, in the right-hand side of which can be seen the covered-in motor driving the red-lead mill. To avoid dust in the packing-rooms, both rooms contain a Sturtevant fan, about 3ft. diameter, running at 900 revolutions per minute and driven by a 5 horse-power motor.

Great care has been taken to protect the motors from dust, and in most cases loose sheet iron covers, which can be lifted by means of wire ropes passing over pulleys suspended from the cross beams, and which are balanced by counter weights, are fixed over the motors. Every precaution is taken to prevent lead poisoning, and it is for this purpose that dust extractors are used in all parts of the works in which there is a likelihood of there being any lead dust in the atmosphere.

PETROL LOCOMOTIVE FOR ASSAM

McEWAN, PRATT AND CO., LONDON, ENGINEERS



PETROL LOCOMOTIVE FOR ASSAM.

THE accompanying illustration shows a petrol locomotive built by Messrs. McEwan, Pratt and Co., of 23, Leadenhall-street, London, to the order of the Assam Oil Company for use in that company's oilfields in Assam. It is built to the requirements of the Indian State railways for metre gauge, has six wheels coupled, the wheel base being 5ft. 6in. It will be used principally for shunting purposes, in consequence of which it was absolutely essential that the whole structure should be of a massive design throughout.

The engine is of the four-cylinder type, and develops 50 brake horse-power at 900 revolutions. The valves are all mechanically operated, and the magneto is fitted with this firm's Murray attachment to facilitate ease in starting the engine. The latter drives through gearing and then by two chains running in oil baths on to one of the axles, arrangements being provided whereby these chains can always be kept at the proper tension. A multiple disc clutch is fitted, with springs to assist in easy starting, and the shock in so doing is taken by springs fitted in the driving wheel. It has two speeds in either direction of 4½ and 10 miles per hour. The locomotive is guaranteed to haul a gross load of 67 tons on the level at 10 miles per hour, or the same load up a gradient of 1 in 84 at 4½ miles per hour; this performance, however, has, we are informed, been considerably exceeded. The draw bar pull, when travelling at 4½ miles per hour up an incline of 1 in 20, was 1900 lb. The consumption of fuel was low. A trial of the engine on the test bench gave 3½ gallons of petrol per hour with the engines running at 900 revolutions per minute and developing 50 brake horse power. This gives .56 of a pint per brake horse-power per hour.

Fuel capacity is provided by two 50-gallon tanks, and four ballast tanks are fitted capable of holding, if necessary, about 1½ tons of ballast. The net weight of the locomotive is 7½ tons, but when fully loaded with ballast and fuel in running order, the weight is approximately 9 tons. Brakes are fitted on all four wheels. A large cooling surface has been provided in the radiators owing to the extremely hot climate prevailing in Assam at certain seasons of the year. The circulation is on the thermo-syphon principle.

A NEW ELECTRICAL INSTITUTION.

ON Friday last the inaugural meeting of a new society, called the Institution of Mining Electrical Engineers, was held at the Midland Hotel, Manchester. The first president is Mr. W. Maurice, and among the objects for which the institution has been formed are: (1) "To consider means for minimising the risks attending the application of electricity to the industry of mining, and to promote the adoption of approved methods and devices tending to increase safety; (2) to promote the general advancement of electrical science in its application to the industry of mining: to facilitate the exchange of information and ideas on this subject amongst the members of the Institution and otherwise, and generally to extend the experience, increase the efficiency and elevate the status of those engaged in such applications." There was a very fair number of gentlemen present, hailing chiefly from the northern counties, and after the formal business of election of officers, &c., had been disposed of, the President delivered an address. This was of a very comprehensive character, and much too long for us to publish *in extenso.* The president said that this association was not an offshoot nor was it a rival of any existing corporate body. On the other hand, it would seek to work in harmony with all whose objects were in any way related to its own. It was new in a wider sense than in merely forming the latest addition to the already large number of technical societies, for although it was intended that it should seek to obtain professional authority and distinction, it stood initially as the inspiration of a small body of hitherto unorganised electrical craftsmen. It was, he said, the first indication of a class consciousness in a large and responsible group of electrical engineers and artisans who had acquired practical experience in mines, and were desirous of extending that experience and of rendering it more generally useful to each other and to the community. It was an indication of the trend of events which was not unworthy of the attention of mine owners that a substantial number of mine workers, occupying for the most part responsible but minor positions, were taking upon themselves to devote some of their limited leisure to the elucidation and publication of matter concerning the practical problems connected with their daily work, in order that the risks to life and property associated with the use of electricity in coal and metalliferous mines might be reduced to the utmost possible extent.

The members dined together in the evening, Mr. Maurice, the president, being in the chair. The toast of the "Institution of Mining Electrical Engineers" was proposed by Dr. Thornton, of Newcastle, and was responded to by the president. Mr. G. H. Winstanley, Lecturer in Mining at the Manchester University, proposed "The Mining Industry," which was replied to by Messrs. Holliday and W. Ritson. The chairman, in the course of a few remarks, stated that the new Institution had the full support of the National Association of Colliery Managers.

On Saturday the members paid a visit to the works of the British Westinghouse Manufacturing Company at Trafford Park, where they were entertained at luncheon.

THE NEW WARSHIPS.

THE contracts for the four new contingent warships were awarded last Saturday by the Admiralty. These vessels come under the Navy Estimates of the current financial year, and their construction was authorised to be commenced on April 1st, 1910, if the progress of foreign naval additions were such as to justify it. Three of the new vessels, we hear, are to be similar to the Orion, laid down a few weeks ago at Portsmouth, and a forecast of which we published in our issue of November 26th last. These battleships will be built by Armstrong, Whitworth and Co., Limited, Newcastle-on-Tyne; William Beardmore and Co., Limited, Dalmuir; and the Thames Ironworks and Shipbuilding Company, London (conditionally). The fourth vessel is to be a cruiser of the Lion type, and will be built and turbined by Vickers, Sons and Maxim. The propelling machinery of the three battleships is likewise to be of the turbine type, that required for the Newcastle ship being supplied by Hawthorn, Leslie and Co., Limited; while the Dalmuir firm will supply its own turbines, and those for the Thames Ironworks will be constructed by the Wallsend Slipway and Engineering Company, Limited, Newcastle-on-Tyne.

THE UNIVERSITY OF SHEFFIELD.—The Council, at its last meeting, appointed Mr. A. B. Coward, B. Eng., to the post of demonstrator in the Department of Engineering. At the same meeting the Pro-chancellor (Mr. George Franklin) and the Vice-chancellor (Sir Charles Eliot) were appointed representatives of the University on the Executive Committee of the Modern University Congress.

THE ELECTRICAL ENGINEERS (LONDON DIVISION).—The annual dinner of the Electrical Engineers (London Division) took place on Saturday last at the Café Monico. Col. R. E. B. Crompton, C.B., the Commanding Officer, was in the chair, and the dinner was attended by over 200 officers, non-commissioned officers, and men with their guests. After the usual loyal toasts, the chairman, in proposing "The Imperial Forces," referred to the needs of national defence, and the increasing enthusiasm in the country for the Territorial Force. Brig.-Gen. F. Rainsford Hanney, R.E., who replied, referred to the past work of the Corps and to the varied possibilities of the future. Col. Crompton then presented the Hopkinson and the Officers' Cups, which are competed for annually for technical work and drill respectively. Both cups were won this year by "A" Company. The technical competition was this year of an unusually severe character. The instructional plant at head-quarters, consisting of two oil engines and a steam engine, with three projectors, was dismantled by an imaginary enemy, who had introduced a number of hidden but very effective hindrances to the running of the engines. The working party, consisting of an officer and thirty non-commissioned officers and men, discovered and rectified the various defects and had the three lights working within three hours of starting work on the "wrecked" plant. The toast of "Science and Engineering" was proposed by Major Leaf and replied to by Professor Kapp and Captain Dumble, R.E., formerly adjutant of the Corps.

RAILWAY MATTERS.

Five accumulator cars have been in operation on the Belgium State Railways since 1899, between Antwerp and Lierre, distant apart about 10 miles. Each car weighs about 40 tons and carries sixty-six people. The Government will buy more cars to operate between Antwerp and Malines.

The first car of a service on which a farthing fare will be charged was run on Thursday, December 16th, over the new track of the Metropolitan Electric Tramways Company from Golders Green Tube Station to Tally Ho Corner, North Finchley. The journey of 3¼ miles will be covered in about twenty minutes.

Work on the Jungfrau Railway is steadily advancing at the rate of between three and four metres a day. The workmen, who number 130, are at present engaged in boring the tunnel between the Eismeer Station, 10,345 ft., and the Jungfrau Joch, 11,090ft. above sea-level. At the present rate of progress the line should be completed towards the end of 1911.

Briquetted Pocahontas coal, in eggette and brick shapes, has been tested on a freight locomotive in comparison with run-of-mine coal, and found to give 10 to 15 per cent. greater evaporation. The tests were made for the U.S. Geological Survey by Messrs. W. T. Ray and Henry Kreisinger, who report it is easier to keep up steam with briquettes than coal.

The annual report of the South Australian Railways Commissioner for 1908–9 states that the permanent survey for the proposed 5ft. 3in. gauge railway line from Gawler to Angaston, a distance of 24 miles, has been completed, and the work of construction is to be put in hand at an early date. It is expected that the line will be completed by February, 1911.

In Italy considerable progress is being made in connection with the electrification of railways. The Government have decided to electrify eleven sections on the State Railways, aggregating 337 miles of track, but on the 3-phase system. Thus the battle of the phases is still undecided. The decision of the Italian State Railways to use 3-phases, while in Germany, Austria, England, Sweden, and America the single-phase system is preferred, is highly interesting.

The *Mexican Herald* of 25th November states that the interests which propose to build the Guadalajara-Chamela Railway have formed a syndicate, and it is planned to begin construction work early next year. The line is to run from the Pacific Port of Chamela to La Vega, 43 miles from Guadalajara, where it is to be connected with the Ameca Line of the National Railways; it will be 325 kiloms. (about 200 miles) long, with a branch line 25 kiloms. (about 16 miles) in length to Ayutla.

The Long Island Railway Company of America announces that by 31st December the electrification of 40 miles of track will have been completed, and more than 140 miles of road will be ready for the operation of electric cars. On 1st June, 1910, the lines will be in full operation, and by that time work will be well advanced on the electrification and double-tracking of the entire North Shore division of the road from Winfield Junction to Flushing, Whitestone, Malba, and Whitestone Landing, and from Whitestone Junction to Port Washington.

Experiments made on the Valtellina three-phase railway, described in *l'Industrie Electrique*, showed the general result that the effect of stray currents from the railway on the adjoining telegraph lines was quite negligible; electrostatic induction was also of small moment, but the electromagnetic perturbations were very serious. It was found necessary, when the line commenced electrical working, to provide metallic circuits for the telegraphs in the neighbourhood of the railway, with translators at the terminal points, but this was both inconvenient and expensive, and required skilled attendance to keep the translators in good working order. Nevertheless, there seemed to be no better way out of the difficulty, short of compelling the railways to use continuous current.

According to an American contemporary, 150 locomotives of the Lehigh Valley Railway are being fitted with a new fuel-saving device. On all the locomotives the air-brake pumps are operated by steam, and it has been the practice to conduct the exhaust steam from the pumps to the smoke-box, to which the stack is attached, and then to release it, causing a draught. Considerable work is done by the brake pumps when the locomotive is at a standstill, thus causing a needless loss of fuel. By the new arrangement the exhaust steam is carried outside instead of inside the smoke-stack. Tests made by the above-named railway show that the company is saving about 1000 lb. of coal per locomotive on the descent of the grade from Glen Summit to Penn Haven Junction, Penn., a distance of twenty-six miles.

The chairman of the Light Railways and Tramways Committee drove the first car over the new length of tramway extending from Golders Green, Hendon, to Tally Ho Corner, Finchley, on Thursday afternoon, December 16th, which section is now opened to public traffic. The length referred to forms part of a line which will eventually link up Cricklewood, Willesden, Harlesden and Acton, in the county of Middlesex. The terminus in the latter district is within about eighty yards of the London United System, which continues through Acton, Ealing, Hanwell, Brentford, Isleworth and Twickenham to Hampton Court, Kingston, Malden, Wimbledon, &c., so that when the section belonging to the Middlesex County Council (referred to above) is linked up at Cricklewood it will be possible to board a car at Barnet (Herts), and travel some 35 miles without a break of more than 80 yards in the total journey.

According to the *Electrician* the Prussian Ministry of Railways has decided that all sleeping cars must be fitted with electric light before October 1st, 1910. This decision has been come to owing to the fact that this form of lighting allows greater safety to the passengers than does gas. The Ministry of Railways, it appears, was not at first at all favourable to the idea of equipping these cars with electric light, in spite of the fact that dangers, arising from using gas for this purpose, had been pointed out by a number of railway authorities. This idea on the part of the Ministry seems to be partly due to the fact that only in Denmark and Sweden was electric lighting universally used, but it is now pointed out that the Orleans railway in France has recently equipped 1100 of its cars with the Stone system of electric lighting, while 900 cars on the same railway are being fitted with the Aiche system. This system is also employed in 1800 cars on the Swiss Railways, and is being fitted in 200 cars at the present time.

The opening of traffic for the Boston Elevated Railway Company's 2.5-mile extension to Forest Hills on November 22nd added another link to the chain of rapid-transit routes radiating from the business centre of Boston to the nearer suburbs. It makes possible a saving of 18 minutes per day to the passenger who travels between his home in the West Roxbury wards of the city and the mercantile district. The value of the time saved will probably tend to deflect traffic from the New Haven suburban steam lines at the south of Boston, on account of the network of distributing stations and tracks which the Boston elevated system maintains in the business centre of the New England capital. By establishing but a single stop between Dudley-street and Forest Hills, the company maintains a high average speed to the suburban centre at the latter point, and transfer tickets to and from surface cars serving the outer suburbs complete the flexibility of the system. The Forest Hills extension and the Cambridge subway now being built are thus, says an American contemporary, simply and clearly parts of a logical scheme of transportation which is benefiting the entire metropolitan district.

NOTES AND MEMORANDA.

Commenting on the growth of the motor car in France, a recently issued consular report states that on February 2nd, 1908, an observer stationed at the entrance to the Avenue des Champs Elysées counted between three and seven o'clock 2953 automobiles passing that spot, and on the 8th of the same month 3430.

A Belgian law of August 20th relating to the use of white lead allows the importation, sale, transportation and use in Belgium of painters' white lead only in form of paste and oil, and prohibits the dry scraping or pumicing of any surface coated with white lead. The importation of white lead in powder, lump, or cake form is allowed for other purposes than for the manufacture of paint.

Great Britain practically monopolises Germany's imports of steam-driven heavy tractors and rollers, which, during the first three-quarters of the current year, reached a value of £20,500, compared with £15,650 in 1908. With the exception of some 280 cwt., the collective tonnage is credited to British makers, whose shipments to Germany exceeded, by over 3600 cwt., Germany's entire exports in this class of goods.

On Thursday, December 16th, Dr. W. H. Eccles and Mr. A. J. Makower read a paper before the Institution of Electrical Engineers on "The Efficiency of Short Spark Methods of Generating Electrical Oscillations." The authors described apparatus which they have used for measuring the efficiency of the form of discharger employed by von Lepel. Particulars of their tests were given. The highest overall efficiency recorded was 14·4 per cent.

It is known that the wave of open-circuit p.d. between the lines of a three-phase generator contains no harmonic which is a multiple of three, whatever the shape of the e.m.f. wave in each phase. When a pronounced third harmonic exists in each phase then the windings ought to be connected in star, and not in mesh. In illustration of these points the author of an article in the *Electrical World* gives the results of tests made on a three-phase alternator whose flux wave had a prominent third harmonic. He explains how the oscillograms verify the theory.

In the course of the discussion on Messrs. Marchant and Watson's paper on "Long-distance Transmission on Overhead Lines" some useful hints were given as regards insulators. Professor Schwatz advocated long spans in order to minimise the number of insulators used. He said that they should be designed to work in compression. As regards the point where to use pin or suspension-type insulators, the limit came when the stress between the line wire and the pin-head became high. It was necessary to have a thick piece of porcelain between the line and pin.

At a recent meeting of students of the Northern Architectural Association Mr. J. G. Smith read a paper on "Portland Cement Manufacture and Testing," giving first a historical sketch of the Portland cement industry, and then describing and illustrating the marked improvement evidenced during recent years in respect of fine grinding. Reference was made to the expansion test more generally recognised and welcomed by cement manufacturers as a means of ensuring more adequate consideration of cement exhibiting progressive increase of strength with age as distinguished from quick-setting cement, which gives high results on a seven days' tensile test and thereafter deteriorates. The author illustrated his paper by practical demonstrations of cement sifting, and gave his audience the opportunity of witnessing tests of briquettes for tensile strength.

A patent issued on November 30th, 1909, on an application filed on December 14th, 1904, by Reginald A. Fessenden, relates to a method for locating the position of ships by means of wireless telegraphy. According to the arrangement proposed, signals are sent out at regular intervals from two or more wireless telegraph stations situated at fixed points, each vessel locating its own position by comparing the strengths of the signals received. Each land station sends out a distinctive signal so that it may be recognised immediately by any vessel. Moreover, the strength of the signal from each land station is varied so as to form a succession of signals of gradually varying intensity so that each signal shall produce the same intensity at a point 20 miles farther from the station than the signal immediately preceding it. Thus the operator on each vessel first identifies the station from which each signal is being sent, estimates the relative distances from the vessel to each land station, and thereby determines the position of the vessel on the sea.

Handling coal and ashes by hand in the 1500 horse-power plant of a paper mill is shown to be pretty expensive in a paper read by Mr. David Gaehr before the Ohio Society of Mechanical, Electrical, and Steam Engineers. The coal is delivered on a covered trestle adjoining the boiler-house and dumped to the ground, whence it is wheeled to the boilers and fired by hand. Three firemen, three coal passers per 12-hour shift, and four shovellers are employed, and the labour cost of handling the coal and ashes amounts to about 1s. 7d. per ton. If half the wages of the head fireman, who merely supervises the fire-room, and one-third the wages of the chief engineer are also charged to this item, the cost is raised to 1s. 10d. a ton. In addition to this heavy expense the ashes must be shovelled into a wagon and hauled to a more remote place on the premises. The firemen and coal passers are worked so hard as to force them to take advantage of every opportunity to exchange their places for better ones, thus making a permanent organisation in the boiler-room a practical impossibility.

An engineering correspondent in Japan, writing in *Ferro-Concrete*, states that he lately had an interview with Professor Omori and Professor Nakamura, the seismologists of Japan, who are sent regularly by the Japanese Government to inspect the results of any important earthquake which may take place, so as to advise the Government as to the best architecture for resisting the effect of earthquakes in Japan. They went to Messina, and as the result of the inspection they are both very much in favour of ferro-concrete as long as the work is thoroughly carried out. At Messina Professor Nakamura saw the house of Mr. Hennebique's agent, which had been quite undisturbed by the earthquake; he also saw some factories of which the frame was ferro-concrete and the walls of brick, the latter having fallen out, leaving the concrete frame intact. Professor Omori also was very interested in what he saw at Messina, especially in the case of two large reservoirs, one of brick and the other of concrete, the former being completely destroyed, while the latter was not in any way damaged.

The President of the Ohio Society of Mechanical, Electrical, and Steam Engineers, Mr. F. W. Ballard, in the course of a paper on power costs for factories, gave calculations showing that the steam consumption of steam pumps is often at least five times that required by large central engines driving generators for supplying energy to motors for doing the same work, and in extreme cases, with long lines of steam pipe and intermittent service, the steam consumption has been found to be ten times what would have been required by central units for the same service. In the discussion which followed the reading of the paper Professor W. T. Magruder reported the results of an investigation which showed that the cost of operating a certain boiler plant for steam heating alone, in the winter-time, was nearly equal to the cost of running the plant for both the motor service and the heating service combined. In speaking of group drives, he cited a case where 800 horse-power was required to run the shafting during the noon hour, while only 1000 horse-power was needed to operate the shop during working hours. With mechanical transmission the losses may be from 40 to 50 per cent., while with electrical transmission the losses may be reduced to 15 per cent.

MISCELLANEA.

According to the *Electrical Engineer*, the Prussian authorities are seriously studying the usefulness of wave telegraphy in fogs, and have established two small experimental stations on the Muggelsee, and very satisfactory results as regards penetration, and also as regards the determination of the direction from which the signal received has come, are said to have been already obtained.

We hear that considerable interest has been created in the German chemical world by the decision to form an Imperial Chemical Institute. This institution is to undertake for the chemical industry similar functions to those which the Imperial Physical Institute performs for engineering. The undertaking is being subsidised by the State, and it is expected that the annual maintenance will cost about £10,000.

It is reported in the *Times* that some interesting experiments in the application of electricity to agricultural purposes have just been made at Mitry-Claye, in the presence of representatives of the Minister of Agriculture, by M. Fillet. Electric motors are used to work a drum which rolls and unrolls a steel cable, to the end of which is attached a large plough. The electrical energy is obtained from a small central station on a neighbouring farm, and is conveyed to the apparatus by copper wires carried on movable posts.

The Blackwell's Island Bridge controversy has apparently been settled by the announcement of the comptroller of New York City that he would make the final payments for the structure. This action is based on the advice of the Corporation Counsel, who holds that the city is equally responsible with the contractor for the failure of the structure to meet the full requirements of the specifications. The approval of the contractor's plans by the city's legal representatives is held to relieve the contractor from full responsibility for his part of the designs of the bridge.

According to a contemporary, a new water-supply system has been completed at Taipeh, Formosa, the water being taken from the river Shinten through 36in. reinforced concrete pipes. The new works comprise two circular reservoirs 170ft. in diameter, and one measuring 180ft. by 90ft. All are 15ft. deep. There are six filter beds, each 100ft. by 125ft. A new concrete pumping station has been erected, and three engines each of 100 horse-power and three of 50 horse-power have been installed. The capacity of the new works is about 5,600,000 gallons, and the daily consumption is about 2,250,000 gallons.

It is reported that the Liverpool Port Authority has decided to proceed at the earliest possible moment with the erection of wireless telegraphic stations on all the lightships and lighthouses on the shore margin of Liverpool Bay, with a centre intercommunication station on the roof of the new dock offices. The instruments will operate over a radius of 25 miles, so that each station will always be in communication with one station or the other. The stations will be quite separate and distinct from that which the Marconi Company has at Waterloo, but they are to work in co-operation with that station. The cost of the installation is estimated at £100,000.

The following information is from the report by H.M. Commercial Attaché at Peking (Mr. W. P. Ker) on the foreign trade of China in 1908, which will shortly be issued:—The Canton waterworks, built at a cost of £300,000, with British machinery set up by a British engineer, were opened in August, 1908, and are run under purely Chinese management. Waterworks supplying the native town at Hankow were approaching completion, under a British engineer, in the spring of 1909. A waterworks company was formed in Swatow in 1908 and the shares eagerly taken up, but, at the time of writing the report, operations had not started. At various other places, such as Chinkiang, Chungking and Chinan Fu, waterworks projects have been mooted, but have failed for want of funds. The next few years are likely to see waterworks started in many of the larger cities.

At a meeting of the Newcastle and Gateshead Chamber of Commerce recently Mr. Shaw, the secretary, reported that he had received a communication from the Postmaster-General stating that the underground telegraph line between Glasgow and Edinburgh had been completed with the exception of a short section within the city of Edinburgh. The line running southward from Newcastle had reached Stockton; the line to the west had reached Penzance, and the extensions from Birmingham and Bristol had reachd Worcester and Berkeley. A pipe is to be laid southwards from Stockton to Leeds, where the underground line from London by way of Warrington and Manchester ends. The line to the west will be completed to Porthcwrnow, where cables are landed, and from Berkeley a pipe will be laid northwards to Gloucester, another step towards the connection of Birmingham with Bristol. A second underground line between London and Birmingham, which has been in progress for some time, will be completed, and a pipe will be laid from Chatham to Canterbury for the extension of the underground line now running from London to Chatham, the intention being to provide underground connections with the landing places of the principal submarine cables to the Continent.

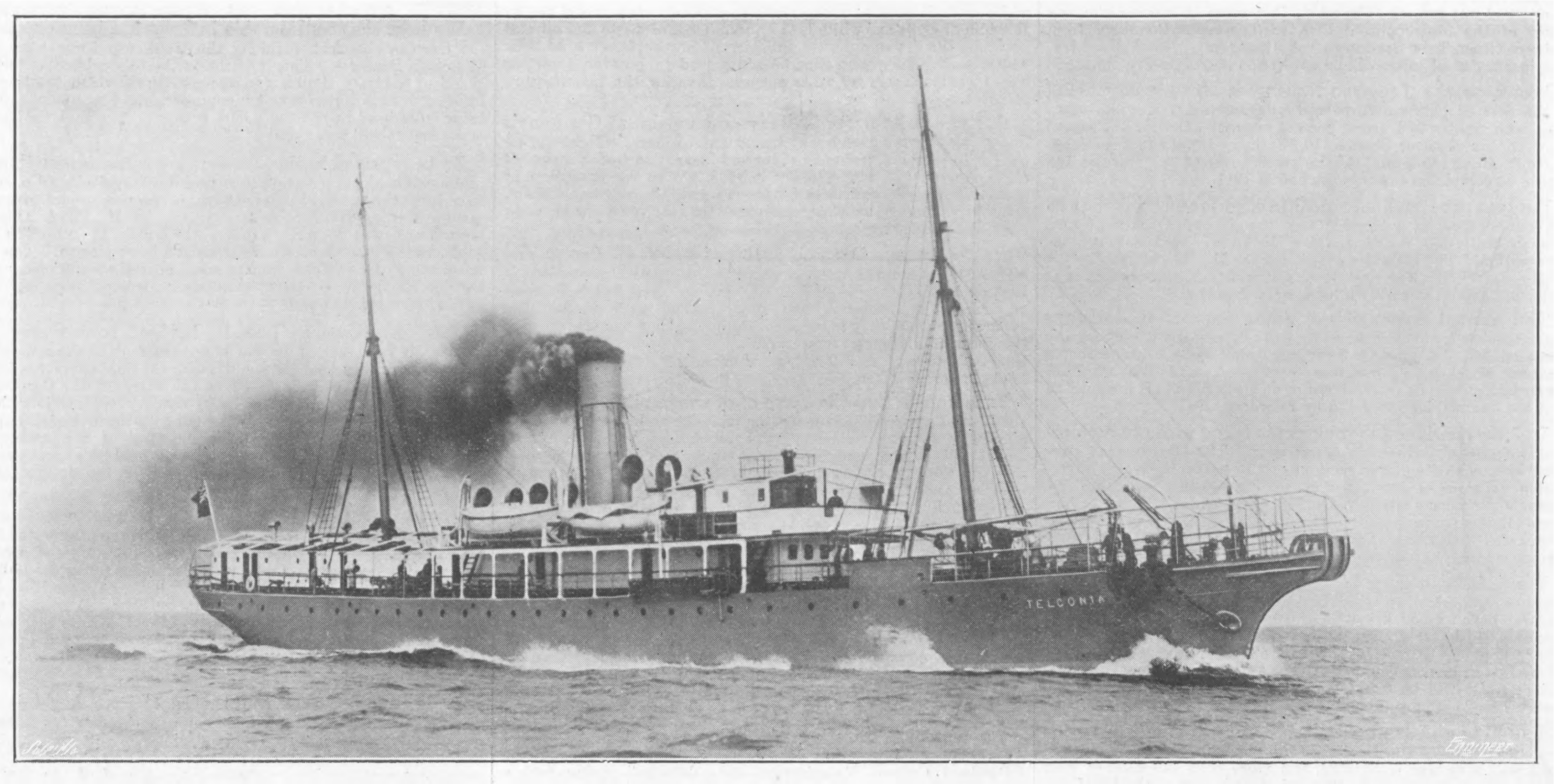
In a paper read before the Institution of Electrical Engineers on "Notes on Methods and Practice in the German Electrical Industry," by Messrs. L. J. Lepine and A. R. Stelling, it is stated that almost all German firms insist upon the acceptance of their own specifications, and will rarely if ever depart from these. Under this system makers stand or fall by their own designs and productions; they do not suffer the annoyance of petty alterations, and the experience of their experts in each branch enables them to supply an adequate article without having to submit to outside individual ideas. However strict a specification may be, bad workmanship will destroy its object. As regards dynamo-electric machinery, an 80 deg. Fah. rise after a six hours' run on full load seems to be the standard figure. Motors are rated to stand 25 per cent. overload for one hour, and 40 per cent. for three minutes, these overloads varying according to the size of the machines, and not being so high as those offered by some of the English makers. The designers differentiate between slow, high, and extra high-speed machines, the latter being classed as "turbo-machinery," and are treated in a separate department. The line of demarcation between slow and high speeds is 20 m./sec. peripheral speed.

A remarkable paper on "Quantitative Measurements in Connection with Radio-Telegraphy" was read before the Institution of Electrical Engineers by Professor J. A. Flemming on Thursday, December 16th. The Professor remarked that it must always be borne in mind that in radio-telegraphic stations the standby costs were so vastly greater than the cost of power actually used in signalling that even a large improvement in the efficiency of transmission would not greatly reduce the total costs. Nevertheless, he shows that there is really room for improvement in this direction. In his efficiency chart for N.C.L. radio-telegraphic plant, with 5 mm. spark gap, he shows the rotary input at 2620 watts. The rotary losses amount to 1139 watts, while the rotary output is 1481 watts. At the next step we find transmission losses put down at 71 watts, and choking coil losses at 610 watts, leaving a transformer input of 800 watts. Of these 800 watts 302 are accounted for by transformer resistance losses, and 53 by transformer iron losses, leaving 445 watts delivered to condenser. There is then a loss of 351 watts in primary oscillation circuit, leaving only 94 watts for delivery to antenna, and antenna resistance accounts for another 16 watts, so that ultimately of the 2620 watts only 78 are used in final radiation work.

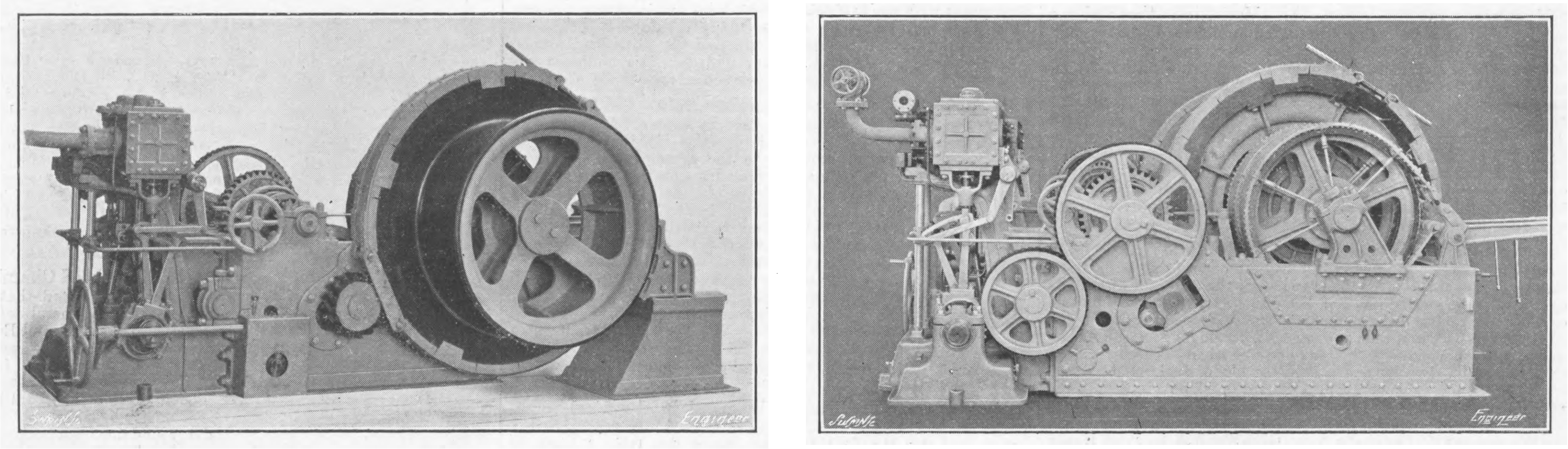
THE CABLE SHIP TELCONIA

SWAN, HUNTER, AND WIGHAM RICHARDSON, LIMITED, WALLSEND-ON-TYNE, BUILDERS

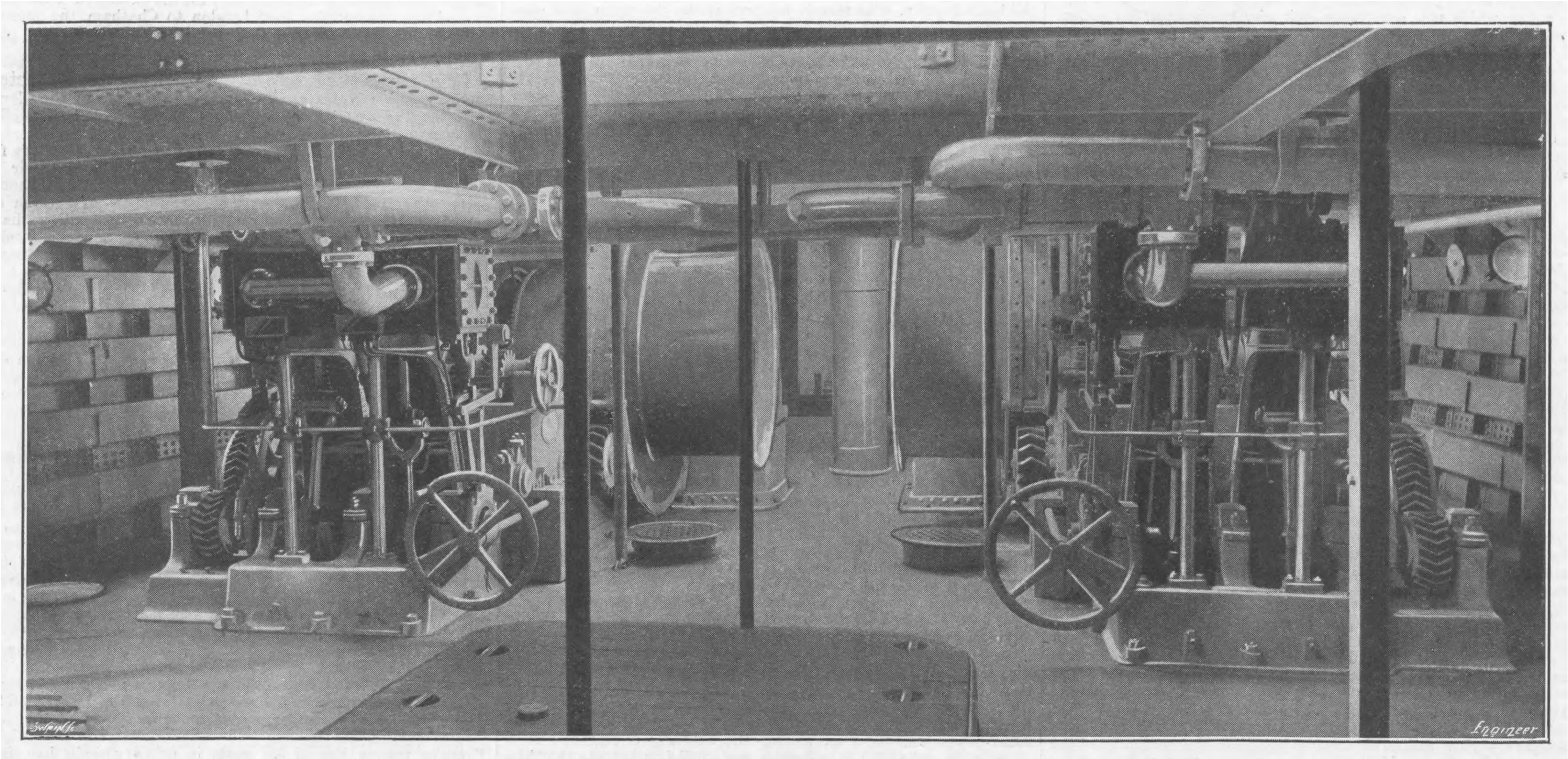
(For description see page 660)



THE VESSEL RUNNING A TRIAL OFF TYNEMOUTH



INBOARD AND OUTBOARD SIDES OF ONE OF THE PICKING-UP MACHINES



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TO CORRESPONDENTS.

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REPLIES.

Masta.—None of our colleges give special attention to railway engineering' but all teach the general principles. Perhaps the Central Institution' South Kensington, would be the best. A training in railway engineering works is absolutely essential.

DEATHS.

On the 10th December, at Forest Side, The Drive, Loughton, Essex, Mr. Frank L. Rowe, for many years the esteemed manager of the Edwards Air Pump Syndicate, Limited.

On Saturday, 27th November, 1909, at Tientsin, North China, in the 55th year of his age, Augustus William Harvey Bellingham, M. Inst. C.E., Engineer-in-Chief to the British Municipal Councils, Tientsin.

THE ENGINEER.

DECEMBER 24, 1909.

Engineering and Industrial Finance.

THE engineering business in Great Britain has during the last thirty years undergone a great change. Up to the eighties the engineering concerns of this country held supremacy among those of the world, and British engineers and machinery were to be found in all parts where such undertakings as waterworks, gasworks, tramways and similar ventures were being carried out. The leading position is being lost in all classes of engineering and industrial work. In the production of cast iron and steel this country is third on the list, and likely to go lower; and the British machinery maker has lost many of his former markets, and finds his present position in the home and colonial markets seriously threatened by the competition from America, Germany, and other countries.

It has been frequently assumed that this great change has been mainly due to the lack of technical education among managers and workmen, absence of commercial enterprise, and the action of hostile tariffs. This may be to a certain extent true, but of late years there has been a great increase in educational facilities, and many of our leading firms can show works equipment and enterprise equal to anything found abroad; there are, however, other factors which are not so frequently recognised. The increase in the use of machine tools and the decrease in the manual skill necessary to carry out various operations have allowed those countries not previously noted for the number or excellence of their mechanical operatives to compete successfully in the engineering world. One of the most important factors is that several nations have recognised that financial organisation, or the direct co-operation between the financial and industrial communities, can be made into a powerful weapon in the fight for the markets of the world. At one time a manufacturer, having obtained a concession for some waterworks or similar undertaking in a foreign country, could rely upon a considerable amount of financial support from his banker, these institutions being then largely interested in local ventures. Of late years a great alteration has taken place, the local banks have been absorbed by the big London banks, the bank owner with his interests has been lost among a board of twenty or thirty directors, banks have ceased to be directly interested in enterprise, and bankers in general, in their anxiety to accommodate all comers, have in many ways neglected the requirements of the home manufacturer for those of his direct competitors in other countries. There are many political economists and others, who, confining their vision to a limited horizon, consider the financial neglect of home industries and the large export of capital that has taken place to be a subject of congratulation. In a matter of this kind reliance must not be placed alone on academic theory, and many of those who have watched the rise of industry and enterprise in the chief competitors of the country state unhesitatingly that it is largely due to the action of financiers in co-operation with industrial interests, action involving frequently temporary loss of profit, to the ultimate advantage of themselves and the countries to which they belong. Large contracts for the supply of war material, battleships, the making of railways or tramways, and the building and operation of waterworks or power stations are not now-a-days decided solely on the cash price and the quality of work or designs submitted by the competing tenderers, though there has been a general levelling up in these two latter items, owing to the spread of education and the information given by the technical and daily Press. Competition for these contracts is frequently decided by a sort of financial artillery contest, technical details and prices being fixed after one party has become master of the situation. It has been the complaint of the manufacturer and contractor in this country that they have had to engage in many industrial struggles almost devoid of financial artillery, and to such an extent has this been the case, that many otherwise promising markets, in which British enterprise could easily compete on a basis of price and quality, have been abandoned as almost hopeless, this being especially the case in dealing with the Continent. Let us take a hypothetical case of a kind that has occurred frequently in connection with municipal and other large undertakings abroad, though something of the same kind has at times occurred at home.

Several firms from different countries enter into competition for an important work, among them being Brown, Jones, and Co., and a German Aktiengesellschaft. After a preliminary investigation by the technical staff, the firms are questioned regarding their financial strength. The English firm's representative states that his company's capital is £200,000, with directors Messrs. Brown and Jones, and their English bankers graciously allow a reference to a local correspondent, but take no further interest. The German firm may have a similar capital, but be backed by one or two of the large German banks with capitals of several millions sterling, and actively assisted by a bank on the spot in connection with them. These financial organisations use every effort on behalf of their customers, and in cases of this kind British firms have repeatedly lost contracts, despite lower prices and superior technical offers. Very often contracts of this kind lead almost to a monopoly in the district for the successful tenderer. It is not unusual after continental concerns have obtained large contracts or concessions, due to financial assistance, to find them coming to the London money market, after taking up prior securities themselves, and obtaining assistance from financiers and the public, though the competing English firm has been flatly refused any financial assistance other than that which may be backed by the mortgage of any buildings, machinery or securities uncovered by debentures. Firms having a call on a hundred thousand pounds or more at short notice are in a position to capture markets in detail, and for this reason a number of enterprises originally started by English firms have been taken over by continental interests, and not only have many Englishmen been replaced by foreigners, but large periodical contracts have been lost to the country. Consular reports from all parts of the world tend to show that the increase of trade of Germany and other continental nations has been largely due to the support given by financial institutions, the absence of such support to British undertakings being frequently noted. Financial support need not mean long credit or wild speculation, but the fact that the support is there when wanted is of the greatest influence. One of the few cases of late years where financiers have given support to British industry abroad has been that of the Argentine, and as a result South America is one of the best foreign markets for the rolling stock makers and general engineering works.

The activities of the Deutsche, Dresdner, and other German banks, which are almost national institutions, have been a great support to German trade and influence in Turkey, China, Spain, South Africa, and South America, and recent events show that the American Government is encouraging enterprise in China through New York bankers. Unfortunately there are in this country no institutions which assist manufacturers to compete with the powerfully backed foreign concerns. Industrial investment trusts have not always been a success, and industrial enterprise has to depend largely on the independent financier or company promoter. There is no doubt that some of the Continental and American banks have gone too far in their support of industry and speculative ventures, but that does not mean that nothing should be done over here. The great joint stock banks, from the very nature of their business, are unable to come to the assistance of commercial ventures to any great degree, but to the minds of many business men comes the thought that if this country is to retain its position some alteration must take place in the existing system of unorganised industrial finance, and weapons must be put into the hands of engineers and traders to enable them to resist the attacks which are taking place from all directions.

Railway Fuel.

It is curious that the quality and peculiarities of the coal used in locomotives is rarely made the subject of papers or discussions. It would seem that coal is regarded by locomotive superintendents as just coal, and nothing more—a substance about which it is not worth while to exchange opinions or try to obtain information. We cannot call to mind the existence of any treatise or book which deals specially with locomotive coal and its influence on the performance of the engines, and the cost of working traffic, and only one paper—see The Engineer, October 18th, 1907; and while this is peculiarly true of Great Britain, it is also true of Europe. In the United States some information has been occasionally collected by circulars sent to the master mechanics of leading railroads, but the results amounted to very little. It is with the more pleasure that we announce the establishment of an International Fuel Association, with its headquarters in Chicago. The First Annual Convention was held on the 21st, 22nd, and 23rd of June last, and we have just received a copy of the "Proceedings," which are full of interest.

The membership in June was only 120, but it is probably twice that now. It includes men from the executive, operating, accounting, purchasing and maintenance departments. According to the opening address of Mr. Eugene McAuliffe, who is "General Fuel Agent" for the Rock Island and San Francisco lines, the Association has grown faster than any railroad organisation that ever sprang into being in the United States, or possibly in the world. The importance of the questions with which it will deal may be gathered from figures going to show that the value of the locomotive coal used in the United States represents about 190,000,000 of dollars, or say, £38,000,000. To this must be added about 90,000,000 of dollars, or £18,000,000, to cover the actual expense of conveying the coal to the railways and putting it on the tenders. General charges represent a further outlay. The total sum paid by the railway companies for coal cannot be much less than 300,000,000 of dollars, or £60,000,000 per year. The President dealt with the extreme desirability of establishing close relations for mutual benefit between the "coal operators"—that is to say, the colliery owners—and the locomotive superintendents. The following passage, which we quote, may be recommended to the consideration of those who hold that the colliery proprietor does not know how to carry on his business, and is for the most part in disposition a combination of Shylock and a vampire:—"There are a great many problems that the coal operator has to meet at certain seasons and in certain localities. A single grade of coal is in active demand; no one wants the remaining grades. We have recently listened to and read a great deal about the conservation of our natural resources. There is not much consistency in exploiting the conservation of coal when operators at certain seasons are compelled to dump hundreds of thousands of tons of screenings or fine coal on the ground, because the trade at that particular season does not want that particular grade of coal."

The paper and discussion on the first day dealt with the supply of coal from the mines and the method of inspection adopted to secure that it was what it pretended to be, and the conditions under which it might be advisable to buy it, although not just what it ought to be. The most interesting question raised was the value of various systems of testing. No one objected to the laboratory test, save on the one ground, namely, that it might, if the sample were not properly taken—which was the rule—be misleading. But in any case, no calorimeter tests can tell what is and is not a good locomotive coal. Some that gave a very high calorific value in the laboratory was quite unfit for the footplate, because it clinkered heavily. The only true test is that made on the engines; but care must be taken that the driver and fireman are not only competent in a general way, but that they understand the peculiarities of the coal they are burning, and so can make the best of it. As we read we see how wide is the difference in many respects between United States and English practice. With the heavy freight or mineral trains of 1800 to 2000 tons, it appears that "shaking" grates are regarded as necessary evils. Mr. Adams, Superintendent of Motive Power, St. Louis and South-Western Railway, read a short paper, "How to Successfully Burn Locomotive Fuel Coal." Clinkering seems to be the standard trouble. But Mr. Adams told his hearers that the clinkering of coal is due to the manner in which it is handled, and not to the coal. Furthermore, in the course of the discussion which followed we read of fire-boxes partly full of ashes and unburned small coal—a condition so rare in this country that it may be said not to exist. There seems to be much force in Mr. Adams' contention, for coal which with some firemen is extremely troublesome and wasteful, with other men does very well. Thus Mr. Adams read a report from one crew which stated that they were making daily trips over a 131-mile division with engines having 20 by 26 cylinders and dead loads of 2000 American tons. The trip is made in from nine to fourteen hours. The consumption on the run is from 11 to 14 tons of Illinois mine run coal, with sometimes 50 per cent. slack. "We very seldom move grates over four or five times over the division. We very seldom clear out the ash-pan between terminals." We may remark incidentally that this gives an average consumption of about 181 lb. per mile, and about 11 miles per hour. Speaker after speaker insisted on the vital importance of training firemen, numerous instances being supplied of cases in which most remarkable results were obtained by educating the men. The entire volume is full of original information. We have light thrown on the inner working of heavy traffic which is highly suggestive. We must reserve its further consideration for the near future.

The picture unfolded before us displays a very heavy and peculiar traffic for which there is no parallel here, or perhaps in Europe. The quality of the coal depends on the districts through which very long railways run. It appears to be dealt with in an extremely rough-and-ready way at the pits, and no more carefully on the engines. As much of it is small, the air spaces between the bars, or what answers to bars, are narrow. Clinkering takes place, because the coal is not properly fired, and the grates are raked to break up this clinker to let air through; but the clinker is not got rid of, and so at last the fire becomes so dirty that the engine fails for want of steam. If, as seems probable, the new association is able to get firing done better, it will have conferred an enormous benefit on the country.

Engineering, Science, and Business.

Those who take interest in the methods of teaching engineering followed or initiated by the teachers, have not we think, failed to perceive that a considerable change has already taken place in the relations between professors and employers of labour—a change, we may add, very much for the best. At one time the professor looked down on the "practical man," and it is quite certain that the practical man did not look up to the professor. Explanations have long been available. We need not concern ourselves with them. We shall be much better employed in taking things as they are, and reporting progress. It may be said at the outset that little confidence existed between the two classes, for neither quite understood or appreciated the other. The man who was all for a scientific training, which too often meant mathematics and little else, tacitly ignored the circumstance that money and engineering were inseparably connected; while the manufacturing engineer, the contractor, and the steam user held that as the professor knew nothing and cared less about commercial matters, he was not competent to turn out really useful engineers. At home and abroad, in every direction, we find misconceptions being cleared up, difficulties overcome, mutual respect compelled, and the proper values attached to the parts played on the world's stage by both parties. We see, too, that the worth of those qualities which were possessed by the earlier non-scientific engineers is being recognised; and that altogether larger and more intelligent views are being held by men in good positions both as professors or scientists, or as representatives of the multitudes who regard engineering simply as a means of making money.

An example well worth citing is supplied by an address delivered last month in the United States by Dr. G. E. Swain, LL.D., Professor of Civil Engineering in Harvard University, on "The Relation of Engineering to Science and to Business." Professor Swain carefully defined the relation of the profession of engineering to some other vocations. He divides engineering under two heads—Science and Art. "Science teaches us to know, and Art to do. Engineering, then, may be considered as an art founded upon some branch or branches of science, such as the science of mathematics, or the science of physics, or the science of chemistry." One object of the address was to emphasise that in engineering, science is not recognised by the world at large, or even by engineers, as much as the art is, and he goes on to say that the art of engineering is largely empirical, and that it should be the duty of all who have the good of the profession at heart to insist on the science as contrasted with the art. Reading this, it is but natural that we should take it for granted that we have the old stock situation reproduced—the scientist everything, the engineer nothing. But as we proceed we see that there is no justification for such a conclusion. What Professor Swain holds is not that science should assume the upper position, but that the man engaged in the art should give science a fair share of recognition; and we have, for, we fancy, the first time in a teacher's address a due insistence on the value of economy. "The engineer must know the laws and forces of nature and the properties of materials, and must be able to apply them economically." He insists on the importance of knowing how to do—that is to say, he rates the art of engineering if possible more highly than he does the science of engineering. We go further, and say that nothing, judging from the world's past experience, is more likely to stultify and incapacitate a man from becoming a useful engineer than the saturation of his brains with pure—that is, unapplied—science. Professor Swain writes with a large experience. He says: "Few of our engineering students really gain the scientific spirit, few of them learn how to reason correctly, most of them are unable to draw correct conclusions from clearly stated premises, and the great majority seem to think that an engineering education is simply learning the rules by which engineering work is done. They inquire simply how, not why; and this attitude is often encouraged by the character of the instruction they receive." This is rather strong language. No doubt it is justified. But is not the situation due in large measure to the circumstance that the teaching is too abstract? and that the connection between what is taught within the walls of a college and what goes on in docks, harbours, and manufactories, our railways and in steamships, is not sufficiently—to use Professor Swain's word—emphasised. In other words, is not the art side of the question kept too much in the background? Professor Swain is quite definite that the proper practice of engineering requires both knowing and doing. But the mere knowing will not enable a man to do, or at least it will not enable him to do economically. Professor Swain sees clearly that the engineer must be distinctly utilitarian. "The scientist may deal with fourth dimensions or other inconceivable vagaries, but the engineer must seek first and foremost the useful." Let any man search his library shelves and make a note of the names of those engineering educational books that make the least reference to the importance of studying economy, or, indeed, regard the profession of engineering in any shape or way from a commercial standpoint. We fancy he will find the list short to a degree that will astonish him. We have not yet got the whole truth in books. We are the more rejoiced to see it advanced in addresses such as those delivered to the Worcester Polytechnic Institution.

It is, however, when Professor Swain leaves the science of engineering for a consideration of its art that he is most instructive. The engineer, he insists, must be very largely a business man. Engineering is business to a very great degree. The engineer deals not only with the design of works, but with their execution and their commercial value. His usefulness will be strictly limited unless he knows how to advise, not only concerning their design, but whether they should be designed at all. He must know how to draw up a contract, how to deal with men, how to smooth difficulties, how to arbitrate when opinions differ, and in many cases how to manage large financial transactions. Is the necessity for the possession of qualifications such as these ever insisted on in technical schools and colleges? Is not the student left to find out for himself, and is he not handicapped in consequence at the outset of his career? We heartily endorse the following passage:—"Engineering is applied science, and its application is directed, in ninety-nine cases out of a hundred, to just one thing—to making money for somebody. No quality will be found of greater value to the engineer than commercial acumen. The young man who looks upon engineering purely as a science, or as the art of applying a science, independent of business principles, will very likely remain a drudge all his life, directed by men of far less scientific ability, but of greater business acumen." We have preached this gospel for many years, through evil report and good report—very little of the latter. We begin to hope for the best when we find that a leading teacher in a great University does not hesitate to admit that engineering has a commercial side of such overwhelming importance that its neglect may leave a man a drudge all his life.

A NEW FORMULA FOR THE TOTAL HEAT OF STEAM.

By ROBERT H. SMITH.

There has been issued this year a new set of steam tables* which differ materially both in matter and in form from the "standard" tables. These latter are inserted in nearly every new book written on steam engineering, the one copied from the other, so that every engineer's library contains more than a score of copies of the same bulky arrays of figures. The figures are exceedingly ancient. They represent excellent work for the age in which they were originated; but since then the means and apparatus of scientific measurement have been almost revolutionised, and many modern first-class pieces of research have revealed material errors in the old experiments. The first efforts towards rectification of the Tables appeared in Peabody's and Robert Heck's works. The new Tables published this year are much more radical in their corrections. They are the result of very laborious, painstaking, and intelligent work by Professor L. S. Marks and Mr. H. N. Davis, of Harvard University, the former a student of this country, although the scene of his labours has now been transferred to the other side of the pond. The tables are the best printed and the most easily read that have been published; they give the quantities for every 1 deg. Fah. temperature and for every 1 lb. per square inch pressure; an extension throughout the whole region of superheated steam covers forty-five pages, and gives the volume, total heat, and entropy. In ten pages in Part II. are given concise explanations of the best ways to use the tables and diagrams. Part III. of twenty pages contains a most interesting and instructive account of all the sources of experimental information from which the new values have been obtained. The book is not only a new valuable aid to accuracy in steam engineering practice, it is also an admirable piece of physical scientific work. Accompanying it are two diagrams of novel construction, the vertical ordinate being "total heat;" and the very considerable practical convenience of this form of diagram for the solution of problems in steam turbine and other high-speed outflow work is fully demonstrated in Part II.

It has long been known to close students of steam physics that the old tables contained practically important errors. In fact, according to well ascertained thermodynamic principles it could be shown that certain parts of the tables were inconsistent with other parts. Until these inconsistencies were eliminated by more accurate modern measurements, it did not seem worth while to take trouble about the exact formulation of the laws of variation of the important steam quantities. The very simplicity of Regnault's expression for the law of total heat, namely, $1082 + .305\ t$, showed that that great physicist did not consider that the accuracy obtained in the measurements justified any very close algebraic analysis of them.

Now that Professor Marks has furnished us with tables that are, in the first place, consistent between their different columns, and that also seem to give data really reliable for comparatively strict accuracy, and now that he has shown what a useful diagram-ordinate the "total heat" may be made, I have endeavoured to analyse the law of total heat algebraically. This has been done by means of a very flexible formula which has been found extremely useful for the accurate representation of a great variety of engineering quantities.

The result has been the discovery of a formula which represents with complete accuracy the figures of the new table throughout the whole range, from 70 deg. Fah. to 500 deg. Fah.; that is, from absolute pressure, $\frac{3}{8}$ lb. per square inch up to 680 lb. per square inch. Below 70 deg. Fah. there is an appreciable difference between the formula and the best experimental measurements; but it must be said that accuracy of measurement of total heat at these extremely low pressures—high vacua in engineering phrase—is very difficult, and it is legitimate to speculate as to whether a formula which fits exactly through so large a range, where measurement is much more capable of exactitude, may not be regarded as being as reliable as the experimental determinations. For example, for the tabular pressure, 0.178 lb. per square inch, the formula gives a total heat less than that in the table against this pressure, and equal to that in the table against the pressure 0.153 lb. per square inch. Now in high-vacuum steam atmospheres there is always an appreciable proportion of air mixed with the steam. It is thus quite reasonable to imagine that the experimental measurement of pressure corresponding to this measurement of total heat was really the sum of the actual steam pressure and of the pressure of the air mixed with it, and that the possibly accurately measured heat was really for a steam pressure much nearer 0.153 than 0.178 lb. per square inch. If one-seventh of the whole pressure, or about $\frac{1}{50}$ lb. per square inch, were due to air, this would completely account for the discrepancy.

In one respect the formula now presented is of startling simplicity, namely, in that it makes the coefficient of the term in *t exactly unity*. The sort of *exactitude* referred to is illustrated by the fact that other sets of constants were tried with this factor made .9938, .997, 1.0066, and 1.055, and that with these factors the formula did not fit the experimental figures nearly so closely. This item of simplicity may have physical significance. The formula is arithmetically convenient in another item, namely, the factor 1,250,000, which is $\frac{1}{8}$th of 10^7. Using it in this divisor form with the help of an ordinary table of reciprocals, it takes not more than half a minute to calculate the total heat for any given temperature. Here again it may be mentioned that in one of the trials this factor became 1,251,150, and this did not fit the desired results nearly so well as $\frac{10^7}{8}$.

Above about 400 deg. Fah. or 230 lb. per square inch above atmosphere, there is as yet no reliable experimental information, so that the tabular numbers, being the result of extrapolation calculations from a formula, have no direct authority.

The formula is—

Total Heat from 32 deg. Fah. of Saturated Steam

$$H = 1826 + t - \frac{1,250,000}{1620 - t}$$

The following table gives values calculated from this formula, and compares them with those of Professor Marks' new Tables. For more ready intelligibility the tabular pressures as well as the temperatures are inserted:—

Temperature, Fah.	Pressure, lb. per sq. in.	Formula, H.	Marks, Table H.	Difference.
30	.081	1069 9	1072.6	−2.7
50	.178	1079.8	1081.4	−1.6
60	.256	1084.7	1085 9	−1.2
70	.363	1089.6	1090.3	−0.7
80	.505	1094.3	1094.8	−0.5
100	.946	1103.6	1103.6	0
150	3.71	1125.7	1125.3	+0.4
200	11.52	1145.7	1145.8	−0.1
250	29.82	1163.6	1163.8	- 0.2
300	67.0	1179.0	1179.1	−0.1
350	134.6	1191.8	1191.5	+0.3
400	247.1	1201.4	1201.3	+0.1
450	421	1207.6	1208.0	−0.4
500	684	1209.9	1209.0	+0.9
600	1574	1200.5	1176	+24.9

The small + and − differences indicate, of course, that these are within the range of probable error in the tabular figures. This means that from about 70 deg. or 80 deg. to about 500 deg. the agreement is complete.

If the specific heat of water were constant, then the term t would, of course, represent solely and completely that part of the heat spent in heating the water, and the remainder, namely, $1826 - \frac{10^7}{8\,(1620 - t)}$, would be the heat of evaporation. Professor Marks' book contains an interesting discussion of some of the various meanings that may be given to the phrase "specific heat of water." According to the definition he adopts as most practically convenient, the specific heat varies from a minimum of 0.997 at about 100 deg. Fah. up to 1.041 at 340 deg. or 120 lb. per square inch pressure.

In this country 58 deg. Fah. may be taken as a good average for the *fresh* feed to a boiler. If H be reckoned from this temperature, then 1800 would be substituted for the constant 1826 in the formula; and this 1800 is a number easy to remember.

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[*] Tables and diagrams of the Thermal Properties of Saturated and Superheated Steam. By L. S. Marks and H. N. Davies. Longmans Green and Co. 1909.

LITERATURE.

Die Crampton-Lokomotive mit Besonderer Berücksichtigung der Deutschen Bauarten. Eine Historich-Technische Abhandlung. Von F. Gaiser. Neustadt a.d. Haardt. 1909.

We can assure those of our readers who are interested in locomotives that they will do well to purchase this book, even though their knowledge of German is exceedingly small. The drawings and photographs which it contains are admirable. They include sectional drawings to a good scale, fully dimensioned in many instances, and external views in black and white, which make the general appearance as well as the details of construction quite clear and intelligible. Furthermore, there are numerous tables giving minute information as to dimensions. The treatise is in every way complete so far as drawings and description can make it. Also, the book is beautifully printed on excellent paper. There are 85 pages, 51 engravings arranged in plate pages, and a number of photographic reproductions and wood engravings. The book is 12½in. by 9in.

The Crampton locomotive met with favour from the first in France, and until a comparatively recent period it retained its popularity. Many of our younger readers have no doubt never seen a Crampton engine, and for their benefit we may say that it was a locomotive with a large and long boiler and a single pair of driving wheels from 6ft. to 8ft. in diameter, the axle of which extended across behind and as close as possible to the fire-box. The first engines had a single pair of leading wheels close to the smoke-box, and a third pair, the axle of which lay in front of the fire-box. This arrangement was sometimes modified subsequently. The cylinders were outside, as was the Stephenson link valve gear. The cylinders were bolted to the frames about midway of the length of the boiler. In some cases the engine was very handsome; in others it was spoiled by huge and unsightly excrescences in the shape of domes and safety valves. The whole type was just the thing to take a Frenchman's fancy. He liked to have everything under the eyes of the driver and readily accessible for lubrication and repairs, and we have no doubt that these were the principal reasons for the spread of this type over France, and thence, very naturally, over Belgium and into Germany.

Thomas Crampton was born in Broadstairs in the year 1816. We find him working on the Great Western Railway in 1842. He took out his first patent in conjunction with John Coope Haddan in 1850-51. He played a leading part in the laying of the first undersea cable, which ran from Dover to Calais. He died on the 19th of April, 1888, and was buried in Kensal Green. Those who desire further particulars of a busy and influential life will find them in our pages at that date.

The book before us is a history not of the man, but of the Crampton locomotive, compiled with much care from data never before published. The first Crampton locomotives built were the Namur and Liège, in 1846, by Messrs. Tulk and Ley, Lowca Works, Whitehaven. They had 16in. cylinders, 20in. stroke; the driving wheels were 7ft. in diameter; the carrying wheels 3ft. 9in.; the total wheel base 13ft.; the boiler pressure 90 lb. There were 192 tubes, 2in. in diameter, and 11ft. long. The grate was 4ft. 3in. long by 3ft. 5in. wide; the total heating surface 989 square feet. The total weight was only 22 tons, of which 10.5 tons were carried by the drivers. Following these, locomotives were built for many lines, differences being introduced to suit varying conditions, and the wish of the companies, but in all the type remained constant. There were always outside cylinders, about midway of the length of the boiler, with the driving axle behind the fire-box. In 1851 an exception was made in a locomotive built for the South-Eastern Railway. The engine was carried on a leading four-wheeled bogie, and a pair of driving wheels as usual, with the axle close behind the fire-box; but the cylinders were inside, and turned a crank shaft, which had no wheels, and drove the driving wheels by outside coupling rods. It was in no way a success. The most noteworthy English Crampton engine was the Liverpool, commonly called the Great Liverpool. This engine was built in 1847, at the time of the Battle of the Gauges. It was maintained that it was impossible to build an engine for the 4ft. 8½in. gauge as powerful as Gooch's Great Western 7ft. gauge locomotives. The Liverpool was the reply to the Iron Duke. The principal dimensions of both are given in the annexed table:—

	7ft. gauge. Iron Duke.	4ft. 8½in. gauge. Liverpool.
Cylinder diameter	18in.	18in.
,, stroke	24in.	24in.
Driving wheel	8ft.	8ft.
Wheel base	18ft. 6in.	18ft. 6in.
Boiler pressure	100 lb.	120 lb.
Tubes, number	303	300
Length	11ft. 6½in.	12ft.
Heating surface—		
Fire-box	147.87 square feet	154 square feet
Tubes	1797.1 square feet	2136 square feet
Total	1945 square feet	2290 ,, ,,
Grate surface	21.66 square feet	21.5 square feet
Weight	35.5 tons	35 tons

Nothing is more striking about these engines than their very small weight and enormous heating surface. The Liverpool attained, it is said, a speed of 79 miles an hour in January, 1848. It did not continue long in service. The wheel base was too much for the light permanent way. But it settled once for all the dispute as to the relative capacities of the broad and narrow gauge. Crampton could do anything that Gooch could accomplish.

Herr Gaiser's illustrations and descriptions cover a great deal of time and a great deal of space. Few modern engineers have an adequate conception of the number of Crampton engines constructed for continental railways. Many of them were very handsome. They looked like fliers. We may cite as an example the Badenia, built for the Badeschen Staatsbahn in 1863. Quite as elegant in design were three locomotives, Nos. 81, 83, and 85, built in 1849 for the South-Eastern Railway. The Crampton system found its way to the United States, and Herr Gaiser gives us an engraving of an extraordinary machine, which looks like a combination of a gipsy van and a traction engine. It was built for the Camden and Amboy Railway. It had an enormous spark-catcher conical chimney, little less in diameter at the top than the boiler barrel. It was built in 1849 by Richard Norris and Sons, Philadelphia. It had cylinders 13in. diameter, with the enormous stroke of 34in. The boiler had 98 tubes 2in. diameter and 12ft. long. The grate was 5ft. by 4ft., and there were about 730 square feet of heating surface. The pressure was 90 lb. Contrasted with this may be mentioned the little Lightning, built in 1849 for the Syracuse and Utica Railway. But for the disproportionate dome this was a beautiful engine, carried on a four-wheeled bogie, a pair of intermediate wheels and drivers. No particulars are given of its dimensions.

It is interesting to examine the detail drawings, particularly of the boilers, and to note how the best modern practice seems to have been anticipated half a century ago.

Herr Gaiser has done his work very thoroughly. He seems to have verified all his dates, and nothing more complete can be imagined than his tables of dimensions. The book concludes with a very intelligent criticism of the Crampton engine. It was impossible to get sufficient weight on the drivers to secure the adhesion necessary to draw heavy trains and utilise the steaming powers of the boilers. The Crampton engine has disappeared because it possessed no specially advantageous characteristic. At the time it was invented, however, it enabled a bigger boiler to be used than was deemed to be possible with any other type on the narrow gauge, and beyond doubt it did much to determine the general adoption of the 4ft. 8½in. gauge, instead of that of the Great Western.

The Institution of Civil Engineers: Newcastle-upon-Tyne Association of Students (Session 1909-1910).—We are informed that the secretarial duties of the Institution have now been taken over by Mr. E. D. Case, 1, Beaufront-terrace, South Boldon, to whom all communications should be addressed.

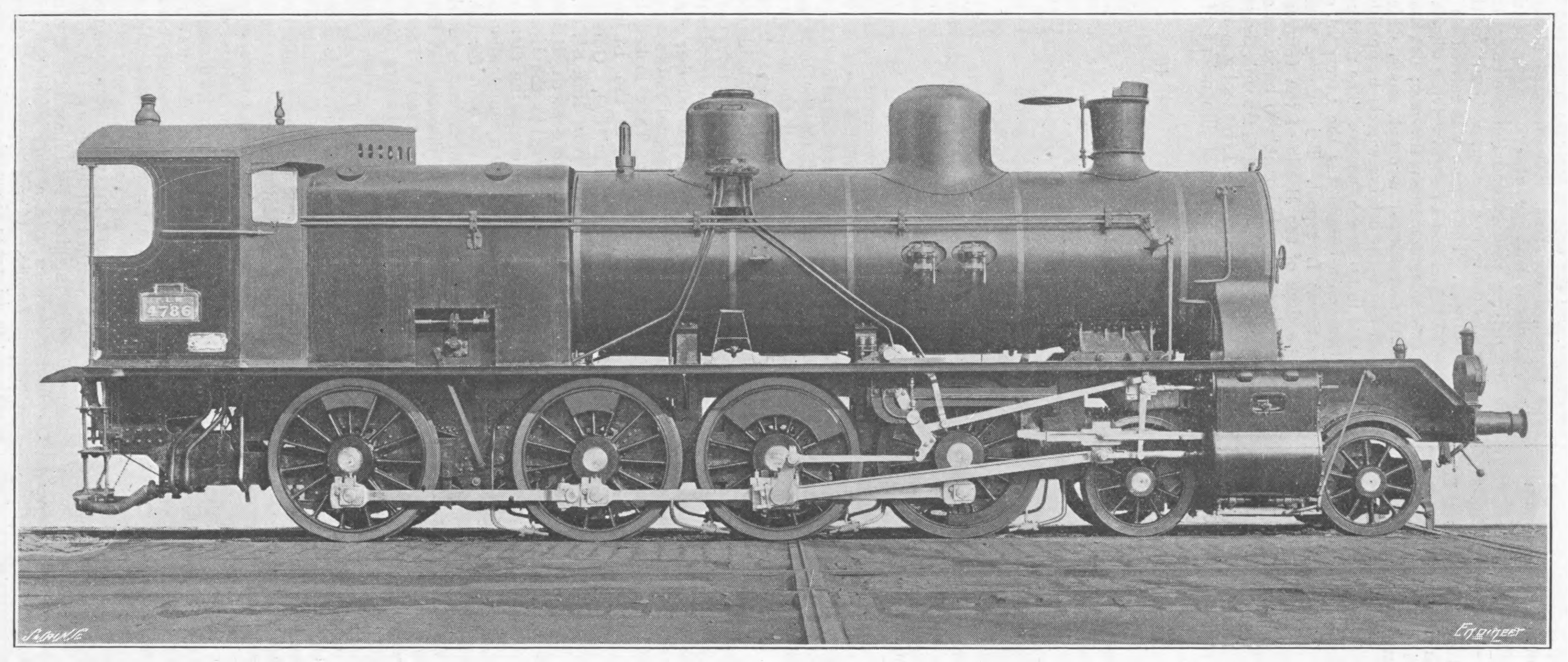
Ordnance Athletic Club.—A smoking concert was held on Tuesday evening at King Edward VII., New Corporation-street, Birmingham, in connection with the Football Section of the Works League of the Electric and Ordnance Accessories Company, Limited, between three and four hundred of the staff and workpeople being present. The evening was a great success.

RECENT LOCOMOTIVES ON THE PARIS, LYONS, AND MEDITERRANEAN RAILWAY

(For description see page 669)

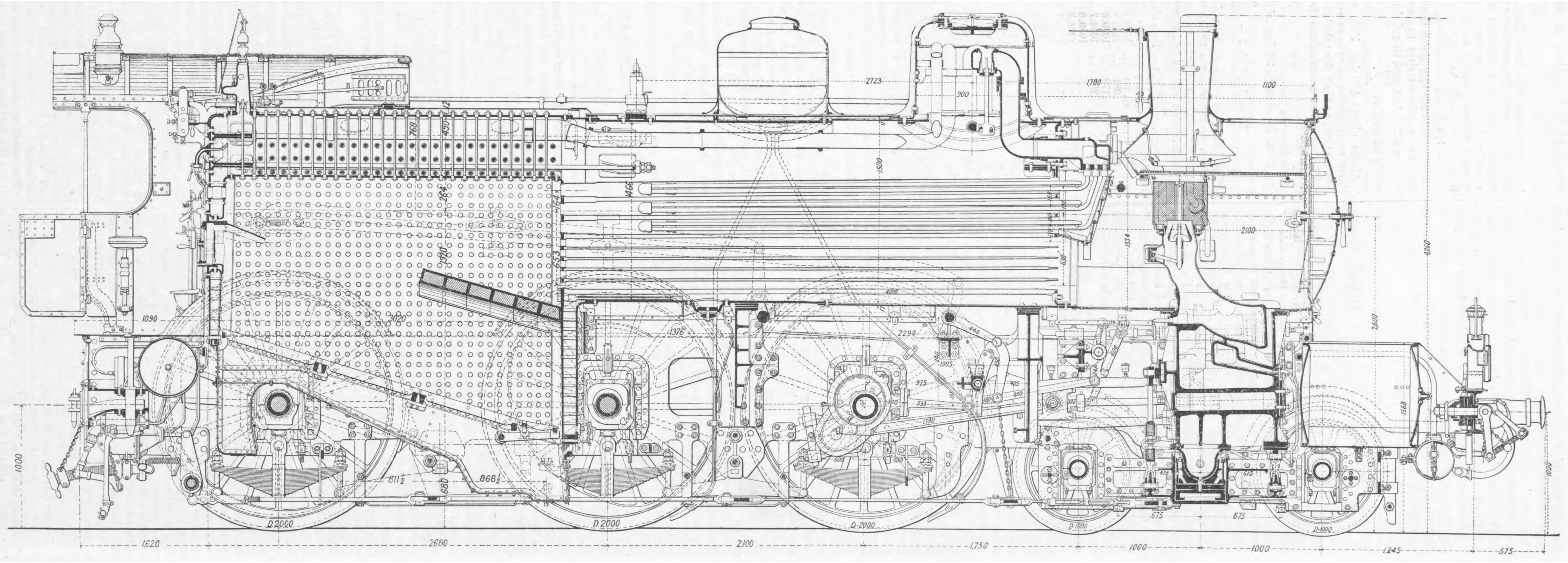
Upper Engraving:—

EIGHT-WHEELS COUPLED
FOUR-CYLINDER
COMPOUND GOODS ENGINE


4786
Swaine
Engineer

Lower Engraving:—

EXPRESS PASSENGER LOCOMOTIVE
FITTED WITH
SCHMIDT SUPERHEATER


1620
2680
2100
1750
1000
1000
1245
575
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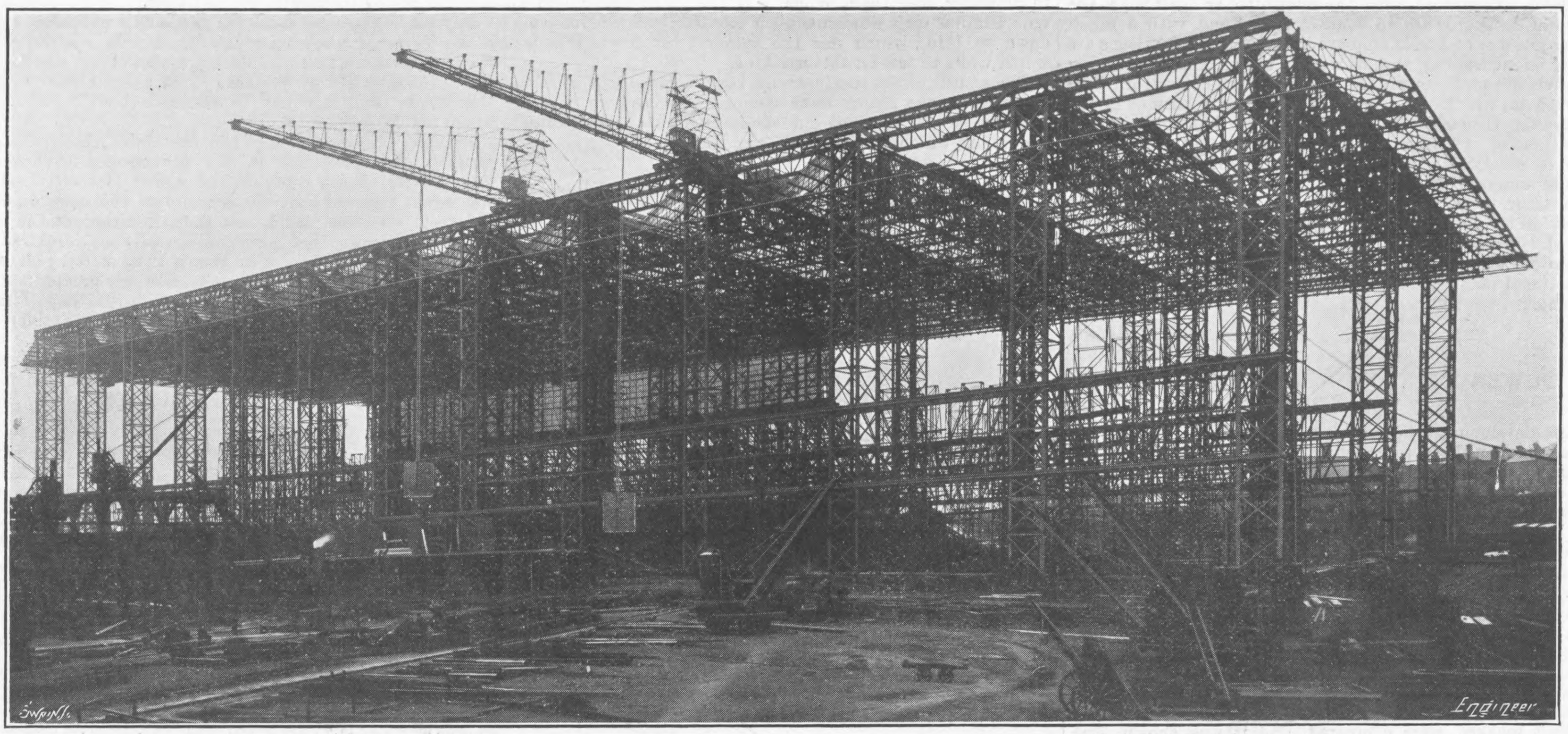
2723
1700
1100
900
1500
2100
4260
2600
1568
1090
1376
2294
1905
925
533
1190
675
675
615
768
490
1466
1020
811½
680
868½
1534
638
4000

SHIPBUILDING BERTHS AND CRANES AT THE WALLSEND SHIPYARD



NEW FRENCH LOCOMOTIVES.

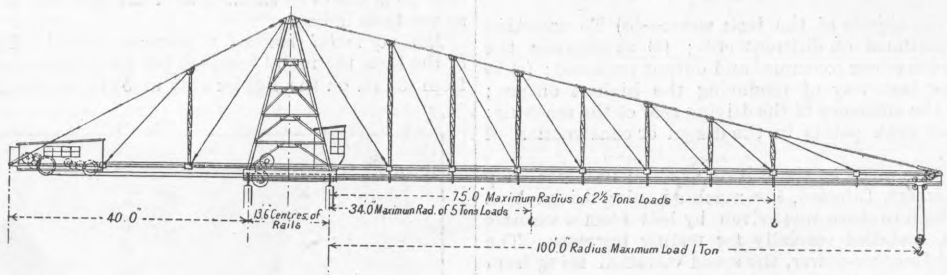
We are enabled, through the courtesy of M. Chabal, locomotive superintendent of the Paris, Lyons, and Mediterranean Railway Company, to reproduce a photograph of the latest goods engines for this railway. The engine illustrated is a four-cylinder compound with a boiler similar to that of the tank engine series 5500, illustrated in our issue of June 4th last. The steam pressure is 225 lb. per square inch, and the driving wheels are 59in. diameter. These engines have been specially designed for heavy service on the main line, and with a view to avoiding double heading on the section from Les Laumes to Dijon, where the ruling gradient is 1 in 125. Their loading on this section is about 830 tons at a speed of 15 miles per hour, while on the easier sections the load is the same, but the average speed is to be raised to 25 miles per hour, and the maximum speed authorised is 48 miles per hour. The system of compounding adopted is that of the late M. Baudry, locomotive superintendent of the company, and a great feature of it is that the admission in the low-pressure cylinders is fixed at all speeds at only 60 per cent.; this is the theoretically correct point with this system.

A few of these engines are fitted, for trial, with Schmidt superheaters, as are ten of the big 4–6–0 express engines Nos. 2691-2700. The superheater, which is worked at 330 deg. Cent., is giving good results. These engines take the place of the 4500 class of 0–8–0 engines, which, owing to all their wheels being coupled, were very limited as to speed. However, this 4700 class of engines, with their 4–8–0 wheel arrangement, are admirably steady at all speeds, while they are even more powerful than the 4500 class. The engines are most comfortably fitted with spring seats for the men, but the temperature of the cab is unpleasantly high, and modifications will no doubt be made, as has been done to the tank engines.

We are enabled also to give a drawing of one of the most recent express engines fitted with a Schmidt superheater. The chief point so far noticed is a decided economy of water, while the engines appear to run more freely at high speeds than with saturated steam. It is too early to give any decisive figures, but so far the results are satisfactory. We hope later to be able to give detailed figures and performances.

NEW CANTILEVER CRANES AT THE WALLSEND SHIPYARD.

There has previously been described and illustrated in The Engineer the large glass-roofed structure covering two of the shipbuilding berths at the Wallsend Shipyard. These sheds, from one of which the Mauretania was launched, are each about 740ft. in length and 150ft. high, the clear width inside the two berths being 100ft. and 95ft. respectively. The engraving on the top of this page is, however, reproduced in order to show more particularly the two cantilever cranes which have quite recently been erected on the top of the sheds. These cranes consist of a central truck with an elevated tower from which depend heavy steel cables, extending to the extreme end of the jib and also to the tail part which carries the machinery and ballast. Special care was exercised in the design of the cranes, so as to make them as light and as strong as possible. The front cantilever is constructed of steel tubes supported at intervals by vertical lattice columns of steel. The length of the cantilever jib is approximately 100ft., while the tail part has a projection of 40ft. The cranes will lift 5 tons up to 34ft., 2½ tons up to 75ft., and 1 ton up to 100ft. distance from the front rail. The work they will have to do is to deal with steel plates and sectional material for the construction of floating docks and ships, and they will very shortly be brought into use in laying down of the large "box" type connection with the pontoon floating dock, of 32,000 tons lifting capacity, the order for which has recently been placed by the Admiralty with Swan, Hunter and Wigham Richardson, Limited. The cranes have three separate sets of electric motors for hoisting, racking and travelling. Direct current electricity at 240 volts is conveyed by two trolley wires running the whole length of the slips. Hoisting is done by a 25 horse-power series-wound motor with powerful electrical and mechanical brakes, the rope being coiled on a very large drum. There is also an over-winding device to prevent the pulley block being lifted too far. The racking motion is driven by a 5 horse-power motor with electric brake. The travelling motion is worked by a 25 horse-power motor with both electric and mechanical brakes. The hoisting speed for 5 tons is 60ft. per minute; lighter weights are lifted more quickly to a maximum of 150ft. per minute. The racking speed is 60ft. per minute loaded, and the travelling speed, when the crane is loaded, is 400ft. per minute. An ingenious device has been fitted by means of which, so soon as an excessive load is applied, an automatic switch in the driver's cabin comes into operation and instantly prevents the load from being lifted or racked outwards, although permitting of the load being lowered or racked inwards. Elaborate means have also been provided to prevent any possible derailment. These cranes were manufactured by Joseph Booth and Brothers, Limited, of Rodley, near Leeds, and the girder track on which they run was designed, constructed, and erected by Swan, Hunter and Wigham Richardson, Limited.


75.0" Maximum Radius of 2½ Tons Loads
34.0" Maximum Rad. of 5 Tons Loads
40.0"
13.6" Centres of Rails
100.0" Radius Maximum Load 1 Ton
"The Engineer"
Swain Sc.

OUTLINE OF THE CANTILEVER CRANE

THE KIEL DOCKYARD SCANDAL.

(*By a German Correspondent.*)

The Kiel Dockyard scandal has now received decent burial. After—for Germany—an unprecedentedly long trial of five weeks' duration, during which the public prosecutors entirely failed to make good their case, the jury returned a verdict of "Not guilty" on every count in favour of the four officials and five merchants accused. An appeal made against this finding has been withdrawn again, and, whatever may be thought of the merits of the inquiry, it is difficult to see how the somewhat broadly-made charges could be substantiated, or what good purpose such substantiation would serve. The defence of the dockyard system has since been undertaken by the Minister of Marine, Admiral Tirpitz, before the Reichstag, who showed that during the trial the naval administrators had had no opportunity of defending themselves, and that, though certain individuals had proved unworthy of the confidence placed in them, the counter-charges made by the accused merchant Frankenthal of want of system amongst the officials generally were undeserved, or at any rate overdrawn. That abuses existed was not denied.

The trial itself, which has been watched with close interest in the country, has thrown cross lights on some German methods which are not without a certain interest of their own.

The Kiel Dockyard is a very extensive establishment, which, as shown by Oberwerftdirektor Admiral von Usedom, of Seymour Expedition fame, must be looked upon principally as a place for the repair and maintenance of the fleet. The object in life of the yard is thus not to make or save money, but to get the vessels that come in for succour ready for sea again in the shortest possible space of time. Even in time of peace night-and-day work has often to be resorted to, and the comparative neglect given to the small percentage of the whole turnover represented by the value of the scrap material is under such circumstances not altogether without its justification. When a large repair has been accomplished with all possible dispatch, and another one is in view, the yard clears for action. The tendency is to throw everything superfluous overboard, as in the case of a warship in presence of an enemy. Higher interests are at stake than scrap iron, and if the children of Abraham, who for a consideration remove this encumbrance, grow rich over the transaction, it may be no more unprofitable to the nation than the employment of a number of additional sub-officials to cope with the buyers and the extra demands made on the time of superiors for their control.

Broadly speaking, the history of the case is as follows:—A number of merchants with Asiatic-sounding names were accused of bribing some of the subaltern officials of Kiel Dockyard to allow them to take away larger and more valuable amounts of scrap material than they had really bought. The head storekeeper and other officials were likewise accused of taking bribes in this way and of generally aiding and abetting the machinations of the merchants. At the outset of the trial, Herr Frankenthal, one of the merchants accused, in the course of his examination made counter charges against the administration of the dockyard, which he said was conducted with an incredible degree of absence of business method. The inference was that, in the face of such conditions, merchants like himself were to be excused for making the most of chances of profit making, which were quite favourable enough without any resort to bribery.

Comparisons made between the weights of scrap material booked by the yard as sold and those noted by the railway officials as forwarded over the line showed discrepancies which, though large in themselves, were much less than the amounts credited by the public prosecutors to the merchants as wrongfully received by them. Further there was at least a doubt whether the railway weights themselves could be strictly relied upon, and it was also shown that the dockyard made a deduction for dirt accompanying the scrap, which appeared to be not altogether unfair.

A good illustration of the general question at issue was the case of a discarded steel mast, which had been sold for about £4 to Herr Frankenthal and resold by him for about £50. The manager of the yard, Admiral von Usedom, explained that the mast was a welded one, which, with the means then available, could not have been cut up into scrap for less than £45, and the carriage of which was necessarily very expensive. Every effort had been made to find a suitable use for it without avail, and its sale for the small sum named was justified by the circumstances.

The popular feeling, backed up by newspaper articles and utterances of certain naval officers, is that the imperial dockyards employ too many officials for the work to be performed, and that their thorough reform is desirable, while the appointment in them of a good proportion of men of business is advocated. Also comparisons are made with the numbers of officials and workmen in the royal dockyards in England. Compared with the vessels to be dealt with, the German dockyards are in some cases credited with a much larger number of hands employed; but such comparisons are apt to be misleading, and, as regards the officials, the higher numbers are partly explained by the system of control above referred to, which also necessitates more book-keeping in the dockyards themselves. The Admiralty has declared its intention of instituting reforms in its own way. In view of revelations at the trial, certain of the officials of the old material department are said to have been removed from their posts, but, according to the speech of Admiral Tirpitz in the Reichstag, the charges against the administration of the dockyards go much too far, and thoroughgoing alterations are not contemplated, except in the old material department itself, where the same trouble is hardly likely to occur again.

POWER TESTS OF MACHINE TOOLS.

By P. V. VERNON.*

THE development of machine tools during the last few years has taken place principally in two directions—first, in the speeds at which they must be capable of running to enable high-speed steel tools to be used up to their limit; and, secondly, in their general design, so as to permit of more easy handling, of taking heavier cuts, and of increased accuracy in their product.

The result of this development has been that, quite apart from the question of high-speed cutting, our present-day tools are better tools, and will produce a greater output, and with a higher degree of accuracy, than formerly, even using the old carbon steel cutters.

In an article I contributed to THE ENGINEER of March 13th, 1908, the dimensions, weights, and powers of ten milling machines of similar nominal capacity, but by different makers, were compared, and it was shown that there was no agreement whatever among the various makers on the questions of the power to be provided and of the weights of the nominally similar machines. As a matter of fact, the figures showed that the heaviest machine of the ten had the least power—in fact, had less than one-third of the power provided by the most powerful machine of the ten, and the powers of the remaining machines were fairly evenly distributed between the high and low limits. The natural inference was that machine tools in many cases were not designed scientifically, or, in other words, their proportions were not determined from experimental researches; and it was owing to a conviction that this was the case, and to a lack of reliable data, that the experiments described in this lecture were undertaken.

It must be understood that the tests to be described have been selected from a very large number that have been made with machines of varying size and type, and also that they are not laboratory tests bristling with microscopic and micrometric refinements, but are practical tests of the kind needed by the designer who has to produce commercial machines in a reasonable time.

The first set of tests was made on a horizontal milling machine, and was published in full in THE ENGINEER of March 19th of this year; but the second set, which relates to a hexagon turret lathe, are entirely new, and have never previously been published.

The broad objects of both sets of tests were to obtain by experiment reasonably exact knowledge of what each machine would do, so as to establish a basis from which the designs of the machines might be improved and their productive powers increased.

In detail, the objects of the tests were:—(*a*) To ascertain the power consumed on different cuts; (*b*) to ascertain the relation between power consumed and output produced; (*c*) to ascertain the best way of producing the highest output; (*d*) to check the efficiency of the driving gear of the machine; (*e*) to discover weak points in the design or construction of the machine.

The tests were made in the private experimental workshop of Alfred Herbert, Limited, the machine being driven by a jackshaft, which in turn was driven by belt from a variable speed motor, installed specially for testing purposes. The motor was of 15 horse-power, the speed variation being from 330 up to 990 in a large number of steps. It was found possible to run the motor up to 30 horse-power for quite long enough periods for the cuts which were taken, and the efficiency of the motor was known at all speeds and loads, the actual brake horse-power being thus easily computed from the electrical readings.

The jackshaft ran on roller bearings, and the power required to run the jackshaft light was measured and deducted from the total horse-powers. The power consumed by the jackshaft when under load could not be measured, but it was assumed that the increase under load would be small, owing to the efficient type of bearing, and to the observed fact that the temperature of the bearings did not rise appreciably during the tests.

The second set of tests were made on a No. 2 hexagon turret lathe, made by Alfred Herbert, Limited, the motor and driving arrangement being the same as before, except that no overhead countershaft was used, the machine being driven direct from the jackshaft.

The lathe was run 25 per cent. faster than its standard speeds for the purpose of these tests. The height of centres was 8in., diameter of single pulley 12in., width of belt 5in., and speed of pulley 500.

Fig. 1 shows the tool holder with its roller steadies and the side cutting tool, the section of which was 1in. by ¾in. The cutting tools were made of "special" high-speed steel, the cutting angle being 48 deg., except on some of the lighter cuts, when a slightly greater angle was found to be better.

Fig. 2 shows the relative positions of work, cutter and steadies, and illustrates in a very graphic manner the way in which the metal is removed, and also the way in which the work is supported while being turned. The material on which the tests were made was mild steel of about 25 tons tensile strength, 15 tons elastic limit, and 44 per cent. elongation.

The method of making the tests was to begin with the largest bar the machine would admit, and to reduce it at one cut 1¼in. in diameter, the depth of cut being, of course, ⅝in. At this cut various speeds and feeds were tried, the speeds naturally having to be reduced as the feeds were increased.

A similar set of tests was then made, reducing the bar 1in. in diameter, and then reducing it ¾in. in diameter, and so on. Similar tests were made on smaller bars progressively down to 1½in., which was the smallest bar it was thought worth while to test on this machine.

The results of the tests were all kept in detail, but as there are far too many figures to be carried in the memory, it will, perhaps, be best to point out the leading facts and the chief deductions which can be made from them.

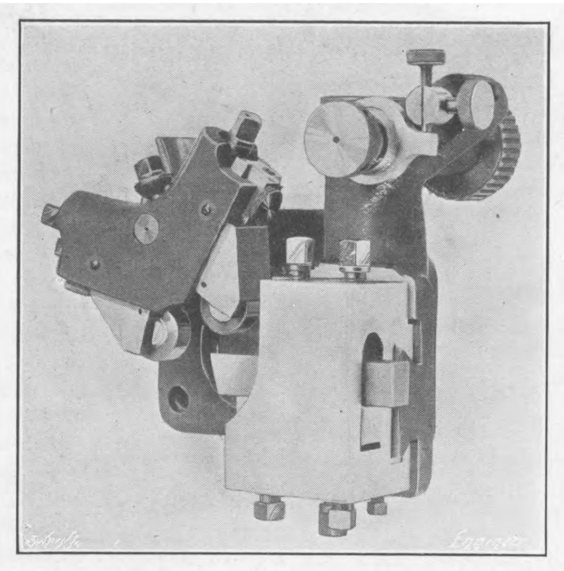


Fig. 1—ROLLER STEADY AND TOOL HOLDER

Maximum output.—The table below gives the six best results, and it should be understood that no tests are recorded in which either the machine or the tool failed.

Number.	Reducing From	To	Speed per minute.	Feed per minute.	Metal removed per minute.	
	in.	in.	ft.	in.	cubic in.	lb.
1	2¼	1	190	11⅜	36.29	10.16
2	2	¾	262	17⅜	36.11	10.11
3	1¾	¾	184	18⅛	35.52	9.94
4	2	1	210	14⅞	35.04	9.81
5	1¾	¾	229	17¾	34.79	9.74
6	2¼	1	236	10⅝	33.89	9.49

The leading fact to be gleaned from this table is the remarkable one that it is possible on the hexagon turret lathe to remove as much as 10 lb. of metal per minute from so small a bar as 2in. using only one tool, and it is more than doubtful whether such results have ever before been obtained on any type of machine tool.

Power consumed.—The maximum horse-power consumed was 23.7 in the case of Test No. 2, viz., the test on the 2in. bar just referred to. Ten years ago the lathe in its then form used to be sold with a 2 horse-power motor, whereas a 20 horse-power motor would now be required if such cuts were to be taken continuously. As a matter of fact, such heavy cuts never last very long, on account of the great rate at which the work is done, and a 10 horse-power motor is generally large enough for the lathe, its overload capacity taking care of the heavy cuts. Still, an increase of from 2 to only 10 is not to be sneezed at if the output is in proportion, as the tests indicate.

Ratio of metal removed to power consumed.—In the whole of the tests the metal removed per horse-power minute varied from .33 lb. on the lighter cuts to .52 lb. on the heavier cuts, showing the combined efficiency of lathe and tool as a cutting apparatus to increase with the output. In order to compare these figures with those obtained by other experimenters, the following table has been prepared from the Manchester experiments made in 1903, cutting soft steel of somewhat similar quality to that referred to above.

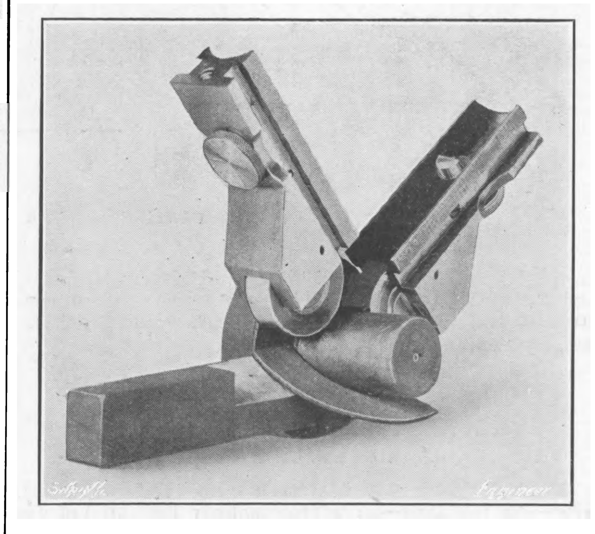


Fig. 2—RELATIVE POSITIONS OF CUTTER AND STEADIES

Material Removed in Pounds per H.P. Minute.

	Horse-power.	lb. per min.	lb. per H.P. min.
Alfred Herbert, Limited, No. 2 hexagon turret lathe, 1909.			
Highest figure	14.4	7.58	.52
Lowest figure	6.1	2.01	.33
Manchester experiments, 1903 (pages 273, 298, and 308).			
Highest figure	8.94	4.41	.49
Lowest figure	17.19	5.6	.32

The similarity of the figures would be remarkable were it not for the fact that the Manchester figures represent nett horse-power at the tool with the losses in the machine deducted, whereas the figures now submitted include all losses in the machine, and, therefore, would indicate a considerably higher net efficiency at the tool. This assumption is borne out by the figures which follow.

It is to be regretted that the particulars published by Mr. F. W. Taylor in his "Art of Cutting Metals" do not permit of a similar comparison being made, but, as Taylor's determinations of tool pressure agree substantially with the Manchester results, it may be assumed that his efficiencies would not be very much different.

Pressure of chip on tool.—The next table shows the comparative tool pressures in the Manchester experiments, those of Mr. F. W. Taylor, and Alfred Herbert, Limited, and it will be noted that the pressure on the hexagon turret lathe tool was very much less than in either of the other examples, showing that it cut more easily and required less power. The steel operated on was a little softer, judging by the tensile strength, but the elongation was greater; and it has been shown by Taylor ("Art of Cutting Metals," page 150, paragraphs 508-509, and page 151, table) that softer steels often cut with higher pressure than harder steels if the elongation is greater. In any case, the difference in pressure was much greater than could be accounted for by the lower tensile strength, and existed in spite of the higher elongation.

Pressure of Chip on Tool.

	Tensile strength, tons per sq. in.	Elongation, per cent.	Pressure on tool, tons per sq. in.	Losses in machine deducted.
Manchester experiments, 1903	26	25	115	Yes
Report, pages 152, 298, and 308	29	26	108	Yes
F. W. Taylor ("Art of Cutting Metals," 1902, page 164) ..	30	29	107	Yes
Alfred Herbert, Limited, 1909*	25	44	74.9	No

* Best result, reducing 2¼in. to 1½in. at 151ft. per minute, twenty cuts per inch, absorbing 14.4 horse-power, including losses in the machine.

CONCLUSIONS.

1. The maximum amount of material removed was 10.16 lb. per minute.
2. The maximum horse-power that could be utilised was 23.7.
3. The maximum amount of material removed per horse-power minute was .52 lb.
4. The highest cutting speed that could be utilised on high output was 295ft. per minute.
5. The highest speed provided (500) could be advantageously employed on the largest bar admitted (2¼in.), and on all smaller bars.
6. The quickest feed available on the lathe (23⅞in. per minute) was used on a 1¾in. bar running at the highest speed provided, viz.—500, with a cut ⅛in. deep.
7. The minimum tool pressure is about 75 tons per square inch, against about 100 tons according to other experimenters.
8. The large output and high efficiency of the tool is primarily due to its small cutting angle.
9. The successful action of the tool on such small bars depends upon using an efficient steady.
10. The maximum results could not be reached with any but a roller steady.
11. Modern machines for bar work must have ample speed range, ample driving and feed power, a rigid machine and ample room for chips, also a liberal supply of cooling liquid.

BUENOS AIRES EXHIBITION, 1910.

IN celebration of the 100th anniversary of the proclamation of the independence of the Argentine Republic, which occurs in May next, the Argentine Government have decided to organise in the capital a series of commemorative exhibitions, congresses, and festivities The exhibitions officially recognised by the Argentine Government will be five in number:—(1) The Railway and Land Transport; (2) the Agricultural and Live Stock; (3) the Hygienic; (4) Art; and (5) Industrial—confined to Argentine products only. In addition to these, there will be an exhibition promoted by the Liga de Almaceneros under the name of the Universal International Exhibition.

The first of these—the Exhibition of Railway and Land Transport—is important from the point of view of manufacturers of railway rolling stock, of tramway material, motor cars or vehicles connected with other means of locomotion. Covered areas have been assigned to the various nations who are taking part, including Great Britain, Germany, Austria, Italy, Belgium, France, and the United States. According to the latest information received from the Commissioner, the area definitely allotted to Great Britain in the Railway and Land Transport Exhibition is 15,000 square metres. An option has, however, been secured upon an additional area of 3000 square metres. Of the other nations Germany had been assigned 6000 square metres and the United States 3500.

On his arrival in Buenos Aires, the Commissioner found that a good deal of preliminary work had been done by the various manufacturers' agents and railway authorities, under the guidance of Mr. Townley, the British Minister, but it remained for him to collate the various individual efforts that had been made, and to secure the necessary facilities for British exhibitors. It is understood that the buildings for this Exhibition are now well on their way to completion, and that most of the space has been already allotted, the last date on which applications can be received being the 31st December.

A special catalogue of the British section will be printed, a reading room will be provided, and other matters of detail tending to facilitate the task of exhibitors of installing their exhibits in the Exhibition are receiving attention. The Exhibition grounds are in a favoured district of the city of Buenos Aires, facing the Palermo Park, and adjacent to the racecourse.

As in the case of the Brussels, Rome, and Turin Exhibitions, the management of the British section of the Buenos Aires Exhibition is in the hands of the Exhibitions Branch of the Board of Trade, and all information can be obtained from the Director of the Branch, 30, Broadway, Westminster, London, S.W.

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* From a paper read before the Coventry Engineering Society on November 19th.

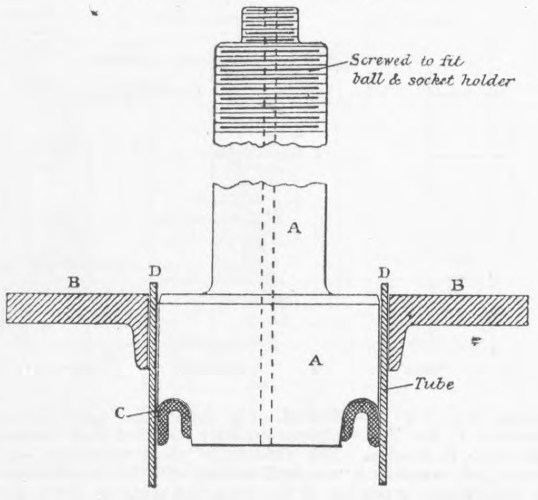
MILD STEEL TUBES IN COMPRESSION AND UNDER COMBINED STRESS.[*]

By Mr. WILLIAM MASON, Associate Member,
of the University of Liverpool.

Preliminary.—One of the most important contributions during recent years to our knowledge of the strength of materials is the paper by Mr. J. J. Guest on "The Strength of Ductile Materials under Combined Stress." The experimental results and the conclusions deduced have gradually been brought to the notice of engineers, and it is only necessary to re-quote Mr. Guest's practical conclusion, namely, "That the condition for initial yielding of a uniform ductile material is the existence of a specific shearing stress." This result, if true, must be of great practical importance; for in all cases of stress—with the exceptions of positive and negative fluid stress—there is shear stress induced over certain planes.

Fig. 1.

Method of Holding Tube End during Tension.



Other investigators[†] have made experiments in combined stress which are confirmatory of Mr. Guest's conclusion. So far as the writer is aware, very little work has hitherto been done in which the compressive stress has been much greater in intensity than the other stresses. In Mr. Guest's tests a principal stress, when compressive, never exceeded the other principal stress in intensity. Mr. Scoble did work on bars under bending and torsion, in which the yield may have been due to the stress on either the compressed or extended side of the bent bar. And Professor Hancock's reports only contained seven tests on simultaneous compression and torsion.

Object and scope of the experiments.—The work described in this paper is largely upon comparative yield-point strengths in compression and shear; though in some cases the stresses have been carried as far as the rupture or collapse of the material. In making tests in compression it is essential that the force shall be axial to the specimens. It appeared to the author that this condition might be attained, approximately at any rate, by the apparatus hereafter described, using tubes as specimens; and that, as in Mr. Guest's experiments, a second stress, at right angles to the direction of the compression, could be conveniently imposed by hydraulic pressure in the interior of the tube. Besides the sets of tests in simple compression and in simultaneous compression and hoop tension, three series of tests were made on certain of the tubes under conditions as follows, namely:—Tests under simple axial tension, simultaneous axial and hoop tension, and simultaneous axial and hoop compression.

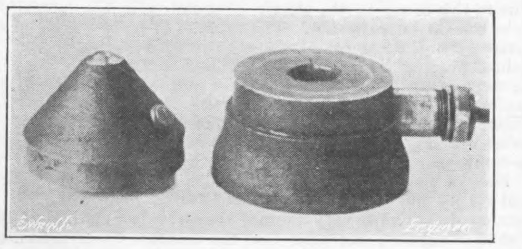


Fig. 2

Material for tests.—The specimens were cut from solid-drawn mild steel tubes. Two sizes of tubes were used, namely, 3in. bore, 14 gauge (about 0.08in. thick), and $2\frac{3}{4}$in. bore, 10 gauge (about 0.128in. thick), the former being cold drawn and the latter hot drawn. Various lengths of specimens of each of these were tested, the lack of uniformity noticeable in the lengths being due to the circumstance that it was difficult to cut, from the same piece, the required lengths of exactly straight tubes. Most of the tubes were supplied by the British Mannesmann Tube Company. They had undergone some degree of annealing, but not so far that they could be considered isotropic for the purpose of the tests. Experiments were made on the tubes both in the condition as supplied and also after further annealing. The latter was done by encasing the tubes in a longer tube of rather larger diameter, the ends of which were blocked up with asbestos and fire-clay. The tube and the outer casing were kept from contact by narrow rings of asbestos. The whole was placed in a coke furnace at a temperature of from 800 deg. Cent. to 850 deg. Cent., and allowed to remain there about 25 minutes, the casing (and tube) being turned round about its axis from time to time.

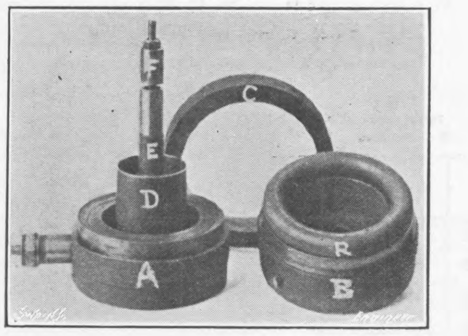


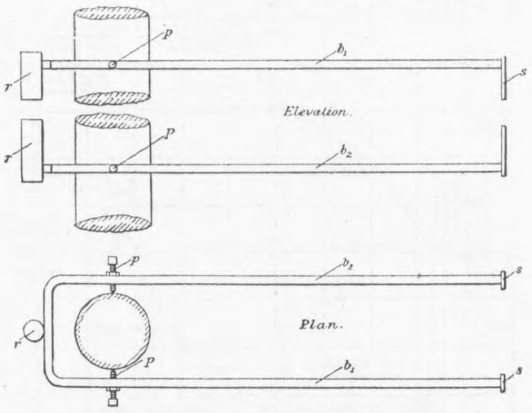
Fig. 3

It was impossible to obtain tubes of exactly uniform thickness of wall. In a long length of tube the thickness would be practically uniform at one section, while at another section there might be a considerable variation. The maximum variation in thickness of wall of the tubes used in the tests was 0.007in., means being taken (see description of apparatus for compression tests) to obtain uniformity of compressive stress. The ends of all the tubes tested were accurately faced up in the lathe.

Apparatus for tension.—After several failures to hold the ends of the tubes, the following plan was adopted:—A holder, A A, Fig. 1, was made for each end of the tube, the larger end of the holder being turned to fit the 3in. bore tube, and the smaller end screwed to fit ball-and-socket holders of the testing machine. The outer end of the 3in. diameter part was slightly bevelled off, while the inner end had a turned cavity to accommodate a cup leather C. A pipe flange B was fitted round each end of the tube, and the slightly projecting ends D of the tube were riveted down into the small conical bevelling on A A. Another pipe flange of bore about 3in. (not shown in the Fig.) was placed face to face with B, and fixed to it with set screws. This second flange kept B in position during the straining of the tube. The tube always broke at some distance away from the holders. The cup leathers C made the interior water-tight for the tests in which water pressure was used to give hoop tension. A hole through the centre of A A allowed the introduction of hydraulic pressure.

Fig. 4.

Diagram of Frame used with Ewing Extensometer.



Apparatus for compression.—Fig. 2 shows the pedestal on which the tube to be compressed rests. Water under pressure could be supplied from the tube shown through a passage in the centre of the pedestal. The conical piece to the left in Fig. 2 is a cap for the top of the tube. This cap was turned so that the axis of the cone was perpendicular to the circular base of the cone, and concentric with it. The cone was placed truly upon the top of the tube so that the axis of the tube and cone were coincident.

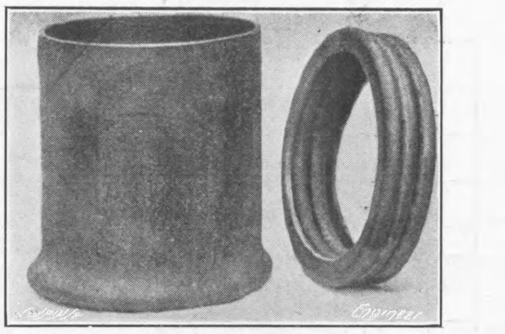


Fig. 5

When, however, the thickness of the walls of the tube was not quite uniform over the circumference, and where, accordingly, the centre of gravity of the ring cross section deviated measurably from the axis of the tube, the cone was placed, by means of a template, in such position that its axis passed through this centre of gravity. By this means an equal distribution of compressive stress was brought on the tube. The greatest eccentricity in the position of the cap to compensate for the variation of thickness was 0.04in.

Apparatus for shear tests.—As before mentioned, the shear was obtained by equal axial compression and hoop tension. The tube to be tested was set up exactly as for compression; and in many cases the tests for yield-point in compression and shear were made on the same tube thus fixed up. Where the thickness of the walls of the tubes was not quite uniform the calculation of the hoop tension was made for the minimum thickness. The joints between the pedestal and tube, and between the cap and tube, were made with thin sheet lead.

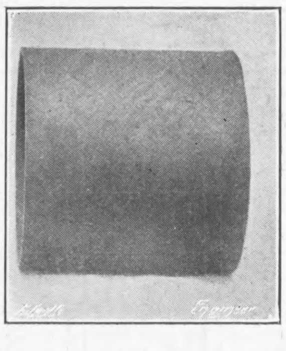


Fig. 6

Apparatus for simultaneous axial and hoop compression.—The difficulty of making reliable tests under these conditions arises from the fact that a jacket exterior to the tube must contain fluid under pressure, and must at the same time be so flexible that it will not impede the elastic or other shortening of the tube under test. In other words, the axial compressive stress on the tube must be calculable as well as the hoop stress. The jacket designed by the author is shown in Fig. 3. It was cast in two exactly similar halves A and B. The exterior cylindrical turned part of each fitted loosely into a ring C, the whole of which was machined except the exterior cylindrical surface. The joint between A and C and between B and C was made by a hollow india-rubber ring R, placed between A and B as a cushion and fitted into C. Water was admitted to the external jacket thus formed through the tube shown. Holes drilled in the inner wall of the rubber ring admitted water to its interior. The piece of tube D (about 4in. long) to be tested is shown in position inside A. The joints between A and B and the tube were made with thin lead rings.

It required about 0.20 ton to compress the rubber ring (when under test) to the working position. The apparatus was calibrated by plugging the holes in the flat ends of A and B, introducing water at known pressures to the whole of the interior of the cavity, and placing the apparatus in the testing machine. The whole load on either half, A or B, is thus known, and also the water pressure; from these the effective area of A and B subjected to pressure may be calculated. When a tube was under test the compressive load on the tube was therefore the load on the testing machine less the effective area of A or B (diminished by the exterior area of the tube) multiplied by the pressure in the jacket. The rods labelled E and F, Fig. 3, have no connection with each other, but each is connected to the tube by three hard steel-pointed screws set in the same horizontal plane. E and F therefore indicated the behaviour of the piece of tube between the two planes of the points, a length of about $1\frac{1}{4}$in. in the tests made. A Ewing compressometer was attached by its own screws to E and F, and measured the relative vertical movement of E and F, and therefore the change of length of the tube between the horizontal planes of the points.

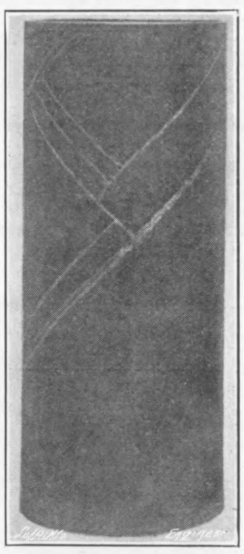


Fig. 7

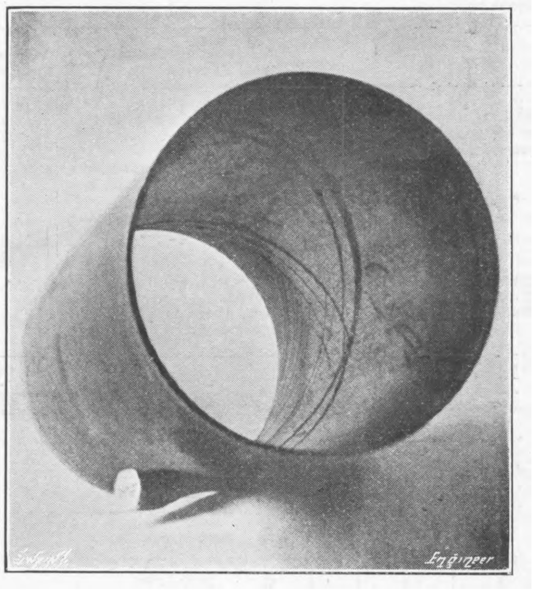


Fig. 8

Measurement of the strains.—The axial strains were those measured. Except in the case of simultaneous axial and hoop compression, a Ewing extensometer was used. This instrument measures diminution or increase of length equally well, and the one employed could be read to $\frac{1}{50000}$ of an inch. The length on which the strain was measured was in some cases 10in. and in the others 5in. As the instrument would not take a specimen of so large diameter as 3in., a frame shown diagrammatically in Fig. 4 was made. It consisted of two equal bars b_1 b_2 each bent into a U-shape. The ends of the U-shaped pieces were bolted to thinner strips *s s*, while at the centre of each bend there was bolted a short length of inch diameter bar *r r*. Steel screws *p p*, with hardened points, fastened the frame to the tube under test in such a manner that the planes of the U's were horizontal and the strips *s s* vertical. The latter acted as hinges when the points *p p* moved slightly owing to the strain of the tube. The extensometer was secured by its own screws to the short bars *r r*.

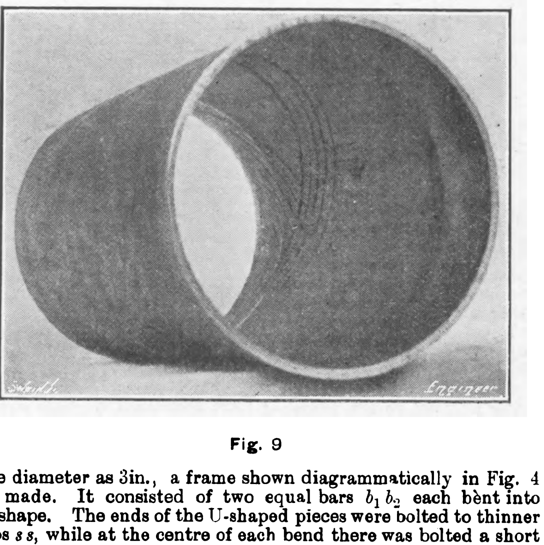


Fig. 9

In the simultaneous axial and hoop compression tests, the (axial) length on which it was attempted to measure the strain was about 1¼in. It was found, however, that the readings of the compressometer were affected by some elastic distortion of the apparatus connecting the compressometer with the tube. The readings, and the curves plotted therefrom, show the yielding of the specimens, but cannot be used to calculate the elastic constants.

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[*] The Institution of Mechanical Engineers.

[†] Professor E. L. Hancock, *Philosophical Magazine*, February and October, 1906; Mr. W. A. Scoble, *Philosophical Magazine*, December, 1906, and "Proceedings" of the Physical Society, September, 1907.

Calibration of the pressure gauge.—The pressure gauge used was of the Bourdon pattern. It was tested against a standard gauge reading to 400 lb. per square inch, which was calibrated by dead weights. It was also tested, for higher pressures, against two standard Bourdon gauges. Also, verification within 2 per cent. was obtained by testing the gauge against the apparatus used for simultaneous axial and hoop compression.

Testing machine.—The testing machine in which the tests were made was the 100-ton Buckton machine in the Walker Engineering Laboratory of the University of Liverpool.

Stress in two dimensions.—In all work hitherto done (so far as the author knows) upon strength under combined stress, and in this work also, the stress has been two dimensional, one set of parallel planes being left entirely, or very nearly, unstressed. Such a condition is always equivalent to that due to two "principal stresses"—that is, to such a state as that of a rectangular plate which is pulled or compressed longitudinally, and simultaneously pulled or compressed in the direction of the breadth, the stresses being both tensions or both compressions, or one being tension and the other compression. If p_1 and p_2 are not equal, shear stress will exist on all planes except those parallel to the faces and the edge planes of the plate. The maximum shear stress will occur thus:—

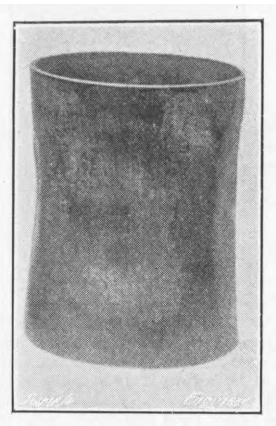


Fig. 10

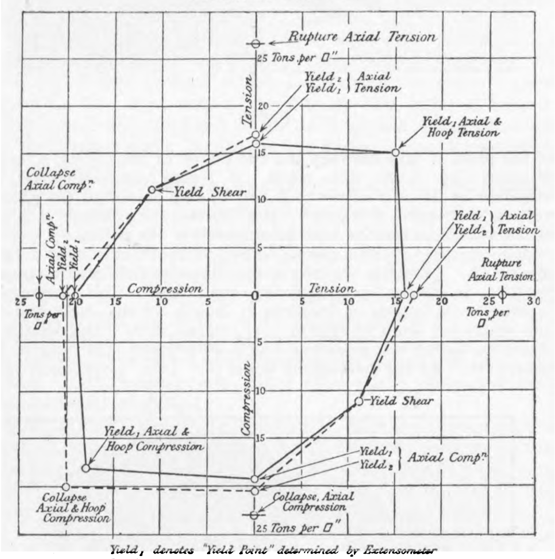
Conditions.		Planes on which greatest shear stress occurs.	Maximum shear stress.
p_1 and p_2 Both tensile or both compressive.	$p_1 > p_2$	Planes parallel to p_2 and at 45° to p_1	$\frac{1}{2}\,p_1$
	$p_2 > p_1$	Planes parallel to p_1 and at 45° to p_2	$\frac{1}{2}\,p_2$
	$p_2 = 0$	Planes at 45° to p_1	$\frac{1}{2}\,p_1$
	$p_1 = 0$	Planes at 45° to p_2	$\frac{1}{2}\,p_2$
	$p_2 = p_1$	Planes at 45° to p_1 and parallel to p_2 Planes at 45° to p_2 and parallel to p_1	$\frac{1}{2}\,p_1 = \frac{1}{2}\,p_2$
and p_2 of opposite sign (one of them compressive and the other tensile).		Planes at 45° to each of the planes on which p_1 and p_2 act Note— When $p_1 = p_2$ there is no normal component of stress on these planes at 45°, *i.e.*, there is pure shear stress on these planes	$\frac{1}{2}\,(p_1 + p_2)$

It will be observed that in the experiments carried out by the author, p_1 corresponds with the axial tension or compression, and p_2 with the hoop tension or compression. In the simultaneous axial compression and hoop tension tests the planes of greatest shear at any point of the tube wall are two planes intersecting on the radius of the tube through the point, at right angles to each other and at 45 deg. to the axis of the tube.

FIG. 11.

Diagram showing Strength of Tube, Not Annealed.
(*See* Table 5.)

Tube 3-inch bore. 0·082-inch thick.



Yield₁ denotes "Yield Point" determined by Extensometer
Yield₂ „ „ „ observed not using „

In the simple compression tests, the planes of greatest shear are any planes cutting the axis of the tube at 45 deg. Thus certain planes of this set are the same as the planes of greatest shear in the simultaneous compression and hoop tension tests. But the latter may not be the planes of least resistance to shear stress if the material is not isotropic; certain of the former set may be weaker under shear. If so, the tube may yield under a less shear stress, induced by simple compression, than the shear stress produced—on other planes—by simultaneous compression and hoop tension even if the theory of yield by shear is true. In other words, if the material is not isotropic, but the condition for yielding is simply the existence of a shear stress of specific intensity, the $\frac{1}{2}\,p_1$ cannot be greater than and will probably be less than

$$\tfrac{1}{2}\,(p'_1 + p_2)$$

where p_1 = yield stress in simple compression.
p'_1 = axial compression stress } at yield under
p_2 = hoop tensile stress } simultaneous stresses.

If the material is isotropic, and if it yields when the shear stress induced anywhere exceeds this specific value—whether there is or is not normal stress on the planes of this shear—we shall expect to find that

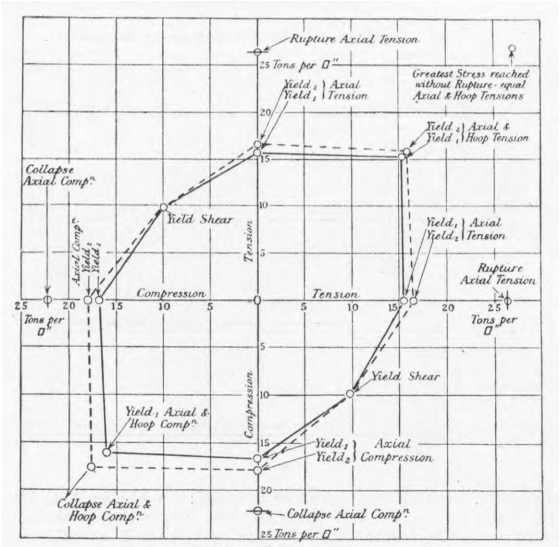
$$\tfrac{1}{2}\,p_1 = \tfrac{1}{2}\,(p'_1 + p_2).$$

The tests.—It will be seen from the Tables II., III., IV., V. in the Appendix of the results of the tests that the specimens are divided into groups. All those in a group were cut from the same length of tubing. The specimens in each group are numbered; where there are two or more with the same numeral but distinguished by "a," "b," the tube has undergone the first test or tests "a," and afterwards a piece has been cut out from it, faced up in the lathe, and subjected to the further test or tests "b." Specimens that were annealed together are shown bracketed. In general more than one test was done on the same specimen; but throughout the work when making a test on a specimen on which further yield-point experiment was to be done, the loading was discontinued when the extensometer showed a definite yield-point or a definite yielding of the test-piece. The fifteen curves, also shown in the Appendix, show how far such stressing was carried. The order of the figures in the columns of the tables corresponds to that in which the tests on a specimen were done.

FIG. 12

Diagram showing Strength of Tube, Not Annealed
(*See* Table 5.)

Tube 3-inch bore. 0·082-inch thick.

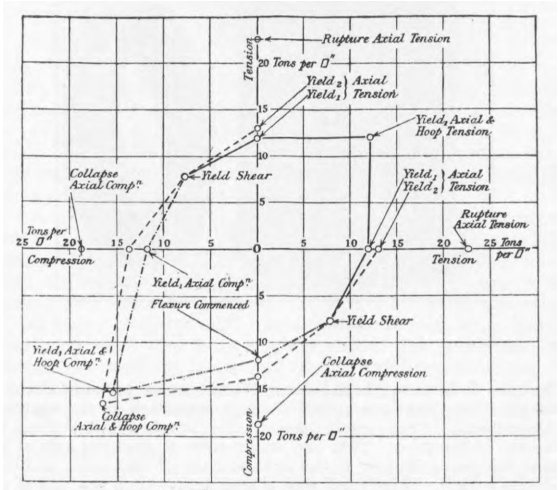


Yield₁ denotes "Yield Point" determined by Extensometer
Yield₂ „ „ „ observed not using „

FIG. 13.

Diagram showing Strength of Tube, Annealed.
(*See* Table 5.)

Tube 3-inch bore. 0·078-inch thick.



Yield₁ denotes "Yield Point" determined by Extensometer
Yield₂ „ „ „ observed not using „

The actual yield-loads and pressures have not been tabulated, nor the dimensions of the cross-sections of the tubes. Each specimen tested was accurately callipered by a micrometer-gauge. The sectional areas of almost all specimens cut from the same tube were sensibly the same, though the maximum and minimum thicknesses varied slightly. A list was made out for use in all the tests of a group in which hydraulic pressure was employed, the list giving the loads on the testing machine and the corresponding pressures on the gauge, so that the required proportion between compressive and hoop stress—usually equal—might be maintained constant throughout a test. The hoop stress varied, of course, from a maximum at the inside skin of the tube to a minimum at the outside. This variation was about 5 per cent. for the 14-G, and about 9½ per cent. for the 10-G tubes. The maximum stress is the one adopted for calculation. Of course, the loads on the testing machine were corrected for the upward thrust of the water pressure, and the pressure-gauge readings rectified according to the curve of calibration of the gauge. Small corrections, appropriate to the calipered dimensions of the tube, were afterwards applied to the yield-stress as indicated on the list mentioned above.

Stress-Strain Curves of some of the Specimens of Group I.

FIG. 14—*No. 1b.* (Table 4.) E = 28·9 × 10⁶. m (Poisson's Ratio) = 4·4. Extension on 5 inches.

FIG. 15—*Nos. 2a and 2b.* (Table 2.) E = 28·2 × 10⁶. C = 11·35 × 10⁶. Contraction on 10 inches.

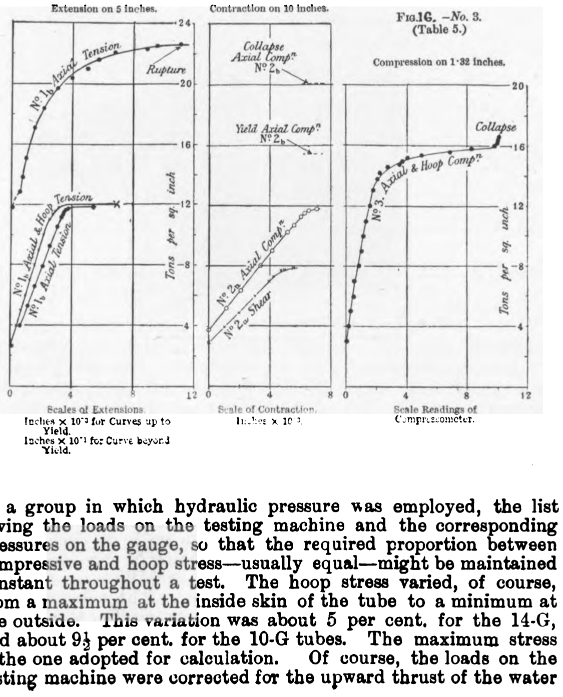


FIG. 16.—*No. 3.* (Table 5.) Compression on 1·32 inches.

Scales of Extensions. Inches × 10⁻³ for Curves up to Yield. Inches × 10⁻¹ for Curve beyond Yield.

Scale of Contraction. Inches × 10⁻³.

Scale Readings of Compressometer.

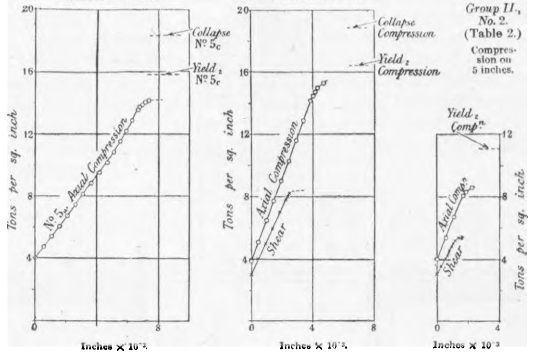
Tests in compression (Tables II. and III.).—It was necessary to ascertain whether the thinness of the tube walls caused premature yielding. Preliminary experiments on the tube in tension gave a yield-point stress rather less than the stress at which yield occurred in short specimens in compression. On the greater number of the specimens cut from the tube of 14-gauge wall thickness, the extensometer showed apparent yielding in compression—due to flexure—at a stress Y_1 considerably below the stress Y_2 at which the first indication of yielding could be detected by a pair of compasses applied to shorter specimens. But certain tests, for example, No. 4, Group I.—Fig. 18; No. 6A, Group V.—Fig. 22; and No. 1, Group VI.—Fig. 25—showed only about the same difference between Y_1 and Y_2 as between similarly observed yield stresses on the tube in tension. The yielding of short specimens, and of those just mentioned, was simultaneous with the commencement of disturbance or peeling of the scale, and many of these showed signs of flexure of the wave kind. Some of the specimens on which the Y_1 had been observed showed slight disturbance of the walls. The stresses Y_1 and Y_2 are both tabulated; but when it was obvious that the yielding occurred by flexure before the yield point of the metal was reached, the corresponding value of Y_1 was left out of the calculations. Neglecting such values, it is certain that the Y_1 stresses were rather below the yield point, while it is probable, from the behaviour and appearance after test of the specimens, that the Y_2 stresses were not less than the true yield stresses of the material in compression.

Stress-Strain Curves of some of the Specimens of Groups I and II.

FIG. 17—*Group II, No. 5a.* (Table 2.) E = 29·7 × 10⁶. Extension on 10 inches.

FIG. 18—*Group I, No. 4.* (Table 2.) E = 29·7 × 10⁶. C = 12·1 × 10⁶. Contraction on 5 inches.

FIG. 19. Group II., No. 2. (Table 2.) Compression on 5 inches.



Inches × 10⁻³. Inches × 10⁻³. Inches × 10⁻³

On all the specimens of the tube of 10-gauge wall thickness the extensometer showed a very definite yielding, which was always simultaneous with the appearance of "Lüder's lines" on the surface. The stresses at this point are entered in the tables in a column headed $Y_1 = Y_2$, and are believed by the author to be those at the exact yield or very closely approximate to the true yield point in compression. It is possible that elastic flexure of the walls of the tubes may have commenced even in the early stages of the tests. If so, the effect was so small that it was not detected. A simple calculation shows that no measurable increase due to this cause in the elastic contraction in the length of the tube was to be expected. The value of Young's modulus calculated from the compression tests came out quite normal, these values ranging from 28.2×10^6 to 30.2×10^6 lb. per square inch. In some cases the stresses at collapse of the tubes are given in the tables for the purpose of comparison with the yield stresses. Collapse always occurred by wave-like flexure of the walls of the tubes—see Fig. 5. The collapse load on the machine was sufficient to compress a tube into the form shown on the right in Fig. 5.

Tests in simultaneous compression and hoop tension (Tables II. and III.).—The tests in simultaneous axial compression and hoop tension always gave very definite results. The method of testing was to so regulate the load and the internal water pressure that the ratio—unity in most cases—of axial compressive to hoop tensile stress was constant throughout a test. In all cases, whether the specimens were or were not annealed, the yield point was perfectly definite. The curves plotted from these tests show a very quick bend from the straight line portion of the stress-strain curve. Moreover, specimens cut from the same tube, similarly annealed or not annealed, gave very uniform values of the yield stress. Interesting markings—"Lüder's lines"—always became visible on the specimens at the yield point, due to the disturbance of the scale on the tube as the metal yielded. Figs. 6 to 9 show these markings. These lines or bands were in parallel spirals, there being two systems of these equally inclined to the generators of the tube surface and inclined at about 88 deg. to each other. They very nearly corresponded with the planes of maximum shear. Sometimes the lines appeared on the outside of the tubes, the time of their appearance exactly coinciding with the first indication of the yield on the extensometer, or when this point had been exceeded by not more than 0.20 ton per square inch of shear stress. When the lines did not appear on the outside they were always to be seen on the inside when examination was made after test. Photographs—Figs. 7 and 8—are of the same tube, and show the markings on the inside and outside respectively. Several of the lines are exactly opposite to each other on the sides of the tube wall—that is, are in the same spiral surface.

FIG. 20.

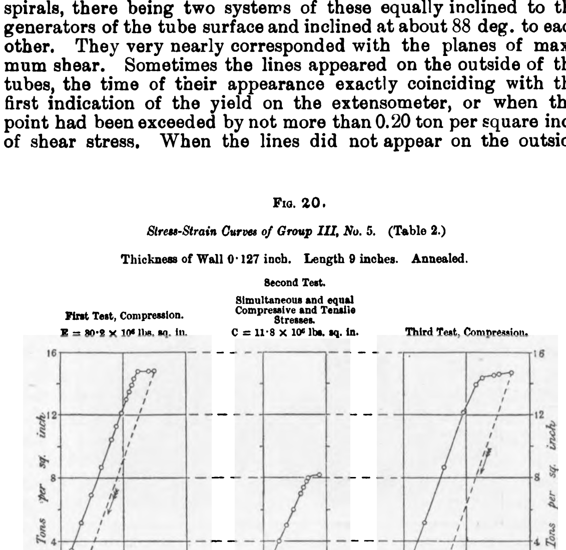
Stress-Strain Curves of Group III, No. 5. (Table 2.)

Thickness of Wall 0·127 inch. Length 9 inches. Annealed.

First Test, Compression. E = 30·2 × 10⁶ lbs. sq. in.

Second Test. Simultaneous and equal Compressive and Tensile Stresses. C = 11·8 × 10⁶ lbs. sq. in.

Third Test, Compression.



Inches × 10⁻³. Strains measured on length of 5 inches.

One or two experiments were made on both annealed and unannealed tubes to ascertain whether the direction of these lines would be altered by the presence of a normal compressive or of a normal tensile component on the planes of greatest shear. The compressive axial stress was made respectively twice, and one half, the hoop tensile stress, but the change, if any, in the angles of the lines was very small. Some tubes which had been strained to the shear yield point showed no buckling or disturbance of the alls, while others did show some slight effect of this sort. Short tubes gave practically the same yield point stress as long tubes. Table I. gives the results of six tests upon specimens of different lenghts :—

TABLE I.

Length.	Stress at appearance of lines.	Remarks.
In		
0.9	12 37	Cut from same tube.
4	12.33	
4	12.87	
3	11.05	Cut from same tube.
6	11.25	
18.7	11.10	

No difference in direction or angles of the markings could be detected whether the tubes were long or short. It was expected that the frictional gripping of the ends against the pedestal and cap would somewhat relieve a tube of the water pressure load near its ends. The above table shows that there can be little such effect. The presence of the lead rings forming the water-tight joint, though squeezed extremely thin, may perhaps be the explanation.

Stress-Strain Curves of some of the Specimens of Group V.

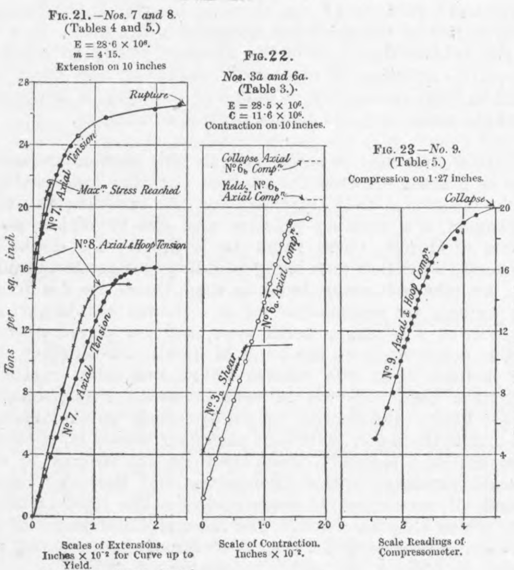


FIG. 21.—*Nos. 7 and 8.* (Tables 4 and 5.) E = 28·6 × 10⁶. m = 4·15. Extension on 10 inches

FIG. 22. *Nos. 3a and 6a.* (Table 3.) E = 28·5 × 10⁶. C = 11·6 × 10⁶. Contraction on 10 inches.

FIG. 23—*No. 9.* (Table 5.) Compression on 1·27 inches.

Results of compression tests compared with results of tests in simultaneous axial compression and hoop tension.—Tables II. and III. The maximum shear stress in a specimen in simple compression being one-half of the compressive stress, one-half of the compressive stress at yield has been subtracted from the shear stress S at yield, induced in the specimen by simple compression and hoop tension of equal amounts. This difference, and also this difference divided by S and multiplied by 100, giving the percentage variation, are given in the Tables II. and III. It will be seen for the 14-G tubes that $S - \frac{1}{2} Y_1$ is always positive, while $S - \frac{1}{2} Y_2$ is sometimes positive and sometimes negative ; while for the 10-G tubes $S = \frac{1}{2} Y$ is always positive. Over the whole range of annealed tubes the percentage variation ranges from + 11.3 to − 9.3 ; on the 10-G tubes above the range is from + 10.2 to + 2 2. The arithmetic mean of the whole of these percentages is + 2.8 per cent.

In Table III., which sets forth the results on tubes in the condition as received from the maker, and without further annealing, $S - \frac{1}{2} Y$ is always positive, and the percentage variation ranges from 20.2 to 8.7. An apparent explanation of the larger differences is that the material was weaker in shear on some other planes than those on which the pure shear—due to equal axial compressive and hoop tensile stress—fell.

Stress-Strain Curves of some of the Specimens of Group VI.

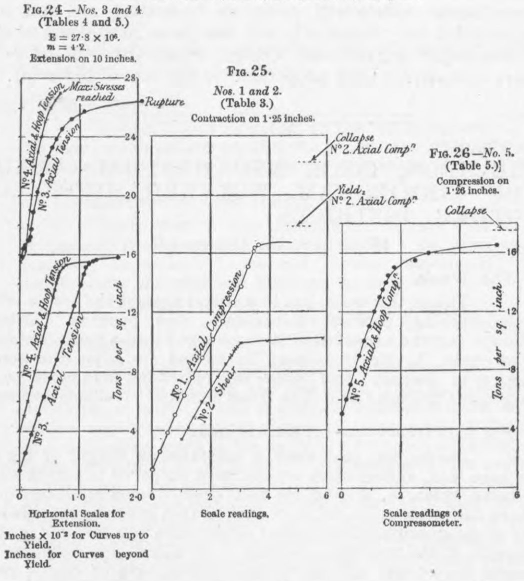


FIG. 24—*Nos. 3 and 4* (Tables 4 and 5.) E = 27·8 × 10⁶. m = 4·2. Extension on 10 inches.

FIG. 25. *Nos. 1 and 2.* (Table 3.) Contraction on 1·25 inches.

FIG. 26—*No. 5.* (Table 5.) Compression on 1·26 inches.

A circumstance that must be mentioned was the existence of a third principal stress, of small amount, in the tests in simultaneous axial and hoop stress, namely, the compressive stress due to the water pressure. This stress varies from an amount equal to the water pressure at the inner surface of the tube to nothing at the outer surface. The hydraulic pressure—and therefore the maximum value of the stress—was, in the case of the 14-G tubes, about 5 per cent., and of the 10-G tubes about 8½ per cent., of the hoop tensile stress.

Tensile tests.—Tables IV. and V. In Table IV. will be found the results of the few tensile tests made, and also comparisons of these with the compression and shear tests. Few tensile tests were made, because the main object of the writer was to obtain checks on other results. It will be seen from Table V. that three tests were made in simultaneous axial and hoop tension of equal amounts, and that the yield stress was practically the same as in simple tension. This is in agreement with the theory that yield occurs by shearing independent of a normal stress. The yield stresses in simple tension and in simple compression do not agree

APPENDIX.

TABLE II.—*Annealed Mild Steel Tubes.*

Comparison of maximum shear stress at yield under simultaneous axial compression and hoop tension with maximum shear stress at yield under simple axial compression. Stresses in tons per square inch.

Tube.				Simultaneous axial compression and hoop tension.				Simple axial compression.									
								Stress at yielding.			Maximum shear stress at yield point.		Stress at collapse.				
Size.	Group.	No of specimen.	Length.	Compressive stress.	Tensile stress.	Maximum shear stress, S.		Y_1.	Y_2.		$=\frac{1}{2} Y_1$.	$=\frac{1}{2} Y_2$.		$S - \frac{1}{2} Y_1$.	$S = \frac{1}{2} Y_2$.	$\frac{S - \frac{1}{2} Y_1}{S} \times 100$.	$\frac{S - \frac{1}{2} Y_2}{S} \times 100$.
			in.														
3in. bore, 14 gauge (about 0·08in.)	I.	1a	3	7.73	7·63	7.68		—	13.72		—	6.86	18.8	—	0·82	—	10.7
		2a	18	8.20	8.10	8.15		†11.30	—		—	—	—	—	0.40	—	4.9
		2b	4	—	—	—		†11.80	15.50		—	7.75	20.1				
		*4	7	8.45	8.38	8.41		15.40	16.35		7.70	8.18	18.9	0.71	0.23	8.4	2.7
		5	7	8.30	8.05	.17		14.50	—		7.25	—	—	0.92	—	11.3	--
	II.	1	7	6.85	7.00	6.93		—	15.00		—	7.50	—	—	-0.57	—	-8.2
		*2	10¼	5.38	5.28	5.33		†8.56 †8.56	11.05		—	5.52	—	—	-0.19	—	-3.5
		3	15	6.78	6.74	6.75		12.5	—		6.25	—	—	0.51	—	7.5	—
		4a	19	5.64	5.56	5.60		†9.1	—		—	—	—	—	-0.52	—	-9 3
		4b	4	—	—	—		—	12.25		—	6.12	18.95				
		*5a	24½	—	—	—		14.02	—		7.01	—	—	0.24	-0.65	3.3	9.0
		5b	7	7.08	7.42	7.25		—	—		—	—	—				
		5c	3	—	—	—		—	15.80		—	7.90	19.30				
		6	4¼	6.30	6.22	6.26	Mean = 622	—	—		—	—	—	—	0.07	—	1.1
		7	4	—	—	—		—	11.03	Mean =12.3	—	—	16.25				
		8	7¼	8.80	4.40	6.60		—	13.60		—	6.15	—				
		9	7¼	3.80	7.80	5.80		—	—		—	—	—				
	IIA.	1a	18	5.28	4.85	5.06		†7.70 †7.82	—		—	—	—	—	-0.46	—	-9.1
		1b	4	—	—	—		—	11.05		—	5.52	17.55				
								$Y_1 = Y_2$.			$\frac{1}{2} Y_1 = \frac{1}{2} Y_2$.						
2¾in. bore, 10 gauge (about 0·127in.)	III.	1	14	8.43	8.52	8.47		16.10			8.05		—	0.42		5.0	
		2	9	8.26	8.30	8.28		16.20			8.10		—	0.18		2.2	
		3	4½	8.58	8.60	8.59		15.60			7.80		—	0.79		9.2	
		4	4½	9.05	9.12	9.08		16.30			8.15		24.80	0.93		10.2	
		*5	9	8.12	8.20	8.16		14.78 14.40			7.39		—	0.77		9.4	
		6	9	8.28	8.53	8.40		15.83			7.91		—	0.49		5.8	
		7	9	10.41 8.55	5.86 8.60	8.13 8.57	Mean =8.35	16.10			8.05		—	0.30		3.6	
		8	8	11.74 8.05	4.81 8.38	8.27 8.21		—			—		—	—		—	
		9	8	11.50	3.82	7.66		—			—		—	—		—	

* Curves are given for these specimens, Figs. 15, 17, 18, 19, and 20. † Flexure commenced (not yield point).

TABLE III.—*Mild Steel Tubes (not Annealed).*

Comparison of maximum shear stress at yield under simultaneous axial compression and hoop tension with maximum shear stress at yield under simple axial compression. Stresses in tons per square inch.

Tube.				Simultaneous axial compression and hoop tension.				Simple axial compression.									
								Stress at yielding.			Maximum shear stress at yield point.						
Size.	Group.	No. of specimen.	Length.	Compressive stress.	Tensile stress.	Maximum shear stress, S.		Y_1.	Y_2.		$=\frac{1}{2} Y_1$	$=\frac{1}{2} Y_2$.		Stress at collapse.	$S - \frac{1}{2} Y_1$.	$S - \frac{1}{2} Y_2$.	$\frac{S - \frac{1}{2} Y_1}{S} \times 100$.	$\frac{S - \frac{1}{2} Y_2}{S} \times 100$.
			in.															
3in. bore, 14 gauge (0.08in.)	IV.	1	3	10.6	10.6	10.6	Mean =10.53	—	—		—	—		—	—	1.67	—	15.9
		2	4	10.7	10.7	10.7		—	—		—	—		—				
		3a	15	10.3	10.3	10.3		—	—		—	—		—				
		3b	4	—	—	—		—	19.1	Mean =17.72	—	9.55	Mean = 8.86	23.0				
		4	2	—	—	—		—	17.3		—	8.65		22.8				
		5	3	—	—	—		—	16.75		—	8.37		22.0				
	V.	1	3	11.05	11.05	11.05	Mean =11.13	—	—		—	—		—	1.51	1.08	13.6	9.7
		2	6	11.25	11.25	11.25		—	—		—	—		—				
		*3a	19	11.10	11.10	11.10		—	—		—	—		—				
		3b	4	—	—	—		—	20.5	Mean = 20·5	—	10.25	Mean =10.25	—				
		4	4	—	—	—		†14.7	—		—	—		—				
		5	4	—	—	—		†16.1	—		—	—		22.1				
		*6a	19	—	—	—		19.25	—		9.62	—		—				
		6b	4	—	—	—		—	20.5		—	10.25		23.0				
	VI.	*1	5½	—	—	—		16.7	—		8.35	—		—	1.45	0.85	14.8	8.7
		*2	6	9.8	9.8	9.80		—	17.9		—	8.95		22.0				
	VII.	1	7	12.7	12.7	12.70	Mean =12.65	—	21.8	Mean = 22.5	—	10.09	Mean =11.25	—	—	1.40	—	11.1
		2	7	12.6	12.6	12.60		—	23.2		—	11.6		—				
								$Y_1 = Y_2$			$\frac{1}{2} Y_1 = \frac{1}{2} Y_2$							
2⅜in. bore, 10 gauge (0.128in.)	VIII.	1	9	10.25	10.28	10.26		16.38 16.00			8.19			—	2.07		20.2	
		2	9	9.80	9.70	9.75		16.10			8.05			—	1.70		17.5	

* Curves are given for these specimens, Figs. 22 and 25. † Flexure commenced, not yield stress.

TABLE IV.—*Results of Tests in Axial Tension and in Axial Compression Compared with Results of Tests in Simultaneous Axial Compression and Hoop Tension.*

Stress in tons per square inch.

				Data from tests.															
				Compression.				Tension.											
				Yield stress.				Yield stress.											
Size of tube.	Group.	No. of tube.	Length.	Y_1.	Y_2.	Stress at collapse.	Simultaneous and equal axial compression and hoop tension. Maximum shear stress = S.	Y_1^1.	Y_2^1.	Stress at rupture.	Maximum shear at $Y_1 = \frac{1}{2} Y_1$.	Maximum shear at $Y_2 = \frac{1}{2} Y_2$.	$\frac{S - \frac{1}{2} Y_1}{S} \times 100$.	$\frac{S - \frac{1}{2} Y_2}{S} \times 100$.	Maximum shear at $Y_1^1 = \frac{1}{2} Y_1^1$.	Maximum shear at $Y_2^1 = \frac{1}{2} Y_2^1$.	$\frac{S - \frac{1}{2} Y_1^1}{S} \times 100$.	$\frac{S - \frac{1}{2} Y_2^1}{S} \times 100$.	Remarks.
			in.																
3in. bore, 14 gauge (about 0.08in.	I.	1a	3	—	13.72	18.8	7.60	—	—	—	—	6.86	—	9.7	—	—	—	—	Cut from same annealed tube
		*1b	20	—	—	—	—	11·85	12.85	22.6	—	—	—	—	5.93	6.42	22.0	15.5	
	IV.	3a	15	—	—	—	10.31	—	—	—	—	—	—	—	—	—	—	—	Cut from same tube. Not annealed
		3b	4	—	19.1	23.0	—	—	—	—	—	9.55	—	7.4	—	—	—	—	
		6	20	—	—	—	—	—	17.3	25.8	—	—	—	—	—	8.65	—	16.1	
	V.	*6a	19	19.25	—	—	11.13	—	—	—	9.62	—	13.6	—	—	—	—	—	Do. Do.
		6b	4	—	20.5	23.0	—	—	—	—	—	10.25	—	7.9	—	—	—	—	
		*7	21	—	—	—	—	16.0	17.0	26.6	—	—	—	—	8.00	8.50	28.1	23.6	
	VI.	*1	5½	16·7	—	—	—	—	—	—	8.35	—	14.6	—	—	—	—	—	Do. Do.
		*2	6	—	17.9	22.2	9.78	—	—	—	—	8.95	—	8.5	—	—	—	—	
		*3	21	—	—	—	—	15.7	16.6	26.47	—	—	—	—	7.85	8.30	19.7	15.1	

* Curves are given for these specimens, Figs. 14, 21, 22, 24, and 25.

well, especially—as might perhaps be expected—for the tubes tested without further annealing, the yield stress in compression being considerably higher than the corresponding ones in tension. The percentage difference $\left(\frac{S - \frac{1}{2} Y'_2}{S} \times 100\right)$ varies from 15 to 23½ per cent. Two similar specimens, one tested in simple tension and the other in simple compression, are stressed equally and similarly on all corresponding plans, except that the stresses in the one case are in the reverse direction to those in the other case. Hence, if the resistance to shearing is independent of the sign of the normal stress, the yield stresses should be equal in magnitude in the two cases.* But three of the tubes tested in tension were not annealed, and it may be that the resistance to shear of the metal was not merely different in various directions, but was also not the same on any one plane against stresses of opposite sign.

Tests given in Table V.—Figs. 11, 12 and 13. So far as the author is aware no series of tests such as given in Table V. have been made previously.

All the tests in a set were on specimens cut from the same piece of tubing; those of one of the sets being annealed together. Where possible the tests were carried up to rupture or collapse of the material. The tests in equal axial and hoop tension could not be carried to rupture on account of leakage of water past the cup-leathers, which ceased to act owing to the increase of diameter of the tubes. The tests in equal axial and hoop compression show almost as high values for the yield and collapse loads as in simple compression. This might possibly be due to the lateral support of the tube by the frictional gripping of the ends, but it may be remarked that there appeared to be little such support afforded to the specimens in compression and internal water pressure—see Table I. Fig. 10 shows a tube which has been tested to collapse in equal hoop and axial compression.

Conclusion.—The experiments show an approximate agreement between the maximum shear stress at the yield point in compression and the yield-point stress in pure shear, the mean difference in the tests of annealed specimens being about 3 per cent. It appears, then, that mild steel in direct compression yields by shearing; and, to a first approximation that the value of this shear stress is independent of any normal compressive stress on the planes of the slide.

TABLE V.—*Results of Tests in Tension, Compression, and Combined Stress, which are Plotted in Diagrams Figs.* 11, 12, *and* 13.

Stresses in tons per square inch.

Size of tube.	Group.	No. of tube.	Length.	Axial tension.			Axial tension = hoop tension.			Shear.	Axial compression.			Axial compression = hoop tension.		Remarks.
				Yield stress.		Stress at rupture.	Yield stress.		Maximum stress attained.	Axial Compression = hoop tension.	Yield stress.		Stress at collapse.	Stress.		
				Y₁.	Y₂.		Y₁.	Y₂.			Y₁.	Y₂.		Yield Y₁.	Collapse.	
3in. bore, 14 gauge (0.08in.)	V.	*6a	19	—	—	—	—	—	—	—	19.25	—	—	—	—	Cut from same piece of tube. Not annealed
		6b	4	—	—	—	—	—	—	11.13	—	20.5	23.0	—	—	
		*7	21	16.0	17.0	26.6	—	—	—	—	—	—	—	—	—	
		*8	21	—	—	—	15.0	—	21.0	—	—	—	—	—	—	
		*9	4	—	—	—	—	—	—	—	—	—	—	18.0	20.0	
	VI.	*1	5½	—	—	—	—	—	—	—	16.7	—	—	—	—	Cut from same piece of tube. Not annealed
		*2	6	—	—	—	—	—	—	9.78	—	17.9	22.2	—	—	
		*3	21	15.7	16.6	26.47	—	—	—	—	—	—	—	—	—	
		*4	21	—	—	—	15.4	15.8	27.0	—	—	—	—	—	—	
		*5	4	—	—	—	—	—	—	—	—	—	—	16·0	17.5	
	I.	1a	3	—	—	—	—	—	—	7.60	—	13.72	18.8	—	—	Cut from same piece of tube. Annealed
		*1b	21	11.85	12.83	22.6	12.0	—	—	—	—	—	—	—	—	
		*3	4	—	—	—	—	—	—	—	—	—	—	15.5	16.60	

* Curves are given for these specimens, Figs. 14, 16, 21, 22, 23, 24, 25, and 26.

The author is much indebted to Professor W. H. Watkinson for affording facilities for carrying out the research in the Walker Engineering Laboratory of the University of Liverpool, and for encouragement in the prosecution of it. Also he wishes to thank those students, especially Messrs. J. R. Beaumont, A. Vas Gomes, H. J. F. Gourley, C. H. Jennings, H. A. T. Smith, and G. E Pym, who very efficiently helped him to make the apparatus and carry out the tests. He is also much indebted to Mr. W. Donaldson, the Chief Instructor in the Laboratory, for his assistance and valuable suggestions.

LETTERS TO THE EDITOR.

(*We do not hold ourselves responsible for the opinions of our correspondents.*)

FERRY STEAMERS.

Sir,—We notice in last week's Engineer, page 645, an illustration and descriptive matter of the double-ended ferry steamer Guanabacoa, and it is there stated that she is the first vessel of her type built in England. We would, however, refer you to your issue of 20th May, 1898, wherein you fully described and illustrated a similar steamer, the Chebucto, built by the late Sir John Shearer and engined by us. This vessel was tried on 12th August, 1897, and was thereafter boarded up and steamed to her destination at Nova Scotia, where she has continued regularly at work ever since.

When readers abroad see the reference made to England, of course they at once accept this in the larger sense as embracing Scotland, and it is to prevent any error or misunderstanding in this connection that we have drawn your attention to the matter.

The Chebucto had a very smart appearance, and was very much admired on the Clyde. McKie and Baxter.

Copland Works, Govan, Glasgow, December 20th.

COMPOUND LOCOMOTIVES.

Sir,—I have read with great interest the article on compound locomotives by Mr. R. M. Deeley, and also your very able editorial on the same subject.

I was surprised, however, to find that neither Mr. Deeley nor yourself made any reference to the latest type of Midland express engine, No. 999, and her sisters. No. 999 has, of course, the same high-pressure boiler as the compounds, but is fitted with two simple cylinders, 19in. by 26in.; driving wheels, 6ft. 6½in. in diameter; and Mr. Deeley's valve gear.

I am sure that it would be of great interest to readers of The Engineer if Mr. Deeley would inform us why, after building forty-five perfectly successful compound engines, he reverted to the simple type; also whether any comparative trials have taken place between the compounds and the 999 class, and, if so, with what results. Obviously a much better idea of the value of compounding can be obtained from a comparison between the 999 class and the compounds than between the 700 class and the compounds.

I do not think there is much mystery about the non-success of the Webb three-cylinder compounds. The engines were a failure because they had no coupling-rods. The high and low-pressure cylinders were rarely running in synchronism. This accounts for the curious "unevenness" of their performances. Sometimes they ran very well indeed, and at other times very badly. Having no coupling-rods, there was nothing to ensure that the high and low-pressure cranks were in their proper relative positions. Harold Smith.

Bradford, December 20th.

THE INSTITUTION OF CIVIL ENGINEERS.

RAILWAY SIGNALLING IN INDIA.

At the ordinary meeting on Tuesday, the 14th December, Mr. James Charles Inglis, President, in the chair, the paper read was "Railway-Signalling in India," by Mr. C. W. Hodson, C S I., M. Inst. C.E. The following is an abstract of the paper:—The author has divided his subject into three parts: signals, interlocking, and block working. In the first part he has given a brief account of the arrangements of signalling which were adopted in the early days of the Indian railways, and how these have been gradually modified from time to time; and he details the latest development, *i.e*, the introduction of the "warning signal," with an extra green light fixed above the ordinary light of a fish-tailed signal, in order to give an indication by night which has the same significance as the fish-tailed arm has by day. This indication consists, therefore, of a "green over red" light, and signifies "pass cautiously, and be prepared to stop short of the signal ahead." It has been in use for more than six years on several Indian railways, and has been found very satisfactory; and the author suggests that it might with advantage be adopted for use on English railways, in order to do away with the anomaly of the present distant signal, and to abolish the dangerous rule known as "section clear, station or junction blocked." In the second part a brief description is given of various installations which have been put up for interlocking the points and signals at simple roadside stations, mostly designed and made up in India, and the author points out the economy of such gear in comparison with installations supplied by English manufacturers. He expresses the opinion that the objections raised to "key-locking" in some quarters are much over-rated, and points out the economy obtainable by it. In the third part the author describes briefly the "Line clear and caution message" system, which is so widely used in India, in spite of certain serious defects, which he points out. These defects have been largely removed by a drastic revision of the General Rules for Working Railways in India, which was undertaken by a strong committee of official representatives of the principal railways in their various departments, assembled at Simla in September, 1903.

The Harris Level.—We have received from Merryweather and Sons, Limited, Greenwich, a small pocket instrument, the invention of Mr. G. W. Harris, A.M. Inst. C.E This tool is intended for a variety of purposes, providing various scales for measuring lengths and angles, while an adjustment converts it into what is intended to be an elementary form of theodolite clinometer or level. Its inventor claims for it a wide range of usefulness, and believes that engineers, architects, plumbers, surveyors, and many others will benefit by its use.

How to Learn the Morse Alphabet.—For those desirous of learning the Morse code, the little diagram invented by Mr. C. O. Grimshaw, 57, St. George's-square, S.W., should prove useful. The method of learning is a mnemonical one, the signal for each letter being shown on the chart associated with that letter in a peculiar and easily remembered fashion, so that a mental picture of each is readily formed by the beginner. Copies of this ingenious chart may be obtained from Lake, Sison and Brown, Limited, Victoria-street, S.W.

The Areameter.—We have received from Mr. A. E. Mallandain, 51, Cheapside, London, E.C., a sample set of a new instrument, to which the above name has been given, and intended for finding the areas of figures. The instrument consists of a celluloid T-shaped lamina. The vertical tail of the tee is not, however, straight, being bound on either side by hyperbolæ extending from its foot to either tip of the horizontal arm. At the junction of the horizontal and vertical axes of the figure thus formed, a small V shape is cut, intended for the reception of a pin, about which the instrument can rotate. The method of finding the area of a figure bounded by a continuous line is as follows:—The pivot being placed somewhere near the centre of the figure, the instrument is rotated about it into consecutive positions, the points where the hyperbolic sides cut the periphery of the figure being marked with a pencil or other means, and the instrument moved on right round the figure. Joining the points thus marked on the boundary with the centre we would divide the figure into a number of triangles, which, by the construction of the instrument, must have equal areas. The form has been so chosen that each of these triangles shall have an area of one square inch, so that we need only count the number of ticks made on the boundary line to obtain the area in square inches. A proportional scale engraved on the celluloid enables fractional parts of one square inch to be measured. The instrument can also be used by sliding it along a straight base, and for this purpose a smaller but a similar lamina is provided, which, if used in the manner of the larger, would divide the area into ½ square inches.

SHIPBUILDING NOTES.

The death of Sir Alfred Jones has removed one who exerted a very real influence on shipbuilding. The man who controlled the Elder Dempster Line and its affiliated companies was an important man in the eyes of the shipbuilder. Sir Alfred Jones believed in up-to-date ships, and, while no unnecessary money was spent upon them, they were in every way sound practical jobs, admirably adapted for those particular trades which he himself had created. As many builders know, he was a most accessible man, and we are sure that in technical circles the regret inspired by his death will be as real as in those with which he was more intimately acquainted.

On Wednesday last the Waratah was posted at Lloyd's. That event, coupled with the return of the Sabine to Capetown, removes the last doubt as to the fate of that unlucky ship. The Waratah was built in 1908 by Messrs. Barclay, Curle and Co. for the Blue Anchor Line. She was a modern vessel of dimensions 465ft. by 59.4ft. by 38ft., having a poop bridge and forecastle of considerable length, the passengers being carried in two erections upon the bridge deck. It is idle to speculate on the cause of the disaster, but there could be no possible question of structural weakness, and there also could be little possibility of defect of stability in a vessel of this type under any but very abnormal conditions.

While that may be safely said in this particular case, it may be pointed out that the practice of fitting long erections on the structural deck, intended for the accommodation of passengers, is a growing practice, and one to which, in the nature of things, there must be a limit. No doubt the increasing attention now being paid to passenger accommodation, and the increasing demands made upon the designer in this respect, are responsible for it. Rooms are larger, and are more of the single berth type, and are placed in more eligible positions, from the point of view of the occupier, than ever before. But two results follow, and, as a matter of fact, have been observed in several cases. First, the ships are top-heavy, and depend for safety largely on the extent of side out of the water, which in passenger vessels is, of course, considerable. Secondly, these erections are subject to considerable straining action themselves, and they also impose stresses of no negligible magnitude on the rigid structure upon which they are built. The natural consequence of this is a constant necessity for repairs of damage, which may not, indeed, be serious, but which inevitably are expensive.

A very interesting launch took place from the Wallsend Yard of Swan, Hunter and Wigham Richardson and Co., Ltd., on Monday, 13th inst., when the first of two steamers which that company is building for the Grand Trunk Pacific Railway Company was placed in the water. The Prince Rupert—with her sister vessel—is intended for a special service between Prince Rupert and Tacoma, and is 320ft. long overall by 42ft. 3in. by 18ft. to main deck. The vessel is designed for a service speed of 18 knots, and the accommodation provided for passengers is of the most modern description. These vessels are interesting as marking the beginnings of a new expansion of the trade possibilities of the North-West.

A question very prominently claiming the attention of those connected with ship design is the proposals now being made in various quarters, substantially to increase the frame spacing in ordinary merchant ships. Some time ago Mr. Wortley, of Messrs. Holt, read a paper before the Institution giving the details of his firm's practice in this respect. Messrs. Holt have been the pioneers in this matter as in several others which could be mentioned. If we remember aright, in their vessels the spacing of frames was 36in., associated with thick shell plating and a multiplicity, or what would now be considered so, of side stringers. As before stated, there are several practicable proposals now being put forward in this direction, and it is very probable that the tendency to space frames widely will prove an increasing one, and must be provided for. Especially will this be so in the case of ships of somewhat complicated design, where the cost of labour bears a relatively high proportion to the cost of material.

THE IRON, COAL, AND GENERAL TRADES OF BIRMINGHAM, WOLVERHAMPTON, AND OTHER DISTRICTS.

(*From our own Correspondent.*)

The Week.

Trade this week has to contend against the treble effects of stocktaking, political disturbance, and pending Christmas holidays, but the expectation is encouraged that a brisk business—at any rate, in pig iron—may be looked for after the general election in January, and when the retarding influences to the market of Christmas and New Year holidays have been overcome.

Pig Iron Improvement Maintained.

During the past week a considerable weight of pig iron has been sold, and smelters are not now prepared to accept all the business which is offering for next year. Some producers quote future deliveries up 1s. to 2s. per ton, but it is clear that this is by way of safeguarding their output rather than as a real gauge of the strength of the market. Buyers, it is noted, are indisposed at present to concede any more for supplies, save in special cases, which have no great significance. A fair tonnage has been sold for next quarter, and, having regard to the costs of production and the possibilities of trade development early in 1910, smelters have no choice but to assume an attitude of caution. The production of pig iron in South Staffordshire has been curtailed since the winter came in, owing to accumulation of stocks, and this curtailment is now strengthening the market. The leading producers are well sold, and are in no anxiety as to business for next year. South Staffordshire common forge iron this week realises 45s. to 46s.; part-mine, 48s. to 49s.; best all-mine, 85s.; and cold-blast, 115s. Some Northamptonshire houses are asking an advance, but buyers are irresponsive. Values generally are firmer, on the basis of about 48s. for ordinary Northampton grades of forge pigs, while Derbyshire iron is offered at 49s., and the quotation for North Staffordshire forge iron is 50s. and upwards.

Merchant Iron.

There is not much recovery to be noted in the bar iron trade. Prices have fallen to such an unremunerative level as regards South Staffordshire common bars that some ironmasters are leaving the trade alone until the conditions become more propitious. Nut and hurdle bars are still quoted as low as £5 12s. 6d., and, as was plainly intimated in last week's report, producers declare that they cannot be turned out at the price. Marked bars are selling more steadily on the £8 basis. There is a regular current of demand for North Staffordshire "crown" bars, but it is only of sufficient volume to keep the mills going about three-quarter time. The rate remains at £6 10s., delivered at ports for the export trade. Gas tube strip iron is still quoted at the standard of £6 5s. and £6 7s. 6d., less 2½ per cent., while hoop iron is £6 15s., rivet iron £6 15s. to £7, and rail rods £7 per ton.

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* The Report of the Steel Committee of Civil Engineers, 1870, shows very close agreement between the yield stress in tension and compression of steel and wrought iron bars. Mr. L. B. Turner has recently published some tests on annealed tubing in simple pull and simple torque. The mean difference of the shear stress at yield point between the two kinds of tests is about 3 per cent.

Boom in Galvanised Iron.

There is quite a boom in the galvanised iron trade. The orders for galvanised sheets on foreign account show an increasing tendency, and it is practically certain that the December returns will show a further large improvement in shipments. All the sheet mills are working at high pressure. Demand is so active that it is said to be in contemplation to restart at an early date South Staffordshire black sheet mills, which have been lying idle for six months past. The galvanisers have their hands full, the quotation for 24 gauge corrugated sheets being £11 to £11 5s., f.o.b. Liverpool. Black sheets are firm at £7 2s. 6d. to £7 5s. for doubles, and £7 15s. to £7 17s. 6d. for trebles, with £7 to £7 2s. 6d. as the figure for singles.

Steel Better.

The steel trade, alike in billets and half-product bars and sections, is in rather better condition, and sellers will not book so far forward as buyers would very much like. Native Bessemer billets rule firm at £4 15s. delivered in Birmingham, and Siemens qualities £4 15s. to £4 17s. 6d. per ton. There is some talk of raising prices. But, so far, there has been no decision except with regard to certain special qualities not very widely used, which have been put up 5s. a ton.

NOTES FROM LANCASHIRE.

(*From our own Correspondent.*)

Manchester, Thursday.

Pig Iron.

The year just closing has been unsatisfactory to almost all traders. The advance in fuel prices is, however, causing makers to quote higher prices, but, as usual, there is much uncertainty whether the full advance will be realised, as buyers still operate sparingly and for present wants. We may summarise the course of prices in this district as follows:—Lincolnshire No. 3 foundry opened at 53s. to 53s. 6d.; the lowest price registered was in March, 49s. 6d. to 50s. A gradual improvement took place, and in August the figure was 54s. 6d. to 55s; September, 56s.; November, 55s., and closing at 53s. Staffordshire, 52s.; closing price, 53s. Middlesbrough open brands, 57s. 7d. to 57s. 10d., which, with slight variations, was maintained to the end of July. At the end of September it was 61s. 4d. to 61s. 7d., and closed for early delivery at 59s. 7d. to 59s. 10d. In Scotch pig iron Gartsherrie has been variable, ranging from 57s. up to 63s., and closing at 59s. Glengarnock opened at 59s. 6d., closing at 60s.; Eglinton, at 57s. 6d., closing at 59s. 6d. West Coast hematite has ranged between 58s. 6d. to 63s. 6d., closing at 61s. to 61s. 6d., with a premium of 2s. 6d. per ton more asked for next year's delivery. East Coast hematite opened at 57s., closing at 60s. 6d., both f.o.t.

Finished Iron.

Lancashire bars, hoops, and sheets have experienced little change.

Steel.

This remark applies to steel generally. There has been no particular fluctuation to note, except that there is an upward tendency at the close for English billets, which have been well held at from £4 10s. to £4 15s. per ton, and foreign billets are now practically off the market.

Copper.

There has been a very quiet feeling to report in this particular department, and the close is somewhat dull. Sheets opened at £76, declining to £70, the worst figure being £74 per ton in January and November. The close was about £1 per ton lower. Tough ingot and best selected have advanced or receded on about the same lines as sheets; the opening was £62 and the close £63 per ton. Tubes have been rather variable, the lowest being 8¾d. and the highest 9d.; brass tubes and condenser close about ½d. lower; rolled brass, brass wire, and brass turning rods show little change. Yellow metal a shade easier.

Sheet Lead.

Has been fairly steady throughout, ranging from £16 to £17 per ton.

Tin.

English ingots have had an upward movement all through the year; commencing at £128 10s., they have gradually advanced with few exceptions to £147 10s. per ton at the close.

The Lancashire Coal Trade.

There was a fair attendance on the Coal Exchange. Household fuel was firm, but there was no advance, as was generally expected. Steam and furnace coal steady. Shipping coal brought about 3d. per ton more money.

Barrow-in-Furness, Thursday.

Hematites.

There is a further improvement to note in the hematite iron trade of the district, and there is a fuller inquiry for forward deliveries of metal. The position of makers is more satisfactory alike as regards the amount of business being done and the prospects of a still better trade in the early future. Consumers are showing more disposition to cover their requirements in the early months of next year, and this is some proof of the opinion that markets are going up, and that it is better to buy at present prices than wait until a better demand arises, with a consequent increase in prices. Several makers are, however, so well assured of the future of the trade that they are hesitating about doing much forward business, and will only make transactions at fully 1s. per ton higher. Makers are asking 63s. 6d. net f.o.b. for mixed Bessemer numbers, and warrant iron sellers are at 61s. 6d. net cash, buyers 6d. less; three months 63s. 4½d. buyers, 63s. 4½d. sellers. The business in special qualities of hematite shows an improvement, and makers believe there will be a much more active demand before long. Ferro-manganese and spiegeleisen are in steady request. There is a fair trade in charcoal iron. Iron ore is in rather better request, and prices are at 12s., 14s. 6d., and 18s., net f.o.b. for ordinary, medium, and best descriptions net at mines.

Steel.

There is a much better market in the steel trades. A brisker inquiry has arisen for shipbuilding material, but whether this will act as an influence to bring the plate mills, so long idle, into operation remains to be seen. There is a better inquiry for rails and for merchant classes, but not much is being done in foundry steel.

Shipbuilding and Engineering.

Vickers, Sons and Maxim have been entrusted with the order to build a new battleship cruiser for the Admiralty—one of the four contingent Dreadnoughts. This order is all the more important because a few weeks ago the Vickers firm obtained the order to build the engines for a sister ship - the Lion—which has just been laid down at Devonport. These two orders, with other orders for Government mountings, will represent more than three millions of money.

Shipping and Coal.

The shipping trade is only moderately employed, but the exports show an increase of over 100,000 tons as compared with the corresponding period of last year. Coal and coke are steadier, with a disposition to increased firmness.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

The Holidays.

The holiday feeling has been evident for some time in regard to business. In the coalfield the miners will cease work on Friday, the 24th inst., and it is not expected that the stoppage will last beyond the following Thursday. At the East End establishments, where the heavy trades are carried on, the holidays will generally extend from Friday evening until Monday, the 3rd January. Christmas falling on a Saturday is looked upon favourably in industrial quarters, as it allows continuous holidays for the time. The cessation of labour is largely taken advantage of for repairs and alterations, as well as, in a considerable number of instances, for stock-taking purposes.

House Coal—Official Advance.

The severe weather which set in suddenly on Sunday has had the usual effect of stiffening the rates in household fuel. It was announced on Monday that the collieries had raised the price 1s. per ton, the advance to take effect the following day. This is the official confirmation of the increased price which has been unofficially obtained for some time. It leaves our quotations of last week unchanged, as they were brought up to the current rate of business. Best Barnsley, 12s. 6d. to 14s. per ton; secondary sorts, from 10s. 6d. to 11s. 6d. per ton. There has been a considerable pressure on the house coal pits in view of the Christmas holidays, and this is being accentuated by the stormy weather. The requirements of London and the Southern and Eastern Counties markets are fairly heavy, chiefly for the better grades. The local demand is also active.

Steam Coal—Railway Contracts.

Interest in the steam coal trade centres in the question of the renewal of locomotive contracts. The railway companies offer an advance of 6d. per ton on last year's prices, and the coalowners stand out for an advance of 9d. per ton. Nothing further has been done in bridging the difference, and, as we have already stated, the railways are still receiving pretty heavy deliveries under existing contracts. They are also picking up "spot lots" to a considerable extent. There has been increased buying for works, with a view to tide over the holidays. The demand for hard coal for shipment is well maintained, and helping somewhat towards the present firm tone in what is regarded as the slackest period of the year.

Gas and Small Coal.

The gas companies and Corporation gas departments have been receiving rather heavier deliveries of late. This feature, however, is usual at the present season. Some business is reported in "spot lots," mainly for foreign markets. The gas contracts are made at midsummer, and the arrangements then come to represented a general reduction of 6d. per ton on last year's price. Small coal continues a good market, as it has been doing most of the year. The activity at present is, of course, largely due to holiday requirements. The best qualities of small coal are in principal request. The chief trade in the higher grades is with Lancashire and Yorkshire textile districts, the qualities for which have not altered in price for a long time, ranging from 4s. 6d. to 5s. 6d. per ton.

Coke.

Furnace coke maintains the firmer tone noted last week. Coke, with little exception, has been rising steadily during the greater part of the year, beginning in January at 10s. per ton for best washed, and 9s. to 9s. 6d. per ton for unwashed, and finishing in December at 12s. 6d. to 13s. per ton for best washed, and 11s. 6d. to 12s. per ton for unwashed.

Pig Iron.

Deliveries have been fairly good of late, but now the holiday feeling is apparent, and very little more will be done this side of 1910. A firmer tone is prevalent, and better business, with improved values, is confidently looked for early in the New Year. Makers of Lincolnshire and Derbyshire irons have not been eager to press sales for some time, as they anticipate increased prices later on, and, in addition, are sold well forward. Current quotations, all net and delivered in Sheffield and Rotherham, are as follows:—Hematite: West Coast, 68s. to 70s. per ton; East Coast, 65s. to 67s. per ton. Lincolnshire: No. 3 foundry, 52s. 6d. per ton; No. 4 foundry, 51s. 6d. per ton; No. 4 forge, 51s. 6d. per ton; No. 5 forge, mottled and white, 51s. 6d. per ton; basic, 52s. 6d. per ton. Derbyshire: No. 3 foundry, 52s. per ton; No. 4 forge, 50s. 6d. per ton.

Bars, Hoops, and Sheets.

Languor still pervades the finished iron trade and its allied branches. Bar iron is exceptionally depressed. Quotations: Bars, £6 10s. per ton; hoops, £7 10s. per ton; sheets, £8 10s. per ton.

Steel, &c.

Fresh orders of consequence in steel are not looked for to any extent towards the close of the year. It is evident, however, that a more hopeful feeling is prevalent with regard to next year's prospects. More inquiries are reported, and with the disturbing factors of electioneering out of the way, it is expected the market may pick up. The home market is at present the most disappointing, and is not likely to greatly improve until shipbuilding yards and engineering establishments experience a general revival. There are reports of more activity in both directions, but the improvement has not been pronounced enough to influence the demand for marine specialities to any considerable extent. High-speed steel and tool steel generally have been steadily in request for the United States, the Colonies, and several of the continental markets. The file trade is still quiet, as it has been for most of the year. Some fair orders for machinery for use in steel works are reported to have been received for Japan.

NORTH OF ENGLAND.

(*From our own Correspondent.*)

Cleveland Pig Iron.

Rather to the surprise and satisfaction of most traders there has been a strong improvement in demand for and prices of Cleveland pig iron, and indeed all kinds of pig iron within the last ten days. Generally people did not expect any change till after the elections, as they and the holidays might be counted upon to check business. But when least looked for there has sprung up a brisk business both on prompt and forward account, and the market at the time of writing is active and buoyant. Naturally traders are sanguine, seeing that the improvement should set in at such a time as this, and they are very hopeful that something better than the present year's trade will be experienced in 1910. The indications certainly are now favourable to better prices and brisker demands, especially as the situation has improved so much in the steel trade and at the foundries. It must be acknowledged that the revival of business has not been so marked in Cleveland pig iron as it is in hematite iron, and whereas the prices of the latter have risen half a crown in about a week, those of Cleveland iron have only advanced 1s. per ton. No. 3 Cleveland pig iron on Tuesday last week was being sold at 50s. 3d. per ton for early f.o.b. delivery, but now 51s. 3d. must be paid, with 1s. more for delivery over the first quarter of 1910. Cleveland warrants have risen from 50s. 1d. cash buyers to 51s. 3½d. this week, some advance being reported every day. No. 1 Cleveland G.M.B. is now at 53s. 6d.; No. 4 foundry at 49s. 9d.; No. 4 forge at 49s. 6d.; and mottled and white at 49s., all for prompt delivery, with 1s. per ton more for delivery up to the close of next quarter. United States consumers and merchants have begun again to inquire for Cleveland iron, but it cannot be reported that any actual business has resulted. Some Canadian orders have, however, been booked this week, and more are in course of negotiation. Canada has lately bought a good deal of pig iron from Teesside—hematite as well as ordinary Cleveland brands.

Hematite Pig Iron.

After long waiting, there is at last a somewhat lively state of business, though this is hardly a favourable time for a revival. However, the activity in the steel industry and the increased demands of all other works which consume hematite pig iron, together with the very pronounced improvement in the shipbuilding trade, have had a good influence, and brought about the opinion of buyers that the time has fully arrived when they ought to buy as freely as possible for delivery ahead, and that the longer they wait the more they are likely to have to pay for what they will need. Consumers generally have been in the market during the last ten days, more particularly Sheffield firms, but they find producers more independent than they have been for a long time, for their position is much better than it has been for nearly three years, and they have fair orders already on their books for execution over the first half of next year. Demand having become more pressing, and the cost of production being increased and likely to increase still further, there has been a smart advance in prices of hematite this week. Representatives of some of the leading Sheffield steel manufacturing firms were last week on Teesside, but it is reported that the negotiations for buying them mostly fell through, in the first place, because the makers of the hematite iron were not prepared to tie their hands with respect to deliveries in the second half of the year, and that was the period for which the consumers chiefly wanted to buy. More than that, the consumers were not prepared to pay a high enough premium over the prompt rate to tempt the producers. When they offered for the second half of the year only as much as was being quoted for delivery in the first two months, the negotiations were not likely to lead to business. Good orders have this week been booked by Teesside firms from Sheffield and elsewhere for execution over the first half of the year. The makers appear already to be tolerably well supplied with orders for execution in the first quarter of the year, and some over the second quarter also, and it was hardly likely that selling prices would fail to move upwards with almost everything favourable to advances. In the early part of last week consumers could get mixed numbers of East Coast hematite pig iron for early delivery at 60s. per ton, a figure which had been ruling for several weeks, but makers put up their quotations to 60s. 6d. before the close of the week, and this week to 61s., then to 61s. 6d., and on Tuesday to 62s. 6d. for prompt and January delivery, and for beyond that till the end of the quarter 65s. is asked and paid.

Ore and Coke.

For a considerable time there has been no business in Rubio ore, and the merchants would not quote for delivery next year, as they could not induce the Spanish mineowners to name prices for 1910, and they are the masters of the situation now. For several weeks 17s. 6d. per ton for Rubio ore delivered c.i.f. Middlesbrough was the nominal rate for early delivery, but this week sellers have rather surprised consumers by quoting 19s. per ton for prompt delivery, and 19s. 6d. for delivery over the first half of next year; in fact, 19s. 3d. has been paid for over the latter period, and some merchants ask even 20s. There is keen competition to secure supplies of Rubio ore, for it is wanted not only by British users, but also by German and United States. Coke is increasing in price, because the supply is hardly equal to the demand; the manufacturers, indeed, take care that it is not, and keep a considerable number of ovens out. They are the more inclined to do that as some of them say they can sell the coal with more advantage and profit to themselves as coal than if they convert it into coke. The price of ordinary furnace coke for early delivery at Middlesbrough is fully 18s. per ton—the best price of the year, and 4s. per ton better than the minimum. Coke is in better request on export account, so that the tendency is towards higher prices.

Shipments of Pig Iron.

The shipments of pig iron from the Cleveland district have improved, especially on foreign account, but it is certain they will fall off next week, it being generally a holiday period. Exports are reported to the United States, but it is in completion of orders which were secured in the early autumn. American consumers are not buying now; indeed, they are not even inquiring, but there are inquiries from Canada, which it is expected will result in business, though the shipments will not be made until the spring.

Manufactured Iron and Steel.

It cannot be said that there is any improvement in the finished iron trade, but the situation is undoubtedly better in the steel industry; works are more regularly employed than they have been for fully two years, and the tendency of prices is upwards. The makers of steel angles have advanced their quotations 5s. per ton—the first change there has been in their prices for months—and they now ask £5 12s. 6d. for ship angles. For iron ship angles the quotation is £7; for steel and iron ship plates, £6; for steel bars, £6; for iron bars, £7; for steel hoops, £6 5s.; for steel strip, £6 2s. 6d.; for steel sheets (singles), £7 5s.; for iron ship rivets, £7 5s., all less 2½ per cent. f.o.t. Galvanised and corrugated steel sheets are at £11 5s. per ton, less 4 per cent. for 24 gauge in bundles and f.o.b. Heavy steel rails are at £5 5s. per ton net f.o.b., and cast iron railway chairs at £5 10s. At the Newport Rolling Mills, Middlesbrough, which have hitherto been engaged in the manufacture of iron plates, the new owners—the Newport Rolling Mills, Limited—propose to enter also upon the production of steel plates, and the necessary plant will shortly be laid down. It is reported that Sheffield capitalists have been inquiring for a suitable site for steel works in the neighbourhood of Middlesbrough.

Coal and Coke.

On the whole the coal trade in Durham and Northumberland has been very brisk this month, there having been a better demand on export as well as home account, and a good time next year is expected. Higher prices are looked for, and they will be needed if the prognostications about the greater cost of working due to the adoption of the Miners' Eight Hours Act turn out to be correct. It is generally expected that there will be no stoppages of work when the Act comes into force on January 1st, as practically all the arrangements have been amicably settled now; but the details have not yet been made known. To put themselves in order, however, the notices to the miners to terminate their hirings have been duly issued. Prices generally are stronger, best steam being at 11s. to 11s. 3d.; best gas at 11s. 3d.; seconds gas, 10s. to 10s. 3d.; coking, 9s. 6d. to 10s; bunkers, 10s. to 10s. 6d.; and smithy, 10s. to 10s. 3d., all for early delivery. Coking coal is very satisfactory in price, and some firms sell it as coal rather than convert it into coke, the consequence being that there is hardly as much coke being produced as the market needs, and the price of this is advancing; fully 18s. per ton must be given for furnace coke delivered equal to Middlesbrough.

NOTES FROM SCOTLAND.

(*From our own Correspondent.*)

The Increase of the Shipping Trade.

The great and steady increase of the shipping trade of Glasgow has necessitated in recent years a large extension of dock accommodation, and the movement of the shipbuilding and engineering works farther down the river has rendered the present cross-river communication quite inadequate. Every effort has been made to house the artisan population in the near neighbourhood of the works, with the result of creating populous towns like Clydebank. But there has been, along with the expansion of industry and trade, an extraordinary development of the traffic across the river, and the present bridge and ferry accommodation has been found quite inadequate to cope with the increase. Not to speak of the growth of the import trade, the returns of the Board of Trade show that during the last ten years the exports of manufactured articles from the Clyde have more than doubled, rising from the value of £10,378,000 in 1898 to £22,121,000 in 1908, an increase in one decade of over 100 per cent., and that, too, notwithstanding that the last-mentioned year was one of serious depression. With all this extension, it will be readily understood that the pressure of both passenger and vehicular traffic, especially the latter, has become extreme. The Clyde Trustees and the Corporations of Glasgow and the adjoining towns are now earnestly considering what can be done to meet the difficulty. The main obstacle to the erection of bridges farther down the river is that they would impede much of the shipping traffic into the harbour and the docks. Swing bridges would cause serious delay to traffic, and high-level bridges would entail enormous expenditure; but the problem has to be faced, and that without delay, for at present numerous vehicles have to make a detour of miles to get across the lowest of the bridges, and in doing so they cause much interruption to the general traffic of the city.

The Pig Iron Market.

There was a stronger tendency in the pig iron warrant market towards the end of last week, ascribed partly to the fact that selling of warrants by tired holders had ceased, allowing some recovery in prices. Some of the recurring strength was, no doubt, also due to inquiries received by merchants for supplies of iron in the early months of the coming year, although it is not yet clear to what extent inquiries will materialise into actual business. A feature of the market since last report has also been a considerable demand for Cumberland hematite warrants, by which other classes of hematite iron were also favourably affected The business in Cleveland warrants has been of considerable extent in the last few days, and business has been done from 50s. 3d. to 51s. cash, 51s. 2d. to 51s. 8d. one month, and 51s. 5d. to 52s. 4d. three months. Cleveland warrants have also changed hands at 51s. 6½d. for delivery on 28th February.

Scotch Makers' Pig Iron.

The special brands of Scotch pig iron have had a firmer tendency generally, and some makers are quoting 1s. advance on the figures of last week. It is stated that good bookings have been made for shipments well into the first six months of the coming year, and that there is an assurance of a favourable demand at home, and particularly with English consumers. The f.a.s. quotations at Glasgow are, for Monkland, No. 1, 57s. 6d.; No. 3, 55s. 6d.; Carnbroe, No. 1, 60s.; No. 3, 57s.; Clyde, No. 1, 62s. 6d.; No. 3, 57s. 6d.; Gartsherrie and Calder, Nos. 1, 63s. 6d.; Nos. 3, 58s.; Summerlee and Langloan, Nos. 1, 64s.; Nos. 3, 58s. 6d.; Coltness, No. 1, 86s.; No. 3, 58s. 6d.; Eglinton, at Ardrossan or Troon, No. 1, 59s.; No. 3, 57s.; Glengarnock, at Ardrossan, No. 1, 65s.; No. 3, 59s. 6d.; Dalmellington, at Ayr, No. 1, 61s. 6d.; No. 3, 56s. 6d.; Shotts, at Leith or Glasgow, No. 1, 63s.; No. 3, 58s; Carron, at Grangemouth, No. 1, 64s.; No. 3, 58s. per ton. There are 43 furnaces making hematite pig iron, 36 ordinary iron, and 5 basic iron, the total of 84 thus in operation in Scotland comparing with 77 at this time last year.

The Hematite Trade.

There has been a very considerable business in Cumberland hematite pig iron in our market since last report, almost entirely for future delivery. The price has improved from 61s. 9d. to 63s. 3d. per ton in the case of purchases for delivery in three months. It has been pointed out that as the stock of this class of iron is small, any decided inquiry is apt to induce a rapid upward movement in price, and that a turn in the market might likely produce as quick a decline. However this may be, the values of hematite iron generally have been influenced in an upward direction, Scotch hematite having risen 2s., and merchants are now quoting 65s. for delivery at the West of Scotland steel works. The output of Scotch hematite has recently been somewhat increased. Hematite ore is firm in price, and, indeed, the high cost and anticipated scarcity of the ore to which attention has been specially called had no doubt a considerable influence with those operators who are buying Cumberland warrants. In the past six days thirteen cargoes of ore reached the Clyde.

Pig Iron Shipments.

The shipments of pig iron from Scottish ports in the past week amounted to 4575 tons, compared with 4858 in the corresponding week of last year. The United States took 100 tons, India 175, France 10, Australia 145, Italy 150, Germany 50, Holland 75, Belgium 55, China and Japan 600, other countries 573, the coastwise shipments being 2641 tons, against 3200 in the corresponding week. The arrivals at Grangemouth of pig iron from the Cleveland district were better than usual, amounting to 11,612 tons, and showing an increase of 1761 tons, compared with the quantity received in the corresponding week of last year.

Finished Iron and Steel,

There has been little change in these departments of trade. Quite a number of works, both iron and steel, have been unable to obtain full employment. The new work coming to hand is reported to be going mainly into the hands of merchants, who continue to control a large amount of the business, and to purchase in the most advantageous directions as to price in all cases where quality can be guaranteed. It is expected that recent orders received by shipbuilders will exert a favourable effect. Makers of malleable iron are still indifferently employed. In the locomotive engineering trade work has become slack, so that some of the men are being discharged, and it is uncertain when they will be re-employed.

The Coal Trade.

The coal trade has been deriving material benefit from the continuance of cold weather. House coal is in brisk demand all over the country, and recent advances in prices are well maintained. The colliers have been making large outputs in view of the holidays, so that there has rarely been any difficulty in obtaining full supplies. The only trouble in this direction is ascribed to railway traction, about which a good deal of complaint is being made, the policy of the companies at present being directed rather to the saving of outlay in running fewer trains than the earning of money by extension of facilities. There is an impression that if the companies would drop their demurrage policy, which so far has produced little besides irritation, and devote their energies to the accommodation of traders, it would be better for all parties concerned. The shipping trade in coal has been good, and the recent advances in prices are still quoted by merchants.

WALES AND ADJOINING COUNTIES.

(*From our own Correspondent.*)

Last Week's Coal Trade.

Notwithstanding unfavourable weather, the fair quantity of tonnage coming in enabled coalowners to despatch a good average total, and on Saturday a tolerably good week was closed by Cardiff sending away 40,000 tons, and Newport, Mon., 13,000. Prices were firm on several days without any case of advance; in fact, the tendency to improve from 16s. best steam to 16s. 9d. and then advance to the 17s. but, as shippers hoped, was not realised, and prices ended with "sticking" at 16s. 6d. The demand this side of the holidays was stated by a prominent member on 'Change to be quiet, shippers having practically obtained all they require. Interest is now centred on the outlook for the New Year. I note a substantial order for 5000 tons best steam coal for Australia, and 120,000 tons, Griffin's coal, Nantyglo, for the Great Southern and Western Railway of Ireland, at about 14s. 6d. Newport, Mon. It was reported last week that Cardiff had sold steam smalls over the New Year in large bulk at 8s. per ton. Cardiff quotations on Saturday were 8s. 9d. to 9s. 3d. best, but cargo smalls were offered at 6s. 9d. to 7s. 6d.

Latest Quotations, Cardiff.

Prospects were regarded on 'Change this week as improving, and higher figures are likely for the beginning of the year. Tonnage arrivals have been considerable, and stocks are rapidly disappearing. Small steam advancing. With harder weather, and a better tone in the labour market, all classes of coal are in stronger favour. Latest prices: Best large steam, 16s. 3d. to 16s. 6d.; seconds, 15s. 6d. to 16s.; ordinaries, 14s. 6d. to 15s.; best drys, 16s. 3d. to 16s. 9d.: ordinary drys, 14s. 6d. to 15s. 3d.; best washed nuts, 13s. to 13s. 6d.; seconds, 12s. 6d. to 13s.; best washed peas, 12s. to 12s. 6d.; seconds, 10s. to 11s. 6d.; very best smalls, 9s. to 9s. 6d.; best ordinaries, 7s. 9d. to 8s. 6d.; cargo smalls, 6s. 9d. to 7s. 6d.; inferiors, 6s. to 6s. 6d.; best Monmouthshire black vein, 15s. 3d. to 15s. 6d.; ordinary Western Valleys, 14s. 6d. to 14s. 9d.; best Eastern Valleys, 13s. 9d. to 14s. 3d.; seconds, 13s. to 13s. 3d. Bituminous: Very best households, 17s. to 18s.; best ordinaries, 15s. to 16s.; No. 3 Rhondda, 17s. 3d. to 17s. 6d.; brush, 13s. 6d. to 13s. 9d.; smalls, 10s. to 10s. 6d.; No. 2 Rhondda, 13s. to 13s. 3d.; through, 9s. 6d. to 10s.; smalls, 7s. to 7s. 6d. Patent fuel, 15s. to 15s. 6d. Coke: Special foundry, 24s. to 27s. 6d.; foundry, 19s. to 20s.; furnace, 17s. to 17s. 6d.; pitwood, 19s. 6d. to 20s.

Newport Coal.

Market opened well, and especially large cargoes were entered for Natal, Cape Town, China, Japan, and Civita Vecchia. Good tone for forward business. Latest:—Best black vein, 15s. to 15s. 3d.; Western Valleys, 14s. 3d. to 14s. 6d.; Eastern Valleys, 13s. 6d. to 14s.; other kinds, 12s. 6d. to 13s. 3d.; best smalls, 7s. to 7s. 6d.; seconds, 6s. 3d. to 6s. 9d.; inferiors, 6s. to 6s. 3d. Bituminous: Best house coal, 15s. to 15s. 6d.; seconds, 14s. to 14s. 6d. Patent fuel, 15s. to 15s. 3d. Coke: Foundry, 18s. to 19s.; furnace, 17s. to 17s. 6d. Pitwood, 19s. 6d. to 19s. 9d.

Swansea Coal.

Considerable animation on 'Change. The successful opening of the new dock, the ending of a long period of suspense, appears to have given new life to the district generally, and the large attendance this week discussed buoyantly the outlook. Steady to firm, with upward tendency, was the general characteristic of the anthracite trade. Latest quotations: Best anthracite, large hand-picked, 23s. to 24s. net; second malting, 21s. to 22s. net; big vein, 17s. 6d. to 19s., less 2½; red vein, 12s. 6d. to 13s. 6d., less 2½; machine-made cobbles, 23s. to 24s. net; Paris nuts, 25s. 6d. to 26s. net; French nuts, 26s. to 28s. net; German nuts, 25s. to 26s. net; beans, 18s. 6d. to 19s. 6d. net; machine-made large peas, 11s. to 12s. 6d. net; fine peas, 10s. 6d. to 11s. net; rubbly culm, 5s. 6d. to 6s., less 2½; duff, 2s. 6d. to 3s. net. Steam coal: Best large, 17s. to 18s.; seconds, 14s. 6d. to 15s.; bunkers, 9s. 6d. to 10s. 6d.; small, 7s. to 9s. Bituminous: No. 3 Rhondda, 18s. to 18s. 6d.; through, 14s. 9d. to 15s. 6d.; small, 10s. 3d. to 10s. 6d. Patent fuel, 13s. to 13s. 6d., all less 2½ per cent. Coal quotations f.o.b., net cash 30 days. A coal authority observes: Quotations for January loading were above current level of prices.

Iron and Steel.

Substantial shipments of rails were made this week by way of Newport and Cardiff. From Newport 3750 tons were sent in arranged portions to Colombo, Madras, and Calcutta. On the 17th inst. 500 tons of rails were despatched to Singapore *viâ* Cardiff. Larger quantities of ore have come in principally to Newport and Briton Ferry from Bilbao and Santander. Ebbw Vale and Blaenavon, also Neath, have been receiving consignments of ore; the latter also of pig iron from Warrington, and Newport from Workington. Large quantities of steel bars have been sent of late to Lydney, chiefly from Newport, Mon. Pig iron has come in as usual from Grimsby. The works at Dowlais are giving increased yields, and mills are well occupied on tin bar, for which there is an increased demand. Market quotations not issued in time for despatch, but prices remain. The leading works are all quoting the same price, according to syndicate arrangements.

Tin-plate.

A good buoyant tone prevails, and last week business was as brisk as ever. From the works the receipts were close upon 80,000 boxes. Shipments were again good—88,763 boxes, and stocks now are 104,459 boxes, as compared with 174,402 boxes. Large loadings expected to be made this week to America, Alexandria, and Rotterdam. The Swansea tin-plate industry is reported as exceptionally brisk. The two large mills started last week are evidence, remarked a member on 'Change, that large sheets are not in future to be the monopoly of northern manufacturers. Two more mills are being brought into operation this week. No list of prices issued, but it was currently reported that values are improving, and tin-plate likely to advance, following upward figures quoted for tin.

Swansea Valley Industries.

Steel trade firm. Considerable activity shown at Baldwin's, Landore, and a good yield of pig iron recorded. This is encouraging, though Swansea imported 880 tons last week. Copper trade maintains a fair briskness. Spelter even busier, and the various factories at Lower Forest, &c., full of trade. Foundries reported all doing well, and fitting shops all actively engaged. The year is ending well for the trade.

Llanelly.

A better tone is reported in iron and steel, and a substantial make in bars, though manufacturers complain that dumping is active. By all makers it is now admitted that the resolution to keep to the policy of the best materials is meeting with its reward. Home make finds acceptance in all quarters, and it is currently discussed that the demands of America are increasing, and likely to increase on that account. Four of the new mills are now in full activity, and are doing well. Coal is exceptionally brisk. The traffic from the leading anthracite collieries and from Barry Port and Gwendnaelt is quite justifying the hopes entertained, and increased locomotive power is being obtained.

Port Talbot.

Total of imports and exports last week was an advance upon the preceding, and amounted to an increase of nearly 7000 tons. Among the items of exports I note 125 tons tin plates, 122 tons steel plates.

The Colliers and Future Agreement.

At a meeting of the Miners' Federation, held in Cardiff on Monday, the outlook with regard to the colliers and the notice handed in was considered to be more favourable. It was decided that the Secretary, Mr. Dalziel, be instructed to arrange a further meeting of the Conciliation Board on December 29th, when the workmen will have some suggestions to make with a view of obviating the necessity for notice to be given on January 1st. If the Board agree, then a general conference to be called for December 31st. Hopes are freely entertained that the district may, as a result of more favourable views entertained, be spared any trade conflict, which at one time was feared might be a long and disastrous one.

AMERICAN NOTES

(*From our own Correspondent.*)

New York, December 15th.

All industries connected with the manufacture of equipment for railroads are crowded to the limit of their capacity. The car building works and the locomotive works are leading in activity, and some car builders have contracts, the execution of which extends up to next summer. The Pressed Steel Car Company has just purchased 5000 tons of iron for delivery next quarter. Bar iron has advanced sharply, the summer price being 1.40 dols., and the present price 1.70 dols. Some makers are asking 1.80 dols. All lines of material are held at the strongest prices. The output of pig iron is equal to the demands, but that of semi-finished steel is below. The merchant bar mills are also overcrowded. Some railroad companies are putting in capacity, and propose to rely upon their own shops for their future car supply. The plate mills are more overcrowded than any other branch of the industry. A number of large concerns are sold up to May 1st. Prices on plates have advanced from 1.35 dols. to 1.60 dols. An order for 4000 freight cars will be placed in a short time by a New England road. Other companies are formulating their requirements for next year. The Pennsylvania has just ordered twenty-seven shunting and five consolidation engines. The Republic Iron and Steel Company will hasten the erection of six open-hearth furnaces at Haselton, Ohio. The Southern Railway has placed an order for 1000 freight cars, and the Missouri-Pacific has also placed heavy orders calling for delivery before April 1st. The steel industry is quieter than it has been for four months. All industries needing equipment are figuring, but their necessities and a number of orders will be placed early in January, to be followed later by a succession of orders that will go very largely to employ the various equipment manufacturing plants to their fullest capacity. It seems to be generally conceded that a higher level of prices will be reached for many lines of manufactured products, though it is the intention of the managers of the steel industry to use their power to maintain prices at a level as nearly as possible. The copper market is steady and unchanged. During November there was a moderate curtailment, and it will be continued to some degree during the present month. In the North-west the curtailment is influenced by the strike of the switch men, which is impeding traffic to a considerable extent. The average price for electrolytic is thirteen and three-fourths. Export of copper up to last Saturday of this month was 6884 tons. All large concerns handling copper are holding to the standard price. Arrivals of tin up to last Saturday 1033 tons, amount afloat 2500 tons. The supply of tin-plate is light, and premium prices are occasionally paid for prompt delivery.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

In consequence of the demolition of their offices at No. 8, Delahay-street, under the Public Offices Sites (Extension) Act, 1908, Messrs. Horne and Co. have removed to 35, Old Queen-street, Westminster, S.W.

The directors of the Midland Railway have appointed Mr. H. Fowler to be chief mechanical engineer, Mr. A. J. Owen superintendent of operations, Mr. L. C. Geach superintendent of motive power, Mr. J. Badwell superintendent of the passenger service, and Mr. E. R. Ward general passenger agent.

Edwin Danks and Co. (Oldbury), Limited, inform us that after official inspection of "Imperial" water-tube boilers under construction in the company's works, the Admiralty have placed the firm upon their list of manufacturers of water-tube boilers. The Water-tube Boiler and Engineering Company, 11, Queen Victoria-street, E.C., will be pleased to supply any further information concerning these boilers.

Dressing Grindstones.—In our last issue we published a short account of a new device for trueing grinding wheels under the above heading. We are asked to call attention to the fact that the tool dealt with is intended for emery and carborundum wheels.

Contracts.—Smith, Major and Stevens, Limited, have just been instructed by the Lords Commissioners of the Admiralty to supply and erect on board the new Dreadnought battleship H.M.S. Neptune four of their electric passenger lifts.—Lassen and Hjort have secured an order for three large water softening plants from the North-Eastern Railway Company.

The Institution of Mechanical Engineers.—An extra general meeting will be held on Friday, 7th January, 1910, at 8 p.m., when two papers will be read and discussed:—"The Application of the Pitot Tube to the Testing of Impulse Water-wheels," by Mr. W. Rankine Eckart, Associate Member, and "An Account of a Visit to the Power Plant of the Ontario Power Company at Niagara Falls," with extracts from papers by officials of the company, by Mr. C. W. Jordan, Associate Member.

Crystal Palace Engineering School.—The Wilson Premium for the best paper read before the Crystal Palace Engineering Society during the present session has been awarded by the Council to J. P. Watson for his paper on "Types of British Locomotives;" other papers read during the session were "Tunnelling," by W. H. Baker, and "Railway Signalling," by L. E. Sawyer. The Premium was presented to Mr. Watson by Mr. W. M. Mordey on the occasion of the 111th distribution of certificates of the above school on Friday, December 17th, at which he presided.

Royal Institution of Great Britain.—As already announced, a Christmas course of experimentally illustrated lectures, adapted to a juvenile auditory, on "Modern Electricity," will be given by Mr. William Duddell, F.R.S.: On Tuesday, December 28th, (1) "First Principles;" Thursday, December 30th, (2) "Electrical Instruments;" Saturday, January 1st, 1910, (3) "Röntgen Rays;" Tuesday, January 4th, (4) "The Generation of Electricity;" Thursday, January 6th, (5) "Electric Oscillations;" and on Saturday, January 8th, (6) "Electric Lighting." Lecture hour, three o'clock.

NOTES FROM GERMANY, FRANCE, BELGIUM, &c.

(*From our own Correspondent.*)

The Silesian Iron Market.

Life increases in most branches of the Silesian iron industry, and compared to this time last year the present state of the iron market may be considered satisfactory. Foreign demand is good, and there is more work holding out; especially with the Northern and Danube districts a large business is being carried on. Girders are in active request, though this is a quiet period for that article. Merchant bars and hoops meet with good request on home and on foreign account. Prospects generally are pretty favourable as regards the development of spring business.

Rheinland-Westphalia.

The market for iron and steel was pretty firm during the week. In the Siegerland rather less has been bought than previously, because dealers have already purchased largely for the next quarter, and buyers do not care to place orders for a further period. Rhenish-Westphalian ironworks are reported to have resolved to show reserve as to forward contracts, but there is a hopeful tone prevailing generally, and employment all round has increased. The Bar Convention has recently been prolonged for another year. Latest accounts from the Düsseldorf 'Change of the 17th inst. state prices for bars to have been raised from M. 104 to M. 110, as compared with M. 104 to M. 108 in the beginning of December. Sheets stand at M. 127.50 to M. 135 p.t., against M. 127.50 to M. 131 p.t. last month.

The Steel Convention.

Sales of the Steel Convention in November of this year have been 390,355 t., as compared with 420,894 t. in October, and against 341,578 t. in November last year. This shows deliveries to have been 30,539 t. lower than in October of this year, and 48,777 t. higher than in November, 1908. Of the deliveries in November 130,480 t. were semi-finished steel, as compared with 133,775 t. in October of this year, and against 111,932 t. in November, 1908; railway material, 153,265 t., against 158,112 t. in October, and 158,306 t. in November last year; sectional iron, 106,610 t., against 129,007 t. in October, and 71,340 t. in November, 1908.

Coal in Germany.

House coal sells freely in Rheinland-Westphalia and in Silesia, and the tone of the coal market generally is more lively than before. It is reported from Berlin that the negotiations regarding the joining of the Central German and Saxon brown coal works have been satisfactorily concluded. The principal office of the Syndicate is to be in Leipzig.

Austria-Hungary.

Nothing of interest can be told of the iron and steel market in Austria-Hungary. A somewhat dull trade is done in raw and in finished iron, few forward orders being booked. Coal is tolerably firm and in good request, dealers buying freely.

Slackening Off in Belgium.

With the beginning of the present month a slight decrease in demand could be felt in the iron and steel industry, but the tone of the market continues firm nevertheless; the healthy condition of the German iron trade will probably be felt in Belgium too later on. Iron bars have not changed in price, but for bars in basic, that realised up to £5 p.t. f.o.b. Antwerp, in November, only £4 18s. p.t. is now quoted; still, the concessions granted, even in special cases, never exceed 1f. to 2f. p.t. Girders show a firm tendency, and the rail trade is favourable, large contracts from Brazil, Egypt and Argentina having been taken at prices that have not unfrequently shown advances of 3s. to 5s. p.t., according to the weight of the order. A languid tone characterises the plate trade, while the business in sheets continues fairly good. The Belgian coal market maintains a quiet but firm condition. Producers, as a rule, show reserve as regards forward orders, because increasing life and higher prices are expected for the next quarter. Consumers, on the other hand, receiving favourable offers from German pits, hesitate to place their orders with inland firms, and so there is comparatively little business transacted in the coal trade just at present. In the Liège and Charleroi district a want of wagons continues to be complained of, demand being particularly lively in these parts, whereas the pits of the Centre and Mons district are doing a moderate business only. Briquettes continue depressed both in demand and in price.

Accounts from Sweden.

From July to September of this year only 66 blast furnaces, 186 furnaces, 15 Bessemer, and 53 Martin furnaces have been in blow, against 86 blast furnaces, 220 furnaces, 18 Bessemer, and 53 Martin furnaces in the same quarter last year. Output from January the 1st to September the 30th of this year was :—

	1909. t.	1908. t.
Pig iron	444,500	427,200
Blooms	83,000	113,900
Billets in Bessemer	43,300	59,700
Billets in basic	190,000	263,000

Total export till October 31st was for 1909, 252,900 t., in 1908, 276,300 t.; of these pig iron amounted to 87,700 t. in 1909 and 94,000 t. in 1908; cast iron, 7300 t. in 1909 and 4600 t. in 1908; blooms, 14,800 t. in 1909 and 16,900 t. in 1908; bars, 87,700 t. in 1909 and 98,000 t. in 1908; drawn wire, 16,700 t. in 1909 and 18,300 t. in 1908; billets, 14,100 t. in this year and 16,300 t. in 1908. Prices generally show a tendency upwards. Owing to suspension of work during part of the year output has been rather limited, and stocks are low, especially in malleable iron and steel. Increasing work is now reported to be coming in both for forward and for immediate delivery.

Royal Meteorological Society.—The monthly meeting of this Society was held on Wednesday evening, the 15th instant, at the Institution of Civil Engineers, Mr. H. Mellish, president, in the chair. Dr. W. N. Shaw, F.R.S., read a paper on "The Variations of Currents of Air Indicated by Simultaneous Records of the Direction and Velocity of the Wind." He said that, in order to form a mental picture of the changes which are taking place in the amount of air flowing past an anemometer, we need to take into account the changes of direction as well as the changes in velocity. He had endeavoured to combine these in what he called a "Vector Diagram," and he pointed out some interesting results which he had obtained from such diagrams. Two practical and interesting papers by Mr. W. G. Reed, jun., were read by the Secretary. These papers formed part of the work done in the course in climatological research given in Harvard University, Mass., under the direction of Prof. R. de C. Ward. The first paper was "A Critical Examination of South American Rainfall Types," the object being to make a simple yet accurate map, showing the seasonal distribution of rainfall in South America. The second paper was "The Study of Phenomenal Climatology." The suggestion has several times been made that treatment of weather elements by days and months is arbitrary and unnatural for places not within the tropics. The author points out that in latitudes subject to cyclones the distribution of weather elements depends largely upon the relation of cyclones and anticyclones; and he, therefore, suggests that the cyclone is a more rational unit than the day or the month.

BRITISH PATENT SPECIFICATIONS.

When an invention is communicated from abroad the name and address of the Communicator is printed in italics.

When the abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent-office Sale Branch, 25, Southampton-buildings, Chancery-lane, London, W.C., at 8d. each.

The first date given is the date of application; the second date at the end of the abridgment is the date of the advertisement of the acceptance of the complete specification.

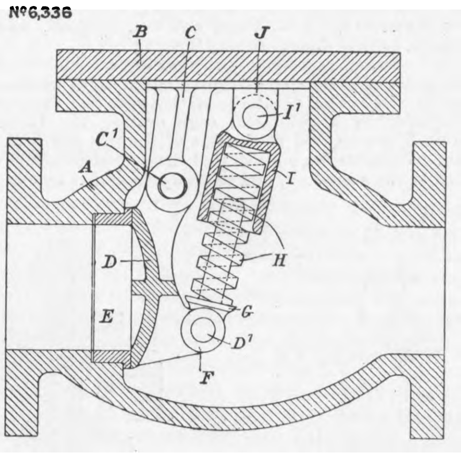
Any person may on any of the grounds mentioned in the Acts, within two months of the date given at the end of the abridgment, give notice at the Patent-office of opposition to the grant of a Patent.

STEAM GENERATORS.

6336. March 17th, 1909.—Improvement in Isolating Valves for Steam Boilers for the Protection of Life, James Halliwell, of Fairfield-terrace, Cherry Tree, Blackburn, Lancaster, engineer.

This invention relates to isolating valves for steam generators, and has for its object to provide new or improved means of preventing the breakage of same by "knocking" due to fluctuations of pressure and the pulsating action of steam. A represents the valve casing, and B the cover; C is a lug cast on the under side of cover B, to which lug is pivoted, by means of a pin C^1, the flat-faced valve D; E represents the valve seat; F is a lug cast on the back of valve D, to which is pivoted, by means of a pin D^1, a guide pin G; J is a second lug cast on the under side of cover B, to which box I is pivoted by means of a pin I^1, and in which box the upper end of spring H is disposed. Spring H is adapted to impart a slight pressure to valve D, at any position of opening, against the steam pressure generated in the boiler, so as to close the valve gradually as the pressure is reduced, and finally maintain it upon its seat.—*December 1st*, 1909.

Nº6,336

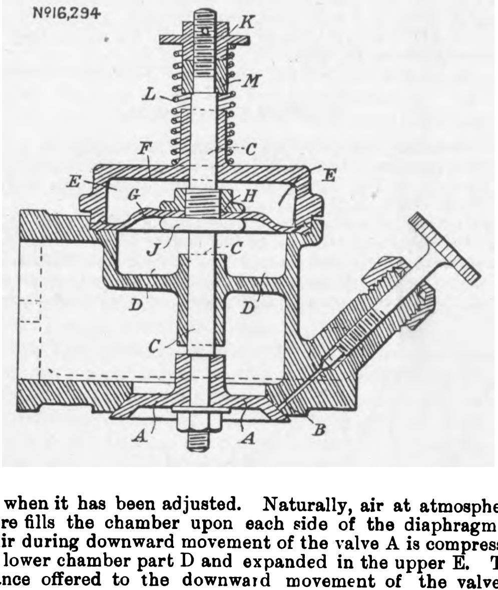


INTERNAL COMBUSTION ENGINES.

16,294. July 13th, 1909.—Improvements in connection with Carburetters for Internal Combustion Engines, Harry Heatly, of 110, Cannon-street, E.C.

The atomising valve A, having at its lip a valve-controlled inlet B for fuel, is carried upon a spindle C in a casing forming part of a carburetter. The valve spindle C passes up through a chamber, the lower part D of which is formed in the casing, while the upper part E is formed in a cover F. The cover F is secured to the casing by flange and set screws, and between it and the casing is tightly held a flexible diaphragm G held on the spindle C by a nut H co-acting with the collar J thereon. The spindle C passes out through the cover F, and between an adjustable flanged nut K on its outer end, and the cover is arranged a spring L tending to close the valve A, a lock nut M being provided for securing the nut K when it has been adjusted. Naturally, air at atmospheric pressure fills the chamber upon each side of the diaphragm G. This air during downward movement of the valve A is compressed in the lower chamber part D and expanded in the upper E. The resistance offered to the downward movement of the valve is therefore equal to the sum of the difference of pressure from atmospheric in each of the two chamber parts D E, which pressure difference obviously increases in rapid ratio—how rapid depending upon the capacity of the chambers—with continued movement of the valve. Since the movements of the valve are very rapid, the possibility of leakage of air into and out of the chambers D E from and to the atmosphere is extremely slight, but, if need be, the possibility of this leakage could be avoided by arranging a diaphragm at either end of a centrally partitioned chamber connecting the diaphragm adjacent to the spindle directly thereto, and that remote by a stirrup or like device passing around the outside of the chamber. Or equivalent devices to like end may be used. There may be substituted for the diaphragm a piston substantially air-tight in the chamber.—*December 1st*, 1909.

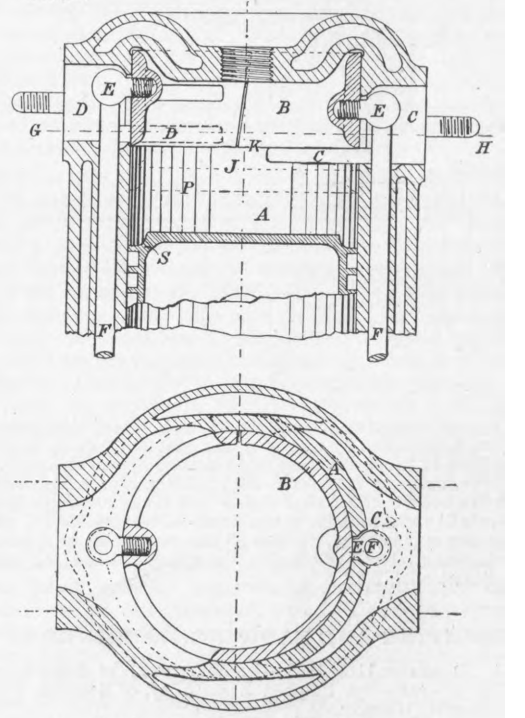
Nº16,294



25,164. November 23rd, 1908.—An Improved Valve Mechanism for Internal combustion Engines, Horace John Howard, of "Briarley," Cherry Orchard, Staines, Middlesex.

The object of this invention is to minimise the noise, to give a freer passage for the inlet and exhaust gases than they would have passing under mushroom valve heads, and to provide means for lubrication. The valve consists of a broad flat split ring covering annular slots cut through the walls of the working cylinder on opposite sides, and arranged to move in an axial direction within the cylinder, in such manner that it opens and closes one of the slots or ports at each end of its travel, its mid position shutting both ports gas-tight. This valve is designed to keep the combustion space clear of projections, rods, or arms, its actuating mechanism being attached to the ring from the outside, through the cylinder walls, to two trunnion pins, which project into the ports, vertical slots extend upwards from the ports to give them the necessary up and down movement, the ring being made broad enough upwards to cover these slots when the ports are closed. The lower edge of the ring uncovers the exhaust port, which is cut lower, by its own width, than the inlet port, which is preferably opened by a registering port or ports cut through the ring itself; or the ports can be reversed, the lower one being used as the inlet. To lubricate the working surfaces the lower edge of the ring is arranged to overlap the path of the piston, and so use the lubricant brought up by a shoulder on the latter. When the ring is in its mid position J its lower edge just clears the highest point reached by the shoulder S on the piston. The valve may be operated by a grooved cam in both directions worked on the two to one shaft, or by a surface cam in one direction, return being by a spring or springs. The dotted lines P, J and K show the three positions of the valve; A is the cylinder, B the split ring valve, C the exhaust ports, D the inlet ports, E E the trunnion pins, F F the actuating rods, S the shoulder on piston.—*December 1st*, 1909.

Nº25,164

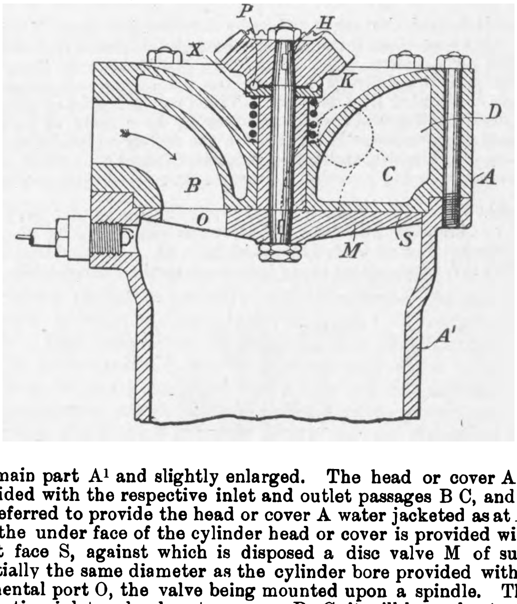


Section Across the line G.H.

25,662. November 27th, 1908.—Improvements in Means for Controlling the Admission and Exhaust of Internal-combustion Engines, Thomas Horsley, Herbert Oswald Horsley, and Henry Benjamin Horsley, all of 10, Coney-street, York.

This invention relates to valves for internal-combustion engines of the type in which a rotary disc valve is provided having an aperture or apertures which on the rotation of the valve communicate with the inlet and exhaust ports at the required time, and has for its object to provide a valve of this type mounted to operate on the inner surface of a separate cylinder head or cover which is provided with curved inlet and exhaust ports opening from the exterior directly through the disc valve into the cylinder at positions determined according to the cycle of operation. The head or cover A of the cylinder is advantageously separate from the main part A^1 and slightly enlarged. The head or cover A is provided with the respective inlet and outlet passages B C, and it is preferred to provide the head or cover A water jacketed as at D, and the under face of the cylinder head or cover is provided with a flat face S, against which is disposed a disc valve M of substantially the same diameter as the cylinder bore provided with a segmental port O, the valve being mounted upon a spindle. The respective inlet and exhaust passages B, C, it will be understood, are directed downwardly to open out on the inner face S of the cylinder head or cover, and are of such curved shape as to be directed out in a direction at right angles to the centre line of the cylinder. The spindle upon which the valve is mounted has its outer protruding extremity H^1 fitted with bevel or other gear by means of which movement is communicated to the valve synchronising with the movement of the crank shaft, and a spiral spring K is provided or other means to maintain the valve against the under face of the cylinder head or cover, which spiral spring may advantageously abut against a loose ring, between which and the boss of the bevel wheel a ball race P is provided, by which friction may be minimised.—*December 1st*, 1909.

Nº25,662

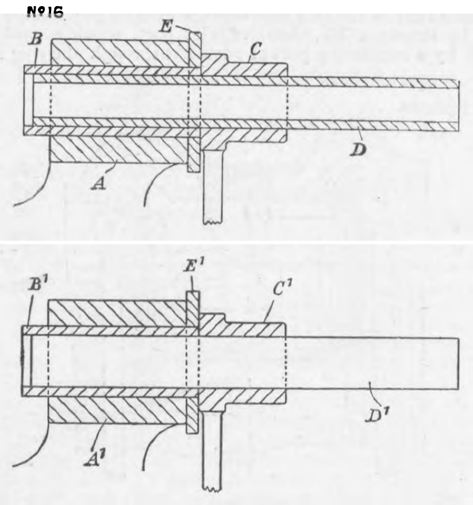


DYNAMOS AND MOTORS.

16. January 1st, 1909.—Improvements in or relating to Dynamo Electric Machines, John Taylor, of Mather and Platt, Limited, Salford Ironworks, Manchester.

This invention relates to improvements in the brush gear of dynamo electric machines, whereby the construction is simplified and cheapened, and the number of parts is lessened by the elimination of nuts, screws, and the like. The upper engraving shows a cross section of the spindle and rocker arm constructed in accordance with the invention. In this figure the tubular spindle D is placed in a hole in the rocker arm A and insulated therefrom by the sleeve of insulating material B and the washer of insulating material E. The tube D also passes through the hole in the eye of the cross connecter or terminal C, and, after being placed in position, is expanded by means of any suitable tool so as to be firmly fixed in the rocker arms or connection eyes or terminals. In the lower engraving is shown a slight alternative arrangement, in which the holes in the rocker arm A¹ and in the connecter eyes or terminals C¹ are shrunk on to the brush-holder spindle D¹, which in this case may be solid, a sleeve B¹ and washer E¹ of insulating material being interposed between the spindle D¹ and the rocker A¹.—*December 1st*, 1909.

Nº16

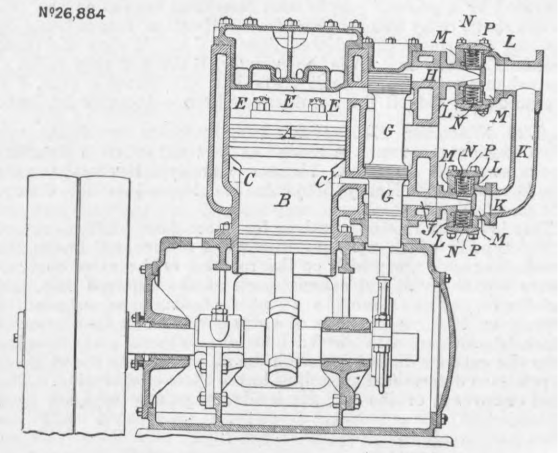


PUMPING AND BLOWING MACHINERY.

26,884. December 11th, 1908.—IMPROVEMENTS IN SINGLE-STAGE AIR COMPRESSORS, Stephen Evans Alley, of Sentinel Works, Polmadie, Glasgow.

The trunk piston, of otherwise usual construction and form, has parts A B of two diameters, the greater A above and the lesser B beneath, thus forming a down-stroke compression chamber C between the annular area formed by the reduction of the cylinder to fit the lower smaller piston part B and the annular piston area due to the difference in area between the lesser lower piston part B and the greater upper piston part A, while between the upper surface of the piston part A (the piston head) and the cylinder cover is formed the usual up-stroke compression space E. Inlet and discharge of air from the two compression spaces C E are controlled by a piston valve G, between the discharges H J from which and the delivery K from the compressor are automatic valves controlling that delivery. These valves consist of thimbles L fitted in cylindrical cavities and bearing upon seats in passages formed in valve-boxes M arranged in the delivery pipes, springs N within the thimbles, and acting between them and covers P on the valve-boxes, being provided to operate them.—*December 1st*, 1909.

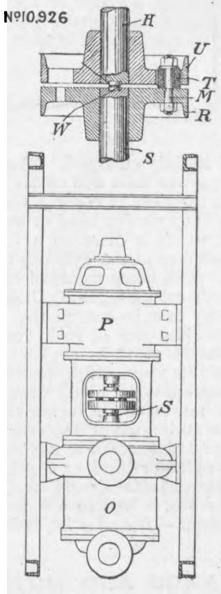
Nº26,884



10,926. November 25th, 1909.—IMPROVEMENTS IN AND RELATING TO CENTRIFUGAL PUMPS, Jens Orten Boving, of 72-74, Victoria-street, Westminster, London, S.W.

This invention relates to an improved method of coupling with the wheel spindle of a centrifugal pump, which spindle is balanced against end-thrust and placed with its axis vertical, a motor whereby the pump is driven, the coupling being so designed and constructed as to permit of a certain degree of flexibility in respect to the alignment of the spindles of the motor and the pump wheel, and yet enable the weight or thrust of the motor to be transmitted in a frictionless manner to the pump spindle. In the arrangement shown, which in many cases will be the most convenient, the suction end of the pump O is downward. When a high speed of revolution is adopted in such a combination a special design of coupling will be requisite, whereby the weight of the rotor of the motor P will be transmitted of the pump spindle S in order that it may be water-borne, and wherein also a degree of flexibility is provided permitting the spindle of one rotor to undergo a small displacement relatively to the other either in an angular direction or laterally. A suitable coupling for this purpose is shown, drawn in section to a larger scale. The spindle S of the pump is fastened to a flange R to which are secured a number of stud bolts M, on which bolts are threaded a plurality of washers T of leather or equivalent material. These washers fit loosely into enlarged orifices provided in the flange U which is secured to the spindle H of the motor. By this known device, a torque can be transmitted from one spindle to the other and at the same time the two spindles will be free to undergo a small relative displacement. The extremities of the two spindles may butt directly on one another, but preferably bearing discs W are interposed, one of which is advantageously made slightly convex. An alternative construction in which the desired flexibility is provided in the manner explained, but in which the end-thrust is transmitted from one spindle to the other through balls mounted in a ring, is also illustrated.—*December 1st*, 1909.

Nº10,926

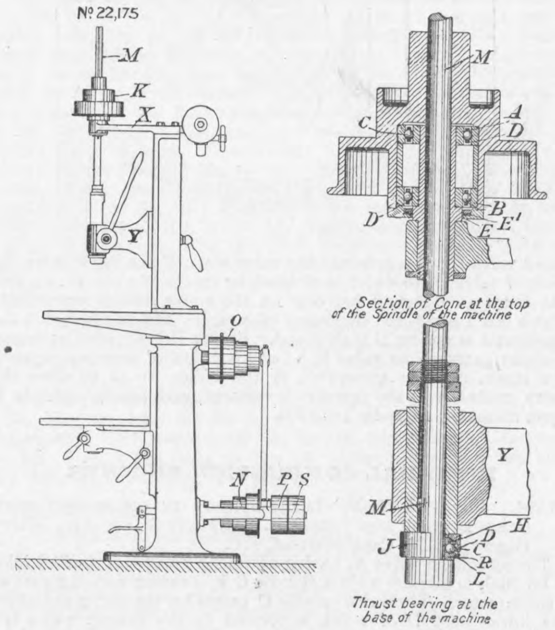


MACHINE TOOLS AND SHOP APPLIANCES.

22,175. October 20th, 1908.—IMPROVEMENTS RELATING TO DRILLING MACHINES, W. W. Ward and Co., Limited, and Walter Deakin, both of Lionel-street, Birmingham.

The ball bearings employed in this drilling machine consist of an inner ring A and outer ring B, these rings being of hardened steel. A series of steel balls C is interposed between the two rings, balls being covered by a gun-metal cage or ring D. Leather dust washers E E¹ are secured at the side of the ball bearings. In the sensitive drilling machine illustrated the drill spindle M is movably mounted in the arms X Y, and to its upper end is keyed the cone pulley. This pulley is driven by a belt from another pulley O on the upper countershaft, the belt passing over the guide pulleys. The cone pulley O is driven by a belt from the pulley N on lower countershaft, which carries the usual fast pulley P and loose pulley S. The cone pulleys K and O, guide pulleys, and loose pulley S are each mounted on ball bearings and provided with leather dust washers, as also is the lower countershaft carrying pulley N. At the base of the drill spindle is a thrust bearing consisting of a casing J and hardened rings H L, a series of balls C and a cage D, the ring L being secured by the expanding spring ring R.—*December 1st*, 1909.

Nº 22,175

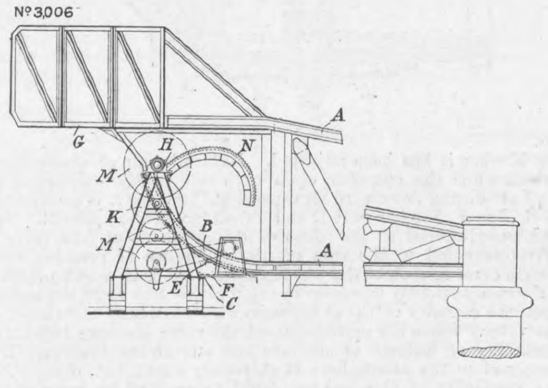

M
K
X
Y
O
N
P
S
M
C
A
D
D
B
E
E¹
Section of Cone at the top of the Spindle of the machine
Y
M
H
J
D
C
R
L
Thrust bearing at the base of the machine

MISCELLANEOUS.

3006. February 8th, 1909.—IMPROVEMENTS RELATING TO MOVABLE BRIDGES, the Cleveland Bridge and Engineering Company, Limited, of Darlington, Durham, and Joab Haigh Walker, of White Draw Bridge, Carmarthen.

This invention consists in constructing a rolling lift bridge in which the turning movement of the leaf or leaves of the opening span is effected by a pinion or pinions in a fixed position co-operating with a rack or racks integral with the bridge portion, and so curved that the pinion or pinions shall always remain in engagement therewith. The invention further consists in the improved construction of bridges hereinafter described. In the form of the invention illustrated the movable leaf A is formed with a circular end B adapted to roll on the bridge support C. Teeth E are provided on the circular portion and adapted to engage with recesses F in the bridge support when the bridge is turned about the horizontal axis, which moves in a horizontal direction as the leaf turns, and a suitable balance weight G is provided. The rotation of the leaf about the horizontal axis is effected by means of pinions H on each side carried by strong frameworks K mounted on the bridge supports, the pinions H being rotated by means of electric motors, or by hydraulic, steam, gas, or hand power through trains of wheels M. The shaft H extends across the width of the bridge, and connects the gear trains on each side of the bridge when more than one pinion H is employed. The pinions H engage with racks N fixed to the leaf, and of such a curved form that they will always remain in engagement with the pinions whatever be the position of the leaf in its movement about the horizontal axis. It will be obvious that the invention is applicable to bridges of other design than that illustrated, and that two movable leaves may be used meeting in the middle of the span, the girders being arranged on the cantilever principle, or other convenient manner.—*December 1st*, 1909.

Nº3,006



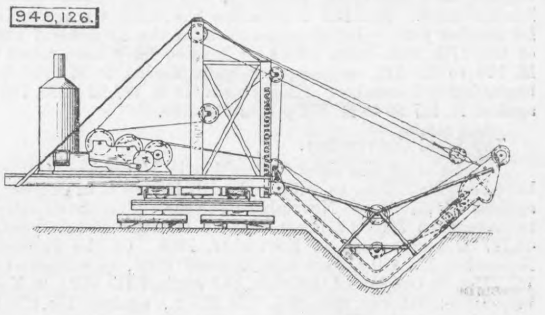
SELECTED AMERICAN PATENTS

(*From the United States Patent-office Official Gazette.*)

940,126. DRAINAGE EXCAVATOR, *M. G. Bunnell, Chicago, Ill., assignor to F. C. Austin, Chicago, Ill.—Filed December 11th*, 1908.

The inventor makes twenty-one claims. The fifth runs as follows :—In a drainage excavator, a vertically swinging runway, an excavating bucket, means for causing the bucket to travel back and forth on the said runway, means whereby the bucket dumps without leaving the runway, and means for effecting a vertical and bodily raising and lowering of the entire runway, whereby the depth of the ditch or trench may be varied without varying the slant or angle of the sides thereof.

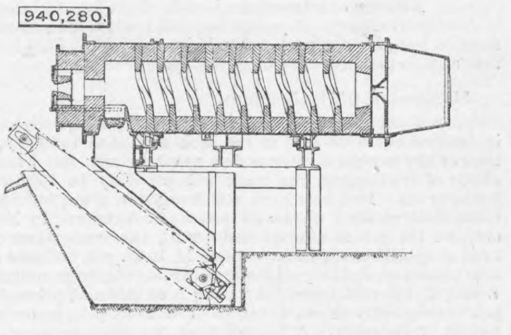
940,126.



940,280. ANNEALING AND HARDENING FURNACE, *W. S. Rockwell, New York, N.Y., assignor to W. S. Rockwell Company, New York, N.Y.—Filed December 4th*, 1908.

The inside of the tube is fitted with spiral fire tiles, by which the articles being treated are moved through the furnace by its rotation and discharged through a door which opens once at each revolution. There are fifteen claims.

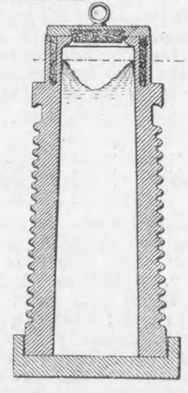
940,280.



940,386. INGOT MOULD, *E. Gathmann, Bethlehem, Pa., assignor to Gathmann Engineering Company, New York, N.Y., a Corporation of Maine.—Filed June 14th*, 1909.

This invention has for its object the retaining of the steel in a fluid condition at the top while it cools at the bottom. The lower portion of the mould is ribbed or roughened to favour heat radiation, while the upper portion is surrounded by heat insulating means, and is closed at the top by a cap or covering of insulating material which is a poor conductor of heat, and which has no chemical effect on the material from which the ingot is cast. There are five claims.

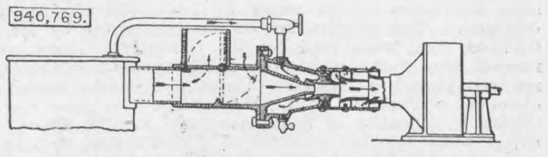
940,386.



940,769. MOTIVE-POWER SYSTEM, *A. Wilstam, Los Angeles, Cal.—Filed March 1st*, 1909.

This patent is for the combination of a steam generator, a flue for conveying the gaseous products of combustion, and provided with a damper, and having a flue gas discharge and an air inlet, a combined superheater and injector connected to the flue. The superheater having steam connection with the generator and means for discharging superheated steam into one or more nozzles of the injector, so as create a flowing current of mixed flue gases and steam, [illegible] battery, exposed to the open air and consisting of a number of [illegible] arranged in tandem of successively increasing capacities and adapted to inject atmospheric air into the path of the jet and expand the mixed aeriform fluid, and a turbine motor, into the intake of which the injector discharges. There are four long claims.

940,769.



OUR MINERAL STATISTICS.

Part III. "Output" of the Mines and Quarries, General Report and Statistics for 1909, made a somewhat belated appearance, not coming to hand until the second week in November. Since the death of Sir C. le Neve Foster, the Blue-book has been without an authoritative name on the cover and fly-leaf. This year, however, we note the name of the Chief Inspector of Mines, who is, of course, Mr. R. A. S. Redmayne. No change is to be noted in the form of presentment of the statistics, which, as formerly, are reproduced as given in the reports of the individual district inspectors. In accordance with our practice in former years we shall confine our review to the metallic and non-metallic minerals other than coal, and this, though mainly from considerations of space, yet to some extent because we feel that British metalliferous mining in its various branches deserves more notice than the very brief references usually made to it by reviewers of this volume would seem to indicate. That more than half of our output of pig iron is made from native iron ore obtained from deposits which show no signs of depletion, is a fact of interest and importance which seems to be by no means common knowledge among engineers. Or again, that in Derbyshire, North Wales, and Scotland we have some of the most productive lead mines in the world, having regard to the areas worked, is insufficiently recognised. It is a common observation that lead mining in Derbyshire is practically extinct, yet the county provided 5262 tons of dressed ore in 1908, over 5000 tons of which we estimate came from the Mill Close mine. We have to estimate the figure because, as in former years, the figures for individual mines are not given in the Derbyshire returns. In all the other lead mining districts it is different, the figures for each mine being given separately.

With regard to the exact source of origin of some of the materials, notably blende and fluor spar, and, to some extent, lead ore and barytes, we have pointed out in former years that it is incorrect to give them as the product of mining, because they have been obtained merely from the dressing of old mine dumps. Probably in the bulk of cases it would prove a very difficult matter to get separate statistics relating to the products of mines and old dumps, especially when both are being worked at the same time, as has been the case for years at the blende mines of Carshield, Northumberland, and Trelogan, Flintshire. Where no discrimination, however, is made it is not surprising that erroneous ideas as to the value of certain mining properties may exist. Old dumps, of course, have only a certain life, and when they are worked out it is only natural that the returns from the working mine near which they are situated should show a decline unless exceptional and satisfactory developments are made underground. Something of this sort is the real explanation of the large falling off in the zinc returns to be noticed in 1908 from the Northumberland and Cumberland district. In connection with this matter of separate returns from dumps, we note with satisfaction that Table 273 of the present volume gives the output and value of tin ore from old dumps at surface of mines. This, as also the reference to arsenical pyrites from dumps, is an innovation which may possibly be carried into other mining districts in succeeding years. Although among the important minerals tin ore is the only one which shows an increase over 1907, yet except in the case of zinc the falling off is in no way serious, and having regard to the continuous fall in values since the first half of 1907 there is really nothing to cause surprise.

Perhaps the most satisfactory feature of the returns is the general improvement shown by Wales, where increases are shown in lead, copper, and iron, while there is only a trifling decrease in zinc compared with England. With regard to the columns in the statistics purporting to give the value of the ore at the mines much might be said. Here, of course, the mine inspectors are largely in the hands of the mine owners, and from what we can judge by perusal of the figures, in many cases we cannot help thinking that the asterisk stating that the value is estimated might be employed more often than is the case. The matter is one of importance and complexity, and justice can not be done to it in the few lines available in a general review like the present: we shall, therefore, dismiss it with merely a word of caution to the uninitiated not to read the values given too closely, but to make further inquiries if information of more than a general character is desired. With respect to the assay values given for lead, copper, zinc, &c., it must not be assumed that the figures are comparable as showing the efficiency of the dressing plant at the several mines, or in different districts. In some cases rich and poor ore are mixed together for purposes of sale, thus reducing the assay value of the rich ore; in other cases the high-grade ore is sold alone, and this assay always figures in the statistics. In many cases the average assay of the ore from a particular mine is obtained from the smelter by the district inspector, the mine owner not concerning himself with the matter. We refer to the point because anyone not conversant with the facts might, for instance, infer that the ore of the Wiregill mine, in Teesdale, of which the assay is given as 77 per cent., has been less efficiently treated than, say, that from the Halkyn mine in Flintshire, for which the figure 83 per cent. is given. As a matter of fact, the bulk of the ore from the former assays 83 per cent. also, but it appears in the statistics as 77, for reasons which have been to some extent explained above.

But to proceed now from the general to the particular, we shall as usual make our individual references in alphabetical order. Arsenic is tabulated both as white arsenic or arsenious acid, and as arsenical pyrites, both of which show a decided increase, though the market price has been considerably lower than it was in [illegible]. The great bulk of the arsenical pyrites wa[illegible] from mines and waste heaps in Devonshire, while the white arsenic came principally from the Cornish tin mines, where it is collected as a calcination product of the tinstone. Passing on to barytes, we note that, as was the case last year, the details are headed barium—compounds—instead of barytes—mainly sulphate—as was formerly the case. The reason for the change is not obvious. There are two barium minerals mined in the United Kingdom, the sulphate and the carbonate, and as these are specially indicated, there seems on the face of it no particular object in altering the former title. Barium compounds have a suggestion of lithopone or other bodies into which barytes enter. These, however, could not be ranked with the ordinary minerals as mines products. We do not suggest that anything of this sort has occurred, though we are at a loss to account for the barytes from the West Riding mine having the stated value of over £4 per ton. The values given in other cases vary from 6s. to 20s. per ton for sulphate, while the ordinary price for the carbonate from the Settlingstones mine, Northumberland, is £2 per ton. This year we note that the Nentsbury mine, Alston Moor, is producing carbonate of barytes, the stated value of which is nearly £3 per ton. In 1907 the output of barytes was the highest recorded, and though 1908 shows a reduction, the total of 38,947 tons is a considerable increase on previous records. For some years the New Brancepeth mine, Durham, has been the principal producer of sulphate; but though it still retains the position, its production in 1908 fell off by close on 50 per cent., and it is now very closely challenged by the Wotherton mine, Shropshire, for first honour. The Derbyshire output is quite insignificant, and no developments have taken place in the county at all commensurable with what we find in Durham, Yorkshire, Westmoreland, and Co. Cork.

We have given more space than usual to barytes, because its occurrence and mining have become of increased importance in the last few years, and because the United Kingdom is now one of the principal producing countries. The increased demand, it may be mentioned, is due very largely to the war in so many countries against white lead paint, and the enforced substitution, therefore, of lithopone or zinc oxide, the former being a chemically precipitated mixture of barytes and zinc sulphide.

Cobalt ore has not been raised from the old Flintshire mine for some years, but we may say that during the last two years some development work has been put in hand with satisfactory results, and the formation of a new company to work the mine is in progress. Passing on to copper, it is quite startling to note that the Levant mine, Cornwall, has lost the leading position which it held for so many years, and that the Glasdir mine, Merionethshire, is now the principal producer of copper ore. As far as values are concerned, this mine, with £6580, beats the combined Cornish output of £6317. With regard to this, however, we note that no reference is made in the statistics to the gold content in the Welsh ore. We are not in possession of any details, but understand that the copper from the Glasdir mine, which is in the neighbourhood of the St. Davids' gold mine, carries considerable gold values. It is at this copper mine that the Elmore vacuum plant is at work concentrating low-grade ore, and our prognostications of two years ago with regard to the future of copper mining in North Wales, are amply justified by the returns for 1908.

The difficulty attending the economical concentration of the low-grade copper ores, which exist in so many places in North Wales, has long militated against the mining industry, and in 1906 the output of copper ore was nil. The copper precipitate, which has for so long been produced from the waters of the old Anglesey mines, is excluded from these references to copper mining. Another new mine in North Wales is the Talysarn, in Carnarvonshire, the ore giving the high dry assay of 20.17 per cent. In Ireland only cuprous pyrites was mined in 1908, and the developments of the present year do not come up for consideration. Of course, the state of the copper market has been all against new British ventures, and has had a serious effect upon more than one of the mines in the list under notice.

Last year we foreshadowed a decreased output of fluorspar owing to slackness in the iron and steel trades, and this has come to pass, the output being 34,700 tons against 49,462 tons in 1907. Compared with ten years ago the present output in Derbyshire and Durham is, of course, very great, but it seems doubtful if any further expansion will occur however much the iron trade may improve; and this because of the new American tariff of 12s. per ton, an impost which has brought something akin to consternation into the two producing centres. Unless the home trade shows a very great improvement we shall expect to see a still further reduction when the figures for 1909 see the light. With regard to the tabulated list of Derbyshire mines, the bulk of these are merely old dumps from which the fluor is collected; so far very little of the Derbyshire product comes from mines, though in Weardale the case is different. The production of gold at the well-known St. David's mine in Merionethshire continues disappointing, and the decline from the bumper year 1904, when the value was £73,925, has not yet been arrested.

Proceeding now to iron, the production, though somewhat less than in 1907, remains about 15 million tons, the great bulk of which continues to come from well known and old established iron mines, coal mines, and quarries. We note that Devonshire is a new-comer with 1400 tons of 57.5 per cent. ore, and Somerset with 2556 tons of 55 per cent. also enters the list. A very interesting feature is the return of 12,832 tons of 41.34 per cent. ore from the new Garregfawr mine in Carnarvon, owned by Alfred Hickman, Limited. These deposits have been shunned in the past from their phosphorus contents, but, of course, this impurity has now-a days no terror for ironmasters. The developments which have been made, including aërial ropeway transit to the Llanberis branch of the London and North-Western Railway, portend an increased output in the current year. The Bryn Castell mine, near Dolgelly, belonging to the Brymbo Steel Company, Limited, is also a new concern, with an output of 2619 tons of 38 per cent. ore. The Coed Llan iron mine in Flintshire shows a rise in its output, but at this property, which has long figured in the returns, work has been largely confined to locating the course and extent of the ore deposit. Judging from the recent boring operations this small hematite mine shows promise of developing into a concern of greater note. Quite recently, we may add, another large iron mining company has commenced work in North Wales. Iron ore, chiefly argillaceous carbonate, has long been obtained to the amount of about 10,000 tons from coal mines in South Wales, and there is nothing which calls for comment as regards this. Glancing at the imports of iron ore, we note a reduction from 8,218,790 tons in 1907 to 6,626,692 tons in 1908, the cause of which needs no particularisation. Newfoundland and Tunis are new to the list of countries whence imported, though the amounts are only trifling compared with Spain.

Passing on to lead mining, it is not surprising that, the fall in the mean price of English pig lead from £19 12s. in 1907 to £13 14s. in 1908, has been reflected in a decreased output of ore, though the fall from 32 533 tons to 29,249 tons is by no means startling. Mill Close, as usual, is the principal producer, with only a slight fall from the previous year. The only English mines showing an increase are Snailbeach, Shropshire, and the small Stang mine recently reopened in Arkendale, North Riding. In Wales the Rhosesmor, in Flintshire, which has come to the front so quickly in recent years, shows a small decrease, while the North Hendre, in the same district, comes very close to it with 2099 tons. It is a great pity that this mine was flooded last spring, just as it had started on a new era of activity and showed such great promise. Features of interest and importance about British lead mining are to be noted at the Scotch mines of Leadhills and Wanlockhead. At the former electric pumping plant is now successfully at work, and at Queensberry mine, Wanlockhead, the new company now in possession is introducing modern developments, which augur well for its future prosperity. This district, despite the riches which have been obtained from it in the past, continues to open up very well, and it is somewhat surprising that more blende is not marketed from the Queensberry mine. With regard to new mines, if we except one or two in Wales there only remains the Norcliff Sough in Derbyshire. Last year's output is lumped with Mill Close, but we shall not be far out in putting it at 100 tons—a figure which will be considerably exceeded this year. This mine now easily takes the second place in the county, and more money is being spent on the new dressing mill than has been the case at a Derbyshire lead mine for many years. The situation of the mine, by the way, is not correctly given in the statistics, but this is of no great moment. Manganese ore continues on the down grade as far as North Wales is concerned, but we notice an output of 256 tons from a new mine at Glandore, County Cork.

The production of tin ore (black tin) was 8008 tons in 1908, against 7080 in the preceding year, though the value was considerably less. This important branch of British mining would require so much of our already exhausted space for adequate reference, that we shall not attempt any examination of the details before us, and so pass on at once to uranium ore, which is returned at the same figure as in 1907, viz., 71 tons, the value, however, being £7550 against £6500. Presumably this came from the Grampound-road mine, though we are only told that it came from the uranium mine. The pitch blende now being obtained from the Trenwith mine, St. Ives, to supply the raw material for the new radium laboratory in London, should go to swell this year's return. In 1908 the price of wolfram ore fell considerably, and we are not surprised to note that the output decreased from 322 tons in 1907 to 233 tons. Despite the increased demand from the steel trade, this mineral now comes from several countries, and the Cornish mines have no monopoly. Coming, in conclusion, to zinc, we have to note a serious falling off in the production of blende, and a very considerable decrease in value, due to the fall in price of the metal. The principal producer is now Great Laxey, in the Isle of Man, instead of Carshield, Northumberland, which now takes the sixth place. It may be mentioned that during last year things were in a somewhat unsettled, not to say critical, state at the Carshield and Nenthead mines, which both belong to the powerful Vieille Montagne Company. The question of abandoning the district had been under consideration, but we are pleased to be able to state that it has been decided to keep on the mines, and a considerable sum of money is now being spent on development work, and the erection of a new dressing mill. This decision, it goes without saying, is of great moment to the population of the isolated village of Nenthead, which depends so largely upon the mines. In 1904 the Nenthead mine was by far the largest producer of blende in Great Britain, with 7322 tons, and with 4140 tons from Carshield, the output of the Belgian company was 11,462 tons, the bulk of which was exported to Belgium for smelting. Teesdale has never been noted for zinc production, but last year 50 tons of blende were raised at Willy Hole mine, belonging to the Teesdale Lead and Zinc Company, Limited. In Derbyshire Mill Close produced 629 tons of 45 per cent. ore, the value of which is given as £786. There seems to be something wrong about this, although the ore is certainly complex. In Cardiganshire the old established Cwmystwyth mine, Devil's Bridge, shows a considerable increase over the preceding year, and now that the county has attracted London and Glasgow capital, it is possible that its mines may revert to something of their former prosperity, with which remark we bring this somewhat lengthy review to an end.

BRITISH AND FRENCH RAILWAY SPEED IN 1909.

The information below preserves the continuity of that formerly furnished annually by the late Mr. Rous-Marten, and endeavours to maintain the high standard of accuracy attained by that gentleman.

The review of the British and French train services covers the summer of 1909, and also the so-called winter programmes, which are arranged to last from October 1st in this country, and from November 1st in France, of the present year, until the summer alterations of 1910 come into force.

The best performances on British railways, as a rule, are found in the summer time-table. On one or two of the French railways the fastest running is, however, performed during the winter and spring, as dictated by the demand for swift luxurious travel to and from the Riviera, &c. Accordingly, runs which are performed only during the summer, or only during the remainder of the year, are duly noted.

The tables enumerating the fastest booked start-to-stop runs are a little differently arranged than hitherto, with the object of giving a better or more representative idea of the locomotive work accomplished by the respective companies. This aim, we think, will be fulfilled by firstly furnishing tables which exclude runs of less than 50 miles in length.

Table A.—*Fastest Booked Start-to-stop Runs of not less than 50 miles in Length on British Railways in 1909.*

Company.	Run.	Miles.	Time occupied.	Speed, miles per hour	Train.
			h. m.		
Great Western	Leamington to Ealing (Broadway)	100⅜	1 41	59·6	4 30 p.m.
North-Eastern	York to Newcastle	80½	1 22	58·9	9.48 p.m.
Great Northern	Grantham to Doncaster	50½	0 52	58·2	4.26 p.m., Sats. only
London and North-Western...	Willesden to Coventry...	88½	1 32	57·7	9.31 a m.
Great Central	Marylebone to Leicester *viâ* Wycombe ..	107½	1 52	57·5	6.20 p.m.
London and South-Western ..	Andover to Vauxhall	65	1 8	57·4	3.25 p.m.
Midland	St. Pancras to Kettering	72	1 16	56·8	3.30 p.m., W*
Caledonian	Perth to Aberdeen	89¾	1 37	55·9	5 58 a.m.
Great Southern and Western...	Ballybrophy to Mallow	77¾	1 28	53·0	12.32 p.m., S†
Glasgow and South-Western...	Carlisle and Kilmarnock	91¼	1 46	51·5	8 p.m. North, and 2 6 p.m. South
Brighton	Victoria and Brighton	51	1 0	51·0	11 a.m. D,‡ 1.20 p.m. and 5 45 p.m. U §
Great Eastern	Liverpool-street to Norwich (Trowse) ...	114	2 14	49·9	9 50 a.m , S†
Lancashire and Yorkshire ...	Wakefield to Manchester	48	0 58	49·6	11.55 a.m. and 2 45 p.m., Sats. only East, 3.22 p.m. West, S,† 3 22 p.m. West, W*
South-Eastern and Chatham...	St. Paul's to Margate	73½	1 33	47·4	5.10 p.m.
North British	Edinburgh to Carlisle	98¼	2 11	45·1	9.30 a.m., S†
Mid. G.W. (Ireland)	Mullingar to Dublin	50	1 14	40·5	5.58 p.m.

* W = Winter, from Oct. 1st, 1909. † S = Summer, 1st July to 30th Sept., 1909. ‡ D = Down direction. § U = Up direction.

Table B.—*Fastest Booked Start-to-stop Runs of not less than 50 miles in Length on French Railways in 1909.*

Company.	Run.	Miles.	Time occupied.	Speed, miles per hour	Train.
			h. m.		
Northern	Paris to St. Quentin	95¾	1 35	60·5	1.50 p.m.
Paris-Orleans	Bordeaux to Angoulême	86¼	1 29	58·1	4.25 a.m.
P.L.M.	Dijon to Mâcon	77¾	1 23	56·2	12 58 p.m., W
Eastern	Paris to Chalons	107½	1 55	56·0	9 a.m.
State (Western)	Paris and Rouen	86¼	1 36	53·9	8.16 a.m. D, and 9.56 p.m. U
State (Old System)	Chartres to Thouars	147¾	2 47	53·0	12.9 p.m.
Southern	Dax to Bordeaux	92	1 48	51·1	12.53 p.m.

In Table A, however, we include the Lancashire and Yorkshire Railway, although it has no run of the standard length.

Table C enumerates runs of less than 50 miles in length by the respective British companies, which yield a higher rate of speed than they are credited with in Table A on the longer standard, and also the fastest running by those companies which possess no express run 50 miles in length.

Table C.

Company.	Run.	Miles.	Time occupied.	Speed, miles per hour	Train.
			h. m.		
North-Eastern	Darlington to York	44½	0 43	61·7	1.8 p.m.
Caledonian	Forfar to Perth	32½	0 32	60·9	7.2 p.m.
Great Central	Leicester to Nottingham	23½	0 24	58·7	2.13 p.m.
Lancashire and Yorkshire...	Liverpool and Manchester	37	0 40	55·4	23 trains
Cheshire Lines	Manchester to West Derby	31¼	0 34	55·1	5.10 p.m.
Great Eastern	Doncaster to Haxey	13½	0 15	54·0	5.24 p.m.
South-Eastern and Chatham	Tonbridge to Ashford	26½	0 30	53·0	4.53 p.m.
Belfast and Northern Counties ..	Londonderry to Coleraine	33½	0 41	49·0	3.20 p.m., S
Great Northern (Ireland)	Drogheda to Dublin	31¾	0 39	48·8	6 56 p.m.
Somerset and Dorset	Blandford to Evercreech	27¼	0 34	48·0	10.22 a.m.
Hull and Barnsley	North Cave to Carlton	16	0 20	48·0	5.30 p m.
Tilbury and Southend	Fenchurch-street to Westcliff...	34¾	0 46	45·3	5.5 p.m.
Mid. G.W. (Ireland)	Mullingar to Athlone	28	0 38	44·2	8.21 a.m.
G.N. Scotland	Huntley to Inveramsay	20¼	0 27	45·0	4 9 p.m.
Highland	Blair Atholl to Perth	35¼	0 51	41·4	11.5 a.m.

A similar table to the above is not required for the French companies, as none possesses a faster booked run than scheduled in Table B.

Analysing the British and French runs, which are booked at a rate of speed of not less than 60 miles per hour, it is found that, for the first time since this comparison was drawn in these columns, France has lost her considerable lead, and, indeed, during the summer had fallen behind this country.

Unfortunately, this altered state of affairs is not due to an increase of British mile-per-minute timings, but to slight decelerations on the Northern Railway of France, which permeate the whole of its service except that between Calais, Boulogne, and Paris.

Last year the French mileage at this speed totalled 519¾, made up as follows:—Longueau to Arras, 41¼ miles, in 40 minutes, speed 61.9, then the fastest run in France; Paris to Longueau, 78¾ miles, in 78 minutes, speed 60.6; Paris to St. Quentin, 95¾ miles, in 95 minutes, speed 60.5, performed three times; and Paris to Busigny, 112½ miles, in 112 minutes; speed 60.3. Only one of the above runs remains, viz., Paris to St. Quentin. The quickest timing between Longueau and Arras now is 42 minutes, speed 58.9; that from Paris to Longueau takes 81 minutes, speed 58.3; the two others from Paris to St. Quentin have dropped to 97 and 98 minutes respectively; and that from Paris to Busigny is allowed 114 minutes, speed 59.2.

The British runs at 60 miles per hour are, as before, viz.:—

Darlington to York ...	44¼	miles in 43	min.,	speed 61.7
Forfar to Perth	32½	,, 32	,,	,, 60.9
York to Darlington ...	44¼	,, 44	,,	,, 60.3
Total	121			

But from October 1st the York—dep. 9.13 p.m.—to Darlington run has been re-timed to take 45 minutes, speed 59.0, so that at the present moment France again leads with a mileage of 95¾ against ours of 76¾. The longest non-stop runs performed by the principal British and French railway companies are given in Table D.

The old main line of the French State Railways is the only continental railway equipped with track troughs. The Eastern Railway shows a train running from Paris to Chaumont—162¾ miles—without an advertised stop, in 3 h. 6 min., speed 52.5 miles per hour, but it really calls at Troyes—104 miles from Paris—for water.

Table D.—*Longest Non-stop Runs.*

Miles.	British companies.	Run.	Time occupied.	Speed, miles per hour
			h. m.	
225¾	Great Western	Paddington to Plymouth (North Road) *viâ* Westbury	4 7	54·8
S 209¼	London and North-Western	Euston to Rhyl	3 57	52·9
S 206½	Midland	St. Pancras to Shipley (Curve)	4 5	50·5
175¾	Great Northern	Wakefield (Westgate) to King's Cross...	3 9	55·7
164¾	Great Central...	Marylebone to Sheffield *viâ* Aylesbury	2 57	55·8
150¾	Caledonian	Carlisle to Perth	3 0	50·2
S 130	Great Eastern...	Liverpool-street to North Walsham	2 38	49·3
124½	North-Eastern	Newcastle to Edinburgh	2 18	54·1
108	London and South-Western	Waterloo to Bournemouth (Central)	2 6	51·4
S 98¼	North British	Edinburgh to Carlisle	2 11	45·1
91¼	Glasgow and South-Western	Kilmarnock to Carlisle	1 46	51·5
86¾	Great Southern and Western	Thurles to Dublin	1 40	52·0
81¾	Brighton	Clapham Junction to Fratton	1 52	45·0
76½	South-Eastern and Chatham	Cannon-street to Dover	1 38	46·2
	French companies.			
147¾	State (Old System)	Chartres to Thouars	2 47	53·0
S 136½	State (Western)	Trouville to Paris	3 7	43·8
120	Northern...	Arras to Paris	2 3	58·5
112¾	Eastern	Chaumont to Belfort...	2 11	51·6
106	P.L.M.	Laroche to Paris *viâ* Héricy	1 59	53·4
92	Southern	Dax to Bordeaux	1 48	51·1
86¼	Paris-Orleans	Bordeaux (St. Jean) to Angoulême	1 29	58·1

NEW CEMENT MILL NEAR MONTREAL.

That American capital appreciates the prospect of the extended use of cement in Canada is shown by the Vulcan Portland Cement Company of New York, which has recently erected a new mill at Longue Point, just beyond the eastern limits of Montreal, at a cost of considerably over a million dollars. The mill is designed for a capacity of 650,000 barrels per annum, and is now in operation. This makes the twenty-third mill now manufacturing Portland cement in the Dominion.

It is evident that the greatest care has been used throughout in the design of this plant, labour-saving devices having been introduced wherever economy would result thereby. The plant is noteworthy in many ways, but of all features its immense reinforced concrete stock house for the storage of finished product stands out predominantly. It is believed that this stock house is the largest of its kind ever constructed.

The plant, of which two general views are given in Figs. 14 and 15 and a plan in Fig. 1, is erected on level ground about half a mile north from the bank of the St. Lawrence River, and is intersected by two lines of railway, the Terminal — an electric railway — and the Canadian Northern Quebec—a standard steam railway. A spur of the electric line runs down to the river. The transportation facilities thus offered enable the company to handle both incoming and outgoing materials to the best advantage. The coal supply is brought by vessels to the company's own dock at the river's edge. The same dock is also employed in making cement shipments by water.

On the north side of the railway lines are the factory offices, the crusher house, the clay storage house and the stone house. To the north of the crusher house is the quarry. The mill building, kiln building, clinker storage, coal storage, coal mill, stock house, transformer house, machine shop and stores are on the south side of the lines. The two parts of the plant are connected by a tunnel under the railways, joining the stone house with the mill building.

The office building is 45ft. by 55ft., of one storey, and of concrete; the clay storage building measures 150ft. by 48ft.; the crusher house, 140ft. by 60ft.; and the stone house, 178ft. by 80ft. They are all on concrete foundations, and have steel skeletons sheeted with corrugated iron. The mill building is 100ft. by 144ft.; the kiln building, 85ft. by 162ft.; the clinker storage, 120ft. by 120ft.; and the coal building, 50ft. by 50ft. These are all steel structures covered with corrugated iron and erected on concrete foundations. The machine shop, transformer house and stock house are of reinforced concrete, being of the following dimensions respectively:—92ft. by 51ft., 45ft. by 46ft., and 242ft. by 105ft. Provision has been made in each case for possible future extensions.

Coal is unloaded from vessels at the company's dock into a hopper, as will be seen by reference to the plan of the dock and coal-handling lines, Fig. 2. The hopper in turn empties into dump-cars running on an inclined trestle into the field of a cableway. By means of a heavy weight lifted by the loaded car on its outward journey the empty car, after dumping, is automatically returned to the hopper. This cableway serves an area 700ft. by 300ft., such a large coal piling ground being necessary from the fact that the whole year's run has to be brought during seven months of navigation season. The coal is transferred by the company's locomotive from the cableway piling ground to the works as required.

Fig. 2 shows how the coal is handled by the cableway to the hopper-bottomed coal cars.

On arriving at the works the cars are run on to an elevated trestle under which is a hopper, beside the coal mill—see Fig. 3. Leading from the hopper is a belt conveyor discharging into a Jeffrey crusher within the building. The crushed coal is then raised by a bucket elevator into a rotary dryer, afterwards passing over a screen to one of three pulverising mills. The coal mill has a capacity of 9 tons per hour. From the mill the coal dust, 95 per cent. of which will pass a standard sieve of 10,000 meshes per square inch, is brought by screw conveyors to one of four coal tanks situated one at the end of each of the rotary kilns in the kiln building, ready for blowing into the kilns.

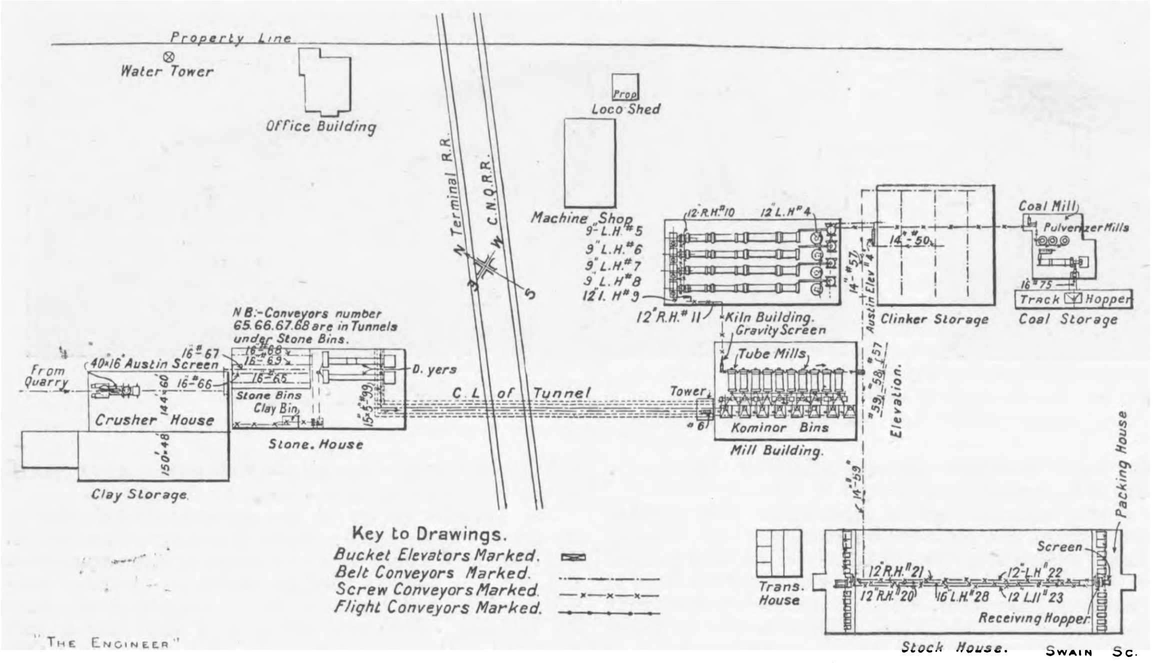

Property Line
Water Tower
Office Building
Loco Shed
Machine Shop
Terminal R.R.
C.N.Q.R.R.
Coal Mill
Pulverizer Mills
Clinker Storage
Coal Storage
Track Hopper
Kiln Building
Gravity Screen
Tube Mills
Kominor Bins
Mill Building
Tower
Elevation
N.B.:-Conveyors number 65.66.67.68 are in Tunnels under Stone Bins.
From Quarry
40×16 Austin Screen
Crusher House
Stone Bins
Clay Bin
Stone House
C. L. of Tunnel
Clay Storage
Packing House
Screen
Trans. House
Receiving Hopper
Stock House.
Key to Drawings.
Bucket Elevators Marked.
Belt Conveyors Marked.
Screw Conveyors Marked.
Flight Conveyors Marked.
"The Engineer"
Swain Sc.

Fig. 1—PLAN OF THE VULCAN CEMENT WORKS, NEAR MONTREAL

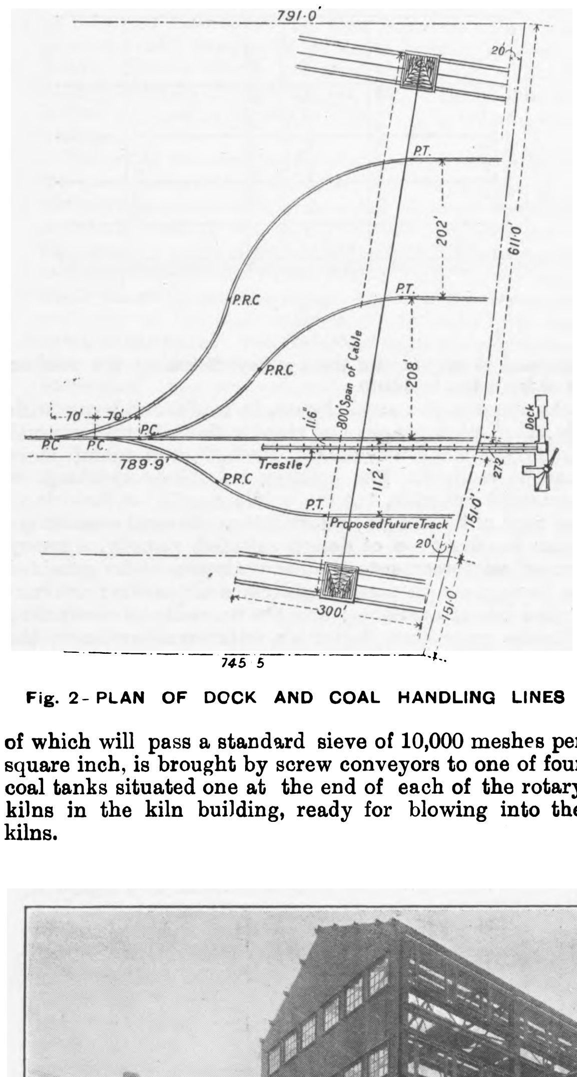

791·0'
P.T.
202'
611·0'
P.R.C.
208'
P.C.
789·9'
Trestle
800' Span of Cable
Proposed Future Track
300'
1510'
745 5

Fig. 2 - PLAN OF DOCK AND COAL HANDLING LINES

The plant is operated by electric power furnished by the Shawinigan Falls Power Company. Current is delivered at the transformer house at the cement works at 40,000 volts, and it is stepped down to 440 volts for use throughout the works. Generally speaking, each machine is operated by its own independent motor. Line shafts are conspicuous by their absence. About 2500 horse-power are required to operate the whole plant when it is running to its full capacity.

From the railway lines northwards for an average width of 900ft. over a length of two miles a stratified limestone rock underlies a few feet of clay and gravel. The limestone is remarkably well adapted for Portland cement manufacture, requiring very little correction. Moreover, we gather that sometimes the actual rock as quarried contains the requisite proportion of materials. In fact, at the time of the visit of our representative the mill was actually running on natural rock. The average analysis of the rock is calcium carbonate 75 per cent., silica 18 per cent., iron, aluminum, and organic matter 7 per cent. Tests have been made systematically over the area by diamond drills to a depth of 125ft. below the surface, proving the property to be a practically inexhaustible quarry for the plant. The rock quarries very readily. At the time this article was written the quarry run was dumped by carts into a hopper at the lower end of a 24in. belt conveyor. On arriving at the upper end of this conveyor, after travelling 200ft., the rock is shot automatically into the hopper of a No. 7½ Austin gyratory crusher, which reduces it to 3½in. and less. It then passes in turn by gravity through a revolving screen to a No. 3 crusher of the same type, where it is further reduced to 2½in. The tailings from the screen and from the second crusher discharge at the lower end of a 16in. belt conveyor, which carries it to the stone house. On reaching this building the crushed rock is delivered into any one of six stone bins having a capacity in all sufficient to make twenty thousand barrels of clinker. The bins are of reinforced concrete. Under the floor of the bins are four tunnels, in each of which is a conveyor. Turning at right angles, the rock is brought to a series of automatic weighing machines arranged on the west side of the building. At this point the necessary amount of clay, should any be required, is automatically added to the rock, the amount being determined by the chemist from frequent analyses of the quarry run. Dry clay, obtained on the property, is stored in a 20-ton bin near the clay weighing machine, to which it is brought by a small screw conveyor. The stone weigher and clay weigher each work at the same speed, discharging automatically and simultaneously into a hopper, the delivery of which is on to another 16in. belt conveyor which has its outlet at the stone driers. After passing these driers,, which are of the rotary type, the raw product is ready for the grinders, to which it travels on a 16in. belt conveyor. The stone and clay bins of this building have been made large enough to ensure a sufficient supply of raw material being at hand so as to guard against unfavourable weather or trifling mishaps at the quarry end. It also obviates Sunday work at the quarry. Exclusive of the quarrying, and from the time the rock is delivered into the hopper of the first conveyor until the raw materials are ready for the grinders, it is worthy of remark that the work of only five men is required. These men seem to be employed largely in keeping everything in order and watching the machines.

The grinding mill building contains eighteen grinding machines, eight kominor mills—see Fig. 16, page 690—and ten tube mills—Fig. 17. Every one of these has its individual motor, each of the former requiring 75 horse-power, and each of the latter 150 horse-power. A novel feature of the setting of the tube mills is the height above the floor at which they are placed, this being sufficient to enable a horse and cart to be driven directly under the battery and stopped at any one, so that the flint balls used for grinding may be readily passed from the cart into the mill through a manhole provided for the purpose. The belt conveyors are also arranged in a manner worthy of notice. The grinding department serves the whole plant, pulverising both the unburnt mixture and the clinker. The conveyors are arranged so that any particular machines may be run on the material desired. Each grinder has its own bin and automatic feeding device. Having passed through a tunnel connecting the stone building with the mill building, the raw mixture is elevated to the top of the latter building and carried again by belt conveyors to any one of the eight kominor bins. After being reduced by the kominor machines it is discharged over a screen into the tube mill bin. In its journey through the tube mill it is further reduced to a sufficient fineness to pass 95 per cent. through a standard 10,000 mesh sieve. Leaving the tube mill, again passing over a

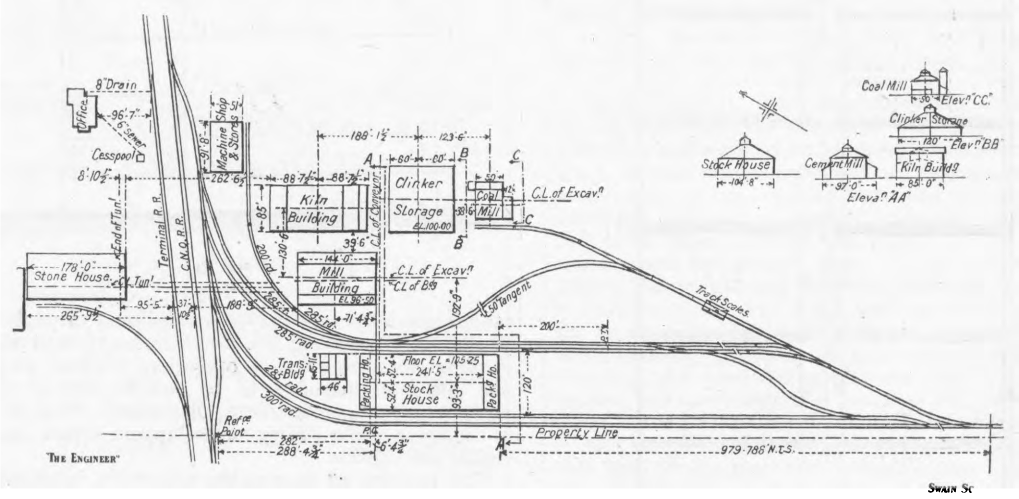

Office
Cesspool
Terminal R.R.
C.N.Q.R.R.
Machine Shop & Stores
Kiln Building
Clinker Storage
Coal Mill
C.L. of Excav.
Mill Building
Stone House
Trans. Bldg.
Packing Ho.
Stock House
Property Line
979·786' N.T.S.
Stock House
Cement Mill
Kiln Bldg.
Clinker Storage
Coal Mill
Elev. "CC"
Elev. "BB"
Elev. "AA"
Track Scales
The Engineer
Swain Sc.

Fig. 3—CEMENT BURNING, GRINDING, AND STORING DEPARTMENTS

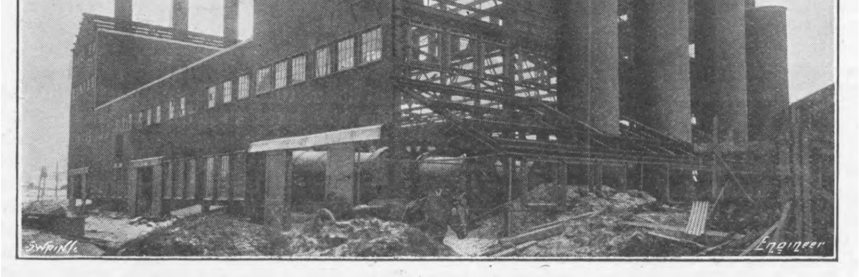

Swain Sc.
Engineer

Fig. 4—THE KILN BUILDING, WITH CLINKER COOLERS

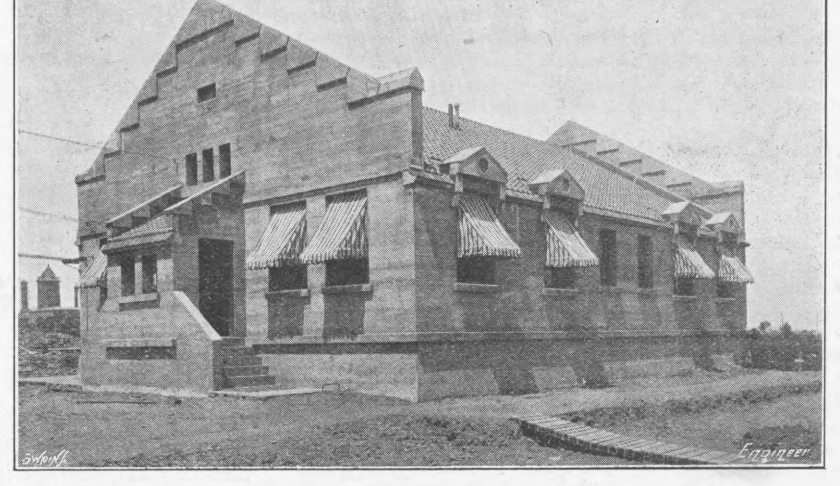

Swain Sc.
Engineer

Fig. 5—THE OFFICE BUILDING

screen, the raw meal enters a screw conveyor for its passage to the kilns.

There are four rotary cement kilns, each 125ft. long, 7ft. 6in. diameter at the front, and 7ft. at the rear—see Figs. 4, 18, and 19. These machines are all mounted on concrete foundations, and are driven by a 75 horse-power motor through Moore and White variable-speed cones. Arriving by the screw conveyor at the desired machine the raw meal is fed into the upper end of the kiln, where the temperature is about 600 deg. Fah. At about 20ft. to 30ft. from the front of the kiln it becomes subjected to a temperature of about 3000 deg. Fah., and finally turns to clinker about 10ft. from the discharge end. The coal to provide the heat is blown into the lower end of the kiln at a pressure of 6 oz. per square inch. The ignition takes place immediately. From each kiln the clinker falls into a pit, whence it is taken by a bucket conveyor to its corresponding clinker cooler, one of which is provided for each kiln. Each cooler is 7ft. 6in. in diameter, 32ft. high, and has a cooling tower up the centre, fed by a 16in. cool air blast. It will be noticed on the engravings—Fig. 4—that these coolers are almost entirely outside of the building. On reaching the bottom of the cooler the clinker has been reduced in temperature to that of the outside air.

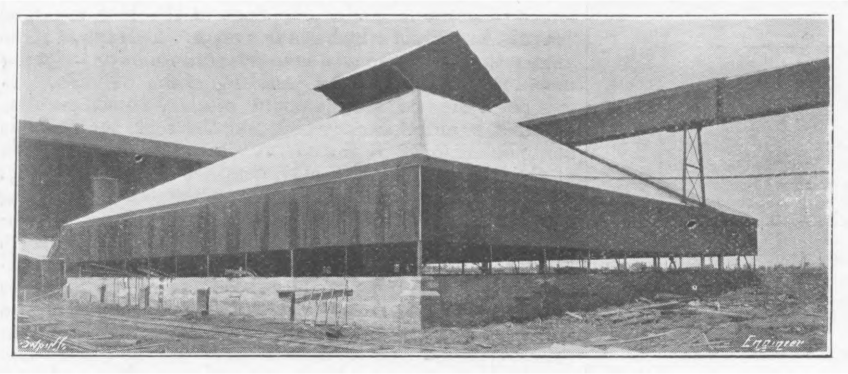

Swain Sc.
Engineer

Fig. 6—THE CLINKER STORAGE BUILDING

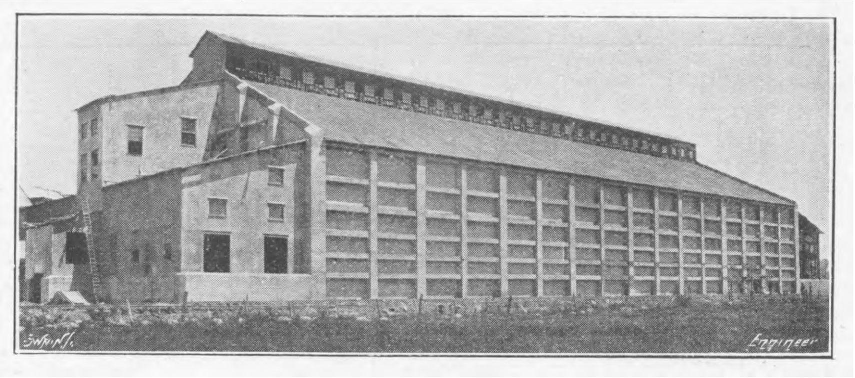

Swain Sc.
Engineer

Fig. 7—THE CEMENT STOCK HOUSE

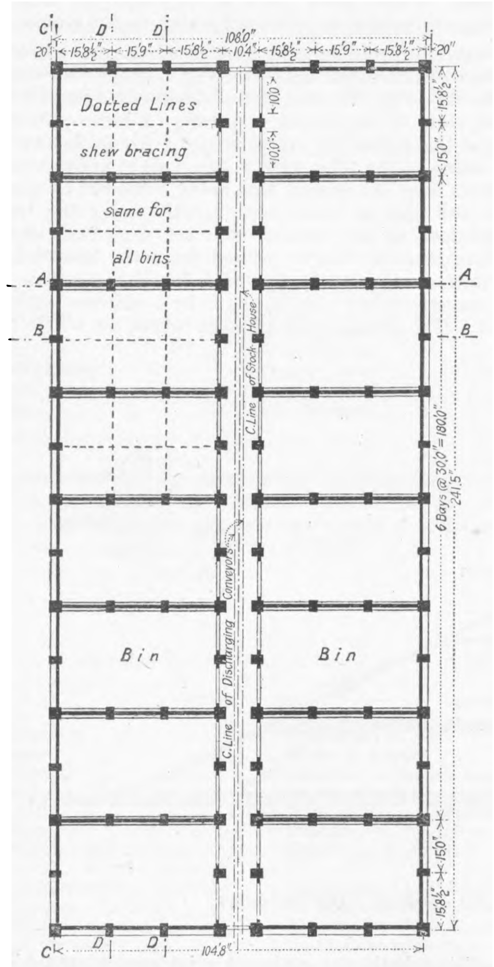

C
D
D
A
B
Dotted Lines
shew bracing
same for
all bins
Bin
Bin
C. Line of Discharging Conveyor
C. Line of Stock House
6 Bays @ 30'0" = 180'0"
108'0"
104'8"

Fig. 8—PLAN OF THE CEMENT STOCK HOUSE

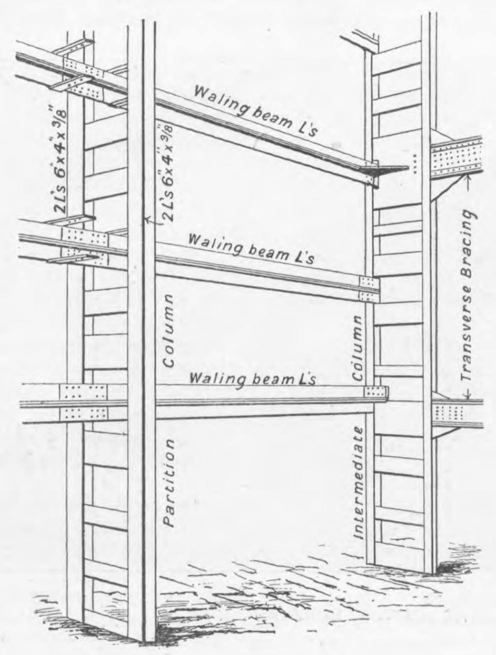

Waling beam L's
Waling beam L's
Waling beam L's
2 L's 6"x4"x3/8
2 L's 6"x4"x3/8
Column
Column
Partition
Intermediate
Transverse Bracing

Fig. 9

A special safeguard against accident has been provided in the erection of a large clinker storage, with a capacity of clinker sufficient for 75,000 barrels of finished product—see Fig. 16. Ordinarily a supply of clinker is kept in this building. However, if desired the burnt product may be taken directly to the grinding department. In either case belt conveyors are used, these being arranged so that any of the kominor machines may be worked on the clinker, and similarly any of the tube mills. Having passed the latter, the cement is finished and ready for disposal.

Mention has already been made of the fact that manual labour has been reduced to a minimum throughout the plant. After leaving the stone house, fifteen men are required to complete the operation to this stage. So the plant is intended to be run by twenty men per shift in the actual manufacturing process. This, of course, is exclusive of the quarry men, shippers, repair men, dock hands and clerks.

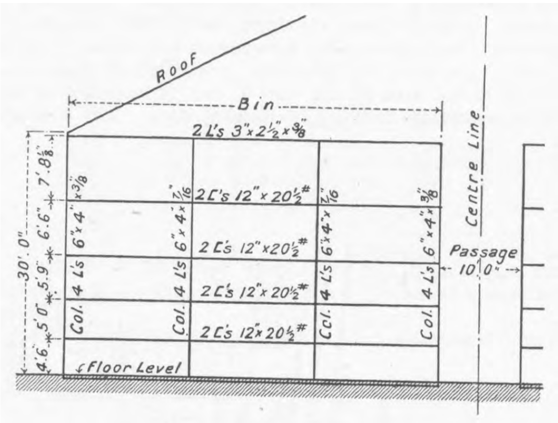

Roof
Bin
2 L's 3"x2½"x3/8
2 C's 12"x20½#
2 C's 12"x20½#
2 C's 12"x20½#
2 C's 12"x20½#
Col. 4 L's 6"x4"x3/8
Col. 4 L's 6"x4"x3/8
Col. 4 L's 6"x4"x3/8
Col. 4 L's 6"x4"x3/8
30'0"
Floor Level
Centre Line
Passage
10'0"

Fig. 10

The cement, on leaving the tube mills, is brought by a screw conveyor to a belt conveyor leading to the top of the cement store or stock house, as it is called—see Fig. 7—where in turn a screw conveyor runs the whole length of the building, and is able to place the cement in any of the sixteen bins into which the building is divided. The stock house gives an immense reserve supply, holding when full 320,000 barrels of cement. From the bins the cement is taken as required by two screw conveyors operating in tunnels under the centre of the floor to the packing house at either end of the stock house. In each packing house is a battery of hoppers receiving their supply from conveyors connected with those last mentioned, which enables the bagging to proceed rapidly. The sidings along either end of the packing houses furnish a convenient means of access to the cars. It is quite unusual to have such a storage capacity, but the Vulcan Company has adopted it as its policy in its American mills to keep a heavy stock for the double purpose of ensuring perfect seasoning in bulk and enabling it to ship any order on the shortest notice.

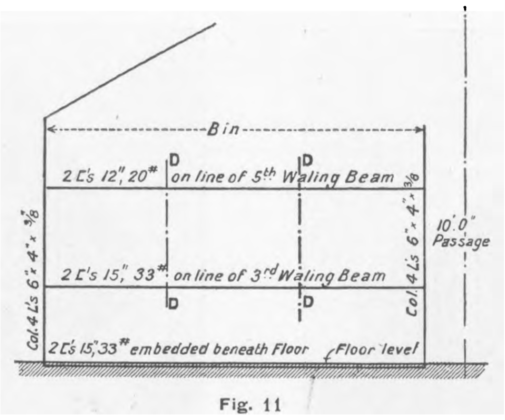

Bin
D
D
2 C's 12", 20# on line of 5th Waling Beam
2 C's 15", 33# on line of 3rd Waling Beam
D
D
Col. 4 L's 6"x4"x3/8
Col. 4 L's 6"x4"x3/8
10'0" Passage
2 C's 15", 33# embedded beneath Floor
Floor level

Fig. 11

The engraving Fig. 5 shows the design of the office. The building is entirely of concrete. The interior is plastered with cement. All floors are of "doloment." Hardwood ornamentation has been used throughout, and finished in the natural colour of the wood. Hot water heating, electric light, and even a shower bath make the building attractive and comfortable for the office staff. The interior is divided by a central hall, on one side of which are the executive offices, the other containing very complete chemical and physical laboratories. The timekeeper's and paymaster's department at the rear overlooks the entrance where all the workpeople are required to register their coming and going on time clocks.

The peculiar design of the pyramid-shaped clinker-storage building—Fig. 6—makes it worthy of description. The floor is of concrete, undermined by three transverse and one side tunnels, through which, by means of conveyors of the belt type, the clinker may be drawn from the building. The superstructure of steel has a very steep roof, with provision for ventilation on all sides. The apex of the roof is supported by a tower standing in the middle of the floor. A belt conveyor leads to the centre of the tower, and delivers the clinker to a spout, which may be revolved to discharge the clinker in any part of the building. Adjacent to the kiln building is a cross wall 5ft. high, to serve as a retaining wall for the clinker pile, and to provide for the conveyors taking the clinker to or from the building.

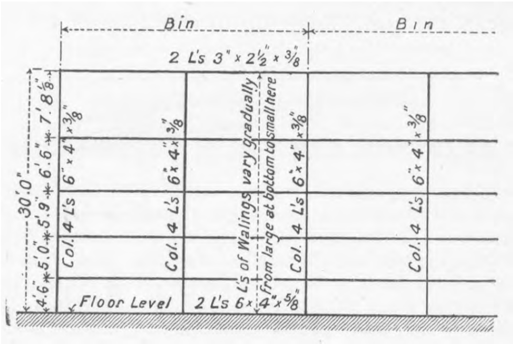

Bin
Bin
2 L's 3"x2½"x3/8
Col. 4 L's 6"x4"x3/8
Col. 4 L's 6"x4"x3/8
Col. 4 L's 6"x4"x3/8
Col. 4 L's 6"x4"x3/8
L's of Walings vary gradually from large at bottom to small here
30'0"
Floor Level
2 L's 6"x4"x5/8

Fig. 12

As regards the stock house, it is difficult even with the aid of photographs and plans to describe this unusual building in such a way that its strength and massiveness may be realised. The building is, strictly speaking, of reinforced concrete, but the reinforcing is unusual from the fact of its being self-sustaining. Several reasons are given for the type of design selected, namely, a heavy riveted reinforcement—the heavy stresses to be provided for throughout in shear, bending, and tension; the unskilled labour available; and the necessity of conducting concrete operations during an unfavourable season, the winter. The arrangement adopted afforded the combined advantages of definite immovable placement of the steel and the elimination of a large amount of scaffolding otherwise necessary to support and brace the forms for the concrete.

It will be seen by referring to the plan of the building seen in Fig. 11, and to a larger scale in Fig. 8, that there is a central passage of about 10ft. width running lengthwise of the building. The side bays thus formed are divided by partition walls to make eight rooms or bins on each side. These bins, 35ft. deep, may be filled with cement in any convenient way, a full bin being adjacent to one that is empty. If necessary the central passage may also be filled. From these conditions it will be seen that the partition walls will be subjected to the same amount of loading from either side, while the outside walls must always have their load from one direction. The walls along the central passage have the same conditions of stress as the outer walls, since the passage will never be filled until after all the bins are full, and it must be emptied before any of the bins can be reached. These loading conditions resulted in the partition walls being designed of a section symmetrical about the central vertical plane, while all other walls are of unsymmetrical section.

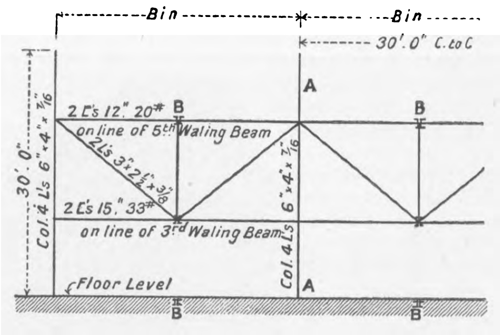

Bin
Bin
30'0" C. to C.
A
B
B
2 C's 12" 20#
on line of 5th Waling Beam
2 L's 3"x2"x3/8
2 C's 15" 33#
on line of 3rd Waling Beam
Col. 4 L's 6"x4"x7/16
Col. 4 L's 6"x4"x7/16
30'0"
Floor Level
A
B
B

Fig. 13

The general arrangement places the partition walls at 30ft. centres.

The foundations are of 1:3:5 concrete, sufficiently large in dimension to distribute the loads on a stiff blue clay foundation 6ft. below the natural surface of the ground. Details of the steel reinforcement are given in the sketches—Figs. 9, 10, 11, 12 and 13. The bents are tied together both transversely and longitudinally of the building as indicated, the braces in the interior of the bins being left exposed. The whole is securely riveted together. Being exposed to the downward thrust of the cement, and possible bridging of it, the longitudinal bracing has diagonals introduced in it to care for the vertical stresses. It will thus be seen that the vertical elements of the main reinforcing consist of a series of posts 15ft. centres lengthwise of the building, tied transversely and longitudinally. The outer posts form the support for the steel roof trusses, 15ft. centre to centre. To the main vertical elements is attached a series of horizontal waling beams to provide for the horizontal stresses set up by the cement. The general position of these may be seen by referring to the engraving showing the exterior of the building—Fig. 7—the panelling showing the main members of the structure both vertically and horizontally. The first walings are at the floor, the next 4ft. 6in. above this, the spacing gradually increasing until the sixth waling near the eave is 7ft. 8in. above its neighbour. The gable walls are carried up above the roof line, and have one additional waling. All other walls stop at the level of the eaves.

The steel skeleton was manufactured in the usual way, except that where diagonal latticing would ordinarily be used, tie plates were substituted to join the component pieces of long members. Fig. 9 shows this departure in a pair of the columns in course of erection. Every column consists of four angles, for partition walls 6in. × 4in. × $\frac{7}{16}$in., and in all others 6in. × 4in. × $\frac{3}{8}$in. They are arranged in pairs with the longer legs outstanding. The partition columns have the short legs turned outwards, while in all other columns the inner pair stand the same way as the outer pair, that is, the short legs look towards the outside of the bin.

The heavy reinforcement of the waling beams in the partition walls consists of two 12in. channels at 20$\frac{1}{2}$ lb. per foot placed with flanges turned inwards. These channels are riveted to the posts, and are tied together at intervals with bolts. In this instance these walings are not really reinforced concrete beams, but are steel beams concrete filled. The reinforcement of all the other beams consists of two angles 6in. × 4in. × $\frac{5}{8}$in. in the lowest, decreasing to 3in. × 2$\frac{1}{2}$in. × $\frac{3}{8}$in. for the topmost waling.

The walls themselves are 10in. in thickness in all except the gable, where they are 11in., and form slabs to resist the cement pressures spanning the distance between the horizontal waling beams. The slab reinforcement, like the columns and walings, is symmetrical in the partitions and unsymmetrical for all the other walls. In the partition walls the slabs contain seven $\frac{3}{4}$in. rounds per panel on each side of the slab, extending vertically from bottom to top of the walls. For the other walls the reinforcement near the outer face is eight $\frac{3}{4}$in. rods continuous from top to bottom. For reverse stresses from continuous beam action these slabs are reinforced at each waling beam with eight rods per panel, $\frac{1}{2}$in. diameter and 3$\frac{1}{2}$ft. long.

The principal reinforcement of the main members above described is supplemented by $\frac{3}{8}$in. rods wound around the columns every 18in. vertically. The waling beams of the outer walls have, in addition to the heavy angles already mentioned, round rods placed as follows during the concreting:—For reverse reinforcements at the supports, four $\frac{3}{4}$in. rods, 6ft. long, placed near the inner face of the wall at the column; and binding stirrups for web reinforcement and bonding of angles to the concrete. The partition columns are finished 24in. by 40in. All others are 40in. by 45in., in every case of uniform size for the whole height. The thickness of concrete outside the heavy metal is 1$\frac{1}{2}$in.

The cement pressure in the bins is calculated from the following assumptions:—Cement, 100 lb. per cubic foot; angle of repose of cement, constant at 15 deg.; coefficient of friction between cement and plain walls, 0.55. Permissible stresses used were:—Concrete, compression, 800 lb. per square inch; shear in concrete, 70 lb. per square inch; steel in tension, 18,000 lb. per square inch; and ratio of moduli at 12.

The concrete for the superstructure was made 1:2:4, the largest size of stone being $\frac{3}{4}$in. The steelwork was left unpainted wherever embedded. During erection the columns and bracing were first set up. After the completion of the concreting the roof trusses were erected. The roof has steel purlins arranged in the usual manner, sheeted with plank and covered with a roofing composition according to the Barrett specification. The principal quantities of the reinforced concrete work of the stock house building are:—Concrete, exclusive of floors, 3570 cubic yards; riveted reinforcing, exclusive of roof, 510 tons; round rods, 103 tons.

This plant is controlled by interests which operate largely in the United States. The staff in charge have grown up with the company and graduated from the older plants. The sales department, of which Mr. W. H. Ford is in charge, in Canada has its office in the Bank of Ottawa Building, Montreal. Mr. S. R. Preston, who had the general design and arrangement of the plant in charge, is now managing the manufacturing operations. To these two gentlemen the writer is indebted for the information in this article.

Silico-manganese and silico-chrome in medium carbons have had considerable popularity abroad for springs and for gears for motor cars. They are also made in low carbons. Chrome steels in high carbons are much used for balls and ball races. Tungsten steels of special analysis are universally used for making magneto magnets.

THE ROYAL COMMISSION ON CANALS AND WATERWAYS.

No. XVII.*

THE FINAL REPORT (ENGLAND, WALES AND SCOTLAND).

The final report of the Royal Commission on the Canals and Inland Navigations of England, Wales and Scotland was issued on Tuesday, Dec. 28th, as a parliamentary paper (Cd. 4979). It is announced that the report of the Commission on Irish waterways will be issued at a later date, the delay being due, we believe, to the wish of the Commissioners to have the report of the Viceregal Commission on Irish Railways before them when preparing their own report on the canals.

The Royal Commission on the Canals and Inland Navigation of the United Kingdom was appointed on the 5th March, 1906 to report on:—

(1) Their present condition and financial position;

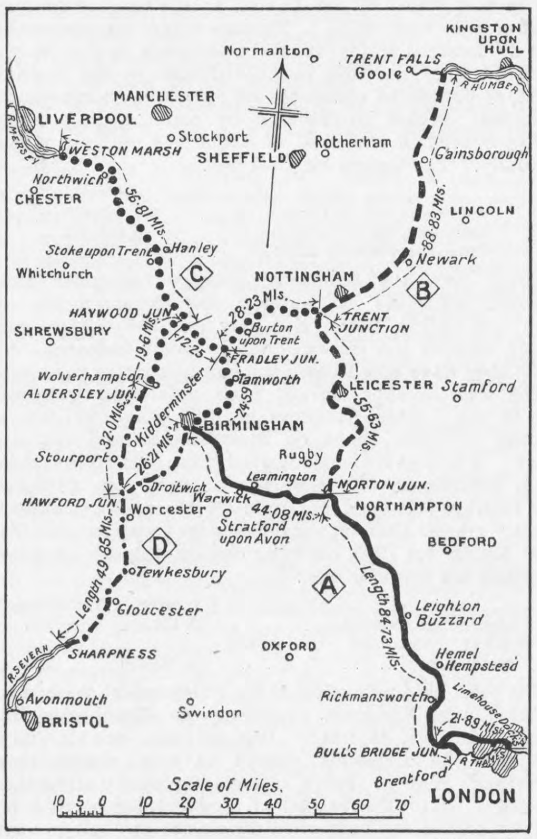
(2) The causes which have operated to prevent the carrying out of improvements by private enterprise, and whether such causes are removable by legislation;

(3) Facilities, improvements and extensions desirable in order to complete a system of through communication by water between centres of commercial, industrial or agricultural importance, and between such centres and the sea;

(4) The prospect of benefit to the trade of the country compatible with a reasonable return on the probable cost; and

(5) The expediency of canals being made or acquired by public bodies or trusts, and the methods by which funds for the purpose could be obtained and secured; and what should be the system of control and management of such bodies or trusts.

The chairman of the Commission is Lord Shuttleworth, and the members are Lord Brassey, Lord Farrer, Sir John Dorrington, Sir John Brunner, M.P., the Rt. Hon. Russell Rea, M.P., who was chairman of the Committee on the Port of London Bill, 1908, Sir W. J. Crossley, M.P., formerly a director of the Manchester Ship Canal, Sir John Wilson, Sir Francis Hopwood, K.C.M.G., K.C.B., Permanent Under-Secretary of State for the Colonies, Mr. J. F. Remnant, M.P., a late member of the L.C.C. and chairman of S. Allsopp and Sons, Limited; Mr. Snowden, M.P., Mr. H. Vivian, M.P., Mr. L. A. Waldron, M.P., chairman of the Grand Canal Company, Ireland; Mr. R. C. H. Davison, M. Inst. C.E, formerly engineer to the Royal Commission on the Port of London (1905); Mr. J. P. Griffith, M. Inst. C.E., engineer to the Dublin Port and Docks Board; Dr. A. T. Herbertson, Reader in Geography in the University of Oxford; Mr. J. C. Inglis, president of the Institution of Civil Engineers and general manager of the Great Western Railway; Mr. H. F. Killick, director of the Leeds and Liverpool Canal Company; and Mr. M. T. Minch, vice-chairman of the Kildare C.C. Lord Kenyon, one of the original members, resigned his seat on the Commission in 1908 on his election to the Board of the London and North-Western Railway Company. Mr. W. B. Duffield is the secretary to the Commission, and Mr. R. B. Dunwoody, A.M. Inst. C.E., engineer and assistant secretary.



THE "CROSS."

The Commission have held 106 sittings, 88 of which have been for the taking of the evidence of 266 witnesses, much of which has been summarised in previous articles of this series. There have also been numerous meetings of special committees, and the members of the Commission have made repeated visits to canals and waterways in many parts of the United Kingdom and on the Continent. The report of Mr. W. H. Lindley, the assistant-Commissioner, on the Waterways of the Continent, has already been dealt with in these pages.† The Commission have received reports from Sir John Wolfe-Barry and Partners on the cost of improving certain main canal routes, and the engineer to the Commission, Mr. Dunwoody, has made special investigation into the question of the water supply for enlarged canals and other engineering matters. His reports, with that of Sir John Wolfe-Barry and Partners and other appendices, will fill three volumes yet to be published. The Majority Report and all the separate minority reports are unanimous in bearing testimony to the excellent services rendered by Mr. Dunwoody, and the thanks of the Commission are also rendered to the Secretary, Mr. Duffield, and the others who have given valuable assistance.

THE MAJORITY REPORT.

The Majority Report is a document of 189 pages, and is signed by the chairman and fifteen other members, five of whom, however, make sweeping reservations. With these reservations and the three separate minority reports we propose to deal in another article. In our leading article in this issue we indicate the tenour of the views of those members who are opposed to the recommendations contained in the Majority Report.

Historical sketch.—The first part of the report consists of an historical sketch which forms an admirable *résumé* of the history of canals and inland waterways in this country. Much of the information contained in this section has already appeared in our earlier articles, and we shall only refer to the general remarks and conclusions of the Commissioners. The report points out that "the largest part of the existing canal system had been completed by the end of the eighteenth century, and the whole of it, with the exception of the Manchester Ship Canal and a few short cuts or arms, was completed before 1830, the year of the opening of the Liverpool and Manchester Railway. It is important to observe that in England and Wales practically all the artificial waterways were made by private enterprise, without any financial assistance from the Government, and, except with regard to some of the waterways in the eastern counties, primarily intended for arterial drainage, without any assistance from local rates. The same statement would by no means be true either of Scotland or Ireland. In Scotland the Caledonian Canal was constructed and improved entirely by means of grants made by Parliament, and the Crinan Canal was completed by means of similar grants. . . . Many, though by no means all, of the English canals were, in their earlier days, successful financially to a high degree, and their shares stood at a considerable premium."

Figures are quoted which show that the net revenue derived at this period from many of the waterways must have been considerable in proportion to the capital cost. This flourishing period in the history of waterways came to a gradual end as the railway era advanced, and everywhere the proportion of long-distance traffic to local traffic by water has become small. The waterways, on the whole, have had no share in the enormous increase of internal transport business which had taken place between the middle of the nineteenth century and the present time. On the other hand, the cost of transport to and from the ports had become of the greatest importance to inland manufacturers by reason of the immense increase in the imports of raw material for manufacturing purposes. As an example;—"To Birmingham and the surrounding districts and to other inland centres, the raw material of iron is of the highest importance. In the year 1892 the total pig iron produced in the United Kingdom from British ores was 4,041,178 tons, and that from foreign ores was 2,668,077 tons. In the year 1907, 5,126,949 tons were produced from British ores and 4,987,332 tons from foreign ores. . . . Manufacturers are tempted to move, and in some cases actually have moved, their works to places where, as in South Wales, Northumberland or Lancashire, coal is found in close proximity to seaports."

On the question of the early rivalry between canals and railways the report says:—"When the era of railways commenced the waterways had attained to the highest point of their prosperity. The canal companies had taken full advantage of the great superiority which they had over road traction, were charging high tolls to the public and conveyed a great traffic for long as well as short distances. As the development of the railway system advanced, it became evident that this position of advantage could not be maintained." Parliament showed its desire to preserve the competition of waterways with railways, and to give equal facilities to both competitors for traffic, but the canal companies took very small advantage of the powers to become carriers and to effect amalgamations with each other, although they did in many cases reduce their tolls, which in some instances were lowered to one-seventh of their former amount. In fear of the power of the railways to destroy their profits, in many cases they opposed Railway Bills in order to arrive at some arrangement in the interests of their shareholders. The result frequently was an actual or virtual transference of the waterway into the hands of the railway company. In other cases the canal companies took powers to convert their own waterways into railways. In the year 1846 Parliament allowed seventeen canals, of a total length of 774 miles, to come wholly or partially under railway control, and practically a third part of the waterway mileage was so transferred in the years 1845-7.

The multiplicity of authorities and the consequent impediments to through traffic is admitted on all hands. The report cites many instances of this, among them the fact that traffic despatched by canal from Birmingham to the Port of London has to pass over no less than seven waterways owned by different authorities. "Assuming that the waterways remain as they are in condition and administration, it is difficult to see that Parliament could do much more than it has already done by . . . . legislation to facilitate long-distance traffic, or by rail and water combined," for the English canal companies have never attempted to establish a clearing-house system under the powers given by the Act of 1888. Apparently they have not had sufficient energy or spirit of co-operation to do this, or else the relative smallness of through traffic has not made it seem worth the trouble. The canal companies, who themselves acted as carriers, at one time wished to establish a clearing-house; but the other non carrying companies were indifferent, and would not co-operate.

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* No. XVI. appeared December 24th.

† The Engineer, October 29th and November 12th, 1909.

The present condition of waterways in Great Britain.—The second part of the report deals with the present condition of the inland navigations, dividing them for the purpose of classification into:—

Canals	1927	miles.
Canalised rivers	1313	,,
Open rivers	813	,,
	4053	,,

The canalised waterways of England and Wales divide themselves into two nearly equal divisions—those with locks under 14ft. wide, or narrow canals, and those with locks over 14ft., or barge canals. Details are given of the present condition of the principal waterways and canals as regards traffic and in other respects. From them it appears that the commercial traffic on the Thames above Staines has become a very insignificant quantity, and on the Severn navigation, "notwithstanding the considerable sums which have been spent and the poor results achieved, the traffic has fallen off." The Trent Navigation Company have, up to the year 1906, spent £150,000 on river improvements, with the result that they do not pay any dividend on either their preference or their ordinary stock. As to the Yorkshire Ouse, "the profits on the traffic itself are small, . . . and the existing work on the river appears to be hardly sufficient to maintain it even in its present condition." As to the Bedford Ouse and the Nene, the account given in the report of these rivers may be summarised by the word deplorable. Coming to the canals and minor rivers, the Commissioners find that the Great Western Railway Company as owner performs, in so far as is practicable, its obligations in maintaining the Kennet and Avon Canal, on the score of which it has been so much blamed in the past. The neighbouring independent Wilts and Berks Canal is derelict, and the Thames and Severn Canal is practically so, in spite of strenuous efforts to revive its traffic; but, in the words of the report, "it is obviously difficult to revive a through traffic by water which has fallen into disuse."

The Oxford, Coventry, and Ashley canals are passed over with brief comment, and the Grand Junction, one of the most important of English canals, is stated to be well maintained and comes in for considerable praise. The Birmingham Canal, controlled by the London and North-Western Railway, comprising nearly 159 miles of narrow waterways, is reported to be generally in good order, and, in spite of complaints, the railway company "appear not to have failed to do their duty in dredging." The Shropshire Union canals are railway controlled, and "no serious complaints" concerning them were made to the Commission; indeed, one witness described them as the best managed in England. The River Dee Conservancy has an annual excess of expenditure over receipts, but the report states that "the question of the improvement of the Dee, both in the interests of the adjacent districts and in that of the inland navigation by the Shropshire Union canals, appears to us to deserve careful consideration." The North Staffordshire Railway Company is stated to maintain the Trent and Mersey Canal in very fair condition. The River Weaver Navigation is well maintained, but the cost of maintenance is heavy, amounting to £574 per mile. The Macclesfield Canal and others belonging to the Great Central Railway Company are in a fair condition, and the Midland Railway canals escape without censure. The abandonment of the Butterley tunnel on the Cromford Canal, proposed by the Midland Railway Company, is recommended in the report.[*] The only railway company owning canals in any way censured in the report is the Great Northern. "The company appear to do nothing to improve (their) canals, and to content themselves with merely providing bare repairs and maintenance. They confine themselves, in short, to the performance of their legal obligations in a more or less adequate fashion."

Coming to the northern canals, the Leeds and Liverpool seems to be well maintained; large sums have been expended upon it in recent years, and the maintenance charge has averaged £150 per mile for some years. The lack of adequate water supply stands in the way of further improvement. The traffic on the Bridgewater Canal has decreased since the construction of the Manchester Ship Canal, but the navigation is kept in good order. The Huddersfield Canal, belonging to the London and North-Western Railway Company, is kept up at a loss, but the Aire and Calder Navigation "carries a very large and increasing traffic. This success seems to be due to its natural position of advantage, energetically utilised by its owners in making costly improvements, and in themselves taking a vigorous part in the carrying trade." The Aire and Calder appears to be one of the few successful inland navigations in the country. As to the waterways of the eastern counties, the report states that the county is eminently suited to purposes of navigation. "It is also the part of England where authorities controlling waterways are the most chaotically multiplied, and when least is done by art to make use of the facilities offered by nature."

The Commissioners summarise their observations on the English and Welsh waterways in the following words:—"The foregoing review of the actual material condition of the English waterways at the present time shows the impediments thrown in the way of through or long-distance traffic by differences in sectional areas, size of locks, depth of channel, and general condition, by divided ownership of different waterways, and by the deteriorating condition and insufficient depth of channel in some sections of through routes. It is never easy to predict whether a cargo loaded at one point may not prove too heavy to be taken through to a distant point."

Coming to Scotch canals, the most important is the Forth and Clyde, now the property of the Caledonian Railway Company, which spends £12,000 a year in maintaining it. Since 1867, when it passed to the present owners, the traffic has decreased from three millions to one million tons per annum, notwithstanding energetic efforts on the part of the railway company to foster its trade. Of the other Scotch navigations, the Caledonian Ship Canal is maintained at an annual loss and the Crinan Canal at a small profit.

Financial position and traffic.—Part III. of the report deals with the financial position and amount and character of traffic on the existing canals. In this connection it must be noted that the tonnage of a cargo conveyed over more than one canal is counted in the returns to the Board of Trade of each canal over which it passes on a single journey. Thus the actual total traffic must be considerably less than the apparent.

While the total tonnage carried on the waterways remained practically stationary in amount between 1888 and 1905, the goods and mineral traffic on the railways increased from 281,747,439 tons in 1888 to 461,139,023 tons in 1905—an increase of 64 per cent. The Great Western Railway mineral and goods traffic in 1905 exceeded the total apparent traffic of the canals and waterways—39,498,926 tons—by over three millions of tons, and the figures of the London and North-Western Railway are still larger. As noted above, a part of the canal traffic is counted more than once. Twenty-one millions of tons of the canal traffic was taken by a small proportion of the canals—982 miles out of 5085 miles. The average length of haul of water-borne traffic is difficult to determine, owing to the absence of returns; but the report contains particulars for certain canals, from which it appears that the average is 17.4 miles on a length of 814 miles for which figures are available. "Almost the whole of the long-distance traffic is carried by railways or by the sea; canal companies only live in most cases by means of local or short-distance traffic, eked out in some cases by rents from house property, and in many cases they would gain rather than lose, as things now stand, by not having to maintain some portions of their waterways." To some extent the diminution of long-distance traffic on the waterways is due to the competition of coasting traffic, although in the main it must, of course, be accounted for by railway competition. The coal carried to London by canal is only about 0.10 per cent. of the total of about 15½ millions of tons annually. The figures for 1905 are:—

	Tons.
Rail-borne coal to London	7,137,473
Sea-borne coal to London	8,494,232
Canal-borne coal to London	18,681

Since 1880 the sea-borne tonnage has more than doubled, while the rail tonnage has increased by less than one million tons. Not only are the canals competing against the railway, but in many industrial districts they have now to face the competition of the roads.

The total revenue derived from canal and waterway tolls in the United Kingdom in 1905 was £921,006, as against £681,231 spent on maintenance and management. The net revenue derived from freight by those canal companies who themselves carry was £167,213. The tonnage conveyed per mile on the railway canals is slightly greater than on the independent waterways. The total figures for 1905, omitting certain mileage for which statistics are wanting, are:—

	Tonnage.	Mileage.
Independent waterways	20,434,411	1923
Railway controlled or owned waterways	13,702,356	1225

The total paid-up capital of the independent waterways of the United Kingdom, excluding the Manchester Ship Canal concerns, is nearly 19½ millions, and in most instances the dividends earned have in recent years decreased, and in some cases vanished altogether. Statistics as to the capital of, and dividends paid by, railway owned and controlled canals are difficult to summarise owing to their being so much mixed up with the finances of the railways.

The causes of decline.—Part IV. of the report deals with the causes which have operated to prevent the carrying out of improvements by private enterprise. The inquiries of the Commission as to the practicability of raising funds by private enterprise for the improvement of waterways have been met with the general reply that it is not possible, the reason usually given being that there is a complete want of faith in the future of canals on the part of the investing public. In the opinion of the Commission the causes of this want of faith are:—

"(1) The haphazard system by which canals were originally constructed, without any uniformity of gauge or locks, and their ownership by so many different authorities and companies; and the arrest of development and amalgamation in consequence of the advent of railways.

"(2) The situation which has been caused by the transfer of many important sections of the waterways to railway companies.

"(3) The kind of paralysis or arrest of development which has resulted from all these causes throughout the whole canal system."

As to the effect of railway control, the report continues:—"It would not, we think, be just to say that, in all or even in most cases, railway companies have failed to discharge the statutory obligations placed upon them . . . to maintain their canals . . . in good working condition. It cannot, we think, be said, broadly speaking, that the canals belonging to railway companies are, at present, worse maintained than are those which are controlled by local authorities, or those which belong to private companies. . . . It is possible that certain canals would not have been maintained at all had they not been in the hands of wealthy railway companies," and many instances are adduced to show the actual benefits derived from the fact of railway ownership. And again—"In most cases we can well believe that, as some of their representatives informed us, they—the railway companies—would not object to be rid of the canals if they could be sure that they would not be used as subsidised instruments of competition against them. It is not just to say, as some have said, that railway companies—except, perhaps, in a few instances—acquired canals in order to strangle them."

On the question of the effect of competition on rates the matter is well summed up in the following words:—"From the point of view of the merchant, the existence of an independent waterway is of value as keeping down railway rates, even if it does not carry much traffic." On the other hand, the Commissioners are convinced "that private enterprise cannot be expected to take the improvement of canals in hand, because, as things now stand, there is no prospect of adequate remuneration, except, perhaps, in a very few cases." Traders will always send large classes of goods by railway, but there are other classes of goods which they would, in the opinion of the Commissioners, prefer to send or receive by water if there were really a marked superiority of cheapness in rate of transport, increased rapidity of transit, punctuality, and regularity of service, as well as adequate arrangements for collection and delivery.

The results of the existing condition of waterways.—Part V., after discussing the relative advantages and economies of rail and water transport, goes on to point out that the dimensions of few English inland water routes allow a cargo of more than 60 tons to be taken in a single boat for any long distance, while on most of the canals only boats holding 20 to 30 tons can be used. The obvious economy of dealing with larger units of load is discussed, and the tendency of certain industries to migrate from the Midlands to the seaboard is illustrated by concrete examples. In connection with this last-named industrial tendency, the report contains the statement:—"It may fairly be held that the State is concerned in ensuring to its citizens by its own action, if private enterprise fails to accomplish this end, the best and most economic modes of transport, so that industry and commerce may be carried on as effectively as possible." The Commissioners have apparently come to the conclusion that private enterprise has failed to secure the requisite degree of efficiency and economy in inland transport, and, in consequence, "if the balance as between railway and waterway transport is to be rectified, and if traffic is to be suitably distributed between them, it is necessary that the main water routes should be so reconstructed or improved as to allow larger cargoes to be conveyed for the same distance by less labour in shorter time than present conditions permit." This, says the report, is the remedy which has been successfully applied in other countries.

The remaining sections of the report deal with the selection of the waterways for proposed improvement, and discuss the probable cost of improvement and the increase of traffic expected as a result of the improvements. With these matters, as well as the recommendations concerning Scottish canals, we shall deal in a future article. For the purpose of illustrating the proposed improvement of "The Cross" waterways, which we refer to briefly in our leading article, we reproduce on page 683 a sketch map, indicating in outline the selected routes.

THE THEORY OF SUPERHEATING.

The use of superheated steam is, beyond question, extending. The principle is, so to speak, forcing itself into favour because of its intrinsic merit. It would appear, however, that the theory of superheating is very imperfectly understood, because it has received small consideration. The use of superheated steam dates back to a period when theory was of little account. In so far as saving in coal was concerned, it invariably gave excellent results; and its use was in all cases given up with regret by those who had tried it. Its lack of permanence was the result invariably of mechanical difficulties; never because it did not save fuel. In recent years it has been taken up and tried simply on its merits, without much regard being paid to reasons why. It has been assumed that nothing could be gained by having a theory; nothing lost by the lack of one. Probably this is to a large degree true; and yet it would seem that a theory would possess interest for a great many engineers, and that a knowledge of one might prove on occasion useful.

As a matter of fact, there are three general reasons given for the economy secured by superheating steam between the boiler and the engine. The first is that it prevents cylinder condensation, and so gets rid of the "missing quantity." The second is that by superheating steam its volume is greatly augmented; and the third is a combination of both. A fourth reason deserves mention here. It is that superheated steam is much more "lively" than saturated steam. It flows more rapidly through ports and passages, and as one result back pressure is reduced. The late D. K. Clark found in his experiments that locomotives with outside cylinders, other things being equal, always had a sensibly higher back pressure than had those with inside cylinders, simply because the exhaust steam from the former was more sluggish than that from the latter. In the present day drivers remark that, whether fuel is saved or not, at all events, there is "more life in the engine." It will be seen that it is not easy to eliminate the consideration of the question of activity, particularly from triple-expansion engines, in which the distances to be traversed are considerable, and the passages are crooked and somewhat contracted.

If we take up the anti-condensation theory we find it very difficult to formulate any definite figures, because so little has been determined as to the nature and causes of initial condensation. Its amount varies in a way that really defies all calculations; and the most we can do is to provide a sufficiently high temperature to prevent condensation. So far, practice in this direction has been pure empiricism. The general rule is to make the steam as hot as it can be made without doing mischief, either to the superheater or the engine. Much depends on the nature of the oil used as a lubricant, and the rate at which the superheat departs. In many instances a superheat of 250 deg. Fah. has, it is said, disappeared entirely before the piston has made one fourth of its stroke, and it is worthy of notice that it is not easy to detect the difference between diagrams with and without superheat. The broad fact is that, be the diagrams what they may, less feed water is used per horse-power with than without superheat.

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[*] *Vide* The Engineer, December 13th, 1907.

The theory of superheating on this basis is that each pound of steam takes in an additional quantity of heat, depending for its amount on the temperature and the specific heat of the steam. Thus, for example, let us suppose that an engine is supplied with 15 lb. of steam per horse-power per hour, the pressure to be 150 lb. absolute, and the feed-water temperature 100 deg. The total heat supplied to each pound by the coal will be, in round numbers, 1123 deg., or to be accurate B.Th.Us., and 1123 × 15 = 16845 as the quantity from which to get as much work as we can. The temperature of 150 lb. is 358 deg. Fah. If now we superheat it by 200 deg. Fah., we have a temperature of 558 deg. Fah. The quantity of added thermal units will be found by multiplying 15 lb. into the specific heat of the steam; what the specific heat of gaseous steam is has not yet been conclusively determined. Under constant pressure—the condition with which we have to deal—Regnault found it to be .475. There is reason, however, to believe that it is higher, and we shall not be far wrong if we take it in round numbers as .500. We have then 200 × .5 × 15 = 1500 units, and the total stands at 18,345. It will be seen that the expenditure of heat in raising the temperature of the steam is very small as compared with that required to make it. It amounts to only about 9 per cent. But the loss by initial condensation may amount very easily to 30 per cent. If this is avoided by superheating it is no wonder that a marked economy follows the use of superheated steam.

As we have said, it is impossible to predicate in any case what the saving will be, because of the lack of the necessary data. There, however, is the theory as far as it goes. A small quantity of heat expended in raising the temperature of the steam will obviate the phenomena, whatever they may be, which bring about the missing quantity; and it is worth notice that this condition holds good whether the missing quantity is explained in the normal way, or by valve leakage as supported by Messrs. Callendar and Nicolson.

We may now proceed to the consideration of the second theory, which is that the saving effected is mainly due to the augmentation of the steam volume, and a general all-round improvement in the quality of the steam. This may be termed the physical theory, and it possesses several ramifications. Thus, cylinder condensation is not prevented by the augmented temperature of the metal, but by the circumstance that dry steam parts with its heat much more slowly to metal than does wet steam. The experiments of Siemens, and Fairbairn and Tate go to show that at first the rate of increase of volume is very rapid—as much as five times that of air. The rate tapers off, however. Thus with 95 lb. steam the rate of expansion up to 331 deg. was nearly three times that of air, and for the next 25 deg. only one-sixth greater. Rankine held that ordinary steam became gaseous when superheated 40 deg. Fah. D. K. Clark held that this result could be obtained when the superheat lay anywhere between 10 deg. and 20 deg. He writes:—"It is thought that the rapidity of expansion by heat near the boiling point is to be accounted for by the supposed insensible moisture of steam in the saturated condition, as generated from water, being evaporated and contributing to increase the quantity of steam without raising the temperature. The argument is plausible; but it might be argued on the contrary that in the converse process of abstracting heat from superheated steam, the accelerated reduction of volume when it approaches the point of saturation is due to incipient condensation, which would be absurd." It does not appear, however, that the statement is really absurd at all. The total withdrawal of superheat ought to leave the steam in its original condition, and if it originally contained free water, that water would of necessity be found at the end of the operation, as there would be no heat available to maintain it as steam. Fairbairn wrote in 1860:—"Close to the saturation point we find a very high rate of expansion, but this rapidly declines as the steam superheats, and at no very great distance above it the rate of expansion nearly approaches that of a perfect gas. Thus, for instance, in experiment (6) where the point of maximum saturation was 174·92 deg., between this and 180 deg., the steam expanded at the mean rate of $\frac{1}{190}$, whereas air would have expanded $\frac{1}{634}$ only; but on continuing the superheating the coefficient was reduced between 180 deg. and 200 deg., from $\frac{1}{190}$ to $\frac{1}{637}$, and for air the coefficient would have been $\frac{1}{639}$, or almost exactly the same, and this rule holds good in every experiment; a high rate of expansion close to the saturation point diminishing rapidly to a close approximation to that of air."

It is not quite clear where Fairbairn got the coefficient $\frac{1}{634}$, but it is immaterial. It may be taken as proved that the rate at which steam expands while being superheated is not less than that of any permanent gas. Applying this to the case we have stated above, we have 15 lb. of steam at a pressure of 150 lb., and an absolute temperature of 819 deg. Fah. and a volume of 44.4 cubic feet. Adding 200 deg. Fah. superheat we have, according to Regnault's tables, an augmented volume of about one-sixth, or, say, 17 per cent. If, however, the steam was in the ordinary condition before it went into the superheater, it is probable that, according to Fairbairn and Tate, the increase in volume would be much larger. We shall not be far wrong, we think, if we assume that superheating steam by 200 deg. Fah. will augment its volume 20 per cent. How much heat will be expended in doing this depends on the specific heat of gaseous steam. It is evident that we have apparently a very important factor here. The augmentation of volume may be counted upon, and that, too, of perfectly dry steam which can lose a good deal of heat before condensation will take place. Nevertheless, it is frequently argued that the increased volume is a wholly negligible quantity, and is never found in the cylinder, a statement which can only be true if the whole of the superheat disappears as soon as the steam enters the clearance space. For the case we are considering it amounts to 1500 units per horse-power per hour. No one has the smallest knowledge of what becomes of it. Liquefaction due to the performance of work takes place with saturated steam because the steam loses latent heat. But is it not possible that when superheated steam is in the cylinder the action is that which occurs when a permanent gas does work? And the first loss is represented by drop in temperature and not by the sacrifice of latent, or it may be said structural, heat—that is, the heat expended in producing the highly unstable fluid known as saturated steam.

The third theory is, as we have said, a combination of the two views. Superheating augments the volume of the steam produced from the feed-water, and it raises the temperature of the cylinder and piston surfaces so high that initial condensation is prevented. We believe that this represents the facts better than either alternative theory taken alone. But none the less is it certain that some anomalies exist which have yet to be explained. One is the exceedingly small effect of superheating on indicator cards. Nominally, this means, of course, that the same average pressure is obtained with a less weight of superheated than saturated steam. But, so far as is known, the only difference in the cards seems to be a reduction to a small extent in back pressure. This can, of course, be explained by saying that superheat is quite ephemeral. The experiments which have so far been made as to the temperatures inside the cylinder are very imperfect. We do not refer to the cylinder walls, but to that of the steam, which is quite another matter. No doubt in many cases superheated steam is carried through considerable distances in badly clothed pipes, and the most that it can accomplish is effecting some reduction in the condensation which would otherwise go on in these pipes, the superheat never reaching the cylinder.

We have failed to find any record of detailed experiments made with really large engines to settle numerically the effect on the consumption of fuel, save those conducted by Isherwood, and recorded in "Experimental Researches in Steam Engineering," published as far back as 1865. They were made with paddle-wheel beam engines of great size; thus the s s. Adelaide had a single cylinder 50in. diameter and 12ft. stroke, driving paddle wheels 31ft. in diameter. Another ship, the Georgeanna, had a cylinder 44in. diameter, 11ft. stroke. The general result was a saving of over 20 per cent. secured by moderate superheating. This investigation was conducted with great care, and Isherwood's report is worth very careful perusal by engineers interested in superheating. We cannot better conclude this paper than with the following extracts from it:—"The very great increase of economic effect practically resulting from even such moderate degree of superheating as will just prevent condensation in the cylinder, can be easily understood, when it is considered that—supposing the condensed steam to be precipitated on the metallic surfaces and not suspended like a mist or fog in the steam remaining in vaporous form—this condensation counts twice against the fuel; once in the reduction of the power, and again in the quantity of heat which has to be imparted to these surfaces by the boiler steam to re-evaporate the water of condensation from them. In other words, all the steam condensed in the cylinder has to be twice evaporated, while no useful effect whatever is obtained from it. Practically, however, it appears that the whole of the steam condensed in the cylinder, due either to the production of power or the expansion *per se*, is not precipitated upon the metallic surfaces. The condensation due to these causes takes place uniformly throughout the whole mass of steam in the cylinder, and the portion which remains in the vaporous form is able to hold a certain weight of it in suspension, while the remainder must fall upon the surfaces. All the condensation, however, due to external radiation, and to the coldness of the interior metallic surfaces, after their exposure to the condenser temperature and action, must be deposited on those surfaces and re-evaporated by the heat of the boiler steam entering for the next stroke of the piston; consequently all such condensation certainly counts twice against fuel, while the previously described condensation, due to the production of power and to the expansion of the steam *per se*, may count only once or they may count in any proportion between once and twice against the fuel."

We have referred above to the smallness of the effect of superheating on indicator diagrams. Referring to his experiments with the s.s. Georgeanna, with various changes of superheating, Isherwood writes, "It will be seen that the expansion curve formed by the steam pressure in the cylinder after the closing of the cut-off valve, was almost identical with what it should be according to the simple law of Mariotte, that is to say, the pressures were inversely as the volumes, without regard to the variation of temperature. The same coincidence will be found in steam engines in good condition working without air leaks and saturated steam; and it is interesting to note the agreement in cases of extreme diversity in the kind and pressure of steam used, size of cylinder, and measure of expansion. It obtains whether the steam pressure be high or low, whether it be saturated, slightly superheated or greatly superheated, and whether the measure of expansion be great or small. Of course it is purely a coincidence, but being a constant one, it has its practical value for approximate results from boiler pressure when the indicator evidence is wanting."

DOCKYARD NOTES.

THE old Indefatigable, of the Apollo class, has been renamed Melpomene, in order to make way for the new cruiser Indefatigable.

IT appears to have originally been the Admiralty policy to make all these Dreadnought cruisers an "I" class, but since the latest has been called Lion, the idea seems to have been abandoned. On the whole, this is rather unfortunate. The idea, of course, commenced with the Pelorus class, every one of which was given a name beginning with "P." The idea was an extremely sensible one, and might with advantage have been carried much further, without going outside the classical list of ship names, and so upsetting the signal-books.

THE final plans of the new Argentine Dreadnoughts have now been passed. The ships will be called Rividavia and Moreno. They will be of 25,000 tons displacement, and carry twelve 12in., twelve 6in., and twelve 4in. The speed will be 22 knots. There will, it is said, be two funnels and two skeleton masts of the new American type. The whole of the twelve big guns will bear on either broadside. The contract is to contain a clause for the completion of the ships in eighteen months.

ORDERS have also been placed for twelve ocean-going destroyers of the same programme. These will be of about 900 tons and 32 knot speed. The contract for four has been placed in this country, four others in France and four in Germany. The contract for this country has been secured by Messrs. Cammell Laird.

THE Greek navy is about to be enriched by an armoured cruiser, presented to it in his will by a patriotic Greek millionaire. The advent of this cruiser has caused considerable heartburning in Turkey, and a vessel of equal power is projected for the Ottoman Empire. Early delivery is *sine quâ non*, and the contract is likely to go to that firm which undertakes to build a vessel in the shortest possible time!

IN this connection it is interesting to note that Germany is reported to have followed the Italian lead of laying down warships on the chance of securing a subsequent purchaser. Rumour has it that the well known firm of Schichau has a half-completed battleship waiting a possible purchaser. Like everything else having to do with shipbuilding in Germany, this rumour is, however, entirely unconfirmed.

THE status of existing naval engineer officers is now on the *tapis*. The question is, fortunately, being discussed with a complete absence of that heat which would have attended it a few years ago. It is now recognised by nearly everybody that directly the new lieutenants (E.) come into the service, all existing engineer officers must be placed on a somewhat similar footing. Any opposition to this that exists may be said to have been created by those, who, with the best will in the world, have agitated in this direction. If things are allowed to take their normal course, it may be taken for granted that no attempt will be made to try the important experiment of two types of engineer officers in the Navy.

WHETHER the new type of engineer officer will be better than the old one, is, to say the least of it, a very open question. The new scheme was primarily designed to overcome certain personal questions that had nothing whatever to do with naval efficiency, which, in consequence, were not really germane to the subject. We have neither wish nor intention to touch upon controversies of this nature. The only possible use of the British Navy is to secure the maximum of efficiency, regardless of anything else. This could probably have been fully secured by a concession to the requests of the existing engineer officers, except for the fact that the British Navy never is, and never will move, with the times. The new scheme may, therefore, be the best compromise and best solution of a very difficult question from the utilitarian standpoint. But whether it is the best from the practical standpoint remains to be proved.

IT is rumoured at Portsmouth that in order to increase the accommodation in the harbour extensive dredging operations are shortly to be undertaken, and that arrangements are to be made so that ships can be moored fore and aft, in order to prevent their swinging with the tide, and so increase their available accommodation. Spithead is theoretically demonstrated invincible about once a month, but for practical purposes it is a quite unsafe place for ships to lie at in war time.

IN connection with modern inventions, a correspondent from Constantinople writes to us to say that he has just discovered there a Turkish monitor, dating from the year 1870, or thereabouts, fitted with a couple of tripod masts practically identical with those that are fitted to the super-Dreadnoughts of to-day!

HOLLAND-AMERICA LINER NIEUW AMSTERDAM.—This large passenger steamer has been in the hands of her builders, Messrs. Harland and Wolff, Limited, Belfast, for the past few weeks, for certain alterations necessitated by the popularity of the vessel in the Holland-America Line. For instance, the bridge front on the awning deck has been extended, thus largely increasing the first-class dining saloon, &c. The saloon is now a magnificent apartment extending the whole width of the ship, and, with the addition of over 150 seats, has been made one of the largest and finest saloons on any vessel crossing the Atlantic. The alterations also provide extra promenading space on the bridge deck for games, &c. The necessary work having been carried out, the ship left Belfast on the 20th instant for Rotterdam, where in due course she will resume her sailings in the New York trade. The Nieuw Amsterdam is a vessel of over 17,000 tons, and was built by Harland and Wolff, Limited, at Belfast in 1906. She is the second largest of the Holland-America fleet, the majority of which have been built by Harland and Wolff, who constructed the Rotterdam—23,980 tons—for that company last year.

RECENT IMPROVEMENTS AT SCARBOROUGH HARBOUR.

THE town of Scarborough is an exception to the rule that industry and pleasure cannot thrive side by side, and its picturesque and busy harbour lying snugly under the Castle hill and cliffs is not one of the least attractions of the famous watering place.

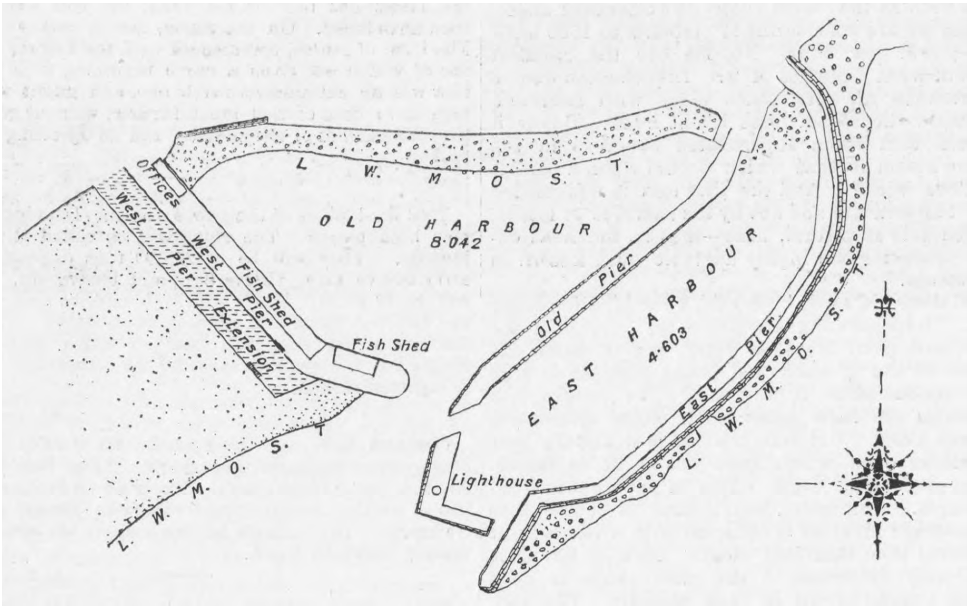
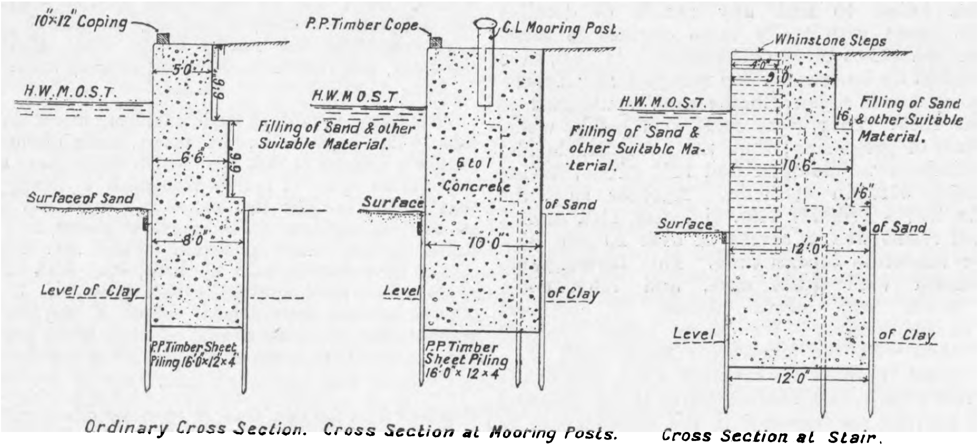

L. W. M. O. S. T.
OLD HARBOUR
8·042
Offices
West Pier
West Pier Extension
Fish Shed
Fish Shed
Old Pier
EAST HARBOUR
4·603
East Pier
L. W. M. O. S.
L. W. M. O. S.
Lighthouse

Fig. 1—PLAN OF SCARBOROUGH HARBOUR

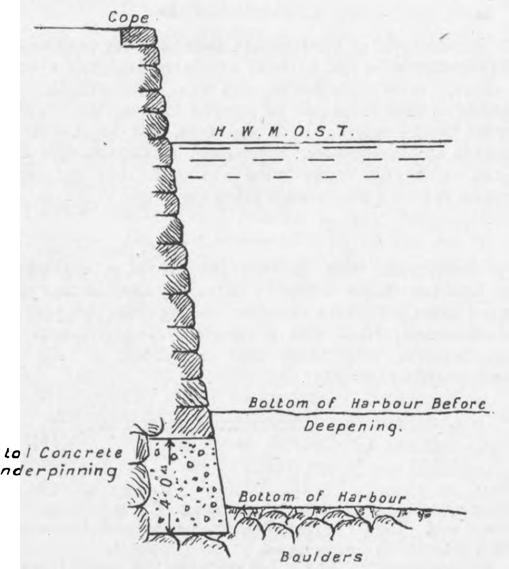
At the height of the fishing season, which happens to coincide with that of the holidays, the port presents a most animated scene. The well-sheltered bay is dotted with smacks and trawlers of every rig and description, and the East and Old Harbours, the combined area of which does not exceed fourteen acres, are so closely packed with fishing craft from Scotland, Lowestoft, Grimsby, and other ports, that it is often possible to cross from place to place by walking over the decks. On the quays also the bustle is almost incredible. Every available space is occupied by buyers and sellers, those engaged in curing and packing fish, and barrels of herrings ready for export to Russia and Germany.


10"×12" Coping
5·0"
6·6"
6·6"
6·6"
H.W.M.O.S.T.
Filling of Sand & other Suitable Material.
Surface of Sand
8·0"
Level of Clay
P.P. Timber Sheet Piling 16·0"×12"×4"
P.P. Timber Cope
C.L. Mooring Post.
H.W.M.O.S.T.
6 to 1 Concrete
Surface of Sand
10·0"
Level of Clay
P.P. Timber Sheet Piling 16·0"×12×4
Whinstone Steps
4·0"
9·0"
H.W.M.O.S.T.
Filling of Sand & other Suitable Material.
Filling of Sand & other Suitable Material.
1·6"
10·6"
1·6"
Surface of Sand
12·0"
Level of Clay
12·0"

Ordinary Cross Section. Cross Section at Mooring Posts. Cross Section at Stair.

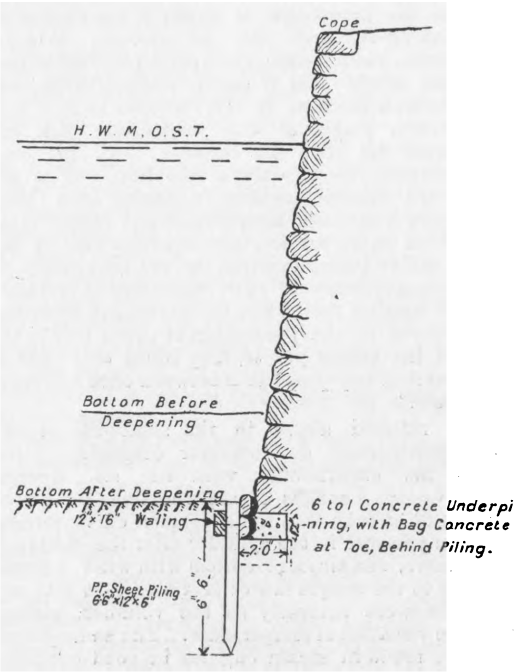
"THE ENGINEER" SWAIN Sc.

Fig. 2—SECTIONS OF THE NEW WALL OF THE WEST PIER EXTENSION


Cope
H.W.M.O.S.T.
Bottom of Harbour Before Deepening.
6 to 1 Concrete Underpinning
Bottom of Harbour
Boulders

Underpinning where Foundation was Hard.

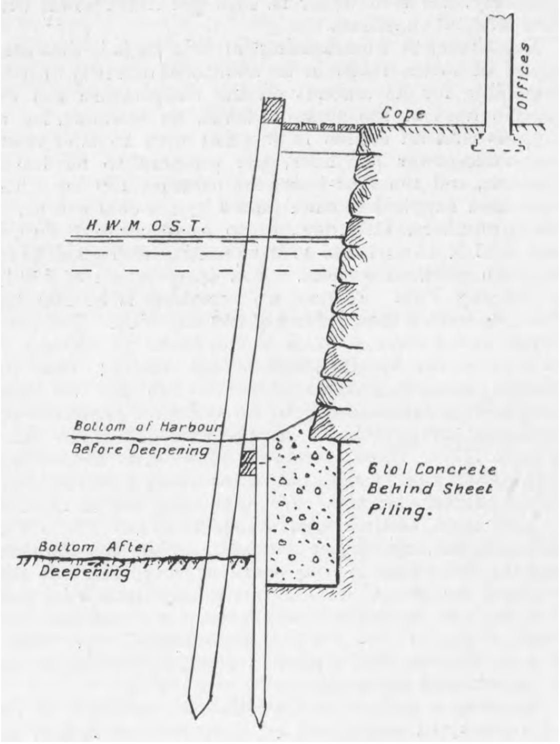
Fig. 3


Cope
H.W.M.O.S.T.
Bottom Before Deepening
Bottom After Deepening
12"×16" Waling
6 to 1 Concrete Underpinning, with Bag Concrete at Toe, Behind Piling.
2·0"
P.P. Sheet Piling 6·6"×12×6"
6·6"

Underpinning where Foundation Varied.

Fig. 4

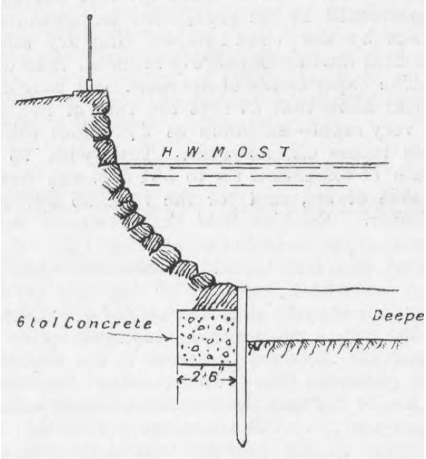
It can be readily understood that the harbour, although so small itself, is one of the most flourishing centres of the fishing industry in the kingdom; in fact, there are only four English ports where a greater quantity of herrings is landed annually. It was with a view to mitigate this state of congestion that the recent improvements were undertaken by the Commissioners of the Port. As it was not possible, for various reasons, to enlarge the harbour, it was decided to deepen it, and to gain additional quay space by widening the West Pier—see Fig. 1. The new wall forming the West Pier Extension is of massive concrete construction, in order to resist the heavy seas which are encountered all along this coast. It has a total length of 650ft., including the return, and is built 70ft. from and parallel to the Old West Pier wall. To form the foundations, a double row of permanent sheet piles was driven through the sand and well down into the clay below. The sand, and on an average a depth of 2ft. of the clay, were then excavated, and a length of concrete was deposited. Where the level of the clay dipped a vertical step was made, and the bottom of the excavation was always kept horizontal. Above the foundation strong wooden temporary shutters, with the inside surface planed, were then erected, and concrete in the proportion of one part of Portland cement to six parts of sand and gravel was put in in layers not less than 2ft. thick, and in lengths of about 20ft. Each length was dovetailed to the next, and in no case was the vertical joint of a length allowed to come nearer than 3ft. to the joint below. The gravel, which was procured from the beach some miles away and was brought to the works in cobles, was of particularly good quality for concrete, as it contained a proper proportion of sharp sand, and the pebbles were of varying size, but nearly all such as would pass through a ring of 1½in. diameter.


Offices
Cope
H.W.M.O.S.T.
Bottom of Harbour Before Deepening
6 to 1 Concrete Behind Sheet Piling.
Bottom After Deepening

Underpinning Behind Offices.

Fig. 5

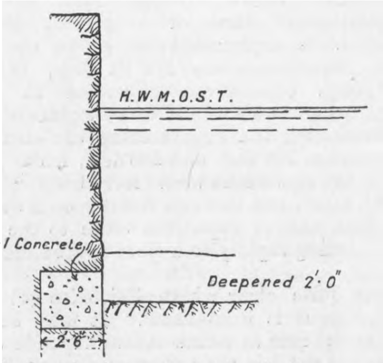
All mixing was done by electrically driven machinery. Cast iron bollards for mooring are built into the wall, and a timber coping runs along its entire length. The space between the old and new walls was filled partly with excavated material from the harbour and partly with sand from outside. When this material had become sufficiently consolidated, whinstone setts were laid at the outer end, and tar macadam, with a bottoming of broken stone, over the rest of the reclaimed area. A much needed addition of some 4300 square yards of quay space was thus made to the West Pier. Sections of the new wall are given in Fig. 2, the first part of which shows the ordinary cross section, the second the cross section at mooring posts, and the third that at a stairway.


H.W.M.O.S.T
6 to 1 Concrete
Deepened 2'0"
2'6"

Underpinning for Curved Wall.

Fig. 6

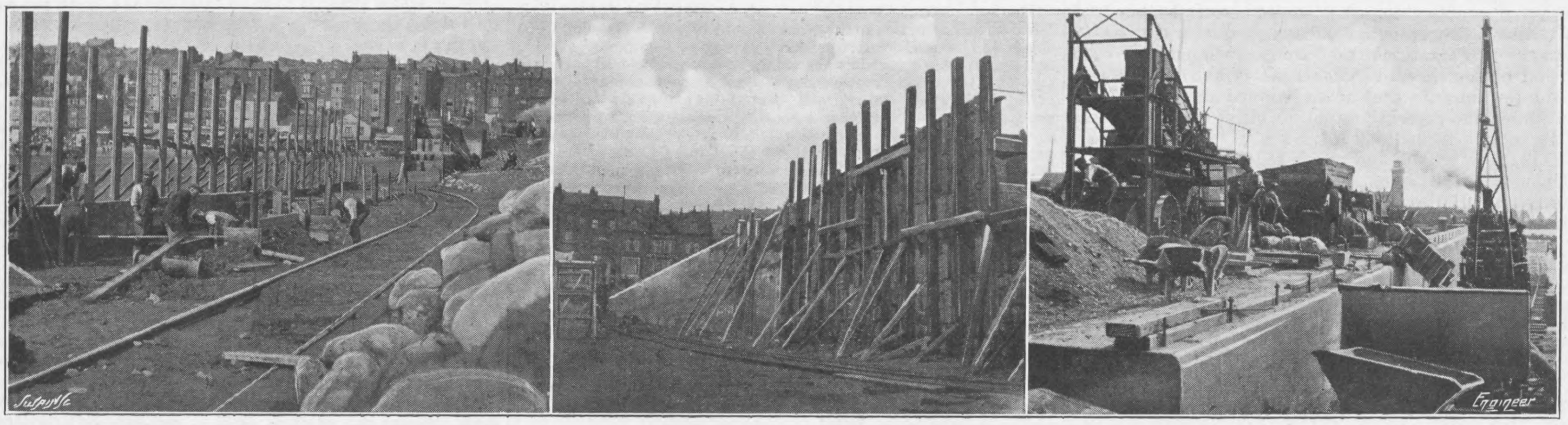
The deepening of the old harbour presented some difficulty, as the quay walls are very old, and are constructed of large irregular boulders without any mortar or cement joints. It was necessary to secure these walls by underpinning before dredging operations could commence. This work, therefore, had to be done in short lengths, and great care was required in shoring up the old walls until the concrete had set. At the outer end of the piers, where dredging was carried to 3ft. below low-water mark, the difficulty was accentuated, as no work was possible except for a very short time at the lowest spring tides. Different methods of underpinning were employed at dif-


H.W.M.O.S.T.
6 to 1 Concrete
Deepened 2'0"
2'6"

Underpinning at Jetty Wall.

Fig. 7

RECENT IMPROVEMENTS AT SCARBOROUGH HARBOUR



Figs. 8, 9, and 10—VIEWS OF THE WEST PIER EXTENSION WALL DURING CONSTRUCTION

ferent places, and examples of some of these are shown in Figs. 3, 4, 5, 6, and 7. Fig. 3 shows how the work was carried out where the foundation was hard; Fig. 4 where it varied; Fig. 5 behind the offices; Fig. 6 where the wall was curved, and Fig. 7 at the jetty wall.

For the deepening of the harbour a bucket dredger was employed—a view of it is given in Fig. 12, and the "cut" it has made is clearly seen. The depth over the greater part of the harbour was carried down to low-water mark of ordinary spring tides, and this necessitated the removal of an average thickness of some 4ft. over the entire area except near the entrance, where the depth was carried some 3ft. lower. The material to be dredged consisted for the most part of boulder clay, and some very large boulders were removed. In some places the boulders were packed so tightly together that blasting had to be resorted to before they could be dislodged. At the upper end of the harbour or Hard, the excavation was done by spade, and the excavated material was removed in tip wagons drawn by a small locomotive, and deposited behind the new West Pier wall. The contractors were Messrs. Firth and Co., of Derby.

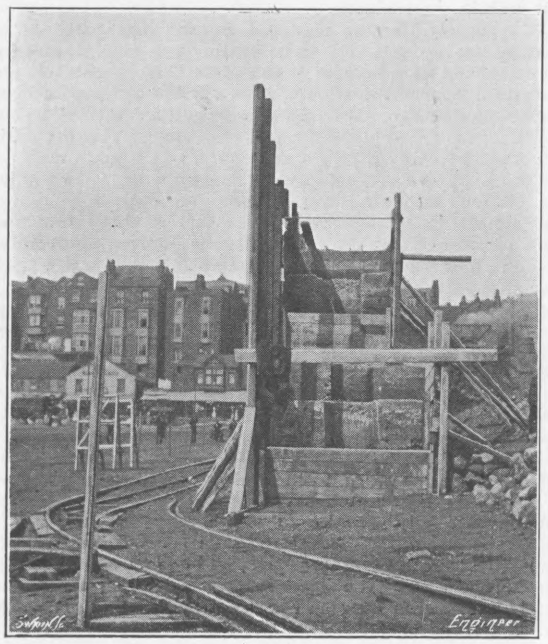


Fig. 11—THE WEST PIER EXTENSION WALL

Towards the cost—some £12,000—of the improvements described above, a grant of £4000 was obtained from the Treasury. The work was carried out from the designs and under the superintendence of Mr. J. D. Howkins, engineer to the Hartlepool Port and Harbour Commission, to whom we are indebted for the information contained in the foregoing and for the illustrations, and the resident engineer was Mr. A. E. Stevenson.

The other illustrations which we are enabled to reproduce show in Fig. 11 the new West Pier walls, with the crane and wagon roads; in Fig. 8 the wall with men erecting shuttering; in Fig. 9 the same, with the shuttering partly removed, and in Fig. 10 the same again, showing the concrete mixer, the motor shed, the crane, and also the wagons, the boilers, and the holding down bolts for the coping. Fig. 13 gives a view of the old harbour, showing the excavation of the Hard slope next the Foreshore road, the Wagon road, &c.

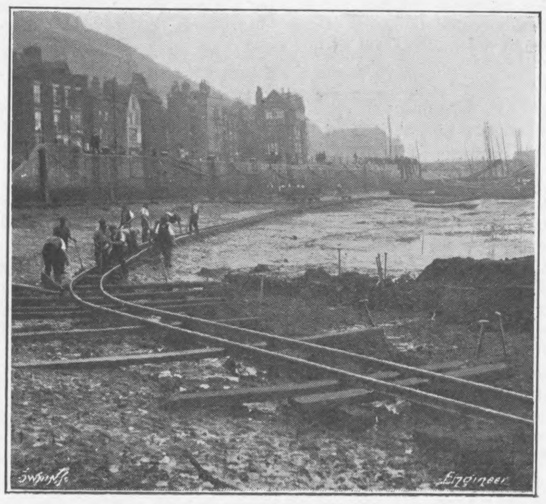


Fig. 13—THE OLD HARBOUR, SHOWING EXCAVATION

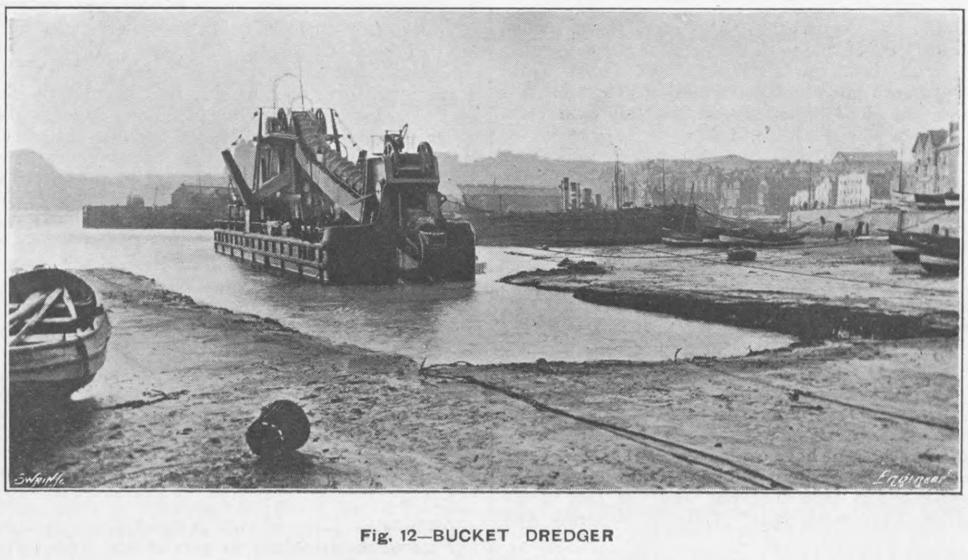


Fig. 12—BUCKET DREDGER

GUNS OF THE UNITED STATES NAVY.

Rear-Admiral N. E. Mason's annual report to the Bureau of Ordnance of the United States Navy for the current year is of considerable interest, inasmuch as it gives us a very good general idea of the advance of navy ordnance material on the other side of the Atlantic.

Rear-Admiral Mason tells us that the most important developments of the year have had to do with guns and their mounts, with powder and projectiles, with armour, with torpedoes, and with that much vexed question, efficient fire control.

In anticipation of the evolution of a more powerful gun for the all-big-gun battleships, the Bureau, about a year ago, began the construction of an experimental 12in. weapon of 50 calibres. This gun has been completed and tested at Indian Head, and the official results show how well it compares with weapons of corresponding weight and calibre elsewhere. In proof, this gun, weighing 54.7 tons, has developed an initial velocity of 3030 foot-seconds and a muzzle energy of 55,446 foot-tons. The powder charge was about 365 lb. In five rounds, fired at 17,000 yards range, the dispersion was less than 100 yards. The battleships Arkansas and Wyoming will carry guns of this type, and it is believed that these vessels will be the first in the world to mount weapons of such power.

A type of 14in. gun is now complete, and will probably be tested before the end of the year. It is designed to fire a projectile weighing 1400 lb. with a velocity of 2600 foot-seconds, representing a muzzle energy of 65,600 foot-tons. A mounting has likewise been worked out for this gun, so should the weapon prove a success—as there is every reason to expect that it will—then the Bureau will be in a position to proceed with the prompt manufacture in case of a demand. In thus anticipating a probable eventuality, the Bureau is saving time and the long delays commonly incident to designing and testing a new weapon. It can now go ahead with definite accomplishments and have a radical advance in ordnance immediately available.

The guns for the Florida and Utah are so far advanced that they will be ready for emplacement long before the ships are ready for them. As is now known, the batteries for these vessels are ten 12in. guns of 45 calibres long, designed with a new type of powder chamber and with increased strength along the chase. The first of these weapons has given very satisfactory results at the proving grounds, and it is intended to assign to them a service muzzle velocity considerably higher than that of the other 12in. guns now afloat, and thus augment their power. The secondary batteries for these ships are composed of sixteen 5in. guns of a new mark, which are especially adapted for torpedo defence. These anti-torpedo weapons use a cartridge case and have a service muzzle velocity of 3150 foot-seconds. The projectile weighs 50 lb.

Admiral Mason reports that the work of relining and modifying the 12in. 40-calibre Mark III. guns has been pushed forward as rapidly as possible ,and these altered weapons have been placed on the battleships Ohio, Missouri, and Virginia, and on the monitors Cheyenne, Ozark, and Tonopah, and will be likewise supplied to the other battleships of the Virginia class, and to the Maine as fast as they are completed and opportunity is afforded for their emplacement. The increase in power gained by relining and hooping these guns to the muzzle is very great, making them, so it is said, nearly equal to the 12in. 45-calibre Mark V. pieces. Admiral Mason says these changes "more than warrant the expenditure incurred," and such would certainly seem to be the case and a happy stroke of economy.

The batteries for the torpedo-boat destroyers just completed and for the large fleet colliers are to be composed entirely of 3in. semi-automatic guns. These weapons are of interest inasmuch as they are to be fitted with a newly designed breech mechanism which, it is said possesses certain desirable features tending to reduce the stress upon the breech block, and to make the guns better adapted for mounting on the open decks of destroyers and colliers.

Turret mountings.—The decision to place guns of higher power in the turrets of the two battleships authorised during the present year necessitated the designing of a new mount. Admiral Mason says:—"Advantage was taken of this to incorporate certain improvements in the design, notably placing the trunnions nearer the front armour plate than heretofore, and thereby reducing the port opening to the minimum considered advisable. These new mounts will also embody a feature whereby it will be possible to easily place the pair of guns in a turret parallel to each other, and to correct variations from parallelism which occur after installation, resulting from deformation of the structure due to firing stresses."

A pneumatic ammunition hoist of novel design was erected, and tested in one of the 8in. turrets of the Massachusetts; the tests were quite successful, and the company which supplied the hoist is now working on the plans of one for a larger calibre turret. Should this design appear practicable the construction of a hoist of the type for erection and trial in a turret of one of the older battleships will be recommended.

During the present year new sight telescopes of improved optical qualities and new and better training sights have been supplied to the turrets of practically all vessels, except the earlier monitors. The experience of the fleet in setting the turret sights to a rapidly changing range at the last battle practice pointed to the necessity of improving the mechanical arrangements for this operation if practicable. A plan for new and improved sight setting arrangements has been worked out.

Powder.—Preparations are well in hand for the extension of the Naval Powder Factory at Indian Head, and in a few months that plant will be able to turn out about double its present output. During the past fiscal year the factory turned out 801,284 lb. of new powder and 432,797 lb. of re-ground and re-worked powder. The new powder cost 0.432 dols. a pound, and the re-worked powder cost 0.156 dols. The object in adding to the Government plant is to enable the service systematically to bring up to the proper amount its reserve supply of powder. Admiral Mason says:—

> There have been no radical changes during the year, nor are any such changes to be anticipated in the near future. Our present nitrocellulose powder has been brought to a degree of perfection which leaves comparatively little room for improvement. New specifications have been prepared by the Joint Army and Navy Board on smokeless powder, which will reduce within very narrow limits the tolerances permitted in manufacture, thus ensuring greater uniformity of product than has heretofore been attained. A more important change has been the addition to the powder of a very minute quantity of a substance which is found to protect the stability of the powder. It is believed that this change will prolong the safe life of the powder by a number of years beyond the period heretofore estimated. The ballistics and stability of the powder are good, and certain suspicions of variation in ballistics which were formerly directed against the powder have been shown to be unfounded, such variations proving to be due to other causes.

The Special Board on Naval Ordnance recommended that all dry houses be converted to the closed-circuit system and a minimum amount of air be used in drying the powder. This has been carried out, and the fans are run by steam engines—the exhaust serving to heat the house. The point of this recommendation is brought out by the fact that it has been found, after careful study at the Naval Ordnance Laboratory, Cavite, P.I., that the main cause of deterioration of powder at that station has been determined to be due to moisture. With proper precautions, and if dried out completely without the use of high temperatures, there is reason to believe that the great bulk of powder of inferior stability on the station could have its life prolonged for several years, thus making it available for use in target practice. Advantage has been taken of the Cavite laboratory to study the effect of tropical light, and light combined with moisture, on the deterioration of smokeless powder; and to investigate the effect of variations in temperature of storage on powder. The constant surveillance of samples of the various lots of powder carried in the magazines of the ships on the station have made it possible to keep the commanding officers of those vessels informed at all times regarding the condition of the powder on shipboard with a degree of accuracy not otherwise easily practicable.

A simple and efficient method has been developed for testing on shipboard the stability of smokeless powder, and testing outfits are being issued to the service as fast as they can be manufactured. The importance of this cannot be over estimated. Only a few years ago awe-inspiring instructions were issued by the Bureau of Ordnance describing a series of most delicate and exacting tests which were to be made from time to time by the ordnance officer of each ship to determine the condition and stability of the smokeless powder in the magazines. Not infrequently this work was done by even less skilful subordinates and by men not over-trained in the niceties of differentiating chemical conditions. As a result, a good deal of powder that was quite safe was given a black mark without good and sufficient cause, and in one instance about 50,000 dols. worth of this propellant was dumped overboard needlessly. Admiral Mason informs us that experiments are still going on in the effort to evolve a new form of smokeless powder, and with very fair results. Progress has also been made in the way of reducing erosion due to high explosive temperatures, which promises to increase the life of the navy's guns.

Projectiles.—In connection with projectiles, as reported last year, certain improvements in form have yielded material increase in range with correspondingly flatter trajectories, wider danger space, and, finally, greater striking velocities and better penetrations at long ranges. Notwithstanding these achievements, however, Admiral Mason says: "It is again necessary to call attention to the unsatisfactory condition of affairs in connection with the reserve supply of armour-piercing projectiles. At present only three firms hold contracts for large armour-piercers, and satisfactory deliveries are not being made. The Bureau is using every effort to assist the manufacturers in the task, which must be recognised as a very difficult one, of developing a projectile which will meet the very severe demands of our present specifications. The difficulties have been temporarily somewhat increased by a change of form which has been adopted for obtaining increased range, but it is believed that this feature of the situation will not prove serious." It is to be hoped that Admiral Mason's optimism may be justified. The adoption of the more pointed shell—an adaptation of the lines of the Spitzer bullet—involve some decided difficulties, and these have not yet been satisfactorily surmounted.

One very practical step in the direction of improving the accuracy of fire when the gun has suffered from erosion has been taken by broadening the rotation band of the projectiles. Admiral Mason says of this change:—

> It is expected to considerably prolong the life of the gun by ensuring a true flight for the projectiles after the gun is much worn that its accuracy with the older bands would have been much impaired.
>
> In the service generally there seems to be an increasing appreciation of the fact that modern ordnance consists largely of instruments of precision, some of which are necessarily delicate, and that these are entitled to the same care as other instruments of precision. This disposition in the service toward more intelligent care and more considerate handling of ordnance material has been very gratifying, and, combined with improvements in various parts of the material itself, has resulted in comparatively few casualties during target practice. A few exceptions have occurred where it has seemed that the ordnance material has been abused, apparently through misdirected zeal and a lack of considerate handling, combined perhaps with a lack of thorough familiarity with the proper functioning of the parts which failed.
>
> This summary of the Bureau's work would be incomplete if it failed to call attention to the great amount of work expended upon the design, manufacture, and test of sights, firing mechanisms, fuses, and other minor but absolutely essential articles of ordnance equipment. Great improvements have been made in all these directions, and the Bureau feels that it may properly express its gratification at the remarkable results which have been obtained in target practice with material which, in many cases, was designed before anyone could have predicted the demands which would be made upon it as a result of the unprecedented development in target practice within the last few years.

In conclusion, Admiral Mason invites attention to the work of the Special Board on Naval Ordnance, which is advisory to the Bureau, and largely directs the line of all experimental investigations.

> As many of the subjects with which the Board has been and continues to be engaged are essentially confidential in their nature, they can only be referred to here in general terms. The following partial list of subjects will give some idea of the importance of its work:—
>
> An investigation of the behaviour of powder in the gun, looking to the more complete solution of the problems of interior ballistics and to practical improvement in smokeless powder.
>
> An investigation of the flight of projectiles as affected by the form of the head, looking to a possible increase in range, penetration, and uniformity of flight.
>
> A study of the erosion of guns, looking to the possibility of reducing this by modifications in the composition and granulation of the powder.
>
> A study of the rotation of projectiles as affected by the material and dimensions of the rotating band, especially after the guns have become seriously eroded.
>
> Experiments with high explosives for the bursting charge of shells and the perfecting of a fuse for use with such explosives.
>
> The angle of impact of projectiles at long ranges and the effect of this angle upon the penetration of armour.
>
> All of the above questions are of great and pressing importance to the service. The sum of 200,000 dollars for experimental work along these lines has been included in the estimates for the coming year, and it is considered very desirable that this sum shall be allowed in full. Every dollar expended in the solution of problems like those outlined above gives a direct and tangible return in the increased efficiency of every individual feature of the offensive and defensive power of our ships.

THE PEKING-KALGAN RAILWAY.

THE opening of the Peking-Kalgan Railway in October last marks a period in Chinese history that will be watched with interest by all those connected with the Far East. The funds for the construction of this railway were obtained from the profits of the Northern Railway, and the line has been built by the Chinese themselves, and is now worked by them also, though, doubtless, in both cases, with some advice from the engineers of the Northern Railway. The engineer-in-chief, his Excellency Chang Tien Yow, is much to be congratulated on his work, which is one of the most difficult railway undertakings that have been carried through in China, and one that must become more important as the work is advanced, forming as it will the most direct route to the Far East, if linked up with the Trans-Siberian Railway near Lake Baikal.

The railway connects with the main line to Hankow at Fengtai Junction, a place well known as the scene of the Boxer outbreak in 1900, where several Europeans lost their lives, and others escaped with difficulty. For people living in Peking the most convenient station is the Hsichihmen, which is within a short distance of the North-Western Gate, from which it takes its name; from here visitors can start to see the Ming Tombs or the Great Wall. Between Chingho and Shaho on a fine day a good view may be obtained of the Summer Palace, the western hills forming a background that shows the golden roofs of the palace glittering in the sunshine. The first 30 miles of the road are flat and uninteresting, with little life to be seen, except the pack trains of mules, donkeys, and camels, laden with skins, furs, and other produce of Mongolia for the Peking market. Near Shaho a serious wash-out occurred last summer that cost the Government 800,000 taels, or about £32 000, to repair and build extra culverts. As such an extraordinary flood had not been known for over forty years, it is hoped that the improvements will secure safety in the future. Although this country is fairly flat, the difficulties to be met with are great, for at times the roads—which are, in fact, the river beds at certain seasons of the year—become impassable torrents of uncertain and unbanked channels. The water thus spreads over a wide area, many culverts are required, and long retaining walls to direct and hold the river in its course must be erected.

Towards mid-day the train arrives at a small town named Nan Kou, at the foot of the pass that guards the entrance of the main road northwards through the Great Wall. Repair shops and a running shed have been built outside this town, and here the chief difficulties of the engineers commenced, a height of about 1500ft. having to be attained in 13 miles at a place called Ching Lung Chiao, the summit of the pass. At Nankow are stationed the three Mallet locomotives that were supplied by the North British Locomotive Company, of Glasgow, to work the trains up the steep gradients of this part of the road. The usual train consists of about 30 axles, or 180 tons, exclusive of engine and tender, and these engines work up the distance of 13 miles in two hours, a good performance, considering the curves, which have a radius of 600ft. To avoid the chances of a breakaway, the engine pushes the train to the top of the Ching Lung Chiao gradient, where a smaller engine couples on and works the train to the terminus at Kalgan. The road up the pass is chiefly laid on the side of the hill, though there are many places where embankments have had to be built across gullies or round spurs of the mountain. Great care and forethought have evidently been spent on these works, and at places where the rivers have their course at the foot much expense has been incurred, and the foot of the embankment has been faced with blocks of concrete and stone.

Between Nankow and Ching Lung Chiao there are four tunnels, the last being 3580ft. long; this one has been cut 200ft. below the Great Wall. Before entering this last tunnel, and also on leaving it, a magnificent view is obtained of the surrounding country, and also of the old pack road, with its constant stream of toiling camels and other animals. The old and the modern methods of transport side by side furnish thought for many questions, and one wonders whether the old conservatism of China has really passed. On reaching the summit of the pass the line emerges on to a plateau, where there is little of interest, and, with the exception of one short section of 1 in 100, the gradient is easy. The country is brown, dusty, and wind-swept, and the towns and villages built of mud, with substantial mud walls enclosing them. Here, too, the earthwork will require careful watching, as the rivers have no well-defined channels, and after heavy rains are apt to cause much trouble. On reaching Kalgan, the terminus, travellers will be much surprised to find such a busy place. All day long the pack trains are arriving in the station yard, and numberless coolies are employed loading the cargo into the railway wagons. From any one of the surrounding hills an idea can be obtained of the extent of this huge plain and the probable route of the extension towards Urga.

From a technical point of view the engineer has much to be proud of, considering the difficulties that he had to contend with. Fault might be found with the angle of the earthwork in places, but this is being corrected, and, whatever may be said, the work has every appearance of being most substantial throughout; in fact, the buildings are an example of lavish expenditure, many being of dressed stone, though the work is said to compare very favourably with other railways from a financial standpoint. The rains will no doubt require much careful attention for some time, as there seem to be hardly enough culverts through the embankments to carry off the surface water. The permanent way is well maintained, and spikes are used in place of chairs to secure the 85 lb. rails. On the whole, the engineer seems to have spared no expense or labour to demonstrate that the Chinese were capable of constructing their own railways on substantial if not on modern lines. As to details of cost and maintenance, and any other of those items dear to an engineer who has been on railway construction, these will probably never be published, though if they were, it would not be possible to compare them with any other railway in China, for nowhere else have such natural difficulties been met with in construction.

As a purely Chinese managed railway the methods of working are unique and even exciting, as, for instance, in shunting, the train being a mixed one. The freight cars are uncoupled from the train and form a buffer to the passenger coaches for other cars that are shunted with "flying shunts," roars of applause from the spectators greeting each shunt as the cars get nearer and nearer to the main body of the train. The station staff would also appear to be ample, one station with six trains in and out daily having two stationmasters, two telegraph clerks, two booking clerks, one train despatcher, four station coolies, one shunter, four pointsmen and four servants. It seems impossible even with a good man at the head of affairs in China to eradicate "squeeze." Perhaps, however, the staff is in keeping with the machinery equipment of the stations, a few details about which may be of interest. Between the two termini, Fengtai and Kalgan, there are five engine sheds, six turntables, and ten water cranes, the termini being fully equipped in every way. The coal in use is from a mine worked by the railway near Hsiahua, and the output will shortly reach 400 tons a day, which will be ample for the requirements of the 124 miles of line now open. There is also a coal mine on a branch line at a place called Mentoukou, about sixteen miles from Hsichihmen, and the coal from both mines is of fair quality, Steel bridges are not plentiful; there is one, however, on the main line of seven 100ft. spans, and one on the branch to the coal mines of eight 100ft. spans. The rolling stock was mostly built at the Tongshan works of the Northern Railway and consists of 57 passenger coaches and over 300 wagons of various kinds and capacity. There are also 23 locomotives, some British built and others bought from the Northern Railway. The gauge is the standard one of 4ft. 8½in. and the rails are 85 lb. We feel sure that no engineer could travel over the line without congratulating His Excellency on having successfully undertaken a work of such magnitude.

CONTINUOUS ANNEALING FURNACE.

MANY advantages have been found in automatic continuous heating for annealing or hardening small steel and iron parts, the work being fed from a hopper into the revolving hearth so as to come in contact with the hot lining and the heated gases. This movement has been found to be much more effective than when the material remains in a fixed position. Internally-fired rotary furnaces have proved very useful for the continuous process. Oil and gas fuel are used with satisfactory results. For annealing, the air inlet may have to be controlled to prevent oxidation, but where the work is to be hardened, the discharge end can be placed directly over the cooling bath. The Rockwell furnace of this system—built by the Rockwell Furnace Company, of New York—was first made horizontal, with a helical groove of rectangular section formed in the refractory lining, so as to feed the material through the revolving horizontal cylinder. Long pieces and unsymmetrical pieces, however, tended to choke the groove, and the furnace is now made with the revolving cylinder slightly inclined and fitted with a smooth cylindrical lining. The inclination can be varied to regulate the speed of passage, and thus vary the period of heating. The cylinder rests on two pairs of rollers carried on pedestals on the tilting bed plate; this also carries the fixed feed hopper and fixed discharge head, the latter having the oil or gas burners and their triple connections. The shaft carrying the two rollers on one side, is driven by bevel gear, with a chain drive to a belt pulley. The temperature is adjustable. The product is delivered by a spout into a cooling tank, in which runs a bucket conveyor discharging the articles into a truck or wheelbarrow. The furnaces are built in sizes up to a capacity of 2000 lb. of material per hour.

THE CHEMISTRY OF FLAME.—The juvenile lectures this Christmas at the Royal Society of Arts will be delivered by Professor Harold B. Dixon, M.A., F.R.S., on January 5th and 12th, his subject being "The Chemistry of Flame." The subject is one that lends itself to experiments, and the nature of flame, the properties of oxygen, the nature of various combinations of air and gas, will all be very fully illustrated and explained.

RAILWAY MATTERS.

We hear that the Swedish engineer, Quitsgaard, has drafted an important scheme for the construction of an electric railway under the Baltic Sound.

The *Mexican Herald* of 3rd December states that a new railway company formed with a capital of 5,000 000 pesos—about £510,000—for the extension of the Interoceanic Railway from Tezuitlan to Nautla, Veracruz, intends to begin work at once on the first section of the new line, from Tezuitlan to Tlapacoyan.

We hear that experiments have been made on the Prussian State Railways with ball bearings for car axle journals. They are said to have shown a decrease of about 10 per cent. in the resistance at a speed of 25 miles an hour, and a much greater decrease in the power required to start. These bearings, after 250,000 miles run, were still in good condition.

The Burma Railways Company, states the *Iron and Coal Trades Review*, intends to replace the existing timber trestle bridges and timber girder spans on the Lashio branch, between Mandalay and Lashio, by steel girders resting on brick masonry abutments and piers. The timber work in these bridges is said to be subject to rapid decay in the wet and moist climate of Burma.

It is announced that the Gas und Wasser Verein, der Verband, der Elektrotechniker, und der Strassen und Kleinbahn Verein have appointed a joint commission to investigate and report upon the question of earth currents and their effects. Two experts, who will go fully into the question of the effects of the tramways on the gas and water mains at Brunswick, Cassel, Nuremberg, Beuthen, Düsseldorf, and Warsaw, have been engaged.

The traffic manager of the Grand Trunk Pacific Railway recently stated that the progress of the line was at present giving every satisfaction, and that there was no doubt in the minds of the directors that through trains between Montreal and the Pacific Ocean would be running in 1912. Great wharves are being constructed at Victoria, at a cost of £20,000, and the work at Prince Rupert, the Pacific terminus of the line, is well advanced. There will shortly be a line of steamers operating between Prince Rupert and Victoria, acting as a feeder for the railway.

It is reported from Winnipeg that arrangements have been completed whereby the Alberta and Great Waterways Railway Company will start work in the spring on the remaining 200 miles of the line to Fort Murray, in the far North-West. This will make it possible for settlers and sportsmen to gain direct access to the 4000 miles of navigable rivers and lakes lying in the region round Lake Athabasca. Steamers will run right up to the border of the Arctic regions, and in addition to tapping a territory believed to be rich in agricultural and mining resources, sportsmen will be provided with a veritable paradise, for the district has been by no means overrun hitherto.

It is the practice of the Cincinnati Traction Company to soak the car motor brushes in sperm oil, which is said to keep them from chipping. and greatly to improve the surface of the commutators. Two sets of brushes are provided for each motor. The lead brush of the No. 1 motor on a car carries the number of the car and the motor numbers, the other brushes are indicated by scratches. One of the two sets of brushes is kept in oil while the other is in use, and a shift is made about every third night. A high-grade Columbia brush is used, from which excellent results are obtained, even though the steep hills in Cincinnati require the motors to work under severe loads.

In a letter to the Cheshunt District Council the manager of the Great Eastern Railway states that his directors are unable to comply with a request that the branch line from Edmonton to Cheshunt should be reopened for passenger traffic and worked by a motor service. They feel sure that there is no possibility of any large measure of traffic being attracted back to the railway even with a frequent motor service, owing to the constancy of the service of cars on the tramway along the public road. The cost of working a motor service has been very carefully inquired into, and the expense is found to be far greater than the revenue that the company could hope to obtain, leaving out of consideration the considerable initial outlay that would be required before such a service could be instituted.

It is now very generally recognised, states the *Railway News*, that the electrification of suburban lines is all a question of density of traffic and whether there is the pressing need for improved terminal facilities which would warrant the large capital expenditure involved. A sidelight is shed upon the aspect of the demand for electrification by the decision arrived at, that the cost of electrifying the Chicago suburban lines is prohibitive, and the authorities of the city of Chicago have been informed of this recent decision. The railway view of the case was presented to the City Council at a recent conference with Mr. Harahan, who made his position clear by stating that he believed the cost of the improvements to be greater than any company would be warranted in making. President Harahan proposes to report to the stockholders that the electrification of the Chicago suburban lines would mean a reduction in their dividends, probably of 2 per cent.

The use of reinforced concrete in the United States in connection with railway work is growing. At a recent meeting of the Concrete Institute, Mr. N. L. Humphrey, who is secretary of the American Joint Committee on Concrete and Reinforced Concrete, referred to this point. He reminded the Institute that, in 1893, when the first bridge constructed of concrete was built in the States, it was not deemed possible that so important a structure as a railway bridge could be made of concrete, and the first bridges so built were very massive affairs. Now much of the massive material has been cut out, and bridges of great beauty are being erected all over America, and, in fact, the use of concrete for bridge construction is quite a common thing. Railway engineers were among the first to realise the advantages of such structures. Not only is the first cost less, but they cost less to maintain. Nearly all the towns in the States now seem to vie with each other in the erection of such bridges. Concrete is now used largely for subways in Boston, New York, and other places, and the material is peculiarly suitable for this purpose where the situation of the work is generally damp.

In his presidential address before the Institution of Electrical Engineers, Dr. Gisbert Kapp said that in Switzerland the Federal Government appointed some years ago a committee of electrical and railway engineers to report generally on the question of electrifying the Swiss railways. The first report dealt with the amount of power required, and urged the Government to secure water-power rights in time. The average power was estimated at 100,000, and that at peak time at 500,000 horse-power. In a second report some standards as to weight and speed of trains, acceleration, horse-power required in starting and running, time interval between trains, and other matters connected with the future electrical service were suggested, while a third report dealt with the question of a standard frequency; but on the question whether the single or three-phase system is to be chosen the committee had not yet pronounced an opinion. From private conversations he had had with Swiss railway men, he inclined to the belief that the decision would be in favour of the single-phase system, especially since by the use of the Deri type of motor it had been found possible greatly to simplify and also lighten the accessory equipment. The first test of this motor for traction was made on the three-phase Engelberg railway, one phase only being used.

NOTES AND MEMORANDA.

Co-partnery shipbuilding yards stand fifth in the amount of work produced during the past year.

Panama Canal excavation during November, 1909, totalled 2,458,152 cubic yards, a daily average of 102 423 cubic yards for the 24 working days. During the month 41,368 cubic yards of concrete was laid, and 285,777 cubic yards of fill placed. The work during the month was hindered by the excessive rainfall, which reached 28.50in. for the 30 days. This is very nearly the highest monthly rainfall observed on the isthmus.

A patent issued on November 23rd to Messrs. B. G. Lamme, R. S. Feicht, and G. H. Garcelon, deals with means for rendering a single-phase induction motor self-starting under full-load torque. The rotor of the machine is arranged to revolve independently of the shaft during the starting period. The arrangement is such that the rotor starts from rest with the machine operating as a split-phase motor. As the speed increases a centrifugal device first opens the auxiliary starting circuit, then short-circuits the added starting resistance in the secondary circuit, and finally clamps the rotor upon the shaft, thereby bringing the shaft with its load up to the full-load speed of the machine.

No use has yet been discovered for tellurium, states an American contemporary. It is classed as a metalloid, and is supplied as a chemical curiosity in the form of a black powder and as a metallic-looking substance with a fine columnar crystal form, in colour somewhat resembling tin. Some of the compounds of tellurium have an offensive, all-pervading, and ineradicable odour. Chemists who have been experimenting with tellurium say, according to the United States Geological Survey, that after three months' exposure to sun, wind, and rain, the clothing worn by them while they were making these experiments, although it had not come into contact with the tellurium compound, was still so unpleasantly scented that it had to be destroyed.

Returns for the first three-quarters of the current twelvemonth show a rise in exports as well as imports of motor cars, in comparison with a like period in 1908. Germany imported 45 business automobiles, valued, roughly, at £19 700, whereas in 1908 the number stood at 37 with a value of £17,500. Austro-Hungary's sales rose, while Switzerland's dropped. The latter country sent vehicles weighing, collectively, 21,900 kilos. over the frontier. As to exports, Germany sent 118 vehicles abroad, as against 108 in 1908. The respective values were, however, £67 550 and £70,400; hence, the increase of tonnage was accompanied by a decline in value. The sales in Russia dropped from 91,100 to 72,100 kilos. Great Britain figures but low in the list of buyers.

An experimental road has been constructed at Truro, by which it is claimed that it has the advantages of being resilient, mud and dust-proof, noiseless, and requiring no removal of the old surface. It consists in spiking down on the roadway sheets of expanded steel similar to those so largely used for the reinforcement of concrete, and laying over it a 2in. depth of ordinary road material treated with coal tar, and rolling well in. The expanded steel is obtained by passing solid sheets of mild steel through a machine, which cuts slits at regular intervals, while the sheets are forcibly expanded, the result being a large sheet of diamond-shaped netting, which, it is claimed, when used in conjunction with properly prepared stone, will give a road surface of considerable endurance.

An American patent has been granted to Mr. N. G. Warth for an improved telephone repeater. A horseshoe magnet covers the receiving coils. The poles of these latter are bevelled to conform to the bevel of the armature, and a small block is mounted directly upon the mica diaphragm of the transmitter. This makes the moving parts very few. The rear wall of the microphone button is re-entrant, to afford a better disposition of the granules. The air-gap of the magnetic circuit is adjustable through a spacing screw in the transmitter mounting, and the permanent magnet is provided with an adjustable magnetic shunt block for deflecting the polarising field from the air-gap. These adjustments provide for the accomplishment of maximum efficiency of action.

The investigation of the meteorology of the upper air, by instruments attached to kites and balloons, has been in systematic operation sufficiently long to justify the issue of a report on the subject, which has just been published by the authority of the Meteorological Committee. An introduction to the report by Dr. W. N. Shaw, the Director of the Meteorological Office, gives, in the first place, an historical survey of similar work hitherto pursued in this country. The main body of the report gives a description of the apparatus and methods in use by Mr. Dines at Pyrton Hill, the details relating to the construction and management of kites and balloons being sufficiently precise to afford a most useful guide to any person wishing to take part in so valuable a department of meteorological work.

It is reported that some successful experiments were recently carried on at Nuremberg in connection with steering a motor boat by means of wireless telegraphy apparatus. At the lighthouse on the lake the antennæ were erected, and on the bridge the transmitting apparatus was placed. On the boat the wire was stretched between two masts 13ft. in height and 13ft. apart. The receiving apparatus was fitted in the forepart of the boat, and in the stern was the switch and electric steering gear. In the course of the trials the boat was made to describe curves to the right or left, and to turn sharply in either direction. The object of the tests was to prove that it was possible to transmit signals to an intermediate point, and thence, as directed by a shore station, to control the steering gear on board a vessel.

The authorities at the Devonport Dockyard, states the *Electrical Review*, express some fear that the main switches which are placed in each building for controlling the lights, may inadvertently be left in the "on" position at the close of the day, though the various lights may have been switched "off." To ensure, therefore, that at the close of each working day the electric current shall be shut off in all buildings not in use, electrical tell-tales are being fitted to all buildings having separate controlling switches. These tell-tales consist of two electric lamps enclosed in red shades placed against the outside of the buildings over the main entrance. They are so connected up that should the switch be left "on" contrary to the regulations, the lamps will continue to burn, and thus warn the police on duty. When the switch is turned to "off" the tell-tale lamps go out.

The following notes concerning the storage in California of crude oil in concrete reservoirs were recently given in *Concrete*. A 1,000,000-barrel reservoir lined with concrete has lately been completed at Port Richmond, Cal., and one of 800,000-barrel capacity is under construction near Bakersfield. The practice is to excavate the earth, which in most fields is a sandy loam, porous, and very dry, to about one-third the depth of the proposed reservoir. With the material removed, a levee is built round the excavation, having side slopes of 1 : 1½ on both faces. The bottom and sides are then covered with about 3in. concrete, often reinforced with expanded metal or some equivalent. Small cracks that occur at the junction of the sides and bottom and along the line between the cut and the embankment soon become filled with sediment, and are believed to permit the leakage of very little oil. A number of such structures in Southern California have recently been examined, and no signs of depreciation in the quality of the concrete were found.

MISCELLANEA.

The Agent-General for Victoria, Australia, has received through his Government a cablegram from the Council of the University of Melbourne advising him that Professor Henry Payne, Professor of Engineering at the South African College, Capetown, has been appointed to the Chair of Engineering at that University.

It has been decided by the proprietors of the Ascot cinnabar claims at Mackaytown, in New Zealand, to proceed with the erection of plant and furnaces, and it is probable that shortly they will be producing up to 10 cwt. daily of metallic mercury. There is reported to be enough ore at present available to keep up this output for some months, and the deposits are said to become richer as the workings are extended.

The South Lincolnshire Water Company, which was incorporated by Parliament in 1906, has deposited a Bill for introduction into Parliament next session, under which it is proposed to further extend their limits of supply so as to include the parish and urban district of Holbeach. The Bill also proposes to repeal the powers obtained by them for the acquisition of the undertaking of the Bourne Waterworks Company, Limited, and to annul the agreement with that company.

We hear that work is rapidly proceeding as a preliminary to the reconstruction of the Quebec Bridge over the river St. Lawrence. The pier on the northern side has been demolished to make way for stronger foundations, and the remainder of the piers are either being broken down or overhauled for use under the new plans. Everything is to be finished by November next according to the contracts, and throughout the winter 500 men will be constantly at work making everything ready for the activities of 3000 bridge-builders in the spring.

All over South Africa are salt-pans, many of these having deposits of great value. Few of them are being worked as business undertakings, and such as are are using the most elementary methods for producing their salt in a marketable form. But the industry in Orange River Colony has made an advance by the importation of machinery capable of producing over 80 tons per week. In the northern parts of Cape Colony during the past year many salt-pans have been acquired on lease from farmers, and no doubt the example of the Orange River Colony salt mines will be followed and machinery purchased properly to develop the industry.

According to the *Electrical World* the number of electrical plants erected for farms is increasing with marked rapidity, and in their opinion it seems probable that the time is coming when well-to-do farmers everywhere, no matter how remote from a city or village containing a central station, will consider electricity as a necessity. At first the current for these country equipments will be generated by plants on the premises; but as the movement becomes more general, central-station companies favourably situated will no doubt find it to their interest to extend their lines along the rural highways to a far greater degree than is done at present.

An appendix to the report of the International Conference on Electrical Units and Standards of 1908 has just been issued. It will be remembered that the specifications of the ohm, ampère, and normal cell in the original report were expressed in general terms so as to admit of modifications in details at the various national standardising laboratories. The appendix now issued contains details of the methods adopted at the National Bureau of Standards of America, at the Central Electrical Laboratory of Paris, at the Reichsanstalt at Berlin, and at the National Physical Laboratory at Teddington. References to the literature of the subject are also given, so that this appendix will prove of great use in electrical laboratories.

According to the *Electrical Engineer*, Mr. Nikola Tesla has announced that as the result of experiments conducted at Shoreham, Long Island, he has perfected a new system of wireless telegraphy and telephony in which the principles of transmission are the direct opposite of Hertzian wave transmission. In the latter, he says, the transmission is effected by rays akin to light, which pass through the air and cannot be transmitted through the ground, while in the former the Hertzian waves are practically suppressed, and the entire energy of the current is transmitted through the ground exactly as though a big wire. Mr. Tesla adds that in his experiments in Colorado it was shown that a very powerful current developed by the transmitter traversed the entire globe and returned to its origin in an interval of 84 one-thousandths of a second, this journey of 24,000 miles being effected almost without any apparent loss of energy.

At the Royal Institution last Tuesday afternoon Mr. William Duddell commenced a course of Christmas lectures on modern electricity. Tracing the early work of electrical discovery done by Volta in the later years of the eighteenth century, the lecturer described the structure of Volta's electric "pile," and produced one of the original "piles" made by Volta. This, he said, came into the possession of the Royal Institution as late as 1902. It was presented by Volta to Faraday when he was at the Royal Institution, but so little was thought of it that Faraday handed it to one of his assistants, who left it at his death to Mr. Leigh Smith, through whom it came back to the Royal Institution. Another historic instrument shown by the lecturer was a magnet from the Great Exhibition of 1851. That magnet, he said, was still one of the most powerful in the world. It supported a "keeper" of 4 cwt., and it was only with great difficulty that the keeper could be pulled away.

The first tests in the United States of firing at balloons were carried out at the Sandy Hook proving grounds on November 27th, when a small three-man captive balloon was anchored at a height of 300ft. and fired at from a distance of 2000 yards. Fifteen shots were fired from a special one-pounder having a range of movement from horizontal to vertical, without hitting the balloon. A larger field gun that could be elevated to about 40 degrees was also tried with smoke-producing shells, several of which passed over and several below the balloon. A third kind of shot was a shrapnel which exploded at a certain set distance, and discharged backward a score or more of balls in a widely expanding cone. The balloon was brought to earth by one of these shot. Before the completion of the tests, which lasted several days, ninety shots were fired with but three hits. Two of these were without effect. As a result of the tests, army officers believe it will be almost as difficult to hit and destroy a dirigible balloon as an aeroplane.

The Regulations adopted in Germany to prevent the rivers from being polluted provide that in the case of factories the water to be emptied into the river must be in an absolutely clean condition, unpolluted by any residues from the manufacturing process. This is accomplished by sending it through one or more settling ponds, and, if necessary, the waste must be passed through filters. The streams are regularly patrolled by inspectors, and any justified claim against the quality of the waters, due to pollution from the factories, is at once investigated and must be remedied immediately, regardless of the cost. The law is strictly enforced, and in the event of any violation, whether unintentional or not, the manufacturer is required to pay all costs in connection with removing the pollution from the streams. A manufacturer having works adjacent to one of the small streams in Saxony who polluted the water was compelled to bear all the expenses of cleaning the stream, and the cost of this work absorbed the earnings of the factory for several years.

THE VULCAN CEMENT WORKS, NEAR MONTREAL

(For description see page 680)

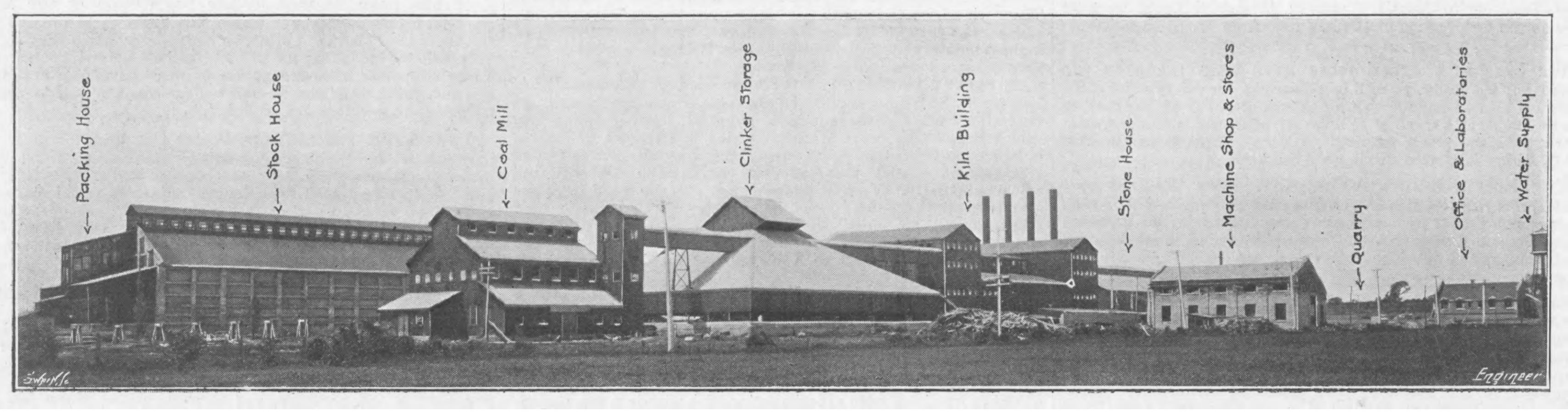

Packing House
Stock House
Coal Mill
Clinker Storage
Kiln Building
Stone House
Machine Shop & Stores
Quarry
Office & Laboratories
Water Supply
Swain Sc
Engineer

Fig. 14—GENERAL VIEW OF THE PLANT, LOOKING NORTH

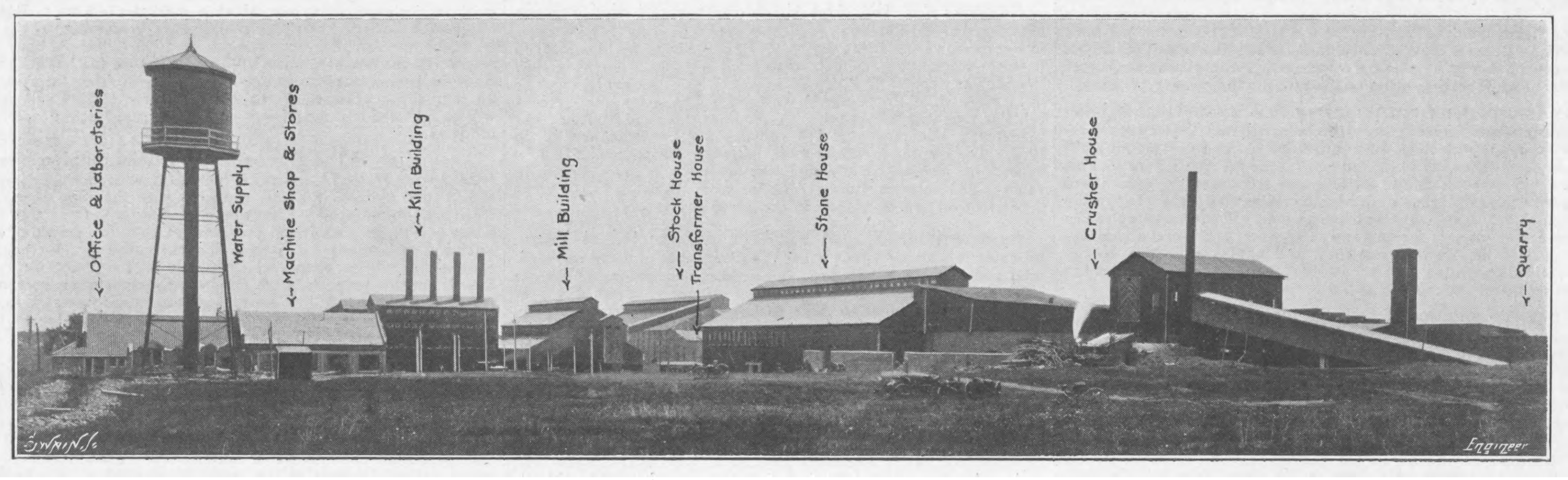

Office & Laboratories
Water Supply
Machine Shop & Stores
Kiln Building
Mill Building
Stock House
Transformer House
Stone House
Crusher House
Quarry
Swain Sc
Engineer

Fig. 15—GENERAL VIEW OF THE PLANT, LOOKING SOUTH

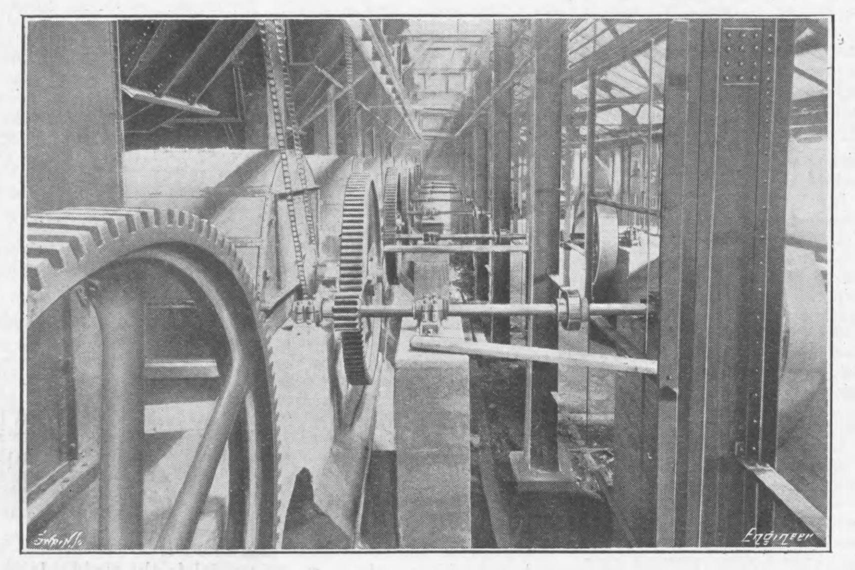

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Fig. 16—THE KOMINOR MACHINES

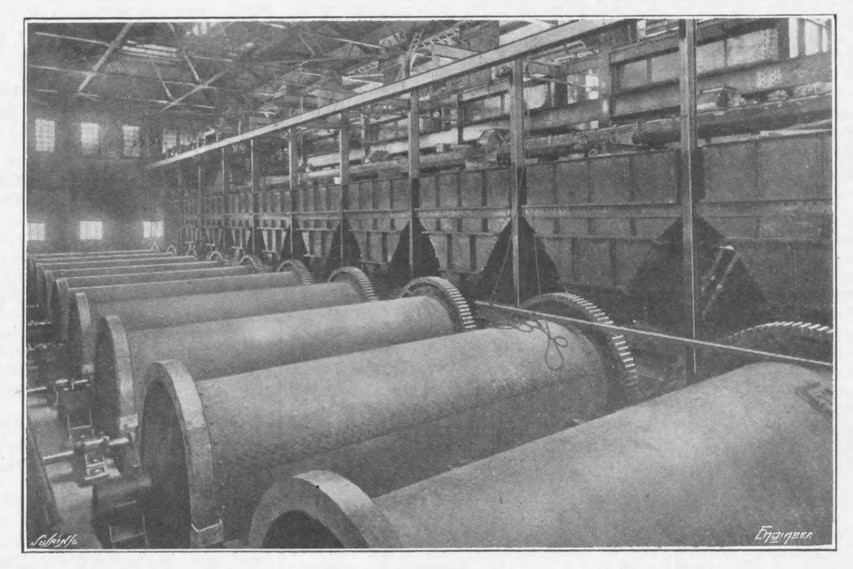
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Fig. 17—THE TUBE MILLS

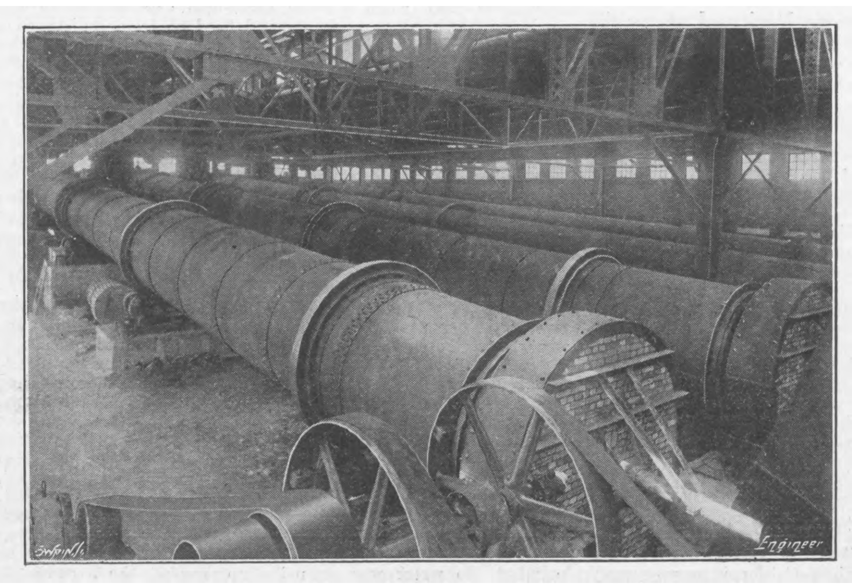
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Fig. 18—THE FOUR ROTARY KILNS

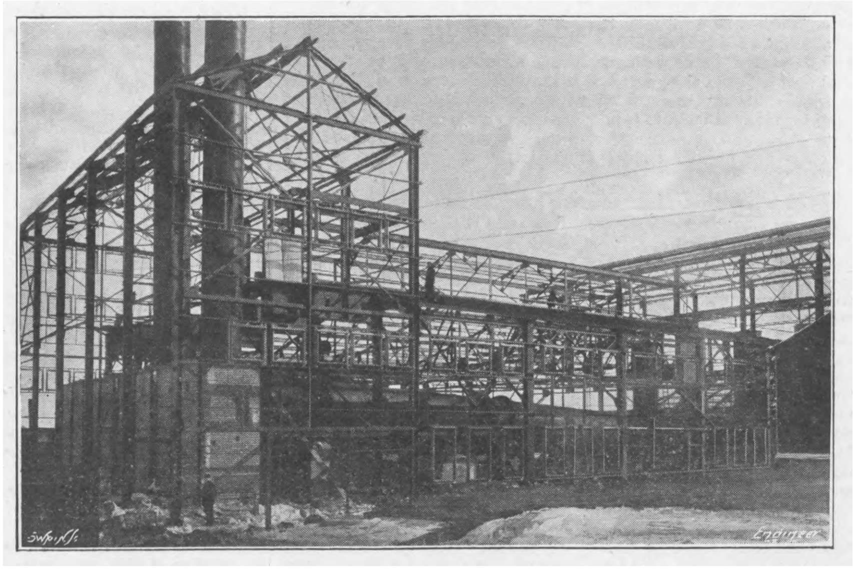
Swain Sc
Engineer

Fig. 19—THE KILN HOUSE UNDER CONSTRUCTION

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TO CORRESPONDENTS.

☞ *In order to avoid trouble and confusion we find it necessary to inform correspondents that letters of inquiry addressed to the public, and intended for insertion in this column, must in all cases be accompanied by a large envelope legibly directed by the writer to himself, and stamped, in order that answers received by us may be forwarded to their destination. No notice can be taken of communications which do not comply with these instructions.*

☞ *All letters intended for insertion in* THE ENGINEER, *or containing questions, should be accompanied by the name and address of the writer not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

☞ *We cannot undertake to return drawings or manuscripts; we must, therefore, request correspondents to keep copies.*

REPLIES.

C. F. (Cardiff).—(1) There are a great many devices for plugging boiler tubes, and it would be as well to see what has already been done by a search at the Patent-office before taking any further steps. (2) Address the Engineering Department. (3) Approach people who supply boiler fittings of various kinds. You will find their names in our advertising columns.

A. W.—We would recommend you to consult:—(1) "Electricity in Factories and Workshops," by A. P. Haslam; Crosby Lockwood and Son. (2) "Reinforced Concrete in Europe," by A. L. Colby; London, Williams and Norgate. "Concrete Steel Buildings," by Twelvetrees; Whittaker and Co. (3) "Lathe Design," by Nicolson and Smith; Longmans. "Machine Tool Design," by Parr; Longmans.

H. R. R. W.—It is quite impossible with the data at hand to arrive definitely at the consumption of gas in the period you mention; first, because you, presumably, do not know when the meter went wrong, and secondly, because the supply pressure varies throughout the twenty-four hours, and the leakage would nearly certainly vary with it. You will have to abide by the by-laws of the gas companies, which are fully recognised in such a case as you propound.

MEETINGS NEXT WEEK.

ROYAL INSTITUTION OF GREAT BRITAIN.—At 3 p.m., at Albemarle-street, Piccadilly, W. A Christmas Course of Experimentally Illustrated Lectures, adapted to a Juvenile Auditory, on "Modern Electricity," by Mr. William Duddell, F.R.S., M. Inst. E.E., M.R.I. Tuesday, January 4th, "The Generation of Electricity." Thursday, January 6th, "Electric Oscillations." Saturday, January 8th, "Electric Lighting."

THE INSTITUTION OF MECHANICAL ENGINEERS.—Friday, January 7th, at 8 p.m., in the Institution House, Storey's Gate, St. James's Park, Westminster, S.W. Extra general meeting. Papers: "The Application of the Pitot Tube to the Testing of Impulse Water Wheels," by Mr. W. Rankine Eckart. "An Account of a Visit to the Power Plant of the Ontario Power Company at Niagara Falls, with Extracts from Papers by Officials of the Company," by Mr. C. W. Jordan.

THE ENGINEER.

DECEMBER 31, 1909.

The Report of the Canal Commission.

THE final report of the Royal Commission on Canals and Waterways dealing with England and Wales and Scotland, which was issued on Tuesday is a remarkable document, notably on account of the unprecedented findings of the majority, but also as being inconclusive in many important respects. We say the document is a remarkable one, but it is also an anomaly, for although the Majority Report is signed by sixteen members out of the nineteen now constituting the Commission, this mere statement of figures by no means represents the true feeling of the Commission as regards the contents of the volume. No less than four of the signatories of the Majority Report also sign a memorandum of reservations which distinctly and conclusively states their entire disagreement with the contents of the principal document, with the exception of the historical and descriptive portions and a few minor recommendations, as to which there is practical agreement on the part of all the members of the Commission. Another signatory to the Majority Report, Mr. Russel Rea, also contributes a reservation as to a portion of the recommendations, which, if correct, destroys the traffic calculations and the financial assumptions founded thereon contained in the Report. The three members who have not attached their names to the Majority Report have each presented individual reports, which dissent practically *in toto* from the views contained in the former document. These individual reports are by Mr. Remnant, Mr. Davison, and Mr. Inglis. Although these three reports arrive at the same or similar conclusions, the writers approach the subject from somewhat different standpoints. Mr. Remnant, in a short but carefully reasoned document, condemns the proposals of the majority on economic considerations. Mr. Davison in his report criticises the transport and financial features of the Majority proposals, and lays stress on the fallacy of attempting to construct a policy of waterways development for our own land based essentially and solely on continental data and experience. His criticisms and conclusions reach to much the same results as the reservations of the four members who have signed the Majority Report. He amplifies and supports their views by figures and facts, and as an answer to the conclusions of the majority, Mr. Davison's report contains in brief form the substance of all the most important arguments which can be brought against the policy of State acquisition and development of waterways. Mr. Davison also makes certain recommendations concerning canals showing vitality, and adds some important suggestions respecting railways. The report which Mr. Inglis contributes to the volume presents, as might have been expected, a view of the questions at issue from the railway standpoint. The report, which extends to thirty-one pages, is a brilliant defence of the railway position, and certainly affords more interesting reading than is usually found within the covers of Parliamentary Blue-books. Mr. Inglis defends the railways in no uncertain language against the charges that have so often been levelled against them, and in some passages does not hesitate to depart from the precedent of colourless and restrained language ordinarily adopted in reports of Royal Commissions. Backed, as Mr. Inglis's statements are, by the weight of his position and expert knowledge, his report must be regarded as representative of the views of railway authorities in general on the question of canal *versus* rail transport.

We have referred to the memorandum signed by the four dissentients, and characterised the Majority Report as anomalous in that these gentlemen—Lord Farrer, Sir John Wilson, Mr. Waldron, and Mr. Killick — while signing the Report, dissent from it in all important respects. It is difficult to understand the reason for this curious action, unless it is that the dissentients felt bound to attach their imprimatur to the excellent and valuable historical and descriptive sections of the Report, which fill a large portion of the volume. With these sections few, even of those most opposed to the policy recommended in the Report, will, we think, find occasion to quarrel, except perhaps in minor details, although Mr. Inglis does regard the historical sketch as seeking to "raise a certain degree of prejudice" against the railway companies in regard to their relations towards the canals. The only other likely explanation of the anomaly in the position of the dissentients seems to us to lie in the fact that the Report is, as we have said, inconclusive. While recommending a policy of State acquisition and extension on a large scale, the majority shelter themselves by recommending that the "Waterway Board" which they propose for immediate constitution "should review the whole situation on the lines of practical business . . . with special regard to finance and benefit to trade and public interests, to the extent of local assistance, to prospects of traffic, and to competition with railways. *If satisfied* that the improvement of the four main routes, or of one or more of them at a time, would be desirable, on these lines, the Waterway Board should propose a scheme or schemes for submission . . . to Parliament." The italics are ours, and it may be that the dissentients, and possibly also some other of the signatories, believe they are not committing themselves to any very definite views or proposals, and are shifting the responsibility for anything which may be done in the future as the outcome of the Report on to other shoulders. This shifting of responsibility is, we venture to think, indefensible, in view of the fact that the Commission has now been sitting for nearly four years, and has carried out an exhaustive inquiry into every aspect of the subject. It may be mentioned that the reports, evidence, and appendices which contain the results of the labours of the Commissioners fill no less than eleven folio volumes, including those which are yet to be issued. Surely, after an inquiry of such a nature, it must be possible to come to some definite and conclusive results, and the implication contained in the Report that the execution of the scheme it elaborates is to be postponed for future consideration would appear to indicate that the signatories have serious doubts as to the soundness of their recommendations. It cannot be doubted that such shirking of responsibility by sixteen out of nineteen members appointed by the King to return answers to certain questions submitted to them will go far to weaken public confidence in the value of such inquiries.

It may possibly be urged by his opponents that Mr. Inglis, in his defence of the railway companies, is biased in his opinions; but even if this view is accepted, it is noteworthy that the Majority Report completely exonerates the railways from the charge of "strangling" the waterways. As to the other members of the Commission who are at variance with the majority no charge of bias can, we think, be maintained. Mr. Davison is an engineering expert completely dissociated from railway interests. Mr. Waldron and Mr. Killick are directors of two important non-railway canal companies, and none of the other dissentients has, we believe, any important interest in railways, with the exception of Lord Farrer, who is a director of the Midland Railway Company. From what we have said it will be clear that the Majority Report is supported by twelve members of the Commission, including Mr. Russell Rea. On the other hand, the remaining seven members are opposed to the recommendations of the majority in all important respects.

What are the recommendations of the majority? In brief, the Report recommends the appointment of a central "Waterway Board" for Great Britain. To this Board would be transferred the waterways which form the four main routes connecting the Thames, the Severn, the Mersey, and the Humber with Birmingham and the Midlands, together with their important feeding branches. These waterways are referred to in the Report, for the sake of brevity, as "The Cross." It is recommended that the canal portions of these waterways be improved and enlarged so as to accommodate barges having a carrying capacity of 100 tons throughout the main lines, and that the river sections be enlarged to admit vessels of a still larger capacity. These improvements are estimated to cost over seventeen and a-half million sterling, exclusive of the cost of acquisition of the existing navigations. The loans raised to meet this expenditure are to be guaranteed by the State, and the expenditure on acquisition is to be met by a free grant from the State. If, for financial or other reasons, the larger works of improvement are postponed the immediate transfer to the Board of the waterways referred to is recommended, accompanied by minor improvements and some reduction of tolls. We have already mentioned the proposed reference to the Waterway Board of the further consideration of the improvement of "The Cross," and an alternative scheme is also suggested which would have the effect of placing the Waterway Board under the control of the Development Commissioners, appointed under the Act of 1909, as regards the consideration of schemes of improvement prepared by the Board, leaving the actual execution of improvements and control of the waterways in the hands of the latter body. The Waterway Board would also have the duty of proposing the acquisition of other waterways than those included in "The Cross," especially "any British waterways of importance now in the hands of railway companies, which should be included in one or more of the earlier schemes."

The Report contains no estimate of the cost of acquiring the waterways, and it is open to serious question whether the estimates of the cost of improvements which are given are sufficient. It is admitted that the estimate of over 17½ millions does not include such items as interest during construction and other financial charges, engineering, legal, and parliamentary expenses, lighting, provision of inland harbours or wharves and their equipment, and the provision of electric or other traction. Mr. Davison in his report submits an estimate of £22,000,000 as the cost of the improvement of "The Cross," and this estimate excludes the cost of acquisition, financial charges, and installation of tractive power. Again, we have grave doubts as to whether the improved canals will be physically capable of passing anything like the increased traffic anticipated in the Report, which admits that additional expenditure would probably be necessary on the duplication of locks and in other directions in case a traffic approaching the estimate were obtained. Even so, no provision appears in the estimates for such extra works.

It seems to us that forty millions is a conservative estimate of the actual cost of this huge scheme when the whole of the expenditure suggested, including the purchase of the existing undertakings, is allowed for. This is but one item of the scheme the country is recommended to adopt—the first instalment of a general system of State subsidised and State controlled transit in competition with the railways of the country. What the cost would be when the northern and other canals were swept into the net of the State it is beyond us to say, but if the other principal waterways are ever dealt with on a scale similar to the proposals for "The Cross" an expenditure of one hundred millions may be reached without difficulty. We shall have something to say in a later issue on the economic and other aspects of this dubious scheme. It should be mentioned that the recommendations respecting Scotland are unanimous. On another page we publish the first portion of a summary of the Majority Report.

Briquettes as a Locomotive Fuel.

In our last impression we called attention to the formation at Chicago of an International Railway Fuel Association. We wrote of what had been said at the first annual convention about locomotive coal, and we added that much remained to be said regarding other forms of fuel. These are principally lignite, or "brown coal," and briquettes. We need not take the first into consideration, because lignite has no interest for British engineers. Some of the information supplied concerning briquettes is worth setting before our readers, because it would appear that they manage to burn highly bituminous coal in that shape without producing any smoke worth naming, and to utilise small coal which would otherwise be wasted.

A paper was read by Mr. C. T. Malcolmson, of the Roberts and Schaefer Company, Chicago, on "Briquetted Coal and its Value as Railway Fuel." This paper is at first historical. It then gives a brief account of the industry as now carried on in the United States, which is growing in importance. The difficulties met with lie principally in the binding material, which is in all cases expensive. It has been found that pitch is the best, but ordinary European pitch is useless, as it becomes soft at 165 deg. Fah., and melts at 212 deg. Fah. Briquetting pitch should be hard enough to be transmitted in open cars in the hottest American weather and remain hard. To gain this end all the lighter oils and about 5 per cent. of the anthracine should be extracted. Pitch with a melting point of anything over 200 deg. Fah. will answer. Various forms of press are used in producing the briquettes. It is with the results obtained, however, and not with the process of manufacture, that we have to do. The discussion turned mainly on Southern coal of what is known as the Illinois type. The average fixed carbon is 50 per cent., volatile combustible about 33, ash varies from 9 to 19 per cent. This coal is used as mine run on the engines. That is to say, it is not screened and contains a large quantity of slack. The experiments made with this fuel in the form of briquettes showed a substantial advantage all round. Slack that was really unfit for use in the fire-box of a locomotive became mechanically fit. It admitted of being properly fired, and was not carried into the smoke-box or dropped through the grate. Very striking photographs were exhibited of locomotives working suburban trains, some burning raw coal, others briquettes. The latter show no smoke; the others do. Careful investigation resulted in demonstrating that a saving can be effected of from 20 to as much as 35 per cent. in the consumption of fuel, while the boilers steam much better. It would occupy more space than we can spare to mention the various reasons given to explain the high efficiency of the briquettes. In the main, however, it must be sought in the mechanical adaptation of the fuel to combustion in a locomotive fire-box, and incidentally to the diminution of waste due to the brittleness of the coal. The most noteworthy test, particulars of which were brought before the meeting, was carried out with a standard consolidation freight engine designed to burn bituminous coal in a fire-box of the semi-wide type fitted with shaking grates. The results do not confirm Mr. Malcomson's statements. But the conditions were not the same. Four return trips were made between Scranton and Elmira with large briquette fuel, and to obtain comparable data four similar trips were made with raw coal. Analysis gave for the briquettes 13,690 and for the coal 14,282 B.Th.U.'s per pound—very high values. The results were that the briquettes burned per 1000 ton-miles weighed 106.4 lb. and the coal 99.89 lb., but the average speed with the briquettes was 18.05 and with the coal 17.68 miles per hour. With the briquettes no firing tools were used, and very little shaking was required. The exhaust nozzle had to be increased a quarter of an inch in diameter for the briquettes, with a corresponding reduction in the back pressure. With small briquettes a better result was obtained.

Mr. Malcolmson's paper, and the long discussion which followed it, can leave no doubt on the mind that, given the necessary conditions and a proper method of manufacture, briquettes form an excellent locomotive fuel, and that briquetted fine coal can be burned without smoke, a result impossible without briquetting. On the other hand, it appears to be difficult to get a briquette fuel which is not excessively dirty as regards the trains. This is notorious on European railways; and one speaker during the discussion said that for this reason he had to confine the use of briquettes to freight trains only The conditions, as we have previously pointed out, prevailing in the United States are very different from those ruling here, mainly, no doubt, owing to the characteristics of American coal, which seems to have a marvellous capacity for clinkering the grates. In all cases too we find that at the other side of the Atlantic the rate of combustion per square foot of grate per hour is much higher than it is in this country. It is hard to reconcile this fact with the statements made about the economical excellence of the American locomotive. We are quite unable to explain the discrepancy. The main interest for English readers lies in the fact that briquettes may be found a more economical fuel than coal. Small slack of all kinds is much cheaper than even roughly screened coal of the same kind; and it ought to be as possible to utilise it in this country as in any other. In South Wales a good deal is being done in manufacturing briquettes, and less, but still something, in other colliery districts. So long, however, as coal remains cheap it will be used as coal. But will it remain cheap? All the indications are that it will not. Some of our Southern railways are now paying over £1 per ton for coal, and that not on the foot-plate. Any further rise cannot fail to direct attention to methods of utilising fuel, much of which is now practically unmarketable. These methods may be for the moment unpopular. We fancy that their unpopularity would disappear if anything like a substantial economy could be secured. No one is likely to pay for briquettes if good round coal can be had at reasonable rates. On the other hand, if briquettes are as efficient as the good round coal and lower in price, then the situation is altered. Continental experience has long been in favour of briquettes. American experience seems to be the same.

Profits on Steel Production.

The important influence which the possession of collieries and coke-making plant brings to bear upon the cost of production of and profits on the manufacture of pig iron and steel has been strikingly illustrated in the case of fourteen of the large works which form about one half of the total constituents of the German Steel Syndicate. All the constituents of the syndicate do not own coal or iron ore mines, but the comparatively few who have neither are gradually endeavouring to acquire their own supplies of coal even if they are unable to secure suitable iron ore mines. The movement in this direction has been proceeding for several years past, and is likely to continue in the future, seeing that the control of coal plays a far greater part in the economical production of iron and steel than that of iron ore in connection with these large undertakings. Apart from this circumstance the supplies of native ore in Germany are insufficient to meet the domestic requirements, so that recourse has to be had to large imports from Sweden and other countries. In particular the rich deposits of iron ore in French Lorraine, to which the attention of British pig iron makers has been directed on several occasions in the past two years, are being drawn upon to a considerable extent by the Teutonic iron and steel producers, and over 2,000,000 tons have been requisitioned from this source in the present year, or twice the quantity obtaining in 1908. This large expansion in the exports is inducing the French iron ore owners to consider the question of increasing the price of the ore which is sent over the frontier mainly from the Briey basin in the Meurthe and Moselle. But if the iron and steel works in the eastern industrial district of France have an abundance of high percentage ore at their disposal, in addition to being able to export a large quantity, they have no supplies of coal near at hand that are available, as the coal deposits discovered in that region a few years ago have been located at comparatively great depths, and it is now considered questionable whether they can be worked on a commercial basis, whilst at the same time the coal is declared to be of an average quality. In the circumstances these French iron and steel producers are compelled to procure several millions of tons of coal and coke from Germany, Belgium, and the Nord and the Pas de Calais every year, and the iron ore exported is therefore largely exchanged for fuel from over the frontiers.

The lack of local supplies of coal and coke, and the cost of carrying them from a distance, are responsible for the fact that the sale prices of iron and steel in the Meurthe and Moselle are usually higher than in the Nord, although less than in the Paris market, where the quotations are generally higher than in any other part of the country. But across the frontier in Luxemburg and Germany, where the sale prices are either controlled by syndicates or regulated by competition, the non-possession of coal mines manifests itself in a different way in the sense that the cost of production is greater, and the degree of remunerativeness is less, than in the case of those works which own collieries. If the question of iron ore is left out of consideration, and attention is devoted solely to the production of pig iron or steel, it is found that four out of the fourteen works previously mentioned have no coal resources of their own at present, and as two of the four do not give any figures relating to their output of steel, they may be dismissed with the statement that both have paid dividends for the year ended with June 30th, 1909. In dealing with the remainder it is necessary to bear in mind that the price of pig iron declined by 15s. per ton during the twelve months in question, and with three exceptions the gross profits per ton of steel ingots produced experienced a reduction as compared with 1907-08. The lowest profits on this basis were 6s. per ton in the case of the Haspe works, and the second position is occupied by the Rombach works with 12s. 3d. per ton, these being the other two works which do not own coal mines. On the other hand, the undertakings which control their own supplies of fuel exhibit very considerable differences in the gross profits per ton of steel made in 1908-09. Thus the accounts of the Rhenish steel works show gross profits of 12s. 4d. per ton; the Dortmund Union, 13s. 3d.; the Georgs-Marien Bergwerks, 18s.; the Hoesch works, 18s. 3d.; Aumetz-Friede, 18s. 9d.; the Bochum Verein, 20s.; Van der Zypen-Wissen, 20s. 4d.; the Guttehoffnungshutte, 23s. 6d.; Phœnix Works, 25s.; and the Deutsch-Luxemburg, 28s. per ton. These figures are reflected in the financial results which, with the exception of one undertaking which is still being financially fortified, show dividends for the thirteen remaining works which range from 4 to 20 per cent. for the year 1908 09, although these are mostly less than in the preceding year.

The figures quoted, while being incomplete in consequence of the different periods of termination of the financial years of other works, demonstrate the great advantage possessed by the coalowning iron and steel works over those which have no supplies of fuel at their own command, and it is, therefore, scarcely surprising to learn that one of the four deficient in the latter respect is now occupied in opening up a coalfield acquired for this purpose. The works which are the most favourably situated are those which, so to say, sit on the coalfields in Rhenish-Westphalia, whilst those situated on the iron ore mines in Lorraine and Luxemburg are less satisfactorily circumstanced unless they are associated with Rhenish-Westphalian coal mines, such as the Differdingen and Aumetz Friede works. On the other hand, certain undertakings in Westphalia are also interested in works in Lorraine and Luxemburg, and the coal supplies of the one complement the iron ore resources and blast furnaces of the other. Combinations of the latter class are already in existence, and that of the Gelsenkirchen Company at Esch and Deutsch-Oth, comprising nine furnaces, is to be increased by the addition of further furnaces and a steel works, and an entirely new blast furnace plant is to be erected at Maizières, near Metz, by the firm of Thyssen and Co.

These developments and other movements of a somewhat similar character are all intended to strengthen the undertakings concerned when the time arrives, either next year, or in 1911, for the attention to be given to the question of the renewal or discontinuance of the German Steel Syndicate in 1912; and it is, therefore, highly probable that in course of time the ordinary blast furnaces, which have just experienced an exceedingly unfavourable year, will either be commercially ruined or absorbed by the large combined iron and steel works having their own collieries, as well as iron ore mines in some instances, and capable of producing steel even at large gross profits per ton during a year of trade depression.

GERMAN COMPETITION IN STEEL.

(*From a Correspondent.*)

THE question of German competition in the iron and steel trade merits more than ordinary attention just now. It is but a matter of a few months when, at their present rate of progress, the Germans will get ahead of us in the exportation of iron and steel, and our long held supremacy in that line will be gone. It is time to take stock. Less than a dozen years ago we exported four times as much iron and steel as the Germans. Now our rivals have nearly drawn level with us in the race, and while we are merely marking time they are making substantial headway. Within quite recent years we have been relegated from the first to the third position as an iron country in point of production. Both America and Germany have got ahead of us. That is not unnatural, perhaps, for those countries have larger populations than Great Britain; but there is no natural reason why we should also be beaten in exports. Such is our manufacturing skill, such are our natural resources, and, above all, such are our geographical advantages that we ought to retain first place as an iron and steel exporting country without any difficulty. We can produce iron and steel better and cheaper, and we can ship the products more convenietly, than any other country. In neutral markets we ought easily to defy foreign competition, save in a few specialities. Besides, we depend so largely upon imported agricultural produce, and, consequently, so largely upon exports of manufactures, that it is essential that we should retain a larger share of the world's export trade in iron products than any other country. It will be a national misfortune, and it will be a national humiliation, if we lose first place in iron exports. That we are in danger of losing first place may be seen by a glance at these figures:—

Iron and Steel Exports from:—

	Great Britain. Tons.	Germany. Tons (metric).
1897	3,318,000	768,000
1898	2,902,000	847,000
1899	3,368,000	777.000
1900	3,213,000	838,000
1901	2,617,000	1,410,000
1902	3,241,000	2,126,000
1903	3,209,000	2.199,000
1904	3.366,000	2,770,000
1905	3,721,000	3,349 000
1906	4 682,000	3,666,000
1907	5,311,000	3,455 000
1908	4,233 000	3,732,000
1909 (first three quarters)	3,074,000	3,089,000

These figures require explanation. It is time we faced the facts. While the world's demand for, and our rivals' production of, iron and iron goods are increasing rapidly, we are doing little or nothing to increase our trade in iron goods. Unless we wake up we shall soon be relegated to a mere fifth-rate position in an industry where we ought to reign supreme. Here we have Germany, a country labouring under natural, geographical, and economic difficulties quite unknown in this country, making great headway while we are standing still!

To begin with, Germany's minerals are neither so cheap nor so good, nor yet so conveniently deposited as ours. Here we have natural shipping facilities, iron ore supplies, coal and limestone, and manufacturing plants, all practically side by side; while in Germany the ore deposits are far removed from the coalfields, and both ore and coal, and, therefore, manufacturing plants, are at long distances from seaboard. While the average haulage distance for iron and steel making materials in Britain is less than thirty miles, in Germany it is not less than 150 miles. In this country it costs in few cases more than about 1s. 6d. per ton to carry ore, or more than 2s. to 3s. per ton to carry coal to the smelters; while in Germany it costs between 6s. and 7s. per ton for assemblage charges. Then, again, the prime cost of Germany's coal is considerably higher than ours. Even if we did not possess an ounce of iron ore in this country, our coal supply is such, and our geographical situation is such that we could easily beat Germany in the iron trade. We can fetch the very best Spanish and Scandinavian ores and land them right alongside our blast furnaces, in the very heart of our best coalfield, at a much less cost for freightage than the Germans can carry their own domestic (and inferior) ore from mines to furnaces. Besides, not only does it cost Germany more for mining and assemblage charges, but after the furnaces have turned out their products, those products, if for export, have to be conveyed nearly ten times as far to a port of shipment in that country as is the case in Britain. And yet Germany is threatening to dislodge us from the first position as an iron exporting country.

Of course, Germany's industrial progress is frequently attributed to cheap transit, cheap mining royalties, and cheap labour. But in competition with Great Britain, it is not strictly accurate to contend that Germany's iron trade is favoured under these headings. That mining royalties do not count for much is proved by the fact that the pitmouth price of coal is higher in Germany than here. That cheap transit does not count for much either has already been explained in connection with Germany's long haulage distances, which completely destroy the alleged advantage of low ton-mile rates. Nor does the German iron industry hold any advantage over the British industry in the matter of cheap labour. Nearly fifteen years ago the British Iron Trade Association delegates to Germany, after visiting the leading iron and steel works there, expressed their "surprise" at finding how very nearly the wages of the German workers approached those of our workers. Mr. J. Stephen Jeans, the secretary, declared that "in not a few cases" the wages for similar classes of work in the two countries "were practically on all fours." Since then wages in the skilled trades have gone up by 22 per cent. in Germany against 11 per cent. in Britain, and unskilled wages have risen by nearly 50 per cent. in Germany against no rise at all in this country. Wages per worker employed, and per unit of output, are actually higher in the iron group of trades in Germany than in Britain. No; Germany's success in the iron and steel trade is not due either to cheap labour or superior natural resources—it is not due to any fundamental advantage over this country.

What, then, is the secret of German success? The reply can be given in one word—organisation. Without its vast system of syndication—its almost military-like productive and distributive methods—and the organised fostering of export trade by bounties, the German iron industry could not possibly have attained its present status. The production, price, and sale of practically every material and article of iron manufacture, from coal and ore to wire nails, are controlled by some syndicate or manufacturers' union. A German syndicate does not, as a rule, control or own any works as do the American "trusts," but only the products of the works. Thus a German firm manufacturing a dozen different articles may be a member of a dozen different syndicates, and not a unit of a single trust. The usual syndicate system is for a number of experts to visit each of the works and ascertain its capacity of production and aptitude for any special line of business. Then orders, which are generally received by the central offices, are allocated to the various establishments, regard being paid to the geographical situation and mechanical equipment of the several firms in order to effect every possible economy. For example, a Russian or Austrian order would, other things being equal, be allotted to a Silesian works, while an English or or French one would go to a Westphalian firm. The whole country is mapped out into trading zones, and if, after careful allocation of orders, any firm is placed at undue advantage in the matter of transit, &c., it is compensated to the extent of the extra carriage. Payments as well as orders usually pass through the central offices, and the syndicate attends to many trade, legal, and other affairs in the interests of its constituents. These German syndicates are manufacturers' trade unions and co-operative societies combined.

In 1897 some of the German iron trade syndicates inaugurated the export bounty policy, and it is this agency which has been mainly instrumental in promoting German competition with this country, The coal, coke, pig iron, and steel syndicates controlling raw materials agreed to supply their associated customers—the iron and steel manufacturers and engineers—with fuel, iron ingots, &c., at cheaper rates when such materials were needed to manufacture for export than when required for the home market. From time to time the bounty rates, or rebates, have been increased or decreased in response to the fall or rise in the home demand. If the home demand has been brisk the bounties have been low; if it has slackened, up have gone the bounties in order to promote exports. Thus we have had the spectacle of Germany doing the most trade abroad when there has been the smallest volume of trade available. Between 1897 and 1905, when the bounties were in practically constant operation, German exports, contrasted with our own, made the following progress:—

Iron and Steel Exports from:—

	Britain. Tons.	Germany. Tons (metric).
1897	3,318,000	768.000
1905	3,721,300	3,349,000

Early in 1906, however, so vigorous had Germany's home demand become, and so good were prices abroad, that the need for export bounties and dumping ceased. The bounties were first reduced and then suspended, and then we got these figures:—

	Britain.	Germany.
1906	4 682 000	3,666.000
1907	5,311,000	3,455,000

During 1908 and most of 1909 there has been depression. Early last year the bounties were reintroduced, and now we get this result:—

	Britain.	Germany.
1908	4,233,000	3,732,000
1909 (first three quarters)	3,074,000	3,089,000

The contrast is striking. In 1908, compared with 1907, Germany increased her exports by 277,000 tons, while ours declined by 1,078,000 tons, and in the first nine months of the current year, compared with the corresponding period last year, while our exports have dropped by another 35,000 tons, those of Germany have risen by 91,000 tons. Our rivals, who are organised, are getting a larger share of the world's trade. We, who are not organised, are getting a smaller share. The lesson is plain and unmistakable. We must organise or be beaten.

LITERATURE.

Electricity. By H. M. Hobart, B.Sc. London: A. Constable and Co., 10, Orange-street, Leicester-square.

A RAPID glance at the illustrations contained in this book is sufficient to show that it differs very materially from most others having the same title. Indeed, it may be said that the volume possesses that desirable but unusual feature—originality. The author has deemed it unnecessary to instruct the reader to procure a stick of sealing-wax and to rub it with a piece of dry flannel or fur. He has considered it expedient to omit all reference to glass rods, electroscopes, Leyden jars, or pith balls. There is not even the slightest trace of anything about Wimshurst's machine, the electrophorus, or Faraday's reversible net, nor is the reader told that if he vigorously rubs the household cat's back he will see sparks—instructive as that experiment is liable to prove. All these things, whilst of interest from a historical standpoint, are of little value to the present generation of electrical engineering students, and it is refreshing to find an author of a book on electricity who recognises this fact. It must, we feel sure, often come as a tremendous surprise to youths who, after having studied that fascinating subject known as frictional electricity, suddenly find that few of the things they have read about have any relation to present-day conditions, and that the electric lighting of our houses and streets, the propulsion of electric trains and tramcars, and the numerous other commercial applications of electricity are in no way dependent upon the invention of Wimshurst's machine, and that electricity is not stored for commercial purposes in Leyden jars.

The first chapter of the book is entitled "The Generation and Conduction of Electricity," and here the author naturally has to explain that electricity is not generated at all, and his remarks in this connection are unique. He says that it is convenient and justifiable to speak of generating electricity, just as we speak of making cake when by suitable agency we transform material substances, such as eggs, flour and milk, into the material substance which we term cake. It is not clear why Mr. Hobart does not adopt the common method of explaining that electricity is not generated, by asking the reader to regard the so-called generators of electricity as electric pumps which set up a potential difference between the ends of the circuit, and so cause electricity which already exists to flow through the conductors constituting the circuit, for whatever objection may be raised against this explanation, it at least has the effect which Mr. Hobart desires of causing the student to lose the idea that electricity is generated.

Some instructive information is given in the second chapter concerning copper, aluminium, and other conducting materials, and following this there is a chapter on energy, wherein the author states that he finds it helpful to think of energy as the life of matter. Before going further, we should mention that throughout this treatise the author in making calculations employs a comma instead of the usual decimal sign. We have not been able to discover the object of this, and we cannot think of any advantage which the practice is likely to have. On the contrary, it is liable, until the reader becomes familiar with the system, to lead to confusion. For example, if one meets with 1,173, a certain amount of thought is at first necessary to decide whether it means one thousand one hundred and seventy-three or one, decimal one seven three, notwithstanding the fact that if it were the former the printer would probably leave out the comma. Many instances occur throughout the book where the author's use of words and terms deviates from that accepted by the physicist. Of this, the preface tells us, the author is well aware, but it is considered useless to oppose beyond a certain point the popular will as regards the use of words. In this connection, it is pointed out that the so-called consumer of electricity really pays for energy, but he calls it electricity, and this meaning of the word has also gradually come to be adopted by engineers. Mr. Hobart does not appear to be a believer in water analogies, for even in his chapter on Ohm's law none of the familiar diagrams employed for illustrating the fall of potential in a circuit are to be found. In this part of the book he gives some curves showing the temperature rise of bright conductors of circular section in still air at 20 deg. Cent. for various diameters; also some curves showing the current required to fuse wires of various sizes and materials. A chapter on the magnetic field contains some information which the student will find well worth acquiring, and the same applies to that section of the book which deals with conductors moving in a magnetic field. The alternating current section is also good, and in a number of places it possesses the merit of originality. For example, in one instance where the familiar right-angled triangle is constructed, to represent the resistance, reactance, and impedance of a circuit, in order to give the reader a useful mental conception of the case, the lines representing the resistance and reactance components are broken in the centres. Across the gap in the resistance component a non-inductive resistance is shown, whilst across the other gap there is a choking coil. Many simple but useful calculations are made in this section of the book, and those students who have been unable to understand what power factor means should be out of their difficulty after having read the latter part of Chapter IX. Professor Kapp's innovation of designating as the "crest" value the maximum instantaneous value of an alternating pressure or current has been adopted in this book.

The last section is devoted to insulating materials, and here again some useful information is given both in text and graphic form. The book, as we have already intimated, is written on practical lines, it contains nothing which is particularly difficult to understand, and, all things considered, it is a decided improvement on most books we have seen having for their title the word "Electricity."

SHORT NOTICES.

Laboratory Notes on Iron and Steel Analyses. By W. Macfarlane, F.I.C. London: Longmans, Green and Co. Price 7s. 6d. net.—This book treats very fully of the chemical analyses and details associated therewith of iron and steel, and covers most of the work of the chemist at a steel works or blast furnace. The author writes with a long experience of his subject behind him. The notes from which the present work was prepared were orginally composed for the guidance of the laboratory staff of an iron and steel works, and have since been found useful to the students in the laboratory at the Wednesbury Metallurgical Centre. It has, therefore, already had a wide test as regards the trustworthiness of its matter, both as a practical and as an educational work, and we can recommend it for its clear style of exposition. Everything is done to simplify the analyses and to economise the chemist's time. As an example, we would point to the arithmetical details associated with each analysis. In all cases the combining weights are given and the formulæ reduced to their lowest expression, and to facilitate the final calculation of place logarithms are given for the known figures entering into the result.

Machine Shop Drawings. By F. H. Colvin. London: Hill Publishing Company, Limited. Price 4s. 6d. net.—This book is intended to give its readers a good working knowledge of shop drawings and to enable them to become expert at "reading" them. It is American in origin, and resembles many other volumes of a "practical" nature coming from that country and now on sale in this. That there is a demand for such works in their native land is shown by their increasing number. With us, however, we doubt if many workmen will be induced to pay 4s. 6d. for a work which, after all, contains very little that cannot be picked up casually during the first year of apprenticeship in the shops, while many of the details in it are wholly American and not applicable in this country. To apprentices the book can scarcely be recommended in place of the ordinary work of the machine design class, while to draughtsmen the work is, or should be, superfluous.

BOOKS RECEIVED.

Deutscher Kalender für Elektrotechniker, 1910. By G. Dettmar. München, Germany: R. Oldenbourg. Price M. 5.

Hennebique Ferro-concrete Theory and Practice. London: L. G. Mouchel and Partners, Limited, 38, Victoria-street, S.W. Price 10s. 6d. net.

THE DETECTION OF FIRE-DAMP.

THE study of the significance of the "cap" or halo which surrounds a flame burning in an atmosphere containing inflammable gas has been taken up by eminent men from time to time ever since the invention of the safety lamp, but until it was definitely proved that the ignition of coal dust in a mine could, under certain circumstances, cause an explosion, and that the presence of small percentages of gas greatly increased the possibility of such ignition, mining men did not attach any great importance to recognition of "caps" which indicate these small percentages. The fact that these small amounts of fire-damp, though much below the proportion necessary to form an explosive mixture of the gas and air alone, could, in the presence of dust become dangerous, once recognised, a number of devices for the detection and estimation of the proportion of fire-damp were introduced.

In order to render the pale blue "cap" more visible, the user of a safety lamp reduces the flame until only the darker blue and nearly non-luminous portion of the flame is visible. Several of the devices referred to therefore used the non-luminous flame of hydrogen or alcohol, with the further advantage that the greater heat of these flames, as compared with that of the ordinary safety lamp flame, gave a much larger and more distinct "cap." Perhaps the best example of the former type is the Clowes device, which consists of a small cylinder of hydrogen attached to the lamp, and provision for burning a jet of this gas inside the lamp. The Pieler lamp is a good example of the alcohol type. An arrangement depending on the increased "glow" of a heated platinum wire in the presence of inflammable gas has also been introduced.

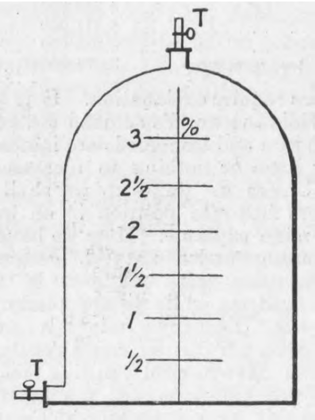


Fig. 1—GASHOLDER

Most of these arrangements, however, are adapted for the use of experts only, and might even be dangerous in other hands. Estimations and tests made by experts, and communicated to the man who must put the results into practice, cannot be as useful as the men's own observations, if means are found to enable them accurately to assess the percentage value of the "cap." The "cap" or halo, which indicates the presence of inflammable gas, being of a pale blue colour shading into a still paler greeny blue, may be unrecognisable to a man whose colour perception is below normal. From the report of the Commission on Safety in Mines it is evident that the reports of mines inspectors and the evidence placed before them impressed the Commissioners with the necessity of ensuring that the man on whom the duty falls should not only be able to see the "cap," but should be able to put a true value on that "cap."

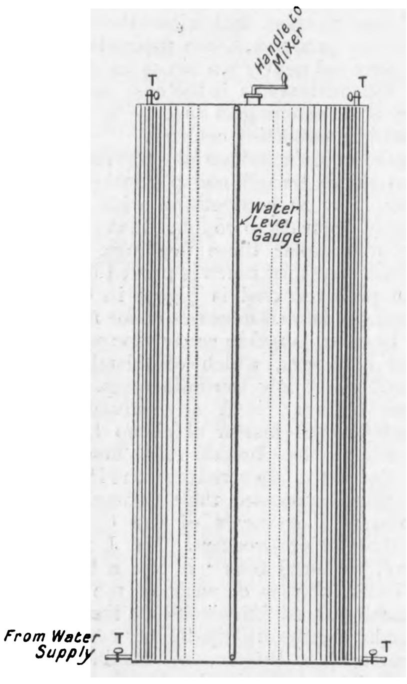


Fig. 2—MIXING CHAMBER

The man on whom this duty falls, in British coal mines, is the "deputy" or "fireman" who is required to make certain daily tests with the object of ascertaining the presence or otherwise of gas in the workings under his charge. He is also the main source of information available to the management as to the state of the mine. The Commission recommend that this official—who need not at present hold any certificate—should be required to obtain a "certificate from a mining school or other place approved by the Secretary of State as to his ability to make tests for fire-damp."

The apparatus, designed by Mr. Winstanley and exhibited by him at a recent meeting of the Manchester Geological and Mining Society, would seem to provide the means of giving the instruction necessary and of testing the man's ability to make tests for fire-damp. It certainly appears to mark a distinct advance in the means available for the study of fire-damp "caps"—particularly from the standpoint of the practical man.

The apparatus consists of a gas holder—Fig. 1—a mixing chamber—Fig. 2—and an ordinary "safety" lamp—Fig. 3—arranged to take all its supply of air from the mixing chamber. The gas holder is a glass aspirator with necks for tap connections—T, T—at the top and bottom. It is carefully calibrated into divisions equal to $\frac{1}{200}$th ($\frac{1}{2}$ per cent.) of the capacity of the mixing chamber. The mixing chamber is a copper vessel provided with the necessary taps and connections—T, T—a water-level gauge and a simple mixing arrangement. The mixing chamber is first entirely filled with water and the bottom of the chamber connected, by means of short tubes, to the bottom of the gas holder, the tops of the two vessels being similarly connected. If it is desired to have a 2½ per cent. mixture of the gas and air, water is allowed to flow from the chamber into the gas holder up to the division representing that percentage, displacing an equal volume of gas. The connections between the two vessels are now closed, and air is allowed to take the place of the remaining 97½ volumes in the mixing chamber, which now contains a 2½ per cent. mixture of gas and air. A simple arrangement insures the thorough mixing of the two, and by again slowly admitting water to the chamber a sufficient supply of the mixture to keep a safety lamp burning for about an hour is obtained. The only modification required in the lamp, which must be of the bonneted or shielded type, is the closing of the ordinary inlet holes, and the addition of a perforated ring tube encircling the gauze, inside the shield, which delivers air or a mixture of gas and air at the point where air would otherwise enter in the ordinary way. This pipe being connected to the mixing chamber the lamp must burn in an atmosphere, the composition of which is determined by the adjustment of the mixture in the chamber.

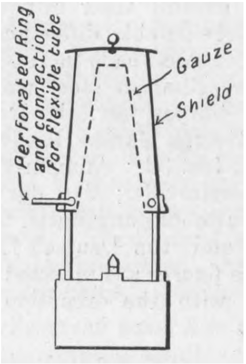


Fig. 5—SAFETY LAMP

In the lamps in use in British coal mines, three illuminants, or classes of illuminants, are in use—colza or rapeseed oil with the admixture of various proportions of mineral oil, colzalene, and similar substances, and mineral oil. Each of these illuminants will give a "cap" of different appearance when burning in the same percentage of gas, so that a man must be able to see for himself the appearances presented by "caps" on the flame of the lamp with which he is to work in the mine when burning in known proportions of gas and air. This the apparatus described above would render possible. The main advantage is that the observer is not guided by descriptions or dimensions depending on the observation of someone else, whose colour perception may differ materially from his own, but is able to note for himself the changes in the appearance of the "cap" in varying but known proportions of gas. Having once learnt the significance of the various "caps," he should be in a position to make sufficiently accurate tests of the presence or otherwise of gas in the mines; and, if present, to estimate the proportion which the particular "cap" shown represents.

KING'S COLLEGE (UNIVERSITY OF LONDON).—In connection with its Faculty of Engineering, a special course of lectures on "Irrigation Works" will be given by Mr. N. F. Mackenzie, M. Inst. C.E., lately Under-Secretary for Irrigation to the Government of India, on Thursdays, at 5.15 p.m., commencing on January 13th. Another special course of lectures on "Reinforced Concrete" will be given by Professor H. M. Waynforth, Assoc. M. Inst. C.E., M.I. Mech. E., on Wednesdays, at 5.30 o'clock, commencing on January 19th, 1910. Another special course of advanced lectures and demonstrations on "Single-phase Electrical Traction" will be given by Professor Ernest Wilson, M.I.E.E., and Mr. Francis Lydall, commencing on Monday, January 17th, 1910, at 5.30 p.m

THE INSTITUTION OF CIVIL ENGINEERS: STUDENTS' MEETINGS.—At the students' meeting held at the Institution on Friday, the 17th December, at 8 p.m., Mr. J. M. Dobson, M. Inst. C.E., in the chair, a paper was read by Mr. H. T. Tudsbery, Stud. Inst. C.E., on "The Foundation and Construction of Dock Walls: with special reference to recent work at Southampton." The author, having discussed the conditions governing the design and construction of dock undertakings, dealt with the survey and preliminary works. In the second part of the paper, the construction of walls built in the dry, concrete-block walls and pier and arch walls was described. The concluding portion of the paper was concerned with cement and concrete. The paper was followed by an interesting discussion in which the following students took part:—Messrs. A. J. Hart, E. Timothy, G. F. Walton, N. Smith, R. A. Inglis, M. W. Pretyman, R. J. Samuel, and P. G. Bowie.

LEAD TRAP PRESS

J. PHILLIPS AND CO, BERMONDSEY, ENGINEERS

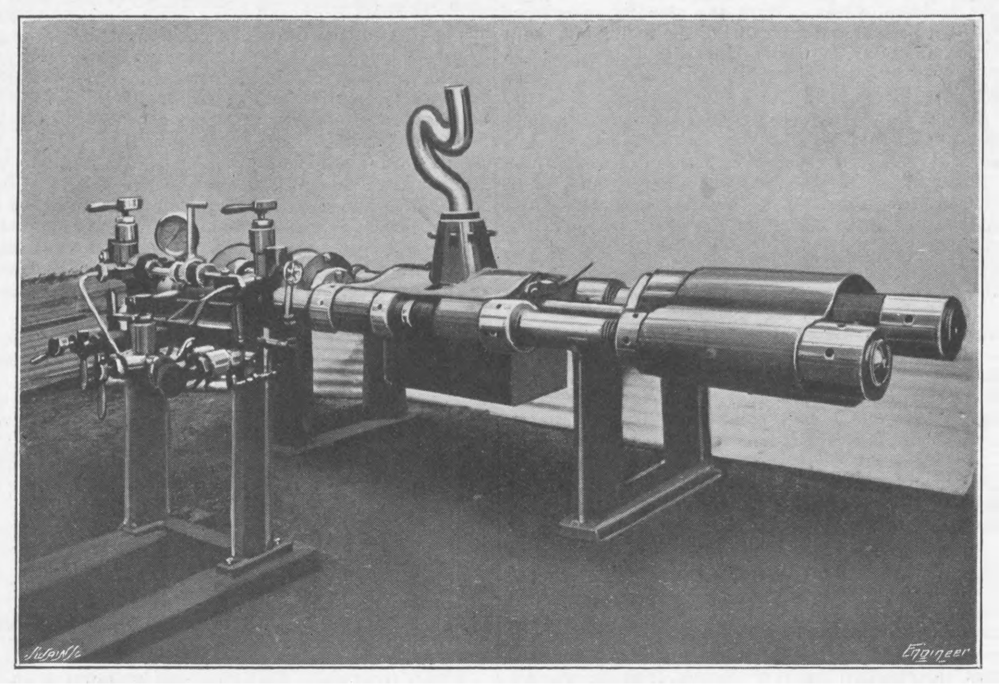


Fig. 1 ε

A LEAD TRAP PRESS.

We were recently afforded an opportunity of inspecting a press for the manufacture of lead traps which has been built by J. Phillips and Co., of Salisbury-street, Bermondsey, to the order of a continental firm. With this machine, which is shown in Fig. 1, several sizes of traps can be made with the same head in position. At the time of our inspection the press was in operation making traps with very narrow curves. These were produced with great ease. In accordance with the usual practice, the press has two double-acting hydraulic cylinders, operated by means of the pump shown in Fig. 2. The trap-forming head is clamped between two crossheads in the usual manner, and the lead rams are bolted to those of the hydraulic cylinders. To charge the press the lead rams are drawn out of the lead containers until the charging ports, cut in their ends, are uncovered, and the molten metal is then poured into these ports. When the hydraulic rams are subjected to equal pressures, the metal is forced up through the centre head, and a straight pipe is formed, but by subjecting one side of the press to a greater pressure than that on the other side a bend is formed in the pipe.

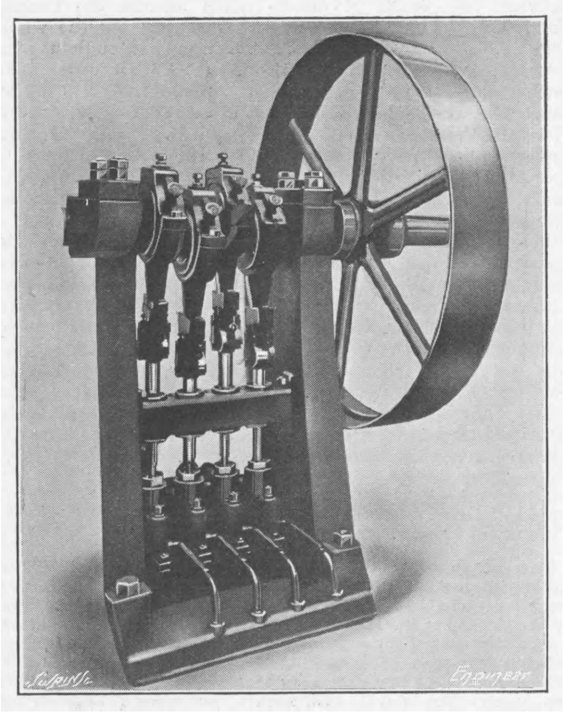


Fig. 2—HYDRAULIC PUMP FOR LEAD TRAP PRESS

By means of valves shown mounted on a stand in front of the press, the hydraulic pressure is under such perfect control that any bend or any angle can be obtained. Gas jets are provided under the centre head, by means of which the molten metal is maintained at the correct temperature. The head in the centre of the machine can easily be removed when necessary; but, as already mentioned, several sizes of traps can be made with the same head in position, the variation in size being obtained by merely changing the dies. In all eight sizes of traps can be made on this press, these sizes ranging from 1in. to 4in. in diameter. The pipe for each of these sizes can also be made in four different thicknesses. It should be mentioned that the firm builds these presses for any class of duty, and for making traps or bends on one or more planes.

HIGH-SPEED PNEUMATIC HAMMER.

The demand which exists for a pneumatic hammer capable of working at high speeds, which can be set to run automatically with various strengths of blow, has induced the firm of Peter Pilkington, Limited, Bamber Bridge, to produce the design shown in the accompanying illustrations—Figs. 1 and 2. The principle on which the hammer works is identical with that of the ordinary forge type, as described in The Engineer of July 19th, 1907. The air cylinder is of considerable length, bored out to two diameters, and at the upper end of the tup there is formed a piston head, working in the upper or larger power cylinder, while the smaller cylinder acts as a guide. Air is admitted under the piston into the upper cylinder for lifting the tup only, and this same air on being exhausted is expanded on the top side of the piston for striking ordinary blows. When a heavy stamping blow is required, the operator can utilise the full air pressure on top of the piston. It should be pointed out, however, that for striking dead blows the lifting area of the piston is in communication with the air supply, as well as with the space on top of the piston, or, in other words, both sides of the differential tup are in communication with the air supply.

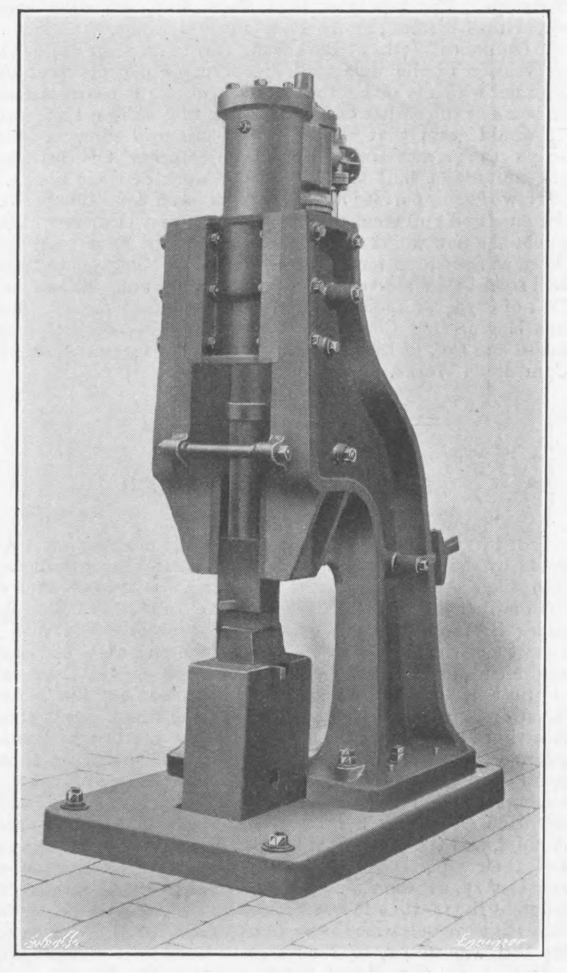


Fig. 1—AUTOMATIC HIGH-SPEED PNEUMATIC HAMMER

In the ordinary pneumatic hammer made by this firm there is only a single operating lever, which serves for all strengths of blow, light or heavy, and also for holding up or down. In the high-speed type illustrated there are provided two levers, one to give the time blow, and the other to fix the automatic blow for any degree of intensity. The self-acting motion consists of the quadrant lever A, which is rigidly connected to a crank or movable fulcrum pin B. This supports another lever C, carrying a roller D at the end, which also operates the piston valve E. When the quadrant lever is in its lowest position—shown in full lines—the movable fulcrum pin will be in its highest position, so that when the air pressure is turned on the tup will rise, and the lever carrying the roller will also rise on the inclined slide F. The piston valve will thus be raised, allowing the air to flow to the top side of the piston, when the tup will be driven downwards. This cycle is repeated automatically so long as the air supply valve is open. When, however, the quadrant lever is moved to its highest position—shown in dotted lines—the fulcrum pin is brought to its lowest position, and this lowers the lever and the piston valve. In this case the air is again admitted to the lower side of the piston, and the tup rises to its top position; the inclined slide again lifts the lever and valve, but since the latter was lowered by the quadrant lever, the valve will not be raised to the same height as previously, and the port to the top of the piston will remain closed. The tup therefore remains in its highest position. When it is desired to operate the hammer by hand, or to strike dead blows, it is only necessary to operate the hand lever C, and thus move the valve, the quadrant lever in the meantime being fixed in its highest position. The force of the blow when the hammer is working automatically is thus regulated by varying the position of the quadrant lever.

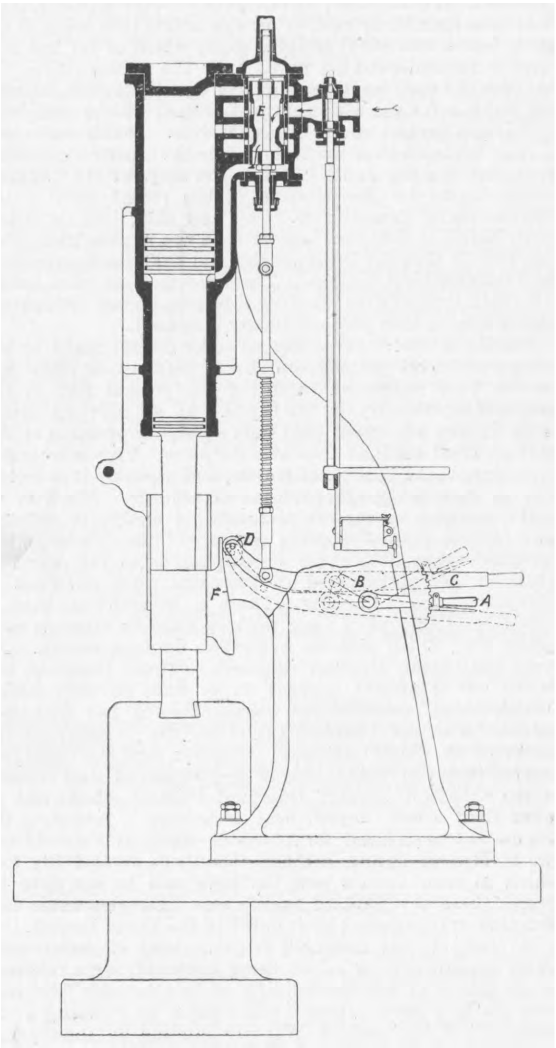


Fig. 2—SECTION THROUGH CYLINDER OF HAMMER

Attention should be called to the method of securing the cylinder between the two standards, the cylinder being provided with two keys, which form part of the cylinder flanges. These keys fit into corresponding recesses in each standard, and take the shear off the bolts which hold the parts together. This type of hammer is made in sizes varying between ½ cwt. and 7½ cwt., and the number of strokes per minute varies between 300 in the smallest to 150 in the largest sizes.

Use of Electricity in Mines.—The Council of the Institution of Electrical Engineers are considering the evidence to be submitted to the Home-office in connection with the inquiry on the use of electricity in mines. The secretary of the Institution will be glad to receive in writing, on or before January 10th next, any observations which members may wish to make on the Special Rules of the Home-office for the Installation and Use of Electricity (Coal Mines Regulation Act, 1887) now in force.

Institution of Electrical Engineers—Glasgow Section.—At a meeting of this body held in the Institution Rooms on December 14th, a paper was read by Mr. W. Arthur Ker on "Continuous Current Boosters and Balancers." Dealing first with two-wire supplies, the author said that for a small town the generating station was often placed near a railway or canal, in order to obtain cheap coal, or to get water for condensing purposes, and that in consequence it was usually at some distance from the consumers, and a feeder or feeders became a necessity. With a healthy growth of the demand a time came when it was necessary to equalise the voltage on the system, as the consumers at the far end got too low a pressure, while that of those nearer the station got too high. The natural method was to lead a two-wire feeder to the mid-point of the network, either keeping the original two-wire line to the town as a second feeder or disconnecting it. Assuming that it was disconnected, there would then be the network supplied by one feeder at its middle point, and it would be possible to regulate the voltage at the feeding point by shunt regulation of the dynamo. As, however, by that time two or more dynamos would be required to supply the demand at times of heavy load, it might be better to put in a booster to compensate for the drop in the feeder and to keep the bus-bar voltage constant. Such a booster might be driven by an electric motor, by a belt, or by an engine, and it might consist of a single-shunt or series-wound generator. If shunt-wound, it would require to be regulated by hand, and with unsteady loads, such as might occur in a small town, hand regulation was not satisfactory. A series-wound booster which required no regulation would therefore be installed. This was, the author explained, the cheapest type of booster, and was quite satisfactory, so long as there was only one feeder, but it could not be used in conjunction with another small booster and feeder, unless certain precautions were taken. Though there were only some twenty stations in the United Kingdom employing two-wire distribution, the author said he had thought it advisable to deal with two-wire boosters somewhat fully, as explanations were more easily made in connection with a two-wire supply than with the more complicated three-wire supply. He then proceeded to deal at considerable length with three-wire boosters, referring also to the use of balancers. A discussion followed.

NAVAL WORK ON THE CLYDE.

OFFICIAL news of the definite ordering by the Admiralty of the four powerful warships which were made supplementary to the year's ordinary programme, although yielding to the Clyde centre much less than that which local notions of equity suggested, and fond rumour had anticipated, has been received on the whole with thankfulness. The order received by William Beardmore and Co., of Dalmuir, to construct and engine one of the three super-Dreadnoughts has caused, in the Dalmuir district at least, the liveliest satisfaction, where work, either naval or mercantile, has for long been at the lowest ebb. What with the order for the "Improved Bristol" cruiser received two months ago, and the outfitting work proceeding on the cruiser Gloucester, sent afloat on October 28th last, there is at least something to show for the calling into being of the great Beardmore naval establishment, which as yet has only fully to its credit one big naval unit, the Agamemnon. In her case the machinery was supplied by a Tyne firm, whereas the turbines for the battleship just ordered will be completed by William Beardmore and Co. themselves. In this connection it may be stated that the turbines for the cruiser Gloucester were seen working under steam in the shops of the Dalmuir establishment on the occasion of the recent visit of the Chinese Naval Commission. The new ship, like its sisters just ordered, is 6000 tons heavier than the Agamemnon, 4600 tons heavier than the Dreadnought, and 2000 tons heavier than the Dockyard-built Neptune. The new vessels are 120ft. longer and 10½ft. broader than the King Edwards, and all the fighting elements have been proportionately increased.

The addition of this ponderous super-Dreadnought to the volume of naval tonnage on hand emphasises what has already been recognised regarding the present state of the shipbuilding industry on the Clyde. At no previous period in its history has there been such a large proportion of the work on hand destined for naval purposes. This is certainly so as regards the number of vessels, and probably it is no less true as regards aggregate volume of tonnage. Much is no doubt wanting, as regards mercantile tonnage, to approximate to the normal working capacity of the shipyards, but the district has little cause to complain as to the extent to which it has participated in the naval work given out to contract by the Admiralty. There is, in addition, quite a considerable amount of naval work on hand for other Governments, *e.g*, Brazil and the Australian Commonwealth. No fewer than seven different shipyards between Greenock and Govan are at present engaged on, or have on their books, British naval contracts, the work embracing two first-class battleships of the Dreadnought class—the Colossus on the stocks of the Scott Company, Greenock, and the vessel just ordered from the Beardmore firm—five second-class cruisers of the "Bristol" and "Improved Bristol" class, and no fewer than fifteen torpedo-boat destroyers. Including the five destroyers on hand for Australia—three at Fairfield and two at Messrs. Denny Brothers, Dumbarton—and the four which Messrs. Yarrow and Co. have still to complete for Brazil, there is a total of twenty-four destroyers under construction or completing their outfit in the Clyde district.

In view of this unusually large amount of naval work under construction or afloat being outfitted, some reference to the records of warship-building on the Scottish river may here not be without interest. In a paper by Professor J. H Biles on "Fifty Years of Warship-building on the Clyde," read before the joint Conference of the Institution of Engineers and Shipbuilders in Scotland and the North-East Coast Institution in August last, a number of statistical tables on this subject were given, from which the following notes are abstracted. The first table dealt with the displacement tonnage of British warships constructed in Clyde shipyards during the five decennial periods beginning 1858 1868, and ending 1898-1908. In the first period, out of a total of 110,496 tons, the Clyde's share was 15,920—just about the tonnage of a modern cruiser. During the ten years beginning 1868, the Clyde produced 53,770 tons out of a total of 235,555 tons, while in the next period the naval productions of Clyde shipyards amounted only to 36,090 tons, although the total addition to the Navy during that time had increased to 255,872 tons. A remarkable advance was made by the Clyde, however, in the decennial period 1888-1898, the total output being 168,069 tons out of a total of 875,060 tons. In the last period dealt with—1898-1908—the Clyde made another notable advance, her contribution to the Navy representing 272,390 tons out of 1,063,430. From these figures it will be observed that the Clyde made an advance of no less than 104,180 tons in the last decennial period, while the total increase to the whole Navy, compared with the previous ten years, was only 188,370 tons. Reduced to percentages, the Clyde's share of the tonnage built for the Royal Navy during these same years has fluctuated as follows:—1858 68, 13 per cent.; 1868-78, 23 per cent.; 1878-88, 14 per cent.; 1888 98, 19 per cent.; and 1898 1908, 26 per cent.

The London and Glasgow Shipbuilding and Engineering Company, Limited, Govan, which was commissioned by the Admiralty about the end of October to build one of the second-class cruisers of the "Improved Bristol" type, is making good progress with the 27-knot torpedo destroyer, the order for which was received about the beginning of the year, and, as little else is at present on the stocks, no time is being lost in proceeding with the preliminaries of the actual construction of the cruiser. The turbine machinery for this vessel, it should be stated, is to be supplied by John Brown and Co., Limited, Clydebank.

For an extension to its working area, as well as to provide the site for a tidal basin in which to complete the outfit of naval and mercantile vessels of the largest size, the London and Glasgow Company has acquired the vacant shipyard adjoining, formerly and for long occupied by Messrs. Robert Napier and Sons, and by their successors, Wm. Beardmore and Co.—who took over the business in 1900—until the latter's removal to Dalmuir early in 1905. It is of interest to recall that the ground now about to be absorbed by the London and Glasgow Company was first used as a shipyard in 1841, when Robert Napier added iron shipbuilding to his already extensive engineering business. Previous to being taken over by Messrs. Wm. Beardmore and Co. in 1900, there had been built at the yard thirty-four warships of different types, while the firm had at that time on the stocks two armoured cruisers, which were completed by Messrs. Beardmore.

The London and Glasgow Company's new basin will be situated in a very convenient position so far as its shipyard is concerned. The engine works are, as is well known, in Lancefield-street, farther up on the other side of the harbour. The shipyard department will extend over a riverside frontage about double that of the present works, and the new dock will be close to the Clyde Trustees' graving docks, and within a very short distance of those parts of the harbour where new vessels are usually berthed when they are not at their builders' works. With the steadily increasing size of ships, both naval and mercantile, the fitting out basin was absolutely necessary for the further development of the business. The river is sufficiently broad opposite the works to provide launching facilities for the largest class of vessels, and with a basin in which these may be completed the firm will be as well situated for all kinds of work as those much nearer the open sea. In order to be better able to compete for the construction of turbine machinery and large reciprocating engines, the company has been converting the erecting shop at its engine works—on the opposite side of the Clyde—into a more modern machine and fitting shop, and it has utilised some vacant area on the east side of the works for the building of a new erecting shop. These several extensions and alterations are in a forward state of progress, and when completed will enable the company to carry out important contracts with more despatch and economy.

The Fairfield Company, Govan, which was at least in the running as regards price—and ability to accomplish—for the super-Dreadnought which has conditionally gone to the Thames Iron Works, has a fair amount of Admiralty work on hand. In its tidal basin the outfitting of the cruiser Glasgow, launched on September 30th, proceeds apace, and of the goodly amount of tonnage on the stocks, eight items are torpedo destroyers, five for the British Admiralty and three for the Australian Commonwealth. Two of the five boats for the Admiralty are the 27-knot craft ordered near the end of last year, one—the Grasshopper—having been launched in November.

John Brown and Co., Clydebank, to which firm rumour had assigned the super-Dreadnought which subsequent and more official information gave to Messrs. Beardmore, are shortly to launch the second-class cruiser Bristol, and they have already consigned to the water three torpedo-boat destroyers ordered a year ago—the Beagle, Bulldog, and Foxhound, the latter being launched on December 11th in the presence of the Chinese Naval Commission. In its engine works the firm has a large amount of naval work, including the turbines of 43,000 indicated horse-power for the armoured cruiser being constructed at Devonport, as also the turbines sub-contracted for with Messrs. Harland and Wolff, Belfast, for the battleship being built at Portsmouth.

This week there was despatched from Glasgow *viâ* the Caledonian Railway *en route* to the South of England the second 12in. naval gun manufactured at the new gun shops of William Beardmore and Co., Limited, Parkhead. This gun, like the first, completed some months ago, is of the largest type used by the heaviest battleships and cruisers in the British Navy. After being fitted with breech mechanism it will be subjected to the testing process, and eventually find a place in the armament equipment of one of the latest warships. The new gun, it is understood, embodies some departures introduced by Rear-Admiral Adair, the chief of the Ordnance Works at Parkhead, having for their object the prevention of the defect of drooping, or deflection of the muzzle, which is understood in naval circles to have attached to some of the earlier examples of the fifty-calibre 12in. gun. It would seem that the Admiralty are now allowing fuller scope to private ordnance manufacturers for bringing ingenuity and skill to bear on the work of their hands.

Now that important contracts have been definitely booked for guns and gun mountings by the Coventry Ordnance Company, the new works of the company which have been laid down at Scotstoun for the manufacture of gun mountings, will soon be in active operation. Messrs. John Brown and Co., of Clydebank and Sheffield; the Fairfield Shipbuilding and Engineering Company, Govan; and Messrs. Cammell, Laird and Co., of Birkenhead, are directly interested in the Company's Works.

SUBMARINE SIGNALLING.

DURING the past few years considerable progress has been made by the Corporation of Trinity House in introducing into their service submarine signalling for the guidance of the mariner in thick or foggy weather. In 1905 and 1906 the Elder Brethren carried out a series of experiments with a view to testing the system, and for the purpose a standard equipment, as supplied by the Submarine Signal Company of Boston, United States, was installed on the North Goodwin Light Vessel, in connection with which one of their receiving apparatuses was fitted on one of the Trinity House steam vessels—the Irene. Tests were made during those years by various Committees of the Elder Brethren, accompanied on some occasions by Lord Rayleigh, their scientific adviser, by Sir Thomas Matthews, their engineer-in-chief, and the officials of the Submarine Signal Company, and their reports as to the efficiency of the bell were so satisfactory, as were also those received from the masters of different liners, that it was decided to fit two of the Corporation's light vessels with the apparatus permanently. Hence on the 18th November, 1907 submarine bells were brought into operation at the Royal Sovereign and the Tongue, and shortly afterwards at the Outer Dowsing and the East Goodwin, since when they have been in action during foggy weather. The results were so promising that consideration was next given to the question of simplifying the mechanism of the bells, which are actuated by the air compressing plant fitted on board Trinity House light vessels for operating aerial fog signals. Certain alterations were accordingly made at the suggestion of Sir Thomas Matthews, the effect of which was to cheapen considerably the cost of manufacture, and bells of the modified design were placed in March of the present year at the Spurn, Outer Gabbard, Owers and Shambles, and quite recently at the Nab and St. Goven.

The Trinity House also turned its attention to applying this system of fog signalling to buoys, and a buoy fitted with a bell, on the Submarine Signal Company's patent, was fixed near the Nab Lightvessel for experimental purposes, the results being most satisfactory. The buoy is now undergoing a further trial off the Wolf Rock Lighthouse, and the reports as to its efficiency from masters of passing vessels are very encouraging.

The Submarine Signal Company had established in the United States a submarine bell suspended from an iron tripod resting on the bed of the sea, and connected by electric cable to a power station on the mainland. The efficiency of submarine bells having proved so satisfactory, the Corporation was induced to put down a bell on this system about a mile seaward of the North Stack fog signal station, in the direct route between Holyhead and Dublin, the necessary electricity being transmitted through a cable from the power producing plant at South Stack Lighthouse, where machinery was available in connection with an aerial fog signal. The work was successfully carried out by the Trinity House, and the bell, which was suspended from a tripod at a depth of 25 fathoms, was brought into operation on the 21st October last, since which date it has been in action during fog, and is believed to have given every satisfaction to the vessels of the London and North-Western Railway Company, the City of Dublin Steam Packet Company, and others. It has been favourably reported on by the Captains of some of the vessels of the White Star Fleet, and on one occasion was heard at a distance of eleven miles. The Trinity House has now arranged to place a similar bell two miles S. by W. ½ W. from the Lizard, the tripod for which will rest on the bed of the sea at a depth of about 35 fathoms, the electric cable being connected to the power producing plant at the electric lighthouse station thereat, and the Corporation intend to extend the system of submarine signalling on light vessels and buoys during next year.

It may be mentioned that three of the Trinity House steam vessels are equipped with the necessary receiving apparatus for locating the position of submarine bells.

SIDELIGHTS ON WORKMEN'S COMPENSATION.

SOME interesting statistics and opinions with regard to workmen's compensation are to be found in the report of Dr. Collie, who is medical examiner to the London County Council. His duties include the examination of men entering the Council's service, the investigation of sickness and cases of accident among the servants of the Council, and medico-legal cases in which claims are made against the Council. Dr. Collie has made discoveries of importance with regard to the eyesight of tramway drivers. In 1904, when he began to examine the eyesight of drivers in the employment of the Council, he found that of 73 examined, 13 were wholly unfit for the service. Two of them could only read at one-third of the normal range, while one man who had actually been driving could not read at 20ft. what he ought to have been able to read at 200ft. If these are the results of an examination of the Council's drivers, what would be the result of an examination of the eyesight of the countless persons who drive motors through the streets of London? Dr. Collie's investigations would appear to justify a change in the law by which persons applying for licences as drivers of motor cars could be made to submit themselves for examination by an eye specialist. Coming to the statistics of workmen's compensation, there is a very striking contrast between the results of claims made against the County Council on the one hand and the statistics for the whole country. In 1908, out of 328,957 cases throughout the country, no fewer than 326,454, or 99.3 per cent., were settled out of court, and of the remaining 2503 which came into court, 82 per cent. went in favour of the applicant. With the County Council, however, things are very different. Acting—as we may assume—under the able guidance of Dr. Collie, they took nearly 25 per cent. of their cases into court, and settled only 75 per cent. outside. In court the Council won over 81 per cent., and lost only 19 per cent.! The inference may be drawn that employers generally and insurance companies are willing to pay up rather than be troubled with litigation. That Dr. Collie is an adept at catching the malingerer is also clear from his report. In one case a man complained of obscure pains and malingered for thirteen months without any objective symptoms. He was six times reported fit for duty, and every time he obtained a certificate of unfitness. At last, having been under observation for nine weeks, he was ordered to be dismissed, and to forfeit all superannuation benefit if he did not return to work at once.

THE ELGAR SCHOLARSHIP.—The Elgar Scholarship in Naval Architecture, of the annual value of £50, and subject to certain conditions, tenable for three years, will be offered for competition by the Council of the Institution of Naval Architects. Candidates must at the time of the examination be students of the Institution, and not less than 18 or more than 21 years of age on 1st March, 1910, and must at that date have been continuously employed for two years upon naval architecture or marine engineering. Further particulars and forms of entry and conditions regulating the admission of students may be obtained from the Secretary, Institution of Naval Architects, 5, Adelphi-terrace, London, W.C. Applications must be sent in by February 1st, 1910.

THE FIRST DREADNOUGHT.—Our contemporary, the *Scientific American*, has just produced an interesting claim to the effect that America produced the first Dreadnought. The claim is that the first "all big gun ship" was the Roanoke, an old frigate which survived the attacks of the Merrimac in Hampton Roads during the Civil War. After the famous fight between the Monitor and the Merrimac, the Roanoke was armoured and fitted with three turrets in the centre line. Unlike the Monitor, so plentifully built at that date (1863), the Roanoke had a high freeboard, and, from the illustrations published by the *Scientific American*, there certainly appears sufficient resemblance to the Dreadnought to substantiate the claim. It is an interesting example of the proverb that "There is nothing new under the sun."

VIENNA SCAVENGING SYSTEM.—The Municipality of Vienna are preparing to lay out over £400,000 on a new scavenging system for the removal and final disposition of house refuse, ashes, &c. It is proposed to adopt the Koprophor method of covered metal receptacles to be placed in the court-yard of every house. These will be emptied into specially constructed ash carts, so designed as to avoid the dissemination of dust in the air. Round metal boxes will be used instead of square, as being more easily cleaned out. Some 60,000 will be required, besides 140 wagons. The refuse will be consumed in three large destructors, to be built in different parts of the city. One will be erected close to the municipal electrical plant, for which it will furnish heat and steam. Every houseowner will have to contribute a special tax of 12s. 6d. a year towards the cost of removal of the refuse. As the city budget for last year shows a considerable deficit, the ratepayers can hardly welcome this contemplated new outlay.

COMPOUND STRESS EXPERIMENTS.[1]

By Mr. C. A. M. SMITH, B.Sc., Associate Member, Assistant Professor of the East London College (University of London).

(I.) *Theories of elastic failure.*—The object of this paper is to give certain experimental results which have been obtained upon solid steel bars subjected to compound or combined stress. An attempt is made to indicate briefly the methods used during the experiments. The practical results of such experiments are chiefly connected with the design of crankshafts and that matter is therefore discussed. The following systems of loading the specimen were adopted, and in each case the maximum stress on the material at elastic failure was noted: (1) Compression only; (2) torsion only; (3) combined compression and torsion; (4) tension only; (5) combined tension and torsion. The notation for such stresses, used throughout the paper, is, for compression $+p$; for tension $-p$; for torsion q. There are four theories of elastic failure of materials:—

(1) *The maximum principal stress theory.*—This is known as the Rankine theory, and may be calculated by the formula

$$\frac{p}{2}+\sqrt{\frac{p^2}{4}+q^2}=C_1.$$

(2) *The maximum principal strain theory.*—This is known as St. Venant's theory and may be calculated by the formula

$$\frac{1}{E}\left\{\frac{p}{2}+\sqrt{\frac{p^2}{4}+q^2}-\frac{1}{m}\left(\frac{p}{2}-\sqrt{\frac{p^2}{4}+q^2}\right)\right\}=C_2.$$

(3) *The maximum shear stress theory.*—This has been called, for mild steel, Guest's law, and may be calculated by the formula

$$\sqrt{\frac{p^2}{4}+q^2}=C_3.$$

(4) *The internal friction theory.*—This is known as Navier's theory, and may be calculated from a formula

$$\sqrt{\frac{p^2}{4}+q^2}\ \mathrm{Sec}\ \phi-\frac{p}{2}\tan\phi=C_4.$$

The first two formulæ are to be found in all text-books on the strength of materials. The results of the author's experiments show that, for mild steel, elastic failure takes place by reason of the maximum shear stress, under all conditions of loading.

(II.) *Previous experiments.*—In order that the object of the investigations may be fully understood, it is thought advisable to mention a few facts of especial interest to members of this Institution. In the year 1900 Mr. J. J. Guest[2] published the results of some experiments made upon tubes subjected to tension, torsion, and internal fluid pressure. Nine steel tubes were used. These experiments did not, for some time, receive very much recognition, probably for two reasons: (1) a great deal of space was occupied, in the paper embodying the results, with a description of the instruments used; (2) engineers are sceptical about results, as to elastic strength of materials, obtained upon tubes. Mr. Guest's experiments and the practical results of the deductions to be made from them have been discussed by the author.

Reference will be made to probable sources of error in these experiments which may have considerably affected the results. Mr. Guest showed that the shear stress at elastic failure was more constant than the principal stress or the principal strain when the material was loaded in tension and torsion. In 1906 Mr. Walter Scoble attempted to solve the problem by conducting tests upon material subjected to combined bending and twisting.[3] These experiments seemed to confirm the above. Although a system of loading by combined bending and torsion was adopted, there was no evidence to show that the material did not fail by reason of a shear stress due to a combined stress of tension and torsion. A difficulty was experienced in locating elastic breakdown. For the tests published the average variation from the mean is, for the shear stress theory, 3.72 per cent., and for the maximum principal stress theory, 18.3 per cent. In America Professor E. L. Hancock[4] attacked the problem, but he obtained contradictory results. The author has dealt with the work of Mr. Scoble and Professor Hancock elsewhere. The experiments of Professor Hancock appear to refute the shear stress theory, but the variations in the results are so great that it cannot be said with certainty that they confirm or reject any of the theories of elastic failure.

It may be mentioned that Mr. Laurence B. Turner has compared the elastic failure of steel tubes subjected to simple tension and simple torsion. He says: "Nineteen comparisons in simple pull and simple torque having been made, it is found that the difference between the shears is generally small." The author has published results on copper tubes, solid steel specimens, hollow machined steel specimens,[5] and various non-ferrous materials.[6]

All of these experiments have been made by independent investigators, and have caused considerable discussion in the technical journals. From the very nature of the problem it was inevitable that any new formula recommended would need experimental results for its support before it would be accepted. Such experimental work involves new apparatus, and requires the consideration of many details which at first appear extraneous to the work, and are in themselves in the nature of preliminary researches or experiments. More than 300 tests have been made at the East London College; most of them included about seventy readings of extensions. It is impossible to include a full account of such work in any one paper, but throughout the author has endeavoured to give references to enable those interested to investigate such details.

After a careful study of the "Proceedings" of the technical societies, it was evident that the engineers demanded further evidence concerning the behaviour of mild steel under combined stress. In June, 1903, Mr. William H. Maw, in the "James Forrest" lecture, commented upon the need of further research work on the subject.[7] In 1906 Mr. C. E. Stromeyer said that "he trusted that the question of compound stresses would, if possible, be taken up by the Institution.[8]

(III.) *Solid steel bars used.*—This was the problem which offered itself for solution when the research work was commenced some years ago by the author. Mr. Guest's experiments, while fully appreciated by a few people, were either not very well known or not sufficiently convincing to influence the general body of engineers. Moreover, there was only evidence that the law held for a combination of stresses due to tension and torsion. Lord Kelvin had suggested that a compression load, in combination with a torque on mild steel, would raise the yield point of the material. If this were proved to be the case the shear-stress theory of elastic failure would seem to break down. It was, therefore, necessary to make experiments upon steel, not only for a combination of tension and torsion, but especially for a combination of compression and torsion.

Preliminary experiments caused the author to adopt solid steel specimens. He found that tubes were unsatisfactory for the following reasons:—

(1) It is only possible to apply a tension load by grips which cause distortion, or by means of solder which necessitates heating the ends of the tubes.

(2) The material is not isotropic. Annealing reduces this evil, but it seems to be doubtful whether it entirely removes it.[9]

(3) Difficulty of making accurate measurement of areas subjected to the loads.

(4) With thin tubes strain-measuring instruments are not easily secured to the specimen.

(5) When loaded in compression the tubes may fail by reason of secondary flexure.

(6) Engineers do not seem to have confidence in the elastic breakdown tests made upon tubes.

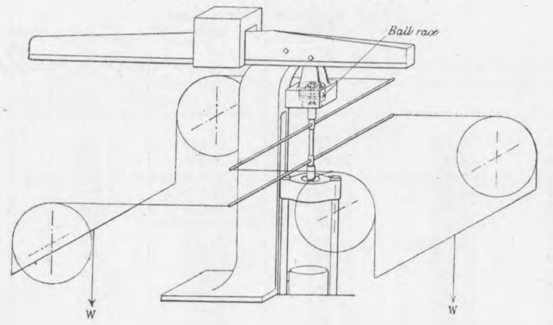
The great advantage to be gained by using tubular specimens is that the stress distribution, during a torsion test, is the same over all of the material.

Preliminary experiments were made upon both solid and tubular mild steel specimens and it was then decided to use solid bars.

(IV.) *Tension and compression tests.*—In most of the author's experiments, quoted in this paper, a specimen of 1in. diameter was used. The length between the shoulders was $4\frac{3}{4}$in. The reason why similar specimens were used for torsion, tension, compression and combined stress tests was that it was desired to make them interchangeable for elastic range tests.[10] The ratio of the length to the diameter was sufficient to ensure that, unless the loading during a compression test was placed with considerable eccentricity, the yield point in compression would be reached before the specimen failed as a strut. If the loading is directly through the axis of the specimen it is safe to make this ratio twenty for a mild steel specimen.

Fig. 1

General View of Combined Tension and Torsion Apparatus showing the Specimen with Torsion Bars and Pulleys

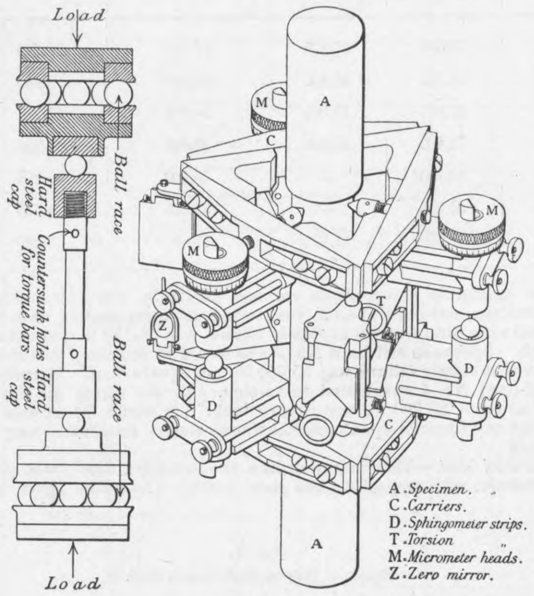


Previous experiments with various grips were made, and as a result the specimens were turned with screwed ends, gas threads being used. The general shape of the specimen and the arrangement of the apparatus is indicated in Figs. 1 and 2. The screwed ends were carefully fitted to the tension grips and the compression caps. The centre $4\frac{1}{2}$in. of the specimen was turned parallel to 1 in 2000. Torque bars were fastened by set screws, which fitted directly on to the specimen at the top and bottom, as shown in Fig. 1.

A 50-ton Wicksteed testing machine was used for the application of tension and compression loads. Ball bearings were fitted so that the specimen was free to revolve when tested in torsion.

The torque bars were flexibly coupled together and moved simultaneously, the friction of the ball bearings being thus eliminated before a reading was taken.

For measuring strains produced by tension or compression stresses the sphingometer was used. An earlier form of the instrument is possibly known to members of this Institution,[11] and the improved type has been described in detail recently by the author.[12] It was necessary to make a number of preliminary experiments upon columns in order to determine the most suitable proportions for the specimens used in the compression tests. It was anticipated that there would be difficulty in securing axial loading for the compression tests, and for that reason some new method of measuring strains was considered desirable. Since the accuracy of the experiments recorded depend upon the instrument a brief description is given, and an isometric projection is shown in Fig. 3.



Figs. 2 and 3

Two carriers are fastened to the specimen, each by three set screws. The distance apart of the set screws is the gauge length, and can be accurately measured. Three strain-recorders, in planes of 120 deg., indicate the "stretch" of the specimen in these three planes. Each strain-recorder is calibrated separately and at the commencement of every test. The sensitiveness of the three strips may be varied as rapidly as the springs of a steam engine indicator. Appendices II. and III. give proofs that the mean extension of the three strips is equal to the extension of the specimen as a whole, and that, given the readings from the three strips, the maximum stress as well as the mean stress on the specimen can be determined. The whole object of the sphingometer is to enable the maximum stress at elastic breakdown upon a specimen in tension or torsion to be calculated.

(V.) *Torsion tests.*—Fig. 1 gives a general idea of how the torque was applied to the specimen. The torque arms were actually secured by means of set screws let into countersunk holes in the specimen. From the end of each torque bar a cord was carried over a bicycle wheel and fastened to a knife-edge upon which rested a hollow bar. A tray was hung by a knife edge on the centre of this bar, and weights marked W were placed in the tray in order to apply a torque.

From the arrangement of the pulleys shown in the sketch it will be seen that every effort has been made to eliminate bending during the application of the torque. Owing to the longer distance between the points of support of the specimen, the stress caused by bending—due to bad application of the torsion load—is greater during a tension than during a compression test.

A probable source of error in Mr. Guest's experiments may now be explained. He used long torque bars at the top end of the specimen, and two shorter bars at the bottom end. These two lower bars were brought against stops. The advantage of this arrangement was that it was only necessary to use one tray and one set of weights; but it is doubtful whether the two shorter bars were stopped in a satisfactory fashion. If only one lever had been resting on the stop, considerable bending resulted. It is almost certain that unequal springing took place, which caused unequal forces at the end of the torque bars. This in turn caused bending of the specimen, and it is probable that the stress caused by such bending was 4 or 5 per cent. of the total stress. An example, selected from the author's data, may make this point clearer. During the torsion tests the weight in the scale-pan at elastic failure was about 100 lb. Let us assume that the difference between the forces at the end of the torque arms was 30 lb. Then, since the distance between the spherical seats of the tension grips was 21in. and the torque bars were secured 8in. from each spherical seat, we should have had a bending moment on the specimen caused by the unbalanced force of 30 lb. This force would produce a stress of approximately 1500 lb. per square inch on the specimens used. The stress on such a specimen, at yield point, obtained by a pure torque was 18,000 lb. per square inch. Thus an error of 10 per cent. could be easily caused by using stops. This method of loading was therefore abandoned by the author, and the arrangement shown in Fig. 1 was adopted.

Incidentally, it may be mentioned that the treatment of the tubes used by Guest, between the experiments made upon the same tube, may have affected their elastic properties, especially if there was any interval of rest.

In the author's experiments the torsional strain was measured by means of a sphingometer strip shown at T, Fig. 3. This was placed at right angles to the strips used in the tension and compression tests. The strip was calibrated for each test. A full description of this additional fitting, together with a proof of the accuracy of the method employed for calibration, has been published.[13]

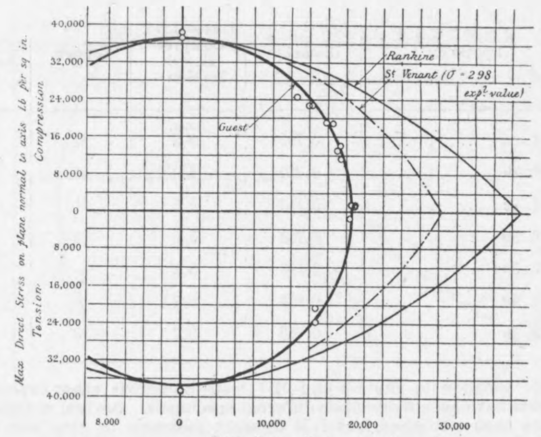
By the use of ball bearings in the testing machine and the pulleys the effect of friction was reduced to a minimum and was negligible.

The sphingometer strips rendered it a simple matter to record any strain however small.

(VI.) *The yield point.*—In the experiments recorded (S S specimens) the elastic limit and the yield point coincided. In the case of perfectly homogeneous specimens loaded in tension and compression in such a manner that the load passes through the axis of the specimen—and consequently there is no bending—the yield point is marked by a rapid increase of stretch which takes place for a small addition of load. The author's experiments showed that the load never is acting exactly through the axis of the specimen. Some of the material used (S S specimens) was remarkably homogeneous, but the load was always slightly non-axial. In such a case there will be an apparent "elastic limit effect" if an extensometer is used which merely measures a mean extension of the specimen. With non-axial loading, and a homogeneous material, the yield point is reached at one portion of the specimen before the whole of it yields. With an extensometer which gives the distribution of stress, there will be an apparent rapid change in the eccentricity of loading directly any portion reaches the yield point. Then will follow the "elastic limit effect" (during which the mean extension of the specimen is slowly increasing for equal increments of load) due to eccentric loading, and then will come the total yield shown by a great increase in strain. What has been recorded in these experiments is the maximum stress on the specimen when the first portion of it reaches the yield point.

Fig. 4. *Experimental results showing the relation of Direct to Shear Stress at failure.*

The shear stress is here plotted to twice the scale employed for the direct stress, the Guest ellipse thus becoming a circle.



Until the load is reached at which this first portion yields there seems to be no "time effect," but at this point that phenomenon becomes most marked.

If the material is not homogeneous the problem is more complex, and need not now be discussed: (1) because the material used, especially that of the S S specimens, was almost homogeneous; (2) and further, such material cannot be expected to give much evidence concerning the theories of elastic failure, since the specimens vary in elastic properties.[14]

Every specimen tested, except those of mild steel, had an elastic limit as distinct from a yield point. This shows that the material was not homogeneous. It would appear that mild steel as now manufactured is very much more homogeneous than other materials used by the engineer. When several specimens were cut off the S S mild steel bar they seemed to be almost exactly similar with regard to elastic properties. The specimens of special steels and non-ferrous materials tested did not possess this property, so essential for the experiments discussed in this paper.

During the torsion tests the loads were added by small increments. In Appendix I. the full record of one of these tests is given. An examination of figures under the columns "Torque load" and "Deflection of torsion strip" will show that the readings were extremely regular until a certain critical load was reached. At that load the beam of light on the scale which recorded the strain began to travel rapidly, and the load was at once removed.

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[1] The Institution of Mechanical Engineers.

[2] *Philosophical Magazine*, 1900.

[3] *Philosophical Magazine*, Vol xii., page 535.

[4] *Philosophical Magazine*, Vol. xii., page 418.

[5] *Journal*, Junior Institution of Engineers, July, 1909.

[6] "Elastic Breakdown of Non-ferrous Metals." Paper read before the Institute of Metals, October, 1909.

[7] Some Unsolved Problems of Engineering." "Proceedings," Institution of Civil Engineers, Vol. cliv.

[8] "Proceedings," Institution of Mechanical Engineers, 1906, page 38.

[9] In this connection it is worth noting that the matter is discussed in *Science Abstracts*, No. 1225 (1908) and No. 965 (1909). Experiments were made to determine the effect of extension, flexure, and torsional strain on iron wires. In the latter abstract we read "metals are only rendered isotropic to a very approximate extent by annealing."

[10] *Journal*, Junior Institution of Engineers, pages 562, 573

[11] "A Method of Detecting the Bending of Columns," "Proceedings," Institution of Mechanical Engineers, 1908, Part III., page 699.

[12] *Journal*, Institute of Metals, 1909.

[13] "The Torsion Sphingometer." Institute of Metals, 1909, Appendix II.

[14] This point is especially revealed in the tests recorded in the author's paper to the Institute of Metals, previously mentioned. The elastic properties of certain specimens of arsenic copper, high-conductivity copper, rolled aluminium, and brass tubes are discussed at length in that paper.

One advantage claimed for tubes in compound stress experiments is that the yield point of the material during a torsion test is well defined. In the torsion tests on these solid specimens of S S steel there was no difficulty in noting the yield point. It is believed that the reasons are: (1) the arrangement to obtain a pure torque and no bending; (2) the material was remarkably homogeneous. It should be mentioned that the torsional strain instrument was so sensitive that the first indication of yielding could be detected, and an interval was allowed so that it was certain that the material would not strain further at each increment of the load. Within the torsional yield point there was no "time effect" upon this material, although that phenomenon had been observed to take place with other specimens, notably aluminium.[15]

(VII.) *The results with the mild steel specimens.*—The accompanying Table I. and the illustration—Fig. 4—show the results obtained with the S S steel. The percentage chemical composition was:—Carbon, 0.20; silicon, 0.08; sulphur, 0.14; phosphorus, 0.032; manganese, 0.50. Table II. gives the results of tests on H T steel, which are shown graphically on Fig. 5. This material was not so homogeneous as the S S mild steel, and the results are therefore not so regular.

TABLE I.—*The Results S S Steel (Tests made during June* 1908 *and Februarg and March*, 1909)

Specimen and test.	Diameter.	Direct load tons + p compression − p tension.	Torsion load.	Ratio* max. stress / mean stress in horizontal section.	p.	q.	Max. principal stress $\frac{p}{2}+\sqrt{\frac{p^2}{4}+q^2}$.	Max. shear stress $\sqrt{\frac{p^2}{4}+q^2}$.	Max. principal strain × 10³.	Torsion slip approx.
			lb.							p.c.
SS I.*a*	1.003	0.5	96	1*	1,420	18,500	19,250	18,540	0.813	1½
SS II.*a*	1.001$_7$	0.5	93	1	1,420	18,960	19,710	19.000	0.833	2
SS II *b*	1.001$_7$	0.5	96	1	1,420	18 580	19,330	18,620	0.817	1
SS II.*c*	1.001$_7$	8.0	74	1†	22,800	14,310	29 700	18,300	1.052	6
SS III.*a*	1.000	8.0	72	1	22,800	13,920	29.400	18.000	1.038	3
SS I.*c*	1.003	0.5	96	1	1,420	18,500	19,250	18,540	0.813	20
SS I.*d*	1.003	0.5	94	1	1,420	18,110	18,860	18,150	0.796	2
SS I*e*.	1.003	5.0	90	1	14,200	17,350	25,850	18,750	0.970	20
SS IV.*a*	1.002	0.5	96	1	1,420	18,540	19,290	18,580	0.816	2
SS IV.*b*	1.002	2.0	90	1.975	11,200	17,390	23,860	18,260	0.916	2½
SS IV.*c*	1.002	4.0	88	1.15	13,080	16,990	24.760	18,220	0.935	2½
SS IV.*d*	1.002	6.0	82	1.125	19,200	15,830	28,100	18,500	1.017	2½
SS IV.*e*	1.002	8.0	65	1.089	24,750	12,540	30,030	17,650	1.046	3
SS I.*f*	1.003	0.5	95	1	1,420	18,300	19,050	18,340	0.805	9
SS V.*a*	1.002$_5$	10.2	0	—	Bent, load removed before yield.					
SS V.*b*	1.002$_5$	0.4	98	1	1,140	18,910	19,450	18,940	0.828	2
SS V.*c*	1.002$_5$	3.0	94	1.134	9,650	18 110	23,545	18,7[illegible]0	0.917	2
SS V.*d*	1.002$_5$	6.0	86	1.111	18,930	16,590	28,550	19,080	1.040	—
SS VII.*a*	1.002	−0.5	95	1	−1,420	18,350	19,080	18,390	0.817	2
SS VII.*b*	1.002				Between 10 and 10.5 tons bent badly and failed.					
SS VI.*a*	1.003				Taken to 9.7—no yield in tension—grips slipped.					
SS VI.*b*	1.003				" 9.5	"	"	"		
SS VI *c*	1.003	−7.0	76	1.192	−23,770	14,690	30,790	18,900	1.088	6
SS VIII.*a*	1.002	−7.0	76	1.036	−20 570	14,660	28,210	17,920	1.010	8
SP 4A	1.026	−12.7	0	1.129	−38,800	0	38,800	19,400	1.284	—
SP 4B	1.026	+12.5	0	1.099	+37,250	0	37,250	18 620	1.233	—
MP 4	0.999	−12.7	0	1.065	−38,600	0	38,600	19,300	1.278	—
MP 6	1.026	+13.5	0	1.050	+38,450	0	38,450	19,220	1.273	—

Torsion slip is given as a percentage of total elastic strain.

p = Maximum direct stress on horizontal plane. q = Maximum shear stress on horizontal plane.

* When given as unity exact value not known.

† In these early tests the stress distribution was not calculated, but a fair average value is taken now, in which case the stress becomes 18,900 and 18,700. Average variation from mean of maximum shear stress is 1.62 per cent.

TABLE II.—*Results of H.T. Steel Tests made in July*, 1909.

Specimen.	Diameter.	Direct load. Compression + Tension −	Torsion.	Ratio maximum / Mean direct strain.	p.	q.	Maximum principal stress $\frac{p}{2}+\sqrt{\frac{p^2}{4}+q^2}$.	Maximum shear stress $\sqrt{\frac{p^2}{4}+q^2}$.
		Tons.						
H.T. 1*a*	0.750	0.2	41	1	10,000	18,500	19,000	18,500
H.T. 2*b*	0.750	3.0	34	1.394	21,200	15,300	25,900	18,600
H.T. 2*c*	0.750	4.0	31	1.017	21,200	14,000	24,600	17,500
H.T. 3*a*	0.750	3.0	28	1.276	19,400	12,600	32,000	15,900
H.T. 3*b*	0.750	5.2	—	1.221	32,200	—	32,200	16,100
H.T. 4*a*	0.750	5.2	—	1.270	33,500	—	33,500	16,700
H.T. 4*b*	0.750	0.2	38	1	1,000	17,100	17,600	17,100

In addition to the S S and H T tests, numerous other experiments have been made upon different specimens. Several of these have been published, but it is thought desirable to give here a complete synopsis of all the work done upon steel. The following table enables the results to be seen.

The usual notation has been used.

In Test A D 4*a*, Table III., one of the balls was out of the race.

TABLE III.—*Tests on Mild Steel Specimens.*

Specimen and test.	Ratio of maximum / Mean longitudinal strain.	Maximum principal stress $\frac{p}{2}+\sqrt{\frac{p^2}{4}+q^2}$.	Maximum shear stress $\sqrt{\frac{p^2}{4}+q^2}$.
S.C. 3*a*	1.000	19.800	19 500
S.C. 3*b*	1.000	19,800	19,500
S.C. 3*c*	1.070	26,100	20,000
S.C. 3*d*	1.058	29,500	20,400
S.C. 3*e*	1.036	32,300	20 400
S.C. 3*f*	1.089	34,900	19 900
S.C. 3*g*	1.062	36,500	18,900

Average variation, from mean, of maximum shear stress on S.C. specimens = 2.16 per cent.

Specimen and test.	Ratio of maximum / Mean longitudinal strain.	Maximum principal stress	Maximum shear stress
S.B. 1*a*	1.000	24.900	23,700
S.B. 1*b*	1.000	24,900	23,700
S.B. 1*c*	1.114	47,600	23,800

Average variation, from mean, of maximum shear stress on S.B. specimens = 0.21 per cent.

Specimen and test.	Ratio of maximum / Mean longitudinal strain.	Maximum principal stress	Maximum shear stress
A.D. 1*a*	1.000	−20,170	19,450
A.D. 2*a*	1.000	−20,560	20,420
A.D. 2*b*	1.083	−31 810	21,[illegible]00
A.D. 3*a*	1.088	−31 570	20,700
A.D. 3*b*	1.114	−35,620	17,8[illegible]0
*A.D. 4*a*	2.958	−38,180	19,190
A.D. 4*b*	1.000	−20,750	20,610
A.D. 5*a*	1.069	+27,950	20,320
A.D. 5*b*	1.043	+30,140	19.710
A.D. 6*a*	1.029	+26,370	20.500
A.D. 6*b*	1.008	+29,050	20,420
A.D. 7*a*	1.102	+32,300	21.300
A.D. 8*a*	1.100	+36,420	18,210
A.D. 10*a*	1.000	+20,560	20,420
A.D. 11*a*	1.000	−19,190	19 050
A.D. 11*b*	1.375	−26,210	20,320

Average variation, from mean, of maximum shear stress on A.D. specimens = 4.02 per cent.

C = 11,660,000 lb. per square inch.
E = 29.250,000.
σ = 0.256.

* Note the stress distribution for this test.

This was not discovered till the end of the test. Great eccentricity of the load was thus caused, and the special seats did not take this up. The ratio of maximum to mean was nearly 3 to 1.

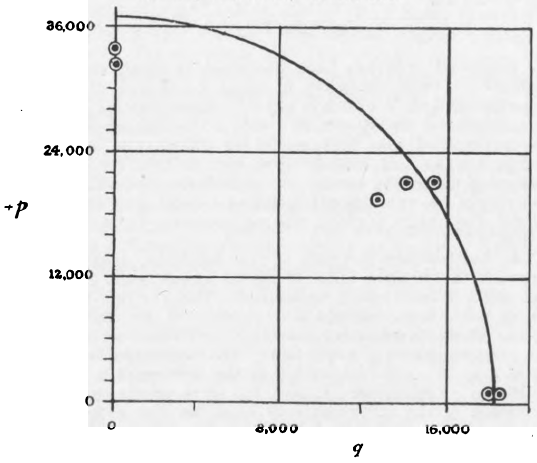
Tests on other steels.—A large number of tests have been made upon special steels, and the author regrets to be compelled to state that the results were extremely unsatisfactory. He refrains from a complete analysis of these tests, although many instructive points have been learnt about the properties of the materials tested. The two great troubles experienced were: (1) Different specimens from the same bar tested in simple torsion or simple direct stress did not give repeated results; (2) the elastic breakdown was "veiled," and the "time effect" so great that no complete result concerning combined stress can be accepted which depends upon such variable material. A few examples will make this clear.

Self-hard steel.—The results of tests made upon this material contrasted sharply with those made upon a good quality mild steel. It was found that, with each of the specimens tested, the strain and stress were not proportional at moderate values of the stress, yet considerable increase in the applied load produced only a sensible increase in the strain. The stress strain diagram for the material gradually bent over. Specimen self-hard No. 1 was tested in pure torsion, and the elastic breakdown occurred when the maximum shear stress reached 16,120 lb. per square inch. Specimen self-hard No. 2 was tested in compression, and the maximum direct stress at elastic failure was 55,750 lb. per square inch. Specimen self-hard No. 3 was tested in tension; the direct stress at elastic failure was 55,650 lb. per square inch. Specimen self-hard No. 4 was tested in torsion, and the stress at elastic failure was 23,000 lb. per square inch. It would be unwise to build any formula upon material whose elastic properties vary so much.

Nickel steel.—This material, like the self-hard steel, was very indefinite with respect to the yield point. The values given are for elastic breakdown. Three tests seemed to suggest that the material obeyed Guest's law. The results are as follows:—N S 1 was tested in compression. Direct stress at elastic breakdown 45,100 lb. per square inch. N S 4 tested in tension. Direct stress at elastic breakdown 46,300 lb. per square inch. N S 3 tested in torsion. Maximum shear stress at elastic breakdown 23,000 lb. per square inch. N S 2 gave unsatisfactory results. It is hoped to investigate the elastic properties of this interesting material further. It may be said at once that the point of elastic breakdown can be considerably raised if the material is overstrained in the direction in which it is again tested. It is worth noting that the elastic breakdown of these nickel steel specimens took place at a stress about 25 per cent. in excess of that required to ensure elastic breakdown of the SS specimens. In Appendix III. curves are shown of a test on this NS material.

FIG. 5.

Results of Tests on High Tensile Steel.



A series of experiments were made upon some specimens of mild steel of very low elastic limit. Two sets were supplied, but there was such variability in the material that the author hesitates to include them.

Several special steels have been tested, but on the whole insufficient material of any one type of such steels has been supplied to produce useful data. Very great difficulty was experienced in securing the instruments to some of the special steels; the specimens must have been most difficult to prepare. The stress at tensile elastic breakdown was 87,000 lb. per square inch on a forged material tested in tension.

The experiments lead to the following general conclusions:—

(1) The elastic failure of mild steel takes place when a definite shear stress is reached, and does not depend upon the value of the maximum principal stress nor the maximum principal strain.

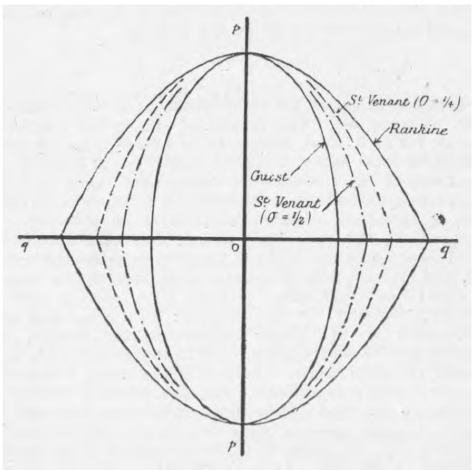
(2) The law, which Guest's work on tubes showed was approximately correct for mild steel tubes loaded in tension and torsion, is confirmed and applies also to the same material loaded in compression and torsion.

(3) The "elastic limit" effect noticeable during tension, torsion and compression tests on mild steel which has not been previously stressed, is probably due to a fault in applying the load, and to the method of measuring strains.

(4) The ratio of maximum to mean direct stress during elastic tests is greater than is usually assumed to be the case—see Appendix III.

FIG. 6. *Curves showing the relation of Direct to Shear Stress at failure according to the three theories of elastic failure.*

Both stresses to the same scale.



(5) The use of spherical seats does not ensure axial loading. This point is here mentioned, as it probably accounts for the discrepant results obtained by experimenters who have measured the elastic limit instead of yield point.

(6) The ratio of the working stresses for mild steel in tension and shear should be 2:1, and not, as is usually quoted in textbooks, 5:4.

The curves—Figs. 6 and 7—show the relationship between torque and direct load at the yield point according to the three theories of elastic failure.

(VIII.) *The practical result.*—Although several cases of combined stress upon mild steel occur in engineering practice, the two chief cases are those of the boiler and the crank shaft. Both cases have been fully discussed by the author. It may be useful to record that if L be the equivalent bending moment, then, according to the four theories of elastric breakdown enumerated above, we have:—

(1) Rankine . . $L = \frac{1}{2}M + \frac{1}{2}\sqrt{M^2 + T^2}$.

(2) St. Venant . $L = \frac{3}{8}M + \frac{5}{8}\sqrt{M^2 + T^2}$.

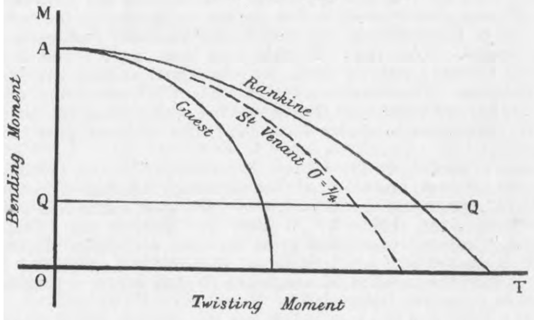
(3) Guest . . . $L = \sqrt{M^2 + T^2}$.

(4) Navier[16] . $L = \frac{1}{1 + \sin\phi}(\sqrt{M^2 + T^2} + M \sin\phi)$.

The diagram, Fig. 7, shows the curves for the first three theories. The fourth theory is comparatively new, and has never been advanced for the purpose of crank-shaft design; and it is omitted from the curves, as it would possibly confuse the diagram. It will be noticed that it reduces to Guest's law if $\tan\phi = 0$—that is, if the coefficient of internal friction for steel is zero. All of the curves agree at A. But if any abscissa Q Q be drawn, it will be seen that, with an equivalent bending moment of value L, the permissible torques at that point shown on the diagram are, according to the three theories, Q = 0.954 L; Q = 1.390 L; Q = 1.673 L. The two latter are 46 per cent. and 76 per cent. higher than the first. In other words, crank shafts designed according to the principal stress or principal strain theory of elastic failure have had a false factor of safety.

FIG. 7.—*Curve showing the relation of Bending-Moment and Twisting-Moment for a constant equivalent Bending-Moment.*

O Q = 0·30 A.



There has been evident, since Guest published his experiments, some hesitation in accepting the practical conclusions which follow from the sheer stress theory of elastic failure. The author trusts that the discussion arising out of this paper and the results enumerated above will end the controversy which has taken place concerning the design of crank shafts and structures subjected to combined stress.

The author desires to thank the authorities of the East London College for the facilities extended to him for carrying out this work, also Sir William H. White, K.C.B., past president, Mr. H. F. Donaldson, C.B., member of Council, and Mr. W. J. Luke, for their personal interest in the experiments. He acknowledges the many opportunities afforded by Professor D. A. Low, and recognises the valuable assistance given by Mr. A. G. Warren and several students of the East London College; Mr. E. T. Cook, the college instrument maker; Messrs. Hadfield's Steel Works, the locomotive superintendent of the South-Eastern Railway, the Hoffman Ball Bearing Company, and other firms, for supplying material.

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[15] "The Elastic Properties of Non-ferrous Materials." Institute of Metals.

[16] Recent experiments on mild steel specimens have given results approximating so closely to Guest's law that it may be stated that Navier's theory need not be considered for the design of crank shafts.

APPENDIX I.

A Combined Stress Test fully worked out.

Specimen S S V, test c.—Length of specimen between gauge points = 3.903in. Diameter, 1.0025in. Length of torque bars = 76.4in. Distance of sphingometer strips from axis of specimen = 2.58in.

Calculations for tension or compression test.—The following readings and calculations were made:—

	Strip No. 1.	Strip No. 2.	Strip No. 3.
Scale readings, compression load 0.5 ton	238	281	332
Scale readings, compression load 3 tons	130	234	134
Calibration equivalent of scale divisions in inches	0.00000776	0.00000917	0.00000752
Extension of strips in inches for load of 2.5 tons	0.000838	0.000431	0.001489
Surface extension in inches	0.000903	0.000824	0.001030

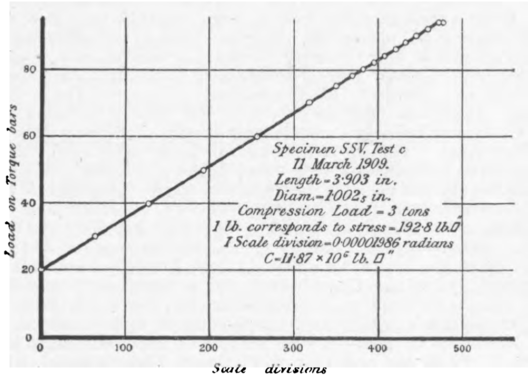
From the above the mean extension = 0.000919in., whence E = 30.2 × 10^6 lb. per square inch.

The maximum surface extension (calculated as in Appendix III.) = 0.001041in., whence ratio $\frac{\text{maximum stress}}{\text{mean stress}}$ on surface perpendicular to axis = $\frac{1041}{919} = 1.134$.

Torsion test.—Calibration of torsion strip gave 1 division = 0.00001986 radians.

Fig. 8.

Curve showing the relation of Torsional Stress to Strain.



A compression load of three tons was kept on the specimen and the torque applied by adding weights to the trays.

Torque load.	Deflection of torsion strips.	Torque load.	Deflection of torsion strips.
20	0	80	383
30	64	82	396
40	128	84	409
50	193	86	422
60	256	88	434
70	319	90	447
75	351	92	461
78	370	94	474*

* Slipped rapidly to 480 and load immediately removed.

Fig. 8 shows the curve for this test, on which the yield point is evident.

It will be seen that an increase of 70lb. caused a deflection of 447 divisions.

$$\text{Whence strain} = \frac{0.501 \times 447 \times 0.00001986}{3.903}$$

$$\text{Torque} = \frac{70 \times 76.4}{2} = \frac{\pi}{16} f d^3$$

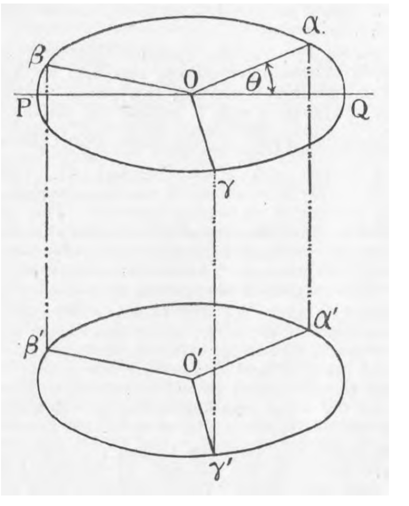
whence f = 13,510 lb. per square inch.
C = 11.87 × 10^6 lb. per square inch.
Now since $(1 + \sigma)\,2\,C = E \therefore \sigma = 0.298$.

Stresses at yield point.

$$p = \frac{3 \times 2240 \times 4}{\pi \times 11005} \times 1.134 = 9650 \text{ lb. per square inch.}$$

q = 18,110 lb. per square inch.
∴ Maximum shear stress = 18,720.
Maximum principal stress = 23,540.
Maximum principal strain = 0.917 × 10^{-3}

Fig. 9.



APPENDIX II.

Proof that the mean extension of the three strips of the sphingometer is equal to extension of the specimen as a whole. Further, that the variations from the mean of the three readings are the variations of the corresponding generating lines on the specimen, magnified in the ratio of the diameter of the cylinder, passing through the strips, to the diameter of the specimen. Also to find the amount of bending.

From the extension of the three sphingometer strips equally spaced round and from the axis of the specimen and parallel to it, we obtain three measurements.

If there were no bending on the specimen and the material were perfectly homogeneous, these extensions would all be equal. That the variations are due to a bending moment (probably because the load is placed eccentrically) is evidenced by the fact that the mean of all the readings, up to the elastic limit of the material, obeys a linear law.

The sphingometer carriers and strips are shown diagrammatically in Fig. 9 to which the following symbols belong:—

Let $\alpha\,\beta\,\gamma$, $\alpha'\,\beta'\,\gamma'$ represent the fixed ends of the sphingometer strips. Let O and O′ be the centres of the triangles $\alpha\,\beta\,\gamma$ and $\alpha'\,\beta'\,\gamma'$. Then the displacement of $\alpha\,\beta\,\gamma$ with respect to $\alpha'\,\beta'\,\gamma'$ may be resolved into a motion of O to or from O′ and a rotation of the plane $\alpha\,\beta\,\gamma$ about some axis such as P Q.

As all motions are relative, there is no need to consider the points $\alpha'\,\beta'\,\gamma'$, and for the purpose of investigation these may be considered fixed. The points $\alpha\,\beta\,\gamma$ move by a combination of two motions. There is the increase (positive or negative) of O O′—the extension—which is part of the increase of length of strip, and there is also the change in length due to an alteration in the inclination of the planes $\alpha\,\beta\,\gamma$, $\alpha'\,\beta'\,\gamma'$ to each other. The line PQ in the plane $\alpha\,\beta\,\gamma$ is called the axis of bending, and the angle between the planes divided by O O′—the radian bend per unit length—is the amount of bending.

The mean extension.—

Let the angle α OQ be θ,

then the angle β OQ is $\left(\theta + \frac{2\pi}{3}\right)$,

and the angle γ OQ is $\left(\theta + \frac{4\pi}{3}\right)$.

Let the angle between the two planes, which were originally parallel, be ϕ after straining. Let x be the true extension of the specimen. Then we have, if

A = extension of strip
$r = O\alpha = O\beta = O\gamma$,

the angle ϕ is measured in radians, and is considered small.

We may take $A = x + \phi\, r \sin\theta$.

Similarly for the other strips we have

$$B = x + \phi\, r \sin\left(\theta + \frac{2\pi}{3}\right)$$

and

$$C = x + \phi\, r \sin\left(\theta + \frac{4\pi}{3}\right).$$

Then the arithmetic mean of the reading of the strips is

$$x + \frac{\phi\, r}{3}\left(\sin\theta + \sin\left(\theta + \frac{2\pi}{3}\right) + \sin\left(\theta + \frac{4\pi}{3}\right)\right) =$$

$$= x + \frac{\phi\, r}{3}\left\{\sin\left(\theta + \frac{2\pi}{3}\right)\right\}\left\{1 + 2\cos\frac{2\pi}{3}\right\}.$$

But

$$2\cos\frac{2\pi}{3} = -1.$$

Therefore the mean reading of the strips is x—that is to say, the extension of the axis of the specimen is obtained by taking the mean of the three strip readings.

FIG. 10.—*Specimen NS 4, Test a.* (23 Nov. 1909.)
Length = 2·05 inches. Diam. = 0·7500 inch. E = 27·1 × 10^6 (for 2 tons).

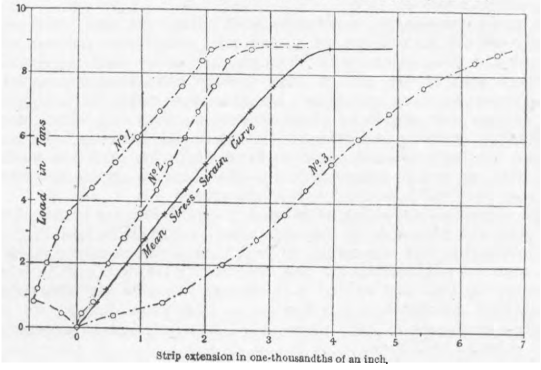
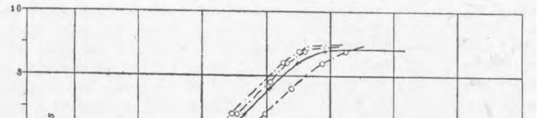


FIG. 11.—*Specimen NS 4. Tension.* (23 Nov. 1909.)
Length = 2·05 inches. Diam. = 0·7500 inch. E = 27·1 × 10^6 (for 2 tons).



Change in length due to bending.—

Let $A' = A - x$
$B' = B - x$
$C' = C - x$

Then we have

$$A' = \phi\, r \sin\theta \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad \text{(ii)}$$

$$B' = \phi\, r \sin\left(\theta + \frac{2\pi}{3}\right) \quad . \quad . \quad . \quad . \quad \text{(iii)}$$

$$C' = \phi\, r \sin\left(\theta + \frac{4\pi}{3}\right) \quad . \quad . \quad . \quad . \quad \text{(iv).}$$

From these equations $\phi\, r\, \theta$ can be found.

It is only necessary to have two equations, since we know that $A' + B' + C' = 0$. It is, however, more convenient to work with the three, and select in practice those expressions which are least dependent on errors of measurement.

Dividing (iii) and (iv) by (ii) we have

$$\text{Cot}\,\theta = \frac{2}{\sqrt{3}}\left(\frac{B'}{A'} + \frac{1}{2}\right) = -\frac{2}{\sqrt{3}}\left(\frac{C'}{A'} + \frac{1}{2}\right).$$

It will in practice be found most accurate to take A as the largest numerically. The value for two expressions of cot θ may be taken; if not quite equal, select a mean value, and look up the angle in the tables.

Having found θ, we have

$$\phi = \frac{A'}{r\sin\theta} = \frac{B'}{r\sin\left(\theta + \frac{2\pi}{3}\right)} = \frac{C'}{r\sin\left(\theta + \frac{4\pi}{3}\right)}.$$

The amount of bending is $= \frac{\phi}{l}$.

APPENDIX III.

A method of determining the maximum stress when given the displacements of three points spaced equally around the specimen.

In any stressed specimen the mean stress can be easily calculated. It remains to find the ratio of the maximum to the mean stress in order to determine the maximum stress to which the specimen is subjected.

Referring to Fig. 9, let A, B and C be the stresses at the points on the specimen corresponding to α β and γ. Let S be the maximum stress on the specimen.

Then, writing stresses for strains in the equations (ii), (iii), and (iv), Appendix II., we obtain the corresponding relations, namely:—

$$A = \frac{A + B + C}{3} + \left(S - \frac{A + B + C}{3}\right)\sin\theta \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad \text{(i)}$$

$$B = \frac{A + B + C}{3} + \left(S - \frac{A + B + C}{3}\right)\sin(\theta + 120 \text{ deg.}) \quad . \quad \text{(ii)}$$

$$C = \frac{A + B + C}{3} + \left(S - \frac{A + B + C}{3}\right)\sin(\theta + 240 \text{ deg.}) \quad . \quad \text{(iii)}$$

Then expanding and eliminating between the first two expressions above we have:—

$$\left(S - \frac{A + B + C}{3}\right)^2 = \frac{4}{3}\left[\left(A - \frac{A + B + C}{3}\right)^2 + \left(A - \frac{A + B + C}{3}\right)\left(B - \frac{A + B + C}{3}\right) + \left(B - \frac{A + B + C}{3}\right)^2\right].$$

The application of this method is first of all shown with hypothetical figures, which are simpler than those actually obtained in practice.

Suppose that the distance of the centre of the strip from the centre of the specimen is four times the radius of the specimen. Suppose the sphingometer readings to be 6, 8 and 10. Then the mean extension of the strips and of the specimen will be 8, and the surface strains will be the mean, together with the differences from the mean of the sphingometer readings reduced in the ratio of 4 to 1, that is,

$$8 + \left(\frac{-2}{4}\right);\ 8 + \frac{0}{4};\ 8 + \frac{2}{4} = 7\tfrac{1}{2};\ 8 \text{ and } 8\tfrac{1}{2}.$$

Then we have from the above if S is the maximum strain

$$(S - 8)^2 = \frac{4}{3}\left[(7\tfrac{1}{2} - 8)^2 + (7\tfrac{1}{2} - 8)(8 - 8) + (8 - 8)^2\right]$$

$$= \frac{4}{3}\left[\frac{1}{4}\right] = \frac{1}{3}.$$

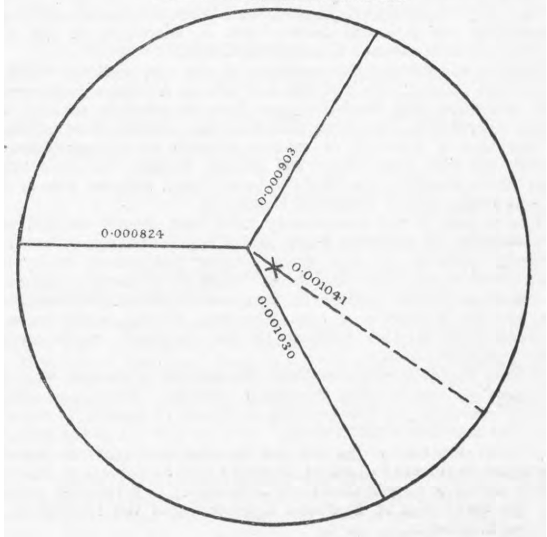
$$\therefore S = 8 + \frac{1}{\sqrt{3}} = 8{\cdot}577.$$

Therefore ratio of maximum to mean strain—also the maximum to mean stress, since by Hooke's law, these are proportional to strains—is 8.577 : 8 = 1.072. This is about the order of stress distribution for a good compression test, viz., 7 or 8 per cent. above the mean.

An actual example of stress distribution is now given. The curves—Figs. 10 and 11—show the load-strip curves and the stress-strain diagrams for this case.

FIG. 12.

Showing method of obtaining ratio of Maximum to Mean Stress across a section perpendicular to axis.



Nickel steel. Stress distribution. Load 8.3 tons.

Strip readings in $\frac{1}{1000}$ths of an inch:—

Strip 1	1.90
,, 2	2.31
,, 3	6.09

The ratio of the radius of action of the strip to the radius of the specimen was measured and found to be = 6.89.

The mean extension of the strips was 3.43in.

The differences from the mean are:—

(1)	−1.53
(2)	−1.12
(3)	+2.56

The surface extensions are:—

$$(1)\ 3.43 + \frac{-1.53}{6.89} = 3.43 - 0.222$$

$$(2)\ 3.43 + \frac{-1.12}{6.89} = 3.43 - 0.163$$

$$(3)\ 3.43 + \frac{2.66}{6.89} = 3.43 + 0.386$$

Then

$$(S - 3.43)^2 = \frac{4}{3}\left\{(-0.222)^2 + (-222 \times -0.163) + (-0.163)^2\right\}$$

$$,, \quad = \frac{4}{3}(0.493 + 0.0362 + 0.0266)$$

$$,, \quad = \frac{4}{3} \times 0.1121 = 0.1496$$

$$S = 3.43 + 0.387.$$

$$\text{Therefore } \frac{\text{Maximum stress}}{\text{Mean stress}} = \frac{3.43 + 0.387}{3.43} = 1.1127.$$

Fig. 12 shows a method of estimating the plane of maximum stress. The three strip readings are set off to scale from a point and a circle drawn in to pass through these lines. This method has not been used by the author, but it seems to be simple. Substituting in the formula is very easy.

APPENDIX IV.

The Method of Gripping Specimens and a Test of Ordinary "Vee" Grips.

In order to determine the effect of the ordinary "Vee" grips in producing excentric loading, and so to compare that method of securing specimens with the spherical seats and screwed specimens, two experiments were made upon a long mild steel specimen. The overall length of the specimen was about 15in. and the diameter of the test portion 0.846in. Sphingometer readings were taken upon the middle 4in. The angle θ is the angle between the line of minimum displacement and strip 1. Between the tests the specimens were removed from the grips and replaced in the same position in the machine. This was done in order to determine if the "Vee" grips would line up similarly in two consecutive tests. It will be seen that such was not the case, as the two tests differ considerably.

Test 1.—At a load of 5 tons on the specimen, the strip extensions, recorded in one-thousandths of an inch were :—(strip 1) – 0.737 : (strip 2) 4.145 ; (strip 3) 3.592 ; which gave a ratio of maximum to mean stress of 1.211. $\theta = 10.3^\circ$.

Test 2.—At a load of 5 tons on the specimen, the strip extensions, recorded as above, were :—(strip 1) – 3.934 ; (strip 2) 11.248 ; (strip 3) – 0.649 ; which gave a ratio of maximum to mean stress of 1.575. $\theta = 39.5^\circ$.

The axes of bending were not widely different, but the stress distribution varied greatly. It therefore appears that this method of gripping the specimen is unsatisfactory for elastic failure tests.

LETTERS TO THE EDITOR.

(*We do not hold ourselves responsible for the opinions of our correspondents.*)

INTERCONNECTION OF ENGINEERING SOCIETIES.

Sir,—Engineering in its progress has been divided into numerous branches which, as time passes, become more and more defined and distinct. In consequence there has appeared from time to time the necessity of forming new societies in order to give adequate attention to the details of the respective branches. The founders of new societies are naturally inspired in their work by the opinion that their objects cannot be obtained from any existing society. There is, however, a great danger that, in their enthusiasm, they may overlook the fact that some other societies have similar objects, and that they might strengthen their cause by recognising the value of the sympathy and influence of such societies. All technical engineering societies have at least one object in common, *i.e.*, "To direct the great sources of power in Nature for the use and convenience of man," and this ideal should of itself be sufficient to ensure a common interest and harmony.

There is also a danger of misunderstanding arising between new and existing societies. A dignified interest on one part might, on account of insufficient opportunity for discussion and explanations, be mistaken for an unwarranted intrusion or interference.

The engineering industry is a busy one, and has, as a rule, very little time to spare for the discussion of social questions. Individuals leave such affairs alone probably under the impression that somebody else will attend to them. Would it not, therefore, be a good policy for one of the existing great institutions to form a small advisory board, whose privilege it would be to confer with other bodies and to form, as it were, an "interconnector" between the various sources of power? It would be formed of experienced men, with a knowledge of the objects of all existing societies and institutions. Having authority to approach founders of any new movement, and interesting themselves in the objects, they could do much to prevent clashing of interests, and thereby advance the science of engineering.

The Institution of Civil Engineers embraces all branches of engineering in one powerful society, and is, therefore, in the best position to form a board to act as mediators.

Those who attended the meetings of the new society, which is at present called "The Institution of Mining Electrical Engineers," will recognise that the writer has them in mind in making the above suggestion. To those who were not present it is sufficient to say that a diversity of opinion existed on a suggestion to modify the title into "Electrical Mining Society," or some other title which would be less likely to be confused with the title of the parent Institution of Electrical Engineers.

The objects of the new society have been clearly defined and explained in the technical Press, and it is plain that they are not entirely covered by the great mining institutions or by the Institution of Electrical Engineers. They aim at the education and advancement of the engineer in charge of electrical plant in mines and also the education of manufacturers, mining engineers, and managers, in matters relating to the electrical requirements, specifically for mines.

Whilst many individuals thus affected are engineers who are members of the existing technical societies, there are others who by reason of previous training would not be eligible for election into the established institutions. But as it is one of the primary objects of the new society to induce men to qualify as capable electrical engineers for mines by study and examination, there is every reason to expect that it will eventually be a training ground for the Institution of Electrical Engineers and the Institution of Mining Engineers.

It is suggested that an Advisory Board to act as an interconnection between engineering technical societies could at the present time do much good service, and the movement in connection with electricity in mines is a case in point requiring immediate consideration.

December 29th. H. W. C.

CENTRIFUGAL FORCE.

Sir,—When two parties to a discussion cease to enlighten each other, it is time that discussion should cease. Mr. Sayers has failed to enlighten me and I have failed to enlighten him. The deduction should be obvious ; yet a last word may be said.

Your correspondent seems to deprecate the practice of asking why, and implies that we should be content to ask how. But Sir Isaac Newton was not content to ask how the apple fell, but why. The search for "why" has been the principal cause of the progress in science.

The discussion about the meaning of the word acceleration has, after all, nothing to do with centrifugal force, simply because there is no acceleration, no change of velocity, no change of direction, no alteration in stress. Furthermore, the revolving mass has no rectilinear velocity to change because it has no rectilinear motion. It cannot have, because its path is a geometrical or Euclidian circle. Mr. Sayers writes:—"Its rectilinear velocity is constantly changing in accordance with Newton's second law. Rate of change of momentum is proportional to the impressed force, and takes place in the direction in which that force acts, for there is a force of constantly changing direction acting on it." There is here some wild confusion of thought. If the second law applies then there must be change of momentum, and, if so, then work must be done ; but it is an obvious fact that there is no change in momentum, and that no work is done.

No more unhappy example could have been cited than the pendulum. The pull of gravity on it is not radial, and does work continuously, accelerating and decelerating the bob, the velocity of which—and its *vis viva*—is constantly varying.

The statement that "Why the radial force does no work on the stone is answered by the fact that it accelerates positively and negatively, or accelerates and decelerates equally and evenly," I do not in the least understand, and I do not think your correspondent does. If it has any meaning, it tries to convey the impossible concept of a mass moving slower and faster at the same time.

I thank Mr. Sayers for referring me to Perry's book. I have no difficulty in measuring centrifugal force. I know the base on which the formula for calculating it, $\frac{Mv^2}{32.2\,R} = C$, rests. All this has nothing to do with the fact that an assumption is made, that a radial force can be balanced by a tangential force, which the human mind refuses to accept as possible. I am not arguing that this assumption should not be made. Unless we do make it, indeed, we cannot calculate the value of centrifugal force in any given case. I take exception to the attempts which are made to explain away a dynamical absurdity of suppositions. The truth is that we are unable to explain centrifugal effort except on the assumption that two forces at right angles can balance each other. Not one of your correspondents contradicts this. Mr. Sayers implicitly accepts it. The proper attitude to take is to say that centrifugal force cannot really be explained, because the only possible explanation involves a contradiction ; but that by making certain algebraic assumptions we can calculate the radial effort. I am quite in accord with your correspondent when he says that science has only managed so far to answer questions concerning How? This is not one of them.

I hope I have made my position clear, and yet some of your correspondents have, I fear, failed to understand me. Put into plain language, they say that a pull is put on the string because a tangential force is exerted by the stone. They admit, as I understand them, that this tangential effort is the sole cause of the radial effort. All the text-books say so. I say that this proposition demands the formation of a concept inconceivable by the human mind.

December 22nd. Pater.

[We do not see that anything would be gained by continuing this discussion.—Ed. The E.]

THE FAILURE OF TECHNICAL EDUCATION.

Sir,—So much has been heard, such unanimity has been apparent among the "eminents" of our own and other professions, on the desirability of technical education, that the bare suggestion that now—after some years working—it has proved an unqualified failure, will come as a complete surprise to those who have not been brought into painful contact with its bankruptcy.

Technical education is a failure, and that not because the younger members of our profession have been slow to use the opportunities which have been presented to them, still less because they have been deficient in energy, desire, and real ability, but because of the continued frigidly unsympathetic attitude of manufacturing engineers and those who control the machinery of employment towards the young engineer who to mere craftsmanship has added a comprehensive understanding of the fundamentals of scientific engineering.

What is the situation at the present moment? Young men, after having served full time in the shops, and subsequently having added an engineering course at one of our technical colleges, find it more difficult to obtain employment than those who are entirely innocent of any technological knowledge.

We must exempt cases where immediate success follows the pressure of great influence, though the extent to which the unscrupulous use of undue influence is prevalent in the engineering profession might well afford subject for inquiry on the part of disinterested shareholders. No ; those to whom I refer are engineers who have no other recommendation than the demonstrated evidence of their brains, ability, and thorough training. We must also exempt employment in the capacity of lecturer or demonstrator at a technical institution, for if it is conceded that the only place for technically and practically trained men is on the staff of a technical institution, then is the failure of technical education admitted, and the complete alienation of active engineering and technical education a proven fact.

I could name instance after instance within the narrow range of my personal knowledge of young men who have passed, with profit and distinction, both through the shops and engineering college who, at the end of their courses, have been compelled to accept employment on a salary less than they could have obtained—perhaps were obtaining—immediately on the completion of the workshop training and prior to the technical training. In many cases the fully trained engineer must, initially, give his services for nothing, and in others obtain wages which an errand boy would refuse, and which would insult a labourer.

In almost all cases the initial salary would fall far short of the interest at 5 per cent. on the capitalised value of his training.

Surely it is not too much to say, that if there is no place in commercial engineering for the thoroughly trained man in which he may legitimately expect a minimum living wage, then either organised technical education is a disastrous failure, or else British engineers in high places have utterly failed to appreciate the value of such men.

I say British advisedly, for things are not so in Germany or the United States.

When I think of the hundreds of able young men who, after graduating in the workshops, enter our technical colleges each year ; who do so only at great sacrifice on their own part and on that of their parents ; when I think of the added sacrifice of all that draws youth from the study ; when I think of the ultimate reward which will be theirs, the cruel disillusion, the crushing disappointment, I am filled with loathing and contempt for the unctuous souls who preach "technical education" in public, and so successfully throttle its devotees in their capacity as the "illustrious heads" of great engineering concerns.

Cardiff, December 23rd. G. Lewis.

SOHO WORKS.

Sir,—In your issue of the 17th you give an article on the Soho Foundry, by C. H. Wall, M. Inst. M.E. It is a most interesting account, especially to those who, like myself, were trained there, I having been an indentured apprentice, and my father, who passed away at the age of eighty-five in June last, assistant works manager.

I want to enlighten Mr. Wall on one point, that of the method employed in heating cranks for shrinking on to the shafts. The plan mentioned by Mr. Wall was not introduced till about the seventies. At or near that time I had to take in hand a crank and shaft from the machines, having previously helped on other cranks which were placed in the centre of a wood pile in the big erecting shop. I considered this a clumsy and dirty job, and hit upon the plan of the lead bath, and, getting the consent of Mr. Walton, the coppersmith, I carted my crank and shaft to his shop and effected a splendid job, and, besides, the crank did not take a quarter the time to finish off. This was the first start of the lead bath, and I was interested to know that it was an accepted plan afterwards. Apologising for taking up your valuable space,

Jas. Forbes.

London, December 29th.

CALENDARS, DIARIES, &c., FOR 1910.

Many excellent wall calendars, diaries, pocket-books, &c., for the year 1910 have reached us. From Henry Simon, Limited, of Manchester, we have received the usual handy desk or wall calendar with large daily tear-off sheets.—A similar calendar, which is intended for hanging on the wall, has also been received from E. R. and F. Turner, Limited, of Ipswich.—The Western Electric Company, of Norfolk House, Victoria Embankment, has sent a tasteful little desk calendar with monthly tear-off sheets.—A desk calendar has been received from the Life Association of Scotland, of 82, Princes-street, Edinburgh ; also a large wall calendar bearing an excellent picture.—Two wall calendars with monthly tear-off sheets have also been received from the Hunslet Engine Company, Limited, of Leeds. A special feature about these calendars is that they are covered with washable gelatine.—Goringe Craddock and Co., Limited, of Wakefield, have sent a exceptionally large wall calendar with monthly tear-off sheets, similar to the one sent out by them last year. — The Ironmonger Diary for 1910, which is issued by the publishers of *The Ironmonger*, of 42, Cannon-street, E.C., is a well-bound and extensive volume, and contains much useful information.—John Smith and Co., of Carshalton, Surrey, have sent us a useful cardboard wall calendar, without tear-off sheets.—From Hamilton Brothers, electrical engineers, Glasgow, we have received a wall calendar, with small monthly tear-off sheets.—A large wall calendar, with monthly tear-off sheets, which is exceptionally well got up, is to hand from the United States Metallic Packing Company, Limited, of 110, Fenchurch-street, E.C.—From Merryweather and Sons, Limited, of 63, Long-acre, we have received the usual attractive wall calendar, having monthly tear-off sheets, and the card on which these are mounted bears some good illustrations of the firm's manufactures.—An excellent combined blotting-pad, calendar, and diary is to hand from the Electrical Power Storage Company, of 4, Winchester-street, E.C.—Another very handy blotting-pad, and, like the former, suitable for office use, is to hand from the Hart Accumulator Company, of Marshgate-lane, Stratford, London, E.—As in previous years, Hayward-Tyler and Co., Limited, of 99, Queen Victoria-street, have issued a handy little pocket diary which contains some information of value to hydraulic engineers.—Cammell, Laird and Co., Limited, of Sheffield, have issued a wall calendar with monthly tear-off sheets, and the card upon which it is mounted bears an attractive picture.—Three exceptionally good wall calendars have been sent to us from Dewhurst's Engineering Company, of Sheffield, each having monthly tear-off sheets, and the cards on which these are mounted bear pictures of a very excellent kind. One of these pictures is of a French village, and it is from a painting by Albert Wallet.—From "Thermit," Limited, of 27, Martin's-lane, Cannon-street, E.C., we have received a very neat little pocket note-book containing some useful engineering and general information and a calendar for 1910 and 1911.—A useful note-book and diary for 1910 is also to hand from Glenfield and Kennedy, of Kilmarnock, Scotland.—A wall calendar having large daily tear-off sheets has reached us from Ashwell and Nesbit, Limited, of Barkley-lane, Leicester.—Alfred Herbert, Limited, of Coventry, have sent us one of their new wall calendars, which is got up in the usual excellent style, having large monthly tear-off sheets, each bearing an illustration of some kind of machine-tool as manufactured at the Coventry Works.—A similar wall calendar having large monthly tear-off sheets is to hand from John Rogerson and Co., Limited, of Wolsingham, Durham.—The "Gloucester" Diary and Director's Calendar for 1910 is to hand from the Gloucester Railway Carriage and Wagon Company, Limited, of Gloucester. This, as is well known, is an exceptionally useful publication, containing among other things a director's calendar, which enables the periodic recurrence of fixed engagements, such as board meetings, to be recorded.—Davey, Paxman and Co., Limited, of Colchester, send a nicely bound pocket diary and note-book, which contains, besides typical illustrations of the productions of the firm, several useful tables, &c.—We have to thank Cammell, Laird and Co., Limited, for a handsome pocket-book and diary. It contains, besides tables, &c., and illustrations of a few of the firm's productions, a note-book of squared paper, and the inevitable coupon.—A very acceptable little book is to hand from W. F. Dennis and Co., of 49, Queen Victoria-street, which contains a calendar for 1910, and some useful data relating to electric and other wires. It is excellently well bound, and its dimensions are such as to allow of it being carried in the waistcoat pocket.—An excellent metal desk calendar provided with monthly and daily cards has reached us from the Atlas Metal and Alloys Company, Limited, of 52, Queen Victoria-street, E.C.

CATALOGUES.

Edmund Coignet, Limited, 20, Victoria-street, Westminster.—This is an interesting pamphlet dealing with the Coignet system of armoured concrete construction as applied to mining and other industries.

R. Waygood and Co., Limited, Falmouth-road, London, S.E.—This is a new catalogue dealing with cranes of all kinds. It is well illustrated and treats of cranes which have been erected for various classes of service.

David Joy and Cooper, Quayside, Bitterne, Southampton.—From this firm we have received a little booklet having reference to David Joy and Cooper's patented steam assistant cylinder for assisting the valve gear in its work of moving and controlling the main valve.

P. J. Mitchell, Caxton House, Westminster, S.W.—A well-got-up little booklet has been sent to us by this firm, having reference to thermal storage. The system described is that designed by Mr. Druitt Halpin. The booklet is well illustrated, and contains a considerable amount of interesting information.

Charles Churchill and Co., Limited, 9-15, Leonard-street, Finsbury, E.C.—"Machinery and Tools" is the title of a tasteful little booklet which has been forwarded to us by this firm. It contains views of the firm's workshops, show-rooms, stock-rooms, offices, &c., and each illustration is accompanied by a concise description.

Fletcher Brothers, Limited, Ashton-under-Lyne, Lancashire.—A well-bound catalogue has reached us which deals with standard boiler mountings and steam pipe valves. It contains numerous illustrations showing the various valves and fittings made by the firm. Prices are given throughout, and all other particulars of interest to buyers.

The Chloride Electrical Storage Company, Limited, 39, Victoria-street, Westminster.—From this firm we have received an interesting pamphlet describing the "Entz" booster, which is employed in conjunction with a battery for dealing with heavy peak loads. The pamphlet deals with this system in a very thorough manner, and there are many illustrations.

Wellman-Seaver and Head, Limited, 47, Victoria-street, London, S.W.—This is an extensive catalogue having reference to chargers for horizontal re-heating furnaces. The catalogue has been compiled to illustrate some of the types of charging machines which the firm has made, and to show the wide range in the size of ingots and slabs handled. The catalogue is printed on excellent paper, and the illustrations are exceptionally good.

Bruce, Peebles and Co., East Pitton, Edinburgh.—Pamphlet No. 18A has reached us, which gives particulars and prices of large-sized continuous-current dynamos and motors. Very complete lists of weights and dimensions are given ; also lists of outputs, both as motors and generators, for all sizes dealt with in pamphlet, at the usual standard voltages. Motors up to 1500 horse-power are listed, also dynamos up to 1100 kilowatts.

Thwaites Brothers, Limited, Vulcan Ironworks, Bradford.—An extensive catalogue has reached us pertaining to metallurgical plant and accessories. Among other things, it deals with water-jacket furnaces, Roots blowers, reverberatory furnaces, hot blast stoves, centrifugal pumps and fans, blowing engines, air compressors, ore hoists weighing machines, ore and coke wagons, ore crushers, crushing rolls, Bruckner roasting furnaces, &c.

Rolls-Royce, Limited, Derby.—The new catalogue which this firm has recently issued on the well-known Rolls-Royce motor car is a unique publication of its kind. Besides containing complete descriptions, specifications, and illustrations of the 1910 chassis, together with testimonials and flattering opinions, the book contains a batch of sporting colour plates reproduced from water-colour drawings by Charles Sykes. These depict the different uses to which the motor car may be put, both in town and country, many of which are worthy of frames.

R. Hunt and Co., Earls Colne.—From this firm we have received a new catalogue dealing with shafting, pulleys, and power-transmission accessories.

The Empire Engineering Company, Caxton House, Westminster, S.W.—A neat little pamphlet has reached us which describes and illustrates the Empire petrol or gas engine.

The British Electrical Trade Supply and Bitumen Company, Canal Bank, Trundley-road, Deptford, London, S E.—This is a small pamphlet dealing with refined Trinidad bitumen.

P. and W. MacLellan, Limited, 129, Trongate, Glasgow.—This firm has sent us a well got up pamphlet, which deals with the Norton ball-bearing jacks and "Sure-drop" contractors' jacks.

Tangyes Limited, Cornwall Works, Birmingham.—Catalogue No. 129 has reached us, which has reference to this firm's "T" type gas engine. We have also received the firm's latest list—No. 134—dealing with belt-driven duplex pumps.

The Central Engine Works, West Hartlepool.—Section 7 of this firm's general catalogue has reached us. It gives numerous illustrations of drop forgings made in iron, steel, copper and Muntz metal up to 1 cwt. in weight, and for all trades.

Arthur R. Brown and Co., 54 and 62, New Broad-street, London.—This is an extensive catalogue having reference to gold dredgers, steamships, harbour dredgers, &c. The catalogue contains many excellent illustrations, and each is accompanied by a concise description.

Holophane Glass Company, 12, Carteret-street, Westminster, London, S.W.—This is a catalogue dealing with the Holophane system of illumination. Among other things it contains some useful engineering data which should interest those associated with illuminating problems.

Andrew Barclay, Sons and Co., Limited, Kilmarnock, Scotland. - A well-got-up booklet has reached us, which illustrates and gives particulars of some of the Oddie-Barclay pumps as manufactured by this firm. The booklet is provided with a thumb index, by means of which any specific information can readily be found.

Merryweather and Sons, Limited, 63, Long-acre, W.C.—A new catalogue has reached us. It deals with all kinds of pumps to be driven by hand or by any kind of engine or other power-producing agent. The catalogue contains numerous illustrations and prices, code words, and other particulars of interest to buyers.

The McKenzie, Holland and Westinghouse Power Signal Company, Limited, 58, Victoria-street, S.W.— The title of a well-got-up little pamphlet to hand from this firm is "All Electric Power Signalling at Yarnton, Great Western Railway." The matter which the pamphlet contains is a reprint of an article which appeared in the *Railway Engineer* for August, 1909.

W. H. Willcox and Co., Limited, 34 and 36, Southwark-street, London, S.E.—From this firm we have received a well-got-up little booklet having reference to "Penberthy" patented injectors. It deals fully with the firm's automatic "Penberthy" injectors, which are for low, medium and high pressures up to 200 lb.; also "Penberthy" auto-positive injectors for high pressures and hot water.

Ransome-ver-Mehr Machinery Company, Caxton House, Westminster, London, S.W.—This is a new catalogue dealing with the Ransome concrete mixer. It is an extensive publication, and is believed to be the most complete catalogue ever compiled relating to concrete mixing machinery. It contains numerous illustrations and nineteen pages are devoted to reports from users of these machines.

The Clyde Structural Iron Company, Limited, Scotstoun, Glasgow.—This is a well compiled catalogue dealing with structural iron and steel work. Its object is to show in as condensed a form as possible the class of work the firm is prepared to undertake. The catalogue illustrates the various departments of the firm's works, and also various kinds of structures which have been built by the firm in different parts.

Davidson and Co., Limited, Sirocco Engineering Works, Belfast.—A well-compiled pamphlet has reached us. It contains a partial list of "Sirocco" fans supplied for mine ventilation in Great Britain. The list includes both the powerful surface fans, capable of handling several hundred thousand cubic feet of air per minute, as well as small auxiliary fans which have been erected under ground, and are used for local ventilation, for supplying fresh air during pit-sinking operations.

Alley and MacLellan, Limited, Sentinel Works, Polmadie, Glasgow.—A new catalogue, No. 25E, has been issued by this firm which gives particulars of sizes, outputs, and prices of two-crank compound and three-crank triple-expansion "Sentinel" engines. The special features of these engines are clearly set forth. The illustrations show engines direct coupled to electric generators, but attention is drawn to the fact that they can also be arranged with belt or rope pulleys for driving factories, mills, &c.

Mansfield and Sons, Limited, James-street, Liverpool.—This is a catalogue having reference to Mansfield's patented oil-gas apparatus. as well as a copy of a pamphlet on Mansfield's well-known oil gas apparatus, which is constructed to generate gas from any kind of oil for commercial, industrial, or domestic purposes where light, power, or heat is required. Three special types are made—namely, (1) for laboratories where Bunsen burners are used, (2) for factories, &c., and (3) for high-pressure lighting. The book contains sectional illustrations of the producer.

Siebe, Gorman and Co., Limited, 187, Westminster Bridge-road, S.E.—A new and well-compiled catalogue has been sent to us by this firm having reference to all kinds of diving apparatus. It is divided into six sections. The first section is devoted to complete sets of diving apparatus, the second to diving helmets and dresses, the third to divers' air hose and the fourth to miscellaneous items of divers' gear. Section five has reference to the firm's electrical department and gives particulars of divers' telephones, electric lamps, exploding apparatus, and so forth. Lastly, in section six, small power driven air pumps, air compressors, receivers and divers' tools, &c., are dealt with.

The Tudor Accumulator Company, 119, Victoria-street, London, S.W.—A new report catalogue has reached us having reference to stationary batteries. This catalogue provides all the data necessary to enable intending purchasers to prepare the preliminary work connected with Tudor battery plants. As a guide for preparing estimates, two examples of estimates are given which contain all items essential for a complete and up-to-date battery plant, and they also show the manner in which the prices are made up. To enable clients to calculate approximately the freight of a battery from English to foreign ports, tables are given showing the approximate weights and dimensions of batteries, including the necessary accessories and spares, packed for shipment, composed of sixty cells, for all the different types contained in the list. The catalogue is a very useful publication.

Jens Orten Böving and Co., 9½, Union-court, Old Broad-street, London, E.C.—This firm has sent us a report on the investigation of an electric shaft furnace by Dr. Haanel. This furnace was designed and erected by the Aktiebolaget Elektrometall, at Domnarfvet, Sweden. Since electrodes and charcoal are necessary for the electric smelting or iron ores, chapters have been added descriptive of the manufacture of electrodes and of the latest types of charcoal furnaces, together with appendices on the progress of electric smelting in Norway and Sweden. From the same firm we have also received two pamphlets, and one has reference to the "Elektrometall" iron-smelting furnace and the other to the "Elektrometall" steel-refining furnace. Jens Orten Böving and Co. are the sole agents for the Elektrometall Company throughout the British Empire.

THE IRON, COAL, AND GENERAL TRADES OF BIRMINGHAM, WOLVERHAMPTON, AND OTHER DISTRICTS.

(*From our own Correspondent.*)

Raw Iron Revival.

The raw iron trade enjoys fully as good a tone this week as last, though the holidays have necessarily restricted the extent of business done. Consumers seem persuaded that we are on the eve of a sensible revival, and they are therefore ordering in advance of requirements, so as to anticipate increased prices as much as possible. The upward movement in prices at Glasgow and Middlesbrough and on the West Coast is regarded as distinctly seconding buyers' expectations in this district, and local users are not therefore alone in the opinion which they have formed of an early improvement. It would be too much to say that the market is unanimous that a better state of values and demand will be with us soon, some buyers, it must be admitted, still being very cautious as to how far they commit themselves. Nevertheless, it may be very fairly reported that makers at date are in command of the market, and will not sell except at an enhanced rate of 1s. to 1s. 6d. per ton, and some special brands at 2s. per ton. Makers continue their policy of refusing to book forward as far as certain of the manufactured ironmasters and ironfounders desire, believing that prices will further advance, and that their interests at the moment lie in the direction of not filling up their contract books. Another reason which persuades them to this course of action is the expectation which exists of dearer prices for hard coke in 1910, and a report was prevalent on Birmingham Exchange this week that the Midland coke ovens have resolved upon a declared advance of 1s. per ton with the opening of January. On the Exchange to-day (Thursday) the price of South Staffordshire forge iron varied from 45s. to 46s., with a strong tone. Other descriptions were dearer. Part-mine was quoted at 49s. to 50s., best all-mine 85s., and cold blast 115s. Some Northamptonshire makers asked 50s., but business could be done at 2s. less. Derbyshire brands stood at 49s. to 50s., and North Staffordshire at about 51s. upwards.

Finished Iron Business.

Little has been done at the finished ironworks this week, the works having been laid off in most of the localities, if not for the entire week, nearly so. Happily, ironmasters will resume next week more hopefully than up till a fortnight or three weeks ago had been thought likely. The stronger condition of the pig iron market is being watched very carefully by the users of rolled iron and by merchants, both home and export, and should it appear probable that the spurt will take on a permanent character and the upward movement in prices become a fixed market quantity these buyers will immediately rush in and order. Stocks in the hands, alike of consumers and middlemen, are generally extremely low, and will require immediate replenishing in case the finished iron market goes up. There is a rather healthier tone in the bar trade. Marked bars are in fairly good request at the £8 basis, and South Staffordshire unmarked bars are feeling to some slight extent the stimulus which has been communicated to the pig iron section. Merchant qualities were quoted up to £6 to-day. North Staffordshire crown bars remain at £6 10s. at ports.

White and Black Sheets.

An excellent report continues possible concerning the state of the white and black sheet trade. Inquiries are very numerous, and all the rolling mills and galvanising pots are extremely busy, with excellent prospects. Not for a long time has the business looked better than it does to-day. So excellent is demand that it would surprise no one if prices were soon to show a decided advance in respect of white sheets. Prices tend to become firmer, but there is no definite movement, about £11 5s. for 24 gauge corrugated sheets f.o.b. Liverpool being the usual quotation. There is a decidedly better tone in the black sheet branch, and a fair amount of orders have been placed on the basis of £7 2s. 6d. to £7 5s. for doubles. Makers of both white and black sheets reported this afternoon that they could have taken plenty more orders if they had been able to promise delivery, but with contract books already full this was largely impossible.

Advance in Chain Cables.

It is reported in the chain cable trade that the makers of best chains for the Admiralty have had some excellent contracts placed, with the result that they are raising their quotations 5s. per ton.

Steel.

The stronger tone in the steel trade is upheld, and the outlook for next quarter is considered to be better both in raw and rolled material. Makers' order books are receiving some considerable additions, and the mills have good prospects of regular work in front of them. Makers of rolled material are faced by advancing quotations for hematites—a circumstance which is certain to lead to early higher prices for finished steel if it is continued. Prices are given this week as:—Angles, £5 17s. 6d. to £6; girder plates, £6 to £6 2s. 6d.; boiler plates, £7 5s.; joists, £5 15s. to £6; mild bars, £6 7s. 6d. to £6 17s. 6d. Half product bars for the sheet makers are steadily moving up in price, and an advance of 2s. 6d., and in some instances rather more, is now demanded, alike with respect to Staffordshire made bars and Welsh bars delivered into this district for sheet makers' consumption. Bessemer bars have risen to £4 17s. 6d. and Siemens sorts to £5, with the prospect of further strength if continental supplies happily remain off the market as now.

NOTES FROM LANCASHIRE.

(*From our own Correspondent.*)

Manchester, Thursday.

Prospects in Pig Iron.

Although there was not a large attendance on the Iron Exchange on Tuesday, there was a better feeling perceptible generally. Consumers evinced greater disposition to operate, and as shipments continue heavy and the warrant market firmer, this state of things is reflected to some extent in this centre. Although there did not appear to be much change in Lincolnshire and Derbyshire on spot, there was a marked advance in Middlesbrough brands and all classes of hematite, the second quarter of the year being quoted for higher figures. Scotch was also the turn dearer. Forge iron was about 6d. higher.

Finished Iron and Steel.

In these classes the market has been rather featureless.

Copper, Lead Tin.

Copper: There was no change to note and business was dull. Lead: Sheets steady, but inquiry slow. Tin: English ingots dearer.

Quotations.

Lincolnshire No. 3 foundry, 54s. 6d.; Staffordshire, 53s. 6d.; Derbyshire, 55s.; Middlesbrough, open brands, early delivery, 60s. 9d.; January-March and April-June, 61s. 1d. Scotch: Gartsherrie, 61s.; Glengarnock, 60s.; Eglinton, 60s. to 60s. 6d., delivered Manchester. West Coast hematite, 64s.; East Coast ditto, first quarter, 65s., both f.o.t. Delivered Heysham: Gartsherrie, 59s.; Glengarnock, 58s.; Eglinton, 58s. to 58s. 6d. Delivered Preston: Gartsherrie, 60s.; Glengarnock, 59s.; Eglinton, 59s. to 59s. 6d. Finished iron: Bars, £6 10s.; hoops, £7 12s. 6d.; sheets, £7 12s. 6d. to £7 17s. 6d. Steel: Bars, £6 2s. 6d. to £6 5s.; Lancashire hoops, £7 5s.; Staffordshire ditto, £6 17s. 6d. to £7; sheets, £7 17s. 6d. to £8; boiler plates, £7 5s. to £7 7s. 6d.; plates for tank, girder, and bridge work, £6 5s. to £6 7s. 6d.; English billets, £4 12s. 6d. to £4 15s.; foreign ditto, nominal; cold drawn steel, £9 5s. to £9 10s. Copper: Sheets, £73; tough ingot, £63 10s.; best selected, £63 10s. Copper tubes, 8¾d.; brass tubes, 7⅞d.; condenser, 8⅞d.; rolled brass, 6½d.; brass wire, 6¾d.; brass turning rods, 6¾d.; yellow metal, 6⅛d. to 6⅜d. per lb. Sheet lead, £17 per ton. English tin ingots, £152 10s. per ton.

The Lancashire Coal Trade.

The chief feature in this market was the resolution on the part of Lancashire coalowners to advance the official price of house coal on the 1st of January, 1910, by 10d. per ton. The announcement was received with very mixed feelings on 'Change, especially by merchants who did not think the advance warranted. On the other hand, those who have contracts running for this class of fuel welcomed the higher price. In other respects there was little of interest to note.

Barrow-in-Furness, Thursday.

Hematites.

There is a steady trade in hematite iron, although the attention of business men has been largely taken up during the past few days with the holidays. The market is, however, so sensitive at the moment when it is gradually emerging from a period of semi-activity to one of probable briskness that those who have iron to buy, as well as those who have iron to sell, are on the *qui vive* as to the possibilities and trend of the market in the early future. It is generally recognised that users of iron are likely to require largely increased deliveries in the early months of the New Year, and to a great extent sales have been made to cover deliveries up to the end of March, and some business has been done beyond these dates. Prompt sales are few in number, as metal is not available in most cases, and, as a consequence, the stocks of metal which were of late accumulated in makers' yards have been largely depleted, and the stocks held in warrant stores remain as for a few weeks past at 18,260 tons. There are good reports of trade in special qualities of hematite, and prospects that this trade will soon be very much busier. The quotation for ordinary specifications is about 66s. Ferro-manganese is selling in larger parcels, as well on home as on foreign and continental account. The demand for spiegeleisen is also very well maintained. A good demand for the best qualities of scrap iron is maintained. Sales of charcoal iron are well maintained. There is a better trade in native qualities of iron ore, and prices are given at 12s., 14s. 6d., and 18s. per ton net at mines for ordinary, medium, and best qualities. Some large purchases of foreign ores have been made, and, in addition to these, a trade has been opened up with the brown hematites of county Antrim.

Steel.

There is more activity at local steel works of late, and fewer days have been given for holidays than is usual; but the fact is that makers were somewhat behind-hand with their deliveries of Bessemer sorts. It is expected that further orders for rails, tin bars, and other Bessemer sorts will be booked early in the year; but there is not the same prospect in the department of mild steel. The mills have been standing a long time now, although there has been a fair consumption of material in Barrow itself. This for some time past has been supplied mainly by South Wales makers, who, it is understood, are out of the ring.

Shipbuilding and Engineering.

Shipbuilders, who have recently secured some good orders, are still tendering for new work. They are employing more men in the various departments, and expect to be even busier still as the New Year advances. Engineers are also very busy, and they are also expecting new orders.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

The Coal Trade—Railway and Shipping Business.

The railway companies have not, at the time of writing, renewed their contracts for locomotive fuel. Their offer of 6d. per ton advance on last year's rates is not acceptable to colliery proprietors, who stand out for 9d. per ton more, as they anticipate higher values will generally prevail in 1910. Large continental buyers are offering more than the 6d. per ton advance.

Gas, House, Small Coal, and Coke.

Midsummer is the season for arranging gas coal contracts. These were generally made at about 6d. per ton less than for the previous year. The improvements in gas systems maintain the demand against the competition of electricity for lighting purposes, and the more efficient burners employed widen the range of coal suitable for use. House coal has kept fairly steady during the whole twelve months. In November the winter advance of 1s. per ton was easily obtained, and towards the end of December was officially confirmed by announcement from the collieries. Small coal has been a good market during the year. The short time latterly worked in the Lancashire cotton trade does not appear to have much affected the demand for the South Yorkshire grades used in the mills, the price of which has been maintained at 4s. 6d. to 5s. 6d. per ton. Coke has been advancing, for the most part, throughout the year, the price at closing being 12s. 6d. to 13s. per ton for best washed, and 11s 6d. to 12s. per ton for unwashed. These quotations compare with 10s. per ton for best washed, and 9s. to 9s. 6d. per ton for unwashed in the beginning of 1909.

The Iron Market—Advance in Hematites.

A striking contrast is shown between the position of pig iron in 1909 and 1908. In the latter year there was a gradual decrease in price, along with a diminution of stocks. This year closes with a rise in price over the opening of 4s. to 5s. per ton for East and West Coast hematites, while there is a total increase in stocks exceeding 250,000 tons. Hematite prices at present are close on those of January 1st, 1908, when East Coast was 71s. per ton; in December, 1909, they are 70s. per ton; West Coast, January 1st, 1908, 75s. per ton; December, 1909, 75s. per ton. These quotations are not delivered in Sheffield and Rotherham. From this it would appear that some confidence is entertained of improvement in the New Year, and that those who think so are giving their opinion practical support. Rumours of American buying were freely current during the autumn, but very little more than a few thousand tons could be traced as exported, and stocks have still gone on increasing.

Lincolnshire and Derbyshire Iron.

Lincolnshire pig iron, for the most part, has been fairly steady in its course. In January the minimum official quotations were:—No. 3 foundry, 49s. per ton; No. 4 foundry, 48s.; No. 4 forge, 47s.; No. 5 forge, mottled and white, 47s.; basic, 48s. On June 4th No. 3 foundry was 50s.; No. 4 foundry, 49s.; Nos. 4 forge, 5 forge, mottled and white, 49s.; basic, 50s. 6d. On August 20th there was an all-round advance, No. 3 foundry rising to 51s. 6d., No. 4 foundry to 50s. 6d., Nos. 4 forge, 5 forge mottled and white to 50s. 6d., and basic to 51s. 6d. On September 3rd there was a further advance, No. 3 foundry making 52s. 6d.; No. 4 foundry, 51s. 6d.; Nos. 4 forge, 5 forge, mottled and white, 51s. 6d.; basic, 52s. 6d. These quotations remain at the close of December; but for delivery during the first six months of next year makers require a premium of from 1s. 6d. to 2s per ton on the official prices. There is strong expectation that the early months will bring better trade and improved values. The quotations, which are net and delivered in Sheffield and Rotherham, are those of the Lincolnshire Ironmasters' Association. In Derbyshire irons the year opened with No. 3 foundry at 51s. per ton; in March the price was 49s.; in June 50s. The tendency continued upward, September seeing the price at 52s., which still rules in December. In January No. 4 forge was 50s.; in March, 48s.; in June, 49s., and in September, 51s. The December price is 50s. 6d. Quotations net, and for delivery in Sheffield and Rotherham. Makers are expecting better prices early in the New Year. They are also well sold forward.

The Steel Trades—Railway and Marine Material.

Very few orders of size are on manufacturers' books, and prices of finished material are considerably lower than they were twelve months ago. At the same time there is less unemployment than at the close of last year. The slight revival in shipbuilding has brought a little more activity in marine specialities made in Sheffield, such as forgings, castings, and the like, on which several firms have been moderately well engaged.

NORTH OF ENGLAND.

(*From our own Correspondent.*)

Cleveland Pig Iron.

THE holidays have naturally interfered with business this week, and have caused shipments to fall off, and stocks to increase rapidly; but that was to be expected, and it has not led to weaker prices. Most of the foundries are closed this week, and that lessens the consumption of Cleveland Nos. 3 and 4 foundry iron considerably, and the quantity of iron sent into Connal's store this month has been the largest reported in any month this year, just as the increase in stock in December, 1908, was the heaviest in that year. From the 24th to the 27th the stock in Connal's was augmented by no less than 4400 tons; but, nevertheless, the prices ruling for all descriptions of pig iron have been this week the highest that has been reported this month, and traders believe that after the elections sellers will have a better time than has been experienced for several months. As makers are already well supplied with orders for execution next quarter, there is no great pressure to sell, especially as the stocks in producers' yards are not heavy. The surplus output seems largely to be going into Connal's store. Holders of warrants are not offering them freely, because they believe they will be able in the spring to sell them to better advantage than at present; they have this week been realising as much as 51s. 5½d. cash for Cleveland warrants, and buyers are prepared to pay 1s. per ton more than this for delivery up to the end of next quarter. This week No. 3 Cleveland G.M.B. pig iron has mostly been sold at 51s. 6d. per ton for early f.o.b. delivery, and 52s. 6d. for delivery over the first quarter of 1910. No. 1 was at 53s. 9d. for prompt delivery, No. 4 foundry at 50s., No. 4 forge at 49s. 9d., and mottled and white at 49s. 3d., with 1s. more for delivery up to the end of March in each case. On Wednesday No. 3 was obtainable at 51s. 3d., and other Cleveland iron prices were down in proportion. Warrants were easier at 51s. 2d. cash sellers.

Hematite Pig Iron.

The spurt in the East Coast hematite iron market is kept up, and it is the chief factor in bringing about a better tone throughout the pig iron trade, as the improvement is known to be genuine, and not induced by speculation. Speculators do not deal with hematite as they do with ordinary Cleveland iron, for there are no warrants. The hematite iron trade of this district is certainly in a satisfactory position once more, makers having lately secured good orders for execution over the next quarter, and, in some cases, over the first half of the year. In the early part of December, and for some weeks prior to that, mixed numbers East Coast hematite pig iron stood at 60s. per ton, but they have gone up rather smartly since, a lot of orders being placed for early execution at 62s. 6d., but 63s. 6d. is now the lowest that will be taken by producers, with 64s. for delivery over January, and 65s. for delivery up to the end of March. These are substantial advances, but makers cannot very well afford to take less when the prices of materials are so high. It will be difficult to turn out mixed numbers at a profit at 65s. where the present charges for ore and coke are levied. In the early part of this month the nominal price of Rubio ore was 17s. 6d. per ton c.i.f. Middlesbrough, now 19s. 6d. is not only asked, but paid, and even 20s. is quoted by some merchants. That alone will increase the cost of production by 5s. per ton of pig iron made. Such is the demand from all quarters for Rubio that the mine owners in the North of Spain can practically dictate their own terms. Consumers of ore are doing their best to obtain suitable ores from other parts of the world, and the tonnage imported from the new enterprises in North Africa has considerably increased this year. Then the cost of making hematite, and, indeed, all pig iron, is enhanced by the raising of the cost of coke. Ironmasters have to pay 18s. per ton for coke delivered equal to Middlesbrough furnaces, that being relatively a shilling per ton dearer than pig iron, for with Cleveland No. 3 at 51s. 6d. per ton, coke in the normal course should be at 17s. Further advances in hematite pig iron will have to be made to enable the ironmasters to secure a reasonable profit on it.

Manufactured Iron and Steel.

It may be taken as an indication of the improvement in trade that more works are in operation now than is usual in Christmas week. More especially is this the case at the steel manufactories, which in some instances were laid off on Christmas Day only. The producers of finished iron are, however, very badly off, and could do with a good many more orders than they are able to secure. No alterations in prices have been made this week, but it will soon become incumbent on producers to quote higher rates, for they have much more to pay for materials than they had at the beginning of the month, both fuel and pig iron having moved upwards. The year closes with the quotations as under:—Steel and iron ship plates, £6; steel ship angles, £5 12s. 6d.; iron ship angles, £7; packing iron and steel, £5 5s.; steel bars, £6; iron bars, £7; steel hoops, £6 5s.; steel strip, £6 2s. 6d.; steel sheets, singles, £7 5s., all less 2½ per cent. f.o.t. Galvanised and corrugated steel sheets, 24 gauge, are at £11 5s. per ton f.o.b., less 4 per cent. Heavy steel rails are at £5 5s. net f.o.b. Nothing further has been allowed to leak out than was mentioned in this column last week about the proposed new steel works to be built on the banks of the Tees by Sheffield capitalists. It has been conjectured that a cutlery manufactory will be started, but that is rather unlikely. Most of the foundries are closed this week, and trade with them is less satisfactory than it is at the steel works, though it is nevertheless beginning to show improvement.

Transporter Bridge over the Tees.

The progress that is being made with the transporter bridge over the Tees at Middlesbrough is reported to be very satisfactory; a good foundation has been found on both sides of the river for the towers, and about two hundred men are now employed on the work, which is being carried out by Sir W. Arrol and Co.

Coal and Coke.

While buying is slow in coal it promises to be brisk as soon as the holidays are over, and prices generally tend upwards. Best Northumberland steam coals are at 11s. per ton f.o.b. and 10s. for seconds, while for best Durham gas coals the price has risen to 11s. 3d. f.o.b., and Durham bunker coals are dearer—10s. to 10s. 9d. f.o.b. being quoted. Coke is moving up in price, foundry sorts varying from 17s. to 18s. per ton f.o.b., and furnace coke is stiff at 18s. per ton delivered at Middlesbrough furnaces.

NOTES FROM SCOTLAND.

(*From our own Correspondent.*)

The Holiday Arrangements.

THE disadvantages of having separate holiday stoppages of business south and north are still with us, and likely to continue for at least some considerable time. Business communications with England during the past week have been largely futile, and in the course of next week a similar disability will be felt between England and Scotland, particularly in the first two or three days of next week. Much time has been employed in stocktaking, and in many cases the process will have to be completed at the end of the New Year holidays. The iron and steel works, shipyards, and other industrial concerns will be closed, as a rule, throughout next week, and it is not expected that there will be anything like a general resumption of work until the 10th or 12th of January.

The Iron Market.

The Glasgow pig iron warrant market was closed on Monday, but at the re-opening on Tuesday a fair business was done. Indeed, there has been in the last few days of the past week, and in the tone of the market this week indications of the probability of a good business being done in the early weeks of the coming year. Since last report, business has been done in Cleveland warrants from 51s. 5d. to 51s. 1d. and up again to 51s. 5½d. cash, from 51s. 7d. to 51s. 9d. and back to 51s. 3d. for delivery in one month, and 52s. to 52s. 5½d. and 51s. 4d. three months. It has been a feature of the market in recent days, that a moderate amount of business has quickly had the effect of lifting prices.

Scotch Makers' Iron.

Merchants and ironmasters seem well satisfied with the amount of fresh business they have been enabled to entertain in the closing days of the year. They state that Canada, Australia and the Continent have made large purchases of iron, and that the home demand has by no means been inconsiderable. Prices of Scotch pig iron are well maintained. The f.a.s. quotations at Glasgow are, for Govan and Monkland, No. 1, 57s.; No. 3, 55s.; Carnbroe, No. 1, 60s.; No. 3, 57s.; Clyde, No. 1, 62s. 6d.; No. 3, 57s. 6d.; Gartsherrie and Calder, Nos. 1, 63s.; Nos. 3, 58s.; Summerlee, No. 1, 64s.; No. 3, 59s.; Langloan, No. 1, 65s.; No. 3, 60s.; Coltness, No. 1, 85s.; No. 3, 58s. 6d.; Eglinton, at Ardrossan or Troon, No. 1, 59s.; No. 3, 57s.; Glengarnock, at Ardrossan, No. 1, 65s.; No. 3, 60s.; Dalmellington, at Ayr, No. 1, 62s.; No. 3, 57s.; Shotts, at Leith or Glasgow, No. 1, 63s.; No. 3, 58s; Carron, at Grangemouth, No. 1, 64s. 6d.; No. 3, 58s. 6d. per ton. One furnace has been taken off hematite since last report, and there are now 42 making hematite, 36 ordinary, and 5 basic iron, the total of 83 furnaces thus in operation in Scotland comparing with 84 last week and 77 at this time last year.

The Hematite Trade.

There has been further dealing in Cumberland hematite warrants, which have been purchased from 63s. 3d. to 64s. for delivery in three months. These transactions proceed on a favourable statistical position as regards the Cumberland product. In the case of Scotch hematite the market has been quiet but steady, and merchants quote 65s. per ton for delivery at the West of Scotland steel works. The arrivals of hematite ore in the Clyde in the past week consisted of twenty cargoes, nearly the whole of it being from abroad.

Finished Iron and Steel.

There has been comparatively little activity in these departments. Inquiries for steel seem to indicate that a fair business may be anticipated after the holidays in shipbuilding material. The foreign demand at the moment is quiet. In the malleable iron trade the outlook is somewhat indifferent, but the general impression seems to be that business may ere long show some improvement.

The Coal Trade.

The coal market has been quiet this week, mainly because orders up to the end of the year were placed some time ago, and there is little inclination to enter into fresh engagements until after the New Year holidays. For such orders as are in the market prices are firm, ell and steam coal being quoted at Glasgow harbour 10s. to 10s. 6d., and splint 10s. 6d. to 11s. per ton.

WALES AND ADJOINING COUNTIES.

(*From our own Correspondent.*)

Last Week's Coal Trade.

THE members on 'Change were not expectant of any pressure of business, and were not disappointed. For two days there was some degree of buoyancy, and then a little spurt ended it, though the impression left on the old frequenters was that the promise of the future is by no means depressing. The labour market is fairly tranquil, and the coal trade of the New Year has abundant promise. Some surprise was expressed that the Northumberland coalowners had practically settled their eight hours' dispute with their men. This lessened the expectation that northern trade might flow this way; but ample bookings have been secured, and sellers were able in several instances to get an advance. One of the problems in front is: Are coalowners to continue troubled with the stormy weather? Even last week it was most trying, and sent pitwood up in price, as well as causing great scarcity.

Latest Coal Quotations, Cardiff.

Quotations remain, very little work doing until Wednesday. Best large steam, 16s. 3d. to 16s. 6d.; seconds, 15s. 6d. to 16s.; ordinaries, 14s. 6d. to 15s.; best drys, 16s. 3d. to 16s. 6d.; ordinary drys, 14s. 6d. to 15s. 3d.; best washed nuts, 13s. to 13s. 6d.; seconds, 12s. 6d. to 13s.; best washed peas, 12s. to 12s. 6d.; seconds, 10s. to 11s. 6d.; very best smalls, 9s. to 9s. 3d.; best ordinaries, 8s. to 8s. 6d.; cargo smalls, 6s. 9d. to 7s. 6d.; inferior sorts, 6s. to 6s. 6d.; very best Monmouthshire black vein, 15s. 3d. to 15s. 6d.; ordinary Western Valleys, 14s. 6d. to 14s. 9d.; best Eastern Valleys, 13s. 9d. to 14s. 3d.; seconds, 13s. to 13s. 6d. Bituminous coal: Very best households, 17s. to 18s.; best ordinaries, 15s. to 16s.; No. 3 Rhondda, large, 17s. 3d. to 17s. 6d.; smalls, 10s. to 10s. 6d.; No. 2 Rhondda, 13s. to 13s. 6d.; through, 9s. 6d. to 10s.; smalls, 7s. to 7s. 6d. Patent fuel, 15s. to 15s. 6d. Coke: Special foundry, 24s. to 27s. 6d.; foundry, 19s. to 20s.; furnace, 17s. to 17s. 6d.; pitwood, 19s. 6d. to 20s.

Newport Coal.

Very little was done at the opening of the market this week. Even the last despatch of the week was affected by holiday conditions. Only 3000 tons were exported on closing day. This week only approximate prices can be given. Very best black vein, 15s. to 15s. 3d.; Western Valleys, 14s. 3d. to 14s. 6d.; Eastern Valleys, 13s. 6d. to 14s.; other kinds, 12s. 6d. to 13s. 3d.; best smalls, 7s. 3d. to 7s. 9d.; seconds, 6s. 6d. to 7s.; inferiors, 6s. to 6s. 3d. Bituminous: Best house coal, 15s. to 15s. 6d.; seconds, 14s. to 14s. 6d. Patent fuel, 15s. to 15s. 3d. Coke: Foundry, 18s. to 19s.; furnace, 17s. to 17s. 6d. Pitwood, ex-ship, 19s. 6d. to 19s. 9d. Owing to the short week the coal despatch was only 57,075 tons foreign and 17,097 coastwise. Heavy stock of coal is lessening.

Swansea Coal.

Little business done and very small attendance. It was stated that many of the collieries were idle, but the outlook is good. Little business now until the New Year. Latest prices:—Best malting anthracite, large hand-picked, 23s. to 24s. net; second malting, large, 21s. to 22s. net; big vein, 17s. 6d. to 19s. 6d., less 2½; red vein, 13s. to 13s. 6d., less 2½; machine-made cobbles, 23s. to 24s. net; Paris nuts, 25s. 6d. to 26s. net; French nuts, 26s. to 27s. 6d. net; German nuts, 25s. to 26s. net; beans, 18s. 6d. to 19s. 6d. net; machine-made large peas, 11s. to 12s. 6d. net; fine peas, 10s. 6d. to 11s. net; rubbly culm, 5s. 9d. to 6s., less 2½ per cent.; duff, 2s. 6d. to 3s. net. Steam coals: Best large, 17s. to 18s.; seconds, 14s. 6d. to 15s.; bunkers, 9s. 6d. to 10s. 6d.; small, 7s. to 9s., all 2½ per cent. less. Bituminous coal: No. 3 Rhondda, large, 18s. to 18s. 6d.; through, 14s. 9d. to 15s. 6d.; small, 10s. 3d. to 10s. 6d. Patent fuel, 13s. to 13s. 6d., all less 2½.

Iron and Steel.

As a holiday week in greater part, prices were not much in evidence. At the Swansea metal market, Siemens steel bars were quoted at £4 17s. 6d., the same as Bessemer. Neither heavy nor light rails were quoted, figures, it is assumed, remaining the same. Pig iron prices were as follows:—Hematite mixed numbers, 62s. 9d. cash and one month; Middlesbrough, 51s. 5d. cash and one month; Scotch, 57s. cash and month; Welsh hematite, delivered, 67s. 6d. to 68s. 6d.; East Coast, 67s., c.i.f. Other quotations:—Copper, £60 17s. 6d. cash, £61 18s. 9d. three months. Lead, English, £13 17s. 6d.; Spanish, £13 7s. 6d. Spelter, £23 2s. 6d. Silver, 24¼d. per oz.

Tin-plate.

Though it was a short week, limited to four days, the quantity of tin-plate sent from the works was a large one, 87,542 boxes, showing that the workmen had worked with considerable vigour, knowing that a time of slackness was at hand. The shipments amounted to 67,908 boxes, and stocks now are close upon 125,000 boxes. The outlook continues satisfactory, and after the holiday influence is gone trade may be expected to be resumed with briskness. Prices remain, with some exceptions; the ordinary Bessemer and Siemens plates are quoted the same as last week, namely, 12s. 7½d. to 12s. 9d. at Liverpool, but at Swansea quotations, I.C. 20 × 14, 112 sheets, 108 lb., 12s. 9d.; wasters, 11s. 6d.; ternes, 28 × 20, 112 sheets, Siemens primes, 22s. to 22s. 3d. Large, altered:—C.A. roofing sheets, £8 10s. to £8 15s. per ton; big sheets for galvanising, £8 7s. 6d. to £8 10s.; finished black plates, £9 17s. 6d. to £10 per ton; galvanised sheets, 24 g., £11 5s. per ton; block tin, per ton, £153 15s. cash, £156 5s. three months.

Llanelly.

The majority of the works are well placed for orders, and a marked improvement has taken place in the bar trade. There has not been much competition with America and Germany, and strong hopes are entertained that dumping will not be so rife in the New Year as it has been in the old. Outlook is stated to be distinctly favourable and collieries have been working well, and the port seems to have had less trouble than the others through the weather. Railway enterprise in connection with the anthracite collieries is expected to be in evidence in the district.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

MESSRS. E. R. CALTHROP AND PARTNERS announce their removal from 3, Crosby-square, to Eldon-street House, Eldon-street, London, E.C. The telephone number and cable address remain the same, namely:—Avenue 4360 and "Raillerais, London."

MESSRS. HOOPER AND SPEAK give notice that they have taken into partnership Mr. Rowland Fielding, and that the firm will in future be known as "Hooper, Speak and Fielding." The offices of the new firm will, on and after the 7th January, 1910, be at 3, London Wall-buildings, E.C. The firm's telegraphic address and telephone number will remain unchanged.

REPORTS from Canton indicate an opening for nitrate of soda as a fertiliser, a British firm there having made a successful beginning in an experiment to introduce it as a substitute for sewage. At Chinan Fu, the capital of Shantung, a German firm recently made experiments with artificial fertilisers, and his Majesty's Consul suggests that there are great possibilities for potassium salts in that province. But the mass of Chinese farmers are so poor and so ignorant that the prospect of generally introducing chemical fertilisers must be considered as still far off.

THE remarkable thermal conductivity of carborundum, states a contemporary, has recently received an interesting application in the manufacture of moulds for cooling aluminium to rapidly chill the cast metal. Aluminium, as, moreover, do all other metals, becomes much denser when it is cast in a carborundum mould, which rapidly extracts heat from the cast metal. By this there is produced a sort of temper which gives the metal a much finer and denser structure. Sand moulds, on the other hand, being poor conductors of heat, cool the metal very slowly, and in consequence allow all the constituents of the metal the time necessary for crystallisation and segregation. The manufacture of these moulds consists, according to the inventor of the process, in dry mixing fine carborundum powder with sugar and clay. The mixture is moistened with sufficient mortar to give a plastic mass to which is given the shape of the desired mould; this is then baked. These moulds also possess the advantage of being much lighter than metallic moulds, and of being readily broken, crushed, reduced to a fine powder and reagglomerated again with a different shape.

A SEPARATE unit type of reinforced concrete wall construction was used last year in building the power-house of a small hydro-electric plant at Newton Falls, Ohio. The pilasters are of monolithic concrete, while the walls between them are hollow and are built of inside and outside thin concrete slabs, which were set before the pilasters were poured, so as to be keyed into them. The slabs were reinforced with No. 28 gauge expanded metal and were made in sizes that could be handled conveniently. Their outer surfaces were corrugated by laying ⅝in. round rods in parallel lines on the surface of the fresh concrete when the slabs were cast and pulling them out after the mixture had taken its initial set. These corrugations were designed to give a good bonding surface for the plaster coat which was applied to the walls after they had been erected. The slabs were allowed to cure and were then placed on edge in proper position. Vertical form boards were placed for the pilasters, extending beyond the surface for the monolithic work, so that the slabs rested against them. The inside faces of the pilasters were moulded against form boards placed in the air space between the wall slabs, and were wired to the outside forms after the pilaster reinforcement had been placed. The inside boards also acted as spaces to keep the slabs the proper distance apart. This distance varied somewhat, but 8in. was the minimum.

NOTES FROM GERMANY, FRANCE, BELGIUM, &c.

(*From our own Correspondent.*)

Rheinland-Westphalia.

In raw and unfinished iron a tolerably good business continues to be done on home and on foreign account. The tendency all round is firm, though quiet, comparatively few fresh orders being secured. In girders there has been more life shown than was expected for this quarter. Competition is keen, both from abroad and among inland producers. The Cologne and Düsseldorf section of West German iron merchants resolved on an immediate rise of M. 5 p.t. for bars, hoops, and plates; other sections of the Union are likely to do the same. Both among producers and dealers the opinion prevails that spring trade will be animated. Official accounts from December 10th show list rates to be as under:—Raw spathose ore, M. 10.90; roasted ditto, M. 15; Nassau red iron ore, M. 11.50 per ton net at mines; spiegeleisen, 10 to 12 per cent. grade, M. 60; white forge pig, Siegerland and Rhenish-Westphalian brands, M. 55; iron for steel making, M. 56 to M. 58; German Bessemer, M. 58 to M. 60; basic, M. 48 to M. 50, free place of consumption; Luxemburg forge pig, free Luxemburg, M. 44 to M. 46; the same for foundry purposes; No. 3, M. 47 to M. 49; German foundry pig, No. 1, M. 56 to M. 58; No. 3, M. 55 to M. 57; German hematite, M. 57 to M. 59, all per ton free at works. Good merchant bars, common quality, M. 98 to M. 104; iron bars, M. 122.50 to M. 125; hoops in basic, M. 122 50 to M. 125; steel plates, M. 106 to M. 112; plates in basic for boiler making purposes, M. 116 to M. 122; sheets, M. 120 to M. 125; drawn wire in iron or steel, M. 127.50, all per ton free at works.

Production of Pig Iron.

According to figures given by the Union of German Iron and Steel Masters, the production of pig iron in Germany, including Luxemburg, was for November of this year 231,926 t. foundry pig, 33,254 t. Bessemer, 715,332 t. basic, 92,118 t. steel and spiegeleisen, 46,421 t. forge pig. From January 1st to November 30th of this year output was as follows:—Foundry pig, 2,260,743 t.; Bessemer, 374,085 t.; basic, 7,516,866 t.; steel and spiegeleisen, 1,002,075 t.; forge pig, 600,394 t.

The Coal Market in Germany.

There is no change to report in the coal trade, the demand being pretty extensive for most sorts. The Rhenish-Westphalian Coal Syndicate resolved to maintain the present reduction in the output for coal, coke, and briquettes during January, 1910, although the demand for house and for engine fuel has generally increased.

Austro-Hungarian Iron Market.

According to reports given lately, the business in iron and steel has been dull and decreasing, and figures show a falling off against last year. During November of this year sales of the United Austrian ironworks have been as follows:—Bars and sectional iron, 258,564 q., or 2934 q. less than in 1908; girders, 102,306 q., or 22,382 q. more than last year; heavy plates, 38,677 q., or 3316 q. less than in 1908; rails, 44,528 q., or 60,872 q. less than in 1908. Output since January 1st of this year was in bars and sectional iron, 2,967,963 q., or 476,672 q. less than last year; girders, 1,251,996 q., or 41,822 q. more than last year; heavy plates, 892,540 q., or 8708 q. less than in 1908; rails, 853,287 q., or 205,883 q. less than in the year before. The market for coal is very firm, and in coke demand has perceptibly increased. Deliveries in brown coal in December were higher than in the corresponding month last year, and figures at the end of this quarter will be more satisfactory than was at first expected.

Firm Tone in Belgium.

Business in the various departments is well maintained. Signs of improvement have even been perceptible in some branches, and the outlook is fairly bright. The Belgian Steel Convention has raised the prices for all descriptions of manufactured iron 3f. p.t. from January 1st, 1910. Demand and inquiry on the Belgian coal market have remained lively, and are improving against previous weeks.

AMERICAN NOTES.

(*From our own Correspondent.*)

New York, December 22nd.

The urgent inquiries that are being made for Bessemer and basic pig, as well as for malleable and low phosphorus iron, point to a coming demand which will not be delayed much after the first of the year. Steel irons are particularly wanted. Foundry and forge irons are at present inactive. Consumers are working up their material for steel products very fast, and are requesting prompt shipments on orders placed. The supply of billets and sheet bars is about absorbed for the first quarter of the year. Orders for the second quarter will soon show themselves, and the lowest quotation for to-day is 29 dollars at Pittsburg, an advance of .50 dollar, with a probability that 30 dollars will soon be reached. The plate and structural mills are being crowded to make deliveries according to contract. Buyers who have placed their contracts can count on deliveries up to May or probably later, but the new buyers who are coming into the market are told that it is practically impossible to deliver them any steel before June 1st. The structural and plate mills are crowded to the limit of their capacity, it being understood, however, that gaps are left which will enable manufacturers to accommodate emergency buyers. It is estimated that these mills have work now for five months ahead. Notwithstanding the efforts made to preserve prices at present levels, the extraordinary demand has jeopardised present prices, and advances may be forced next month. All kinds of crude material are very strong. The unsettling factor in the market is the large amount of new work that is constantly coming up. The American Bridge Company has booked 600,000 tons of material for this year. The average daily booking of business by the United States Steel Corporation for this month has been 40,000 tons. Demand is coming from all quarters. Building requirements are very heavy.

Hardware manufacturers are heavy buyers of raw material. Engineering plants constructing heavy machinery have been delaying the placing of orders for spring, and several inquiries recently made from these sources lead manufacturers to believe that they will come into the market next month. The new municipal building of this city is to be erected soon, and the lowest bid of seven to furnish the ironwork and stone was 5,895,000 dollars. A great deal of municipal building is being arranged for throughout the larger cities of the country. These requirements cannot be met in time for spring construction, and the authorities who have been authorising the projected work have been informed of the difficulty of getting material before midsummer. Total sales of copper this month, 17,991 tons for export. The production of copper last year, according to figures just published, was 875,849,129 lb. Total domestic and foreign, 1,095,700,123 lb., which is just a trifle in excess of 1907.

According to the *Railway News*, the Great Western Railway Company is about to arrange for the reconstruction of a portion of a bridge over the river Severn at Gloucester.

BRITISH PATENT SPECIFICATIONS.

When an invention is communicated from abroad the name and address of the Communicator is printed in italics.

When the abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent-office Sale Branch, 25, Southampton-buildings, Chancery-lane, London, W.C., at 8d. each.

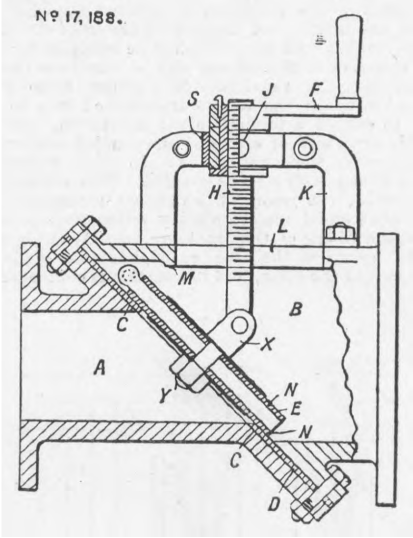
The first date given is the date of application; the second date at the end of the abridgment is the date of the advertisement of the acceptance of the complete specification.

Any person may on any of the grounds mentioned in the Acts, within two months of the date given at the end of the abridgment, give notice at the Patent-office of opposition to the grant of a Patent.

STEAM GENERATORS.

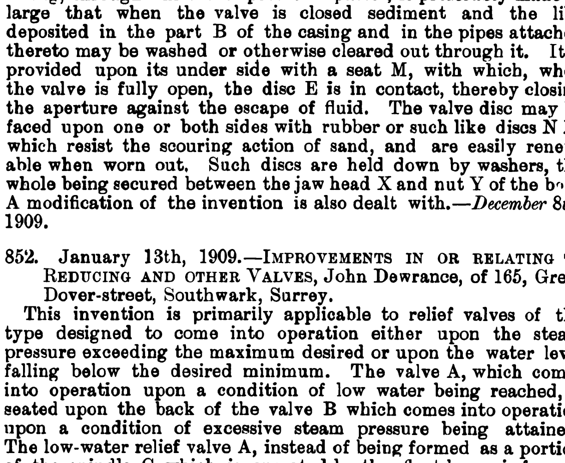
17,188. July 23rd, 1909.—Improvements in Straightway Valves, Stewarts and Lloyds, Limited, of Nile-street, Birmingham.

The casing is made in two parts A and B, flange-jointed at an angle of about 45 deg. to the axis. The bore of A is that required to pass the desired volume of fluid, the part B is made of larger internal diameter, in order to expose a portion of the face of the inclined flange of A, for the purpose of forming a valve seat C, which may be covered by a sheet of india-rubber or similar substance D, which not only serves to make the joint between the casing parts, but also forms a readily renewable valve seating, which is especially useful when mill-pulp is to be handled. The valve disc E is pivoted above the orifice to the casing member B, so as to swing on to its seat, or up into a horizontal position, the upper part of B being enlarged and recessed to accommodate the disc when in the latter position, and keep it clear of the line of flow. The valve is operated by means of a hand wheel F, keyed to a nut, through which works a screw spindle H, pinjointed to the valve disc E. To permit the spindle to swing in accordance with the motion of the disc the nut is rotatably secured in a frame S, which in turn is mounted on trunnions J in a cavity formed in the bridge K, which latter is conveniently constructed in two halves held together by bolts. The aperture L in the casing, through which the spindle H passes, is preferably made so large that when the valve is closed sediment and the like deposited in the part B of the casing and in the pipes attached thereto may be washed or otherwise cleared out through it. It is provided upon its under side with a seat M, with which, when the valve is fully open, the disc E is in contact, thereby closing the aperture against the escape of fluid. The valve disc may be faced upon one or both sides with rubber or such like discs N N, which resist the scouring action of sand, and are easily renewable when worn out. Such discs are held down by washers, the whole being secured between the jaw head X and nut Y of the bolt. A modification of the invention is also dealt with.—*December 8th*, 1909.


Nº 17,188.

852. January 13th, 1909.—Improvements in or relating to Reducing and other Valves, John Dewrance, of 165, Great Dover-street, Southwark, Surrey.

This invention is primarily applicable to relief valves of the type designed to come into operation either upon the steam pressure exceeding the maximum desired or upon the water level falling below the desired minimum. The valve A, which comes into operation upon a condition of low water being reached, is seated upon the back of the valve B which comes into operation upon a condition of excessive steam pressure being attained. The low-water relief valve A, instead of being formed as a portion of the spindle C which is operated by the float lever, is formed separately therefrom; the valve being supported upon a shoulder X formed on the spindle, against which shoulder the valve is held by means of a nut. The upper extremity of the spindle projects beyond the nut and terminates in a squared or similarly formed end Y. The high-pressure relief valve B is held down upon its seat by means of a bridge piece D which stands astride of the low-water relief valve nut and spindle end, the bridge piece being held down by means of a spindle P, which passes through a guide and connects, in the usual manner, with a weighted lever. In the event of either of the valves becoming defective by reason of wear or otherwise, the cover of the valve chest or casing is removed and with it the weighted lever and holding down spindle P. The bridge piece D having been withdrawn, two box spanners are applied, one (S) to the square end of the low-water relief valve spindle, and the other (R) to the nut which serves to hold that valve upon the spindle. The nut may now be unscrewed, whilst the spindle C is held against rotation. Upon the removal of the nut, the low-water relief valve A is free to be withdrawn, and thereupon the high-pressure relief valve B may be lifted out or may be re-ground to its seat.—*December 8th*, 1909.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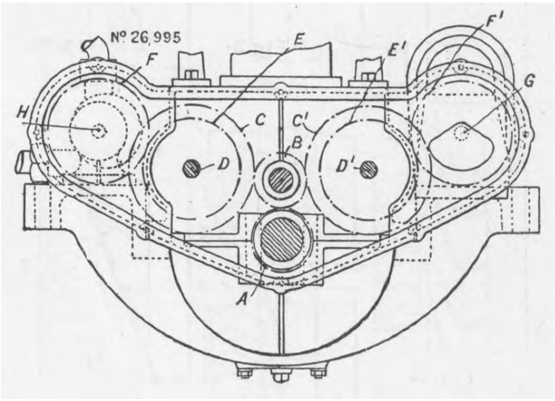
INTERNAL COMBUSTION ENGINES.

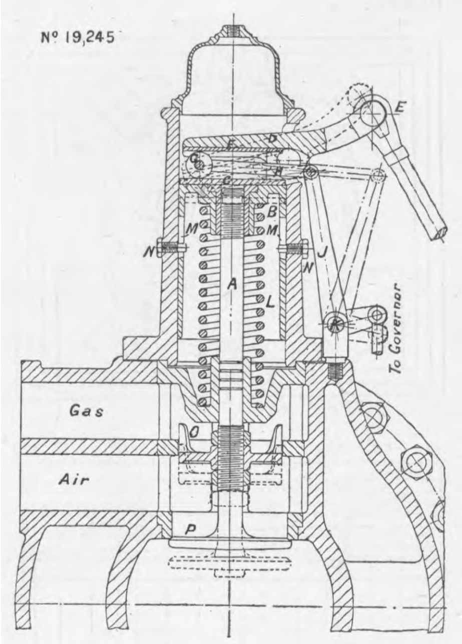
26,995. December 12th, 1908.—Improvements in the Valve Gear of Internal Combustion Engines, *Firmin Brückert, engineer, of Ferriére la Grande, in France.*

According to this arrangement the valve gear is driven by means of intermediary toothed pinions, the central one of which pinions is mounted on an auxiliary shaft having its axis out of line with those of the camshafts of the motor. On the main shaft of the motor is fixed a toothed wheel A which gears with a central pinion B, mounted on an auxiliary shaft lying between the line drawn through the camshafts D D¹ of the motor which carry the driven pinions C C¹ on the one hand, and between the pinion of the main shaft by which this auxiliary shaft is driven, on the other hand. By this arrrangement it is claimed a great reduction of the wear and tear of this gear is attained compared with the systems of gearing now in use. On the camshafts D D¹ are further fixed pinions E E¹ which gear with pinions F F¹, the latter being mounted on a pump shaft H and the shaft G of the magneto respectively.—*December 8th*, 1909.


Nº 26,995

19,245. August 21st, 1909.—Improved Means for Governing Internal Combustion Engines, Herbert Vincent Senior and Frederick Howard Livens, both of Ruston, Proctor and Co., Limited, Sheaf Ironworks, Lincoln.

This invention relates to a device for controlling the admission valve of an internal combustion engine, the object being to obtain this result with the fewest number of parts, at the same time providing a simple means by which the opening of the gas valve can be timed in relation to the opening of the admission valve, both of these being on the same spindle. A is the valve stem which is secured to a guided plunger B, having on its upper side a hardened face C. D is a lever of the first order, the outer arm E of which is operated by a cam shaft in the usual manner. On the under side of the inner arm of the lever D there is fixed a hardened face F, and a roller G is moved between the face F and the face C by means of the twin link H, which is connected to the lever J, which is secured to a rocking shaft K, operated by the governor in any convenient manner. It will be seen therefore that the stroke of the valve is varied according to the position of the roller on the top of the guided plunger. The spring L returns the valve to its seat in the usual way. To prevent the plunger from turning round, slots M M are made in the plunger, in which the ends of the screws N N fit. The gas valve O is screwed on to the spindle A, and the admission valve P is made solid with it; therefore, by screwing the valve O up or down the spindle, on which it is secured, by the locknuts shown, it is evident that the time of the opening of the valve O can be varied in relation to the time of the opening of the valve P, as in practice it is found an advantage for the valve P to open more or less in front of the valve O, in order to clear away the exhaust gases.—*December 8th*, 1909.

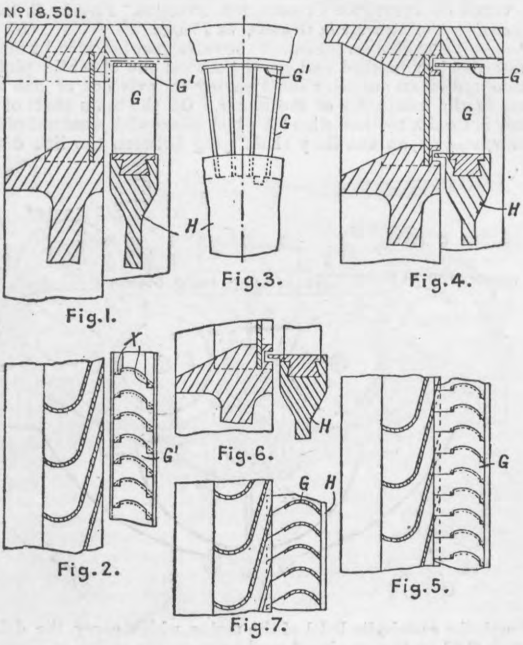

Nº 19,245

TURBINES.

18,501, April 21st, 1909.—Shrouding and Leakage Preventing Devices for Turbine Blades, James Howden, director, and John Holloway, both of 195, Scotland-street, Glasgow.

This invention relates to improvements in turbines of the impulse and the reaction type actuated by steam, gas or other elastic fluid. Referring to Figs. 1, 2 and 3, the improved shrouding G in its simplest form is produced by constructing each of the rotating blades so that when the blades and distance pieces are fitted in the groove in the wheel H the blades interlock with each other at their outer ends and support each other laterally and circumferentially, and form a continuous and firm band without riveting that can be ground true and smooth on its periphery and on each side, enabling the wheel with its blades to run truly and steadily with little tendency to vibration, and permitting the shrouding to be brought close to the outer casing with safety, thus tending to prevent the leakage of steam passing over the outer ends of the blades. As shown in Fig. 2, the bent curved and checked circumferential forward part of each blade forming the shroud G^1 bears against the rounded back of each preceding blade and also at both sides enters the rectangular parts cut out for this purpose at X. A further development involving the application to the shrouding of an arrangement of projecting rim which is not claimed as new *per se* is shown in Figs. 4 and 5, which are respectively a vertical section and sectional plan of a stator with fixed guide blades and the outer part of a rotating wheel with its blades. As shown in said Figs. 4 and 5, a groove or recess, preferably rectangular, is formed both above and below the nozzle orifices, though in some cases only one groove or recess, *i.e.*, the upper one, may be provided. Into these recesses enter a continuous projecting rim on the shrouding at the outer ends of the blades at the side receiving the steam, and a similar projecting rim at the inner ends of the blades on the same side of the rotating disc. The said projecting rims may also be formed on the distance pieces between the blades as shown in Figs. 6 and 7. There are three other illustrations.—*December 8th*, 1909.

Nº 18,501.

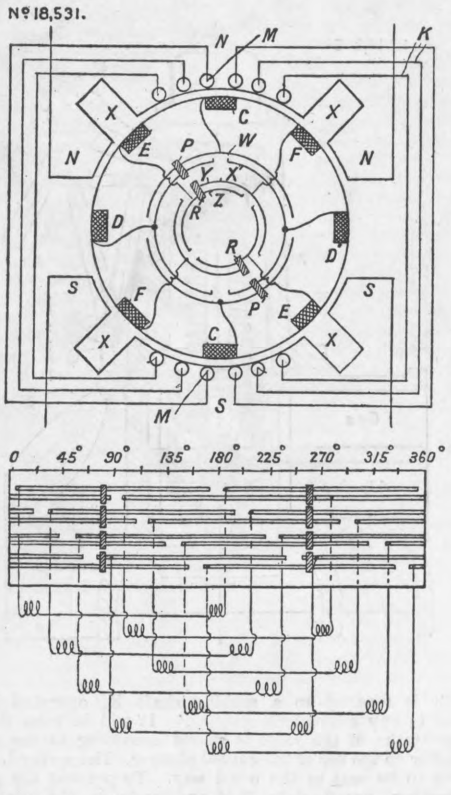


DYNAMOS AND MOTORS.

18,531. September 3rd, 1908.—Single-phase Induction Motor, *Giovanni Bestelli and Francesco Spinelli, both of* 14, *Via Lazzro Palazzi, Milan, Italy.*

The poles N and S of the stator present two deep recesses X, inclined at 45 deg. to the axis of the poles. These recesses are somewhat wider than the several coils C, D, E, and F of the armature or rotor, but the poles of the stator must not present any interruption. These poles present a width greater than 90 electrical degrees, half of them being situated on the one side and the other half on the other side of the polar axis. According to the output required of the machine, the winding of the rotor consists of a larger or smaller number of coils, the ends of which are connected with the pairs of semicircles W, X, Y, and Z. The coils are connected in pairs, each pair—independently of the brushes—being independently and completely insulated from the others. Each pair consists of two coils relatively displaced by 90 electrical degrees; in a bi-polar machine they together exactly constitute a cross. The connected coils are fixed to two conjugated semicircles, the breaks in which (like the coils) are situated at 90 deg. one from the other. The two coils of each pair are likewise connected one with the other by means of two brushes P P, R R, these brushes being intended to connect one with the other the two pairs of semicircles corresponding to a pair of staggered coils. The brushes are independently and completely insulated one from the other. The brushes are mounted on the commutator in such a manner that—as shown—they effect the reversal from one semicircle to the other exactly at the moment at which the active wires of the corresponding coils are located opposite the recess X. The stator of the motor is provided with a compensation winding K, the active wires of which are arranged in the holes M. The winding can either be short circuited or closed through a resistance. The lower engraving shows diagrammatically the development of the rotor of a single-phase motor, comprising four pairs of coils, each of which is connected with the corresponding pair of conjugated semicircles.—*December 8th*, 1909.

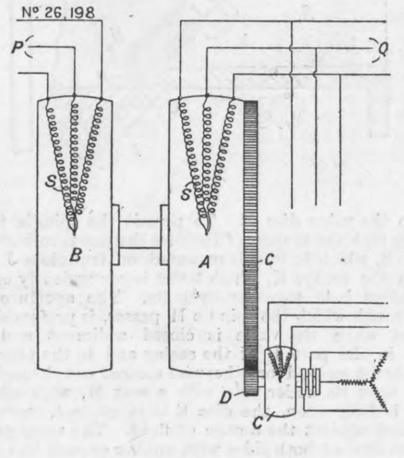
Nº 18,531.



26,198. December 4th, 1908.—Improvements in and relating to Alternating Current Dynamo Electric Machinery, The Lancashire Dynamo and Motor Company, Limited, of Trafford Park, Manchester; Arthur Pemberton Wood, of "Whitefold," Alan Drive, Hale, Chester; and Robert Stafford McLeod, of 21, Victoria-avenue, Didsbury, near Manchester.

This invention relates to alternating current dynamo electric machines, such as are employed to connect together, say, at a sub-station, two alternating current supply stations of different frequencies, so that both supplies shall be available for a common system of mains, or so that energy may be transferred between the supplies as may be required. The object is to provide an arrangement in which the torque transmitted may be regulated so as not to exceed a predetermined maximum, and so that a considerable departure of either of the coupled stations from its normal frequency is permitted, and so that supplies having frequencies of any ratio may be coupled. Two alternators A and B are provided, the rotors of which are mechanically coupled together; what would under ordinary circumstances be referred to as the stator of one of the machines, say A, but which will be referred to herein as the case A, is, however, made rotatable about the axis of the rotor, and its rotation is controlled by gearing it, say, by spur gearing C D to any suitable device, such, for example, as an electro motor, which, whilst permitting rotation of the case, will apply to it a torque which will not exceed a predetermined maximum magnitude; A is the machine with the rotating case, and B is the other machine. The case-controlling device is an alternating current induction motor C. The speed of rotation of the coupled rotors will be that corresponding with the frequency of the supply P to which the stator windings S of the B machine are connected, and if the frequency of the supply Q to which the stator winding S of the A machine are connected corresponds with this speed and the number of poles of the A machine, the case of the latter will remain stationary, and will be held stationary by the torque transmitted to the case by the case-controlling motor. Should the frequency of the one supply or the other change, the effect will be to tend to alter the torque between the case and the rotor of the machine A, and as the case motor is arranged to exert an approximately constant torque on the case, the latter will rotate in one direction or the other, in accordance with the relative effect of the change of frequency, and by so rotating it will accommodate the frequency changer to the altered ratio of the frequencies. There are two other illustrations.—*December 8th*, 1909.

Nº 26,198

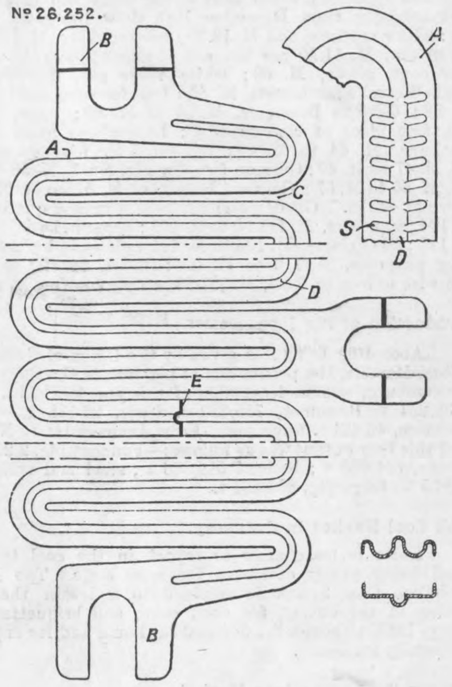


SWITCH GEAR.

26,252. December 4th, 1908.—Improvements in Resistance Grids for Electrical Purposes, Allen West, of 118, Queen Victoria-street, London, E C.

This invention relates to improvements in resistance grids for electrical purposes, its object being to provide in a grid that is stamped sheet iron or from other suitable metal the necessary strength and rigidity, and to render it capable, even when made from thin metallic sheets, of retaining its shape when strongly heated by the current, besides having by reason of its construction an increased radiating surface. The grid A, with the connectors B, is stamped from a single sheet of metal, and when so cut forms a sinuous but continuous length from top to bottom. This is preferably effected by cutting out strips or forming spaces C from alternate sides. A corrugation D is imparted to the grid bars parallel to their edges, which corrugations may be formed when the grid is stamped from the blank sheet, or may be formed by a previous or subsequent operation, depending upon the class of metal, its thickness, or other contributing factor. The invention is not limited to a single corrugation, nor to the particular section shown at E. Any of the sections shown in the right-hand bottom corner may be employed, or any modification thereof, without departing from the spirit of the invention. The top right-hand engraving shows a modified form of corrugation, in which the middle corrugation D has a series of longitudinal strengthening corrugations S, forming a herring-bone type of indentation, the whole corrugation running substantially parallel to the bars of the grid.—*December 8th*, 1909.

Nº 26,252.

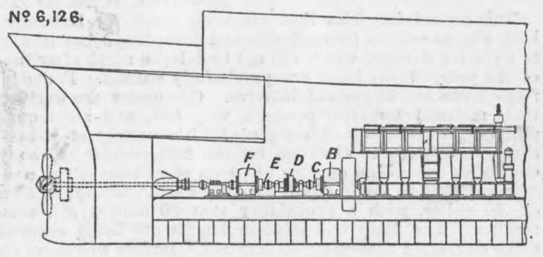


SHIPS AND BOATS.

6126. March 15th, 1909.—Improvements relating to the Propulsion of Ships and the like, Charles Day, of 45, Scotland-street, Glasgow.

This invention relates to the propulsion of ships in which the propelling power is delivered from the prime mover to the propeller at times directly and at times by electric transmission. An internal combustion engine may be employed—which is shown as having six cylinders, but which may be of any suitable design—which engine is coupled, or is adapted to be coupled, direct to a dynamo B. The rotor shaft C of the dynamo, or the engine shaft, is adapted to be connected by a clutch D with the shaft E of the electric motor F, the latter shaft being connected with, or formed integrally with, the propeller shaft. The internal combustion engine may be constructed and arranged to be capable of being varied in speed from that required to propel the ship at full speed to that required to propel it at half speed. At all ahead ship speeds from full to half direct driving may be employed, but for speeds less than half electrical transmission is made use of, the motor F receiving electrical energy from the dynamo. The electrical drive may also be employed for reversing, the astern speed being not greater than half the full ahead speed, suitable electrical switches and gear being provided. As the propulsive power varies approximately as the cube of the speed, then, with such an arrangement, the maximum capacity of the electrical apparatus may be about one-eighth of the full-speed power of the prime mover.—*December 8th*, 1909.

Nº 6,126.



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